THE ANNUAL REPORT FOR 1986

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INTERNATIONAL ATOMIC ENERGY AGENCY

THE ANNUAL REPORT FOR 1986

CONTENTS

LIST OF ABBREVIATIONS

AGRIS	Agricultural Information System
ARCAL	Regional co-operative arrangements for the promotion of nuclear science and technology in Latin America
BWR	Boiling-water reactor
CANDU	Canadian deuterium-uranium (reactor)
CEC	Commission of the European Communities
C/S	Containment/surveillance
EEC	European Economic Community
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
IMO	International Maritime Organization
INTOR	International Tokamak Reactor
NDA	Non-destructive assay
NEA	Nuclear Energy Agency of OECD
NNW	Non-nuclear-weapon (State)
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NUSS (programme)	The Agency's programme on nuclear safety standards for nuclear power plants
NW	Nuclear-weapon (State)
OECD	Organization for Economic Co-operation and Development
OSART	Operational Safety Review Team
PWR	Pressurized-water reactor
R&D	Research and Development
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (INFCIRC/167)
SIT	Sterile-insect technique
SQ	Significant quantity
Tlatelolco Treaty	Treaty for the Prohibition of Nuclear Weapons in Latin America
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UNIPEDE	International Union of Producers and Distributors of Electrical Energy
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VIC	Vienna International Centre
WEC	World Energy Conference
WHO	World Health Organization
WMO	World Meteorological Organization
WWER	Water-cooled and -moderated reactor (Soviet Union)

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1. All sums of money are expressed in United States dollars.

2. The designations employed and the presentation of material in this document do 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.

EXECUTIVE SUMMARY

Nuclear power

1. The total installed nuclear power-generating capacity in the world increased by about 8.9% during 1986, reaching 273.7 GW(e) by the end of the year. Nuclear power plants accounted for more than 15% of the world's electricity generation in 1986, at the end of which there were 397 nuclear power plants in operation (see Table 1), representing an accumulated operating experience of more than 4200 reactor years.

2. The most important event in 1986 in the nuclear power field was the Chernobyl accident. The overall effects of this accident on the nuclear power programmes of Member States have yet to be seen. It produced an expected immediate upsurge in public and political opposition to nuclear power in many countries, but it did not cause the cancellation of any nuclear power programmes. The delays in some nuclear power projects and the slowing down of some programmes may be attributable, at least partly, to the accident. The only power reactor permanently shut down during 1986 was the Chernobyl No. 4 unit.

3. During the year, 23 new plants came on line (in Canada, Czechoslovakia, France, the Federal Republic of Germany, Hungary, Japan, the Republic of Korea and the United States), while the construction of two reactors (in the United States) was cancelled and that of one (Philippines) suspended. There was still no general upturn in the ordering of new nuclear plants nor in construction starts. Regarding advanced nuclear systems, the highlight in 1986 was the grid connection of the 1200-MW(e) Super Phénix fast breeder reactor in France.

4. Efforts to help strengthen developing Member States infrastructures for the planning, implementation and operation of nuclear power projects continued through interregional and national training courses, technical co-operation projects, advisory missions and guidebooks.

5. A senior expert group was established to study mechanisms to assist developing countries in the promotion and financing of their nuclear power programmes and held two meetings during 1986.

Table 1

Nuclear power reactors in operation and under construction at the end of 1986

Country name	In operation		Under construction		Electricity generated by nuclear power reactors in 1986		Total operating experience (to end 1986)	
	Number of units	Total MW(e)	Number of units	Total MW(e)	TW(e)·h	% of total	Years	Months
Argentina	2	935	1	692	(5.4)*	(11.3)	16	7
Belgium	8	5 486			37.1	67.0	72	1
Brazil	1	626	1	1 245	0.1	0.1	4	9
Bulgaria	4	1 632	2	1 906	11.2	30.0	34	6
Canada	18	11 249	5	4 361	67.2	14.7	169	6
China			1	288				
Cuba			2	816				
Czechoslovakia	7	2 799	9	5 508	(16.2)	(21.0)	28	6
Finland	4	2 310			18.0	38.4	31	4
France	49	44 693	14	17 809	241.4	69.8	384	6
German Democratic Republic	5	1 694	6	3 432	(12.2)	(11.6)	62	5
Germany, Federal Republic of	21	18 947	4	4 052	112.1	29.4	235	7
Hungary	3	1 235	1	410	7.0	25.8	6	9
India	6	1 154	4	880	4.5	(2.7)	60	8
Iran, Islamic Republic of			2	2 400				
Italy	3	1 273	3	1 999	8.2	4.5	72	10
Japan	35	25 821	10	8 431	166.5	24.7	321	5
Korea, Republic of	7	5 380	2	1 800	26.6	43.6	21	7
Mexico			2	1 308				
Netherlands	2	507			4.0	6.2	31	9
Pakistan	1	125			0.5	(1.8)	15	3
Poland			2	880				
Romania			3	1 980				
South Africa	2	1 842			8.8	6.8	4	3
Spain	8	5 599	2	1 920	35.9	29.4	64	10
Sweden	12	9 455			67.0	50.3	111	2
Switzerland	5	2 932			21.3	39.2	58	10
Union of Soviet Socialist Republics	50	27 657	32	29 910	(148.0)	(10.0)	579	11
United Kingdom	38	10 222	4	2 520	51.8	18.4	732	10
United States of America	99	84 592	21	23 301	414.0	16.6	1 051	0
Yugoslavia	1	632			3.8	5.4	5	3
Worldwide[a]	397	273 715	133	117 848	1 514.6		4 210	2

[a] "Worldwide" figures include Taiwan, China, where there are six units with a total capacity of 4918 MW(e) in operation and where a total of 32 years and 1 month of operating experience had been gained.

* Figures in brackets indicate estimates — no data provided by Member States.

Nuclear safety and radiation protection, including the Agency's response to the accident at Chernobyl

6. At the invitation of the Government of the Soviet Union, the Director General, accompanied by two senior experts in nuclear power and nuclear safety, travelled early in May to the Soviet Union for discussions with the Soviet authorities of the actions which might be taken within the framework of the Agency in order to enable all to learn from the accident and to facilitate consideration of the national and international nuclear safety measures required.

7. In immediate response to the accident, the Agency facilitated international data exchange aimed at defining areas affected by radioactive releases, establishing informal contacts with radiation protection authorities in most European countries in order to obtain a more complete picture of the extent of the areas affected by the accident. Also, together with WHO, WMO and UNSCEAR, it began planning for the systematic collection of data.

8. In May and June, the Board of Governors decided on the actions to be taken immediately within the Agency framework. These included the drafting of two international agreements (see paragraph 9 below), a post-accident review meeting (see paragraph 10 below), a special session of the General Conference (see paragraph 11 below), and a meeting of experts from Member States to review Agency safety programme plans and priorities (see paragraph 12 below).

9. In July and August, a governmental expert group met in Vienna and drafted two international agreements: the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. The Conventions were adopted at the special session of the General Conference (see paragraph 11 below). The Convention on Early Notification entered into force on 27 October.[1]

10. From 25 to 29 August, at a review meeting convened by the Agency, nuclear experts from the Soviet Union and experts from the rest of the international nuclear community exchanged information on accident experience; in the following week, the Agency's International Nuclear Safety Advisory Group (INSAG) prepared a report on the meeting and made recommendations for further activities.

11. A special session of the General Conference was held in September for the sole purpose of considering measures to strengthen international co-operation in nuclear safety and radiological protection. In addition to adopting the Conventions referred to in paragraph 9 above, the Conference reached a significant consensus on certain basic policy questions — namely, that nuclear power will continue to be an important source of energy for social and economic development; that each country is responsible for securing the highest level of safety in its nuclear energy activities; that there is scope for further international co-operation in nuclear safety; and that the Agency has the central role to play in encouraging and facilitating such co-operation.

12. In November, the Expert Working Group on International Co-operation in Nuclear Safety and Radiation Protection made recommendations on Secretariat proposals for an expanded nuclear safety and radiation protection programme designed to strengthen international co-operation in improving nuclear power safety. In December, the Board of Governors approved the expanded programme for 1987 and also laid the basis for the consideration, within the Agency, of a number of proposals concerning international co-operation in the field of nuclear safety.

13. All the above-mentioned activities were greatly assisted by the co-operation of and contributions from the Governments of the Soviet Union and other Member States and various international organizations.

14. With the increasing emphasis on operational safety at nuclear installations, Agency OSART missions were invited to nuclear power plants in six countries (four missions taking place in the last four months of the year), the Agency's Incident Reporting System was expanded and strengthened, the first mission under a programme for assessing safety-significant events at nuclear power plants (the ASSET[2] programme) took place, and missions were sent to assess safety at twelve research reactors in eight countries.

15. The shift from the preparation to the implementation of NUSS documents continued; the last of the NUSS guides were issued, Member States were helped in interpreting NUSS documents in connection with licensing, and work relating to severe accident management was accelerated. In the field of probabilistic safety assessment (PSA), the Agency continued to assist Member States in using PSA techniques to analyse severe nuclear accidents.

16. Work on the development of occupational radiation protection guidance continued, with increased emphasis on radiation protection advisory missions to assess and upgrade the quality of radiation protection at specific facilities in various Member States. Further publications on the safe transport of radioactive materials were prepared and the Agency continued to provide routine personal monitoring services.

Nuclear fuel cycle

17. The Agency continued to collect and disseminate, in co-operation with NEA, up-to-date information on world uranium resources and supply, on

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[1] The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency entered into force on 26 February 1987.

[2] ASSETs: Assessment of Safety-Significant Events Teams.

uranium exploration and production activities, and on nuclear fuel cycle requirements and facilities. Technical assistance in uranium exploration and resource development continued to be provided to developing countries.

18. Surplus production of uranium in the past has resulted in oversupply and low market prices. Production is now running at a level below reactor consumption, and exploration is at low levels. Existing and committed production is sufficient to meet requirements only until the early 1990s, with consequent concern about long-term uranium supplies.

19. In the field of fuel performance, emphasis was placed on materials reliability under high burn-up, abnormal and accident conditions and on improvements in fuel utilization and fabrication. As regards the back-end of the nuclear fuel cycle, the main emphasis was on technical, environmental, economic and safety aspects of transport and on the short- and long-term wet and dry storage of spent fuel.

Radioactive waste management

20. In response to the needs of developing countries, preparations were made for the start of a Waste Management Advisory Programme (WAMAP) aimed at providing more comprehensive and better co-ordinated assistance.

21. With many nuclear reactors reaching the end of their operating lifetime, the Agency's programme on decommissioning and decontamination assumed greater importance. A scientific afternoon devoted to this subject was held during the thirtieth regular session of the General Conference.

22. In the field of waste management, recommendations relating to the mining and milling of uranium and thorium ores, to the management of wastes from nuclear power plants and to the dumping of wastes at sea were issued. Tentative guidance on principles for exemption from regulatory control were issued, together with an interim progress report on an initial application of the principles.

Application of nuclear techniques

23. In the area of food and agriculture, the Agency, through the Joint FAO/IAEA Division, continued to help developing Member States to improve their agriculture and food production through the application of isotopes, ionizing radiation and related techniques, especially biotechnology.

24. Over 180 technical co-operation projects were carried out in 60 developing Member States; also, 13 regional and interregional projects were carried out. In addition, research was co-ordinated through 43 programmes involving 450 research contracts and agreements.

25. In the life sciences area, assistance continued to be rendered to Member States — and especially the developing countries among them — with the application of nuclear techniques in medicine, biology and health-related environmental research.

26. The scientific committee of the IAEA/WHO network of Secondary Standard Dosimetry Laboratories (SSDLs) held its first meeting. The present status of and future trends in the radiation therapy of cancer in developing countries were reviewed at a symposium organized by the Agency in co-operation with WHO.

27. The Agency continued to promote exchanges of information in the physical and earth sciences and to assist both developing and developed countries with the application of nuclear techniques in experimental physics, analytical and radiation chemistry, non-destructive testing, radiation processing, industrial process control, geology, mining and hydrology. Emphasis was placed on research reactor utilization and the provision of nuclear data services to developing countries.

Technical co-operation

28. During 1986, a total of 854 projects were operational and 71 training courses were held. These activities involved 1930 expert assignments. In addition, 937 persons received training under the fellowship programme. Progress made in programme delivery in 1986 is reflected in the following table.

Item	1983	1984	1985	1986
Number of expert assignments	1099	1530	1846	1930
Number of expert man-months served	1020	1550	1585	1516
Number of expert assignments undertaken by Agency staff	333	378	418	449
Number of purchase orders processed	2405	2970	3391	3738
Number of fellows in the field	612	702	615	734
Number of visiting scientists	65	123	188	203
Number of participants in study tours and training courses	659	850	926	972

29. Total resources for technical co-operation activities in 1986 increased by 9% over the previous year to $39.3 million (1985: $36.1 million). All-time high net expenditure rates were attained for the programme as a whole (67.6%) and for that part of the programme financed from the Technical Assistance and Co-operation Fund (75.7%).

Seibersdorf Laboratories

30. The Seibersdorf Laboratories continued to provide practical support to Agency programmes and advice and assistance to developing Member States. It

supported the implementation of technical co-operation projects and provided training for young scientists and technicians. Following the Chernobyl accident, a programme on the monitoring of fallout radioactivity in the environment and in food was initiated.

31. A new laboratory wing — the construction costs of which were shared by FAO and the Agency and which contains substantial amounts of equipment and supplies donated by Member States — was inaugurated in October as a replacement of the old building used for agricultural work at Seibersdorf.

International Laboratory of Marine Radioactivity

32. A new seat agreement between the Agency and the Principality of Monaco entered into force on 17 October. Work continued on the preparation of additional temporary laboratory facilities for occupation in 1987.

International Centre for Theoretical Physics

33. The Centre continued to address physics problems both of immediate practical relevance and of a more fundamental nature through colleges, workshops and other activities relating to physical processes and mathematical modelling. The participation of scientists in the activities of the Centre — with over 3650 scientists from developing and developed countries — reached its highest level in 1986.

Safeguards

34. In 1986, as in previous years, the Secretariat, in carrying out the safeguards obligations of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material- or the misuse of facilities, equipment or non-nuclear material subject to safeguards under certain agreements- for the manufacture of any nuclear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown[3]. It is considered reasonable to conclude that nuclear material under Agency safeguards in 1986 remained in peaceful nuclear activities or was otherwise adequately accounted for.

Physical protection of nuclear material

35. At its thirtieth regular session, the General Conference adopted a resolution on the Convention on the Physical Protection of Nuclear Material in which it continued "to express the hope that the Convention will enter into force at the earliest possible date and that it will obtain the widest possible adherence".[4]

Committee on Assurances of Supply

36. The Committee on Assurances of Supply (CAS) held its eighteenth to twentieth sessions in January, April and November respectively.

37. It continued to consider principles of international co-operation in the field of nuclear energy, but had still not reached a conclusion by the end of its twentieth session. It agreed that further consideration could be given to this matter at its twenty-first session (scheduled to start on 11 May 1987, after the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy, see paragraph 38 below) in the light of possible further developments.

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

38. The Preparatory Committee of the Conference held its seventh session from 10 to 21 November 1986 in Vienna and concluded its work related to the preparations for the Conference, which was held from 23 March to 10 April 1987 in Geneva.

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

39. Several matters of interest to the Agency were discussed at the forty-first session of the General Assembly. In the debate that followed the presentation of the Agency's annual report for 1985, delegates indicated their broad support for the Agency, its safeguards system, its technical co-operation programme, its work in the field of nuclear safety and its role in relation to the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy. In its resolution on the report the General Assembly affirmed its confidence in the role of the Agency in the application of nuclear energy for peaceful purposes, urged all States to co-operate in carrying out the work of the Agency, welcomed the signing by a significant number of States of the two Conventions regarding nuclear accidents (see paragraphs 9 and 11 above) and called upon those States which had not yet done so to become parties to them as soon as possible.

40. The General Assembly adopted resolutions on the establishment of nuclear-weapon-free zones in the

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

[4] The Convention, which required 21 ratifications or acceptances for its entry into force, entered into force on 8 February 1987.

Middle East and in South Asia. In resolution 41/48, it called upon all countries of the Middle East which had not done so to agree to place all their nuclear activities under Agency safeguards pending the establishment of such a zone.

41. In resolution 41/93 on Israeli nuclear armament, the General Assembly reiterated "its condemnation of Israel's refusal to renounce any possession of nuclear weapons", once more requested the Security Council "to take urgent and effective measures to ensure that Israel complies with Security Council resolution 487 (1981) and places all its nuclear facilities under International Atomic Energy Agency safeguards", reiterated its request to the Security Council "to investigate Israel's nuclear activities and the collaboration of other States, parties and institutions in the nuclear field", reiterated its request to the Agency "to suspend any scientific co-operation with Israel which could contribute to its nuclear capabilities", called upon "all States and organizations that have not yet done so to discontinue co-operating with and giving assistance to Israel in the nuclear field" and reaffirmed its "condemnation of the continuing nuclear collaboration between Israel and South Africa".

42. A similar request to the Security Council was made in resolution 41/12 concerning the Israeli military attack on Iraqi nuclear installations. In this resolution the General Assembly also stated that it considered that "Israel has not yet committed itself not to attack or threaten to attack nuclear facilities in Iraq or elsewhere, including facilities under International Atomic Energy Agency safeguards" and called for the immediate conclusion of an international agreement on the prohibition of military attacks on nuclear facilities as a contribution to promoting and ensuring the safe development of nuclear energy for peaceful purposes.

43. In resolution 41/55B the General Assembly noted with regret the non-implementation by South Africa of resolution GC(XXIX)/RES/442 on South Africa's nuclear capabilities, adopted in 1985 by the General Conference, and in resolutions 41/55A and 41/55B it demanded once again that South Africa submit forthwith all its nuclear installations and facilities to inspection by the Agency.

44. In September 1986 the Agency's General Conference adopted a resolution relating to a matter which had previously been discussed by the United Nations General Assembly and which was subsequently also the subject of resolutions adopted by the General Assembly during its forty-first session (see paragraph 42 above). In resolution GC(XXX)/RES/468 on South Africa's nuclear capabilities, the General Conference once again demanded that South Africa immediately submit all its nuclear installations and facilities to Agency safeguards. Also, it called upon those Member States which had not done so yet to end all nuclear co-operation with the South African régime and to stop all purchases of Namibian uranium. The Board of Governors was requested "to consider recommending the suspension of South Africa from the exercise of the privileges and rights of membership in accordance with Article XIX.B of the Statute at the thirty-first session of the General Conference if, by that time, South Africa has not complied with the relevant General Conference resolutions and conducted itself in accordance with the purposes and principles of the Charter of the United Nations".

Personnel and Finance

45. At the end of 1986, the number of members of the Secretariat (including persons serving under Special Service Agreements and on temporary assistance contracts) was 1994—746 in the Professional and higher categories, 1109 in the General Service category and 139 in the Maintenance and Operative Service category.

46. The Regular Budget total for 1986 was $118 756 000, of which $108 972 179 was to be financed from contributions made by Member States on the basis of the 1986 scale of assessment, $4 458 000 from income from work for others and $5 325 821 from other miscellaneous income.

THE AGENCY'S ACTIVITIES

TECHNICAL CO-OPERATION

Programme and implementation

47. The technical co-operation programme at the beginning of 1986 consisted of 808 active projects. During the year, 22 footnote[a] projects were made operational and 18 projects were approved under the Reserve Fund. Also, six new UNDP-funded projects were added to the programme, so that 854 projects were operational during 1986. Of this total, 95 projects were completed and four were cancelled.

48. The provision of technical assistance in 1986 involved arranging for 1930 expert assignments, processing 3738 purchase orders for equipment and supplies, devising training programmes for 937 fellows and visiting scientists, and organizing 71 training courses for 972 participants, in addition to furnishing general logistic and administrative support.

49. Of the assistance delivered in 1986, the largest portion (21%) again related to the application of isotopes and radiation in agriculture; other important fields were nuclear safety (17%), reactor technology (16%), industry and hydrology (13%) and nuclear physics (10%).

50. Technical Divisions of the Secretariat played an active part in supporting technical co-operation activities. During 1986, 130 technical officers provided support of various kinds to the 854 projects that were operational during the year; they also appraised 647 project requests received from Member States for the 1987 technical co-operation programme, undertook 449 assignments for a total of 145 man-months and evaluated 1060 fellowship applications.

Resources and delivery

51. Total new resources available for technical co-operation in 1986 amounted to $39.3 million, which is 9% higher than the figure for the previous year (see Figure 1). The Technical Assistance and Co-operation Fund (TACF) accounted for 70.8% of the total available resources, extrabudgetary funds for 14.5%, UNDP for 8.9% and assistance in kind for 5.8%.

52. The value of the programme planned for implementation (total adjusted programme for 1986) was $52.4 million. Obligations were entered into for goods and services valued at $35.4 million, yielding an overall net expenditure rate for the programme of 67.6% (1985: 57.9%). Disbursements in 1986 (actual cash outlays) are shown in Figure 2.

53. Net expenditure by resource category during 1986 is summarized in the following table.

Resource category	Adjusted programme ($)	Net expenditure ($)	Net expenditure rate (%)
TACF	37 020 799	28 015 778	75.7
Extrabudgetary funds	10 372 758	3 335 280	32.2
UNDP	4 157 575	3 480 543	83.7
Funds in trust	822 646	565 525	68.7

54. As in the past, expenditures were highest in respect of the equipment component. This component's share of the total net expenditure in 1986 was 51%; expert services accounted for 21%, fellowship training for 14%, training courses for 12% and sub-contracts and miscellaneous together for 2%.

55. The following table summarizes the expenditure of technical co-operation resources by assistance component.

Assistance component	Adjusted programme ($)	Net expenditure ($)	Net expenditure rate (%)
Experts	13 200 505	7 275 711	55.1
Equipment	26 722 492	18 142 653	67.9
Fellowships	6 378 230	4 997 035	78.3
Training courses	4 569 962	4 270 999	93.5
Sub-contracts	1 229 604	506 740	41.2
Miscellaneous	273 086	203 987	74.7
Total	52 373 879	35 397 125	67.6

56. Net expenditure rates were significantly higher for all programme components, owing in large part to the Secretariat's close monitoring implementation indicators and to prompt follow-up.

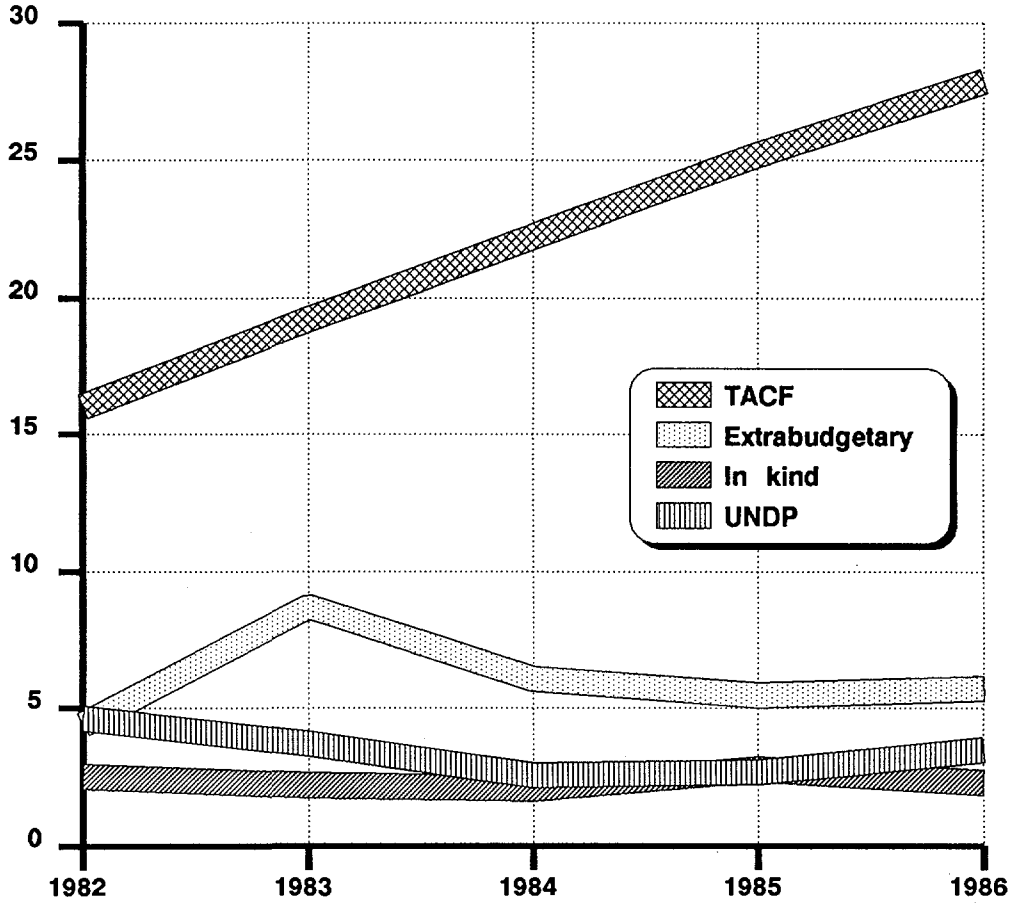
Distribution of assistance

57. Figure 3 shows disbursements by field of activity and year over the period 1984-86 as a percentage of the total disbursements for those years. As can be seen from the table, agriculture again ranked first, followed by nuclear safety and reactor technology.

FIGURE 1

RESOURCES AVAILABLE FOR AGENCY TECHNICAL CO-OPERATION PROGRAMMES: 1982-1986

(in millions of dollars)

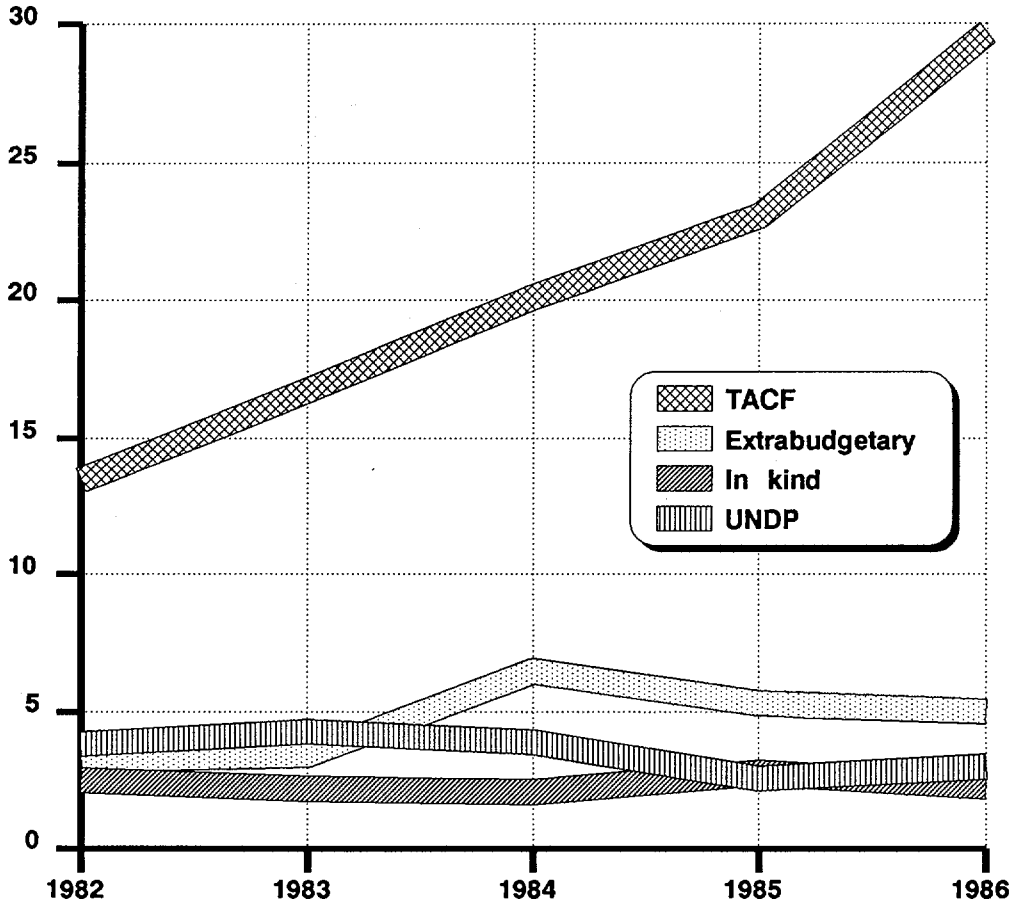


TACF	16.003	19.241	22.232	25.197	27.860
Extra-budgetary funds	4.413	8.715	6.062	5.484	5.716
Assistance in kind	2.493	2.172	2.066	2.765	2.282
UNDP	4.631	3.706	2.541	2.654	3.480
TOTAL	27.540	33.834	32.901	36.100	39.338

FIGURE 2

TECHNICAL CO-OPERATION DISBURSEMENTS:

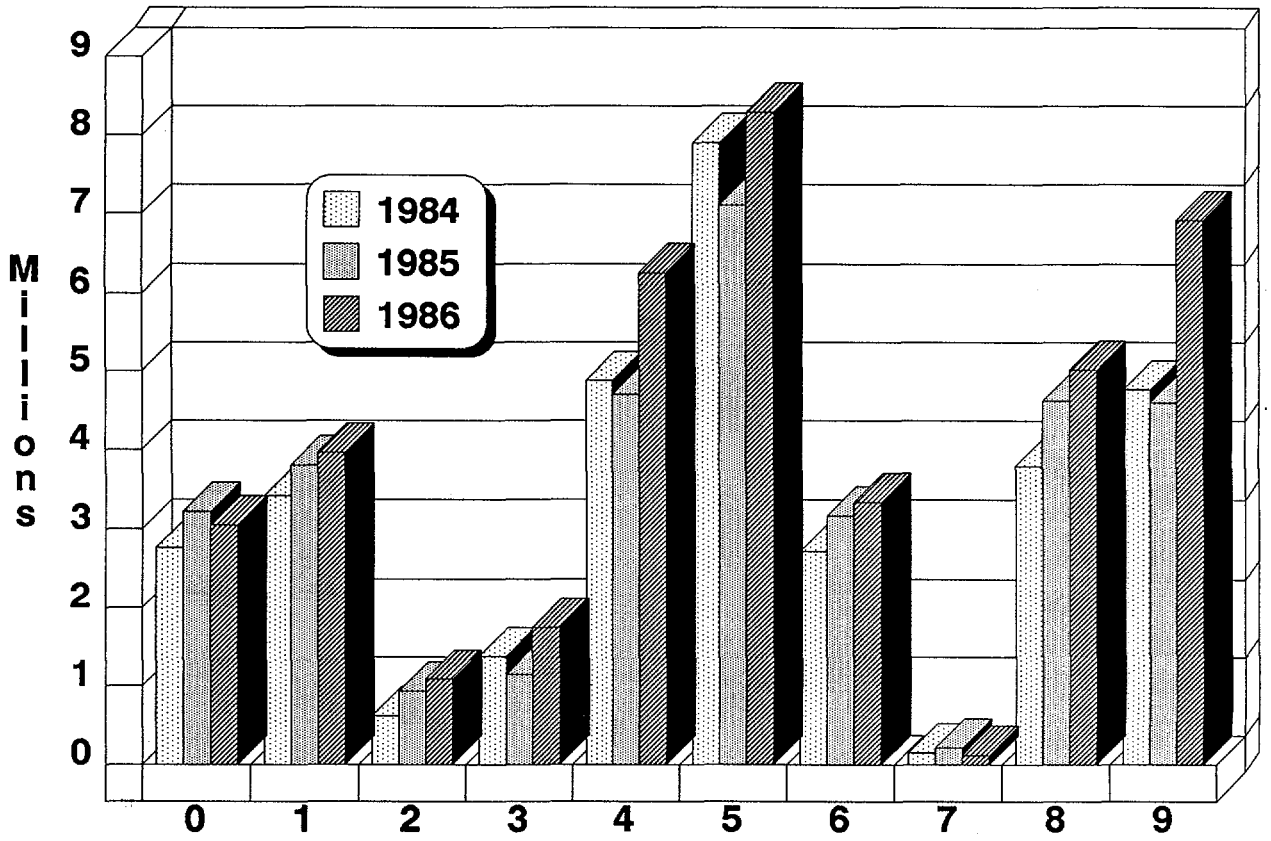
1982-1986
(in millions of dollars)



TACF	13.451	16.736	20.124	23.062	29.683
Extra-budgetary funds	3.235	3.423	6.493	5.326	5.025
Assistance in kind	2.493	2.172	2.066	2.765	2.282
UNDP	3.827	4.284	3.899	2.563	2.990
TOTAL	23.006	26.615	32.582	33.716	39.980

FIGURE 3

DISTRIBUTION OF DISBURSEMENTS BY FINANCIAL YEAR AND FIELD OF ACTIVITY: 1984-1986

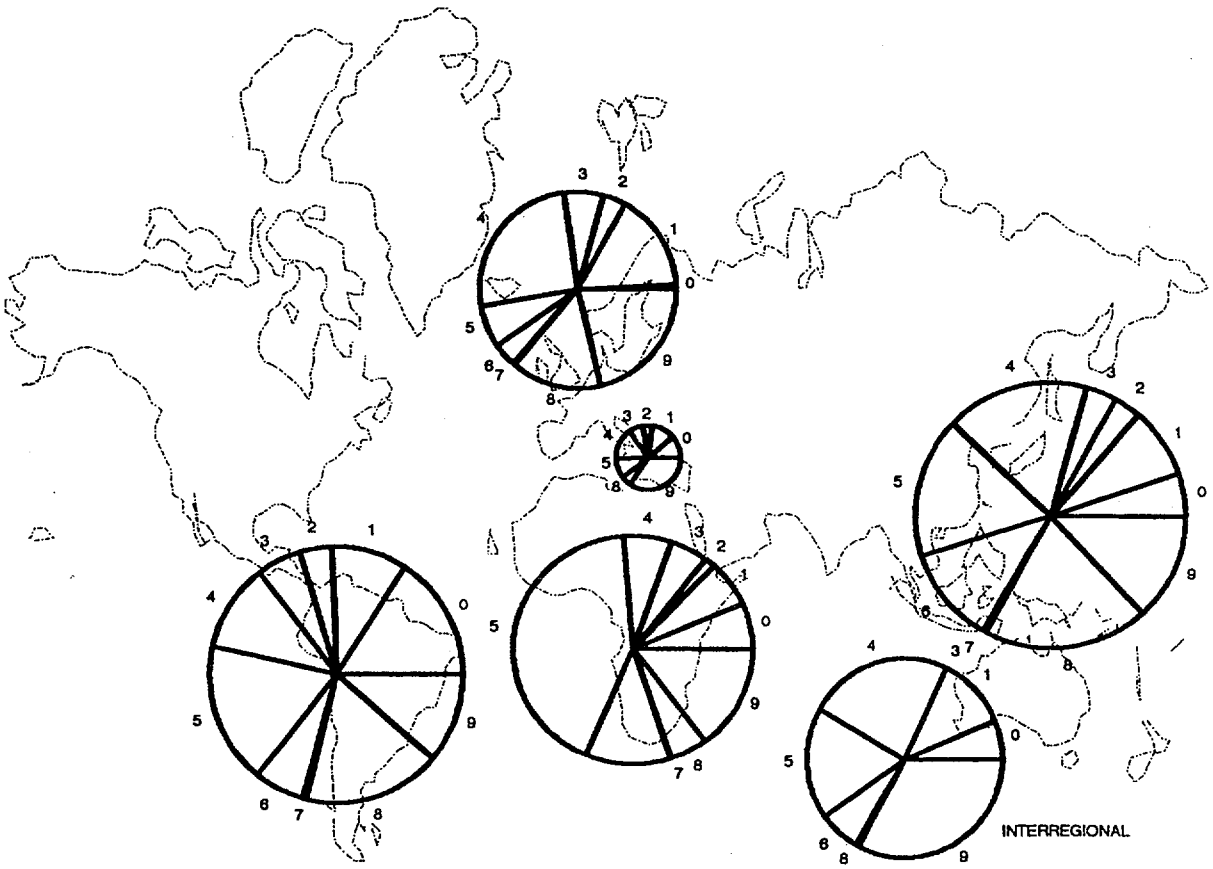


Summary in thousands of dollars

Field of activity	1984		1985		1986	
	$	%	$	%	$	%
0 - General atomic energy development	2,770.5	8.5	3,218.7	9.5	3,057.2	7.6
1 - Nuclear physics	3,422.1	10.5	3,809.1	11.3	3,973.7	9.9
2 - Nuclear chemistry	620.5	1.9	942.0	2.8	1,092.1	2.7
3 - Prospecting, mining and processing of nuclear materials	1,384.1	4.2	1,145.2	3.4	1,751.6	4.4
4 - Nuclear engineering and technology	4,887.8	15.0	4,710.8	14.0	6,257.5	15.7
Application of isotopes and radiation in						
5 - Agriculture	7,904.8	24.3	7,104.3	21.1	8,292.7	20.7
6 - Medicine	2,737.1	8.4	3,178.9	9.4	3,342.6	8.4
7 - Biology	156.5	0.5	223.0	0.7	122.2	0.3
8 - Industry and hydrology	3,804.3	11.7	4,625.0	13.7	5,023.1	12.6
9 - Safety in nuclear energy	4,775.0	14.6	4,597.5	13.6	6,921.6	17.3
Miscellaneous	118.8	0.4	161.4	0.5	146.0	0.4
GRAND TOTAL	32,581.5	100.0	33,715.9	100.0	39,980.3	100.0

FIGURE 4

DISTRIBUTION OF DISBURSEMENTS BY FIELD AND REGION: 1986



Summary in thousands of dollars

Field of activity	Africa $	Asia & Pacific $	Europe $	Latin America $	Middle East $	Inter-regional $	All regions $
0 - General atomic energy development	525.7	564.3	44.4	1,428.7	140.4	353.7	3,057.2
1 - Nuclear physics	521.5	906.6	881.0	879.7	143.2	641.7	3,973.7
2 - Nuclear chemistry	115.0	345.6	204.8	368.3	58.4	0.0	1,092.1
3 - Prospecting, mining and processing of nuclear materials	406.5	392.2	349.4	512.9	90.4	0.2	1,751.6
4 - Nuclear engineering and technology	523.0	1,827.6	1,393.3	1,000.4	195.2	1,318.0	6,257.5
Application of isotopes and radiation in							
5 - Agriculture	3,360.8	1,833.8	378.8	1,578.8	124.4	1,016.1	8,292.7
6 - Medicine	917.6	1,260.5	213.0	572.3	0.0	379.2	3,342.6
7 - Biology	6.8	54.8	15.0	45.6	0.0	0.0	122.2
8 - Industry and hydrology	411.0	2,116.3	800.9	1,599.5	64.1	31.3	5,023.1
9 - Safety in nuclear energy	1,158.7	1,384.0	1,153.9	988.7	424.0	1,812.2	6,921.6
Sub-total	7,946.6	10,685.7	5,434.6	8,974.9	1,240.1	5,552.4	39,834.3
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	146.0
GRAND TOTAL	7,946.6	10,685.7	5,434.6	8,974.9	1,240.1	5,552.4	39,980.3

58. How programme emphasis varies from region to region can be seen in Figure 4. In 1986, agriculture was the leading field for Africa, industry and hydrology for Asia and the Pacific and for Latin America, and nuclear engineering and technology for Europe and for the Middle East. Most interregional assistance was in the field of nuclear safety, which was the second most important field for the programme as a whole.

59. The following table shows the assistance provided to each region as a percentage of the total disbursements in each of the last three years.

	Overall share in %			
Region	1984	1985	1986	1984–86
Africa	25.5	20.9	19.9	21.9
Asia and the Pacific	26.7	28.4	26.8	27.3
Europe	11.5	13.1	13.6	12.8
Latin America	24.7	22.7	22.5	23.2
Middle East	0.9	1.6	3.1	1.9
Interregional	10.7	13.4	13.9	12.8

60. The relative shares of Europe, the Middle East and Interregional increased last year as compared with 1985, while those of Africa, Asia and the Pacific and Latin America remained relatively constant.

General observations

61. Evaluation has become an integral part of the Agency's technical co-operation activities and is playing an important role in the effort to make these activities more effective. The evaluations carried out in 1986 have resulted in a number of recommendations for improving the quality of the programme. Periodic monitoring of all operational projects through the interim project implementation reporting system continued in 1986. The system is now well established and the rate of reporting from the field is increasing steadily; over 700 interim reports were completed in 1986.

62. In-depth evaluations of 48 projects were conducted in 1986. The areas covered by such evaluations in 1986 included nuclear electronics, applied nuclear science laboratories, the fate of trypanocidal drugs in cattle, industrial applications of isotopes and radiation technology, non-destructive testing and radiation protection (including the Operational Safety Review Team (OSART) programme). An evaluation of the Agency's programme of nuclear power training courses, initiated at the request of the Board of Governors, was completed in 1986; it led to four major recommendations designed to strengthen this programme.

63. The role of women in development has been receiving increasing attention in the governing bodies of the United Nations system. Accordingly, and in recognition of the contribution women can make to development efforts, the Secretariat has, for a number of years, been monitoring the participation of women in Agency technical co-operation programmes. In 1981, for instance, 17.0% of all fellows were women; the corresponding figure for 1986 was 21.7%. Some 11% of all visiting scientists in 1981 were women; the figure was 13.8% in 1986. Of the 519 training course participants in 1981, 64 — or 12.3% — were women; in 1986, the figure was 16.2%. Although the percentage of women serving as experts increased only from 2.2% in 1981 to 4.3% in 1986, the percentage of women serving as training course lecturers rose from 1.7% to 6.1% during the same period.

64. Although the increases have been modest — in terms both of absolute numbers and percentages — the Agency's figures compare well with those for the United Nations system as a whole. In order that the Agency's record may be further improved, the Secretariat will, when inviting governments to submit nominations for fellowships and training courses, continue to stress that special consideration should be given to qualified women candidates.

65. The 112.3% increase in the value of the programme delivered between 1980 and 1986 was achieved with a staff increase in the Department of Technical Co-operation of 12.2% and with an increase in Regular Budget expenditures for this Department of 38.7%. As a result, direct administrative costs as a percentage of the value of the technical assistance delivered dropped in 1986 to 12.5%.

Energy, electric system and nuclear power planning

66. The main activities in 1986 were: (a) energy, electric system and nuclear power planning missions to developing Member States; (b) nuclear power planning training courses focussing on energy and electricity demand analysis and on electric system planning; and (c) the provision to developing Member States of up-to-date tools and methodologies for electric system and nuclear power planning.

(a) *Planning missions*
Agency advisory teams visited Malaysia in January and August, Turkey in March, Tunisia in March and June, Indonesia in June, Venezuela in August, and Bangladesh and Thailand in November. The Agency received visits by members of national counterpart teams from Thailand in January, Indonesia in February, Malaysia in April and December, Turkey in August, and Venezuela in November.

(b) *Training courses*
A first national training course on "Electric system expansion planning (WASP)" [5] was held in China during April and May (six weeks), with the participation of 31 engineers from various Chinese ministries, electric power organizations, electricity institutes and planning institutes, all of which are now using the WASP methodology for electric system planning.

A second interregional training course on "Energy demand forecasting for nuclear power planning" – a specialized course, for national energy planners, on the use of the Agency's computer model MAED[6] – was held at the Argonne National Laboratory, United States of America, with 30 participants from developing countries. The Agency's draft guidebook on energy and electricity demand forecasting for nuclear power planning (to be published during 1987) was used as a textbook.

(c) *Planning tools and methodologies*
An advisory group reviewed progress in improving the Agency's WASP methodology and commended, in particular, work done jointly by the Agency and Electricidade de Portugal (EDP) in adapting the EDP computer model VALORAGUA[7] for use with WASP. The group recommended that the Agency continue to adapt and make available to developing countries state-of-the-art tools and appropriate methodologies for energy and electric system planning as a means of assisting them to determine the role appropriate to nuclear power in their energy systems. The group also recommended further strengthening of the Agency's collaboration with the World Bank.

67. Co-operation between the Agency and the World Bank in the field of energy and electric system planning in developing countries was maintained. A senior Agency staff member was seconded to the World Bank, at its request, to serve as project manager for a new UNDP-financed technical assistance project for which the World Bank has been designated as the executing agency and the objective of which is to improve the energy and electric system planning capabilities of developing countries in Europe, the Middle East and North Africa. Co-operation between the Agency and the World Bank in various activities involved in this project – including country case studies, training courses and seminars – should increase the Agency's expertise in the field of project financing, help to familiarize the World Bank with the possibilities of nuclear power in those developing countries and permit optimum use to be made of Agency and World Bank technical assistance resources.

68. The Agency continued to co-operate with industrialized Member States and with other international organizations in the adaptation and use of methodologies for forecasting electricity demand in developing countries, in support of studies of the role of nuclear power. In this context, the United Nations Economic Commission for Europe (ECE) hosted a meeting of an Agency technical committee on "Energy and nuclear power planning: United Nations and other international organization approaches" in Geneva.

69. In October, three experts from Argonne National Laboratory (ANL), United States of America, assisted the Agency in testing the ENPEP[8] package, a promising microcomputer package which was developed at ANL with United States government funding and which includes modules for analysing energy demand, computing energy demand/supply balances, making electricity demand projections, electric system planning and analysing the impacts of different energy plans (account being taken of financing arrangements, manpower needs, resource requirements, environmental burdens, etc.).

[5] WASP: Wien (Vienna) Automatic System Planning.

[6] MAED: Model for Analysis of Energy Demand.

[7] VALORAGUA is a power system simulation model for carrying out detailed analyses of power systems with a large hydro-electric component. It is being tested this year in a case study for Turkey, with funding provided by the World Bank.

[8] ENPEP: Energy and Power Evaluation Programme.

70. Also in October, an Agency team visited Viet Nam to advise on the preparation of a nuclear power project and on the formulation of a proposal for Agency technical assistance covering — inter alia — planning tools, manpower development, project management and quality assurance (QA).

71. The Agency co-operated with NEA in completing an update of "Nuclear energy and its fuel cycle: prospects to 2025" (the "Yellow Book"). The Agency's TUV[9] model was used to analyse long-term energy and electricity demands, and its SCENARIOS[10] model was used to calculate fuel cycle requirements for selected nuclear power reactor deployment strategies.

72. In August, the Agency published the 1986 edition of the comprehensive review "Nuclear Power: Status and Trends".

73. The booklet "Energy, electricity and nuclear power estimates for the period up to 2000" (Reference Data Series No. 1) was updated using data from the Agency's Energy and Economic Data Bank (EEDB) and Power Reactor Information System (PRIS).

Economics of nuclear power

74. A revised guidebook on methodologies and procedures for the economic evaluation of bids for nuclear power plants was published in 1986 (Technical Reports Series No. 269).[11]

75. A guidebook on bid invitation specifications for nuclear power plants, intended particularly for managers and senior professional staff of electric utilities planning to issue a request for bids for a first nuclear power plant, was completed (the guidebook is being published in 1987).

76. An advisory group reviewed recent cost experience with nuclear and conventional power plants; cost data for nuclear and coal-fired power plants were reviewed and a reference set of cost data for general economic comparisons was prepared. In future, emphasis will be placed on comparisons of generation costs for nuclear and fossil-fired power plants in individual developing countries.

77. In co-operation with a consultant from a French bank, the Agency continued work on developing and testing a financial analysis model of the impact of various procedures for project financing on the financial balances of electric utilities.

Senior expert group on the promotion of nuclear power in developing countries

78. Following discussions in the Board of Governors in February 1986, a senior expert group was established to study mechanisms to assist developing countries in the promotion and financing of their nuclear power programmes. The group, which held two meetings during 1986, decided to focus initially on defining the constraints on the introduction of nuclear power in developing countries and how they have evolved. Responses from selected Member States to a questionnaire on the constraints experienced by them permitted a systematic review of ways and means of overcoming those constraints, of which the difficulty of obtaining financing on bearable terms is a major one.

79. The question of financing was examined by a sub-group which concluded that for many developing countries the financing of nuclear power is hampered by: (i) the poor credit-worthiness of the country; (ii) the fact that the export financing terms for nuclear power projects penalize nuclear power plants vis-à-vis other types of power plant; and (iii) the technical and financial uncertainties associated with nuclear power projects, which increase the financial risks. The sub-group recommended close co-operation between the Agency and the World Bank both in electric power sector studies and in energy and nuclear power planning studies. Also, it outlined a series of actions which might be taken by lenders, suppliers/investors, international agencies and developing countries. The senior expert group recommended that the Agency acquire more expertise in nuclear power financing, either by developing its own expertise or by co-operating with other organizations, in particular the World Bank.

Manpower and infrastructure requirements and development

80. Work on a series of guidebooks aimed at providing systematic information on infrastructure requirements and development for the introduction of nuclear power continued, with the publication of a guidebook entitled "Engineering and science education for nuclear power" (Technical Reports Series No. 260) and the completion of guidebooks entitled "Nuclear power project management", "Assessment and development of supporting industrial infrastructures for nuclear power" and "Introducing nuclear power plants into electric power systems of limited capacity: Problems and remedial measures". At the end of 1986, only two guidebooks in this series remained to be completed.

81. Three interregional training courses were supported: one on planning and feasibility studies (in France), one on commissioning (in the United Kingdom) and one on the qualification of operations staff (in the Federal Republic of Germany). Agency training courses on project management and plant operations management were held in support of national training efforts in

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[9] TUV: Technical University of Vienna.

[10] SCENARIOS: Simulation Code for Estimating Needs in Alternative Reactor Introduction and Operation Scenarios.

[11] A computer program to assist in the economic evaluation of bids is available from the Agency in diskette form for running on personal computers.

China and the Republic of Korea. A seminar entitled "Supporting industrial infrastructure requirements and development for nuclear power" was held in Vienna.

82. Support was provided for 35 technical co-operation projects (32 country projects and three interregional projects) in the field of infrastructure planning, where there was a shift away from general guidance towards specific assessments and the formulation of concrete plans for manpower development etc. Agency staff members provided advice under technical co-operation projects in Bangladesh, Brazil, China, Indonesia, the Republic of Korea, Malaysia, Mexico and Viet Nam.

83. Major UNDP projects on manpower development in Argentina and China were supported.

The Small and Medium Power Reactors (SMPR) study

84. Following the conclusion of the first phase of the SMPR study, in 1985, plans were made for country-specific feasibility studies. However, no interest was shown by countries which might have benefited from such a study.

85. Pursuant to a recommendation made at the end of the first phase of the SMPR study, it had been intended to convene an advisory group on the subject of constraints on the introduction of SMPRs in developing countries. However, as the senior expert group referred to in paragraphs 78 and 79 was carrying out a review of constraints on the introduction of nuclear power in general in developing countries, it was decided to await the outcome of the senior expert group's review.

Technical performance of nuclear power

86. At the end of 1986, PRIS — to which all but two Member States with power reactors report routinely — contained data for a total of about 3100 years of power reactor operation and on about 20 700 outages. During the year, 20 requests from outside the Agency (mainly from utilities and related organizations) for special PRIS data sets were answered. Background information was provided on a trial basis for OSART missions and other safety-related activities.

87. Efforts to improve further the quality of reporting to PRIS continued, with the help of a standardized questionnaire agreed upon with UNIPEDE, WEC and CEC (which collects data from its member States for transmission to the Agency).

88. Data received in 1986 for the report on "Operating experience with power reactors in Member States" during 1985 showed a further slight increase in nuclear power plant load and availability factors (the worldwide averages were 69.5% and 70.8% respectively in 1985, as against 68.7% and 70.1% in 1984). More importantly, it was found that the power reactor performance records of those Member States and utilities which, in the past, had had outstanding or steadily improving records were generally even better than before — confirmation of the conclusion that factors specific to the country in which a plant is located or to the organization operating it have the most important influence on plant performance (see paragraph 85 of the Annual Report for 1985, GC(XXX)/775).

89. The Agency provided nuclear power plant availability data for a WEC study on the availability of power plants in general from which it was concluded that in OECD countries the performance of PWRs and BWRs has generally improved to the point where they now have higher availabilities than fossil-fired plants in corresponding size ranges.

90. The Agency co-operated with NEA in the preparation of a report entitled "Status and trends of nuclear power plant performance data".

91. Following recognition of the importance of analysing load and availability factor data on the basis of planned duty cycles rather than of calendar years, initial steps were taken in an advisory group towards a more systematic analysis of outage information.

92. Two specialists' meetings were held under the auspices of the International Working Group (IWG) on the Reliability of Reactor Pressure Components. The first, on the results of load- and time-dependent material performance studies in which irradiation effects were not considered, indicated that there was no need to be greatly concerned about losses of structural material integrity due to degradation and that such studies could provide valuable data for lifetime material performance assessments. The second, on reactor pressure vessel behaviour under transient conditions caused by thermal shock, brought out the importance of the correlation between thermal shocks and vessel lifetime.

93. A research co-ordination meeting held during the autumn showed that the co-ordinated research programme on the optimization of pressure vessel surveillance programmes was progressing well.

94. The IWG on Nuclear Power Plant Control and Instrumentation selected three subject areas for future information exchange: (i) designing the man-machine interface so as to minimize the probability and effects of human error, (ii) the design and use of different types of plant simulator and (iii) improving plant availability.

95. Two specialists' meetings were held under the auspices of the IWG. The first, on the power supplies of instrumentation and control systems in nuclear power plants, showed that improvements had been achieved in the reliability of such power supplies through the separation of power supply trains, a reduction in the number of voltage levels and the diversification of equipment. At the second, on the reliability of actuating devices, the present status of actuating device design and operational experience with actuating devices were reviewed and various methods for testing actuators, valves, motors, reactivity control mechanisms etc. were discussed.

96. A research co-ordination meeting was held under the co-ordinated research programme on modelling approaches for training simulators.

Quality assurance and control (QA/QC)

97. Following the Chernobyl accident, efforts were devoted to determining how the Agency could best help nuclear power plant management to use QA in achieving higher levels of both performance and safety in plant operation.

98. The NUSS safety guide "Quality Assurance during commissioning and operation of nuclear power plants" (SG-QA5) was revised and the revised version (SG-QA5 Rev.1) published.

99. Work continued on two manuals, "QA for computer software" and "QA for control and instrumentation and electrical equipment".

100. An interregional training course on QA was held in France; in addition, the Agency organized courses for local personnel in China, the Republic of Korea and the Philippines. Staff members carried out technical co-operation missions to those three countries and also to Mexico and Yugoslavia. Five technical co-operation projects in the QA field were supported.

Fission reactor systems

101. The present status of LMFBR programmes in Eastern and Western Europe, India, Japan and the United States was reviewed by the IWG on Fast Reactors, which also selected several topics relating to cost reduction and safety enhancement for specialists' meetings. Specialists' meetings were held on cover gas purification and flow-induced vibrations in LMFBRs.

102. Satisfactory progress continued to be made under the co-ordinated research programmes on "Sodium boiling noise detection". At a research co-ordination meeting, work started on the preparation of a final report and on the formulation of recommendations for the designers and operators of LMFBRs.

103. Satisfactory progress was also made in the first year of a co-ordinated research programme entitled "Intercomparison of LMFBR core mechanics codes", in which 13 institutes in 91 countries are taking part.

104. The co-ordinated research programme on "Future applications of advanced reactors", which was completed with the preparation of a final report for publication in 1987, gave the participating institutions in Member States a good insight into the possible future applications of advanced reactors and fuel systems as long-term energy sources.

105. The state-of-the-art of graphite components for gas-cooled reactors was reviewed and directions for future R&D programmes identified at a specialists' meeting held in Tokai Mura, Japan.

106. The present status of gas-cooled reactors and their role in electricity generation and in process steam and process heat production were discussed at a technical committee meeting held in Jülich, Federal Republic of Germany. Considerable emphasis was placed on smaller gas-cooled reactors that incorporate passive safety mechanisms and are suitable for modular design and shop fabrication.

107. A co-ordinated research programme on "Design codes for components of gas-cooled reactors" was established with the participation of most of the countries engaged in the development of gas-cooled reactors.

Advanced light-water reactors

108. A technical committee meeting in Washington, D.C., reviewed current trends in the development of a next generation of light-water reactors (LWRs) and concluded that new LWRs based on current technology are more likely to be deployed in the near future than new LWRs based on revolutionary concepts of which the technical and - in particular - economic feasibility still has to be demonstrated.

Nuclear fusion

109. A technical committee meeting in Yalta, USSR, reviewed the present worldwide status of and recent progress made in fusion reactor experiments, design and technology. At a subsequent workshop, areas in which further work needs to be done in order to advance towards the goal of a commercial fusion power reactor were identified.

110. A technical committee on fusion reactor safety provided an international forum for an exchange of information on current fusion safety studies in Member States. The "Fusion Safety Status Report", published by the Agency in 1986, provided a basis for the identification of high-priority fusion R&D issues.

NUCLEAR FUEL CYCLE

Uranium resources and production

111. The near-term outlook for uranium continued to be governed by large uranium inventories (estimated to be equivalent to three or four years of reactor-related requirements) and low prices, with uranium production remaining below the 1985 and 1986 reactor-related requirement level of about 41 000 tonnes.

112. In 1985 (the latest year for which reliable figures are available at present), the shift in the geographical distribution of uranium production in WOCA[12] continued. The production share of the United States, the leading uranium-producing country in WOCA through 1983, declined further, from 15% to 12%, while that of Canada, the leading producer since 1984, increased further, from 29% to 31%.

113. Also in 1985, contract prices for uranium continued to decline: in Canada, the average price paid for deliveries of uranium under Canadian export contracts declined from about $70 to $67.50/kg; in the EEC area, prices paid declined by about $2/kg, to slightly over $75/kg; and in the United States, the average price for domestic and imported uranium declined by about $5/kg, to $68.5/kg. In 1986, spot market prices remained at the $44/kg level.

114. Uranium exploration continued at a low level in WOCA countries as a consequence of low prices, but many developing countries (particularly in Asia and the Middle East) continued to intensify their exploration efforts.

115. NEA, in collaboration with the Agency, issued the eleventh edition of the publication "Uranium Resources, Production and Demand" (the "Red Book"). As part of an effort to further improve data input to the Red Book, a group of consultants continued work on a manual on the appraisal of undiscovered uranium resources.

116. An improved version of the Resources and Production Projection (RAPP) computer model was used in a number of long-term (up to the year 2035) supply and demand analyses based on various resource and reactor requirement projections and on various assumptions about supply constraints, and a technical report entitled "Long-term uranium supply-demand analyses" was issued. Detailed documentation on the RAPP model was prepared and is available to Member States.

117. An advisory group reviewed economic practices relating to uranium exploration, resource appraisal and production and advised on the application of economic evaluation methods in uranium exploration and mining projects.

118. A report entitled "Correlation of uranium geology between South America and Africa" (Technical Reports Series No. 270) was published, and work on reports entitled "Recognition of uranium provinces", "Uranium deposits in proterozoic quartz-pebble conglomerates" and "Uranium deposits in Asia and the Pacific: geology and exploration" was completed.

119. A technical committee meeting on "Uranium deposits in magmatic and metamorphic rocks" was held in Salamanca, Spain, and one on "Geological data integration and analysis" was held in Vienna.

120. A manual on "Practical borehole logging procedures for mineral exploration, with emphasis on uranium" (Technical Reports Series No. 259) and a technical report on "Vein-type uranium deposits" (IAEA-TECDOC-361) were issued. Work on a technical manual entitled "Geochemical exploration for uranium" was completed, while work continued on a manual on contractual arrangements for uranium exploration and mining and on manuals entitled "Radon in uranium exploration" and "Construction and use of calibration facilities for radiometric field equipment".

121. An advisory group on the use of airborne radiometric data in defining the natural background radiation environment, which discussed the problems of using old data, recommended that a technical report be prepared on methods of standardizing and back-calibrating such data, on reporting units and on standards of presentation. It also recommended that the Agency begin compiling a worldwide index of available data. In addition, the group reviewed the use of airborne gamma survey methods in obtaining information for emergency response purposes and recommended that a report be prepared on equipment and calibration specifications.

122. Work began on preparations for the publication, starting in 1987, of a Uranium Newsletter which would replace the newsletter previously published by the NEA/IAEA Joint Group of Experts on R&D in Uranium Exploration Techniques. Several hundred requests for inclusion in the mailing list had been received by the end of the year.

123. The preparation of potassium, uranium and thorium reference materials for use in laboratory gamma-ray analyses of geological samples was completed. [13]

124. Data on 2500 uranium occurrences were added to the International Uranium Geology Information System (INTURGEO), bringing the total number of occurrences described to over 6000. An atlas of world uranium occurrences was prepared for publication as a technical report. Guidelines were established for a publication on deposit classification and associated recognition criteria based on INTURGEO.

125. Thirty-one technical co-operation projects concerning uranium exploration and resource development

[12] World outside the Centrally planned economies Area.

[13] Distribution of sets of these materials started early in 1987.

in 25 countries were supported. In connection with the Agency's efforts in support of such projects, a group of consultants reviewed microcomputer hardware and software suitable for use in uranium geology and exploration applications.

Processing and production of nuclear and reactor materials

126. An advisory group on the processing and production of nuclear and reactor materials reviewed the present status of the technology and the Agency's past, present and planned activities in this field.

127. A technical committee meeting on "Advances in uranium refining and conversion" was held in Vienna and the proceedings prepared for publication.

128. A group of consultants began preparing a manual on analytical techniques in uranium exploration and ore processing. Two other groups began preparing a guidebook on the development of uranium mining and ore processing projects and a guidebook on the design, construction and operation of pilot plants for uranium ore processing.

129. A technical document on "Ion exchange technology in the nuclear fuel cycle" (IAEA-TECDOC-365) was published, and the proceedings of a technical committee meeting on the development of projects for the production of uranium concentrates was prepared for publication.

130. A technical document was prepared on the basis of information in the Nuclear Fuel Cycle Information System (NFCIS), which covers almost 300 facilities for uranium ore processing, uranium refining and conversion, uranium enrichment, fuel fabrication, away-from-reactor spent fuel storage, reprocessing, heavy-water production, nuclear-grade zirconium metal production and Zircaloy tubing production in 32 countries.

Reactor fuel design, fabrication and performance

131. The IWG on Water Reactor Fuel Performance and Technology met in September and formulated recommendations for the Agency's activities during the period 1987-89 in fields such as fuel fabrication technology, fuel reliability and safety, and fuel utilization.

132. A symposium was held in Stockholm on "Improvements in water reactor fuel technology and utilization", and technical committee meetings were held on "Properties of materials for water reactor fuel elements and methods of measurement" and "Water reactor fuel behaviour and fission product release in off-normal and accident conditions".

133. The proceedings of earlier meetings on "External cladding corrosion in water power reactors" and "Fuel rod internal chemistry and fission product behaviour" were published.

134. The final research co-ordination meeting under a co-ordinated research programme on "Fuel element cladding interaction with water coolant in power reactors" was held at Trombay, India, in conjunction with an Indian topical meeting on water chemistry in nuclear energy systems. Proposals were made for a five-year (1987-91) follow-up programme entitled "Investigations on water chemistry control and coolant interaction with fuel and primary circuit materials in water-cooled power reactors" and aimed at providing Member States with information on matters such as water chemistry practices, choices of materials, water treatment, and decontamination.

135. The co-ordinated research programme on "Development of computer models for fuel element behaviour in water reactors" was completed and the final report was prepared for publication in 1987.

136. The collection of data obtained through post-irradiation examinations of water reactor fuel in storage pools and hot cells continued under a co-ordinated research programme entitled "Examination and documentation methodology for water reactor fuel", one aim of which is the unification of the methods used in such examinations.

137. Work started on the preparation of a guidebook on "Quality assurance for water reactor fuel design and manufacture" and on updating the guidebook on "Quality control of water reactor fuel" (Technical Reports Series No. 221) through the addition of chapters on mixed-oxide fuels and gadolinium-doped fuels.

138. Support was provided for technical co-operation projects in Brazil, China, Egypt, Indonesia, the Republic of Korea and Romania.

Spent fuel management

139. A technical document entitled "Spent fuel management: current status and prospects of IAEA programme" was prepared following a meeting, in March, of an advisory group which concluded that questions of spent fuel management (which include questions concerning technical, environmental, economic and safety aspects of the transport, storage and reprocessing of spent fuel) are still of central importance for achieving the optimum commercial utilization of nuclear energy.

140. Two consultants' meetings were held for the purpose of preparing a report (to be issued in 1987) on the dry and wet storage of spent fuel in the light of responses to a questionnaire sent to Member States in 1985.

141. A technical committee considered questions regarding the behaviour of used fuel assemblies and storage equipment under long-term wet storage conditions at a meeting held in Leningrad, Soviet Union.[14]

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[14] To avoid overlapping, the programme of the meeting was co-ordinated with those of other international meetings, including that of the Third International Spent Fuel Storage Technology Workshop, held in Seattle, United States.

National presentations and follow-up discussions during the meeting clearly showed that there is continuing confidence in the use of wet storage for fuel clad in zirconium alloys.

142. The meeting in Leningrad once again brought out the fact that many important problems in the field of spent fuel storage can be solved only through international co-operation, and it was the unanimous opinion of the participants that the Agency could and should serve as an international co-ordinator in promoting the acceptance, at the national level, of reasonable decisions regarding the safe and economic storage of spent fuel.

143. The preparation of a technical document entitled "Long-term wet spent nuclear fuel storage" was completed.

144. The co-ordinated research programme on the behaviour of spent fuel assemblies during extended storage (known as the BEFAST programme), which produced useful information on the integrity of fuel cladding and the operational reliability of storage facilities, ended in June with a research co-ordination meeting in Leningrad. A follow-up programme entitled "Behaviour of spent fuel and storage facility components during long-term storage" (BEFAST-II) started in September, with 12 participating countries.

145. At a technical committee meeting on materials used in the construction of the main equipment items involved in the back-end of the nuclear fuel cycle, it was concluded that the reliability of such materials is extremely important for safe and efficient back-end operations. The technical committee considered common approaches to achieving further materials reliability improvements in back-end operations (such as the interim and long-term storage of spent fuel, the direct disposal of spent fuel, the long-term storage of high-level solid waste, the storage and vitrification of high-level liquid waste, and spent fuel treatment) and made recommendations for future Agency work.

146. A group of consultants on the safety and reliability of structural materials used in nuclear fuel cycle facilities assessed — inter alia — materials selection criteria and in-service performance and made recommendations regarding future Agency activities.

147. At a consultants' meeting on the safety of spent fuel storage in at-reactor pools, an analysis of the present situation and plans for future work were presented.

148. A study tour on spent fuel management, with 26 participants from 21 developing countries, visited at-reactor and away-from-reactor spent fuel storage and waste management facilities in Czechoslovakia, France, the Federal Republic of Germany, Sweden and the United Kingdom. The study tour programme also included lectures, demonstrations and discussions with scientific personnel.

Waste management

149. The Agency co-operated in two large conferences on radioactive waste management, one held in the United States and the other in Canada.

150. At the thirtieth regular session of the General Conference, the scientific afternoon was devoted to the "decommissioning and decontamination of nuclear facilities for normal and unplanned situations". An issue of the Agency's "Bulletin" dealt with the same topic, and another issue was devoted to various aspects of radioactive waste management.

151. Preparations were made for the start, in 1987, of an interregional technical co-operation project (WAMAP — Waste Management Advisory Programme) aimed at meeting more fully the needs of developing countries for appropriate radioactive waste management systems.

152. Support was provided for 15 technical co-operation projects concerned with radioactive waste treatment and disposal in Algeria, Bangladesh, Chile, Egypt, Indonesia, the Republic of Korea, Mexico, Peru, the Philippines, the Syrian Arab Republic, Thailand and Turkey.

Handling, treatment, conditioning and storage of radioactive waste

153. The 17th annual edition of "Waste Management Research Abstracts" (containing over 650 abstracts from 31 countries) was published. This was the first edition containing abstracts submitted on computer tape.

154. An interregional training course on radioactive waste management was held at various nuclear centres in Canada for 31 participants from 25 countries.

155. A guide on the design of radioactive waste management systems at nuclear power plants (Safety Series No. 79) was issued as a follow-up document to the code of practice on the management of radioactive wastes from nuclear power plants (Safety Series No. 69).

156. Reports (to be issued during 1987 in the Technical Reports Series) on the pretreatment of low- and intermediate-level solid and liquid wastes, the design of off-gas and air cleaning systems for nuclear power plants and the treatment, conditioning and disposal of iodine-129 were completed, while work continued on reports on: the treatment of alpha-bearing wastes; the solidification of organic radioactive wastes; the treatment and conditioning of abnormal radioactive wastes at nuclear power plants; the immobilization of low- and intermediate-level wastes with polymers; the design and operation of off-gas cleaning and ventilation systems at facilities handling low- and intermediate-level radio-

active materials; the treatment of off-gases from radioactive waste incinerators; and the design and operation of off-gas cleaning systems at high-level liquid waste conditioning facilities.

157. A regional seminar on low- and intermediate-level waste management options, designed specifically for developing countries, was held in Brazil, with more than 60 participants from 12 Latin American countries.

158. Co-ordinated research programmes on the evaluation of solidified low- and intermediate-level waste forms and packages, the retention of iodine and other airborne radionuclides during abnormal and accident conditions, and the performance of solidified high-level waste forms and engineered barriers under repository conditions continued.

Decontamination and decommissioning of nuclear facilities

159. A report was published on the state-of-the-art in the methodology and technology (including remote-system technology) of decommissioning nuclear facilities (Technical Reports Series No. 267) and a report was completed on methods for reducing occupational exposure during the decommissioning of nuclear facilities. Work continued on reports dealing with the decontamination and demolition of concrete and steel structures and with factors relevant to the recycling and reuse of components from the decommissioning of nuclear installations.

160. A research co-ordination meeting was held on the decontamination and decommissioning of nuclear facilities.

Underground disposal of radioactive wastes

161. A symposium on the siting, design and construction of underground repositories for radioactive wastes was held in Hanover, Federal Republic of Germany, with 240 participants from 32 countries; the symposium included a panel discussion on performance and safety assessments and related field investigations of deep geological repositories. The symposium participants visited three repository sites (Gorleben, Konrad and Asse). The proceedings of the symposium were published.

162. The Board of Governors approved a code of practice and guide to the code on the safe management of wastes from the mining and milling of uranium and thorium ores — an updated version of Safety Series No. 44.

163. Work continued under a co-ordinated research programme on the migration and biological transfer of radionuclides from shallow land burial sites. Work also continued on the development of international standards for the underground disposal of high-level radioactive wastes and on acceptance criteria for the disposal of radioactive wastes in deep geological formations.

164. A co-ordinated research programme on the geochemistry of transuranic actinides and long-lived fission products was initiated.

165. Work started on the preparation of reports concerning (i) the regulation of underground repositories for the disposal of solid radioactive wastes, (ii) in situ experiments for the disposal of radioactive wastes in deep geological formations, and (iii) borehole plugging and shaft sealing in the underground disposal of long-lived radioactive wastes.

Sea dumping and releases of radioactive effluents

166. The Agency's revised Definition and Recommendations relating to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention), which had been approved by the Board in 1985, were issued as Safety Series No. 78 — 1986 Edition.

167. A GESAMP[15] report on an oceanographic model for the dispersion of wastes disposed of in the deep sea was published as Technical Reports Series No. 263. Draft reports on upper dose bounds for the sea disposal of radioactive wastes and on assessing the impact of the deep sea disposal of low-level radioactive wastes on living marine resources were prepared. A GESAMP working group, with the Agency as the lead organization, continued work on the modelling of coastal marine environments.

168. In collaboration with NEA and WHO, the Agency continued work on principles for the exemption of radiation sources and practices from regulatory control. Tentative guidance on exemption principles was formulated and a technical document (IAEA-TECDOC-401) containing an interim progress report on an initial application of the principles to the disposal of very low-level radioactive wastes in the terrestrial environment was issued. Work began on the application of exemption principles to the recycling of contaminated materials from nuclear facilities.

169. A technical document on the environmental migration of radium and other contaminants present in liquid and solid wastes from the mining and milling of uranium (IAEA-TECDOC-370) was issued following the completion of a co-ordinated research programme.

170. A technical document on atmospheric dispersion models for application in relation to radionuclide releases (IAEA-TECDOC-379) and one on mechanisms of solid-liquid interactions and their modelling (IAEA-TECDOC-367) were issued.

171. A report on the role of sediments in the transport and accumulation of radioactive pollutants in rivers and estuaries and one on procedures for assessing the reliability of environmental transfer models were finalized.

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[15] IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution.

NUCLEAR SAFETY AND RADIATION PROTECTION

172. As can be seen from paragraphs 6-16, activities in this area were greatly influenced by the Chernobyl accident.

Safety of nuclear installations

173. In August the Agency convened a review meeting on the Chernobyl accident at which nuclear experts from the Soviet Union and experts from the rest of the international nuclear community exchanged information on accident experience and in September the International Nuclear Safety Advisory Group (INSAG) prepared a report on the meeting and made recommendations for further activities. During 1986 INSAG also completed a report on the source term for severe accidents at light-water-cooled nuclear power plants and a technical note on improvements in quality assurance.

174. In November the Expert Working Group on International Co-operation in Nuclear Safety and Radiation Protection, which had been established by the Director General at the Board's request, made recommendations on Secretariat proposals for an expanded nuclear safety and radiation protection programme to be implemented as part of international post-Chernobyl efforts to improve nuclear power safety.

175. The Agency sent six Operational Safety Review Team (OSART) missions to review and assess operational safety at nuclear power plants in six countries (Finland, the Federal Republic of Germany, the Republic of Korea, Mexico, the Netherlands and Sweden); the mission reports to the national authorities covered management, personnel training and qualification, the conduct of operations, maintenance, plant surveillance and experience feedback, radiation protection, plant chemistry and emergency response capability. Technical observers from developing countries took part in the missions so as to gain experience.

176. The Agency's Incident Reporting System (IAEA-IRS) received 78 reports in 1986, bringing the total since 1983 to 264, including 73 from non-OECD countries. Canada, the United Kingdom and Yugoslavia joined the system, so that 24 of the 25 Member States with operating nuclear power plants are now participating.

177. Five IRS meetings were held to discuss and evaluate reported incidents.

178. The first "Incident Report Review" was prepared (for restricted distribution) and new guidelines for the submission of incident reports to the system were drafted.

179. Close co-operation was maintained with NEA, whose incident reporting system covers the OECD countries.

180. The Agency tested the methodology of its ASSET (Assessment of Safety-Significant Events Team) programme at the Krsko Nuclear Power Plant, in Yugoslavia; the team also reviewed safety-significant events which had occurred at the plant and provided the operating organization and the regulatory body with an independent opinion on the appropriateness of corrective actions taken and on possible further actions to prevent the recurrence of similar events.

181. The Agency explored the use of nuclear power plant performance indicators as an additional tool in identifying areas of possible safety concern requiring further investigation.

182. Safety analysis codes available on the Agency's computer were used by 30 experts in analysing the safety at plants in four Member States. The Agency, in co-operation with the Central Physics Research Institute of the Hungarian Academy of Sciences, sponsored a standard-problem exercise involving a simulated loss-of-coolant accident at one of the Institute's experimental facilities. At a final workshop, representatives of the eleven participating countries compared calculated and experimental values as a means of obtaining an indication of computer code and modelling technique effectiveness.

183. A seminar held in Munich, Federal Republic of Germany, addressed operating procedures and operator training for abnormal conditions at nuclear power plants and identified aids critical to the effective operator management of possible accidents.

184. The Agency provided assistance to China and the Netherlands with the interpretation of NUSS documents in connection with licensing. In addition, at a two-week workshop held in China as part of a UNDP project international experts presented examples of NUSS requirements as implemented in actual designs.

185. As part of its efforts to promote the implementation of NUSS requirements in the operational area, the Agency published a manual on the maintenance of systems and components important to safety and initiated work on a manual for in-service inspection.

186. A technical committee considered effects of ageing on components, systems and structures, a safety matter growing in importance as more nuclear power plants approach the end of their planned lifetimes.

187. The Agency, in co-operation with CEC, drafted a state-of-the-art document on hydrogen generation, transport and combustion and mitigation systems for a wide spectrum of postulated nuclear power plant accidents.

188. Work continued on a technical document on accident management which is based on approaches being developed in Member States and which includes operator guidelines to help limit accident consequences.

189. Work also continued on a technical document on improving corrosion control at light-water-cooled nuclear power plants so as to protect safety barriers and reduce worker exposures.

190. At a seminar on regulatory inspections in connection with nuclear power plant construction, commissioning and operation, 64 participants from 32 countries exchanged field experience and discussed issues related to — inter alia — the use of resident inspectors and the taking of enforcement action.

191. At a specialist meeting in the Soviet Union, 50 papers were presented on strong earthquake-induced ground motion and the seismic evaluation of nuclear power plants. The proceedings of the meeting were prepared for publication.

192. Work continued on nuclear power plant site safety documents concerning (i) the flooding of river sites, (ii) probabilistic safety assessment for seismic events, (iii) dose assessment in siting and (iv) the prevention of hydrological contamination after a severe accident.

193. Technical co-operation missions on various aspects of nuclear power plant siting were undertaken to Brazil, Iraq, Morocco, the Syrian Arab Republic, Turkey and Yugoslavia. Support was provided for an interregional project on the collection of seismic data needed in nuclear power plant siting; a report was prepared on methods and procedures for compiling historical data on earthquakes.

194. The Agency sent missions to perform general safety assessments at 12 research reactors in 8 countries (Chile, Egypt, Greece, Indonesia, Jamaica, Malaysia, Mexico and Spain). In addition, it sent special missions to Peru, the Syrian Arab Republic and Uruguay in response to requests concerning specific research reactor safety issues.

195. Technical documents on probabilistic safety assessment for and the siting of research reactors were published, and work continued on the preparation of technical documents on the safety analysis of and design and operational safety criteria for research reactors.

196. A co-ordinated research programme on probabilistic safety assessment for research reactors was initiated with the participation of ten countries (Argentina, Australia, Austria, Czechoslovakia, Peru, Switzerland, Turkey, the United Kingdom, the United States and Yugoslavia), the aim being to obtain a better understanding of the safety characteristics of specific reactors.

197. In August the Agency published the Nuclear Safety Review for 1985, an overview of significant developments worldwide during the year in nuclear safety and radiation protection.

Risk assessment

198. The Agency continued to assist Member States in using probabilistic safety assessment (PSA) techniques to analyse severe nuclear accidents. An interregional technical co-operation project originally limited to power reactors was extended to include research reactors.

199. Increased emphasis was placed on documenting studies of PSA contributions to safety decisions, on reflecting operating experience in PSAs and on preparing guidelines for the use of PSAs.

200. A report was prepared on the development of probabilistic safety criteria in Member States.

201. On the basis of operating experience, a document on computer aids for reactor operators and one on identified critical operator actions to be emphasized in training (particularly training on simulators) were prepared.

202. UNEP, WHO and the Agency jointly organized a workshop, in France, on the relevance to nuclear safety of techniques used in assessing health and environmental risks from transport, non-nuclear energy systems and other industrial installations; experts from 18 countries and 10 international organizations discussed the status of studies for a joint project on assessing, controlling and managing health and environmental risks from energy and other complex industrial systems.

Radiation protection

203. As an immediate response to the Chernobyl accident, the Agency established informal contacts with radiation protection authorities in most European countries in order to obtain a more complete picture of the extent of the areas affected by the accident. Also, together with WHO, WMO and UNSCEAR, it began planning for the systematic collection of data. The international organizations involved met several times to discuss actions needed for improving accident response capabilities and established an "Inter-Agency Committee for the Co-ordinated Planning and Implementation of Response to Accidental Releases of Radioactive Substances".

204. A data base was started in support of a global assessment of radiological consequences of the Chernobyl accident, to be carried out by UNSCEAR in 1987-88. Experts from the Soviet Union exchanged information on the radiation situation in the Soviet Union during the review meeting on the Chernobyl accident convened by the Agency in August (see paragraph 173). Initial dose assessments carried out by affected countries other than the Soviet Union indicate that average doses in those countries during the first year after the accident were only a fraction of the average annual dose due to natural background radiation, the most exposed groups incurring less than ten times the average annual dose.

205. As part of the continuing implementation of the Basic Safety Standards for Radiation Protection (Safety Series No. 9), the Agency published Safety Series documents entitled "Radiation protection glossary" (Safety Series No. 76), "Principles for limiting releases of radioactive effluents into the environment" (No. 77) and "Derived intervention levels for application in con-

trolling radiation doses to the public in the event of a nuclear accident or radiological emergency: principles, procedures and data'' (No. 81).

206. Also, the Agency issued a technical report entitled ''Biological dosimetry: Chromosomal aberration analysis for dose assessment'' (Technical Reports Series No. 260) and technical documents entitled ''What the general practitioner (M.D.) should know about medical handling of overexposed individuals'' (IAEA-TECDOC-366), ''Study of radioactive materials in the Baltic Sea'' (IAEA-TECDOC-362) and ''Fusion safety statrus report'' (IAEA-TECDOC-388).

207. The following documents were prepared for publication: ''Radiological safety aspects of the operation of proton accelerators'', ''Compendium of neutron spectra and detector responses for radiation protection purposes'', ''Personnel radiation monitoring'', ''Basic principles for occupational radiation monitoring'', ''Radiation protection in occupational health'', ''Assessment of off-site consequences of an accident in a nuclear facility: Techniques and decision making'' and ''Training courses on radiation protection''.

208. The Agency published a supplement to the 1985 edition of the ''Regulations for the safe transport of radioactive materials'' (Safety Series No. 6) and the results of an examination of how Member States had adapted Safety Series No. 6 in their regulations on radioactive material transport. Work was completed on three documents designed to assist Member States in interpreting Safety Series No. 6: ''Schedules of requirements for the transport of special types of radisoactive material consignments'', ''Advisory material'' on the 1985 edition of Safety Series No.6 and ''Explanatory material'' on the 1985 edition of Safety Series No. 6.

209. Other publications on radioactive materials transport prepared last year addressed issues such as regulatory control, radiological impacts and radiation protection optimization. Work on the development of guidance for transport emergency planning and preparedness continued, and work on guidance for the safe transport of uranium hexafluoride (covering both radiological and chemical hazards) was initiated.

210. A symposium on the optimization of radiation protection (organized jointly by the Agency and NEA) and one on the packaging and transport of radioactive materials (PATRAM 86) were held and the proceedings published. The proceedings of a symposium on emergency planning and preparedness for nuclear facilities (held in 1985) were also published.

211. The Agency continued to support co-ordinated research programmes on the use of realistic chest phantoms in the calibration of counting facilities and on carbon-14 from nuclear installations.

212. Support was provided for 78 technical co-operation projects and 25 missions. Radiation protection advisory teams (RAPATs) visited 10 Member States (the Dominican Republic, Ecuador, Egypt, Iceland, Kenya, Mexico, Panama, Venezuela, Zaire and Zambia) in order to help in defining long-term goals for technical co-operation in radiation protection. Special radiation protection missions to seven countries (Algeria, China, Iraq, Jordan, Malaysia, Niger and Portugal) were organized.

213. International training courses on radiation protection were held in Argentina, Brazil and Saudi Arabia, and the Agency provided lecturers for training programmes in a number of other Member States. Sixty fellowships and scientific visits were arranged in the area of radiation protection. Four regional meetings within the framework of ARCAL were sponsored.

Physical protection

214. Preparations were completed for an international training course on the physical protection of nuclear facilities and materials (the seventh in the series of such courses) to be held in 1987 in Albuquerque, United States.

Radiation protection service

215. Various environmental, food and human contamination measurements were carried out at the Seibersdorf Laboratories in response to the Chernobyl accident.

216. Personnel monitoring services continued to be provided on a routine basis to the Agency's radiation workers, for technical co-operation experts and for trainees from Member States.

217. Personnel thermoluminescence dosimetry services were provided for four countries (Mali, Nigeria, Sierra Leone and the United Arab Emirates) where such services were not available locally.

218. In connection with technical co-operation projects, missions visited eight countries (Albania, Ethiopia, Ghana, Kenya, Sudan, the United Republic of Tanzania, Zaire and Zambia) to advise on the establishment or improvement of national radiation protection services.

219. Training in the operation of radiation protection services was given to 13 fellows — from Algeria, Ethiopia, Ghana, the Islamic Republic of Iran, Kenya, the Libyan Arab Jamahiriya, Sudan, Tunisia, the United Republic of Tanzania and Zambia. Eight of them also participated in a 10-week introductory course on radiation protection services held in Vienna. In addition, radiation protection officers from Ethiopia, Morocco and the United Republic of Tanzania were received as scientific visitors at the Agency's Health Physics Laboratories at Headquarters and at Seibersdorf.

Soil fertility, irrigation and crop production

220. Assistance to Member States continued through 66 research contracts and agreements and 63 technical co-operation projects.

221. Work continued under a co-ordinated research programme aimed at maximizing crop yields in pasture systems through the increased utilization of atmospheric nitrogen rather than expensive nitrogen fertilizers, nitrogen-15 labelling techniques being used in assessing nitrogen fixation. Both agronomic and genetic factors were studied under another programme with a view to increasing nitrogen fixation in — and the yields of — legumes in Latin America and South East Asia.

222. Isotope techniques continued to be employed in assessing the release of nitrogen from the fern Azolla used as biofertilizer in rice paddies, and studies continued on management practices that would enhance the value of Azolla for paddy rice. Isotope techniques were also employed in evaluating the usefulness of rock phosphate as a source of phosphorus for plant growth.

223. With high soil salinity affecting very extensive areas of cultivable land in different parts of the world, isotope- and radiation-aided ongoing studies of agronomical practices which would promote plant growth in saline soils and increase crop yields continued and additional studies were initiated. The emphasis remained on increasing biological nitrogen fixation and fertilizer and water use efficiency and selecting crop varieties which are tolerant to and may reduce soil salinity, thereby enabling less tolerant crops to grow.

224. Two training courses on the use of isotopes and radiation techniques in studies of soil-plant relationships were organized at the Agency's Agricultural Laboratory at Seibersdorf, Austria, with the help of the Austrian Government. Also at the Agricultural Laboratory, extended specialized training was given to eight fellows from developing countries. A workshop on the use of isotope techniques in soil-plant-water studies was held in Colombia for scientists from Andean countries.

225. An advisory group considered priorities for research into the use of trees in agricultural systems to restore and maintain soil fertility, to combat erosion and desertification and to provide fuelwood.

Plant breeding and genetics

226. Assistance to Member States was provided through 43 technical co-operation projects. Two international and two national training courses were held on the use of induced mutations for plant improvement, and 29 scientists received training through fellowships or scientific visits.

227. Methodological developments in mutation breeding (including developments based on the use of in vitro technology and double-haploid techniques) were promoted through 58 research contracts, 60 research agreements and 2 technical contracts. The activities supported included work on increasing disease resistance in grain legumes, cereals and root and tuber crops and increasing nitrogen fixation by grain legumes.

228. Work done at Seibersdorf included research — using maize — on somaclonal variation derived from in vitro culture, studies on chimerism in irradiated sunflower, and the development of in vitro culture techniques for technical assistance projects concerning banana, cacao and cassava. Also at Seibersdorf, a training course was held and four fellowship holders underwent extensive periods of training.

229. The possibility of accelerating the development of new crop plants under a future mutation induction/domestication project was assessed by a group of experts, which concluded that key characters of domestication are monogenic and recessively inherited and that they can be obtained by mutation induction.

230. New crop cultivars developed through mutation induction were reported from China (71), the United States (6), India (3), Australia (2), the Federal Republic of Germany (2), Kenya (2), the Soviet Union (1), Canada (1) and Japan (1).

Animal production and health

231. Assistance to Member States continued through 151 research contracts and agreements and 37 technical co-operation projects.

232. Co-ordinated research programmes continued on the control of parasitic diseases, on the reproductive efficiency of large ruminants, on the optimization of grazing animal productivity in the Mediterranean and North African regions and on the productivity of sheep and goats in Africa.

233. Co-ordinated research programmes also continued on the productivity of domestic buffalo in Asia (within the framework of RCA) and on the reproductive efficiency of cattle, sheep and cameloids in Latin America (within the framework of ARCAL). Current research was reviewed and work plans for the future established at research co-ordination meetings on the reproductive efficiency of large ruminants, on livestock in Latin America and on the productivity of buffalo in Asia.

234. With funds provided by Sweden (Swedish International Development Authority - SIDA) and the Netherlands (Technical Assistance Department of the Ministry of Foreign Affairs), co-ordinated research programmes were established on the use of radioimmunoassay and enzyme immunoassay procedures in monitoring reproductive efficiency and the epidemiology of diseases in livestock.

235. A symposium on the use of nuclear and related techniques in studies on animal reproduction, nutrition, diseases and environmental adaptation, held in Vienna,

was attended by 130 participants, of whom 104 were from developing countries.

236. Two regional training courses were held — one (in Venezuela) on the use of radioimmunoassay techniques in animal reproduction studies and the other (in Kenya) on the use of immunoassay methods in animal reproduction studies and disease diagnosis. The courses were attended by 48 Latin American and African scientists.

237. A laboratory programme in support of studies on animal diseases was initiated, with the focus on the development of immunoassay kits for use in the diagnosis and epidemiological study of viral, bacterial and parasitic infections.

Insect and pest control

238. Assistance to Member States continued through 37 research contracts and agreements and 15 technical co-operation projects.

239. The BICOT project [16] continued to make good progress. By the end of the year, the target tsetse fly species (*Glossina palpalis palpalis*) had been eradicated from more than 85% of the project area and reduced by 95% in the remaining area through the release of sterile males after population reduction by means of insecticide-impregnated screens.

240. Implementation of the MISR-MED project [17] was postponed by the Egyptian Government.

241. The mass-rearing of flies continued at the La Molina laboratory in Lima, Peru, in support of the MOSCAMED project — a project aimed at eliminating the medfly from the southern valleys of Peru. Intensive trapping and bait-spraying were followed by weekly releases of sterile flies. Towards the end of the year, quarantine measures were introduced so as to prevent the reintroduction of flies into cleared areas.

242. Research and training activities continued at Seibersdorf in support of ongoing field projects and in anticipation of future projects.

243. Co-ordinated research programmes continued on the genetic sexing of medflies through the manipulation of radiation-induced conditional lethals and on methodologies for using the sterile-insect technique in tsetse fly eradication or control. In the mass-rearing of tsetse flies, significant progress was made in the use both of artificial diets and of locally collected blood (fed to the flies either fresh or after preservation through deep freezing).

244. Two co-ordinated research programmes were initiated — one on medfly trapping methods and the other on the use of F-1 sterility to control lepidopteran pests of cereals and other crops.

Agrochemicals and residues

245. Assistance to Member States continued through 79 research contracts and agreements and 13 technical co-operation projects.

246. Co-ordinated research programmes continued on pesticide residues in livestock products, stored grains, food plants and rice–fish ecosystems and on controlled-release pesticide formulations.

247. Co-ordinated research programmes also continued on the fate of persistent pesticides in the tropics and on improving rural methane production from biomass.

248. A co-ordinated research programme was initiated with the aim of assessing the impact of bound pesticide residues on non-target organisms.

249. Research continued at Seibersdorf on — inter alia — the development of analytical methods, the development of improved pesticide formulations and the quality control of radioisotope-labelled pesticides. Also, radiotracer studies continued at Seibersdorf in connection with two Italian-supported projects in Kenya — one on developing methods for the determination of trypanocidal drug residues in cattle and one on isolating micro-organisms (obtained from African termites) containing enzymes capable of degrading lignocellulose.

250. An advisory group on isotope-aided studies of insect attractants for pest management examined ways of developing practices which improve the efficiency and safety of pest control while maintaining quantity and quality in agricultural production. Also, a consultants' meeting was held on the bioconversion of lignocellulosic agricultural residues to animal feed components.

Food preservation

251. Assistance to Member States continued through 48 research contracts and agreements and 24 technical co-operation projects.

252. The number of countries participating in the work of the International Consultative Group on Food Irradiation increased to 26. The activities of the Group focused on the promotion of international trade in irradiated foods, training, feasibility studies and public education. Guidelines on the use of irradiation — inter alia — as a quarantine measure and as a method for ensuring the hygienic quality of foods were prepared by the group; also, marketing and public relations strategies were developed.

253. A regional seminar on the practical application of food irradiation in Asia and the Pacific took place in Shanghai, China.

254. As a result largely of efforts made within the framework of the second phase of the Asian regional

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[16] FAO/IAEA/Government of Nigeria Project for the Biological Control of Tsetse Flies by the Sterile-Insect Technique, the aim of which is to eradicate the tsetse fly from a 1500 km^2 area in Nigeria.

[17] A project, jointly sponsored by the Agency and the Government of Egypt, for eradicating the Mediterranean fruit fly (medfly) from Egypt.

project on food irradiation (RPFI Phase II), four commercial/demonstration irradiators were either under construction or at an advanced stage of planning in the region covered by the project at the end of 1986.

255. Within the framework of ARCAL, a workshop on food irradiation was held at Piracicaba, Brazil; it was attended by 19 participants from 8 Latin American countries. Action plans for a regional co-ordinated research programme on food irradiation and for the harmonization of legislation were adopted at the workshop.

256. An expert mission evaluated the infrastructure available for and the technical and economic feasibility of food irradiation in African countries with a view to the initiation of a regional co-ordinated research programme. A group of consultants formulated parts of a programme for food irradiation in developing countries in Europe and the Middle East.

Medical applications

257. A regional seminar for Africa on the quality control of imaging instruments and an interregional training course on nuclear applications in parasitology were held in Cairo.

258. An annual interregional training course on nuclear medicine was held in Moscow, followed by a study tour of several nuclear medicine centres in the Soviet Union and the German Democratic Republic.

259. Research co-ordination meetings were held to review (i) progress in optimizing nuclear medicine procedures for the diagnosis of thyroid disorders, (ii) the diagnostic efficacy of imaging procedures for liver diseases and (iii) the maintenance of nuclear instruments in Asia and Latin America. Research co-ordination meetings were also held to review work done under co-ordinated research contracts in developing nuclear technology for the early diagnosis of malaria, schistosomiasis and other tropical parasitic diseases.

260. A training course on the use of bulk reagents was held in Bangkok, the aim being to promote the use of bulk reagents in the radioimmunoassay of thyroid-related hormones in RCA countries.

261. Technical advice and assistance were provided in connection with 93 technical co-operation projects covering 45 countries.

Dosimetry

262. The scientific committee of the network of Secondary Standard Dosimetry Laboratories (SSDLs), at its first meeting, recommended that the Agency's dosimetry measurement standards be calibrated at the International Bureau of Weights and Measures (BIPM). Also, the committee proposed a programme for improving the coherence and accuracy of SSDL reference instrumentation.

263. Guidelines concerning radiation measurement standards and defining the role of SSDLs within the international measurement system were circulated to all Member States.

264. A workshop on dose calibrations held at the SSDL in Quito, Ecuador, within the framework of ARCAL was attended by SSDL staff from 12 Member States, who were able to compare their dosimetry standards with the Agency's reference instrument.

265. About 120 radiotherapy departments, mainly in Latin America, the Far East and the Pacific region, participated in the cobalt-60 postal dose intercomparison service being conducted by the Agency and WHO; the improvements in dosimetry accuracy observed during the previous few years were found to have persisted. Following the recommendations of a group of consultants, the prototype of a human-shaped phantom for use in cobalt-60 dose intercomparisons was produced and preparations were made for testing it.

266. During the first year of operation of the international high-dose assurance service [18], 79 dose checks were performed for 26 radiation processing facilities in 17 Member States.

267. Following a series of electron dosimetry intercomparison studies conducted at a number of national standards laboratories, the reference dosimetry systems to be used for an international dose assurance service for electron irradiation facilities were selected.

Radiation biology

268. Relevant techniques for the radiation-sterilization of tissue grafts for clinical use in Asia and the Pacific region were promoted through an RCA co-ordinated research programme. The progress achieved under this programme was reviewed at a research co-ordination meeting held in Sri Lanka. A training course organized in co-operation with WHO and held in Sri Lanka was attended by participants from nine Member States in the region.

269. The Agency's code of practice for the radiation sterilization of medical supplies was reviewed and updated by an advisory group.

270. The present status of and future trends in the radiation therapy of cancer in developing countries were reviewed at a symposium organized by the Agency in co-operation with WHO. The results of research into ways of improving cancer therapy by combining irradiation with chemical treatments and hyperthermia were reviewed at a research co-ordination meeting.

271. A training course on cervical cancer brachytherapy using manual and remote after-loading was held in Malaysia, and support continued to be provided for the IAEA/WHO technical co-operation project in Egypt on the use of the manual after-loading technique in the treatment of cervical cancer.

272. A consultants' meeting was held on the use of californium-252 in interstitial and intracavitary therapy.

273. A co-ordinated research programme was initiated on nuclear techniques for use in the fermentation processing of cassava.

Trace elements in the environment and in nutrition

274. Assistance to Member States continued through 48 research contracts and agreements and 2 technical co-operation projects.

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[18] See para. 231 in document GC(XXX)/775. The aim of the service is to increase dosimetry accuracy and reliability at participating facilities.

275. The results of a co-ordinated research programme on dietary intakes of trace elements, measured by nuclear and other techniques, were reviewed at a research co-ordination meeting held in Vienna. Research co-ordination meetings on nuclear-related techniques in occupational health studies and on toxic elements in foodstuffs were held in Denmark and India respectively.

276. As a result of an intercomparison exercise involving 72 institutes in 32 Member States, a new biological reference material intended for use in connection with the determination of minor and trace elements in human diets was certified; it is now available under the Agency's analytical quality control services programme.

277. The Agency published a technical report on nuclear-based techniques for the in vivo study of human body composition, which includes a directory of systems for in vivo measurements by neutron activation analysis, X-ray fluorescence analysis and the nuclear resonance scattering of gamma-rays.

278. A training course on nuclear techniques in health-related environmental research and monitoring was held in Australia.

279. A seminar on applications of stable isotopes in human nutritional and medical studies and an advisory group meeting on nuclear-based techniques in environmental and occupational health were held in Vienna.

PHYSICAL SCIENCES

Nuclear physics

280. Assistance was provided in introducing nuclear science programmes into the curricula of universities in a number of developing Member States. An inter-regional training course on the use of neutron generators was organized. IAEA technical documents on selected topics in nuclear electronics were published.

281. A co-ordinated research programme on modular nuclear instruments based on the Eurocard System (a system for the supply of circuits on cards which can be easily inserted into and removed from instruments) continued with the construction of a four-channel area monitor and a multichannel analyser.

282. Advisory group meetings were held on national activities in nuclear science and on interfacing between small computers and nuclear experiments.

Research reactor support programme

283. In the area of research reactor utilization, two reports were prepared on the technology and use of low-power research reactors and of research reactors in national nuclear programmes. During a study tour on research reactor utilization, the participants visited well-utilized facilities in five countries.

284. Activities relating to the conversion of research reactors in order that they may use low-enriched uranium (LEU) fuels included a meeting on the standardization of specification and inspection procedures for plate type LEU fuels with a view to reducing replacement fuel costs. The first in a series of publications on safety and licensing aspects of core conversion was prepared.

285. Updated information from the Research Reactor Data Base was published in a booklet entitled "Nuclear research reactors in the world".

Fusion

286. The Eleventh International Conference on Plasma Physics and Controlled Nuclear Fusion Research was held in Kyoto, Japan.

287. In view of the fact that the participants in the INTOR exercise had indicated a willingness to proceed with the conceptual design of a next-step tokamak fusion experiment called the "Engineering Test Reactor" (ETR), to be performed under the aegis of the Agency, the INTOR Workshop modified its tasks for 1987 so as to include preparatory work on the proposed new project.

288. Several technical committee meetings and specialists' meetings were held for the purpose of exchanging information on current aspects of fusion research.

289. The Agency continued to provide assistance in co-ordination and information exchange to a number of developing Member States with fusion and plasma physics programmes.

Industrial applications and chemistry

290. As part of the Agency's efforts to promote the transfer of nuclear technologies employed in industry and chemistry, support was provided for 120 technical co-operation projects in 44 countries.

291. A co-ordinated research programme on the use of nuclear techniques in the study of pollutant transfer in the environment, with emphasis on interactions of solutes with geological media, was initiated with the aim of harmonizing activities in this area.

292. Work continued on the preparation of a guide-book entitled "Radioisotope tracers in industry".

293. A consultants' meeting on the electron beam processing of combustion flue gases (a technology which has attracted considerable interest owing to the problem of acid rain) was attended by 33 participants from 12 Member States (23 observers from 5 Member States also attended).

294. A consultants' meeting on the qualification and certification of non-destructive testing (NDT) personnel was held in Milan, Italy, in connection with the Agency's continuing efforts to harmonize the training and certification of NDT personnel in Member States.

295. An advisory group assessed the usefulness of irradiation techniques in biotechnology, in the development of new polymers and in medical and biological applications of polymers, while another advisory group carried out a technological and economic comparison of irradiation and conventional techniques in various applications. A co-ordinated research meeting on the radiation modification of polymers for industrial use was held in Cairo.

296. Insulators for fusion applications were reviewed at a consultants' meeting.

297. Recent developments in radionuclide generator technology — including advances in alternative $^{99}Tc^{m}$ generation techniques, which are of particular importance for developing countries with medium and small research reactors — were reviewed at a seminar attended by 77 participants from 38 Member States.

298. At a research co-ordination meeting, several new hepatobiliary imaging agents were reported and plans for the preparation of new brain and heart radiopharmaceuticals labelled with $^{99}Tc^{m}$ were discussed.

299. The reactor production of fluorine-18 and techniques for labelling organic compounds with fluorine-18 were discussed at a consultants' meeting.

300. An interlaboratory comparison of the performance of $^{99}Tc^{m}$ sublimation generators recently developed under a research contract was initiated.

301. The role of nuclear analytical techniques in analytical chemistry was discussed by an advisory group which concluded that such techniques have certain characteristics which make them uniquely reliable in trace element analysis. The use of nuclear analytical techniques in the analysis of environmental samples was discussed in a consultants' meeting, where it was concluded that such techniques are now well established in environmental research.

302. Reports of work on borehole logging and on-line analysis using X-ray fluorescence and neutron activation analysis were presented at a meeting held within the framework of a co-ordinated research programme on the use of nuclear analytical techniques in mineral exploration, mining and processing.

Isotope hydrology

303. During 1986 the Agency supported 44 technical co-operation projects in 33 countries, assistance being provided with — inter alia — the evaluation of water resources, the assessment of geothermal energy potential, the strengthening of analytical capabilities, the establishment of an environmental isotope laboratory and the solving of hydrogeological problems. Also, technical guidance was given in support of projects concerned with sediment transport dynamics and water pollution.

304. Through 52 research contracts involving 37 countries, the Agency continued to support the development of new and the improvement of existing isotope hydrology techniques. Of these 52 contracts, 32 formed part of 4 co-ordinated research programmes concerned with groundwater problems, geothermal resources exploration and the dating of old groundwater — one in the Far East (financed by Australia), two in Latin America (financed by the Federal Republic of Germany and Italy) and one in various African and Asian countries.

305. An IAEA/UNESCO regional seminar on isotope hydrology techniques for Asia and the Pacific region held in Jakarta, Indonesia, was attended by 60 participants from 10 countries.

306. Courses on the use of isotope techniques in hydrology were held in Cuba, Guatemala and the Dominican Republic, with the participation of 91 hydrologists, hydrogeologists and geologists.

307. An advisory group consisting of 21 experts from 12 European and North American countries which discussed the application of isotope techniques in studies of the hydrogeology of fractured and fissured rocks emphasized the need for integrated studies where isotope hydrology provides additional knowledge and the importance of defining the problems to be studied before applying isotope techniques.

308. A research co-ordination meeting on the dating of old groundwater was held in Vienna and one (for Latin American countries) on the application of isotope and geochemical techniques in geothermal resources exploration was held in Bogotá, Colombia.

309. An IAEA/UNDP regional seminar on the application of isotope techniques in hydrology in North African countries, held in Rabat, Morocco, was attended by 23 participants. Also, the Agency supported a UNDP seminar on the reutilization of processed waste waters in agriculture held in Tunis, Tunisia.

310. Agency staff members presented papers at a workshop on "Techniques in accelerator mass spectrometry" held in Oxford, United Kingdom, and at a meeting on "Isotopes in nature" held in Leipzig, German Democratic Republic. A review paper on the use of isotopes in studies of lakes was published in the second volume of the "Handbook of Environmental Isotope Geochemistry" (Elsevier). Lectures on isotope hydrology were given at post-graduate courses held in Monselice, Italy, and in Prague.

311. The Agency participated in the seventh session of the Intergovernmental Council of the International Hydrological Programme (IHP), convened by UNESCO to examine all projects in Phase III of the IHP.

312. A technical document on mathematical models for the interpretation of tracer data in groundwater hydrology (IAEA-TECDOC-381) and the eighth volume in a series of technical reports on environmental isotope concentrations in precipitation (Technical Reports Series No. 264) were issued.

Nuclear data

313. The Agency continued to provide nuclear and atomic data services to Member States and to co-ordinate the activities of a worldwide network of data centres. During 1986 the Agency fulfilled more than 600 requests from 40 Member States for experimental and evaluated data, data processing computer codes and publications. The Agency continued to publish the quarterly Bulletin on Atomic and Molecular Data for Fusion and the Computer Index of Neutron Data (CINDA).

314. As part of its continuing effort to keep abreast of the nuclear data requirements of nuclear science and technology, the Agency convened expert groups to review the status of and assess the requirements for nuclear data in the design and use of neutron sources and in the development of fusion technology.

315. In order to stimulate the production of necessary new nuclear data and to improve the accuracy of existing data, the Agency convened research co-ordination meetings on methods of calculating the effects of high-energy neutrons on the properties of reactor structural materials.

316. Detailed comparisons and tests of different data evaluations were carried out within the framework of a co-ordinated research programme on the validation and benchmark testing of actinide nuclear data. A co-ordinated research programme on the measurement and analysis of 14-MeV neutron cross- sections brought

together extensive measurement results and critical analyses of nuclear data measurement techniques.

317. An updated version of a handbook — published in 1974 — on nuclear activation cross-section data was prepared for publication.

318. The results of a seven-year co-ordinated research programme on the measurement and evaluation of transactinium isotope nuclear decay data were published under the title "Decay data of the transactinium nuclides" (Technical Reports Series No. 261). Work started on a handbook of nuclear data for safeguards, and an initial compendium was prepared.

319. A group of consultants defined high-priority requirements for nuclear data to be used in the analysis of nuclear geophysics measurements. Another group of consultants laid the foundations for a co-ordinated research programme designed to produce an international file of evaluated gamma-ray decay data for use in detector efficiency calibration.

320. Workshops on nuclear data applications and reactor physics were held at the International Centre for Theoretical Physics in Trieste and at the Jozef Stefan Institute in Ljubljana, Yugoslavia. A complementary interregional training course on the preparation of nuclear data for reactor calculations was held at the Bhabha Atomic Research Centre in Bombay, India.

321. The Agency continued to provide equipment, fellowships and experts within the framework of an interregional project on nuclear data techniques and instrumentation designed for the training of nuclear scientists in developing countries.

322. At Headquarters, five fellows received training in various aspects of bibliographic and numerical data processing and contributed to the Agency's nuclear data programme by writing data reviews, helping to produce the nuclear activation cross-section data handbook referred to in paragraph 317 and improving some of the evaluated data files.

THE LABORATORIES

Seibersdorf Laboratories

I. Agricultural; in support of the joint FAO/IAEA programme

Soil fertility, irrigation and crop production

323. Fertilizer and water use studies continued for annual crops, pastures and orchards. The availability of nutrients from natural sources (rock phosphate, guano) and through nitrogen fixation in leguminous plants and in Azolla (the fern used in rice paddies) continued to be investigated in field and greenhouse experiments utilizing isotopic techniques.

324. Services to co-ordinated research programmes and technical co-operation projects continued through analytical assays of about 13 000 samples for nitrogen-15 determination; additional facilities for increased analytical throughputs were established.

325. Thirty-nine scientists attended two interregional training courses, and eight fellows and four scientific visitors received training in nuclear techniques for use in soil–plant relationship research.

Plant breeding and genetics

326. In vitro studies were carried out with maize to assess mutagen effects and somaclonal variation; plant regeneration in vitro from maize leaf segments was achieved. Mutagenesis and radiosensitivity in shoot tip cultures of plantain and banana clones were studied, and work continued on in vitro morphogenesis in cacao with a view to developing a new mutation breeding technique.

327. Nineteen scientists from developing Member States participated in an interregional training course on mutation breeding, and six fellows received training for a total of 24 man-months. Three training films were produced.

328. About 400 seed samples and several tissue cultures were irradiated as a service to plant breeding institutes.

Animal production and health

329. A disease diagnostics laboratory was established as a complement to the existing facilities for animal nutrition and reproduction studies.

330. Work continued on the characterization of agro-industrial by-products and other non-conventional feed resources using the rumen simulation technique and on the formulation of balanced ruminant diets designed to optimize the use of locally available feed resources.

331. Over 700 radioimmunoassay kits (equivalent to 70 000 assay units) were supplied to technical co-operation and research contract counterparts.

332. Staff members instructed in three regional training courses, and four fellows received training either in animal nutrition work or in the use of radioimmunoassay techniques at the Laboratory.

Insect and pest control

333. Back-up support for the tsetse fly eradication project in Nigeria (the BICOT project) continued with the production and shipment of 600 000 puparia and 1500 litres of dried blood, the procurement of equipment and supplies, and visits to the project site. Artificial diets for feeding tsetse flies were improved. Four new species of tsetse fly were colonized using in vitro feeding techniques.

334. More efficient procedures for the mass-rearing of medflies were developed and the quality of the mass-reared insects was improved. Field tests demonstrated the advantages in SIT eradication programmes of releasing males only, and further progress was made in developing temperature sensitivity as a mechanism for the sexing of medflies. Strains of the bacterium *Bacillus thuringiensis* suitable for controlling medfly adults were found and underwent development studies.

335. Ten fellows, two scientific visitors and an intern received a total of 56 man-months of training in the SIT and in related insect control techniques.

Agrochemicals and residues

336. Pesticide formulation experiments continued, new formulations being applied in rice paddies in Indonesia and Hungary and in water hyacinth cultures at the Seibersdorf Laboratories.

337. Sensitive analytical methods were developed for determining trypanocidal drugs in milk and animal tissue.

338. Three trainees received training in the use of radioisotopes and in general analytical work.

II. Life sciences

Environment and nutrition

339. Following the Chernobyl accident, more than 2400 determinations were performed in order to assess the distribution of radionuclides in the air, soil, rainwater, grass, fruits and various other environmental compartments; nine potentially hazardous radionuclides (^{140}Ba, ^{134}Cs, ^{137}Cs, ^{131}I, ^{132}I, ^{99}Mo, ^{103}Ru, ^{90}Sr and ^{132}Te) were identified and determined in almost all the samples, and in a number of samples the radionuclides ^{141}Ce, ^{144}Ce, ^{136}Cs, ^{133}I, ^{134}I, ^{95}Nb, ^{106}Rh, ^{106}Ru, ^{129}Te and ^{95}Zr were also identified. A consultants'

meeting on the determination of radionuclides in grass samples and one on fallout radioactivity monitoring in the environment and in food were convened. Technical advice on the assessment of radioactive contaminants in environmental samples and in foodstuffs was provided to a number of institutes in developing Member States.

340. About 8800 determinations were performed of various trace elements in some 2000 samples using analytical methods such as neutron activation analysis, the inductively coupled plasma (ICP) technique, atomic absorption spectrometry, fluorimetry, liquid scintillation counting and photometry. Analytical capabilities were further extended through improvements in sample preparation methods and in the utilization of the Laboratory's ICP equipment.

341. A four-week training course on advanced analytical techniques, organized by the Agency in co-operation with UNIDO, was attended by 22 participants. In addition, four trainees received altogether 19 man-months of training in the use of various analytical methods.

Radiation dosimetry

342. The Agency's Secondary Standard Dosimetry Laboratory (SSDL) continued to provide postal dose intercomparison services for radiotherapy hospitals in co-operation with WHO. Three batches of thermoluminescence dosimeters were evaluated for a total of 120 hospitals. Calibrations and test studies of solid thermoluminescence dosimeters using a semi-automatic read-out system were continued.

343. A new cobalt-60 source and a new X-ray generator were installed.

344. Calibrations were performed for members of the SSDL network, and dosimeters from the Agency's SSDL were used in an interregional workshop on the calibration of secondary standard dosimeters in Ecuador.

345. Calibration irradiations were performed continuously for the Agency's radiation protection services.

346. A one-week calibration workshop held at the SSDL was included in the Agency's Introductory Course on Radiation Protection Services. Six trainees received a total of 14 man-months of training in dosimetry standardization.

III. Physical sciences

Chemistry and analytical quality control

347. One intercomparison of trace element analyses was completed, while 14 intercomparisons (including measurements of radionuclides) were still running at the end of the year; laboratories in 33 countries took part in one or more of these intercomparisons.

348. Three reference materials were added to the list of such materials available from the Agency; the list now contains 47 items. The Laboratory supplied 1300 aliquots of such materials in response to 430 orders from Member States. For the homogeneity testing and characterization of intercomparison samples, 250 trace element determinations were carried out.

349. A consultants' meeting was held on future plans for the Analytical Quality Control Service (AQCS) programme.

350. Co-operation continued with the World Meteorological Organization (WMO) in the analysis of rainwater and air-filter samples in support of WMO's background air pollution monitoring network. Some 2900 analyses for trace elements and radionuclides (uranium and tritium) were performed. Studies on types of air filter suitable for air pollution monitoring were carried out.

Hydrology

351. In support of technical co-operation projects and in order to obtain data for the global precipitation monitoring network, approximately 160 water samples were analysed for oxygen-18, 1700 for deuterium, 1000 for tritium, 140 for carbon-14 and 170 for carbon-13. In addition, chemical analyses (some 2000 individual determinations) were performed on 225 water samples in support of technical co-operation projects.

Soil water research

352. Field and laboratory experiments were carried out in support of a co-ordinated research project for comparing nuclear and non-nuclear methods in soil water studies.

353. Three fellows received training for a total of 24 man-months in the use of nuclear methods in soil physics research. Support was provided for seven technical co-operation projects and staff members carried out missions to Nicaragua and Uruguay.

Instrumentation

354. The prototype of a radiation monitor which can be used both for on-site radiation protection and for electronics training was completed.

355. About 50 instruments of different types received from Member States and from various Agency laboratories were repaired and serviced.

356. Five fellows received a total of 23 °man-months of training in nuclear electronics, directed mainly to the servicing of electronic equipment and to the repairing and maintenance of factory-made nuclear measurement instruments.

IV. Safeguards analytical laboratory (SAL)

357. SAL received about 650 samples of uranium, 210 samples of plutonium or mixtures of uranium and

plutonium, and 225 samples of spent fuel solutions; 126 — or 61% — of the samples of spent fuel solutions were sent for analysis to laboratories belonging to the Agency's network of analytical laboratories (NWAL).

358. Total shipment and analysis delays were reduced on average by 18–29% for plutonium and spent fuel solution samples. The analyses of uranium samples were performed on time.

359. SAL and NWAL analysed 19 uranium oxide samples for the characterization of non-destructive assay working standards and performed about 1000 measurements to test improved analytical procedures and in connection with joint projects being conducted within the framework of Member States safeguards support programmes.

360. A four-isotope tracer batch for use in the analysis of spent fuel solution samples by a new and more accurate isotope dilution procedure was prepared and characterized. A set of spent fuel solution samples for the quality control programme of the Agency's safeguards analytical services was also prepared and characterized, about 700 extra measurements by SAL and NWAL being required for this purpose.

361. Several ten-year-old glove boxes and a mass spectrometer were decommissioned and replaced by new equipment. The plutonium and the mass- and gamma-spectrometry laboratories within SAL were reorganized in order to increase the analytical throughput.

International Laboratory of Marine Radioactivity

362. In order to obtain data and samples for evaluating the radiobiological impacts of radionuclides in the marine environment, field studies were performed in co-operation with institutes in Denmark, France, the Federal Republic of Germany, Sweden and the United States. Comparisons were made of the behaviour in different marine environments (Mediterranean Sea, Baltic Sea, Arctic Sea) of radionuclides (^{99}Tc, actinides, fission products) from different sources (nuclear fuel reprocessing plants, nuclear accidents, etc.). Studies were carried out of the chemical speciation of transuranium elements in sediments from Thule, Greenland, and the Baltic Sea.

363. Reference samples of materials of marine origin were distributed to the national laboratories of Member States for radionuclide measurement quality control purposes; an intercalibration exercise involving radionuclide measurements on a fish flesh sample was organized with the participation of approximately 60 institutions in 30 countries.

364. Work continued on compiling inventories, inputs and outputs in the marine environment for ^{137}Cs, ^{210}Po, ^{210}Pb, ^{14}C and plutonium isotopes. An expert group recommended that the exercise be expanded to include ^{90}Sr, ^{3}H and radium isotopes and that a final report be submitted to UNSCEAR in 1991.

365. Vertical fluxes of natural and artificial radionuclides associated with sinking particulate matter were measured by deploying sediment traps in biologically productive and non-productive areas of the Pacific and the Mediterranean in order to assess the extent to which marine organisms transport various radionuclides.

366. Extensive data on natural ^{210}Po-^{210}Pb concentrations in different species of shallow- and mid-water open ocean organisms were collected and used in making predictions about animal feeding habits and the food-chain transfer of other nuclides of interest.

367. A Marine Environmental Studies Laboratory (MESL) was established within the International Laboratory of Marine Radioactivity as an organizational unit for co-ordinating non-radioactive marine pollution studies involving — inter alia — UNEP's Ocean and Coastal Area Programme (covering the Mediterranean, the Kuwait region and the West and Central Africa region) and the Intergovernmental Oceanographic Commission of UNESCO.

368. The Laboratory provided assistance in the development and application of guidelines and reference methods for marine pollution studies and prepared a number of reference materials for intercalibration purposes and for the quality control of data on trace metals, chlorinated hydrocarbons and petroleum hydrocarbons.

369. A number of marine chemists received training both in Monaco and in their own laboratories in the measurement of trace metals, chlorinated hydrocarbons and petroleum hydrocarbons in the marine environment.

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

370. The main fields of research and training for research at the Centre in 1986 were:

(a) Physics and energy (nuclear physics, non-conventional energy, plasma physics);
(b) Fundamental physics (elementary particles and fundamental theory);
(c) Physics of condensed matter (including atomic and molecular physics);
(d) Applied physics (laser physics, fibre optics and microprocessor technology);
(e) Mathematics (applicable mathematics);
(f) Physics of the environment and of natural resources (physics of the atmosphere, the oceans and the earth, and soil physics);
(g) Physics of the living state; and
(h) Physics and development.

371. Over 3650 scientists took part in activities at the Centre, in two major projects outside Trieste and in training at Italian laboratories, staying for a total of almost 3820 man-months. Sixty per cent of them were from developing countries, accounting for 82% of the total man-months. One hundred and twenty-two of them were associated members from 39 developing countries and approximately 420 of them were researchers from federated institutes in 43 developing countries.

Physics and energy

372. In February, a workshop on applications of nuclear data in reactor physics was held with the participation of 61 scientists from developing countries (out of a total of 81). Later in the year, a workshop on solar and wind climatology and a college on solar energy were held with the participation of 61 and 54 scientists from developing countries (out of a total of 91 and 71 respectively).

Fundamental physics

373. High-energy physics research was carried out throughout the year with the participation of 133 scientists from developing countries (out of a total of 213).

374. As every year, a workshop on high-energy physics and cosmology was held during the summer, with a total attendance of 146 physicists, of whom 100 were from developing countries.

375. Other activities included: a symposium on perspectives in particle physics; a spring school on supergravity, supersymmetry and superstrings; a topical meeting on astrophysics particles; a meeting on elementary particle phenomenology; a workshop on aspects of particle confinement achievements and prospects for nuclear physics; and a meeting on spinors in physics and geometry. One hundred and thirty-one physicists from developing countries (out of a total of 462 physicists) took part in these activities.

Physics of condensed matter

376. Research was conducted throughout the year with the participation of 112 scientists, 94 of them from developing countries.

377. During the summer, a workshop on condensed matter, atomic and molecular physics brought together 247 physicists (195 from developing countries). Also, meetings (entitled "Adriatico Research Conferences") were organized on the following topics: quantum chaos; dynamic screening and surface spectroscopy; relativistic many-body problems; heavy-fermion systems; and the physics of structure and complexity.

378. Other activities consisted of: a winter school on the technology, characterization and properties of epitaxial electronic materials; a spring college on order and chaos in non-linear physical systems; IUPAP's [19] fourth Trieste semiconductor symposium; the second international conference on shallow impurity centres; and a working party on the physics of condensed matter at high pressures. The Adriatico Research Conferences and the other activities brought together 695 participants, of whom 301 were from developing countries.

Applied physics

379. The following activities were organized: a school on physics in industry; a workshop on optical fibre communications; an international conference on synchrotron radiation; and a school on advanced techniques in computational physics. These activities brought together 467 scientists, of whom 272 were from developing countries.

Mathematics

380. Seventy-one mathematicians from developing countries and six from industrialized ones took part in the Centre's mathematics research programme. Other activities included workshops on dynamic systems, global differential geometry and the representation theory of Lie groups; 125 mathematicians from developing countries and 98 from industrialized ones participated.

Physics of the environment and of natural resources

381. An autumn course on seismology, a second autumn course on mathematical ecology and an

[19] IUPAP: International Union of Pure and Applied Physics.

Adriatico research conference devoted to atmospheric aerosols were attended by 353 scientists (230 of them from developing countries).

Physics of the living state

382. A workshop on the quality control of X-ray equipment was attended by 241 scientists (162 of them from developing countries). In addition, a third summer college on biophysics (membranes) and a college on neurophysics were held.

Physics and development

383. As in the past, a number of the experts and leading scientists taking part in activities at the Centre lectured on physics and its relevance to development.

Training at Italian laboratories

384. Ninety-one grants were awarded to scientists from developing countries for training at Italian university and industrial laboratories under a programme started in 1982.

External activities

385. A workshop on curriculum development in physics, mathematics and computer science was held in Nairobi and a regional college on microprocessors was held in Beijing.

386. In the field of training for physics and mathematics teachers, the Centre sponsored 19 courses, 28 workshops/symposia and eight projects in 27 countries. In addition, the Centre sponsored five visiting scholars so as to enable them to provide scientific guidance in developing countries.

Meetings hosted by the Centre

387. The Centre hosted several meetings, including meetings organized by the Third World Academy of Sciences (TWAS). Among them were: a school on applications of nuclear gamma resonance spectroscopy and TWAS round tables on synchrotron radiation, Mössbauer spectroscopy and haemoglobinopathies.

Book and equipment donation programme

388. In 1986, the Centre distributed 20 000 copies of scientific journals, 20 000 sets of proceedings and 10 000 books received from other institutions to 500 libraries in 90 developing countries. Also, unused supplies and scientific equipment made available to the Centre were shipped to laboratories in developing countries.

Awards

389. The 1986 Dirac Medals were awarded to Y. Nambu (Chicago) and P. Poliakov (Moscow) for their contributions to theoretical physics.

390. The 1986 S. Eklund Prize was awarded to Prof. Chike Obi (Nigeria) for his contributions to mathematics.

SAFEGUARDS

Safeguards statement for 1986

391. In 1986, as in previous years, the Secretariat, in carrying out the safeguards obligations of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material — or the misuse of facilities, equipment or non-nuclear material subject to safeguards under certain agreements — for the manufacture of any nuclear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown [20]. It is considered reasonable to conclude that nuclear material under Agency safeguards in 1986 remained in peaceful nuclear activities or was otherwise adequately accounted for. However, this statement should be seen in the light of the following observations:

(a) Extensive safeguards activities in 1986 resulted in more than 2050 (1980 in 1985) inspections carried out at 595 (514) nuclear installations in 53 (51) non-nuclear-weapon States and 4 (4) nuclear-weapon States. In 36% (32%) of inspections nuclear material was verified by non-destructive assay (NDA). More than 325 (290) automatic photo and television surveillance systems operated in the field, and 10 300 (9300) seals applied to nuclear material were detached and subsequently verified at Headquarters. About 1030 (1270) plutonium and uranium samples were analysed, with some 2840 (3250) analytical results being reported. Accounting and other safeguards data comprising 867 000 (561 000) data entries were processed and stored in the Agency's computer;

(b) About 270 (150), mostly minor, discrepancies or anomalies were found. All cases were satisfactorily explained upon subsequent appraisal or investigation, except for a number of cases in which surveillance or bundle counters failed to provide conclusive results and the inventories of nuclear material concerned have not yet been reverified. In some of these cases the inventories cannot be reverified. The reported unresolved anomalies were caused by Agency equipment failures or by inconclusive information given by such equipment. In no case is there any indication of a diversion;

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

(d) The safeguards findings refer for each facility to the latest available State report, Agency inspection, analysis, etc. relating to that facility.

Safeguards coverage

392. At the end of 1986 there were 164 safeguards agreements in force with 96 States, compared to 163 agreements with 96 States at the end of 1985, a project agreement concluded with Thailand for the supply of nuclear fuel for a research reactor having entered into force in September.

393. A safeguards agreement was concluded with Albania covering all its nuclear material and facilities. Safeguards agreements pursuant to NPT were concluded with Belize, Brunei Darussalam, Equatorial Guinea and Tuvalu; these agreements have not yet entered into force.

394. In July, Portugal acceded to the safeguards agreement of 5 April 1973 between the non-nuclear-weapon States of the European Community, EURATOM and the Agency.

395. Negotiations commenced for the conclusion of a safeguards agreement pursuant to the offer by China to place some of its civilian nuclear installations under Agency safeguards. When this agreement enters into force there will be safeguards agreements in force with all five nuclear-weapon States.

396. Discussion of a trilateral safeguards agreement between Spain, EURATOM and the Agency was initiated.

397. During 1986, four non-nuclear-weapon States became party to NPT: Malawi in February, Colombia in April, the Yemen Arab Republic in May, and Trinidad and Tobago in October [21]. The total number of States party to the Treaty at the end of 1986 was 134, including three nuclear-weapon States.

398. At 31 December 1986, 46 of the 131 non-nuclear-weapon States party to NPT had not complied, within the prescribed time limit, with their obligations under Article III.4 of the Treaty regarding the conclusion of the relevant safeguards agreement with the Agency. However, with the exception of Viet Nam, none of these States has, as far as the Agency is aware, significant nuclear activities.

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

[21] In February 1987, Spain announced its decision to adhere to NPT.

399. Safeguards were actually applied in 41 non-nuclear-weapon States under agreements pursuant to NPT or to NPT and the Tlatelolco Treaty, and in one non-nuclear-weapon State pursuant to the Tlatelolco Treaty.

400. Thirty-nine safeguards agreements based on INFCIRC/66/Rev.2 were in force with the following nine non-nuclear-weapon States not party to either NPT or the Tlatelolco Treaty: Argentina, Brazil, Chile, Cuba, India, Israel, Pakistan, South Africa and Spain. Safeguards were actually applied in eight of the nine States pursuant to these agreements. Also, safeguards were applied pursuant to INFCIRC/66/Rev.2-type agreements in Viet Nam and the Democratic People's Republic of Korea, both party to NPT [22].

401. In five of the nine States referred to in the first sentence of the preceding paragraph, unsafeguarded facilities of significance for safeguards were known to be in operation or under construction.

402. All five nuclear-weapon States have complete unsafeguarded nuclear fuel cycles. Voluntary-offer agreements were in force with four of these States during the whole of 1986. In accordance with the relevant agreements, certain facilities in the four States were designated by the Agency for inspection and were inspected. In addition, in one of these States safeguards were applied in 1986 to some facilities in accordance with INFCIRC/66 Rev.2-type agreements.

403. On 31 December 1986, there were in non-nuclear-weapon States 485 nuclear facilities under safeguards or containing safeguarded nuclear material (474 in 1985); there were also 414 locations outside facilities containing small amounts of safeguarded material (413 in 1985) and two non-nuclear installations (two in 1985). There were also nine facilities in nuclear-weapon States under Agency safeguards pursuant either to voluntary-offer agreements or to safeguards transfer agreements (ten in 1985).

404. At the end of 1986, the nuclear material under Agency safeguards, including that covered by voluntary-offer agreements with nuclear-weapon States, amounted to 8.4 t (7.9 t in 1985) [23] of separated plutonium [24], 194.5 t (156.2 t) [23] of plutonium contained in irradiated fuel, 13.2 t (12.3 t) of high-enriched uranium (HEU), 27 911 t (24 546 t) of low-enriched uranium (LEU) and 47 402 t (43 044 t) of source material. The greater part of this material was in those non-nuclear-weapon States party to NPT where safeguards are being applied to all peaceful nuclear activities. Non-nuclear material under Agency safeguards included 1470 t (1432 t) of heavy water.

Major activities during 1986

Safeguards implementation

405. Noteworthy developments in this area included the following:

- The number of major facilities at which inspection goals were attained for the whole facility was 14% higher in 1986 than in 1985;
- A total of 2054 inspections (compared to 1981 in 1985) were performed, representing 8292 man-days of inspection (compared to 7750 in 1985);
- Inspection effort deployed in 1986 achieved a coverage of 86.2% (72.9% in 1985) with regard to the total planned actual routine inspection effort;
- The number of inspections where NDA measurements were performed was 754, compared to 637 in 1985;
- The timeliness of providing inspection statements improved further in 1986, the average time between an inspection and the dispatch of the results in 1986 to the State being reduced to 85 days (from 111 days in 1985);
- The facility attachment for a major mixed-oxide (MOX) fuel fabrication plant entered into force, and evaluation of the implementation of the safeguards approach designed for this plant commenced;
- At another MOX fuel fabrication plant all plutonium was verified, including material in the process line;
- The facility attachment for a uranium enrichment plant based on centrifuge technology entered into force (all commercial enrichment plants subject to Agency safeguards now have facility attachments in force);
- Discussions started on the implementation of safeguards at a uranium pilot enrichment plant based on nozzle technology;
- Safeguards related to heavy water at a nuclear power plant were fully implemented in accordance with new departmental guidelines. The material balance was closed and statistically evaluated;
- In one State, a simultaneous physical inventory verification involving unirradiated natural uranium at all facilities in the natural uranium fuel cycle was carried out for the fourth consecutive year;

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

[23] The figures for 1985 given in paragraph 342 of GC(XXX)/775 (the Annual Report for 1985) — 9.0 t and 155.1 t — have been found to be incorrect. An amount of 1.1 t of separated plutonium was reported in the Annual Report for 1985 on the basis of incorrect classification codes in the relevant State reports. The correct classification indicates that the plutonium was in irradiated fuel.

[24] In safeguards, "separated plutonium" includes recycled plutonium in fuel elements until their discharge from the reactor.

— In a nuclear-weapon State, inspections were initiated at a LEU fuel fabrication plant which, with respect to inventory and throughput, is the largest facility of its kind under Agency safeguards;
— Discussions continued on the application of safeguards to a semicommercial enrichment plant in South Africa;
— Discussions with South Africa started on the application of safeguards at a hot cell facility;
— A draft safeguards agreement for the application of safeguards to heavy water was submitted to a State at its request;
— Discussions continued with Argentina concerning safeguards equipment to be installed at a heavy-water production plant subject to safeguards, which is expected to begin operations in 1988. The modifications to the plant piping required for later installation of the safeguards equipment were agreed to and initiated;
— Efforts to speed up the preparation and conclusion of outstanding facility attachments and to update some existing facility attachments continued. Fifteen new facility attachments and 25 revised facility attachments entered into force;
— The IAEA Offices in Tokyo and Toronto continued to make a significant contribution to effective and efficient safeguards implementation. Larger office accommodation, providing better instrumentation handling facilities and improved working conditions, was acquired in May 1986 in Tokyo. Consultations were held on the conversion of the two offices into regional offices.

Safeguards information treatment

406. Noteworthy developments in this area included the following:

— Some 30 000 State reports (21 000 in 1985) were processed. The overall size of the data base increased by 20%, to approximately 5.2 million records;
— The installation, late in 1985, of a new mainframe computer and data storage facility increased the efficiency of the IAEA Safeguards Information System (ISIS) by eliminating the production backlog and substantially reducing response times;
— For reports on international transfers received in 1986, the Agency was able during the year to match 84% (79% in 1985) of the notifications of shipments with notifications of receipts; 28% of the reports (30% in 1985) were totally processed by computer, while 72% (70% in 1985) required human processing. For domestic transfers the corresponding figures were: 97% matched (97% in 1985); 85% (83% in 1985) processed by computer; and 15% (17% in 1985) requiring human processing;
— Regular bilateral consultations on improving the process of confirming international transfers were held with a group of States and with most other States involved in significant nuclear activities;
— The implementation of recommendations made by consultants on the improvement of State-to-State contacts regarding international transfers was facilitated by the Agency's introducing the regular distribution of a list of contact points and addresses in all States;
— Statements on the timeliness of State reports were formalized as required by safeguards agreements and were dispatched with consolidated book inventory statements;
— Initial discussions were held with States reporting pursuant to INFCIRC/66/Rev.2-type agreements on possible approaches to the standardization of accounting reports, with a view to the more efficient transmission and treatment of data on magnetic media;
— The efficiency of ISIS was increased through the introduction of improved software, and the system was enhanced in respect of monitoring, data retrieval and hardware performance;
— A strategic plan for the further development of ISIS was prepared;
— Software was developed for the introduction of a standardized stratification for inspection reporting;
— A new, computerized system for safeguards equipment inventory control was implemented;
— A microcomputer system for following up and balancing material movements at a large MOX fuel fabrication plant was designed and implemented for use in the field;
— A data conversion system for the direct loading into ISIS of data reported by States on microcomputer diskettes was designed and implemented;
— New kinds of printout were developed to assist inspectors in comparing operators' records with States' accounting reports to the Agency.

Safeguards development and technical support

407. In the development of instruments, methods and techniques:

— a format was established for NDA procedures for inspection use and the first ten such procedures were written and tested;
— the development of enrichment monitoring systems for use in the inspection of cascade areas at centrifuge-type uranium enrichment plants continued, with the aim of full inspection implementation by the end of 1987;
— work on the implementation of computerized portable NDA systems continued, with the

objective of routine deployment of such systems using commercially procured equipment;
- the development of advanced safeguards surveillance equipment continued, notably in the field of closed-circuit television, with the ultimate aim of replacing existing photographic systems, which are fast becoming obsolete.

408. Special attention was paid to the design, development and improvement of new safeguards approaches for reprocessing plants, HEU and MOX fuel fabrication plants and nozzle-type uranium enrichment plants:

- With regard to reprocessing, two technical reports describing the present status of technologies relevant to safeguards at reprocessing plants were distributed for Member State comment, the field testing of near-real-time materials accountancy continued, with encouraging results, and a simplified model for calculating the plutonium inventory in mixer-settler solvent extraction systems was developed under an Agency contract;
- With regard to MOX fabrication, a series of technical meetings was held on the safeguards approach for a new, automated MOX fuel fabrication plant, and advice on the implementation of safeguards at MOX fuel fabrication plants was provided by SAGSI;
- With regard to enrichment, a safeguards approach for a nozzle-type pilot enrichment plant was developed.

409. The development of improved safeguards approaches for other nuclear fuel cycle facilities continued, in particular for spent fuel stores at away-from-reactor locations, for on-load refuelled reactors and for light-water reactors.

410. The development of detailed guidelines for establishing and maintaining State Systems of Accounting for and Control of Nuclear Material (SSACs) was completed with the publication of guidelines for irradiated fuel reprocessing facilities and for centrifuge-type enrichment facilities.

411. The following statistics provide an overview of the technical services provided in 1986 (1985 values in brackets):

Twin photo units in use	260	(250)
Photo cameras repaired and tested	340	(340)
Twin photo unit failures related to equipment	0.9%	(0.4%)
Surveillance films developed and reviewed	1 946	(1 825)
Seals verified	10 300	(9 300)
Shipments of equipment	249	(225)
Procurement actions	767	(804)
Samples analysed by SAL and NWAL [25]	1 036	(1 276)

The reduction in the number of samples analysed was caused mainly by operational changes at a few bulk-handling facilities.

412. A computerized system (named EQUIS) for safeguards equipment inventory control went into service.

413. A programme for the deployment of STAR video surveillance systems initiated early in the year was interrupted at the end of the year as the performance of the systems was not up to expectations. Measures to improve their performance were initiated.

414. The first multiplex TV surveillance system was installed in October and was operating satisfactorily at the end of the year.

415. Recently developed portable multichannel analysers went into service, but problems with detectors and temperature stability continued.

416. The in-field maintenance of NDA equipment continued to increase.

417. NWAL was used significantly more than in 1985.

Safeguards evaluation

418. Further improvements were made in the review and evaluation of inspection reports and of inspection statements to States pursuant to safeguards agreements based on INFCIRC/153 (Corrected) and on INFCIRC/66/Rev.2. Altogether 2195 inspection reports (2342 in 1985) and 2279 inspection statements (2482 in 1985) were reviewed using computer-assisted review procedures. The computerized evaluation of the result of each inspection was introduced, the conclusions being transmitted to the relevant Division of Operations at regular intervals.

419. Internal reviews were made of safeguards applied in one randomly selected State and follow-up assessments were made of the implementation of actions recommended as a result of three previous internal reviews.

420. Work continued on establishing a comprehensive quality assurance programme for the Department of Safeguards.

421. Progress was made in redesigning the format and content of inspection statements pursuant to subparagraphs 90(a) and (b) of INFCIRC/153 (Corrected).

422. Further work was done on elaborating the inspection goal attainment criteria which will be necessary given the technological developments expected over the next 15 years.

423. More data from inspection activities required complex evaluation. A larger number of material balances for bulk-handling facilities were evaluated by

[25] NWAL: the Agency's network of analytical laboratories. Eight national laboratories were members of NWAL in 1986, at the end of which arrangements were being made to increase that number to eleven.

increasingly computer-assisted procedures which are being standardized. Progress was made in the evaluation of NDA measurements and tank calibrations. A new procedure for calculating sample sizes was developed with a view to optimizing the use of verification measurements. In the computer processing of data for evaluation purposes, improvements were made in data storage and in computer programs for data relating to a number of safeguards activities.

Standardization, training and administrative support

424. Advice continued to be provided in a variety of areas, especially financial management, manpower recruitment and allocation, and overall management.

425. Financial management involved preparation of the safeguards budget and financial plan and the monitoring of expenditure. Manpower responsibilities included the preparation of job descriptions and vacancy notices, the processing of applications, the projection of manpower needs, an analysis (for SAGSI) of the use of General Service staff for complementary inspection purposes, and the recording of inspector designation problems. Overall management included generic issues such as organizational structure, reducing the number of internal co-ordination groups, and the interrelationship of managerial responsibilities. Support was provided in the processing of documentation for inspection travel and other duty travel, the level of which continued to increase.

426. In the field of safeguards standardization, efforts were concentrated on further refining the system of computerized inspection reports (CIRs) so as to make it more "user friendly", amending the Safeguards Manual and developing a comprehensive "Safeguards Management Information System". In addition, the development of standardized inspection procedures and of model subsidiary arrangements for INFCIRC/66/Rev.2-type agreements was started, with the support of Member States:

- As part of the work on refining the CIR system, a new stratification scheme (to be introduced at the beginning of 1988) for inspection reporting was developed;
- The Safeguards Manual was reviewed and more than 20 chapters and sub-chapters were amended. Preparation of a volume of reference material (for issue in 1987) was completed. A compilation of selected safeguards documents was issued as a separate set of reference material for staff who frequently need those documents during negotiations, consultations and discussions of safeguards matters;
- Work continued on the design of a comprehensive "Safeguards Management Information System", through which additional managerial information on the use of human, financial and technical resources will be more readily available;
- Standardized inspection procedures were prepared and introduced for the verification of heavy water in power reactors and of uranium hexafluoride in cylinders.

427. Introductory courses for new inspectors included comprehensive inspection exercises in the German Democratic Republic and the Soviet Union and NDA and C/S exercises in the United States. Eleven advanced and refresher courses for Professional staff were held at Headquarters and in four Member States (France, Sweden, the United Kingdom and the United States). Two courses were designed for broader participation.

428. Ten safeguards trainees participated in the third training programme for junior professionals from developing countries, which consisted of classroom lectures and visits to operating nuclear facilities at Mol, Belgium, and safeguards training at Headquarters. The trainees attended an inspection exercise in the German Democratic Republic and individual trainees accompanied Agency inspectors in the field. It is expected that several of the trainees will be offered positions in the Department of Safeguards during 1987. A fourth programme, which includes nine safeguards trainees, began in January 1987.

429. Two training courses on SSACs were held: a regional course for Member States in the Far East, South East Asia and the Pacific region was held in Australia and attended by participants from ten countries; a basic training course for Member States with limited but growing nuclear activities was held in the Soviet Union and attended by participants from 16 countries.

Support by outside expert groups and by Member States

430. SAGSI met twice during the year, each time for a period of five days. The first of the two meetings was held in Canada, where members gained first-hand experience of the conditions under which the Agency applies safeguards to CANDU-type reactors. At its second meeting, SAGSI started to study the safeguards issues arising from the application of safeguards at CANDU-type reactors.

431. SAGSI finalized its advice to the Director General regarding safeguards at MOX fuel fabrication plants. In addition, SAGSI — inter alia — reviewed and advised on the Agency's practice of using General Service staff for complementary inspection purposes and considered the Agency's SIR for 1985.

432. Substantial contributions to the safeguards development programme were again made through national programmes in support of Agency safeguards. Australia, Belgium, Canada, France, the Federal Republic of Germany, Italy, Japan, the Soviet Union, the United Kingdom, the United States and the European Community provided support within the framework of formalized support programmes. Other Member States

(notably Austria, Bulgaria, Czechoslovakia, Finland, the German Democratic Republic, Hungary, the Netherlands, Romania, Sweden and Switzerland) continued to contribute through research and development agreements, contracts and test programmes. Further testing of safeguards equipment for CANDU reactors was carried out in Argentina, Canada, India, the Republic of Korea and Pakistan. Argentina continued to co-operate with the Agency in the development of a safeguards approach for a heavy-water production plant.

433. At the third "Support Programme Co-ordinators' Meeting" the Safeguards Development Report for 1984-85 was presented and there was a wide-ranging discussion on the impact of support programmes on safeguards implementation.

434. A symposium, a number of seminars and a number of advisory group and similar meetings took place in 1986:

- About 250 participants attended a symposium entitled "Recent advances in nuclear material safeguards" at which 126 papers were presented;
- A seminar on safeguards accounting data was held, and all States and organizations reporting such data were invited;
- Seminars with the participation of five Member States were held to discuss the present status of ISIS and to make recommendations for its improvement;
- An advisory group on safeguards surveillance techniques agreed on a comprehensive set of recommendations dealing with the transition from photographic to television surveillance systems and the development of advanced surveillance techniques and of authentication and tamper-indicating methods;
- A group of consultants on high-count-rate gamma spectrometry systems made recommendations on the safeguards applications of detectors, preamplifiers, pulse processors and the other components of such systems and offered views on future developments;
- A group of consultants considered the problems of safeguarding fast reactors and made recommendations for the improvement of safeguards approaches;
- A group of consultants reviewed progress in establishing methods and procedures for improved assessments of safeguards effectiveness and began to examine, in co-operation with the Department of Nuclear Energy and Safety, the feasibility of applying reactor safety assessment procedures in safeguards evaluations;
- A group of consultants evaluated the quality of plutonium gamma-ray spectrometry measurements for safeguards and made recommendations for improving the physical measurement algorithms and defining the measurement error model and algorithms; also, it considered the design of the NDA data base and data transfer procedures;
- A group of consultants evaluated the quality of neutron coincidence measurements for safeguards and made recommendations on stratification for new software related to the physical measurement algorithms, on the definition of the measurement error model and/or algorithms, and on the definition of the data elements (including the raw data) to be stored in the NDA data base;
- A group of consultants discussed new material on sampling plans, measurement error estimation, calibration procedures and near-real-time accounting procedures for inclusion in the next issue of the Safeguards Technical Manual on Statistical Concepts and Techniques.

435. Committees and other regular forms of contact, including working arrangements with facility operators, continued to make a significant contribution to the solution of problems relating to safeguards implementation.

The Agency's resources

Manpower

436. There was an increase of six inspector positions in the budget for 1986 and, thanks to further improvements in recruitment procedures, which led to the more rapid filling of vacancies, the number of available inspector (including inspection assistant) man-years rose

Table 2
States having significant nuclear activities
(at the end of the year indicated)

	Number of States		
	1984	1985	1986
NNW States with safeguards applied under NPT and/or Tlatelolco agreements	41	42	42
NNW States with safeguards applied under INFCIRC/66/Rev.2 agreements[a]	11	11	11
NNW States without safeguards agreements in force	0	0	0
Total number of NNW States with significant nuclear activities	52	53	53
NW States with voluntary-offer agreements in force	3	4	4
Other NW States	2	1	1
Total number of States with significant nuclear activities	57	58	58

[a] Some States with INFCIRC/66/Rev.2 agreements which have not yet been suspended although NPT agreements have entered into force are listed under NPT agreements only.

Table 3

Approximate quantities of material subject to Agency safeguards except that covered by voluntary-offer agreements with NW States (at the end of 1986)

Type of material	Quantity of material (t)		Quantity in SQ
	in NNW States	in NW States	
Nuclear material			
Plutonium[a] contained in irradiated fuel	150.3	8.5	19 855
Separated plutonium	7.7	0.7	1 045
HEU (equal to or greater than 20% uranium-235)	13.2	0	295
LEU (less than 20% uranium-235)	22 201	1 180	7 763
Source material[b] (natural or depleted uranium and thorium)	32 802	0	2 752
Total significant quantities			31 710
Non-nuclear material[c]			
Heavy water	1 470	0	[d]

[a] The quantity includes an estimated 51.8 t (6475 SQ) of plutonium in irradiated fuel, which is not reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountancy and C/S measures are applied).

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

[c] Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2-type agreements.

[d] "Quantity in SQ" does not apply to non-nuclear material.

from 171.9 to 175.9 — an increase of 2.3% — and there was an increase of 4.2% in the available man-years of designated inspectors (and inspection assistants) for carrying out inspections at facilities. 86.2% of the planned actual routine inspection effort was carried out. As in 1985, no new Professional posts for safeguards staff outside the inspectorate were approved.

Equipment

437. Expenditure on equipment and expendable items amounted to $4.3 million. In addition, $1 million was set aside for use (together with $1.3 million set aside in 1985) in the acquisition of equipment required for the application of safeguards at a heavy-water production plant. In total, the 1986 funds either utilized for equipment and expendable items or set aside for later use amounted to $5.3 million; this represented a budget underrun of somewhat less than $100 000.

Table 4

Approximate quantities of material subject to Agency safeguards[a] in installations designated for inspection under voluntary-offer agreements with NW States (at the end of 1986)

Type of nuclear material	Quantity of material (t)	Quantity in SQ
Plutonium contained in irradiated fuel	35.7	4460
Separated plutonium	0	0
LEU (less than 20% uranium-235)	4 530	920
Source material (natural or depleted uranium and thorium)	14 600	800
TOTAL		6180

[a] This table does not include small quantities of HEU rounded to zero SQ.

Table 5

Installations in NNW States under safeguards or containing safeguarded material at 31 December 1986

Installation category	Number of installations		
	INFCIRC/153[a]	INFCIRC/66/Rev.2	Total[b]
A. Power reactors	151	27	178 (172)
B. Research reactors and critical assemblies	150	26	176 (177)
C. Conversion plants	4	2	6 (6)
D. Fuel fabrication plants	27	9	36 (37)
E. Reprocessing plants	4	2	6 (6)
F. Enrichment plants	5	1	6 (5)
G. Separate storage facilities	32	2	34 (30)
H. Other facilities	40	3	43 (41)
I. Other locations	386	28	414 (413)
J. Non-nuclear installations	0	2	2 (2)
TOTALS	799	102	901 (889)

[a] Covering safeguards agreements pursuant to NPT and/or Tlatelolco Treaty.
[b] Numbers for 1985 are indicated in parentheses for comparison.

Table 6

Installations in NW States under INFCIRC/66/Rev.2 safeguards agreements or designated for inspection under voluntary-offer agreements at the end of 1986

Installation category	Number of installations		
	INFCIRC/66/Rev.2	Voluntary offer	TOTAL[a]
A. Power reactors	0	3	3 (3)
B. Research reactors and critical assemblies	0	1	1 (1)
D. Fuel fabrication plants	0	1	1 (1)
F. Enrichment plants	0	1	1 (2)
G. Separate storage facilities	2	1	3 (3)
TOTAL	2	7	9 (10)

[a] Numbers for 1985 are indicated in parentheses for comparison.

Table 7

Situation on 31 December 1986 with respect to the conclusion of safeguards agreements between the Agency and non-nuclear-weapon States in connection with NPT

Non-nuclear-weapon States which have ratified, acceded to or succeeded to NPT[a] (1)	Date of ratification, accession or succession[a] (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Afghanistan	4 February 1970	In force: 20 February 1978	257
Antigua and Barbuda	1 November 1981		
Australia	23 January 1973	In force: 10 July 1974	217
Austria	27 June 1969	In force: 23 July 1972	156
Bahamas	10 July 1973		
Bangladesh	27 September 1979	In force: 11 June 1982	301
Barbados	21 February 1980		
Belgium	2 May 1975	In force: 21 February 1977	193
Belize	9 August 1985	Approved by the Board, Feb. 1986	
Benin	31 October 1972		
Bhutan	23 May 1985		
Bolivia[b]	26 May 1970	Signed: 23 August 1974	
Botswana	28 April 1969		
Brunei Darussalam	25 March 1985	Approved by the Board, Sep. 1986	
Bulgaria	5 September 1969	In force: 29 February 1972	178
Burkina Faso	3 March 1970		
Burundi	19 March 1971		
Cameroon	9 January 1969		
Canada	8 January 1969	In force: 21 February 1972	164
Cape Verde	24 October 1979		
Central African Republic	25 October 1970		
Chad	10 March 1971		
Colombia	8 April 1986		
Congo	23 October 1978		
Costa Rica[b]	3 March 1970	In force: 22 November 1979	278
Côte d'Ivoire	6 March 1973	In force: 8 September 1983	309
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 People's Republic of Korea	12 December 1985		
Democratic Yemen	1 June 1979		
Denmark[c]	3 January 1969	In force: 21 February 1977	193
Dominica	10 August 1984		
Dominican Republic[b]	24 July 1971	In force: 11 October 1973	201
Ecuador[b]	7 March 1969	In force: 10 March 1975	231
Egypt	26 February 1981	In force: 30 June 1982	302
El Salvador[b]	11 July 1972	In force: 22 April 1975	232
Equatorial Guinea	1 November 1984	Approved by the Board, June 1986	
Ethiopia	5 February 1970	In force: 2 December 1977	261
Fiji	14 July 1972	In force: 22 March 1973	192
Finland	5 February 1969	In force: 9 February 1972	155
Gabon	19 February 1974	Signed: 3 December 1979	
Gambia	12 May 1975	In force: 8 August 1978	277
German Democratic Republic	31 October 1969	In force: 7 March 1972	181
Germany, Federal Republic of	2 May 1975	In force: 21 February 1977	193
Ghana	5 May 1970	In force: 17 February 1975	226
Greece[d]	11 March 1970	Accession: 17 December 1981	193
Grenada	19 August 1974		
Guatemala[b]	22 September 1970	In force: 1 February 1982	299
Guinea-Bissau	20 August 1976		

(1)	(2)	(3)	(4)
Haiti[b]	2 June 1970	Signed: 6 January 1975	
Holy See	25 February 1971	In force: 1 August 1972	187
Honduras[b]	16 May 1973	In force: 18 April 1975	235
Hungary	27 May 1969	In force: 30 March 1972	174
Iceland	18 July 1969	In force: 16 October 1974	215
Indonesia	12 July 1979	In force: 14 July 1980	283
Iran, Islamic Republic of	2 February 1970	In force: 15 May 1974	214
Iraq	29 October 1969	In force: 29 February 1972	172
Ireland	1 July 1968	In force: 21 February 1977	193
Italy	2 May 1975	In force: 21 February 1977	193
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		
Kiribati	18 April 1985		
Korea, Republic of	23 April 1975	In force: 14 November 1975	236
Kuwait[e]			
Lao People's Democratic Republic	20 February 1970		
Lebanon	15 July 1970	In force: 5 March 1973	191
Lesotho	20 May 1970	In force: 12 June 1973	199
Liberia	5 March 1970		
Libyan Arab Jamahiriya	26 May 1975	In force: 8 July 1980	282
Liechtenstein	20 April 1978	In force: 4 October 1979	275
Luxembourg	2 May 1975	In force: 21 February 1977	193
Madagascar	8 October 1970	In force: 14 June 1973	200
Malawi	18 February 1986		
Malaysia	5 March 1970	In force: 29 February 1972	182
Maldives	7 April 1970	In force: 2 October 1977	253
Mali	10 February 1970		
Malta	6 February 1970		
Mauritius	25 April 1969	In force: 31 January 1973	190
Mexico[b]	21 January 1969	In force: 14 September 1973	197
Mongolia	14 May 1969	In force: 5 September 1972	188
Morocco	27 November 1970	In force: 18 February 1975	228
Nauru	7 June 1982	In force: 13 April 1984	317
Nepal	5 January 1970	In force: 22 June 1972	186
Netherlands[f]	2 May 1975	In force: 21 February 1977	193
New Zealand	10 September 1969	In force: 29 February 1972	185
Nicaragua[b]	6 March 1973	In force: 29 December 1976	246
Nigeria	27 September 1968		
Norway	5 February 1969	In force: 1 March 1972	177
Panama	13 January 1977		
Papua New Guinea	25 January 1982	In force: 13 October 1983	312
Paraguay[b]	4 February 1970	In force: 20 March 1979	279
Peru[b]	3 March 1970	In force: 1 August 1979	273
Philippines	5 October 1972	In force: 16 October 1974	216
Poland	12 June 1969	In force: 11 October 1972	179
Portugal[g]	15 December 1977	Accession: 1 July 1986	193
Romania	4 February 1970	In force: 27 October 1972	180
Rwanda	20 May 1975		
St. Lucia	28 December 1979		
St. Vincent and the Grenadines	6 November 1984		
Samoa	17 March 1975	In force: 22 January 1979	268
San Marino	10 August 1970	Approved by the Board, Feb. 1977	
Senegal	17 December 1970	In force: 14 January 1980	276

(1)	(2)	(3)	(4)
Seychelles	12 March 1985		
Sierra Leone	26 February 1975	Signed: 10 November 1977	
Singapore	10 March 1976	In force: 18 October 1977	259
Solomon Islands	17 June 1981		
Somalia	5 March 1970		
Sri Lanka	5 March 1979	In force: 6 August 1984	320
Sudan	31 October 1973	In force: 7 January 1977	245
Suriname[b]	30 June 1976	In force: 2 February 1979	269
Swaziland	11 December 1969	In force: 28 July 1975	227
Sweden	9 January 1970	In force: 14 April 1975	234
Switzerland	9 March 1977	In force: 6 September 1978	264
Syrian Arab Republic	24 September 1969		
Thailand	7 December 1972	In force: 16 May 1974	241
Togo	26 February 1970		
Tonga	7 July 1971	Approved by the Board, Feb. 1975	
Trinidad and Tobago	30 October 1986		
Tunisia	26 February 1970		
Turkey	17 April 1980	In force: 1 September 1981	295
Tuvalu	19 January 1979	Approved by the Board, Feb. 1986	
Uganda	20 October 1982		
Uruguay[b]	31 August 1970	In force: 17 September 1976	157
Venezuela[b]	26 September 1975	In force: 11 March 1982	300
Viet Nam	14 June 1982		
Yemen Arab Republic	14 May 1986		
Yugoslavia	3 March 1970	In force: 28 December 1973	204
Zaire	4 August 1970	In force: 9 November 1972	183

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

[b] The relevant safeguards agreement refers to both NPT and the Tlatelolco Treaty.

[c] The NPT safeguards agreement with Denmark (INFCIRC/176), in force since 1 March 1972, has been replaced by the agreement of 5 April 1973 between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency (INFCIRC/193) but still applies to the Faroe Islands. Upon Greenland's secession from EURATOM as of 31 January 1985, the Agreement between the Agency and Denmark (INFCIRC/176) re-entered into force as to Greenland.

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

[e] Kuwait signed NPT on 15 August 1968 but has not yet ratified it.

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

[g] The NPT safeguards agreement with Portugal (INFCIRC/272), in force since 14 June 1979, was suspended on 1 July 1986, on which date Portugal acceded to the agreement between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency of 5 April 1973 (INFCIRC/193).

Table 8

Agreements providing for safeguards, other than those in connection with NPT, approved by the Board as of 31 December 1986

Party(ies)[a]	Subject	Entry into force	INFCIRC
(While the Agency is a party to each of the following agreements, only the State(s) party to them is (are) listed.)			
(a) *Project Agreements*			
Argentina	Siemens SUR-100	13 March 1970	143
	RAEP Reactor	2 December 1964	62
Chile	Herald Reactor	19 December 1969	137
Finland[b]	FiR-1 Reactor	30 December 1960	24
	FINN sub-critical assembly	30 July 1963	53
Greece[b]	GRR-1 Reactor	1 March 1972	163
Indonesia[b]	Additional core-load for TRIGA Reactor	19 December 1969	136
Iran, Islamic Republic of[b]	UTRR Reactor	10 May 1967	97
Jamaica[b]	Fuel for research reactor	25 January 1984	315
Japan[b]	JRR-3	24 March 1959	3
Malaysia[b]	TRIGA-II Reactor	22 September 1980	287
Mexico[b]	TRIGA-III Reactor	18 December 1963	52
	Siemens SUR-100	21 December 1971	162
	Laguna Verde Nuclear Power Plant	12 February 1974	203
Morocco[b]	Fuel for research reactor	2 December 1983	313
Pakistan	PRR Reactor	5 March 1962	34
	Booster rods for KANUPP	17 June 1968	116
Peru[b]	Research reactor and fuel therefor	9 May 1978	266
Philippines[b]	PRR-1 Reactor	28 September 1966	88
Romania[b]	TRIGA Reactor	30 March 1973	206
	Experimental fuel elements	1 July 1983	307
Spain	Coral-I Reactor	23 June 1967	99
Thailand[b]/United States	Fuel for research reactor	30 September 1986	342
Turkey[b]	Sub-critical assembly	17 May 1974	212
Uruguay[b]	URR Reactor	24 September 1965	67
Venezuela[b]	RV-1 Reactor	7 November 1975	238
Viet Nam[c]	Fuel for research reactor	1 July 1983	308
Yugoslavia[b]	TRIGA-II Reactor	4 October 1961	32
	Krsko Nuclear Power Plant	14 June 1974	213
Zaire[b]	TRICO Reactor	27 June 1962	37
(b) *Unilateral submissions*			
Albania	All nuclear material and facilities	Approved by Board,	June 1986
Argentina	Atucha Power Reactor Facility	3 October 1972	168
	Nuclear material	23 October 1973	202
	Embalse Power Reactor Facility	6 December 1974	224
	Equipment and nuclear material	22 July 1977	250
	Nuclear material, material, equipment and facilities	22 July 1977	251
	Atucha II Nuclear Power Plant	15 July 1981	294
	Heavy water plant	14 October 1981	296
	Heavy water	14 October 1981	297
	Nuclear material	8 July 1982	303
Chile	Nuclear material	31 December 1974	256
	Nuclear material	22 September 1982	304
Cuba	Nuclear research reactor and fuel therefor	25 September 1980	298
	Nuclear power plant and nuclear material	5 May 1980	281
	Zero-power nuclear reactor and fuel therefor	7 October 1983	311

Party(ies)[a]	Subject	Entry into force	INFCIRC
Democratic People's Republic of Korea	Research reactor and nuclear material for this reactor	20 July 1977	252
India	Nuclear material, material and facilities	17 November 1977	260
Pakistan	Nuclear material	2 March 1977	248
Spain	Nuclear material	19 November 1974	218
	Nuclear material	18 June 1975	221
	Vandellos Nuclear Power Plant	11 May 1981	292
	Specified nuclear facilities	11 May 1981	291*
United Kingdom	Nuclear material	14 December 1972	175
Viet Nam	Research reactor and fuel therefor	12 June 1981	293
(c) *Tlatelolco Treaty*			
Colombia	All nuclear material	22 December 1982	306
Mexico[d]	All nuclear material, equipment and facilities	6 September 1968	118
Panama	All nuclear material	23 March 1984	316
(d) *Agreements concluded with nuclear-weapon States on the basis of voluntary offers*			
France	Nuclear material in facilities submitted to safeguards	12 September 1981	290
Union of Soviet Socialist Republics	Nuclear material in facilities selected from list of facilities provided by the U.S.S.R.	10 June 1985	327
United Kingdom	Nuclear material in facilities designated by the Agency	14 August 1978	263
United States of America	Nuclear material in facilities designated by the Agency	9 December 1980	288
(e) *Other agreements*			
Argentina/United States of America		25 July 1969	130
Austria[d]/United States of America		24 January 1970	152
Brazil/Germany, Federal Republic of[d]		26 February 1976	237
Brazil/United States of America		31 October 1968	110
Colombia/United States of America		9 December 1970	144
India/Canada[d]		30 September 1971	211
India/United States of America		27 January 1971	154
Iran, Islamic Republic of[d]/United States of America		20 August 1969	127
Israel/United States of America		4 April 1975	249
Japan[d]/Canada[d]		20 June 1966	85
Japan[d]/France		22 September 1972	171
Japan/United States of America		10 July 1968	119
Japan[d]/United Kingdom		15 October 1968	125
Korea, Republic of/United States of America		5 January 1968	111
Korea, Republic of[d]/France		22 September 1975	233
Pakistan/Canada		17 October 1969	135
Pakistan/France		18 March 1976	239
Philippines[d]/United States of America		19 July 1968	120
Portugal[d]/United States of America[e]		19 July 1969	131
South Africa/United States of America		26 July 1967	98
South Africa/France		5 January 1977	244
Spain/Germany, Federal Republic of[d]		29 September 1982	305
Spain/United States of America		9 December 1966	92
Spain/Canada[d]		10 February 1977	247

* Amended in 1985 to cover specified nuclear facilities. The amendment entered into force on 8 November 1985 (INFCIRC/291/Mod.1/Corr.1).

Party(ies)[a]	Subject	Entry into force	INFCIRC
Sweden[d]/United States of America		1 March 1972	165
Switzerland[d]/United States of America[e]		28 February 1972	161
Turkey[d]/United States of America[e]		5 June 1969	123
Venezuela[d]/United States of America[e]		27 March 1968	122

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

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

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

[c] The requirement for the application of safeguards under this agreement is satisfied by the application of safeguards pursuant to the agreement of 12 June 1981 (INFCIRC/293).

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

[e] Application of Agency safeguards under this agreement has been suspended in the United States of America in order to comply with a provision of INFCIRC/288.

Table 9

Facilities under Agency safeguards or containing safeguarded material on 31 December 1986

A. Power reactors

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Atucha NPS	Lima	x
	Embalse PR	Embalse	—
Austria	Tullnerfeld	Zwentendorf	x
Belgium	BR3-CEN	Mol	x
	DOEL-1	Doel	x
	DOEL-2	Doel	x
	DOEL-3	Doel	—
	DOEL-4	Doel	—
	Tihange-1	Tihange	x
	Tihange-2	Tihange	—
	Tihange-3	Tihange	—
Brazil	Angra-1	Angra dos Reis	x
Bulgaria	Kozloduy-I, Unit 1	Kozloduy	x
	Kozloduy-I, Unit 2	Kozloduy	x
	Kozloduy-II, Unit 1	Kozloduy	x
	Kozloduy-II, Unit 2	Kozloduy	x
	Kozloduy-III, Unit 1	Kozloduy	x
Canada	Bruce A, Unit 1	Tiverton	x
	Bruce A, Unit 2	Tiverton	x
	Bruce A, Unit 3	Tiverton	x
	Bruce A, Unit 4	Tiverton	x
	Bruce B, Unit 1	Tiverton	x
	Bruce B, Unit 2	Tiverton	x
	Bruce B, Unit 3	Tiverton	x
	Bruce B, Unit 4	Tiverton	x
	Douglas Point	Tiverton	x
	Gentilly-2	Gentilly	x
	NPD G.S.	Rolphton	x
	Pickering-1	Pickering	x
	Pickering-2	Pickering	x
	Pickering-3	Pickering	x
	Pickering-4	Pickering	x
	Pickering-5	Pickering	x
	Pickering-6	Pickering	x
	Pickering-7	Pickering	x
	Pickering-8	Pickering	x
	Point Lepreau G.S.	Point Lepreau	x
Czechoslovakia	Al	Bohunice	x
	EDU-1, Unit 1	Dukovany	x
	EDU-1, Unit 2	Dukovany	x
	Dukovany-2	Dukovany	—
	V-1, Unit 1	Bohunice	x
	V-1, Unit 2	Bohunice	x
	V-2, Unit 1	Bohunice	x
	V-2, Unit 2	Bohunice	x
Finland	Loviisa-1	Loviisa	x
	Loviisa-2	Loviisa	x
	TVO-1	Olkiluoto	x
	TVO-2	Olkiluoto	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
German Democratic Republic	Bruno Leuschner-I, Unit 1	Greifswald	x
	Bruno Leuschner-I, Unit 2	Greifswald	x
	Bruno Leuschner-II, Unit 1	Greifswald	x
	Bruno Leuschner-II, Unit 2	Greifswald	x
	Rheinsberg PWR	Rheinsberg	x
Germany, Federal Republic of	AVR	Jülich	—
	GKN	Neckarwestheim	x
	KFK-MZFR	Eggenstein-Leopoldshafen	x
	KKB	Brunsbüttel	x
	KKG	Grafenrheinfeld	—
	KKI	Ohu	x
	KKK	Geesthacht-Krümmel	—
	KKP-1	Philippsburg	x
	KKS	Stade	x
	KKU	Stadland	x
	KKW Brokdorf	Brokdorf	—
	KKW Mülheim-Kärlich	Mülheim-Kärlich	—
	KKW Philippsburg, Block 2	Philippsburg	—
	KKW SNR-300	Kalkar	—
	KNK	Eggenstein-Leopoldshafen	x
	KRB	Gundremmingen	x
	KRB II, Block B	Gundremmingen	—
	KRB II-C	Gundremmingen	—
	KWG Grohnde	Grohnde	—
	KWO	Obrigheim	x
	KWW	Würgassen	x
	RWE-BIBLIS-A	Biblis	x
	RWE-BIBLIS-B	Biblis	x
	Thorium Hochtemperatur Reaktor	Hamm	—
	VAK-KAHL	Karlstein-Grosswelzheim	x
Hungary	PAKS-I, Unit 1	Paks	x
	PAKS-I, Unit 2	Paks	x
	PAKS-II, Unit 1	Paks	—
India	RAPS Unit 1	Rajasthan	x
	RAPS Unit 2	Rajasthan	x
	TAPS Unit 1	Tarapur	x
	TAPS Unit 2	Tarapur	x
Italy	ENEL	Borgo-Sabatino	x
	ENEL	San Venditto	x
	ENEL	Caorso	x
	FERMI	Trino-Vercellese	x
Japan	Fugen	Tsuruga-Fukui	x
	Fukushima Dai-Ichi-1	Okuma-Fukushima	x
	Fukushima Dai-Ichi-2	Okuma-Fukushima	x
	Fukushima Dai-Ichi-3	Okuma-Fukushima	x
	Fukushima Dai-Ichi-4	Okuma-Fukushima	x
	Fukushima Dai-Ichi-5	Okuma-Fukushima	x
	Fukushima Dai-Ichi-6	Okuma-Fukushima	x
	Fukushima Dai-Ni-1	Naraha-Fukushima	x
	Fukushima Dai-Ni-2	Naraha-Fukushima	x
	Fukushima Dai-Ni-3	Naraha-Fukushima	x
	Fukushima Dai-Ni-4	Naraha-Fukushima	x
	Genkai-1	Kyushu	x
	Genkai-2	Kyushu	x
	Hamaoka-1	Hamaoka-cho	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Japan	Hamaoka-2	Hamaoka-cho	x
	Hamaoka-3	Shizuoka-ken	—
	Ikata-1	Nishiuwa-gun	x
	Ikata-2	Nishiuwa-gun	x
	JPDR	Tokai-Mura	x
	Kashiwazaki-1	Niigata	x
	Mihama-1	Mihama-Fukui	x
	Mihama-2	Mihama-Fukui	x
	Mihama-3	Mihama-Fukui	x
	N.S. Mutsu	Minato-Machi Mutsu	x
	Ohi-1	Ohi-cho, Fukai-ken	x
	Ohi-2	Ohi-cho, Fukai-ken	x
	Onagawa-1	Tsukahama	x
	Sendai-1	Sendai	x
	Sendai-2	Sendai	x
	Shimane-1	Kashima-cho	x
	Takahama-1	Takahama	x
	Takahama-2	Takahama	x
	Takahama-3	Takahama	x
	Takahama-4	Takahama	x
	Tokai-1	Tokai-Mura	x
	Tokai-2	Tokai-Mura	x
	Tsuruga-1	Tsuruga	x
	Tsuruga-2	Tsuruga	x
Korea, Republic of	Kori-1	Pusan	x
	Kori-2	Pusan	x
	Kori-5	Pusan	x
	Korea Nuclear Unit 6	Yangsam	x
	Korea Nuclear Unit 7	Pusan	x
	Korea Nuclear Unit 8	Pusan	x
	Wolsung-1	Ulsan	x
Mexico	Laguna Verde 1	Alto Lucero	x
	Laguna Verde 2	Alto Lucero	x
Netherlands	GKN	Dodewaard	x
	PZEM	Borssele	x
Pakistan	KANUPP	Karachi	x
Philippines	PNPP-1	Morong, Bataan	x
South Africa	Koeberg-1	Cape Town	x
	Koeberg-2	Cape Town	x
Spain	Almaraz-1	Almaraz	x
	Almaraz-2	Almaraz	x
	Asco-1	Asco	x
	Asco-2	Asco	x
	Cofrentes	Cofrentes	x
	José Cabrera	Almonazid de Zorita	x
	Lemoniz-1	Lemoniz	x
	Lemoniz-2	Lemoniz	x
	Santa María de Garona	Santa Maria de Garona	x
	Trillo-1	Trillo	—
	Vandellos	Vandellos	x
Sweden	Barsebäck I	Malmö	x
	Barsebäck II	Malmö	x
	Forsmark I	Uppsala	x
	Forsmark II	Uppsala	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Sweden	Forsmark III	Uppsala	x
	Oskarshamn I	Oskarshamn	x
	Oskarshamn II	Oskarshamn	x
	Oskarshamn III	Oskarshamn	—
	Ringhals I	Göteborg	x
	Ringhals II	Göteborg	x
	Ringhals III	Göteborg	x
	Ringhals IV	Göteborg	x
Switzerland	KKB-I	Beznau	x
	KKB-II	Beznau	x
	KKG	Gösgen-Däniken	x
	KKL	Leibstadt	x
	KKM	Mühleberg	x
Union of Soviet Socialist Republics	Novo Voronezh Unit 5	Novo Voronezh	x
United States	Salem NGS Unit 1	Salem County, New Jersey	x
	Turkey Point 4	Dade County, Florida	x
Yugoslavia	Krsko	Krsko	x

B. Research reactors and critical assemblies

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	RA-1	Constituyentes	x
	RA-2	Constituyentes	x
	RA-3	Ezeiza	x
	RA-4	Rosario	x
	RA-6	Bariloche	x
Australia	HIFAR	Lucas Heights	x
	MOATA	Lucas Heights	x
	CF	Lucas Heights	x
Austria	ASTRA	Seibersdorf	x
	SAR	Graz	x
	Triga-II	Vienna	x
Bangladesh	Atomic Energy Research Est.	Ganakbari Savar Dhaka	x
Belgium	BR1-CEN	Mol	x
	BR2-CEN	Mol	x
	BRO2	Mol	x
	CEN-Venus	Mol	x
	Thetis	Gent	x
Brazil	IEAR-1	Sao Paulo	x
	RIEN-1	Rio de Janeiro	x
	Triga-CDTN	Belo Horizonte	x
Bulgaria	IRT-2000	Sofia	x
Canada	McMaster	Hamilton	x
	NRX	Chalk River	x
	NRU	Chalk River	x
	PTR	Chalk River	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Canada	Slowpoke-AECL	Ottawa	x
	Slowpoke-Dalhousie Univ.	Halifax	x
	Slowpoke-Ecole Polytechnique	Montreal	x
	Slowpoke-Saskatchewan	Saskatoon	x
	Slowpoke-Toronto University	Toronto	x
	Slowpoke-University of Alberta	Edmonton	x
	Slowpoke-Kingston	Kingston	—
	WR-1	Pinawa	x
	ZED-2	Chalk River	x
Chile	La Reina	Santiago	x
	Lo Aguirre	Santiago	x
Colombia	IAN-R1	Bogotá	x
Czechoslovakia	LR-O	Rez	x
	SR-OD	Vochov	x
	VVR-S	Rez	x
Democratic People's Republic of Korea	Critical assembly	Nyonphyon	x
	IRT-DPRK	Nyonphyon	x
Denmark	DR-1	Roskilde	x
	DR-3	Roskilde	x
Egypt	Nuclear Research Centre	Inshas	x
Finland	Triga II	Otaniemi	x
German Democratic Republic	RAKE	Rossendorf	x
	RRR	Rossendorf	x
	Training Reactor AKR	Dresden	x
	Training research reactor	Zittau	x
	WWR-S M	Rossendorf	x
	FMRB	Braunschweig	x
	FRF-2	Frankfurt	x
	FRM	Garching	x
	GKSS-FRG1	Geesthacht	x
	GKSS-FRG2	Geesthacht	x
	KFA-FRJ1	Jülich	x
	KFA-FRJ2	Jülich	x
	KFA-NEA	Jülich	x
	SUR 100	Bremen	x
	SUR 100	Eggenstein-Leopoldshafen	x
	SUR 100	Hannover	x
	SUR 100	Kiel	x
	SUR 100	Hamburg	x
	SUR 100	Ulm	x
	SUR 100	Stuttgart	x
	SUR 100	Garching	x
	SUR 100	Furtwangen	x
	SUR 100	Darmstadt	x
	SUR 100	Aachen	x
	Triga	Mainz	x
	Triga	Hannover	x
	Triga II	Heidelberg	x
	BER-2	Berlin (West)[b]	x
	SUR 100	Berlin (West)[b]	x
Greece	GRR-1	Attiki	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Hungary	Training reactor	Budapest	x
	WWR-S M	Budapest	x
	ZR-4	Budapest	x
	ZR-6	Budapest	x
Indonesia	Gama	Yogyakarta	x
	MPR-30	Serpong	—
	PPTN	Bandung	x
Iran, Islamic Republic of	TSPRR	Teheran	x
Iraq	IRT-5000	Baghdad Tuwaitha	x
	Tamuz-1	Baghdad Tuwaitha	x
	Tamuz-2	Baghdad Tuwaitha	x
Israel	IRR-1	Soreq	x
Italy	AGN-201	Palermo	x
	CESNEF-L54	Milan	x
	ESSOR	Ispra	x
	Impiante Pec del CNR	Brasimone, Bologna	—
	RANA	Santa Maria di Galeria	x
	RB-1	Montecuccolino	x
	RB-2	Montecuccolino	x
	RB-3	Montecuccolino	x
	RTS-1	San Piero a Grado	x
	TAPIRO	Santa Maria di Galeria	x
	Triga-RC1	Santa Maria di Galeria	x
	Triga-2	Pavia	x
Jamaica	Centre for Nuclear Sciences	Kingston	x
Japan	DCA	Oarai-Machi	x
	FCA	Tokai-Mura	x
	HTR	Kawasaki-shi	x
	JMTR	Oarai-Machi	x
	JMTR-CA	Oarai-Machi	x
	JOYO	Oarai-Machi	x
	JRR-2	Tokai-Mura	x
	JRR-3	Tokai-Mura	x
	JRR-4	Tokai-Mura	x
	Kinki University R.R.	Kowake	x
	KUCA	Kumatori-cho	x
	KUCA	Kumatori-cho	x
	KUCA	Kumatori-cho	x
	KUR	Kumatori-cho	x
	Musashi College R.R.	Kawasaki	x
	NAIG-CA	Kawasaki-ku	x
	NSRR	Tokai-Mura	x
	Rikkyo University R.R.	Nagasaka	x
	TCA	Tokai-Mura	x
	TODAI	Tokai-Mura	x
	TTR	Kawasaki-shi	x
	VHTRC	Tokai-Mura	x
Korea, Republic of	Triga II	Seoul	x
	Triga III	Seoul	x
	Kyung-Hee Univ.	Seoul	x
Libyan Arab Jamahiriya	IRT-TAJURA	Tajura	x
Malaysia	Puspati	Bangi, Selangor	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Mexico	Triga	Ocoyoacac	x
	SUR 100	Mexico City	x
Netherlands	HOR	Delft	x
	HFR	Petten	x
	LFR	Petten	x
Norway	HBWR-Halden	Halden	x
	JEEP-II	Kjeller	x
Pakistan	PARR	Rawalpindi	x
Peru	RP-O	Lima	x
Philippines	PRR-1	Diliman, Quezon City	x
Poland	Agata	Swierk	x
	Anna	Swierk	x
	Ewa	Swierk	x
	Maria	Swierk	x
	Maryla	Swierk	x
Portugal	RPI	Sacavem	—
Romania	RP-01	Margurele	x
	Triga II	Pitesti-Colibasi	x
	VVR-S	Margurele	x
South Africa	SAFARI-1	Pelindaba	x
Spain	ARBI	Bilbao	x
	ARGOS	Barcelona	x
	CORAL-1	Madrid	x
	JEN-1 and JEN-2	Madrid	x
Sweden	R2	Studsvik	x
	R2-O	Studsvik	x
	RO	Studsvik	x
Switzerland	AGN 201P	Geneva	x
	AGN 211P	Basel	x
	Crocus	Lausanne	x
	Proteus	Würenlingen	x
	Saphir	Würenlingen	x
Thailand	TRR-1	Bangkok	x
Turkey	TR-1	Istanbul	x
	ITU-TRR	Istanbul	x
Union of Soviet Socialist Republics	IR-8 Research Reactor	Moscow	x
Uruguay	Lockheed	Montevideo	x
Venezuela	RV-I	Altos de Pipe	—
Viet Nam	Da-Lat Research Reactor	Da Lat	—
Yugoslavia	RA	Vinca	x
	RB	Vinca	x
	Triga II	Ljubljana	x
Zaire	Triga-Zaire	Kinshasa	x

C. Conversion plants, including pilot plants

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	UO_2 Conversion Plant	Cordoba	—
Canada	Eldorado Resources Ltd.	Port Hope	x
Japan	Japan Nuclear Fuel Conversion Co. Ltd.	Tokai-Mura	x
	Ningyo R&D	Ningyo	x
	PCDF	Tokai-Mura	—

D. Fuel fabrication plants, including pilot plants

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Atucha Fuel Fabrication Plant	Ezeiza	—
	Fuel Fabrication Plant (CANDU)	Ezeiza	—
	Pilot Fuel Fabrication Plant (HEU)	Constituyentes	x
Belgium	Belgonucléaire-BN-MOX	Dessel	x
	FBFC	Dessel	x
Brazil	Fuel Fabrication Plant Resende	Resende	x
Canada	CGE	Peterborough	x
	CGE	Toronto	x
	CRNL Fuel Fabrication	Chalk River	x
	WCL	Port Hope	x
Denmark	Metallurgy	Roskilde	x
Germany, Federal Republic of	ALKEM	Hanau	x
	Exxon	Lingen	x
	NUKEM	Wolfgang	x
	RBU-1	Wolfgang	x
	RBU-2	Karlstein	x
India	NFC	Hyderabad	x
Indonesia	IPEBRR	Kecamatan	—
Iraq	ERLFF	Baghdad Tuwaitha	x
Italy	Comb. Nuc.	Policoro	x
	COREN	Saluggia	x
	Fabnuc	Bosco Marengo	x
	IFEC	Saluggia	x
Japan	JNF	Yokosuka	x
	MNF	Tokai-Mura	x
	NFI (Kumatori-1)	Kumatori, Osaka	x
	NFI (Kumatori-2)	Kumatori, Osaka	x
	NFI (Tokai) Fuel Fabrication	Tokai-Mura	x
	PPFF	Tokai-Mura	x
Korea, Republic of	Fuel Fabrication Pilot Plant	Daejeon	x
Romania	Romfuel	Pitesti Colibasi	x
Spain	Planta Metall. Juan Vigon Res. C.	Madrid	x
	Fuel Fabrication Plant Juzbado	Salamanca	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Sweden	ASEA - ATOM	Västeras	x
United States of America	Westinghouse Electric Corp.	Columbia, S.C.	x

E. Chemical reprocessing plants, including pilot plants

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

F. Enrichment plants, including pilot plants

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Brazil	Sep. Noz. Enrichment Plant	Resende	—
Germany, Federal Republic of	Uranit*	Jülich	—
	URENCO Deutschland, UTA-1	Gronau	x
Japan	PNC Pilot Enrichment Plant	Ningyo	x
Netherlands	URENCO Nederland	Almelo	x
	Ultra-Centrifuge*	Almelo	—
United Kingdom	BNFL Centrifuge plant and associated storage	Capenhurst	x

* Location associated with enrichment technology.

G. Separate storage facilities

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Storage of 20% enriched uranium	Cac	—
Belgium	BN UF_6 store	Dessel	x
	Belgoprocess	Mol	x
	FBFC	Dessel	—

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Canada	Bruce A	Tiverton	x
	Bruce B	Tiverton	x
	CRNL	Chalk River	x
	Gentilly-1	Gentilly	x
	Long term storage at CRNL	Chalk River	—
	Pickering	Pickering	x
	WNRE	Pinawa	x
Czechoslovakia	AFRS	Bohunice	—
Denmark	Risø Store	Roskilde	x
France	COGEMA UP2 spent fuel storage ponds	La Hague	—
German Democratic Republic	Interim storage facility for spent fuel assemblies	Lubmin	—
Germany, Federal Republic of	Braunkohle	Wesseling	x
	Bundeslager	Wolfgang	—
	Exxon Nuclear UF6 Lageranlage	Lingen	x
	KFA Jülich Lager f. bestr. AVR Kugeln	Jülich	—
	KFK-FR-2	Eggenstein-Leopoldshafen	—
	Lager II Leese	Landesbergen-Leese	—
	Lageranlage für abgereichertes Uran	Kalkar	—
	Transnuklear Halle	Hanau	—
	Urananlage	Birkenfeld	x
Iraq	Separate storage facility	Baghdad Tuwaitha	x
Italy	Avogadro	Saluggia	—
	Deposito Prodotti Uraniferi	Bosco Marengo	x
	Deposito Ritmo	Santa Maria di Galeria	—
	Ispra Central Storage	Ispra	x
Japan	KUFFS	Kyoto	x
Luxembourg	International Metals S.A.	Luxembourg-Dommeldange	—
Pakistan	Storage at Government depot	Karachi Malir	x
Portugal	Instalacao de Armazenagens	Sacavem	—
Sweden	Central long term storage	Oskarshamn	—
Switzerland	Diorit Storage	Würenlingen	x
United Kingdom	Sellafield Pu-storage	Sellafield	x
	Oxide Fuel Storage Pond	Sellafield	x

H. Other facilities

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Labo. de Calificacion	Constituyentes	—
Australia	Research Laboratory	Lucas Heights	x
Belgium	BCMN	Geel	x
	CEN-WASTE	Mol	—
	CEN-Labo	Mol	x
	I.R.E.	Fleurus	x
	PULAB	Mol	x
Canada	Physics, Chemistry, Fuel Eng., Health Phys., R&D	Chalk River	x

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Czechoslovakia	Nuclear Fuel Inst. (UJP)	Zbraslav	x
	Research Laboratories	Rez	x
Denmark	Hotcell Plant	Roskilde	x
German Democratic Republic	Uran Technikum	Rossendorf	—
Germany, Federal Republic of	KFA-Lab	Jülich	—
	KFA-heisse Zellen	Jülich	—
	KFK-IK/1	Eggenstein-Leopoldshafen	—
	KFK-heisse Zellen	Eggenstein-Leopoldshafen	x
	KFK/IHCH	Eggenstein-Leopoldshafen	x
	KFK/IMF3	Eggenstein-Leopoldshafen	x
	KWU-heisse Zellen	Karlstein	x
	Transuran	Eggenstein-Leopoldshafen	x
Hungary	Institute of Isotopes	Budapest	x
Italy	CNEN-LAB. TEC.	Santa Maria di Galeria	x
	CNEN-LAB.PU.	Santa Maria di Galeria	x
	Joint Research Centre	Ispra	—
Japan	JAERI-Oarai R&D	Oarai-Machi	x
	JAERI-Tokai R&D	Tokai-Mura	x
	MAPI Ohmiya	Ohmiya	x
	NERL, University of Tokyo	Tokai-Mura	x
	NFD	Oarai-Machi	x
	NFI Tokai II	Tokai-Mura	—
	NRF Neutron Radiation Facility	Sakura-Mura	x
	PNC Tokai R&D	Tokai-Mura	x
	PNC-Oarai R&D	Oarai-Machi	x
Korea, Republic of	PIEF	Daejeon	—
Netherlands	ECN+JRC	Petten	x
	Kema Lab.	Arnhem	x
Norway	Research laboratories	Kjeller	x
Poland	Institute of Nuclear Research	Swierk	x
	Miscellaneous locations combined in one material balance area	Various	x
South Africa	Hot Cell Complex	Pelindaba	—
Sweden	Central storage fresh fuel	Studsvik	x
Switzerland	Fed. Inst. of Reactor Research	Würenlingen	x

J. Non-Nuclear Installations

State[a]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Heavy water plant	Arroyito	—
	Heavy water storage	Buenos Aires	—

[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] The interests of Berlin (West) are represented within the United Nations system by the Federal Republic of Germany.

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

INFORMATION AND TECHNICAL SERVICES

International Nuclear Information System (INIS)

438. In 1986, the input to the INIS data base totalled about 90 400 documents, an input volume exceeded only in 1983 (92 113 documents). The size of the data base had risen to 1 056 900 records by the end of the year. The fraction of the input supplied by INIS members in machine-readable form increased from 96% to 99.2%.

439. In May, the annual consultative meeting of INIS Liaison Officers, held in Washington, D.C., completed a general review of INIS operations started in 1984.

440. In March, the optical character reader (OCR) processing machine, which had become obsolete, was disconnected and three major input centres switched to other machine-readable media, such as magnetic tape in worksheet format or various types of diskette. The output of INIS on magnetic tape was converted to 9-track tape for all processing centres.

441. In October, 24 participants from East European countries attended an INIS training seminar held in Berlin, German Democratic Republic.

442. Revised versions of "INIS: Authority List for Journal Titles" and "INIS: Thesaurus" were issued.

443. The INIS Clearinghouse again distributed a large number (540 000) of microfiches, partly as a result of orders for backfiles of fiches; the income from the Clearinghouse's operations was again high. By the end of the year, the non-conventional literature data bank contained 230 000 records and the total collection of microfiche masters numbered 192 000 documents (270 000 microfiches).

444. The INIS Clearinghouse ordered a new microfiche camera with a view to improving the quality and speed of production of INIS documents on microfiche.

445. A prototype (containing over 30 000 items) of "INIS ATOMINDEX" on compact disk was demonstrated to INIS Liaison Officers.

446. Thirty-seven Member States and two international organizations used the facility for remote on-line access to the INIS and AGRIS data bases, the income from users being approximately equal to the marginal cost of providing this service.

INIS statistics

	1985	1986
Number of records added to the data base	86 529	90 401
Number of microfiches distributed	700 000	540 000
Number of full microfiche subscriptions	37	37
Number of participating Member States	74	74
Number of participating international organizations	14	14
Direct access usage (connect hours)	2 046	2 174

Agricultural Information System (AGRIS)

447. Use of the multilingual indexing vocabulary (AGROVOC) became mandatory in January 1986.

448. Retrieval services continued to be provided, with nearly 1000 retrospective searches and some 600 SDI (selective dissemination of information) searches.

Computer services

449. At the central computer site, utilization of the IBM 3083 computer (dedicated to safeguards data processing) and of the IBM 3081 (shared by other users) increased by 28%. In order to handle the increasing amount of on-line processing, a new operating system was installed on both computers. By the end of 1986, services were being provided on the IBM 3081 to over 100 on-line users concurrently during peak demand periods. Despite an upgrading of the IBM 3081 memory and the installation of the IBM 3083 at the end of 1985, response times at the end of the year were increasing owing to a steady increase in the demand for services.

450. The demand for central printing made the continuation of round-the-clock operation (started in November 1985) necessary, but delays were frequent even with round-the-clock operation as the printing capacity was often exceeded by the demand.

451. The work station installation backlog from 1985 was cleared and the work stations planned for 1986 were installed. By the end of the year, approximately 600 work stations (word processors, personal computers, and terminals connected to the central computers) were available in user areas — over twice as many as at the end of 1984.

452. Training courses for end-users emphasized the use of standard software packages for personal computers.

453. Experts from developing countries continued to use the central computing facility for reactor safety analyses.

454. There was a 5% increase in the accessing of the Agency's on-line data bases by Member States, with significant utilization of the international packet-switching network line installed in 1985. The direct telecommunications line between United Nations Headquarters in New York and the Agency's central computing facility did not become operational owing to problems in New York.

Library services

455. The VIC Library continued to develop applications of computer techniques aimed at increasing efficiency and providing a more cost-effective service.

456. Library tours and demonstrations of the Library's automated systems were organized for 90 official visitors, new staff members and trainees. Automation planning assistance was provided to the Library of the International Centre for Theoretical Physics, Trieste, three staff members from which underwent a one-week course at the VIC Library.

457. The number of active exchange agreements with other institutions increased to 117, with the result that 1680 journal titles were received free of cost to the Library.

458. The number of volumes in the book collection increased by 3589 to 71 134. The number of current titles in the journal collection stood at 4090 at the end of the year. The collection of United Nations documents increased by 38 038 to 988 038 and that of technical reports by 18 304 to 535 404.

459. The VIC Library lent 10 770 books and 228 films and dealt with 3188 reference questions. Through its inter-library loan programme, it borrowed books and journal articles to meet 4971 user requests. Current awareness bulletins in 13 subject series covering the tables of contents of 340 journals were distributed in 16 063 copies.

Scientific journals

460. Twelve regular issues of "Nuclear Fusion" were published, the ninth of them containing a comprehensive review of high-magnetic-field tokamaks.

461. The fifth edition of the "World Survey of Activities in Controlled Fusion Research", covering fusion-oriented research at 275 institutes in 39 Member States and the activities of four international organizations, was published as a special supplement to "Nuclear Fusion" and presented at the Eleventh International Conference on Plasma Physics and Controlled Nuclear Fusion Research, held in Kyoto, Japan.

ADMINISTRATION

LEGAL AFFAIRS

Amendment to Article VI.A.1 of the Statute

462. An amendment to Article VI.A.1 of the Agency's Statute providing for the designation by the Board of Governors each year of the ten — instead of nine — Member States "most advanced in the technology of atomic energy including the production of source materials" had been accepted by 39 Member States by the end of the year [26]. The amendment will come into force when it has been accepted by two thirds of the Member States in accordance with their respective constitutional requirements.

Physical protection

463. The Convention on the Physical Protection of Nuclear Material [27] was signed by six more States — Argentina, Ecuador, Indonesia, Liechtenstein, Mongolia and Spain — and ratified by three more States — Indonesia, Liechtenstein and Mongolia. By the end of the year, 45 States and one regional organization — EURATOM — had signed the Convention and 20 States had ratified it [28].

Privileges and immunities

464. Two further Member States — Australia and the Holy See — accepted the Agreement on the Privileges and Immunities of the Agency [29]. By the end of the year, 59 Member States were parties to the Agreement.

Conventions relating to nuclear accidents

465. Pursuant to a decision taken by the Board of Governors on 21 May, a group of governmental experts met in Vienna from 21 July to 15 August to draft international agreements on the early notification of a nuclear accident and on assistance in the event of a nuclear accident or radiological emergency. Experts from 62 Member States and representatives of ten international organizations attended the meeting, at which the group adopted by consensus the texts of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [30]. The two Conventions were subsequently endorsed by the Board of Governors and adopted by the General Conference at a special session held from 24 to 26 September. The Conventions were opened for signature by all States in Vienna and at United Nations Headquarters in New York on 26 September and 6 October respectively.

466. The Convention on Early Notification entered into force on 27 October, thirty days after it had been signed by three States — Czechoslovakia, Denmark and Norway — without reservation as to ratification. Instruments of ratification of the Convention were deposited by Finland and the Soviet Union in December. The Convention had been signed by 58 States by the end of the year [31].

467. The Convention on Assistance had been signed by 57 States by the end of the year, but only Norway had signed it without reservation as to ratification [32].

Nuclear legislation advisory services

468. Advice on nuclear legislation and regulatory activities was provided to Algeria, Morocco and Tunisia. In the case of Algeria and Tunisia, the advice related primarily to the elaboration of regulations implementing radiation protection decrees based on the Agency's Basic Safety Standards for Radiation Protection. In the case of Morocco, besides the elaboration of similar regulations, the advice related to the framing of legislation connected with the implementation of a nuclear power programme.

Regional overview course on nuclear regulation

469. In co-operation with the Atomic Energy Licensing Board of Malaysia, the Agency organized a Regional Overview Course on Regulatory Aspects of

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[26] Forty-two Member States had accepted the amendment by the end of February 1987.

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

[28] Switzerland deposited its instrument of ratification with the Director General on 9 January 1987, so that the Convention, which required 21 ratifications or acceptances for its entry into force, entered into force on 8 February 1987 pursuant to Article 19.1. It had been signed by 46 States by the end of February 1987.

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

[30] Reproduced in documents INFCIRC/335 and INFCIRC/336 respectively.

[31] A total of 61 States had signed the Convention by the end of February 1987. It was ratified by the Byelorussian and Ukrainian Soviet Socialist Republics in January 1987 and by Sweden in February 1987.

[32] Instruments of ratification were deposited with the Director General by the Soviet Union on 23 December 1986 and by the Byelorussian and Ukrainian Soviet Socialist Republics on 26 January 1987, so that the Convention entered into force on 26 February 1987. By the end of February, 60 States had signed the Convention.

Radiation and Nuclear Safety in Kuala Lumpur. The course covered regulatory issues and activities involved in radiation protection and nuclear safety, extending from regulatory preparations to the enforcement of regulations. A total of 40 participants from 15 Member States took part in the course, for which cost-free experts were provided by Canada, France, the Federal Republic of Germany and the United States.

Regional Co-operative Agreement

470. Within the framework of the Regional Co-operative Agreement for Research Development and Training Related to Nuclear Science and Technology (RCA) [33], the Agreement Establishing the Asian Regional Co-operative Project on Medical and Biological Applications of Nuclear Techniques entered into force on 20 May, following notification of acceptance by Japan, Bangladesh and the Philippines; it was subsequently accepted by Indonesia, Sri Lanka and Pakistan.

Finance

471. On the basis of an exchange rate of 19.50 Austrian schillings to one United States dollar, the General Conference appropriated an amount of $98 680 000 for the Regular Budget. This amount had to be adjusted in accordance with the adjustment formula presented in the attachment to resolution GC(XXIX)/RES/446 in order to take into account the exchange rate actually experienced during the year — 15.25 Austrian schillings to one United States dollar.

472. The Regular Budget for 1986 at an exchange rate of 15.25 Austrian schillings to one United States dollar amounted to $118 756 000, of which $108 972 179 was to be financed from contributions by Member States on the basis of the 1986 scale of assessment, $4 458 000 from income from work for others and $5 325 821 from other miscellaneous income.

473. The actual obligations in 1986 amounted to $113 995 605, resulting in an unencumbered balance of $5 363 141.

474. The target for voluntary contributions to the Technical Assistance and Co-operation Fund in 1986 was established at $30 million. At the end of the year, $26 719 915 had been pledged by Member States in support of the technical assistance programme. Net new obligations incurred during 1986 amount to $31 448 949.

475. A total of $9 473 624 was offered in extrabudgetary contributions by Member States, the United Nations and other international organizations during 1986. Of this amount, $3 853 775 was for technical assistance projects, $2 646 162 was in support of safeguards, $396 632 was for projects in the field of food and agriculture, and $500 215 was in support of RCA. The remaining $2 076 840 was in support of various other projects implemented by the Agency.

Public Information

476. The Chernobyl accident greatly increased interest in the activities of the Agency and hence contacts between the Agency and news media all over the world. More than 500 journalists were accredited to the Post-Accident Review Meeting held at the end of August and to the special and regular sessions of the General Conference. Over 1000 requests for information, mainly from news media, were received during the first weeks after the Chernobyl accident. Sixteen press conferences were arranged during that period.

477. During 1986, the Agency distributed information material (brochures, pamphlets and press releases) in response to more than 2000 requests for information from the public. All brochures and leaflets on nuclear safety were updated, and two new brochures were distributed during the Post-Accident Review Meeting.

478. The first Chinese-language edition of the "International Atomic Energy Agency Bulletin" was published early in 1986 [34]. As a service for news media and the general public, the Agency began to issue periodic "IAEA Newsbriefs" containing short reports on Agency activities.

479. The Agency mounted 14 exhibitions at the VIC, the Hofburg Congress Centre and other meeting venues in a number of Member States. Staff members lectured on the work of the Agency to nearly 40 groups of visitors to the VIC.

General Services

480. Close co-ordination was maintained with UNIDO and the other United Nations organizations located at the VIC on all questions relating to the cost-effective operation of the VIC complex and the use of common areas.

481. Technical and engineering services were provided in connection with the construction of a new agricultural laboratory building and a chemical store at Seibersdorf. Measures to improve industrial safety within the Agency's premises at the VIC and at Seibersdorf were initiated. Preparations started for the forthcoming move of the International Laboratory of Marine Radioactivity in Monaco.

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[33] Reproduced in document INFCIRC/167. The RCA First and Second Extension Agreements have been reproduced in documents INFCIRC/167/Add.8 and Add.11 respectively.

[34] The "Bulletin" is now published in five languages (English, Chinese, French, Russian and Spanish) and distributed to about 33 000 readers (including government and industry officials, journalists, scientists and researchers) in over 160 countries.

482. Technical improvements were made and procedural changes introduced in order to cope with the increasing volume and cost of cable, telex and facsimile messages.

483. Purchases of scientific and non-scientific equipment and supplies and expenditures in connection with scientific and maintenance contracts amounted to around $12.6 million; nearly 3200 procurement actions were involved.

484. Assistance in finding accommodation and advice relating to housing problems were provided to staff members of the international organizations located at the VIC and persons accredited to these organizations. Approximately 335 lease contracts were concluded with the help of the VIC Housing Service.

485. The Commissary, with a range of around 5500 articles, served about 8000 households. Total sales amounted to approximately AS 277 million.

Publishing and Printing Services

486. One hundred and sixty separate books or journal issues were published. The net income to the Agency from the sale of Agency publications was $1 152 114 in 1986, compared with $884 492 in 1985 and $864 938 in 1984.

487. The output in terms of page impressions was 224 million in 1986, compared with 312 million in 1985.

488. Document and publication printing services continued to be provided also for UNIDO and the United Nations bodies based at the VIC. However, owing to a considerable decline in the volume of printing for other organizations [35] while the volume of printing for the Agency remained stable, the capacity of the Agency's printing facilities had to be adjusted through a reduction in staff.

Translation

489. The Division of Languages translated over 32 000 standard pages into the six working languages of the Agency (Arabic, Chinese, English, French, Russian and Spanish). About 1.5 man-years were spent on the preparation of summary records.

490. Almost complete equipping of the Division's typing pools with word-processors made it possible for them to deal with the exceptional workload which arose during the year. Trials with computerized translation continued.

491. Word-processor training for translators began towards the end of the year, and plans were made for the automation of document registration and tracking.

[35] The income from services provided for other organizations was $1.10 million in 1986, compared with $1.61 million in 1985.

Personnel

492. At the end of 1986, the number of members of the Secretariat was 1994 — 746 in the Professional and higher categories, 1109 in the General Service category and 139 in the Maintenance and Operatives Service category [36].

493. Among the 590 staff members in posts subject to geographical distribution, 78 nationalities were represented.

494. The third traineeship programme for graduates and junior professionals from developing areas, which began in January 1986, was completed in December 1986; 16 trainees participated. The aim of the programmes is to qualify the trainees for employment with the Agency or for relevant work in their home countries.

495. The Secretariat continued to participate in the work of United Nations bodies established for the purpose of co-ordinating or regulating conditions of employment — for example, the International Civil Service Commission (ICSC), the Consultative Committee on Administrative Questions (CCAQ) and the United Nations Joint Staff Pension Board (UNJSPB). In 1986 the emphasis was on pensions.

496. An interim measure introduced by the ICSC for minimizing the effect of currency fluctuations on salaries (the "Remuneration Correction Factor") was adopted by the Agency as of 1 September 1986.

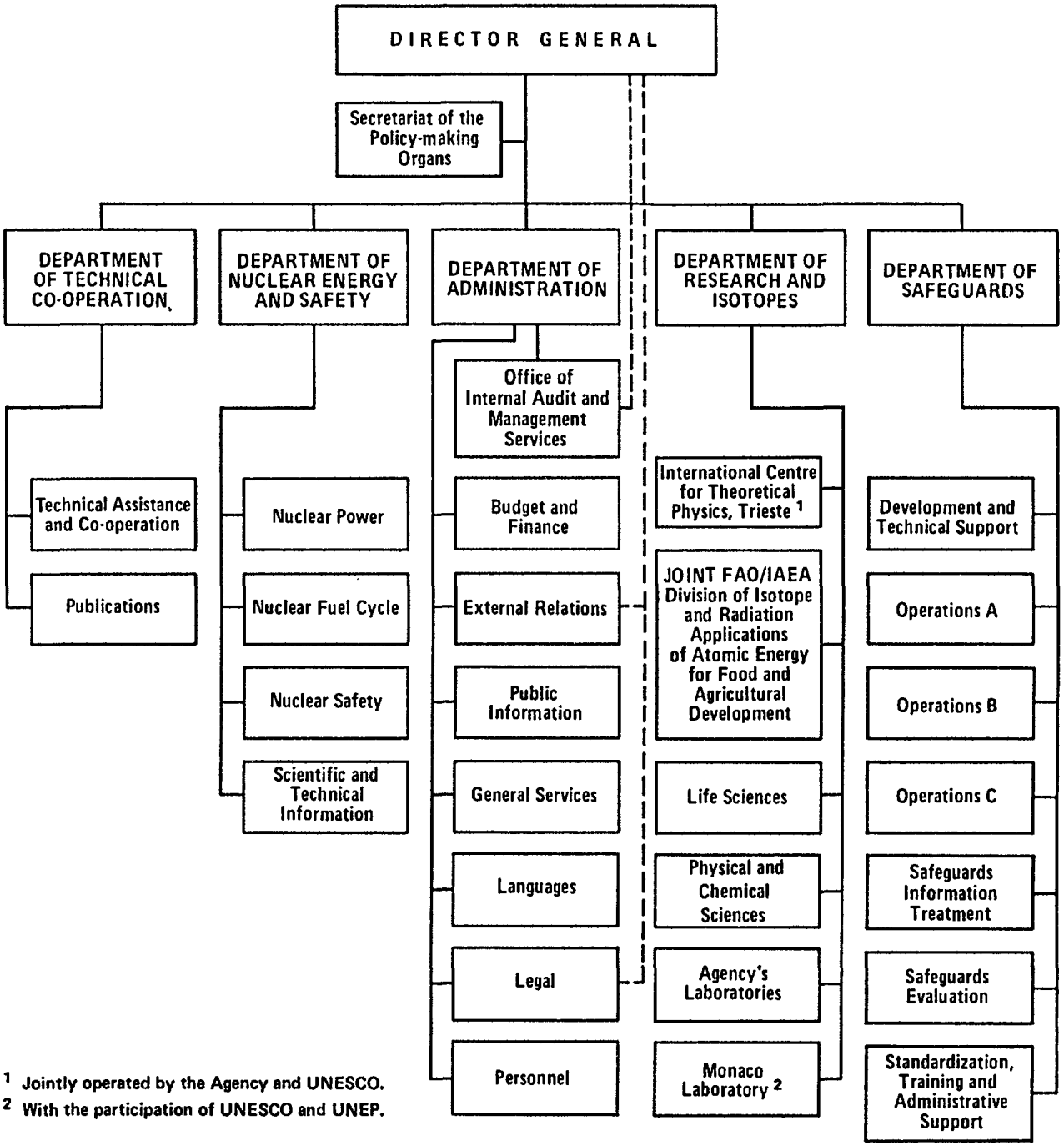
497. Steps were taken to implement, with effect from the beginning of 1987, common classification standards for General Service and related categories prepared by and for Vienna-based organizations and promulgated by the ICSC.

498. As a result of improvements in recruitment procedures, vacancies as a percentage of total man-months represented by established posts were reduced to 8.5% (in 1984 the figure was 11.6%).

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

[36] These figures represent: members of the Secretariat occupying manning table posts (1531) or charged to manning table posts (92), to the temporary assistance fund (161) and to consultancy funds (25); officials serving on a reimbursement basis (178) or on secondment (7).

ORGANIZATIONAL CHART



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