THE ANNUAL REPORT FOR 1978

GC(XXIII)/610

Printed by the
International Atomic Energy Agency
in Austria - August 1979

INTERNATIONAL ATOMIC ENERGY AGENCY

THE ANNUAL REPORT FOR 1978

CONTENTS

List of abbreviations

Agency	International Atomic Energy Agency
AGRIS	Agricultural Information System
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
IAEA	International Atomic Energy Agency
INFCE	International Nuclear Fuel Cycle Evaluation
INIS	International Nuclear Information System
LMFBR	Liquid-metal fast breeder reactor
NEA	Nuclear Energy Agency of the Organisation for Economic Co-operation and Development
NPT	Treaty on the Non-Proliferation of Nuclear Weapons (reproduced in document INFCIRC/140)
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (INFCIRC/167)
Tlatelolco Treaty	Treaty for the Prohibition of Nuclear Weapons in Latin America
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

NOTE

All sums of money are expressed in United States dollars.

INTRODUCTION

Trends in the use of nuclear power

1. During 1978, 15 000 MW of new nuclear power plant were installed (compared with 10 000 MW during the preceding year) bringing the world's nuclear capacity to about 110 000 MW at the end of the year or 5.8% of the world's total electrical generating capacity. Nine nuclear power stations amounting in total to 8700 MW were ordered in 1978. However, earlier orders for five stations amounting to 5700 MW were cancelled. As a result the net addition to the world's nuclear power commitment amounted only to 3000 MW (compared with orders of 53 300 MW in 1974). One must expect that in 1979, after the accident at Three Mile Island, the prospects for further orders will be even slimmer in most Western countries.

2. The trend was most markedly negative in North America and certain countries of Northern and Central Europe (including Austria) where the net commitment to nuclear energy was lower at the end of the year than at its start. On the other hand 1978 was generally a good year for nuclear energy in France and Japan. In France orders were placed for four new nuclear power plants, the "Cogema" commercial reprocessing plant completed its first full year of operation (it is now the only plant in the world reprocessing light-water fuel on a commercial scale) and the EURODIF enrichment plant came into commercial production in February 1978. The Soviet Union and other socialist countries also announced expanded nuclear power programmes[1]. In the developing countries new nuclear plant was ordered only in the Republic of Korea which concluded contracts for two stations.

The coming energy crisis

3. New commitments to nuclear power are decreasing at a time when the world appears to be entering upon a lengthy and profound crisis in energy supply. As the prospect looms nearer of declining petroleum production, of shrinking reserves and of further rises in prices it is almost universally recognized that, at least for the production of electricity, the only other choices which the world has until the end of this century are coal and nuclear power. Conservation measures may be speeded up in the more affluent countries and more investment made in alternative technologies but neither is likely to have an appreciable

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[1] According to figures available to the Agency the installed nuclear capacity in the socialist countries amounted to 10 230 MW; the capacity of plants under construction amounts to 20 080 MW and planned to 24 060 MW (the country totals in the three categories being the Soviet Union: 60 stations; the German Democratic Republic: 13 stations; Czechoslovakia: 12 stations; Bulgaria: 6; Hungary: 4; Romania: 3; Poland: 2).

effect in retarding the growth in demand for electricity for two to three decades. (In 1978, for instance, world electricity consumption grew by 6% compared with an increase of almost 4% in the consumption of primary energy.)

4. The year 1978 provided an opportunity for almost every competent international organization to reaffirm these choices and for the statesmen of the world to express their concern about the energy future and their conviction that further development of nuclear power is indispensable and that the slippage in the execution of nuclear programmes must be reversed. Yet only in a diminishing number of countries are these convictions reflected in effective nuclear power programmes.

5. Two of the main restraints on a greater use of nuclear power - public misgivings about the safety of nuclear power plants and the risk of further proliferation of nuclear weapons - are the subject of the Agency's regulatory activities, in particular its nuclear safety and safeguards operations. In this light "promotion of nuclear power" and its regulation are interdependent; neither can exist without the other.

Safeguards

6. In 1978, as in previous years, the Secretariat, in carrying out the safeguards programme of the Agency, did not detect any discrepancy which would indicate the diversion of a significant amount of safeguarded nuclear material for the manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device. In the light of the report which the Director General submitted to the Board on the implementation of safeguards in 1978, it is reasonable to conclude that nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for. In this sense, the Agency's safeguards activities, which expanded substantially in 1978, have continued to contribute to regional and international security and to reduce concern about the risks of proliferation as a consequence of the spread of nuclear technology.

7. During the year much attention was given to completing the attachments specifying in detail the safeguards to be applied at nuclear facilities in Japan and in the non-nuclear-weapon States of the EURATOM countries. All attachments for Japanese plant were completed by 1 December 1978.

8. By the end of 1978 NPT membership had increased from 103 to 106 Parties. Safeguards agreements had been concluded with all but four of the thirty-one NPT non-nuclear-weapon States that had any significant nuclear activity and with thirty other NPT Parties which do not as yet have any nuclear activities. There was also a marked increase in the amount of nuclear material under safeguards: an increase of 82%, to 65 tonnes in the case of plutonium, 5% and 11.8 tonnes in the case of highly enriched uranium, by 31% and 10 300 tonnes of low enriched uranium and by 138% and 29 200 tonnes in the case of source material.

9. On one point however there was no progress between 1977 and 1978. The number of non-nuclear-weapon States that were operating unsafeguarded nuclear facilities remained unchanged at five, and the number of those which had unsafeguarded facilities capable of making nuclear weapons material remained unchanged at three.

10. There have, moreover, been disquieting reports that the number of States in which unsafeguarded nuclear facilities are in operation may increase rather than decline in the

years ahead. If this were to happen it would reverse a trend which began in 1970 when NPT came into force - the trend towards bringing all civilian nuclear activities throughout the world under the international safeguards of the Agency.

INFCE

11. During 1978, the Agency continued to participate in and to provide assistance and support to the eight working groups and the Technical Co-ordination Committee of the International Nuclear Fuel Cycle Evaluation, according to the Board's authorization of February 1978. The first plenary conference of INFCE, held in November 1978, requested the Agency to publish the INFCE report and to serve as depositary for all INFCE documentation. The final INFCE plenary conference is planned for 25 to 29 February 1980.

Plutonium storage

12. The Agency held its first meeting of experts on arrangements for the international storage of separated plutonium from 4 to 6 December 1978.

Nuclear safety

13. At the end of 1978, it was still possible to say that there had been twenty years of nuclear power generation without a single radiation-induced death or a serious radiation-induced injury at any nuclear power plant. In the strictest sense, this statement remains true even after the accident that occurred on 28 March 1979 at Three Mile Island in the United States of America. Statements as to whether any deaths from cancer will ensue from the radiation released by the accident and if so, how many, depend upon complex and controversial epidemiological interpretations of the effects of low-level radiation. It is essential that every effort should be made to gain a clearer insight into and a more generally accepted understanding of this matter. It is often overlooked that since 1955 an independent international body, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), has given authoritative guidance on this matter in its biennial report.

14. On the basis of UNSCEAR's 1977 conservative estimates of risk [2] it has been calculated that one year of power production from the nuclear plants now operating might cause about 60[3] cancer fatalities throughout the world. This compares with the 2900[3] cancer fatalities that are caused by fall-out from one year of nuclear tests (average rate of 1951-1976), with 6700[3] cancer fatalities from one year of medical uses (X-rays, etc.) and with 35 000[3] cancer fatalities each year from natural radiation, out of the total of about

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[2] The 1977 UNSCEAR report states that the average risk of inducing a fatal malignancy is taken as being in the region of 10^{-4} rad^{-1}. It is emphasized that such estimates are derived predominantly from rates observed following absorbed dose of over 100 rad. While the rate per rad from doses of a few rad is unlikely to be higher than this value, it might be substantially lower.

[3] In deriving these figures the direct proportionality relation is assumed between dose and effect i.e. with no threshold.

five million deaths from cancer throughout the world each year (according to WHO estimates about one out of ten deaths each year is now caused by cancer)[4].

15. The Agency is also expanding its studies in the field of low-level radiation effects and is preparing to hold a symposium on the comparative health impacts of nuclear and alternative sources of energy.

16. The Agency's own nuclear safety standards programme, NUSS, is now in its fifth year and the first five codes of practice and eleven safety guides were published or completed in 1978. The Agency has also continued to place special emphasis on nuclear safety in its training programme; the first major training course entirely devoted to nuclear safety was held at Argonne, United States of America, in 1978. Besides numerous other routine safety activities the Agency began in 1978 to study the problems and costs involved in decommissioning commercial nuclear power reactors; the provisional conclusion was that decommissioning would represent about 10 to 15 per cent of the original capital costs.

17. Most of the Agency's nuclear safety activities for the last twenty years have consisted of standard setting of the NUSS type and in safety training. In recent years there has also been an expansion of field work. During 1978 safety and siting missions were sent to 17 countries. It is particularly in this area of direct assistance to Member States that the possibilities of expanding the Agency's safety work and responsibilities should be reviewed. While principal responsibility for safety has to remain with the Government concerned, countries having a limited nuclear safety infrastructure are likely to be increasingly dependent upon the Agency for advice and help in emergencies and for round-the-year assistance in ensuring that adequate safety and personnel standards are maintained.

Development-oriented work

18. The value of nuclear science techniques in agriculture is shown by the fact that work is now going on in 60 projects in 41 countries, improving crop yields, producing more and better proteins and new crop varieties and combating animal diseases and insect pests. In 1978 the Agency and FAO assisted a large project in Mexico which is using the sterile insect technique in order to stop the northward migration of the Mediterranean fruit fly. This insect pest has established itself in Guatemala and is threatening to invade Mexico, where it could cause losses amounting to $500 million a year. The Agency supplied the Mexican authorities during 1978 with weekly shipments of up to 30 million sterilized Mediterranean fruit flies. Mexico is building a large sterilization facility which will provide the main support for the project.

19. The Agency continued its programmes to help developing countries to set up pilot food irradiation facilities, and together with the Netherlands Government it established a new international facility for food irradiation technology at Wageningen on the technical and economic feasibility of this technique.

20. In the field of life sciences, tropical medicine, water resources development and many other fields of radiation and radioisotope techniques have continued to make a useful contribution to health and well-being in many developing countries.

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[4] Cancer statistics 1979, WHO Technical Report Series No. 632.

21. The Regional Co-operative Agreement (RCA) entered its sixth year in 1978. It concentrated on improving the production of grain legumes, the yield and quality of domestic buffalo and on developing technology for preserving dried fish. Research on environmental questions and physics was also promoted under the project.

22. During 1978, several measures were taken to implement the recommendations of the group of experts which met in August 1977 to review the Agency's technical assistance programme[5]. In particular, the programme began to shift towards larger projects designed to have a greater economic and social impact, direct liaison with Member States was improved, and new methods for monitoring and planning of programmes were introduced.

23. Consultations continued on the revised "Guiding Principles and General Operating Rules to Govern the Provision of Technical Assistance by the Agency" (the revised document was subsequently approved by the Board in February 1979).

Fusion: the INTOR Project

24. The Agency's International Fusion Research Council has launched preliminary studies of a major project which, if realized, would be designed to demonstrate by international co-operation the scientific, technical and engineering feasibility of generating electricity by thermonuclear fusion. In 1978, the Agency set up a series of workshops and a steering committee (Japan, the Soviet Union, the United States and the Commission of the European Communities taking part) to outline the first stage of the study. The project goes under the name INTOR (the International Tokamak Reactor). This represents the main step forward taken at the international level for many years towards the eventual use of fusion as a source of energy and, if it is successful, fusion energy may become technically available early in the next century.

Matters of special interest to the General Assembly of the United Nations

25. In 1978, the General Assembly once again gave detailed attention to the Agency's activities. It urged all States to support and further the safeguards of the Agency, invited the Agency to strengthen its technical assistance activities, to consider broadening the scope of the second major conference on nuclear power and its fuel cycle (to be held in 1981 or 1982) so as to include measures to promote international co-operation in the peaceful uses of nuclear energy, particularly in the developing countries, and invited the Agency to give thorough, prompt and fair consideration to the proposals for an increase in the representation of the areas of Africa and of the Middle East and South Asia on the Board of Governors. This proposal was further discussed by the Board at its meetings in June 1979; the summary records of the Board's discussion on this question will be made available to the General Conference in December 1979.

26. Another resolution (33/4) invited all States "to continue to consider the convening, at an appropriate stage, of an international conference or conferences under the auspices of the United Nations system, aimed at promoting international co-operation in the peaceful uses of nuclear energy in accordance with the objectives of General Assembly Resolution 32/50".

27. The General Assembly and its subsidiary bodies, including the Special Committee against Apartheid, continued to call for cessation of nuclear co-operation with South

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[5] GC(XXII)/597, para. 45.

Africa, requested the Security Council to take steps to prevent South Africa from developing nuclear weapons and demanded that South Africa place all its nuclear facilities under IAEA safeguards (General Assembly Resolutions 33/183.G and 33/63). In another resolution, the Security Council was requested to call upon all States to end all transfer of nuclear equipment or fissionable material or technology to Israel (33/71.A). Details of the application of safeguards in these States are given in the chapter on safeguards of this report.

28. The General Assembly also took preliminary steps in Resolution 33/57 for the organization of the second Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. The Agency will render the necessary assistance and provide such services as may be required. Note has also been taken of the following Resolutions: 33/60 and 33/71 C, 33/64 as well as 33/91.

The Tlatelolco Treaty

29. Encouraging progress was made in 1978 towards the full implementation of the Treaty for the Prohibition of Nuclear Weapons in Latin America. For this to be effected, ratification of the Treaty by Argentina and Cuba and ratification of Additional Protocol I by France and the United States remain to be completed.

Administrative matters

30. Further progress has been made in the preparations for the transfer of the Agency to its Permanent Headquarters ("The Vienna International Centre for the United Nations and the International Atomic Energy Agency") at the Donaupark. This is now expected to take place in October/November 1979.

31. A further decline in the value of the United States dollar caused financial difficulties to the Agency. Stringent economy measures were applied during 1978 and are continuing in 1979. The changes in exchange rates have also greatly reduced the purchasing power of former staff of the Agency who have retired in Austria; in some cases, the value of their pensions has fallen by half. It is essential and urgent for the United Nations family to take steps to alleviate these hardships and to restore the pension system to its former role as a crucial and effective element in the conditions of service of United Nations staff.

TECHNICAL ASSISTANCE AND TRAINING

32. The total volume of the technical assistance provided by the Agency to developing countries last year rose by 44%. Table 1 analyses the trends in types of assistance.

Table 1

Distribution of technical assistance by type
(in thousands of dollars)

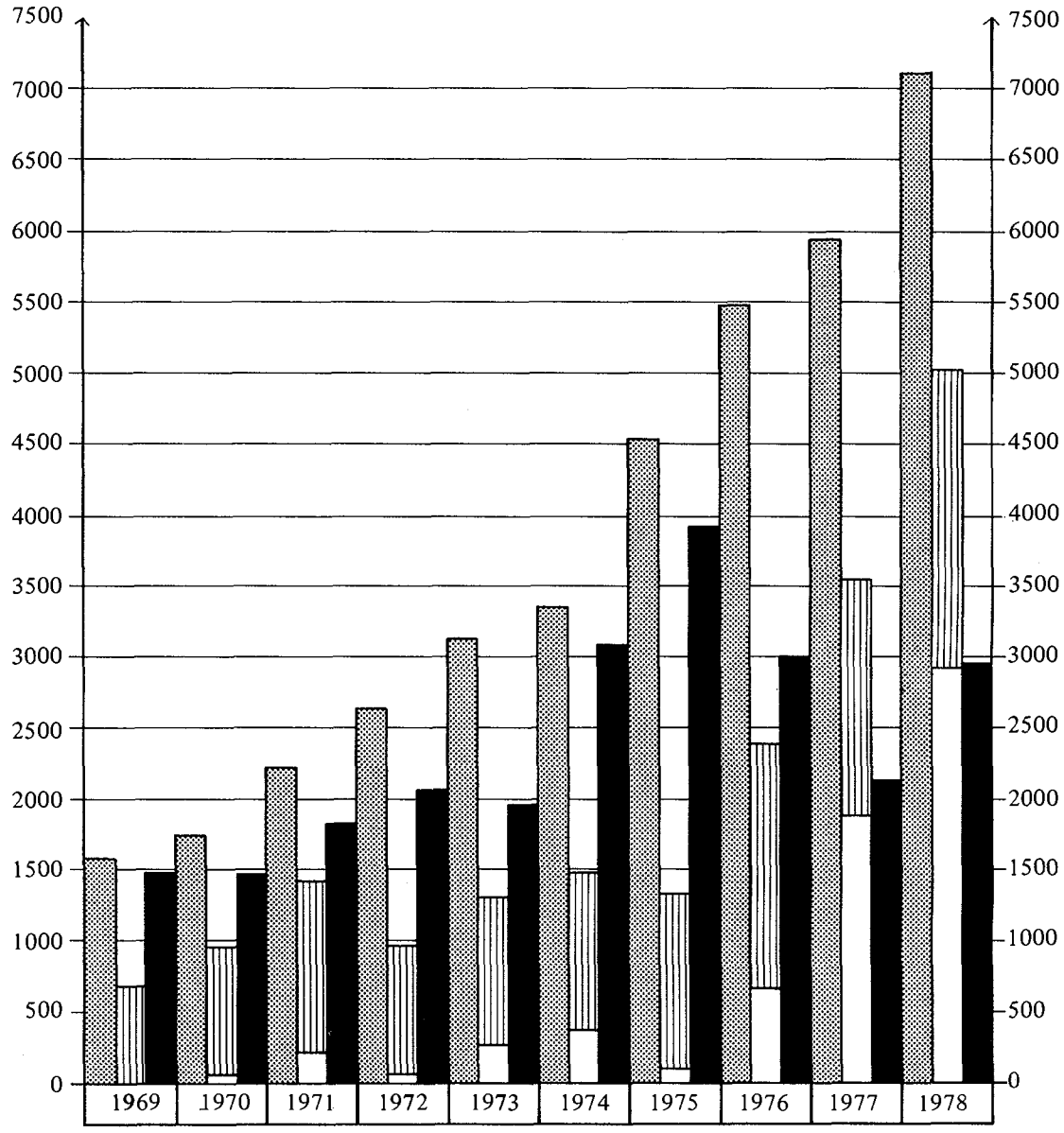
Type	1977		1978		1969-1978	
	%	$	%	$	%	$
Experts	36.3	3275.6	29.9	3 884.3	33.7	23 455.1
Equipment	33.8	3048.7	41.9	5 458.2	36.4	25 305.5
Fellowships	29.9	2703.9	28.2	3 665.0	29.9	20 765.5
Total	100.0	9028.2	100.0	13 007.5	100.0	69 526.1

33. During 1978 the Agency was responsible for administering technical assistance to some 400 regular programme and about 45 other projects ranging from the provision of a consultant for a few days to large-scale activities lasting several years and involving annual expenditures in six figures.

34. The main source of funds for the Agency's regular programme is the voluntary contributions of Member States to the General Fund. The target for 1978 was $7 million and the amount actually pledged was $6.4 million, or 92%, compared with a target of $6 million and pledges of $5.4 million, or 91% in 1977. Other sources of support are extrabudgetary contributions, UNDP funds, assistance in kind made available by a number of donor countries, miscellaneous income, including assessed programme costs, and funds made available by Member States to finance assistance for themselves. The total resources made available for 1978 programmes amounted to $15 million, an increase of $3.4 million over 1977. The largest rise was in extrabudgetary funds ($1 027 000 more than in 1977), followed by an increase of $998 000 in the voluntary contributions of Member States. The upward trend in the resources made available for Agency technical assistance programmes during the past ten years can be seen in Figure 1.

FIGURE I

RESOURCES AVAILABLE FOR
AGENCY TECHNICAL ASSISTANCE PROGRAMMES: 1969–1978
(in thousands of dollars)



	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Agency funds	1586	1749	2225	2637	3125	3348	4539	5492	5961	7116
Extrabudgetary funds	13	61	218	60	267	367	110	648	1899	2926
Assistance in kind	658	894	1197	900	1032	1114	1212	1737	1648	2104
UNDP funds	1484	1469	1839	2072	1964	3082	3942	3002	2144	2954
TOTAL	3741	4173	5479	5668	6388	7911	9803	10879	11652	15100

Agency funds Extrabudgetary funds Assistance in kind UNDP funds

35. Of the $15 million available for 1978, approximately $7 million was spent and $3.5 million was allocated to approved projects that had begun but where the committed funds had not yet been spent. This latter sum included unliquidated obligations totalling $2.5 million and outstanding assistance in kind valued at $1 million. The monetary value of the assistance provided from the resources made available for 1978 and those carried forward from prior years was, at $13 million, 44% higher than the $9 million provided in 1977. The breakdown of the $13 million was $2 954 000 from UNDP funds, $6 527 500 from Agency funds, $1 539 200 from extrabudgetary funds and $1 986 800 from assistance in kind provided through the Agency.

Table 2

Agency technical assistance by source: 1970-1978
(in US dollars)

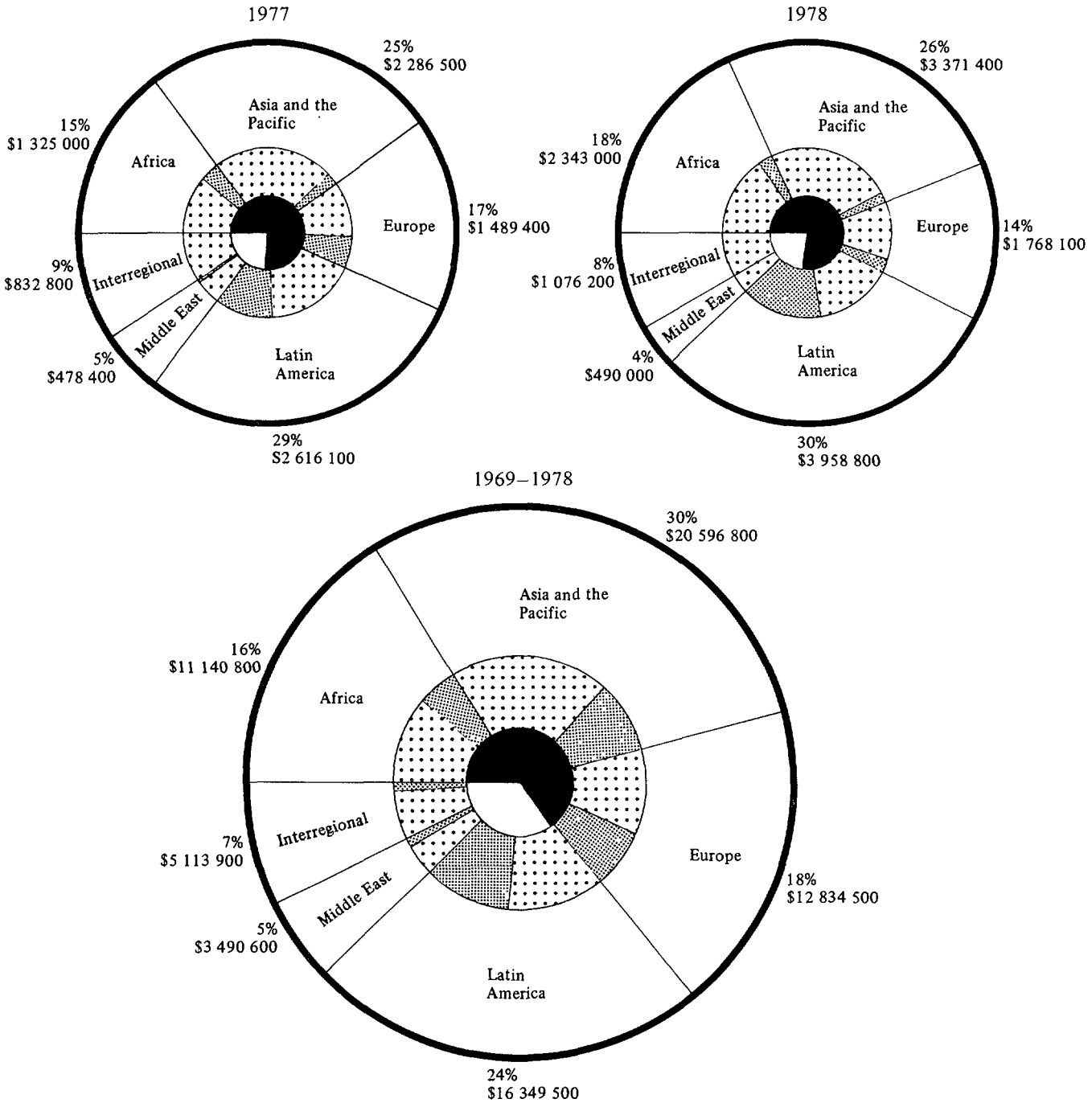
Year	UNDP funds	Agency funds	Extrabudgetary funds	Assistance in kind	Total
1970	1 469 200	1 619 300	75 500	819 100	3 983 100
1971	1 838 800	2 124 600	60 000	921 700	4 945 100
1972	2 072 000	2 556 000	85 700	779 000	5 492 700
1973	1 964 300	2 675 900	87 100	1 039 400	5 766 700
1974	3 081 600	2 413 200	170 300	1 077 400	6 742 500
1975	3 941 500	3 423 500	252 900	942 300	8 560 200
1976	3 002 300	3 954 700	358 800	1 021 500	8 337 300
1977	2 144 400	4 997 100	602 400	1 284 300	9 028 400
1978	2 954 000	6 527 500	1 539 200	1 986 800	13 007 500

The unliquidated obligations and assistance in kind outstanding at the end of 1978 totalled $6 812 500, consisting of $689 800 for expert services, $2 333 100 for equipment and supplies, and $3 789 600 in respect of fellowships and training courses.

36. The regional distribution of the assistance provided in 1978 is shown in Figure 2, which also gives information in respect of 1977 and the ten-year period 1969-1978. It will be seen that the largest increase in 1978 was in Africa, namely, 3% (its ten-year average also went up 1% as compared with the figure for 1968-1977), followed by Asia and the Pacific and Latin America with an increase of 1% each (Latin America's ten-year average went up 2% over that for 1968-1977). For Europe there was a decrease of 3% in 1978; there was a corresponding 2% decrease in its ten-year average as compared with 1968-1977.

FIGURE 2

DISTRIBUTION OF TECHNICAL ASSISTANCE BY REGION AND SOURCE
(1977, 1978 and 1969–1978)



LEGEND (distribution of technical assistance by source):

INNER RING	(region distribution)	INNER CIRCLE	(overall distribution)	1977	1978	1969-1978
	Agency resources		Agency resources	76.2%	77.3%	65.3%
	UNDP		UNDP	23.8%	22.7%	34.7%

37. The distribution of the assistance in terms of the fields of activity in which it is provided varies from year to year. During the last decade, however, the largest shares have been provided in two fields, namely, in the "application of isotopes and radiation in agriculture" and in "nuclear engineering and technology". A 1977:1978 comparison is given in Table 3 of the amount of assistance provided in what were the top five fields of activity in 1978. It can be seen that the largest increase took place in "general atomic energy development" (+4.5%, an increase of $860 000), whereas the largest decrease was in "nuclear engineering and technology" (3.6%, due to the fact that the assistance provided in this field in 1978 - although $389 900 higher than in 1977 - only went up by one fifth, whereas the assistance provided in 1978 in all fields increased by more than two fifths).

Table 3

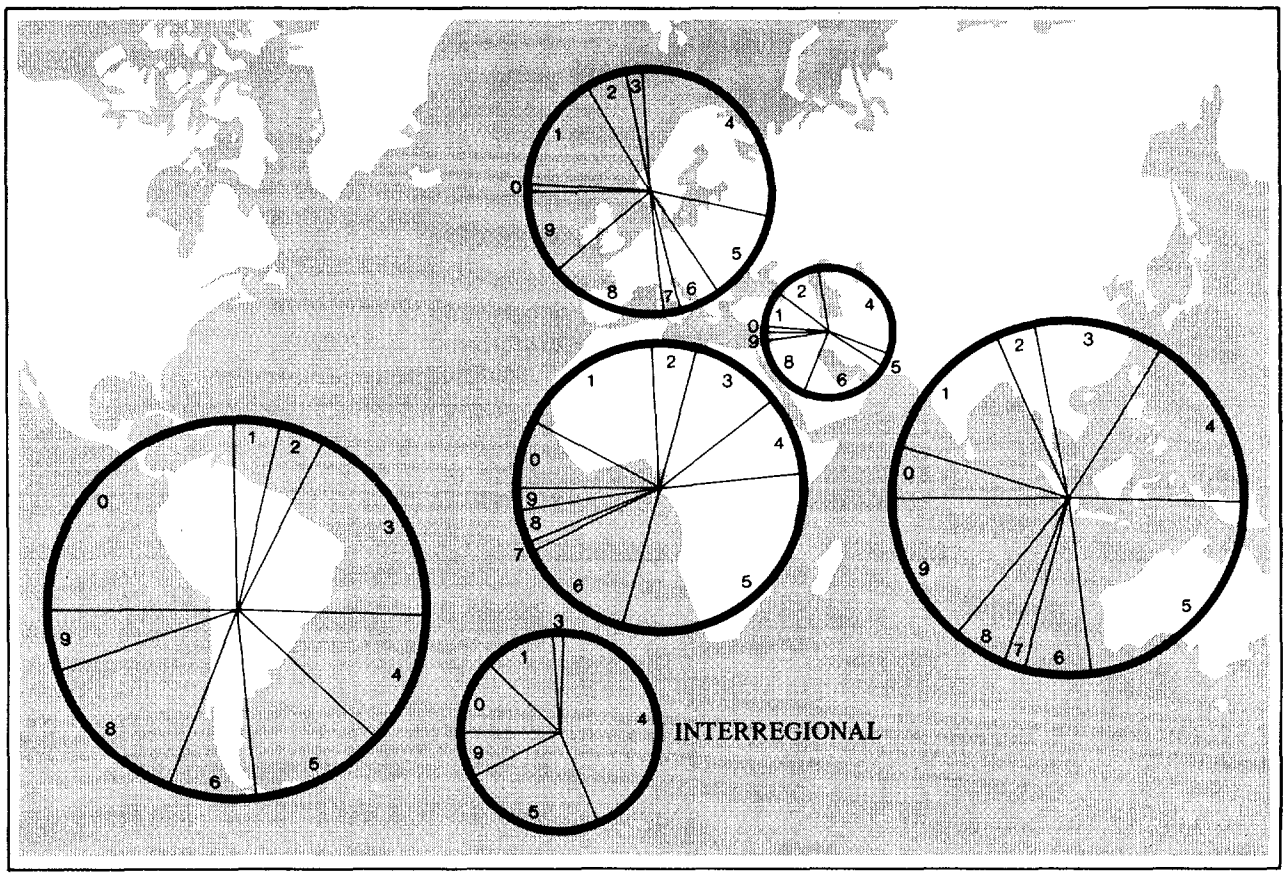
Assistance by field of activity and type: 1977 and 1978
(in thousands of dollars)

Field of activity	Year	Experts	Equipment	Fellowships	Share of total programme	
		$	$	$	$	%
Application of isotopes and radiation in agriculture	1977	737.7	525.9	529.0	1 792.6	19.9
	1978	827.4	1066.2	550.2	2 443.8	18.8
Nuclear engineering and technology	1977	508.2	573.1	891.4	1 972.7	21.8
	1978	574.2	812.4	976.0	2 362.6	18.2
General atomic energy development	1977	320.9	208.9	93.6	623.4	6.9
	1978	474.5	766.3	242.6	1 483.4	11.4
Nuclear physics	1977	313.2	250.9	194.5	758.6	8.4
	1978	337.1	649.5	461.5	1 448.1	11.1
Prospecting, mining and processing of nuclear materials	1977	696.0	239.2	155.7	1 090.9	12.1
	1978	663.8	539.7	209.4	1 412.9	10.9
Total	1977	2576.0	1798.0	1864.2	6 238.2	69.1
	1978	2877.0	3834.1	2439.7	9 150.8	70.4
Total assistance	1977	3275.6	3048.7	2703.9	9 028.2	100.0
	1978	3884.3	5458.2	3665.0	13 007.5	100.0

38. The relative importance in 1978 of each of the ten fields of activity is shown in Figure 3 by region and for all regions.

FIGURE 3

DISTRIBUTION OF TECHNICAL ASSISTANCE BY FIELD AND REGION: 1978 [a/]



SUMMARY

Field of activity	Africa %	Asia and the Pacific %	Europe %	Latin America %	Middle East %	Inter-regional %	All regions %
0 - General atomic energy development	8	5	1	25	1	12	11
1 - Nuclear physics	17	13	16	4	9	12	11
2 - Nuclear chemistry	5	4	5	4	12	–	4
3 - Prospecting, mining and processing of nuclear materials	10	12	2	18	–	2	11
4 - Nuclear engineering and technology	9	16	30	11	33	43	18
Application of isotopes and radiation in: 5 - Agriculture	31	23	12	12	3	24	19
Application of isotopes and radiation in: 6 - Medicine	13	6	5	7	23	–	8
Application of isotopes and radiation in: 7 - Biology	1	2	2	–	–	–	1
Application of isotopes and radiation in: 8 - Industry and Hydrology	4	5	16	14	17	–	9
9 - Safety in nuclear energy	2	14	11	5	2	7	8
	100%	100%	100%	100%	100%	100%	100%

[a/] For each region, the relative monetary value of the technical assistance provided by the Agency is denoted by the size of the circle superimposed over the region on the map. The size of the segments in each circle indicates the share of total assistance given in the various fields of activity.

39. Following the recommendations of a group of experts to advise on the implementation of the Agency's technical assistance programme, changes were introduced to improve the efficiency with which the assistance programme is administered. Changes were also made to help reduce the disparities between the currencies needed to meet the requests for assistance and the currencies available to satisfy them. Although the backlog of assistance previously approved but not yet fully implemented continues to be a problem, the imbalance between the Agency's holdings of convertible and non-convertible currencies causes greater difficulties. Thus at the end of 1978 there was a deficit of $2.1 million in the convertible currencies needed to implement approved assistance for which only convertible currency could be used, while there was a corresponding surplus of $2.1 million in non-convertible currencies which had not been earmarked for individual projects.

40. On the basis of experience the 1979 regular programme will clearly identify the type of currency that is expected to be available to finance assistance to individual projects. This will also meet the desire of the donors of non-convertible currencies to receive earlier notice of the kind of equipment needed so that they may expedite their planning; certain donor countries have also indicated their willingness to accept payment in several annual instalments for large items of equipment that would have been too costly to finance under the Agency's regular programme for any one year. This has enabled several projects to be included in the 1979 regular programme which could not otherwise have been accommodated.

41. Although these changes in programming by currency type will ensure that the trend towards a further increase in the imbalance in currencies will not continue, they cannot be expected to have an immediate impact on the existing imbalance. This situation can only be redressed if new programme commitments in convertible currencies are kept below the level of expected new resources in those currencies for a number of years. It will of course be possible to absorb new commitments in non-convertible currencies, and the overall growth of the regular programme need not therefore be affected.

42. Other changes resulting from the recommendations of the group of experts included the introduction of multi-year assistance approvals, the appointment of technical assistance liaison officers by more than 40 Member States, changes in the time-table for the submission and processing of requests for expert services and equipment so that work on requests can be started earlier, and the closer monitoring of implementation.

43. The 1979 regular programme includes assistance to a total of 30 multi-year projects with a cumulative value of about $3.7 million. Of these, seven are projects for which Agency assistance will exceed $150 000 each: three call for the expenditure of $1.7 million in non-convertible currency over the period 1979-1982, and two others, estimated to cost $380 000, can only be implemented if additional funds become available. Moreover, by phasing technical assistance over a number of years, more realistic programming is possible even for small and medium-sized projects. By scheduling an expert assignment to start late in the year and to continue into the next year, the programme becomes more flexible; it gives the recipient country more time in which to line up counterparts for the expert and permits a more accurate prediction of his likely arrival. This procedure has been followed in 17 of the 30 multi-year projects in the 1979 regular programme and also avoids tying up a large share of the available resources during the initial year so that more projects can be started under a given year's programme.

44. It is also hoped that the introduction of large-scale assistance to multi-year projects will attract additional donations, especially in support of those assistance approvals which can only be implemented should additional funds become available.

45. To assist Member States in the preparation of requests for assistance, including multi-year projects, the Agency sent programming missions to countries in Africa, Asia and the Pacific, and Latin America in 1978. The missions sent to Asia dealt with nuclear power programmes, whereas the other two were general in nature. That the programming missions were successful is indicated by the fact that most of their recommendations have been reflected in recent requests for assistance to be provided under the Agency's regular programme.

NUCLEAR POWER AND REACTORS

Introduction

46. The provision of technical and economic information to all Member States and the supply of assistance to requesting developing countries in the planning and implementation of national nuclear power programmes and of fuel cycle services require continuous work in estimating nuclear power growth and costs, the assessment of uranium resources, of the reliability and fuel performance of present reactor types and of the prospects of advanced nuclear systems and the training of nuclear manpower.

Nuclear power growth

47. The total of 15 000 MW(e) of new nuclear power plant capacity brought into commercial operation during 1978 raised the world's nuclear power capacity at the end of the year to around 110 000 MW(e), or 5.8 per cent of the world's total electrical generating capacity. Nine nuclear power stations with a total capacity of some 8700 MW(e) were ordered through firm contracts or letters of intent in 1978 but, as orders for five stations totalling 5700 MW(e) were cancelled, the net addition to world nuclear commitments was only some 3000 MW(e).

48. As the rates of growth of electricity consumption and nuclear power generation cannot at present be forecast with accuracy, it is now thought preferable to publish ranges of figures rather than single figures (Table 4). These indicated that nuclear capacity could be between 20 and 26 per cent of total world electrical generating capacity by the year 2000, compared with just under 6 per cent in 1978.

Table 4

Estimates of installed total electric and nuclear capacity
(in thousands of MW(e))

	1977	1978	1980	1985	1990	2000
Total electric	1800	1900	2100	2700-3000	3300-3700	5500-6600
Total nuclear	95	110	170	300-350	475-600	1100-1700
Percentage share of nuclear (%)	5.3	5.8	8	11.7-12	14-16.2	20-26

Nuclear power costs

49. With uranium and enrichment prices remaining fairly stable in constant money terms, and considering the 14.5 per cent increase in oil prices that will take effect gradually through 1979, the competitive position of nuclear power plants is expected to improve in the coming year provided their capital costs do not increase faster than those of conventional stations.

50. However, uncertainties continue to affect the back-end of the nuclear fuel cycle and in some cases the supply of fresh nuclear fuel.

51. A group of experts from countries that have recently bought or negotiated the purchase of nuclear power stations reported that in industrial countries increases in the investment costs of nuclear power plants have been paralleled by similar increases for coal-fired stations, which are also affected by stringent environmental standards.

52. In developing countries, the first nuclear power stations carry high economic penalties because they are burdened with all the expenditures arising from the building of an industrial and transport infrastructure and from the training requirement of a new technology. Consequently, special attention is being devoted by the Agency to the training needs of developing countries in the economic evaluation both of nuclear power programmes and of alternative expansion plans for electric power systems.

53. At the same time, as the future role of nuclear power can be assessed only in the light of general energy developments, an energy data bank covering past primary energy statistics and permitting simple extrapolations of future energy demands has been established. It is being continuously improved through the introduction of more refined models capable of providing ranges of estimates for primary and electric energy demands on national, regional and global levels.

54. Finally, as nuclear fuel cost trends obviously depend on future nuclear power strategies involving different combinations of reactor types, a comprehensive computer programme capable of tracing the consequences of alternative nuclear developments for all the sectors of the fuel cycle has been developed. Its first results served as a basis for a substantial part of the analyses carried out for INFCE. At a later stage, it may be used for a detailed study of the impact of a variety of parameters on the future fuel cycle costs of nuclear power.

Uranium resources

55. Figure 1 shows the growth of reasonably assured uranium resources over the past 14 years. Although the sharp acceleration recorded since 1975 as a result of higher uranium prices is encouraging, the present total may under certain conditions still fall short of the cumulative requirements of reactor strategies likely to be employed up to the turn of the century. Additional reasonably assured resources with higher costs, as well as estimated additional resources, not included in Figure 1, could alter this situation. Substantial prospecting efforts would however be required to specify the location of estimated additional resources. New evaluations on uranium supply and producibility are under way in INFCE in which the Agency has played an important role.

56. During 1978 the Agency's technical support for uranium exploration and ore processing was expanded. This continues to strengthen the ability of the 28 Member States concerned to achieve self-sufficiency in uranium exploration and development programmes.

57. The joint IAEA/NEA Steering Group on Uranium Resources met on several occasions and started preparing the 1979 issue of the joint report "Uranium Resources, Production and Demand". Six long-term research and development programmes, aimed at an increase in uranium discovery rates, were approved; it is expected that they will be funded by the States which are members of the Group. The Group also completed the IUREP (International Uranium Resources Evaluation Project) phase-I report, which consists of an appraisal of the speculative uranium resources of 185 countries. From these countries, 20 were selected for further evaluation in an "orientation phase".

Fuel performance

58. An international symposium on water reactor fuel element fabrication, with special emphasis on its effects on fuel performance, confirmed that fuel fabrication is in a position to meet today's performance requirements. The majority of the world's

reactors are operating at a failure level of less than 0.05 per cent; this operational experience is based on more than 5 million fuel rods. Design, technological, quality control and other improvements are, however, still possible and are being implemented.

59. A specialists' meeting on fuel element performance computer models showed that the fuel element computer model is a better method of predicting the performance and reliability of nuclear fuel than very expensive reactor loop and laboratory tests.

60. A review entitled "Main Causes of Fuel Element Failures in Water-Cooled Power Reactors" has been prepared and is being published.

61. The interest of Member States in more technical exchanges similar to the symposium on design, construction and operating experience of demonstration LMFBRs which the Agency organized in 1978 has been very high and work has started on an advanced fuels and materials programme for 1980-81, taking INFCE work into account.

62. Under a UNDP-assisted project to develop a nuclear power reactor programme in Romania, test fuel elements from Romania have been successfully irradiated in both the BR-2 reactor in Belgium and the MZFR reactor in the Federal Republic of Germany.

Manpower development

63. In the Agency's assistance to developing countries, there was some shift of emphasis from help in the formulation of nuclear power programmes to nuclear manpower development. Most of the developing countries with large electric grids have, with Agency assistance, formulated nuclear power programmes and have identified lack of qualified specialists as a major restraint in implementing them.

64. To help in overcoming this problem, the Agency organized during 1978 eight interregional training courses - on nuclear power project planning and implementation, on construction and operations management and on a few other specific aspects of nuclear power design and construction. By the end of the year more than 500 trainees from developing countries had taken part in these courses. Regional courses on national participation in nuclear power programmes and on quality control were held for the regions of Asia and the Pacific. Work was also started on a guidebook on manpower requirements and development for nuclear power programmes.

65. A symposium on problems associated with the export of nuclear power plants brought out some of the many ways in which the requirements to be met by nuclear power plants in developing countries differ from those to be met in advanced countries, not least as regards the size of station that can be accommodated.

66. Of the countries for which preliminary nuclear power planning missions were organized and to which advisory services were provided during the year, Morocco and Sri Lanka at present have grids that are too small to accept commercially available nuclear power plants, while Indonesia and Malaysia have initiated extensive studies on the feasibility of introducing nuclear power. A programme for Agency assistance in these studies has been established. Direct assistance was given to Bangladesh in evaluating technical bids for a small nuclear power plant.

Improvements in reliability

67. Work on the reliability of nuclear power plant systems carried out in 1978 through the International Working Groups on the Reliability of Reactor Pressure Vessel Components and on Nuclear Power Plant Control and Instrumentation was concerned with the operational problems that are considered most acute, such as time and load degradation of reactor

materials, repairs to pressure components and achieving electromagnetic compatibility in equipment design. Another important example of international co-operation on reactor pressure vessel safety, now that there are many years of operational experience, is the co-ordinated research programme on the irradiation embrittlement of reactor pressure vessel steels.

Advanced reactors

68. Major improvements in the total nuclear energy supply that will be available to the world and increases in the range of its application are possible through the development of advanced nuclear power technology. Breeder reactors may achieve a hundredfold increase in the energy derivable from a given amount of uranium as compared to present proven systems. In addition, there is an interest in the potential use of high-temperature reactors for process heat applications as a substitute for fossil fuels or as a means of increasing the usefulness of coal through gasification. The Agency is fostering information exchanges and other forms of collaboration among Member States engaged in the development of advanced nuclear power technology.

69. Successful experience with operating fast breeder reactors - including the BN 350 in the Soviet Union, Phénix in France and the PFR in the United Kingdom - continued to accumulate. Phénix was refuelled for the first time after achieving a maximum burn-up of 72 000 MWd/t without fuel failures. Experimental analysis of the spent fuel showed that a breeding ratio of 1.16 had been achieved, which was significantly greater and more promising than the 1.10 predicted.

70. Construction of the BN 600 fast breeder reactor in the Soviet Union and the 1200-MW(e) Super-Phénix in France continued on schedule. In the Federal Republic of Germany the construction of the 300-MW(e) SNR 300, a joint Fast Reactor Project of the Federal Republic of Germany, Belgium and the Netherlands, likewise made further progress. In Japan, a construction licence for the 300-MW(e) Monju fast reactor was applied for. The FFTF fuel test reactor facility in the United States was filled with sodium in preparation for commissioning in 1979.

71. Countries participating in the International Working Group on Fast Reactors continued to give high priority to the development of these reactors as an important step towards increased energy independence.

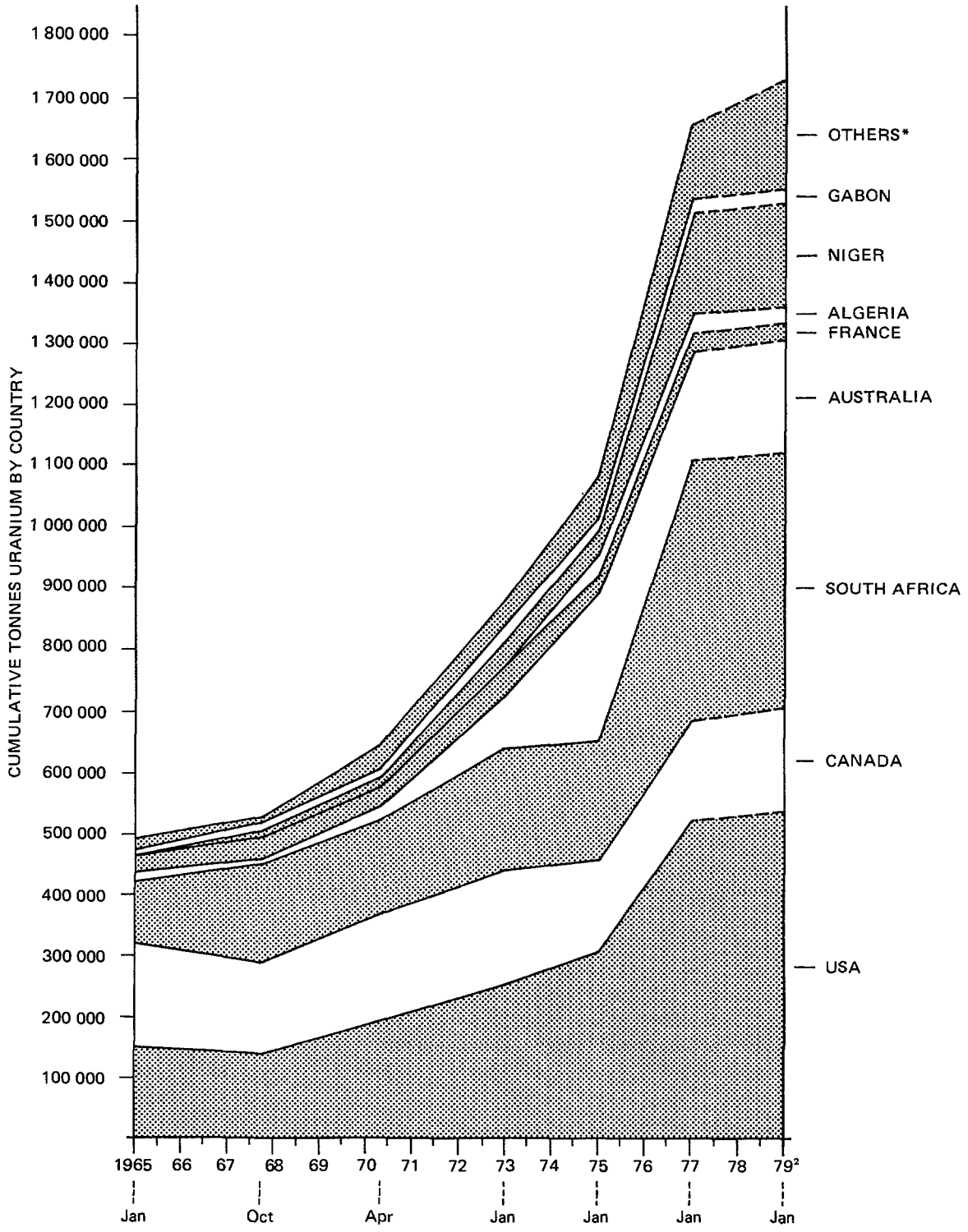
72. National programmes were presented at the first meeting of the International Working Group on High-Temperature Reactors. Engineering design work and planning for a helium-gas-turbine direct-cycle reactor to produce electricity are in progress in the Federal Republic of Germany, and interest in process heat for such applications as coal gasification and steel-making is growing in a number of countries.

Table 5

Nuclear power reactors in operation in IAEA Member States
as of 11 December 1978

Country	Number of reactors	Capacity (MW(e) net)
Argentina	1	345
Belgium	4	1 676
Bulgaria	2	837
Canada	10	4 755
Czechoslovakia	2	491
Finland	2	1 080
France	14	6 353
German Democratic Republic	4	1 287
Germany, Federal Republic of	15	8 174
India	3	602
Italy	4	1 382
Japan	21	12 279
Korea, Republic of	1	564
Netherlands	2	499
Pakistan	1	126
Spain	3	1 073
Sweden	6	3 700
Switzerland	3	1 006
United Kingdom of Great Britain and Northern Ireland	33	6 982
United States of America	69	49 989
Union of Soviet Socialist Republics	27	7 616
21 Member States	227	110 816

Figure 4. Growth of Reasonably Assured Uranium Resources[1]
(NEA/IAEA Joint Working Party on Uranium Resources)



* Others: Argentina, Brazil, Central African Empire, People's Republic of the Congo, Denmark (Greenland), Federal Republic of Germany, India, Italy, Japan, Mexico, Morocco, Portugal, Spain, Yugoslavia, Zaire .

[1] In following production cost categories: 1965, 1967, 1970 at \$10/lb U_3O_8 (\$26/kg U), 1975 at \$15/lb U_3O_8 (\$ 39/kg U) and 1977 and 1979 (projected) at \$30/lb U_3O_8 (\$80/kg U).

[2] Resources for 1979 are projected.

NUCLEAR SAFETY AND ENVIRONMENTAL PROTECTION

New codes and safety guides

73. The 227 nuclear power stations now operating in 21 of the Agency's Member States have a total operating life of 1700 reactor years. And in 1978 no significant accident involving the nuclear parts of these stations was reported or discovered.

74. The Agency is devoting a large and wide-ranging effort to help ensure that this excellent record continues. In particular, for the past five years work has been proceeding on the preparation of a series of some 50 codes of practice and safety guides for thermal-neutron nuclear power stations under the Nuclear Safety Standards (NUSS) programme.

75. The five codes of practice (on government organization, siting, design, quality assurance and operation) were published in 1978 and 11 safety guides, which cover in more detail some aspects of the corresponding codes of practice, were submitted for publication. Drafts of a further 29 safety guides are in various stages of development and are expected to be published during the next three to four years.

76. The codes and guides are based on national and international safety recommendations and on the practices of Member States. They provide a standard framework to which developing countries in particular can refer when embarking on a nuclear power programme. They give substantial assistance in identifying problems, establishing minimum requirements for safety and suggesting acceptable methods of achieving them.

77. Although they are written in a way that will allow them to be readily transformed into national codes and guides, their interpretation requires a thorough knowledge of the topic and sound engineering judgement such as will only be found where there is an adequately staffed regulatory body.

78. All these documents will be included in the Agency's Safety Standards and will in future form part of power reactor project agreements between the Agency and Member States.

Power plant exports

79. The importance of this topic was underlined by the symposium - held in 1978 - on the problems associated with the export of nuclear power reactors.

80. A significant part of this symposium was devoted to aspects of nuclear safety of concern to developing countries, and emphasis was placed on the need for an effective regulatory organization. A particular problem for a regulatory body in a developing country, especially when dealing with its first nuclear station, is the difference between the plant being offered or built and the "reference" plant. It may therefore have to deal with numerous modifications and problems that have not been reviewed by the regulatory authority of the exporting country.

81. One of the ways in which the Agency is helping with this and other problems encountered by developing countries with nuclear power programmes, such as the safety aspects of site selection and the safety assessment of plants before construction and during operation, is by meeting an increasing demand for short-term expert missions. During 1978 such missions were sent to Brazil, Chile, Egypt, Malaysia, Mexico, Portugal, Spain, Turkey and Yugoslavia.

82. To assist countries in improving the safety level of research reactors, missions were sent to Algeria, Argentina, Australia, Indonesia, Malaysia, Peru, Thailand and Uruguay.

83. Another way of improving nuclear safety is through training, and the first training course devoted exclusively to nuclear safety was held last year at Argonne National Laboratory, in the United States. Also, lectures on nuclear safety were included in more general courses held at Argonne and at the Karlsruhe Nuclear Research Centre, in the Federal Republic of Germany. More courses on safety will be held in 1979.

Regional co-ordinated research programmes

84. The need for international co-operation on environmental matters is particularly important where a major river runs through the territories of several countries with nuclear power programmes. A notable example of the way the Agency can help by bringing Member States together to discuss common problems is in the co-ordinated research programme on the radiological safety of the Danube catchment area and the radioecology of the Danube. This programme has resulted in intensive research into harmonized measuring techniques which, it is hoped, will lead to an acceptable international monitoring system. An attempt is being made to initiate similar co-operation between countries bordering on the Baltic.

85. In South East Asia, the co-ordinated research programme on environmental monitoring, now at the end of its second three-year term, has proved successful in encouraging a better evaluation of the underlying sources of radiation exposure of the population in the area.

Spent fuel management and waste management

86. One of the principal issues associated with the more rapid expansion of nuclear power programmes is the growing concern about the management of the spent fuel and of the radioactive wastes that arise from the various stages of the nuclear fuel cycle.

87. As regards waste management, although suitable processes for managing the present amounts of radioactive wastes and effluents exist, more needs to be done to demonstrate the technology and to harmonize the principles on which waste management policies should be based. A major continuing activity of the Agency is therefore the formulation of guidelines (which will ultimately lead to the preparation of codes) for the underground disposal of radioactive wastes.

88. In 1978 the Agency's programme on the disposal of radioactive waste into geological formations was expanded, on the advice of an advisory group, to include all underground disposal of radioactive waste. A series of technical documents covering regulatory activities, siting, waste acceptance criteria, and repository design, construction, operation and shutdown is being developed, with consideration being given to each underground disposal method of interest. A technical review committee on underground disposal has been established and has met to co-ordinate the preparation of documents and to formulate guidelines for the Agency's underground disposal programme.

89. Draft documents that have been prepared for publication in 1979 cover:

- shallow land burial;
- the development of regulatory procedures for the disposal of solid radioactive waste in deep continental geological formations;
- the options for the underground disposal of radioactive waste;
- the handling and storage of high-level radioactive liquid wastes requiring cooling.

90. Based on recommendations of a consultants' group and two advisory groups, the Agency issued, in connection with the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Dumping Convention), a revised definition

of high-level waste unsuitable for ocean dumping and recommendations for dumping radioactive waste not covered by the Agency's definition. The Third Consultative Meeting of the Contracting Parties to the Convention took note of the Agency's revised definition and recommendations for the purpose of implementing the Convention with respect to radioactive waste and other radioactive matter.

91. The Agency also recommended that the revised definition and recommendations be noted by the parties to the Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention) for the purpose of implementing the related protocol regarding dumping from ships and aircraft. An advisory group was convened in December 1978 to consider the technical and scientific aspects of the selection, management and surveillance of ocean sites used for dumping solid low-level radioactive wastes.

Decommissioning

92. The problems that can arise with the decommissioning of nuclear facilities have been under continual review and study by the Agency for several years and papers presented to a joint IAEA/NEA symposium on this subject in November indicated that no insurmountable technical problems are foreseen in decommissioning, with present-day technology, commercial nuclear power reactors. The cost of completely dismantling a large nuclear power station is likely to be around 10 to 15 per cent, in real terms, of the original capital cost.

Risk assessment

93. There is a marked discrepancy between the way the public regards the risks involved in the use of different energy systems and the technical data on what those risks really are. The Agency believes the "nuclear debate" could be made less irrational if there were a better understanding of what governs public attitudes towards various risks and if there were more effective ways of describing, comparing and quantifying risks.

94. For several years the Agency has been collaborating with the International Institute for Applied Systems Analysis (IIASA) on a joint project to develop and apply techniques for providing a quantitative assessment of public attitudes towards different energy systems and to consolidate the available data on both nuclear and conventional risks. It involves, among other things, determining the relative importance of technical and economic factors as compared to social and psychological factors in the formation of such attitudes.

95. At present, one of the problems in making comparisons is the lack of data on the risks involved in using conventional and so-called renewable sources of energy.

96. Data are being sought on the probability of accidents, on their likely consequences and geographical distribution, and on the degree of uncertainty involved. Particular attention is being devoted to determining the cost-effectiveness of various risk reduction systems.

97. The results of pilot studies on how the risks and benefits of five energy systems are perceived by the public have been used in the development of a questionnaire to be used in several countries.

FOOD AND AGRICULTURE

General

98. Work has continued in the main areas where the applications of nuclear techniques have become established as indispensable tools. These include plant breeding and genetics, soil fertility, irrigation and crop production, insect and pest control, pollution, animal production and health, and food preservation.

99. In 1978, over 60 technical assistance projects were supported in 41 developing Member States and more than 200 laboratories and other institutions participated in some 25 co-ordinated research programmes.

Insect control

100. A notable venture is the large mass-rearing facility now under construction in Mexico, where techniques developed in the Agency's laboratory will be used. This is expected to bring about a breakthrough in the large-scale application of the sterile insect technique (SIT) to fruit flies, and especially the Mediterranean fruit fly. A major function will be the training of personnel from Mexico and other countries.

101. The Mediterranean fruit fly has established itself in Guatemala and is threatening to invade Mexico, where the potential loss in agricultural income is estimated at $500 million a year. To counter this threat the Mexican Government, agencies in the United States, FAO and the Agency have started a pest management programme that relies heavily on the sterile insect technique. For its part the Agency supplied the Mexican authorities during 1978 with weekly shipments of up to 30 million sterilized Mediterranean fruit flies for training purposes and release. It also assisted in the training of Mexican personnel and the design of mass-rearing equipment and provided consultancy services.

102. At Vom, Nigeria, the project being conducted by the Agency and the Nigerian Government in co-operation, for demonstrating the advantages and economics of the sterile insect technique in the control or eradication of tsetse flies entered its field trial stage at the end of the year. Tsetse fly rearing technology has advanced rapidly, and Belgium, the Federal Republic of Germany and the United Kingdom are contributing to this project in cash or in kind.

103. Considerable progress has been made in feeding two tsetse fly species through membranes, and at least two sources of blood have proved satisfactory. Rearing methods, based on both animal (in vivo) and membrane (in vitro) feeding, which reduce labour requirements and increase the conformity of the product have been developed at the Seibersdorf Laboratory. The sexual competitiveness of flies reared by these methods has been studied under laboratory and field conditions.

104. Through contracts under a co-ordinated research programme, the Agency is supporting research in other Member States interested in tsetse fly control by the sterile insect technique. Also, a new co-ordinated research programme on the use of isotopes in pest management, with emphasis on rice insects, was started in 1978.

Improving crop production

105. Work continued under the co-ordinated research programme on micronutrient deficiencies in flooded rice soils. Zinc-65-aided field experiments conducted during 1978 in eight Member States yielded valuable information on the optimum application rate and the most efficient source and application method for zinc fertilizers in the case of flooded rice grown on zinc-deficient soils. The residual effects of zinc fertilizers with successive rice crops are at present being evaluated.

106. During 1978, nitrogen-15-aided field experiments were undertaken in ten Member States as part of the co-ordinated research programmes, partially supported by the Federal Republic of Germany, on agricultural nitrogen residues with particular reference to their conservation as fertilizers and behaviour as potential pollutants. Useful results were obtained on the uptake of soil and fertilizer nitrogen by different crops, on quantities of fertilizer nitrogen residues in the rooting zone and on losses of nitrogen through leaching in multiple cropping systems.

107. A new co-ordinated research programme (partly supported by Sweden) dealing with the biological fixation of atmospheric nitrogen by crops and a study of management practices which might decrease the need for nitrogen fertilizer were started in 1978.

108. The co-ordinated research programme on soil water regimes was completed. Exhaustive studies on hydraulic conductivity in soil profiles as a function of soil moisture content and then estimates of water losses through deep percolation were performed in twelve Member States. The results have provided a sound basis for the development of practices aimed at reducing water losses, avoiding the accumulation of salt near the soil surface and increasing crop yields.

109. A co-ordinated research programme was started with the primary aim of improving soil water storage under dry farming conditions in semi-arid regions by increasing water infiltration, reducing evaporation and applying organic matter.

110. An FAO/IAEA international symposium on the use of isotopes and radiation in research on soil-plant relationships was held in Colombo in December 1978.

Improving crop quality

111. At an FAO/IAEA regional seminar on the utilization of induced mutations for crop improvement held in Ibadan, Nigeria, in October 1978, it was concluded that induced mutation techniques could complement classical plant breeding methods in Africa and it was recommended that effective co-ordination of projects be established, regular workshops convened and more training opportunities provided.

112. A research co-ordination meeting was held in Poland in May 1978 on the improvement of vegetatively propagated crops and tree crops by mutation induction. Good progress was reported for all 17 research projects, eight of which are supported financially by the Agency. The use of induced mutations is now well established as a plant breeding method in the case of vegetatively propagated plant species. Results of practical significance have been obtained at institutions associated with the FAO/IAEA co-ordinated research programme for apomictic forage grasses, sugar cane, fruits and ornamentals. Several clones have been released as new cultivars, their commercial value far exceeding the modest financial assistance provided by the Agency.

113. Eight years of work in co-operation with the Gesellschaft für Strahlen- und Umweltforschung (GSF), Federal Republic of Germany, on seed protein improvement in cereals and grain legumes culminated in an FAO/IAEA/GSF symposium at Neuherberg in September 1978. Promising nutritionally improved genotypes of wheat, maize, rice, barley, sorghum, millet and a number of legume species were reported.

Animal production and health

114. A co-ordinated research programme, partly funded by Sweden, to study the water requirements of herbivores in wet and dry tropical regions by tritium labelling is being phased out. Water usage in the production and survival of various species in various environments has been determined. Co-ordinated studies of animal production using radioimmunoassay techniques are being focused on reproductive performance in small and large ruminants, with a view to identifying the endocrinological factors associated with low reproductive efficiency. A co-ordinated research programme involving the use of isotope techniques in diagnosing moderate imbalances of macro- and micro-elements is continuing until 1981; selenium, copper, zinc and phosphorus are of particular interest.

115. A multi-disciplinary co-ordinated research programme on the use of nuclear techniques for improving the productivity of domestic buffalo has been implemented under the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA); the programme involves studies of nutrition, reproductive efficiency and parasitic diseases. The countries taking part are Bangladesh, India, Indonesia, Malaysia, the Philippines, Sri Lanka and Thailand. A co-ordinated research programme on the control of tick and tick-borne disease was started.

Protection of the environment

116. The Agency is continuing its environmental protection activities through co-ordinated research programmes on the use of nuclear techniques in studies of:

(a) The conservation of soil nitrogen residues as fertilizers and the control of their behaviour as potential pollutants;

(b) Pesticide residues in edible oil-seeds and related products;

(c) The interactions between agrochemical residues and biota in soil and aquatic ecosystems; and

(d) The interactions between atmospheric sulphur pollutants and sensitive crops.

117. These programmes receive financial support from the Federal Republic of Germany and the Swedish International Development Authority (SIDA).

Food preservation

118. Food irradiation has received increasing recognition as a physical process for reducing food spoilage losses. Large-scale, long-term wholesomeness experiments, some performed as part of the International Project in the Field of Food Irradiation (IFIP), in which 24 countries are participating, have demonstrated that properly irradiated foods are safe for consumption. So far, 26 food items have been given limited or unlimited public health clearance in 19 countries.

119. Both the recognition of the safety of irradiated food for human consumption and the considerable progress made in standardizing food irradiation techniques have led to intensified food irradiation studies. This is reflected in the many new pilot irradiation facilities installed in countries like Bangladesh, Belgium, Colombia, Ecuador, Indonesia and the Netherlands and which are available for the purpose of studying the technological and economic feasibility of food irradiation.

120. Under a trilateral agreement between FAO, the Agency and the Netherlands Ministry of Agriculture and Fisheries, an International Facility for Food Irradiation Technology (IFFIT) was established in Wageningen, the Netherlands, to be used as a centre for food irradiation training and for pilot-scale studies on the technological and economic feasibility of food irradiation.

121. Following the recommendations made in 1976 by a joint FAO/IAEA/WHO expert committee on the wholesomeness of irradiated foods, a draft general standard for irradiated foods and a draft code of practice for the operation of radiation facilities used for the treatment of foods were accepted at step 6 of the nine-step procedure for the elaboration of Codex Standards in April 1978 by the Codex Alimentarius Commission of the Joint FAO/WHO Food Standards Programme.

LIFE SCIENCES

122. In the life sciences, the Agency is concerned with promoting applications of radiation which are beneficial, particularly to man, and with understanding and learning how to avoid the harmful effects. The Agency's work is concentrated on the scientific and technical aspects of the subject and aims to foster the development of techniques for the application of radiation and radionuclides in medicine, biology and health-related environmental research and to promote the use of techniques for improving accuracy in radiation dosimetry. It is performed in close collaboration with other United Nations organizations, particularly WHO, to which the Agency leaves applications which are routine.

Effective use of nuclear medicine instruments

123. Under a co-ordinated research programme, a survey relating to the use and maintenance of nuclear medicine instruments in 70 laboratories in eight countries in South-East Asia has been completed and a report is in preparation. This will, it is hoped, stimulate the introduction of improved maintenance strategies and encourage regional co-operation. A similar survey has been initiated in Latin America and one - for Africa - is in the planning stage.

124. A review of nuclear medicine instrument systems has been continued with special emphasis on the technical requirements for their effective use in developing countries. Reports are being written on non-interruptible and stabilized power supplies for laboratory instruments, liquid scintillation counters for nuclear medicine applications, whole-body counters and nuclear medicine instruments for in vivo measurements. A prototype well scintillation counter system for use in radioimmunoassay procedures has been developed in the Agency's Laboratory and is being tested in four Member States.

125. Five co-ordinated research programmes have been continued and developed further, and a new co-ordinated research programme has been started on quality control in the in vitro assay of thyroid-related hormones.

Dosimetry standards

126. The IAEA/WHO secondary standards dosimetry laboratories (SSDLs) provide an essential link between primary standards laboratories and radiation users. They have helped reduce the danger of patients being irradiated without dosimetric controls and the uncertainties concerning the doses given. The network has grown rapidly and at the end of 1978 comprised 40 members and 11 affiliated members; also, a few additional applications for membership have been received. Intercomparisons of thermoluminescent dosimetry techniques among SSDLs in five Member States have been carried out.

127. The joint IAEA/WHO postal dosimetry service for cobalt-60 teletherapy was serving 160 institutions during 1978.

128. With a view to the provision of a standardization and intercomparison service for Member States, preliminary dose intercomparisons have been conducted among 11 laboratories scattered throughout the world and possessing large cobalt-60 gamma irradiators for radiation processing.

129. A total of 178 californium-252 needles has been distributed in 24 Member States for use in teaching and research involving neutron radiation.

Radiation biology

130. Progress has been made in developing a chromosome-based system which should help in ascertaining hazards to man from exposure to low doses of radiation. Current information on late biological effects of radiation was reviewed at a symposium held in Vienna in March 1978. The symposium proceedings could be useful in studies dealing with radiation protection standards, epidemiological surveillance and risk assessment.

131. The Agency launched a co-ordinated research programme on the use of radiation in the preparation of vaccines against malaria, schistosomiasis, bilharzia, filariasis and hookworm disease.

132. New examples of the application of radiobiological research in improving cancer radiotherapy were demonstrated under the current co-ordinated research programme on substances which increase the vulnerability of tumours to radiation. More attention than before was paid to the therapeutical use of neutrons, protons and other heavy particles.

Environmental health

133. On the basis of reports published in the literature and reviewed by the Secretariat, preliminary conclusions have been drawn to the effect that nuclear power is safer than most other energy sources in terms of health hazards per unit of energy production.

134. At an advisory group meeting, techniques for the photon activation analysis and particle-induced X-ray emission analysis of trace elements in human hair were recommended for international use. A research co-ordination meeting concluded that hair is a good indicator for the primary monitoring of inorganic pollutants such as lead, mercury and arsenic. Using the nuclear analysis of hair, some participants in the Agency's programme on this subject found cases of increased exposure and even internal contamination of man in various countries.

135. A health-related environmental research project involving the use of nuclear techniques was started for countries in South Asia and the Far East. The objective of this project is to test nuclear-based analytical methods for the monitoring of inorganic pollutants in man.

PHYSICAL SCIENCES

136. The Agency's work in the physical sciences is aimed at co-ordinating the efforts of scientists in Member States and promoting the exchange of nuclear data and of information relating to physics, chemistry, the industrial applications of isotopes and isotope hydrology. Special attention is given to fusion research, to raw material and water resource problems and to education and training in nuclear science and techniques.

Physics

137. The Agency assisted a number of developing countries in starting or strengthening nuclear science projects and supervised the implementation of projects included in the regular programme of technical assistance or sponsored by UNDP. Particular emphasis is put on promoting inexpensive nuclear techniques which can be utilized in various fields. With consultants' help, the present status and the potentials of sub-critical and critical assemblies in research and training were evaluated with a view to their suitability for developing countries.

138. The programme on research reactors included several technical assistance projects related to the establishment of new research reactor laboratories and to the renewal and upgrading of existing facilities. The compilation of research reactor data is being completed with information received from Member States.

Fusion

139. The Agency continued its programme of international co-ordination in controlled fusion research.

140. The International Fusion Research Council recommended that the fusion workshop which is meeting this year crystallize the technical objectives and nature of the next fusion device of the tokamak type (the International Tokamak Reactor - INTOR), which could be constructed internationally under the auspices of the Agency. This would follow the large tokamak experiments at present under construction, which should reach the break-even region (Lawson criteria). In the new experiment, which might cost between $1 and 2 billion, the aim would be to take the maximum reasonable steps to demonstrate the scientific, technical and engineering feasibility of generating electricity by pure DT fusion. A steering committee representing Japan, the Union of Soviet Socialist Republics, the United States of America and the Commission of the European Communities considered the scope and programme of this workshop, which will identify the main characteristics of INTOR.

141. At the Seventh International Conference on Plasma Physics and Controlled Nuclear Fusion Research, held in Innsbruck, Austria, the latest results towards achieving reactor plasma parameters were reported. Technical committee meetings on the progress in inertial confinement fusion (United States of America), on powerful neutral injectors for fusion reactors (United Kingdom) and on the engineering of large tokamak experiments (France) discussed these major fields of fusion research. A consultants' meeting (Poland) identified those problems not requiring large apparatus which could be tackled by developing countries.

Industrial applications and chemistry

142. Increasing attention was given to the non-electric power applications of peaceful atomic energy development and their socio-economic importance to developing Member States. A technical mission to ten Member States in Asia and the Pacific (in connection with RCA) carried out a comprehensive review of local industries and determined opportunities for expanding the application of isotopes and radiation technology and accelerating their introduction over the next five to ten years. Expert meetings were held on radiation

processing and the use of nucleonics systems for industrial process control. These expert studies show that real opportunities exist for expanding industrial isotope and radiation applications in developing countries with concomitant economic and social gains.

Isotope hydrology

143. Adequate supplies of water are an essential requirement for the expansion of both agriculture and industry. Isotope techniques have been shown to be particularly useful in hydrological investigations, especially where the data have previously been inadequate.

144. The techniques of isotope hydrology are now well established and used world-wide. During 1978 their present status and application were reviewed at a symposium in Neuherberg, Federal Republic of Germany; hydrologists from English-speaking countries in Africa were informed of their potential usefulness at a seminar in Nairobi; and an advisory group studied their application in arid zones.

145. Consultants and analytical services were provided to Member States, and UNDP projects in a number of developing countries led to a better understanding of solutions to those countries' hydrological problems.

Nuclear data

146. The Agency expanded its contacts with and services to developing countries and, in response to 217 requests for nuclear data received during 1978, provided over 39 000 numerical data sets to scientists in more than 30 Member States.

147. A course on nuclear theory for applications was held in Trieste in co-operation with the International Centre for Theoretical Physics. The course offered 91 participants from 29 countries an extensive review of and training in nuclear theory as applied to nuclear data computation.

148. At its tenth meeting, held in Bucharest, the International Nuclear Data Committee reviewed the Agency's nuclear data programme and recommended the improvement of nuclear data needed for the investigation of radiation damage in fission and fusion reactors and for the design of alternative fuel cycles such as the Th-U fuel cycle.

149. The Agency convened the first international meeting on nuclear data for fusion reactor technology. An advisory group meeting was convened to finalize the details for the creation of a new international file of evaluated neutron cross-section data for reactor dosimetry applications and to establish procedures for the testing and adjustment of these data.

THE LABORATORIES

150. The Agency operates three laboratories to provide support services for the technical programmes. The main laboratory, at Seibersdorf, and the smaller laboratories at the Agency's Headquarters in Vienna cover metrology, chemistry, hydrology, nuclear medicine and agriculture. Samples taken during the Agency's inspections of nuclear facilities are also analysed at Seibersdorf. The Monaco Laboratory performs studies of radioactivity in the marine environment and is carrying out several projects with the United Nations Environment Programme (UNEP).

151. The laboratories do not perform any independent research, but are concerned mainly with analytical and calibration services. They also do important work in the development of instruments and techniques to meet the special needs of the developing countries and of the Agency's safeguards inspectors. Another key function is training. Under the Agency's fellowship programme, some eight to ten fellows work with the laboratory staff on current problems for periods ranging from a few months to three years.

Analytical services

152. The number of institutes participating in the analytical quality control programme in chemistry increased to 533, in 52 Member States. Three new reference materials for the analysis of trace elements in geological materials were introduced, while some biological reference materials, the stock of which was exhausted, were phased out. The total number of standard and reference materials available under this programme from Headquarters and from the Monaco Laboratory is now 29.

153. Analytical services rendered to uranium prospection projects in Member States involved 2312 analyses on 929 samples. Bioassay samples provided twice yearly by all Agency inspectors and the personnel of the Safeguards Analytical Laboratory (SAL) were measured for ^{239}Pu by alpha spectrometry to ensure the absence of internal contamination.

154. In 1978 SAL analysed 132 samples of spent fuel and plutonium product materials by isotopic dilution mass spectrometry and 37 plutonium product samples and 414 uranium product samples by wet chemical methods.

155. Some 400 mixed ^{233}U and ^{242}Pu spikes were prepared and calibrated for the isotopic dilution mass spectrometry analysis of input solutions to safeguarded reprocessing plants.

156. The resin bead technique for the analysis of spent fuel samples containing nanogram amounts of uranium and plutonium is being subjected to a test exercise. The first stage of the exercise was completed and is being followed by a comparison of isotopic dilution analyses performed at SAL and Oak Ridge National Laboratory.

157. Significant efforts have been made to resolve analytical difficulties and improve analytical techniques, especially in the wet chemical analysis of spent fuel and plutonium and the automatic titration of uranium.

158. The results of an intercomparison of analyses of UO_2 product samples have been received and are being evaluated, and two similar exercises have been prepared for 1979.

Metrology

159. Within the service for the intercomparison of calibrated radionuclide solutions, 45 samples of 29 different radionuclides calibrated by eight national standards laboratories were received and registered by the metrology laboratory. Six calibrations were performed by the laboratory and the results incorporated in the tables for the respective isotopes.

Agriculture

160. Under the Agency's co-ordinated research contract and training programmes, the agriculture laboratory analysed a total of 8000 plant and soil samples for their ^{15}N content, developed methods to screen seed protein mutants in various cereal species, irradiated batches of seed material for purposes of mutation breeding (mainly for breeders in developing countries), provided training in mutation breeding techniques and in isotope and radiation techniques for use in soil fertility and plant nutrition research, and improved the methods of mass-rearing tsetse flies and the Mediterranean fruit fly (medfly). It now provides technical back-up for a large medfly control programme in Mexico.

Marine studies

161. At the International Laboratory of Marine Radioactivity, in Monaco, work has continued on the assessment of the behaviour of natural alpha-emitting radionuclides and transuranic elements in certain marine plant and animal food chains. Intercalibration exercises on radionuclides, using marine sediment samples, showed that fractions of transuranics leached from sediments with strong acids are different, probably due to the chemical states of transuranics in the sediments.

162. From measurements of plutonium and americium in seawater samples collected from several profiles in the Mediterranean, it is clear that the vertical distribution of these two elements differs.

163. Recent studies of faecal pellets from surface plankton have shown their important role in removing transuranic elements from the water and putting them into the sediments. A quantitative assessment of the downward vertical flux of these materials is being made using in situ sediment traps. The Laboratory is investigating how to determine the levels of the radionuclides which reach the sediments and whether these transuranics are then available for uptake by benthic species.

164. More precise computational methods for determining the dose rate to fish eggs in environments contaminated with radioactivity and a radioecological classification of dose rate zones of chronic irradiation of aquatic organisms and ecosystems by ionizing radiation have been developed.

165. Research on non-nuclear pollutants was carried out under several UNEP contracts.

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

166. The Centre is now established as a unique meeting place for physicists from all countries, and through the dedicated association of a number of outstanding physicists it has earned a high scientific reputation. It is run jointly by the Agency and UNESCO.

167. The Centre has helped directly to reduce the brain-drain from developing countries and continues to provide valuable post-doctoral research training opportunities at very low cost for physicists from such countries. New ways of enhancing the utility of physics to the developing countries and of extending the basic understanding of physics are continuously being sought. The Centre has been particularly successful in establishing a corps of highly qualified solid state physicists in several developing countries in Latin America, the Far East and - to a limited extent - Africa.

Courses and seminars

168. During 1978, the physics and technology programme included a spring college on modern materials followed by a two-day symposium on classical fluids. In continuation of the condensed matter physics programme, the summer solid state physics workshop included a symposium on electromagnetic phenomena near metal surfaces. The Centre also hosted, for three weeks, the second Latin American workshop on self-consistent theories of condensed matter. The Centre now has a permanent condensed matter physics group which will ensure continuity in this activity.

169. High-energy and particle physics research was, as in the past, active throughout the year and was highlighted by the Sixth Trieste Conference on Particle Physics.

170. Extended courses were held on mathematical economics and on systems analysis. The main emphasis was placed on methods directly applicable to problems in the home countries of the attending scientists.

171. Considerable work was done in the field of physics and energy during the year, one or more courses being held in each of its sub-components. A winter course on nuclear physics and reactors was organized in collaboration with staff at the Agency's Headquarters and a conference was dedicated to recent progress in many-body theories. A one-week workshop on drift waves in high-temperature plasmas was also held.

172. In continuation of the solar energy work which began last year at the Centre, a seminar on solar energy thermal storage was organized in collaboration with "Coopération Méditerranéenne pour l'Energie Solaire" (the Italian Section at Cosenza) and the International College of Applied Physics, Catania. This was followed by a seminar in French on solar energy financed by the French Ministries of Foreign Affairs and of Co-operation, the French Centre of Scientific Research and the Commission for Solar Energy.

Regional activities

173. The Centre contributed intellectually and/or financially to the support of participants from developing countries attending meetings and courses in various countries.

174. Also, the Centre hosted the fourth colloquium on high-resolution spectrometry, organized by the Astronomical Observatory of the University of Trieste, and a conference on current advances in the field of differential equations, organized by the Mathematics Institute of the University of Florence.

175. In addition to nearly 1000 individuals taking part in the activities mentioned above, another 280 scientists came to the Centre for independent research during 1978.

176. Financial support continued to be given by the Danish Energy Agency, the Swedish International Development Authority, the International Union of Pure and Applied Physics and the Italian National Institute for Nuclear Physics. The Centre also collaborated closely with the Institute of Theoretical Physics and the Advanced School of Physics in Trieste and with the "Consorzio per l'incremento degli studi e delle ricerche" of the University of Trieste, and indirect support was received from the Organization of American States and through an agreement between the British Royal Society and the Italian Accademia dei Lincei.

SAFEGUARDS

General

177. In 1978, as in previous years, the Secretariat, in carrying out the safeguards programme of the Agency, did not detect any discrepancy which would indicate the diversion of a significant amount of safeguarded nuclear material for the manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device. In the light of the report which the Director General submitted to the Board on the implementation of safeguards in 1978, it is reasonable to conclude that nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for.

178. The considerations which lead to this conclusion and certain reservations to which it is subject are set forth in the Safeguards Implementation Report.

179. As has been pointed out previously, the Agency now has extensive experience in applying safeguards in power reactors, particularly light-water reactors. It has limited experience in safeguarding fast breeder reactors and reprocessing plants. Approaches for safeguarding the first enrichment plant to come under international safeguards are now being worked out. There is thus a continuous evolution in the Agency's approach to safeguards and in the way they are being applied.

180. The main emphasis during 1978 was on consolidation and rationalization in order to improve the effectiveness of safeguards and, in particular, to develop better procedures for evaluating the effectiveness of their application.

181. The Standing Advisory Group on Safeguards Implementation (SAGSI) contributes to the effort to improve the effectiveness of safeguards. During two series of meetings which it held in 1978 it considered the following:

(a) Technical criteria for the application of Agency safeguards;

(b) Current Agency procedures for determining goal quantities of nuclear material for the planning of inspections;

(c) Current Agency procedures for determining detection timeliness for the planning of inspections;

(d) The use and quantification of containment and surveillance in Agency safeguards;

(e) Diversion strategies used as a basis for planning the implementation of Agency safeguards.

Increased safeguards coverage

182. By the end of 1978, 61 of the 103 non-nuclear-weapon States party to NPT had concluded with the Agency the required agreements placing all their nuclear activities under Agency safeguards. Of these 61 States, 31 had significant nuclear activities. Three

of the four[6] other parties to NPT which have significant nuclear activities had not yet completed the procedures required for bringing their agreements with the Agency into force. All nuclear activities of which the Agency is aware in these four States were, however, covered by safeguards under previous agreements.

183. In 1978, as in 1977, the Agency was applying safeguards in 12 non-nuclear-weapon States which were not party to NPT but which had substantial nuclear activities - namely, Argentina, Brazil, Chile, Colombia, the Democratic People's Republic of Korea, India, Indonesia, Israel, Pakistan, South Africa, Spain and Turkey (the process of accession to NPT was, however, reported to be well advanced in Indonesia and Turkey). In eight of these 12 countries all substantial nuclear activities of which the Agency was aware[7] were covered by a mosaic of individual safeguards agreements. In four of these 12 countries (India, Israel, South Africa and Spain) and in Egypt, which has signed but not yet ratified NPT, unsafeguarded nuclear facilities were in operation. However, only in three was the unsafeguarded plant significant from the point of view of producing weapons-grade material. In this respect the situation did not change between 1977 and 1978.

184. During 1978 all facility attachments under the NPT agreement with Japan entered into force. By the end of the year 61 of the 115 facilities in the non-nuclear-weapon States of EURATOM were covered by facility attachments; in the remaining facilities, safeguards were implemented on the basis of ad hoc inspections and of reporting procedures which had been partly brought into line with the Agency's requirements.

185. In 1978 safeguards were being applied in the United Kingdom and the United States to nuclear material returned under certain safeguards transfer agreements. The Agency applied safeguards in France for the first time, pursuant to a France/Japan/Agency safeguards transfer agreement.

186. The agreement with the United Kingdom and EURATOM under which the Agency may apply safeguards to any nuclear material in civil nuclear plants entered into force on 14 August 1978. The Agency was informed that steps were being taken for the ratification of a similar agreement with the United States.

187. An agreement with France and EURATOM which is similar in many respects to the agreement with the United Kingdom was signed on 27 July 1978.

188. From paragraphs 138 and 139 above, it will be clear that by far the major part (85% of the total for plutonium and 95% of the total for uranium) of the nuclear material under safeguards is now in States that have submitted all their peaceful nuclear activities to safeguards, as a consequence of their being parties to the NPT or the Tlatelolco Treaty, and that safeguards are also being applied outside the scope of these treaties to significant facilities and material in 12 non-nuclear-weapon States.

189. There are significant differences in scope and procedures as between the types of agreement concluded under and outside NPT. In practice, however, the differences in the technical application of safeguards are fairly small and, in the interest of efficiency and standardization, they are being narrowed down as much as possible.

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[6] Peru, Portugal and Venezuela. The fourth party is "the Republic of China".

[7] Enquiries have been addressed to Pakistan concerning the use made of technology transferred to Pakistan for the development of reprocessing capacity.

190. The number of plants under safeguards also increased during 1978; the plants included certain facilities for which very frequent or continuous inspection was needed. The quantity of plutonium under safeguards rose by 82%, to 65 t; the quantity of highly enriched uranium under safeguards increased by 5%, to 11.8 t. Safeguarded low-enriched uranium and source material rose by 31% and 138% respectively, to about 10 300 t and 29 200 t.

191. These changes were reflected in a significant inrease in the amount of information contained in accountancy reports submitted by States and in the work involved in processing the information. The amount of information handled was over 80% higher in 1978 than in 1977, with more than 200 000 entries concerning nuclear material movements, physical inventory details, etc. being processed.

Safeguards development and technical support

192. A computerized system for forecasting the quantities of nuclear material that will come under safeguards and other safeguards data has been brought into operation.

193. The Agency continued to improve its approaches and procedures for safeguarding types of facilities - such as reprocessing plants, enrichment plants, mixed-oxide fuel fabrication plants, large-scale critical facilities and fast breeder reactors - which are now coming under safeguards. Further work was also done in standardizing safeguards approaches and procedures for light-water reactors, CANDU-type reactors and low-enriched uranium fuel fabrication facilities, in respect of which considerable safeguards experience exists.

194. Within the joint Agency/Canada safeguards research and development programme, attention is being given to ways in which facilities can be designed in order to permit the easy application of safeguards. As part of this programme, the Agency and Canada are studying modifications of the standard design of CANDU reactors to make the application of safeguards to such facilities easier and more effective.

195. The Agency has established an "International Working Group on Reprocessing Plant Safeguards" to consider the main problems of safeguarding reprocessing plants.

196. The Agency continued to assist Member States in developing their systems of accounting for and control of nuclear material (SSACs), by holding an advisory group meeting in April and through continuing consultations with individual States.

197. The availability of measurement equipment suitable for inspection use and the improvement of national accounting and control systems were two of the many topics discussed at the fourth Agency symposium on international safeguards technology.

198. A highly significant step forward in safeguards verification of the plutonium content of bulk material by non-destructive assay under typical field inspection conditions was achieved by using a compact and easily transportable high-level neutron coincidence counter. When the counter is used together with a high-resolution gamma ray spectrometer and a programmable calculator, the amount of plutonium in samples of plutonium dioxide powder from 100 grams to 2 kilograms can be determined, on the spot, by the inspector.

199. Several Member States are providing substantial technical assistance in support of Agency safeguards activities. The assistance includes the training of safeguards staff, the development and provision of advanced instrumental systems, and the provision of experts. In 1978 the United States of America provided support in an approximate value of US $4 million and Canada in an approximate value of $C 1 million; the Federal Republic of Germany is offering support in kind equivalent to DM 10 million over the period 1978 to 1980. In addition, support was provided by the Governments of Australia, France, Japan, the Soviet Union and the United Kingdom.

Safeguards Information Treatment

200. The increasing amount of records and reports which the Agency is handling is shown by the following table:

Year	1976	1977	1978
Number of accounting records processed during the year	30 000	117 813	208 589
Number of inspection records processed during the year	-	-	4 158
Cumulative number of records in Safeguards Information System	87 690	205 523	418 270

201. The Agency also held another annual seminar to assist Member States in preparing and transmitting accurate and timely safeguards information. The seminar was well attended, with participants from 23 countries.

202. The Agency introduced effective security procedures for protecting safeguards information in the computer data base. This enabled the Secretariat to use actual safeguards data in order to test new software which was being developed for the advanced safeguards information system. This software makes it possible to check all significant data received from nuclear installations and certain types of data collected by inspectors.

Stage of implementation of safeguards agreements

203. To provide a fuller view of the stage reached in implementing safeguards agreements, this year's report includes for the first time a table which shows the status of the relevant Subsidiary Arrangements for nuclear facilities which are under safeguards or which contain safeguarded nuclear material.

204. In the few instances where no formal Subsidiary Arrangements have been concluded, ad hoc arrangements have enabled the Agency to apply effective safeguards. However, as a matter of policy and in the interest of standardization, economy and efficiency, the Agency is concluding Subsidiary Arrangements for these facilities[8] as well as for all others.

[8] Paragraphs 39 and 40 of document INFCIRC/153 explicitly require the conclusion of Subsidiary Arrangements, prescribe their content and set explicit time limits for the conclusion of such arrangements. Most of the safeguards agreements now in force under document INFCIRC/66/Rev.2 also require the conclusion of Subsidiary Arrangements; certain earlier agreements did not, however, specify a time limit for their conclusion.

Table 6

NPT and NPT-related agreements in force

NPT	47
NPT and Tlatelolco Treaty	9
NPT-related agreements concluded with nuclear-weapon States	1
NPT and Additional Protocol I of Tlatelolco Treaty	1
	58

Table 7

Agreements in force other than those in connection with NPT[a/]

Project agreements	25
Unilateral submissions	14
Trilateral agreements	31
	70

a/ Pursuant to the entry into force of safeguards agreements in connection with NPT the application of Agency safeguards has been suspended in the case of 28 of the above agreements: 15 project agreements, one unilateral submission and 13 trilateral agreements (in the last category of agreements the suspension applies to both parties in two cases and to one party only in 11 cases).

Table 8

Non-nuclear-weapon States Party to NPT which by 31 December 1978 had not yet complied with Article III. 4 of the Treaty stipulating the deadline for the entry into force of the relevant safeguards agreement to be concluded with the Agency

Bahamas
Benin
Bolivia
Botswana
Burundi
Central African Empire
Chad
Costa Rica
Democratic Kampuchea
Gabon
Gambia
Grenada
Guatemala
Guinea-Bissau
Haiti
Ivory Coast
Kenya
Lao People's Democratic Republic
Liberia
Libyan Arab Jamahiriya
Mali
Malta
Nigeria
Panama
Paraguay[a/]
Peru
Rwanda
Samoa[a/]
San Marino
Senegal
Sierra Leone
Somalia
Syrian Arab Republic
Togo
Tonga
Tunisia
United Republic of Cameroon
Upper Volta
Venezuela

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a/ At the date of publication of the annual report for 1978, the safeguards agreements with Paraguay and Samoa had entered into force.

Table 9

Reported quantities of nuclear material under Agency safeguards

	Amount by years (tonnes)				
	1974	1975	1976	1977	1978
Plutonium					
(a) Contained in irradiated fuels	4.4[a/]	6.7[a/]	11.8[a/]	12.3[a/]	21.3[a/]
(b) In other forms	1.9	2.3	2.8	5.7	19.4
(c) Total	6.3	9.0	14.6	18.0	40.7
Uranium enriched to more than 20%					
(a) Fissile content	1.7	1.9	1.8	5.9	7.0
(b) Total element	3.6	4.2	3.0	11.2	11.8
Uranium enriched to less than 20%					
(a) Fissile content	52	65	80	189	238
(b) Total element	2 301	3 091	3 613	7 849	10 318
Source material (natural and depleted uranium and thorium)	3 910	4 440	5 336	12 234	29 163

a/ These figures represented only the plutonium amounts reported to the Agency by the State. In addition there are significant amounts of plutonium in reactor cores and cooling ponds which are not required to be reported to the Agency and which are contained in fuel elements to which item accountancy and containment and surveillance measures are applied. A rough estimate of the total of such quantities is, in tonnes, 5 for 1974, 8 for 1975, 12 for 1976, 18 for 1977 and 25 for 1978.

Table 10

Nuclear installations including pilot plants under Agency safeguards, or containing material safeguarded[a/]

Nuclear installations	End of 1978		
	NPT	Non-NPT	Total
Facilities			
Power reactors	88 (78)	24 (22)	112 (100)
Conversion and fuel fabrication	29 (32)	4 (4)	33 (36)
Enrichment	3 (3)	0 (0)	3 (3)
Reprocessing	4 (4)	1 (1)	5 (5)
Research reactors and critical facilities	140 (135)	30 (34)	170 (169)
Separate storage facilities	20 (9)	2 (3)	22 (12)
Other locations	28 (28)	0 (0)	28 (28)
	312 (289)	61 (64)	373 (353)
Locations outside facilities	225 (197)	9 (9)	234 (206)
Total	537 (486)	70 (73)	607 (559)

a/ Figures in brackets indicate status as at the end of 1977.

Table 11

Situation on 31 December 1978 with respect to the signature of, ratification of, or accession to, NPT by non-nuclear-weapon States, and the conclusion of safeguards agreements between the Agency and these States in connection with NPT

Non-nuclear-weapon States which have signed, ratified or acceded to NPT[a] (1)	Date of ratification or accession[a] (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Afghanistan	4 February 1970	In force: 20 February 1978	257
Australia	23 January 1973	In force: 10 July 1974	217
Austria	27 June 1969	In force: 23 July 1972	156
Bahamas	10 July 1973		
Barbados			
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
Central African Empire	25 October 1970		
Chad	10 March 1971		
China, Republic of	27 January 1970		
Colombia			
Congo	23 October 1978		
Costa Rica[b]	3 March 1970	Signed: 12 July 1973	
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			
Denmark[c]	3 January 1969	In force: 21 February 1977	193
Dominican Republic[b]	24 July 1971	In force: 11 October 1973	201
Ecuador[b]	7 March 1969	In force: 10 March 1975	231
Egypt			
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	Approved by the Board	
Gambia	12 May 1975	In force: 8 August 1978	
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	11 March 1970	Provisionally in force: 1 March 1972	166
Grenada	19 August 1974		
Guatemala[b]	22 September 1970	Signed: 20 July 1978	
Guinea-Bissau	20 August 1976		
Haiti[b]	2 June 1970	Signed: 6 January 1975	
Holy See	25 February 1971	In force: 1 August 1972	187
Honduras[b]	16 May 1973	In force: 18 April 1975	235
Hungary	27 May 1969	In force: 30 March 1972	174
Iceland	18 July 1969	In force: 16 October 1974	215
Indonesia			
Iran	2 February 1970	In force: 15 May 1974	214
Iraq	29 October 1969	In force: 29 February 1972	172
Ireland	1 July 1968	In force: 21 February 1977	193
Italy	2 May 1975	In force: 21 February 1977	193
Ivory Coast	6 March 1973		
Jamaica[b]	5 March 1970	In force: 6 November 1978	265
Japan	8 June 1976	In force: 2 December 1977	255
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			
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		

(1)	(2)	(3)	(4)
Libyan Arab Jamahiriya	26 May 1975		
Liechtenstein	20 April 1978	Signed: 6 September 1978	
Luxembourg	2 May 1975	In force: 21 February 1977	193
Madagascar	8 October 1970	In force: 14 June 1973	200
Malaysia	5 March 1970	In force: 29 February 1972	182
Maldives	7 April 1970	In force: 2 October 1977	253
Mali	10 February 1970		
Malta	6 February 1970		
Mauritius	25 April 1969	In force: 31 January 1973	190
Mexico[b/]	21 January 1969	In force: 14 September 1973	197
Mongolia	14 May 1969	In force: 5 September 1972	188
Morocco	27 November 1970	In force: 18 February 1975	228
Nepal	5 January 1970	In force: 22 June 1972	186
Netherlands[d/]	2 May 1975	In force: 21 February 1977	193
New Zealand	10 September 1969	In force: 29 February 1972	185
Nicaragua[b/]	6 March 1973	In force: 29 December 1976	246
Nigeria	27 September 1968		
Norway	5 February 1969	In force: 1 March 1972	177
Panama	13 January 1977		
Paraguay[b/]	4 February 1970	Signed: 18 January 1978	
Peru[b/]	3 March 1970	Signed: 2 March 1978	
Philippines	5 October 1972	In force: 16 October 1974	216
Poland	12 June 1969	In force: 11 October 1972	179
Portugal	15 December 1977	Signed: 7 August 1978	
Romania	4 February 1970	In force: 27 October 1972	180
Rwanda	20 May 1975		
Samoa	17 March 1975	Approved by the Board	
San Marino	10 August 1970	Approved by the Board	
Senegal	17 December 1970	Approved by the Board	
Sierra Leone	26 February 1975	Signed: 10 November 1977	
Singapore	10 March 1976	In force: 18 October 1977	259
Somalia	5 March 1970		
Sri Lanka			
Sudan	31 October 1973	In force: 7 January 1977	245
Suriname[d/]	30 June 1976	In force: 5 June 1975	230
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	
Trinidad and Tobago			
Tunisia	26 February 1970		
Turkey			
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	Signed: 23 June 1978	
Viet Nam[e/]	10 September 1971	In force: 9 January 1974	219
Yemen Arab Republic			
Yugoslavia	3 March 1970	In force: 28 December 1973	204
Zaire	4 August 1970	In force: 9 November 1972	183

a/ The information reproduced in columns (1) and (2) was provided to the Agency by the depositary Governments of NPT, and an entry in column (1) does not imply the expression of any opinion on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers. On the basis of a communication received from the Permanent Mission of the USSR to the Agency certain ratification and accession dates have been changed and the accession of Guinea-Bissau added.

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

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

d/ Agreements have also been concluded in respect of the Netherlands Antilles (INFCIRC/229) and Suriname, under NPT and Additional Protocol I to the Tlatelolco Treaty. These agreements entered into force on 5 June 1975. Suriname attained independence on 25 November 1975. By letter of 30 June 1976 the Government of Suriname notified the Government of the United States of America of Suriname's succession to NPT.

e/ Viet Nam is reconsidering adherence to the commitments of the former Administration under international agreements.

Table 12

Agreements providing for safeguards other than those in connection with NPT, approved by the Board as of 31 December 1978

Party(ies)[a]	Subject	Entry into force	INFCIRC
Bilateral Agreements			
(a) Project Agreements			
Argentina	Siemens SUR-100	13 Mar 1970	143
	RAEP Reactor	2 Dec 1964	62
Chile	Herald Reactor	19 Dec 1969	137
Finland[b]	FiR-1 Reactor	30 Dec 1960	24
	FINN sub-critical assembly	30 Jul 1963	53
Greece[b]	GRR-1 Reactor	1 Mar 1972	163
Indonesia	Additional core-load for Triga Reactor	19 Dec 1969	136
Iran[b]	UTRR Reactor	10 May 1967	97
Japan[b]	JRR-3	24 Mar 1959	3
Mexico[b]	TRIGA-III Reactor	18 Dec 1963	52
	Siemens SUR-100	21 Dec 1971	162
	Laguna Verde Nuclear Power Plant	12 Feb 1974	203
Pakistan	PRR Reactor	5 Mar 1962	34
	Booster rods for KANUPP	17 Jun 1968	116
Peru	Research Reactor and fuel therefor	9 May 1978	266
Philippines[b]	PRR-1 Reactor	28 Sep 1966	88
Romania[b]	TRIGA Reactor	30 Mar 1973	206
Spain	Coral I Reactor	23 Jun 1967	99
Turkey	Sub-critical assembly	17 May 1974	212
Uruguay[b]	URR Reactor	24 Sep 1965	67
Venezuela	RV-1 Reactor	7 Nov 1975	238
Viet Nam[b]	VNR-1 Reactor	16 Oct 1967	106
Yugoslavia[b]	TRIGA-II	4 Oct 1961	32
	KRSKO Nuclear Power Plant	14 Jun 1974	213
Zaire[b]	TRICO Reactor	27 Jun 1962	37
(b) Unilateral submissions			
Argentina	Atucha Power Reactor Facility	3 Oct 1972	168
	Nuclear material	23 Oct 1973	202
	Embalse Power Reactor Facility	6 Dec 1974	224
	Equipment	22 Jul 1977	250
	Nuclear material, material, equipment and facilities	22 Jul 1977	251
Chile	Nuclear material	31 Dec 1974	256
China, Republic of	Taiwan Research Reactor Facility	13 Oct 1969	133
Democratic People's Republic of Korea	Research reactor and nuclear material for this reactor	20 Jul 1977	252
India	Nuclear material, material and facilities	17 Nov 1977	260
Mexico[b]	All nuclear activities	6 Sep 1968	118
Pakistan	Nuclear material	2 Mar 1977	248
Panama[c]	All nuclear activities		
Spain	Nuclear material	19 Nov 1974	218
	Nuclear material	18 Jun 1975	221
Switzerland	Nuclear material		
United Kingdom	Nuclear material	14 Dec 1972	175

Party(ies)[a]	Entry into force	INFCIRC
Trilateral Agreements		
(While the Agency is a party to each of the following agreements, the list only mentions the States party to them.)		
Argentina/United States of America	25 Jul 1969	130
Australia[b]/United States of America	26 Sep 1966	91
Austria[b]/United States of America	24 Jan 1970	152
Brazil/Germany, Federal Republic of[b]	26 Feb 1976	237
Brazil/United States of America	20 Sep 1972	110
China, Republic of/United States of America	6 Dec 1971	158
Colombia/United States of America	9 Dec 1970	144
India/Canada[b]	30 Sep 1971	211
India/United States of America	27 Jan 1971	154
Indonesia/United States of America	6 Dec 1967	109
Iran[b]/United States of America	20 Aug 1969	127
Israel/United States of America	4 Apr 1975	249
Japan[b]/Canada[b]	12 Nov 1969	85
Japan[b]/France	22 Sep 1972	171
Japan/United States of America	10 Jul 1968	119
Japan[b]/United Kingdom	15 Oct 1968	125
Japan[b]/Australia[b]	28 Jul 1972	170
Korea, Republic of/United States of America	19 Mar 1973	111
Korea, Republic of[b]/France	22 Sep 1975	233
Pakistan/Canada	17 Oct 1969	135
Pakistan/France	18 Mar 1976	239
Philippines[b]/United States of America	19 Jul 1968	120
Portugal/United States of America	19 Jul 1969	131
South Africa/United States of America	28 Jun 1974	98
South Africa/France	5 Jan 1977	244
Spain/United States of America	28 Jun 1974	92
Spain/Canada[b]	10 Feb 1977	247
Sweden[b]/United States of America	1 Mar 1972	165
Switzerland/United States of America	28 Feb 1972	161
Turkey/United States of America	5 Jun 1969	123
Venezuela/United States of America	27 Mar 1968	122

a/ An entry in this column does not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities or concerning the delimitation of its frontiers. The Socialist Republic of Viet Nam is reconsidering adherence to the commitments of the former Administration under international agreements.

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

c/ At present Panama has no significant nuclear activities. The agreement is concluded under Article 13 of the Tlatelolco Treaty.

Table 13

Nuclear facilities under Agency safeguards or containing safeguarded material under agreements in force as of 31 December 1978

A. Research reactors and critical facilities

State[a]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force	
Argentina	RA-1	Constituyentes	Argonaut	0.12	x	x	
	RA-2	Constituyentes	Argonaut	0 03	x	x	
	RA-3	Ezeiza	Pool-tank	5 00	x	x	
	RA-4	Rosario	Solid-homogeneous	0 00	x	x	
Australia[b]	HIFAR	Lucas Heights, N. S. W.	Tank	11.00	x	x	
	MOATA	Lucas Heights, N. S. W.	Argonaut	0.01	x	x	
	CF	Lucas Heights, N. S. W.	Critical Facility	0.00	x	x	
Austria[b]	SAR	Graz	Argonaut	0.01	x	x	
	TRIGA-VIENNA	Vienna	Triga II	0.25	x	x	
	ASTRA	Seibersdorf	Pool	12.00	x	x	
Belgium[b]	BR1-CEN	Mol	Tank	4.00	x	x	
	BR2-CEN	Mol	Tank	100.00	x	-	1/
	Thetis	Gent	Pool	0 15	x	x	
	BRO2-CEN	Mol	Tank	0.00	x	-	1/
	CEN-Venus	Mol	Tank	0.00	x	-	1/
Brazil	IEA-R1	São Paulo	Pool	5.00	x	x	
	IPR-R1	Belo Horizonte	Triga I	0.10	x	x	
	RIEN. 1	Rio de Janeiro	Argonaut	0.01	x	x	
Bulgaria[b]	IRT-2000	Sofia	Pool	2.00	x	x	
Canada[b]	NRX	Chalk River, Ont.	NRX	30.00	x	x	
	NRU	Chalk River, Ont.	NRU	125.00	x	x	
	WR-1	Pinawa, Manitoba	Organic-cooled	60.00	x	x	
	McMaster	Hamilton, Ont.	Pool-type	2.5	x	x	
	Slowpoke - Toronto	Univ. of Toronto	Pool-type	0.02	x	x	
	Slowpoke - Ottawa	Ottawa, Ont.	Pool-type	0 02	x	x	
	PTR	Chalk River, Ont.	Pool-type	0.00	x	x	
	ZED-2	Chalk River, Ont.	Pool-type	0 00	x	x	
	ZEEP	Chalk River, Ont.	Tank	0.00	x	x	
	Slowpoke - Halifax	Dalhousie Univ.	Pool-type	0.02	x	-	n/
	Slowpoke - Montreal	Ecole Poly.	Pool-type	0.02	x	x	
	Slowpoke - Edmonton	Univ. of Alberta	Pool-type	0.02	x	-	n/
Chile	Herald	Santiago	Herald	5.00	x	x	
	MTR	Lo Aguirre	Pool	10.00	x	-	1/
China, Republic of	THOR	Hsin-chu	Pool	1.00	x	x	
	TRR	Huaitzupu	NRX	40.00	x	x	
	ZPRL	Lung-Tan	Pool	0.01	x	x	
	THAR	Hsin-chu	Argonaut	0.01	x	x	
	MER	Hsin-chu	Mobile Educational Reactor	0.00	x	x	
Colombia	IAN-R1	Bogotá	Pool-type	0.02	x	x	
Czechoslovakia[b]	SR-OD[e]	Pilsen	Pool	0.00	x	x	
	SR-DB[e]	Pilsen	Pool	0.00	x	x	
	VVR-S	Rez	Tank	10.00	x	x	
	TR-O	Rez	Tank	0.00	x	x	
Democratic People's Republic of Korea	IRT (modified)	Nyonpyon	Pool-tank	2.00	x	-	k/
	Critical assembly	Nyonpyon	Tank	0.00	x	-	k/
Denmark[c]	DR-1	Risø	Homogeneous	0.00	x	x	
	DR-3	Risø	Tank	10.00	x	x	
Finland[b]	FiR-1	Otaniemi	Triga II	0.25	x	x	
German Democratic Republic[b]	WWR-S(M)	Rossendorf	Tank	10.00	x	x	
	RRR	Rossendorf	Tank	0.00	x	x	
	RAKE[e]	Rossendorf	Tank	0.00	x	x	
	Training Reactor AKR	Dresden	Tank		x	-	1/

State[a]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force
Germany, Federal Republic of[b]	FRM	Garching	Pool	4.00	x	- [l]
	GKSS-FRG1	Geesthacht	Pool	5.00	x	- [l]
	GKSS-FRG2	Geesthacht	Pool	15 00	x	- [l]
	GFK-FR-2	Karlsruhe	Tank	45.00	x	- [l]
	KFA-FRJ1	Jülich	Pool	10.00	x	- [l]
	KFA-FRJ2	Julich	Tank	23 00	x	- [l]
	Triga	Mainz	Triga I	0.10	x	x
	Triga 2	Heidelberg	Triga II	0.25	x	x
	FMRB	Braunschweig	Tank	1.00	x	x
	Triga	Hanover	Triga II	0.25	x	x
	Triga	Neuherberg	Triga II	1 00	x	x
	GFK-SNEAK	Karlsruhe	Critical assembly	0 00	x	- [f]
	KFA-KAHTER	Julich	Critical assembly	0 00	x	x
	ADIBKA	Jülich	Aqueous Homogeneous	0.00	x	x
	SUR 100	Garching	Solid-homogeneous	0.00	x	x
	SUR 100	Darmstadt	Solid-homogeneous	0.00	x	x
	SUR 100	Stuttgart	Solid-homogeneous	0.00	x	x
	SUR 100	Hamburg	Solid-homogeneous	0.00	x	x
	SUR 100	Kiel	Solid-homogeneous	0.00	x	x
	SUR 100	Ulm	Solid-homogeneous	0.00	x	x
	SUR 100	Karlsruhe	Solid-homogeneous	0.00	x	x
	SUR 100	Bremen	Solid-homogeneous	0.00	x	x
	SUR 100	Furtwang	Solid-homogeneous	0.00	x	x
	SUR 100	Aachen	Solid-homogeneous	0.00	x	x
	KFA-1TR	Jülich	Critical assembly	0.00	x	x
	BER-2	Berlin (West)	Aqueous Homogeneous	5 00	x	x
	SUR 100	Berlin (West)	Solid-homogeneous	0.00	x	x
Greece[b]	GRR-1	Athens	Pool	5 00	x	x
Hungary[b]	WWR-SM	Budapest	Pool	5 00	x	x
	ZR-4	Budapest	Pool	0 00	x	x
	ZR-6[e]	Budapest	Pool	0 00	x	x
	Training reactor	Budapest	Tank	0 01	x	x
Indonesia	PRAB (TRIGA II)	Bandung	Triga II	1.00	x	x
Iran[b]	TSPRR	Teheran	Pool	5.00	x	x
Iraq[b]	IRT-2000	Baghdad	Pool	2 00	x	x
Israel	IRR-1	Soreq	Pool	5 00	x	x
Italy[b]	Triga 1-RC1	Casaccia	Triga I	1 00	x	x
	AGN-201	Palermo	Solid-homogeneous	0.00	x	x
	CESNEF-L54	Milan	Aqueous Homogeneous	0 05	x	x
	ESSOR	Ispra	Tank	40 00	x	- [l]
	RTS-1-S PI A	Pisa	Pool	5 00	x	- [g]
	RANA	Casaccia	Pool	0 01	x	x
	RB-2	Montecucco	Argonaut	0 01	x	- [g]
	RITMO	Casaccia	Pool	0.00	x	x
	TAPIRO	Casaccia	Fast neutron	0 00	x	x
	Triga 2	Pavia	Triga II	0 25	x	x
	ROSPO	Casaccia	Tank	0 00	x	x
	RB-1	Montecucco	Graphite	0.00	x	x
	RB-3	Montecucco	Tank (D_2O)	0 01	x	x
Japan[b]	DCA	Oarai-Machi	Critical Facility	0 00	x	x
	FCA	Tokai-Mura	Critical Facility	0.00	x	x
	HTR	Kawasaki-shi	Pool	0.10	x	x
	JMTR	Oarai-Machi	Tank	50.00	x	x
	JMTR-CA	Oarai-Machi	Critical Facility	0.00	x	x
	JOYO	Oarai-Machi	EBR	50.00	x	x
	JPDR	Tokai-Mura	Boiling-Water	90.00	x	x
	JRR-2	Tokai-Mura	Tank	10.00	x	x
	JRR-3	Tokai-Mura	Tank	10.00	x	x
	JRR-4	Tokai-Mura	Pool	3.50	x	x
	Kinki University	Kowake	UTR-B	0.00	x	x
	KUR	Kumatori-cho	Pool	5.00	x	x
	KUCA	Kumatori-cho	Critical Facility	0.00	x	x
	NSRR	Tokai-Mura	Triga (pulse)	0.30	x	x
	Musashi College of Technology	Tamalku	Triga-II	0.10	x	x
	NAIG-CA	Kawasaki-ku	Critical Facility	0.00	x	x
	Rikkyo University	Nagasaka	Triga-II	0.10	x	x
	SHE	Tokai-Mura	Critical Facility	0.00	x	x
	TCA	Tokai-Mura	Critical Facility	0.00	x	x

State[a]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force	
	TODAI	Tokai-Mura	Fast Neutron Source Reactor	0.002	x	x	
	TTR	Kawasaki-ku	Pool	0.10	x	x	
	"Mutsu" (Nuclear Ship)	Minato-Machi Mutsu	PWR	36.00	x	x	
Korea, Republic of[b]	KRR - TRIGA II	Seoul	Triga II	0.10	x	x	
	KRR - TRIGA III	Seoul	Triga III	2 00	x	x	
Mexico[d]	Centro Nuclear de Mexico	Ocoyoacac	Triga III	1.00	x	x	
	Training reactor facility	Mexico City	SUR-100	0.00	x	x	
Netherlands[b]	LFR	Petten	Argonaut	0 01	x	x	
	HOR-THS	Delft	Pool	2 00	x	x	
	BARN	Wageningen	Graphite	0.10	x	x	
	HFR	Petten	Tank	45.00	x	-	l/
	DELPHY	Delft	Critical assembly		-	x	
Norway[b]	JEEP-II	Kjeller	Tank	2 00	x	x	
	HBWR	Halden	HBWR	25.00	x	x	
Pakistan	PARR	Rawalpindi	Pool	5.00	x	x	
Peru	RP-O	Lima	Tank	0 00	x	-	m/
Philippines[b]	PRR-1	Diliman, Quezon City	Pool	1 00	x	x	
Poland[b]	EWA	Świerk	Tank	8 00	x	x	
	Maryla[e]	Świerk	Tank	0.00	x	x	
	Anna	Świerk	Graphite	0 00	x	x	
	Agata	Świerk	Pool	0.00	x	x	
	Maria	Świerk	Tank	30 00	x	x	
Portugal	RPI	Sacavem	Tank	1 00	x	-	n/
Romania[b]	VVR-S	Margurele	Tank	10.00	x	x	
	RP-01	Margurele	Critical Facility	0.00	-	x	
	Triga	Pitesti	Triga II	14.00	-	x	
South Africa	SAFARI-1	Pelindaba	Tank	20 00	x	-	n/
Spain	JEN-1 and JEN-2	Madrid	Pool	3 00	x	x	
	CORAL-1	Madrid	Fast Critical Facility	0.00	x	x	
	ARBI	Bilbao	Argonaut	0.01	x	x	
	ARGOS	Barcelona	Argonaut	0.01	x	x	
Sweden[b]	R2	Studsvik	Tank	50.00	x	x	
	R2-O	Studsvik	Pool	1.00	x	x	
	KRITZ	Studsvik	Pool	0.00	x	x	
	R-O	Studsvik	Pool	0.00	x	x	
Switzerland[b]	Proteus	Würenlingen	Critical Facility	0.00	x	x	p/
	Saphir	Würenlingen	Pool	5.00	x	x	p/
	Diorit	Würenlingen	HW	30.00	x	x	p/
	Crocus	Lausanne	Pool	1.00	x	x	p/
	AGN201P	Geneva	Solid-homogeneous	0.00	x	x	p/
	AGN211P	Basel	Pool	0.00	x	x	p/
Thailand[b]	TRR-1	Bangkok	Pool	2.00	x	x	
Turkey	TR-1	Istanbul	Pool	1.00	x	x	
United Kingdom	Zebra	Winfrith	Critical Facility	0.00	x	x	
Uruguay[b]	RUDI	Montevideo	Lockheed	0 10	x	x	
Venezuela	RVI	Alto de Pipe	Pool	3.00	x	x	
Yugoslavia[b]	Triga II	Ljubljana	Triga II	0.25	x	x	
	Boris Kidric R.	Vinča	Tank	6.50	x	x	
	RB	Vinča	Critical Assembly	0.00	x	x	
Zaire[b]	Triga	Kinshasa	Triga II	1.00	x	x	

B. Nuclear power reactors

State[a]	Name of power reactor	Location	Type	Capacity MW(e)	In operation	Subsidiary arrangements in force	
Argentina	Atucha Nuclear Power Station	Atucha	PHWR	319	x	x	
	Embalse	Cordoba	Candu	600	-	x	
Austria[b]	Tullnerfeld	Zwentendorf	PWR	700	-	x	
Belgium[b]	BR-3-CEN-Mol	Mol	PWR	11	x	x	
	DOEL-1-Antwerp	Antwerp	PWR	412	x	x	
	DOEL-2-Antwerp	Antwerp	PWR	412	x	x	
	SEMO-Tihange	Tihange	PWR	920	x	x	
Brazil	Angra-1	Angra dos Reis	PWR	975	-	x	
Bulgaria[b]	Kozloduy-1[e]	Kozloduy	PWR	440	x	x	
	Kozloduy-2[e]	Kozloduy	PWR	440	x	x	
Canada[b]	Bruce-1	Tiverton, Ontario	Candu	788	x	-	[h]
	Bruce-2	Tiverton, Ontario	Candu	788	x	-	[h]
	Bruce-3	Tiverton, Ontario	Candu	788	x	-	[h]
	Bruce-4	Tiverton, Ontario	Candu	788	-	-	[h]
	DPGS	Kincardine, Ontario	Candu	208	x	x	
	Gentilly-1	Gentilly, Quebec	Candu	250	x	x	
	Gentilly-2	Gentilly, Quebec	Candu	600	-	-	[o]
	NPD	Ralphton, Ontario	Candu	22	x	x	
	Pickering-1	Pickering, Ontario	Candu	540	x	x	
	Pickering-2	Pickering, Ontario	Candu	540	x	x	
	Pickering-3	Pickering, Ontario	Candu	540	x	x	
	Pickering-4	Pickering, Ontario	Candu	540	x	x	
China, Republic of	FNPS-1	Ching-San	BWR	636	x	x	
	FNPS-2	Ching-San	BWR	636	-	x	
Czechoslovakia[b]	A1	Bohunice	HWGC	143	x	x	
	V. 1 Bohunice-1	Bohunice	PWR	440	x	x	
Finland[b]	Loviisa-1[e]	Loviisa	PWR	440	x	x	
	Loviisa-2[e]	Loviisa	PWR	440	-	x	
	TVO-1	Okiluoto	PWR	660	x	x	
German Democratic Republic[b]	Rheinsberg PWR	Rheinsberg	PWR	80	x	x	
	Bruno Leuschner-1[e]	Greifswald	PWR	440	x	x	
	Bruno Leuschner-2[e]	Greifswald	PWR	440	x	x	
	Bruno Leuschner-3	Greifswald	PWR	440	x	x	
	Bruno Leuschner-4	Greifswald	PWR	440	-	x	
Germany, Federal Republic of[b]	KRB-1-Gundremmingen	Gundremmingen	BWR	250	x	x	
	GFK-MZFR-Karlsruhe	Karlsruhe	PWR	58	x	x	
	VAK-KAHL-Grosswelzheim	Grosswelzheim	BWR	16	x	x	
	AVR-Jülich	Jülich	HTGR	15	x	-	[g]
	KWL-1-Lingen	Lingen	BWR	267	x	x	
	KNK-Karlsruhe	Karlsruhe	SZR	21	x	-	[l]
	KWW-Wurgassen	Wurgassen	BWR	670	x	x	
	KKS-Stade-1-HAM	Stade	PWR	662	x	x	
	KWO-Obrigheim	Obrigheim	PWR	345	x	x	
	KKB-Brunsbuttel	Brunsbuttel	BWR	805	x	x	
	RWE-BIBLIS-A	Biblis	PWR	1204	x	x	
	RWE-BIBLIS-B	Biblis	PWR	1300	x	x	
	GKN-Neckarwestheim	Neckarwestheim	PWR	805	x	x	
	KKU-Unterweser	Unterweser	PWR	1300	x	x	
	KKI-ISAR	Ohu	BWR	907	x	x	
	GKSS-Geesthacht	Geesthacht	BWR	12	x	-	[g]
	KKP-Philippsburg	Philippsburg	BWR	907	x	x	
India	Tarapur-1	Tarapur	BWR	190	x	x	
	Tarapur-2	Tarapur	BWR	190	x	x	
	Rajasthan-1	Rajasthan	Candu	200	x	x	
	Rajasthan-2	Rajasthan	Candu	200	-	x	
Italy[b]	E. N. E. L. - Latina	Latina	GCR	160	x	-	[g]
	E. N. E. L. - Garigliano	Garigliano	BWR	160	x	x	
	FERMI-TRINO-VER	Turin	PWR	256	x	x	
	E. N. E. L. - Caorso	Caorso	BWR	920	x	x	

State[a/]	Name of power reactor	Location	Type	Capacity MW(e)	In operation	Subsidiary arrangements in force	
Japan[b/]	Fugen	Tsuruga	ATR	165	x	x	
	Fukushima-1	Okuma-Fukushima	BWR	460	x	x	
	Fukushima-2	Okuma-Fukushima	BWR	784	x	x	
	Fukushima-3	Okuma-Fukushima	BWR	784	x	x	
	Fukushima-4	Okuma-Fukushima	BWR	784	x	x	
	Fukushima-5	Okuma-Fukushima	BWR	784	x	x	
	Fukushima-6	Okuma-Fukushima	BWR	1100	-	x	
	Genkai-1	Kyushu	PWR	559	x	x	
	Hamaoka-1	Hamaoka-cho	BWR	540	x	x	
	Hamaoka-2	Hamaoka-cho	BWR	840	x	x	
	Ikata-1	Nishiuwagun	PWR	566	x	x	
	Mihama-1	Mihama-Fukai	PWR	340	x	x	
	Mihama-2	Mihama-Fukai	PWR	500	x	x	
	Mihama-3	Mihama-Fukai	PWR	826	x	x	
	Ohi-1	Ohi-cho	PWR	1175	x	x	
	Ohi-2	Ohi-cho	PWR	1175	x	x	
	Shimani	Kashima-cho	BWR	460	x	x	
	Takahama-1	Takahama	PWR	826	x	x	
	Takahama-2	Takahama	PWR	826	x	x	
	Tokai-1	Tokai-Mura	Magnox	166	x	x	
	Tokai-2	Tokai-Mura	BWR	1100	x	x	
	Tsuruga	Tsuruga	BWR	357	x	x	
Korea, Republic of[b/]	Kori-1	Kori	PWR	564	x	x	
Netherlands[b/]	GKN-Dodewaard	Dodewaard	BWR	54	x	x	
	PZEM-Borssele	Borssele	PWR	468	x	x	
Pakistan	KANUPP	Karachi	Candu	125	x	x	
South Africa	Koeberg-1	Cape Town	PWR	1100	-	x	
	Koeberg-2	Cape Town	PWR	1100	-	x	
Spain	Almaraz-1	Province of Caceres	PWR	930	-	-	m/
	Almaraz-2	Province of Caceres	PWR	930	-	-	m/
	Asco-1	Province of Tarragona	PWR	930	-	-	m/
	Asco-2	Province of Tarragona	PWR	930	-	-	m/
	Cofrentes	Province of Valencia	BWR	975	-	-	m/
	José Cabrera	Almonacid de Zorita	PWR	153	x	x	
	Lemoniz-1	Province of Viscaya	PWR	930	-	-	m/
	Lemoniz-2	Province of Viscaya	PWR	930	-	-	m/
	Santa Maria de Garona	Province of Burgos	BWR	440	x	x	
	Sayago	Province of Zumora	PWR	1000	-	-	o/
	Valdecaballeros-1	Province of Badajoz	BWR	1000	-	-	o/
	Valdecaballeros-2	Province of Badajoz	BWR	1000	-	-	o/
Sweden[b/]	Barsebäck-1	Near Malmö	BWR	580	x	x	
	Barsebäck-2	Near Malmö	BWR	580	x	-	n/
	Forsmark-1	Near Uppsala	BWR	900	-	-	o/
	Oskarshamn-1	Oskarshamn	BWR	440	x	x	
	Oskarshamn-2	Oskarshamn	BWR	580	x	x	
	Ringhals-1	Near Göteborg	BWR	760	x	x	
	Ringhals-2	Near Göteborg	PWR	830	x	x	
	Ringhals-3	Near Göteborg	PWR	912	-	-	o/
	Ringhals-4	Near Göteborg	PWR	912	-	-	o/
Switzerland[b/]	Mühleberg	Mühleberg	BWR	306	x	x	p/
	Beznau I	Beznau	PWR	350	x	x	p/
	Beznau II	Beznau	PWR	350	x	x	p/
	KKG	Gösgen-Däniken	PWR	920	x	x	p/

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

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Argentina	Pilot Fuel Fabrication Plant	Constituyentes	Fuel fabrication	x
Belgium[b/]	FBFC	Dessel	Fuel fabrication	- 1/
	Belgonucleaire-BN-MOX	Dessel	Mox fuel fabrication	x
Canada[b/]	CRNL Fuel Fabrication Plant	Chalk River	Fuel fabrication	x
	Canadian General Electric Fuel Fabrication Plant	Peterborough Ontario	Fuel fabrication	x
	Canadian General Electric Pelletizing Plant	Toronto Ontario	Fuel fabrication	x
	Westinghouse Fuel Fabrication Plant	Port Hope Ontario	Fuel fabrication	x
	Eldorado Nuclear Ltd	Port Hope, Ontario	Conversion	x
	Westinghouse Fuel Fabrication Plant	Varennes Quebec	Fuel fabrication	- h/
China, Republic of	INER Fuel Fabrication Plant	Lung Ton	Fuel fabrication	x
Czechoslovakia[b/]	Nuclear Fuel Institute	Prague	Fuel fabrication	x
Denmark[c/]	Metallurgy Department Risø	Risø	Fuel fabrication	- 1/
Germany, Federal Republic of[b/]	ALKEM-Wolfgang	Hanau	Mox conversion and fuel fabrication	- g/
	NUKEM-Wolfgang	Hanau	Conversion and fuel fabrication	- f/
	RBU-1-Wolfgang	Hanau	Conversion and fuel fabrication	- 1/
	RBU-2-Karlstein	Karlstein	Fuel fabrication	- 1/
	KWU-Karlstein	Karlstein	Fuel fabrication	x
	GWK-WAK-Leopoldshafen	Karlsruhe	Reprocessing	x
India	Nuclear Fuel Complex	Hyderabad	Enriched uranium fuel conversion and fabrication	x
Italy[b/]	Fabnuc-Bosco Marengo	Alessandria	Fuel fabrication	- g/
	COREN	Saluggia	Fuel fabrication	- g/
	EUREX	Saluggia	Reprocessing	- 1/
	IFEC	Saluggia	Fuel fabrication	- g/
	ITREC-Trisaia	Rotondella	Reprocessing	- 1/
Japan[b/]	PNC Reprocessing Plant	Tokai-Mura	Reprocessing	x
	NFI (Kumatori-1)	Kumatori, Osaka	Fuel fabrication	x
	SMM (Tokai-1)	Tokai-Mura	Fuel fabrication	x
	JNF	Yokosuka	Fuel fabrication	x
	MNF	Tokai-Mura	Fuel fabrication	x
	PPFF	Tokai-Mura	Fuel fabrication	x
	MAPI	Ohmiya	Fuel fabrication	x
	NFI (Kumatori-2)	Kumatori, Osaka	Fuel fabrication	x
	NFI (Takayama-2)	Takayama	Fuel fabrication	x
	PNC (Tokai R&D)	Tokai-Mura	Enrichment	x

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Netherlands[b/]	URENCO-Almelo	Almelo	Enrichment	- g/
	Ultra-Centrifuge	Almelo	Enrichment	- g/
Norway[b/]	Fuel Element Pilot Production Plant	Kjeller	Fuel fabrication	x
Romania[b/]	Demfuel	Pitesti	Fuel fabrication	- g/
Spain	Metallurgical Plant Juan Vigon Research Centre	Madrid	Fuel fabrication	x
	Pilot Reprocessing Plant Juan Vigon Research Centre	Madrid	Fuel reprocessing	x
Sweden[b/]	ASEA - ATOM	Västeras	Fuel conversion and fabrication	x

D. Separate storage facilities and other locations*

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force	
Australia[b/]	Research Laboratory	Lucas Heights	Other locations	x	
Belgium[b/]	CEN-Labo-Mol	Mol	Other locations	-	1/
	BCMN-Geel	Geel	Other locations	-	1/
	IRE-Mol	Mol	Other locations	-	r/
	Overpelt-Olen	Olen	Separate storage	-	1/
	Eurochemic-Mol	Mol	Separate storage	-	1/
	BN-Mol	Mol	Separate storage	-	g/
Canada[b/]	Chalk River Nuclear Laboratories	Chalk River	Other locations	x	
Czechoslovakia[b/]	Research Laboratories	Rez	Other locations	x	
Denmark[c/]	FAB. STO. Risø	Risø	Separate storage	-	1/
German Democratic Republic[b/]	Miscellaneous locations combined in one material balance area	Various	Other locations	x	
Germany, Federal Republic of[b/]	KFA-NEA-Jülich	Julich	Other locations	-	g/
	KFK-LAB-Karlsruhe	Karlsruhe	Other locations	-	1/
	KFA-LAB-Jülich	Jülich	Other locations	-	g/
	KWU-Hotcell-Karlstein	Karlstein	Other locations	-	1/
	KFK-Hotcell-Karlsruhe	Karlsruhe	Other locations	-	1/
	TRANSURAN-Karlsruhe	Karlsruhe	Other locations	-	1/
	KFK-RA. CHEM. Karlsruhe	Karlsruhe	Other locations	x	
	KWU-LAB-Erlangen	Erlangen	Other locations	x	
	TRADE-Karlsruhe	Karlsruhe	Separate storage	-	g/
	Braunkohle-Wesseling	Wesseling	Separate storage	-	1/
Hungary[b/]	Institute of Isotopes	Budapest	Other locations	x	
Italy[b/]	CNEN-LAB. TEC-Casaccia	Casaccia	Other locations	-	1/
	CNEN. LAB. PU. -Casaccia	Casaccia	Other locations	-	1/
	CCRM-Ispra	Ispra	Separate storage	-	1/
	CCRM-ECO	Ispra	Separate storage	-	g/
	AGIP Bosco-Marengo	Alessandria	Separate storage	-	g/
Japan[b/]	JAERI-Oarai R&D	Oarai-Machi	Other locations	x	
	JAERI-Tokai R&D	Tokai-Mura	Other locations	x	
	NERL, University of Tokyo	Tokai-Mura	Other locations	x	
	NFD Research Fac.	Oarai-Machi	Other locations	x	
	NRF Research Fac.	Tokyo	Other locations	x	
	Japan Atomic Power-Tsuruga	Tsuruga	Separate storage	x	
	Chubu Electric Power	Hamaoka	Separate storage	x	
	TEPC-Fukushima No. 1 P	Tokyo	Separate storage	x	
	Shikoku Electric Power	Ikata	Separate storage	x	
	Japan Atomic Power-Tokai	Tokai	Separate storage	x	
	Japan Atomic Power-Tokai 2	Tokai	Separate storage	x	

* The category "Other locations" includes accountability areas containing more than one effective kilogram of nuclear material.

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force
	Chugoku Electric Power	Shimane-ken	Separate storage	x
	Kansai Electric Power-Takahama 1 & 2	Takahama-machi	Separate storage	x
	Kyushu Electric Power-Genkai	Genkai-cho	Separate storage	x
	Kansai Electric Power	Mihama-cho	Separate storage	x
	Kansai Electric Power-Ohi	Takahama-machi	Separate storage	x
Netherlands[b/]	R. LABO-Petten	Petten	Other locations	- 1/
Poland[b/]	Institute of Nuclear Research	Świerk	Other locations	x
	Miscellaneous locations combined in one material balance area	Various	Other locations	x
Sweden[b/]	Miscellaneous locations combined in one MBA	Various	Other locations	x
	Central Hot Laboratory	Studsvik	Other locations	x
UK	Windscale storage facility	Windscale	Separate storage	x
USA	Argonne National Laboratory	Argonne	Separate storage	x

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

b/ NPT safeguards agreement.

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

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

e/ In the Annual Report for 1977 this nuclear facility was erroneously included under the one immediately preceding.

f/ In force on 1 February 1979.

g/ In force on 1 March 1979.

h/ In force on 15 March 1979.

i/ In force on 1 April 1979.

j/ In force on 5 April 1979.

k/ In force on 23 April 1979.

l/ When the Annual Report for 1978 was finalized, the agreed date of entry into force was 1 October 1979.

m/ Proposal made by the Agency in November 1978.

n/ Proposal has been made or will be made by the Agency in 1979.

o/ No proposal made as yet by the Agency.

p/ Concluded pursuant to the Switzerland/USA/Agency safeguards agreement (INFCIRC/161).

q/ Under negotiation.

r/ Shut down in 1979.

INIS

205. During 1978 a further eight Member States agreed to participate in the INIS, bringing the total number of participants to 60 countries and 13 international organizations. For the first time more than 70 000 references were processed. By the end of the year, the file of information had grown to almost 400 000 items and there were almost 100 000 documents available in microfiche form in the publications "library".

206. INIS is the first operational information system to combine decentralized input preparation with the centralized processing of information. The methods and equipment used for processing the input are among the most modern available. They include optical character recognition, on-line data entry through computer terminals and computerized photocomposition.

207. During 1978 an experimental on-line facility was established to enable a number of organizations to consult the INIS computer files directly from their own terminals. By the end of the year, ten European countries were participating in this experiment and recording a steadily increasing use of the facility.

208. Special workshops were organized within the framework of the INIS training programme to teach staff from information centres in Austria, Czechoslovakia, Hungary, the Netherlands, Norway and the United Kingdom how to make the best use of the on-line methods of information retrieval. Also, a large-scale seminar was held in Vienna. As in previous years, these training activities were undertaken jointly with AGRIS.

209. INIS has been expanded to cover, from January 1979, literature dealing with the medical applications of ionizing radiation and radionuclides; also, a system for the indexing of records that contain numerical data has been implemented.

Larger computer

210. The new computer, an IBM 3032, installed in December 1978, is more powerful and less expensive than the previous one. It will provide faster processing of safeguards data, support the Agency's and UNIDO's computerized administrative and information systems, process data for INIS and be the central resource for the development of access to data files by means of teleprocessing equipment. The use of on-line terminals increased during 1978.

211. In 1978 an agreement was reached to provide computer support to UNRWA (United Nations Relief and Works Agency for Palestine Refugees in the Near East) on the same basis as that on which the Agency supports UNIDO. Processing of UNRWA data started early in 1979.

ADMINISTRATION

External and legal affairs

Physical protection

212. Although the physical protection of nuclear materials and facilities is the responsibility of individual States, Governments have a legitimate interest in the effectiveness of the measures adopted by other countries, and there have been growing demands for international co-operation through the Agency. In 1978 representatives of 40 Governments met to continue negotiating a convention on the physical protection of nuclear materials, and considerable progress was made.

213. The first interregional course on physical protection was over-subscribed, and the United States Government is planning to repeat the course in co-operation with the Agency on a more regular basis. Work is proceeding on the preparation of a handbook on physical protection and a data bank has been established.

214. Advice was provided to Egypt and Malaysia on the elaboration of nuclear legislation and connected regulatory matters.

International plutonium management

215. In July the Director General circulated to all Member States a Secretariat study on the international management and storage of plutonium and spent fuel, which had been prepared with the assistance of consultants. The plutonium storage aspects of this study were followed up in December by the first meeting of an expert group on international plutonium storage, convened to prepare proposals for an international plutonium storage system under the provisions of the Statute.

216. Twenty-one Member States and two observers participated in the meeting. Good progress was made in discussing principles for the deposit and release of plutonium, the location and management of internationally supervised stores and possible institutional arrangements. The work of the expert group will continue in 1979.

Move to the Vienna International Centre

217. During the year, construction work on the Agency's Permanent Headquarters progressed substantially and the move to the Vienna International Centre is expected to start in October 1979. This large building complex, covering approximately 250 000 square metres, will accommodate the Agency, certain units of the United Nations and UNIDO. Work on the organization of joint services with UNIDO and the United Nations advanced according to plan.

Increased staff

218. Last year 169 staff members left the Agency and 251 were appointed. Of the new staff members, 101 were in the Professional category.

219. At the end of the year, the total number of staff in the Professional and higher categories was 507; there were 777 in the General Service category and 279 in the Maintenance and Operatives Service category. Among the staff subject to geographical distribution 66 nationalities were represented in the Secretariat on 31 December 1978, compared with 64 a year earlier.

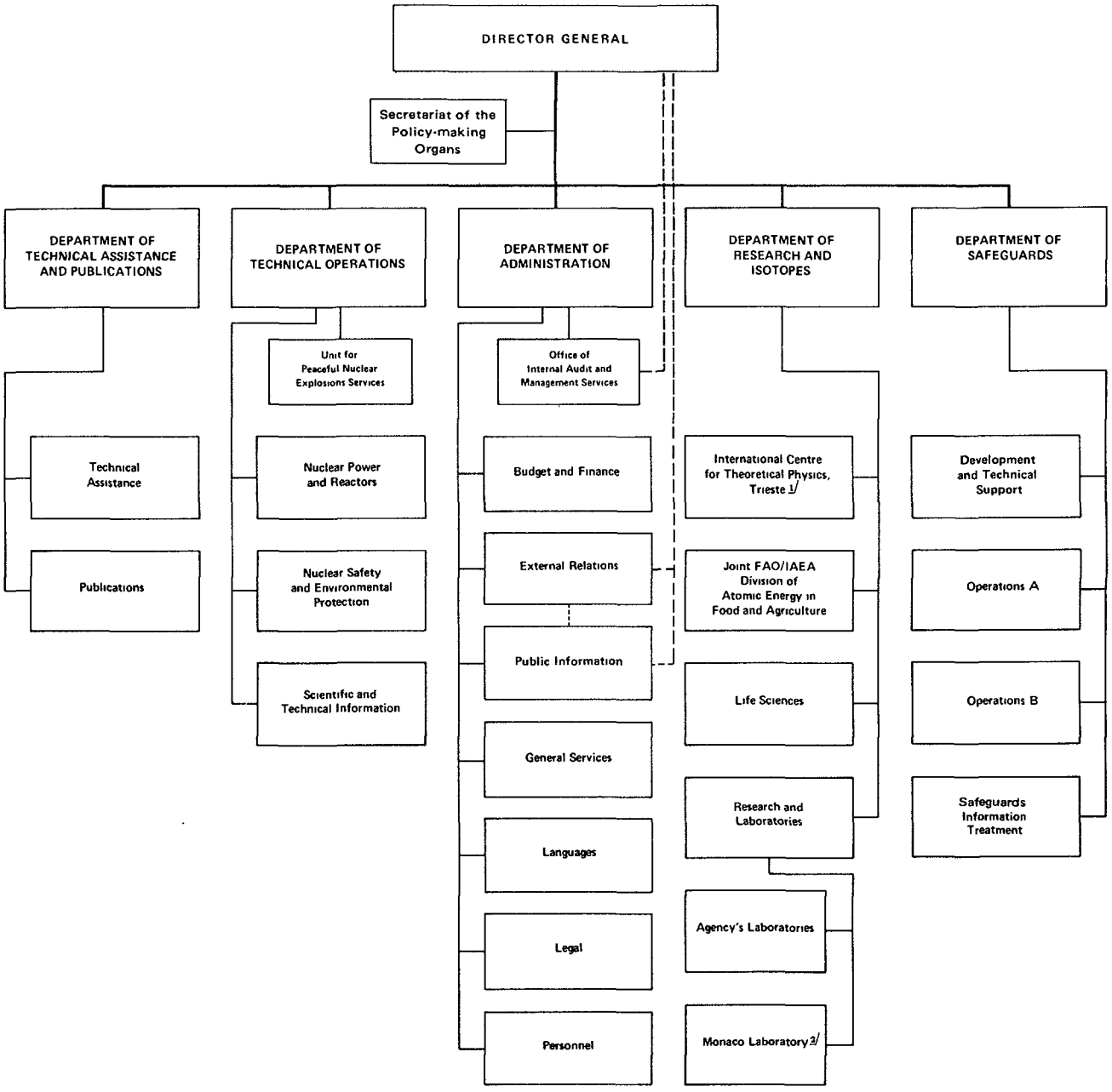
220. The organizational chart at the end of the chapter shows the structure of the Secretariat.

Joint Inspection Unit Reports

221. Listed below are the reports and notes issued by the Joint Inspection Unit (JIU) during the period July 1977-June 1978.

Report number	Title
JIU/REP/77/5	The Implications of Additional Languages in the United Nations System
JIU/REP/77/6	Some Aspects of Backstopping of Technical Co-operation Activities in the United Nations System
JIU/REP/77/7	Women in the Professional Category and above in the United Nations System
JIU/REP/78/1	Programming and Evaluation in the United Nations
JIU/REP/78/2	United Nations Public Administration and Finance Programme 1972-1976
JIU/REP/78/3	Role of Experts in Development Co-operation
Note number	**Title**
JIU/NOTE/77/3	Views of the Joint Inspection Unit on Agency Overhead Costs
JIU/NOTE/78/1	Expanded Preliminary Note on a New System for Agency Support Costs
JIU/NOTE/78/2	Staff Welfare in the United Nations, some Specialized Agencies and IAEA

ORGANIZATIONAL CHART



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