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REPORT OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

Note by the Secretary-General

1. The thirty-second report of the International Atomic Energy Agency for the calendar year 1987 **(GC(XXXII)/835)** is submitted herewith to the General Assembly. Major developments since this report was published will be covered by the annual statement of the Director General of the Agency to the General Assembly. This report has been transmitted in accordance with the provisions of article III, paragraph 1 **(a),** of the Agreement governing the relationship between the United Nations and the International Atomic Energy Agency (General Assembly resolution 1145 (XII), annex).

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

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* A/43/150.

THE ANNUAL REPORT FOR 1987

GC(XXXII)/835

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INTERNATIONAL ATOMIC ENERGY AGENCY

THE ANNUAL REPORT FOR 1987

CONTENTS

LIST OF ABBREVIATIONS

ARCAL	Regional co-operative arrangements for the promotion of nuclear science and technology in Latin America
ASSET	Analysis of Safety-Significant Events Team
CANDU	Canadian deuterium-uranium (reactor)
CEC	Commission of the European Communities
CMEA	Council for Mutual Economic Assistance
EEC	European Economic Community
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
IWO	International Maritime Organization
INTOR	International Tokamak Reactor
ISIS	IAEA Safeguards Information System
UDA	Non-destructive essay
WEA	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	Preesurized-water reactor
QA	Quality assurance
R&D	Research and Development
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (INFCIRC/167)
SQ	Significant quantity

UUDP	United Nations Development Programme
UNEP	United Notions Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
VIC	Vienna International Centre
WHO	World Health Organization
WMO	World Meteorological Orgenization
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 thia document do not imply the expression of eny opinion whatsoever on the part of the Secretariat concerning the legal statue of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

3. The term "non-nuclear-weapon State" is used as in the Final Document of the 1968 Conference of Nor-Nuclear-Weapon States (United Net ions document A/7277).

EXECUTIVE SUMMARY

Thirtieth anniversary of the IAEA

1. 1987 marked the thirtieth anniversary of the Internotional Atomic Energy Agency, its Sttatute having entered into force on 29 July 1957.

Personnel and finance

2. At the end of 1987, the number of members of the Secretariat (including pereonm serving under Special Service Agreement@ end on temporrry assistance contracts) was 2026 - 771 in the Professional end higher categories, 1121 in the General Service category and 134 in the Maintenance and Operative Service category.

3, The Regular Budget total for 1987 war $145 913 000, of which $136 378 959 was to be financed from contributions made by Member States on the basis of the 1987 ecele of assessment, $4 894 000 from income from work for others and $4 640 041 from other miscellaneous income.

Nuclear power

4. The total installed nuclear power generating cap&city in the world increased by about 8% during 1987, reaching 297.9 GW(e) by the end of the yeer. Nuclear power plents accounted for more than 16% of the world's electricity generation in 1987, et the end of which there were 417 nuclear power plants in operation (see Table 1), representing en accumulated operating experience of around 4600 reactor years.

Table 1

Nuclear power reactors in operation and under construction at the end of 1987

Country name	In operation		Under construction		Electricity supplied by nuclear power reactors in 1987		Total operating experience (to end 1987)	
	Number of units	Total MW(e)	Number of units	Total MW(e)	TW(e).h	% of of total	Years	Months
Argentina	2	935	1	692	6.0	13.4	18	7
Belgium	7	5 477			39.6	66.0	79	7
Brazil	1	626	1	1 245	1.0	0.5	5	9
Bulgaria	5	2 585	2	1 906	11.5	28.6	38	8
Canada	18	12 142	4	3 524	72.9	15.1	188	0
China			2	1 188				
Cuba			2	816				
Czechoslovakia	8	3 207	8	5 120	20.7	25.9	36	1
Finland	4	2 310			18.5	36.6	35	4
France	53	49 828	10	13 410	251.3	69.8	434	6
German Democratic Republic	5	1 694	6	3 432	10.3	(9.7)*	67	5
Germany, Federal Republic of	21	18 947	4	4 047	123.2	31.3	256	6
Hungary	4	1 645			10.3	39.2	10	2
India	6	1 154	8	1 760	4.7	2.6	66	8
Iran, Islamic Republic of			2	2 392				
Italy	2	1 120	3	1 999	0.1	0.1	75	10
Japan	36	26 888	12	10 692	182.6	29.1	357	5
Korea, Republic of	7	5 380	2	1 800	37.4	53.3	28	7
Mexico			2	1 308				
Netherlands	2	507			3.4	5.2	33	9
Pakistan	1	125			0.3	(1.0)	16	3
Poland			2	880				
Romania			3	1 980				
South Africa	2	1 842			6.2	4.5	6	3
Spain	9	6 529	1	990	39.5	31.2	72	11
Sweden	12	9 646			64.4	45.3	123	2
Switzerland	5	2 932			21.7	38.3	63	10
Union of Soviet Socialist Republics	56	33 616	28	25 098	187.0	11.2	631	11
United Kingdom	38	IO 294	4	2 520	48.9	17.5	770	10
United States of America	106	92 982	13	14 844	455.0	17.7	1 154	4
Yugoslavia	1	632			4.3	5.6	6	3
Worldwide[a]	417	297 927	120	101 643	1 652.2		4 616	8

[a] "Worldwide" figures include Taiwan, China, where there were six units with a total capacity of 4884 W(e) in operation and where a total of 38 years and 1 month of operating experience had been gained.

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

5. During thr year, 22 nuclear power plant8 came on line (in Bulgaria, Canada, Czechoslovakia, France, Hungary, Japan, Spain, thr Soviet Union and the United States) and conrtruction work started on nine plantr (in Bulgaria, China, India and Japan). No construction cancellatfonr were reported by Member States.[1]

6. Although the worldwide rvolution of nuclear powrr continued to be influenced by the 1986 Chernobyl accident, the lessons learned from the accident caused an upsurge in nuclear safety awareness which rhould in the long term be of benefit to nuclear powrr, In most Member Stater, there appeared to be no significant changes in the public and political acceptance of nuclear power, whereas there was a clear increase in concern regarding environmental effects not attributable to nuclear power, In some Member States where the opposition to nuclear power is strong, the rlow-down or suspension of nuclear power programmer continued; mort other Member Stater with nuclear power programmes, however, reasserted their commitment to nuclear power. In particular , the Soviet Union and other CMEA countries reaffirmed their intention to proceed with extensive nuclear power programmes, and in the United Kingdom a decision was taken to proceed with the conrtruction of a eerier of PWR-type nuclear power plants.

7, An Agency conference on nuclear power performance and safety held in Vienna from 28 September to 2 October 1987 was the first major conference organized by the Agency in that subject area after the Chernobyl accident.

8. A study by a senior expert group of mechanisms to assist developing countries in the promotion and financing of their nuclear power programmer resulted in a number of recommendations, most of them for an intensification of on-going Agency activities but some for additional actions to be undertaken within the Agency and in developing Member States.

9. Efforts to atrengthen developing Member States' infrartructuree for the planning and implementation of nuclear power projects continued through interregional and national training courses, seminars, workshops, technical co-operation projects, advisory missions, guidebooks, manuals and technical committee meetings. A gradual shift in emphasis was initiated towards promoting improvements in plant operation and maintenance practices, in order to reach uniformly high levels of safety, reliability and economic perfonance world wide,

Nuclear fuel cycle

10, The Agency continued to collect and disseminate, in co-operation with NEA, up-to-date information on world uranium resources and supply, on uranium exploration and production activities, and on nuclear fuel cycle requirements end facilities. Particular attention was paid to the long-term uranium supply/demand situation, to the economics and eafety and regulatory aspects of uranium mining, and to the possibilities of using data acquired and techniques developed during uranium exploration for emergency response purposes.

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[1] During the previous year, 23 plants came on line, construction work started on one plant and there were two cancellations and one suspension of construction work.

11. In the field of reactor fuel performance, emphasis was placed on improving fuel utilization and the operating conditions at nuclear power plants, with considerable effort devoted to questions of fuel reliability, safety, economics and quality.

12. As regards the back-end of the nuclear fuel cycle, the main emphasis was placed on the technical, environmental, economic and safety aspects of spent fuel storage and on the strategies and options of spent fuel management as a whole.

Radioactive waste management

13. During 1987 there was a shift of emphasis in the Agency's waste management programme towards the increased provision of practical help to Member States in the management of radioactive wastes. The Waste Management Advisory Programme (WAMAP) was launched, and there was a prompt and positive response from Member States, with four WAMAP missions being carried out in 1987 and 13 being requested for 1988.

14. In response to recent accidents with sealed radiation sources, the Agency initiated a programme under which it is offering guidance and practical help to Member States in the management and disposal of unwanted radiation sources.

15. Work on the formulation of standards and criteria for the management of radioactive wastes continued. The preparation of a document proposing international. standards for the disposal of radioactive wastes in deep geological formations entered the final stage.

Nuclear safety and radiation protection

16. Ten OSART missions visited nuclear power plants in seven countries, commitments were made for missions to plants in Czechoslovakia, Hungary, Japan and the Soviet Union in 1988, and a report on generic results of the first 18 missions was prepared. Under an "Operational Safety Indicators" programme a set of plant-specific indicators was developed to facilitate OSART reviews. The number of reports on unusual events made to the Incident Reporting System (IRS) rose from 266 to 421, the IRS data base was reviewed using the ASSET (Analysis of Safety-Significant Events Team) methodology to identify possible generic root causes, and international co-operation in operational experience feedback was intensified.

17. An Agency symposium on safety aspects of nuclear power plant ageing and life extension was heavily attended and a state-of-the-art report on the subject was completed. Substantial progress was made in developing severe accident management strategies and methods. Considerable assistance with nuclear facility siting was provided to Member States. INSAG neared the end of work on basic safety principles for nuclear power plants. The NUSS Codes of Practice were revised for submission, in 1988, to a recently established advisory group known as NUSSAG for final review and endorsement and to the Board for approval. The Secretariat started analysing the responses to a questionnaire which had been sent to Member States for the purpose of collecting information on their regulatory practices. INSARR (Integrated Safety Assessment of Research Reactors) missions visited five countries, and case studies on specific research reactor types continued. In the area of probabilistic safety assessment (PSA), support for reactor PSA studies was

provided to 18 Member States, a library of PSA computer codes was ret up and personal computer roftwarr *for* PSA work developed, a research report on nuclear fuel cycle risk criteria was completed and an IAEA/UNEP/WHO project on the risks ● rrociated with complex industrial ● ymtomm was initiated.

18. Work continued on the development of guidance relating to thr radiation protection of occupationally exposed persons and to principles for rotting disposal limits for effluent and other wastes. Work also continued on the development of models for thr real-time forecasting of exposures from nuclear ● ccidontr and of ● data bare for dose assessment. The Agency's Regulations for thr Safe Transport of Radioactive Materials were updated and ● upplomonted, and research began on the radiation protection implication@ of trrnrport accidents involving radioactive materials. RAPATs reviewed radiation protection infrartructurer in eight countries and recommended long-term programmes for strengthening thorn,

19. Meetings were organized o n methodologies for thr conduct of ● □ studiesfollowing a nuclear accident, the biological dorimetry of serious over-•xporurem and the handling of radiation injury. Guidance documontr were issued on ● aremrinS the off-rite conrequencer of nuclear facility ● ccidmtrr, Assistance was provided to Brazil under the Convention on Assistance in the Case of a Nuclear Accident *or* Radiological Emergency following the Goiania accident, Thr capability of the Agency to perform its functionr under that convention and undrr the Convention on Early Notification of a Nuclear Accident was strengthened, in particular through the establishment of arrangements for use of WMO's Global Telecommunication Syrtem to transmit measured radiological data. The Agency continued to co-operate with other organizations in the development of a more uniform approach to setting derived intervention levels for foodstuffs. Radiological data from Member States wore collated for use by UNSCEAR in assessing the radiological impact of the Chernobyl occident,

Application of nuclear techniques

20. 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.

21. About 200 technical co-operation projects were carried out in 62 developing Member States; also, 14 regional and interregional projects were carried out. The Joint FAO/IAEA Division co-ordineted 30 research programmer involving 480 research contrecte and agreements dealing with the use of nuclear and related techniques to solve food production and protection problems.

22. In the life sciences area, assistance continued to be rondered to Member States - and especially the developing countries among them - with the application of nuclear techniques in medicine (in-vivo and in-vitro nulear medicine and radiotherapy) and nutritional and health-related environmental studies, with applied radiation biology work and with radiation doeimetry work, Many of the activities in question are carried out in co-operation with WHO.

23, Within the framework of ARCAL, a CEC-eupported programme was set up to promote the use of bulk reagents in radioimmunassay work,

24, Technical issues relating to domimetry and radiotherapy were examined at a rympomium organized by the Agency in co-operation with WHO.

International co-operation in fusion research

25. In March 1987, representatives of the world's four major fusion programmes - being conducted in Japan, the Soviet Union, the United States, and the European Community - met in Vienna under Agency auspices and agreed to begin a conceptual design tudy for an international thermonuclear experimental reactor. The project, referred to am ITER, ham the goal of producing a design for the next-step tokamak experiment, It represents a logical continuation and xpanmion of work done through the Agency-sponsored INTOR (International Tokamak Reactor) workshop, in which Japan, the Soviet Union, the United States, and the European Community worked am partners from 1979 onwards.

Technical co-operation

26. During 1987, a total of 962 projects were operational and 64 training courses were held. These ctiviticrm involved 1808 expert assignments. In addition, 1030 persons received training within the framework of the fellowship programme. A five-year summary of programme delivery is Riven in the following table.

Item	1983	1984	1985	1986	1987
Number of expert assignments	1099	1530	1846	1930	1808
Number of expert man-months served	1020	1550	1585	1516	1356
Number of expert/lecturer rrignmentm undertaken by Agency staf f	333	378	418	449	407
Number of purchase orders processed	2405	2970	3391	3738	3701
Number of fellows in the field	612	702	615	734	870
Number of visiting scientists	65	123	188	203	160
Number of participants in training courses	659	850	926	972	945

27. Total resources for technical co-operation activities in 1987 increamed by 5.5% over the previous year to $41.5 million (1986: $39.3 million). The implementation rate attained for the programme as a whole was 61.3%; it was 67 . 0% for that part of the programme financed from the Technical Assistance and Co-operation Fund.

Seibersdorf Laboratories

28. The Agency's Laboratories at Seibersdorf provided experimental back-up services to the programmes of the Department of Research and Isotopes in food and agriculture, physical and chemical sciences and life sciences and supported the Department of Technical Co-operation by offering in-service training for individual fellows, organizing training courses and supplying technical officers for technical co-operation projects. Training, research and service activities were performed in such areas as soil fertility, irrigation, crop mutation, insect and pest control, pesticide analysis and formulation, and animal nutrition, health and reproduction (Agriculture, FAO/IAEA programmes); and analytical chemistry, radiation dosimetry, electronics, instrumentation and isotope hydrology (Physical, Chemical and Life Sciences). In addition, the Laboratories provided analytical services for the Department of Safeguards. The Safeguard Analytical Laboratory (SAL) received more than one thousand samples of nuclear material, the total time needed to conclude verifications by destructive analysis being reduced.

Safeguards

29. In 1987, 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[2]. It is considered reasonable to conclude that nuclear material under Agency safeguards in 1987 remained in peaceful nuclear activities or was otherwise adequately accounted for.

Conventions

30. The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency entered into force on 26 February 1987[3]. The Convention on the Physical Protection of Nuclear Material entered into force on 8 February 1987. A joint IAEA/NEA working group of governmental experts adopted by consensus the text of a Joint Protocol relating to the application of the Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention) and the Convention on Civil Liability for Nuclear Damage (Vienna Convention).

Committee on Assurances of Supply

31. The Committee on Assurances of Supply (CAS) held its twenty-first session in May 1987, shortly after the conclusion of the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy. Concluding, in the light of the outcome of that

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[2] 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.

[3] The Convention on Early Notification of a Nuclear Accident had entered into force on 27 October 1986.

Conference, that early progress was unlikely either on principles of international co-operation in the field of nuclear energy or on any new topics, CAS decided not to fix any date or agenda for its next session. Inrtead it requested the Bureau to consult members of the Committee, and agreed that the Chairman should report thr outcome to the Board in Juno 1988 and recommend at that time a date and agenda for the next session of CAS,

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

32, The Conference was held from 23 March to 10 April 1987 in Geneva. In the course of the general debate, delegates agreed that the Agency should continue to play its central role among multinational institutions in promoting international co-operation in the peaceful uses of nuclear energy, and appreciation was voiced for the ● rrietance the Agency had provided, particularly through its technical assistance programmes, throughout its 30 years of existence, It was generally felt that the role of the Agency ehould be reinforced, especially with regard to co-operation and information exchange for the benefit of developing countries. It was also generally felt that the Agency rhould play the principal role in taking appropriate action with respect to any decisions and recommendations resulting from *the* Conference.

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

33. Several matters of interest to the Agency were discussed at the forty-second session of the Qeneral. Assembly, In the debate that followed the prerantation of the Agency's annual report for 1986, delegates indicated their broad support for the Agency, its safeguards system, its technical co-operation programme, and its work in the field of nuclear safety. In its resolution on the report, the Qeneral Assembly affirmed "its confidence in the role of the Agency in the application of nuclear energy for peaceful purposes" and urged all States to co-operate in carrying out the work of the Agency.

34. In resolution 42/24, on the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy, the Qeneral Assembly requested the Agency, "as the central organization for peaceful nuclear co-operation, to continue its effortr, in close collaboration with the concernad specialized agencies and other relevant organizatione in the United Nations system, with the specific aim of strengthening and broadening international co-operation in the peaceful uses of nuclear energy for economic and social development,,.

35, The General Aeeembly adopted a number of reeolutione on environmental matter6. In resolution 42/186, it adopted "The Environmental Perspective to the Year 2000 and Beyond" as "a broad framework to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound development, and specifically as a guide to the preparation of further syetem-wide medium-term environment programmes and the medium-term programmes of the organizatione and bodies of the United Nations system, in the light of [United Nations Environment Programme] Governing Council decision 14/13". In this resolution the General Aeeembly called upon "the governing bodies of the organs and organizatione of the United Nations system to consider the Environmental Perspective and take it into account in the development of their own medium-term plans and programmes am relevant to their own mandates" . In resolution 42/187, on the Report of the World

Commission on Environment and Development, the General Assembly decided to transmit the report to all Governments and to the governing bodies of the organs, organizations and programmes of the United Nations system, inviting them to take account of the analysis and recommendations contained therein in determining their policies and programmes. Many of the Agency's activities in 1987 were such as to help in achieving environmentally sound development, and in the preparation of future programmes of the Agency the Environmental Perspective and the World Commission's analysis and recommendations will be taken into account.

36. The General Assembly adopted a number of resolutions on the establishment of nuclear-weapon-free zones in the Middle East and in South Asia. In resolution **42/28,** 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 in the Middle East.

37. In resolution **42/44,** entitled "Israeli nuclear armament", the General Assembly reiterated "its condemnation of Israel's refusal to renounce any possession of nuclear weapons", reiterated also "its condemnation of the co-operation between Israel and South Africa" and once more requested the Security Council "to take urgent and effective measures to ensure that Israel complies with Security Council resolution 487 **(1981)".** It called upon all States and organizations that had not yet done so "to discontinue co-operating with and giving assistance to Israel in the nuclear field" and reiterated its request to the Agency "to suspend any scientific co-operation with Israel which could contribute to its nuclear capabilities". It also requested the Agency "to inform the Secretary-General of any steps Israel may undertake to place its nuclear facilities under International Atomic Energy Agency safeguards".

38. In resolutions **42/34A** and **42/34B** the General Assembly demanded once again that South Africa submit forthwith all its nuclear installations and facilities to inspection by the Agency.

39. In September 1987 the General Conference adopted two resolutions relating to matters which had previously been discussed by the United Nations General Assembly and which were subsequently the subject of resolutions adopted by the General Assembly during its forty-second session (see paragraphs 37 and 38 above).

40. In resolution **GC(XXXI)/RES/470,** on Israeli nuclear capabilities and threat, the General Conference demanded "that Israel place all its nuclear facilities under Agency safeguards" and requested the Director General "to consider implementation by the IAEA of provisions in United Nations General Assembly resolutions **41/12** and **41/93** in relation to the IAEA". The Director General was also requested "to report to the Board of Governors and the next session of the General Conference on Israeli nuclear capabilities and threat and on the implementation of this resolution*'. It decided to include an item entitled "Israeli nuclear capabilities and threat" in the agenda for the thirty-second regular session of the General Conference.

41. In resolution **GC(XXXI)/RES/485,** on South Africa's nuclear capabilities, the General Conference decided "to consider and take a decision on the recommendation of the Board of Governors contained in its report **GC(XXXI)/807** to suspend South Africa from the exercise of the privileges and rights of membership in accordance with Article **XIX.B** of the Statute, at the

thirty-second regular session of the General Conference*'. The Director General was requested "to continue to take all possible measures to ensure the full implementation of resolution GC(XXX)RES/468 and to report to the thirty-second regular session of the General Conference in this regard". The Conference also decided "to include in the agenda of the thirty-second regular session of the General Conference an item entitled 'South Africa's nuclear capabilities'".

Resolutions adopted by the Agency's General Conference

42. In September 1987 the General Conference adopted resolutions concerning: Israeli nuclear capabilities and threat (GC(XXXI)/RES/470); the Agency's accounts for 1986 (GC(XXXI)/RES/471); the Convention on the Physical Protection of Nuclear Material (GC(XXXI)/RES/472); measures to strengthen international co-operation in nuclear safety and radiological protection (GC(XXXI)/RES/473); the sharing of nuclear-safety-related information (GC(XXXI)/RES/474); the protection of nuclear installations against armed attacks (GC(XXXI)/RES/475); Regular Budget appropriations for 1988 (GC(XXXI)/RES/476); Technical Assistance and Co-operation Fund allocation for 1988 (GC(XXXI)/RES/477); the Working Capital Fund in 1988 (GC(XXXI)/RES/478); scale of assessment of Members' contributions for 1988 (GC(XXXI)/RES/479); relationship agreement between the Agency and the United Nations Industrial Development Organization (GC(XXXI)/RES/480); the financing of technical assistance (GC(XXXI)/RES/481); staffing of the Agency's Secretariat (GC(XXXI)/RES/482); amendment of Article VI.A.2 of the Statute (GC(XXXI)/RES/483); revision of Article VI of the Statute as a whole (GC(XXXI)/RES/484); South Africa's nuclear capabilities (GC(XXXI)/RES/485); and examination of delegates' credentials (GC(XXXI)/RES/486).

TECHNICAL CO-OPERATION

General issues during 1987

43. Human resources development is one of tha key elements of technology transfer. In this connection, almort 2000 professionals from developing countrier benefited from Agency training courses and fellowships, and almort 2000 expert assignments were undertaken. These activities were complemented by the provision of equipment valued at $16 million. As a result of the Agency's efforts to promote human resources development, a number of developing Member States have already established appropriate infrastructures and have acquired the capability to carry out, on their own, substantial parts of their nuclear programmer.

44. The provision of preparatory assistance continued during 1987 under the special project approved by the Board for that purpose. In total, 53 missions were planned, of which 50 were carried out. This involved 62 expert assignments to 28 countrier for a total of 16 months. Pro-project support in 1987 resulted in the formulation of 33 project proporals which were approved within the framework of the 1988 programme.

45. Throughout the year, close contacts were maintained with Member States as a follow-up to the Technical Co-operation Policy Review. A number of steps for improving the quality of the programme were initiated, including the design of new project request forms for the 1989-90 programme which aim to enhance the linkage between project and national priorities.

46. Since its introduction four years ago, 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 there activities more effective. Regular monitoring of all operational projects through the interim project implementation reporting system continued in 1987, and, at the request of a number of technical officers, fuller information is being provided on the technical progress being made in individual projects. The 1987 evaluation reports indicated that the two most common problems were the placement of project-related fellows and shortages of national counterpart staff. A joint effort to address these concerns is now being undertaken by the Secretariat and Member States.

47. Hid-project and end-of-project evaluations of 63 projects were conducted in 1987. The areas covered by such evaluations in 1987 included radiation protection, radioactive waste management, applied nuclear science laboratories and applications of nuclear techniques. The provision of expert services and fellowship training were addressed by process evaluations completed in 1987. In both cases, the evaluations concluded that the Secretariat had responded effectively to the challenges associated with rapidly growing programme demands and that these activities were contributing to technology tranrfer. Also, the first country programme evaluation, intended to gauge the impact of Agency assistance to a specific Member State, was undertaken.

48. The role of women in development ham 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 effortm , the Secretariat ham, 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 fellow8 were women; the corresponding figure for 1987 was 19.9%. Of the 519 training course participants in 1981 , 64 - or 12.3% - were women; in 1987, the figure was 16.0%. Although the percentage of women serving am experts increased only from 2.2% in 1983. to 5.3% in 1987, the percentage of women serving am training course lecturers rose from 1.7% to 8.6% during the same per'.od. In the Division of Technical Assistance and Co-operation, the share of women serving am Professionals increased from 14.7% in 1981 to 26.5% in 1987.

Programme implementation and programme trends

49. The technical co-operation programme at the beginning of 1987 consisted of 880 active projects, During the year, 22 footnote-& projects were made operational and 18 projects were approved under the Reserve Fund. Also, seven new UNDP-funded projects were added to the programme, mo that 962 projects were operational during 1987. Of this total, 132 projects were completed and three were cancelled,

50. The provision of technical ammimtance in 1987 involved arranging for 1808 expert assignments, processing 3701 purchase orders for equipment and supplies, devising training programmes for 1030 fellows and visiting scientists, and organizing 64 training courses for 945 participants, in addition to furnishing general logistic nnd administrative support.

51. Of the assistance delivered in 1987, the largest portion (20%) related to nuclear engineering and technology; projects in this field covered reactor modernization, metallurgy , nuclear instrumentation and reactor control, isotope production, radiation engineering and quality assurance. The next most important field was the application of imotopee and radiation in agriculture (18%), where the focus was on optimizing fertilizer and water use, enhancing biological nitrogen fixation, promoting mutation breeding, increasing livestock production, establishing food irradiation facilities and conducting pesticide residue studies. At 15%, nuclear safety and radiation protection ranked third in the programme; the activities involved primarily the promulgation of laws and etandards, the organization of radiation protection services, domimetry and environmental monitoring, reactor safety and radioactive waste management. Other important fields were: industry and hydrology (13%), covering the radiation sterilization of medical products, non-destructive testing, nucleonic control systems, water and eed iment dynamics, the determination of various parameters related to groundwater recharge and general water resource management; nuclear physics (9%), involving such activities as neutron activation analyeie, mass spectrometry, the use of solid-state detectors and reactor physics studies; and nuclear medicine (9%), dealing with radiotherapy, radiotoxicology, medical physics and radiopharmacy.

52. Technical Divisions of the Secretariat played an active part in mupporting technical co-operation activities. During 1987, 142 technical officers provided eupport of various kinds to the 962 projects that were operational during the year; they also appraised 724 project requests received from Member States for the 1988 technical co-operation programme, undertook 407 aeeignmente, either as experts or as training course lecturers, for a total of 117 man-months, and evaluated 1213 fellowship applications.

Resources and delivery

53, Total new resources available for technical co-operation in 1987 amounted to $41.5 million, which is 5.5% higher than the figure for the previous year (see Fig. 1). The Technical Assistance and Co-operation Fund (TACF) accounted for 72.5% of the total available resources, extrabudgetary fundr for 13.7%, UNDP for 6.2% and assistance in kind for 7.4%. Pledges end miscellaneous income, reduced by currency exchange losses, covered 88.6% of the TACF target of $34 million (in thr previous year, 92.7% of the TACF target of $30 million had been covered). The decline in percentage attainment of the target, which began in 1983, continued unabated.

54. The value of the programme planned for implementation (total adjusted programme for 1987) was $56.1 million, Obligations were entered into for goods and servicer valued at $34.4 million, yielding an overall implementation rate for the programme of 61.3%. Disbursements in 1987 (actual cash outlays) are shown in Fig. 2.

55, Implementation by resource category during 1987 is summarized in the following table.

Resource category	Adjusted programme ($)	Net expenditure ($)	Implementation rate (%)
TACF	40 436 825	27 078 352	67.0
Extrabudgetary fundm	11 901 496	4 467 566	37.5
UNDP	3 307 300	2 568 677	77.7
Funds in trust	457 226	251 370	55.0

56, Am in the past , diebureementm were highest in respect of the equipment component. This component's share of the tot81 delivery in 1987 was 50%; expert services accounted for 19%, fellowship training for 20%, training courses for 10% and sub-contracts for 1%.

57. The following table summarizes implementation by assistance component,

Assistance component	Adjumted programme ($)	Net expenditure ($)	Implementation rate (%)
Experts	14 363 060	7 983 739	55.6
Equipment	28 230 075	16 232 729	57.5
Fellowships	7 816 838	6 499 385	83.1
Training courses	4 472 962	2 926 849	65.4
Sub-contracts	904 315	549 535	60.8
Miscellaneous	272 952	173 344	63.5
Direct costs	42 645	384	0.9
Total	56 102 847	34 365 965	61.3

58. Although the overall implementation rate, which is an indicator of the degree to which the Agency has been able to set technical assistance inputs in motion in a given year, declined somewhat as compared with 1986, disbursements, representing technical assistance actually received by recipient countries, reached $46.3 million, a figure 15.7% higher than in the previous year.

Distribution of assistance

59. Figure 3 shows disbursements by field of activity and year over the period 1985-87 as a percentage of the total disbursements for those years. As can be seen from the table, nuclear engineering and technology ranked first, followed by agriculture and nuclear safety.

60. How programme emphasis varies from region to region can be seen in Fig. 4. In 1987, agriculture was the leading field for Africa and Latin America, nuclear engineering and technology for Asia and the Pacific and for Europe, and nuclear safety for the Middle East; most interregional assistance was also given in the field of nuclear safety, which was the third most important field for the programme as a whole.

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

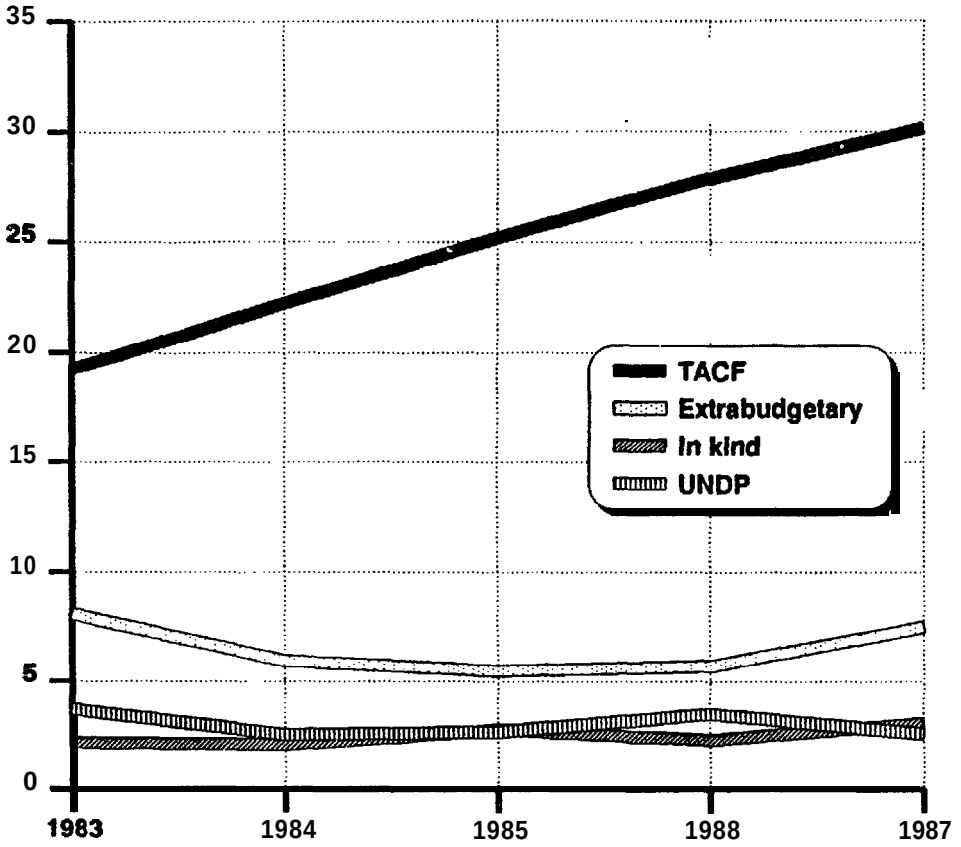
	Overall share in %			
Region	1984	1985	1986	1987
Africa	25.5	20.9	19.9	18.5
Asia and the Pacific	26.7	28.4	26.8	30.0
Europe	11.5	13.1	13.6	18.9
Latin America	24.7	22.7	22.5	20.3
Middle East	0.9	1.6	3.1	2.1
Interregional	10.7	13.4	13.9	9.9

62. The relative share of Asia and the Pacific and of Europe increased last year as compared with 1986, while those of Africa, Latin America and the Middle East declined somewhat, as did the interregional share. It should be noted, however, that the above figures refer to disbursements from all sources. In the Agency's regular programme of technical co-operation for 1987 as approved by the Board, the regional distribution was as follows: Africa - 24%; Asia and the Pacific - 26.5%; Europe - 16.4%; Latin America - 22.7%; the Middle East - 3.8%. and Interregional - 6.6%.

FIGURE 1

RESOURCES AVAILABLE FOR AGENCY TECHNICAL CO-OPERATION PROGRAMMES: 1983-1987

(In millions of dollars)

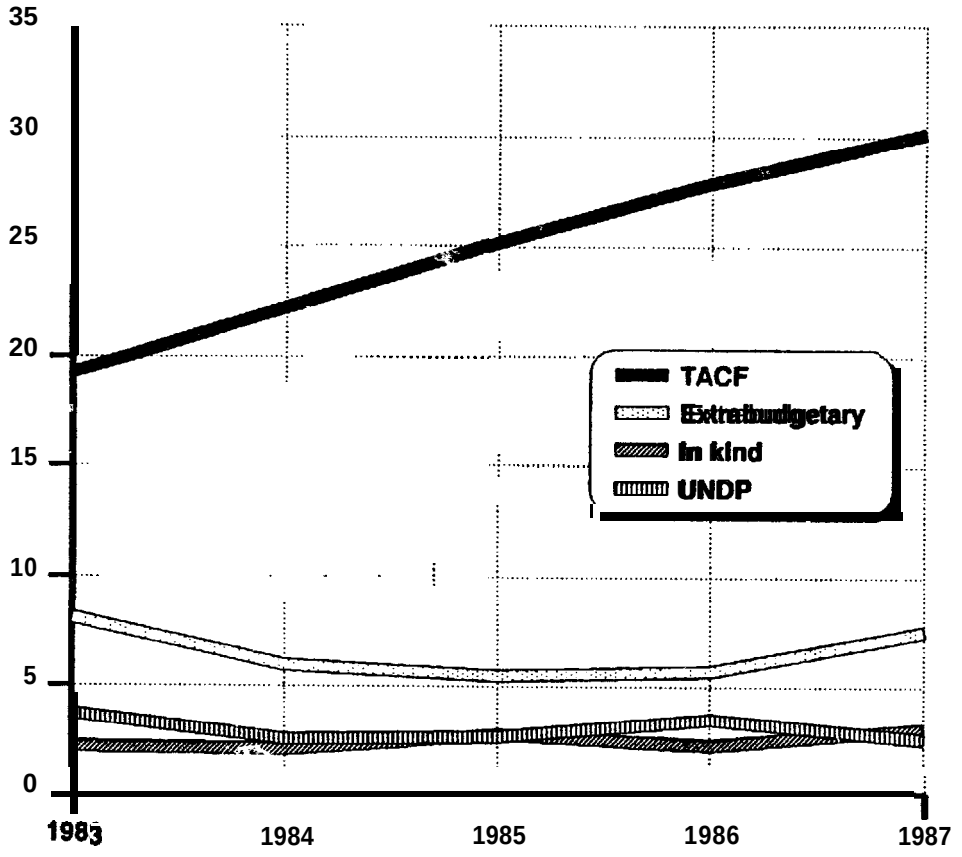


TACF	19.241	22.232	25.197	27.860	30.153
Extra-budgetary funds	8.101	5.964	5.484	5.702	5.700
Assistance In kind	2.172	2.066	2.765	2.282	3.066
UNDP	3.706	2.541	2.654	3.480	2.568
TOTAL	33.220	32.803	36.100	39.324	41.487

FIGURE 1

RESOURCES AVAILABLE FOR AGENCY TECHNICAL CO-OPERATION PROGRAMMES: 1983-1987

(in millions of dollars)



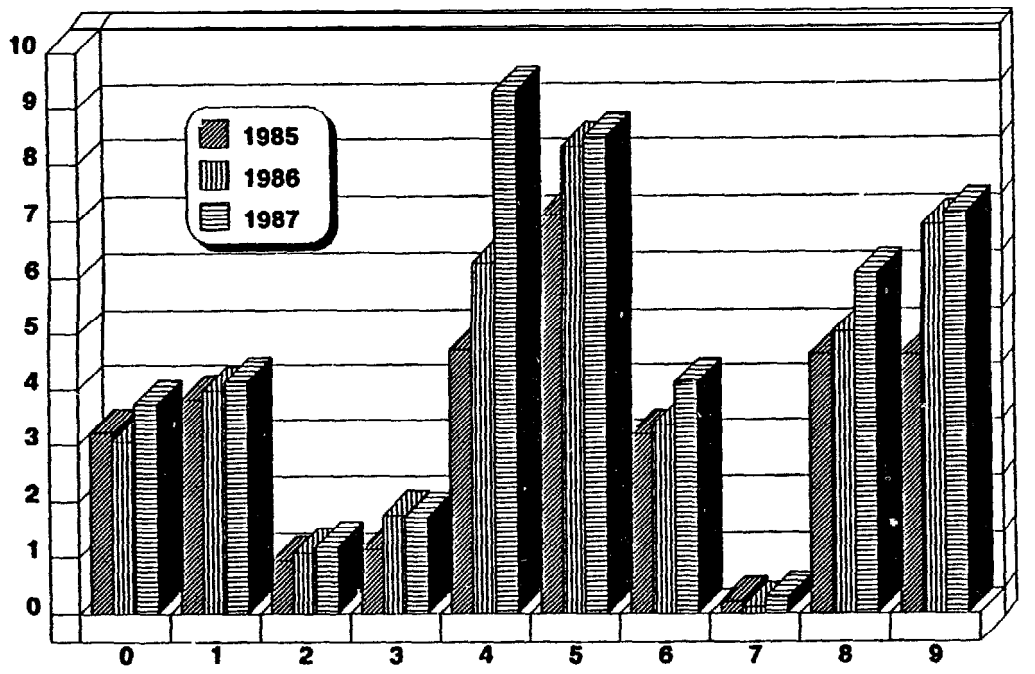
TACF	19.241	22.232	25.197	27.660	30.153
Extra-budgetary funds	8.101	5.964	5.484	5.702	5.700
Assistance In kind	2.172	2.066	2.765	2.282	3.068
UNDP	3.706	2.541	2.654	3.480	2.568
TOTAL	33.220	32.803	36.100	39.324	41.487

FIGURE 3

DISTRIBUTION OF DISBURSEMENTS

BY FINANCIAL YEAR AND FIELD OF ACTIVITY: 1985-1987

(in millions of dollars)

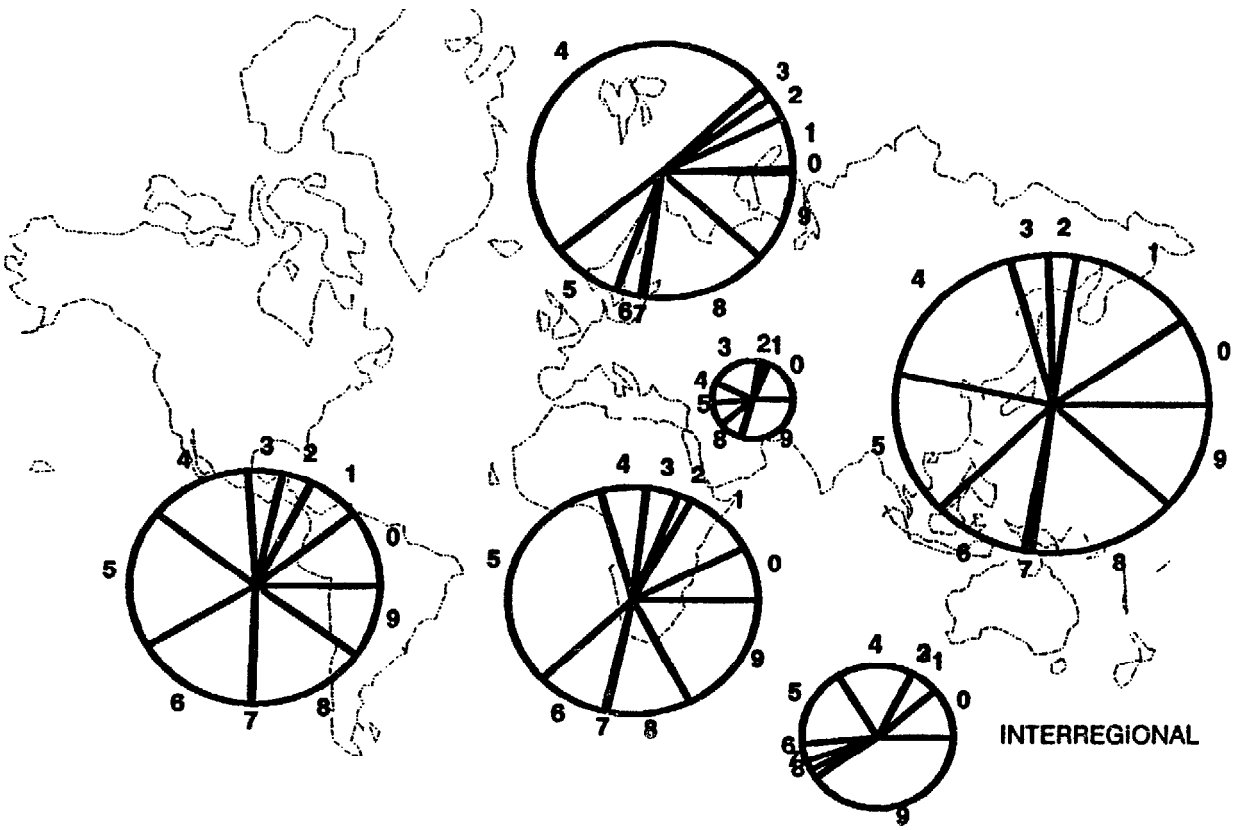


Summary in thousands of dollars

Field of activity	1985		1986		1987	
	$	%	8	%	$	%
0 - General atomic energy development	3,218.7	9.5	3,057.2	7.8	3,742.9	8.1
1 - Nuclear physics	3,809.1	11.3	3.973.7	9.9	4,139.1	8.9
2 - Nuclear chemistry	942.0	2.8	1,092.1	2.7	1,198.3	2.6
3 - Prospecting, mining and processing of nuclear materials	1,145.2	3.4	1,751.6	4.4	1,716.8	3.7
4 - Nuclear engineering and technology	4,710.8	14.0	6,257.5	t5.7	9,296.9	20.1
Application of isotopes and radiation In 5 - Agriculture	7,104.3	21.1	8,292.7	20.7	8,465.4	18.3
6 - Medicine	3,178.9	9.4	3,342.6	8.4	4,112.4	8.9
7 - Biology	223.0	0.7	122.2	0.3	296.3	0.6
8 - Industry and hydrology	4,625.0	13.7	5,023.1	12.6	6,060.7	13.1
9 - Safety In nuclear energy	4,597.5	13.8	6.921 .6	17.3	7,146.1	15.4
Miscellaneous	161.4	0.5	146.0	0.4	170.1	0.4
GRAND TOTAL	33,715.9	100.0	39,980.3	100.0	46,345.0	100.0

FIGURE 4

DISTRIBUTION OF DISBURSEMENTS BY FIELD AND REGION: 1987



Summary in thousands of dollars

Field of activity	Africa $	Ma & Pacific $	Europe $	Latin America $	Middle East $	Inter-regional $	All regions $
0 - General atomic energy development	661.2	1,314.0	51.0	1,016.6	182.5	517.8	3,742.9
1 - Nuclear physics	620.6	1836.1	551.0	639.5	13.2	278.7	4,139.1
2 - Nuclear chemistry	162.3	408.9	246.2	365.0	23.9	0.0	1,198.3
3 - Prospecting, mining and processing of nuclear materials	352.0	545.8	178.3	435.4	204.7	0.6	1,716.8
4 - Nuclear engineering and technology	523.0	2,409.8	4,283.3	1,245.5	83.2	752.1	9,296.9
Application of isotopes and radiation in							
5 - Agriculture	2,816.6	2,178.3	753.4	1,804.5	94.2	818.4	8.4684
6 - Medicine	784.8	1381.4	270.3	1597.4	0.0	188.5	4,112.4
7 - Biology	30.0	117.6	36.4	11.6	0.0	100.5	298.3
8 - Industry and hydrology	928.1	2,127.7	1,366.4	1.452.3	91.2	95.0	8860.7
g - Safety in nuclear energy	1,482.6	1,623.8	1804.1	914.3	292.1	1829.2	7,146.1
Sub-total	8551.2	13,923.4	8,742.4	9,392.3	985.0	4560.6	46,174.9
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	170.1
GRAND TOTAL	8551.2	13,923.4	8,742.4	9,392.3	985.0	4'580.8	46,345.0

Nuclear power planning and implementation for developing countries

(a) Planning tools and methodologies

63. Electricidade do Portugal (EDP) adapted and made available to the Agency its computer program VALORAGUA[4] to be used, jointly with WASP[5], In electric power system ● xpanaion planning studies where developing countries wish to ● aaow possible futurr hydro-•loctric and nuclear power components.

64, The WASP package, adapted *for* operation on microcomputers, was further improved and made available to 31 Member States; MAED[6] was ● lro adapted for operation on microcomputrrr, thr intention being to make thr now version available after it has undergone testing.

65, In co-operation with the Intonational Institute for Applied Systems Analysis (IIASA), the Agency developed - for use on microcomputorr - a model for the ● nalyrir of energy demand in basic industries (MAED-BI) as a function of the demand for the products of those industries.

66, Within the framework *of* international co-oprration in the adaptation and use of methodologies for forecasting electricity demand in developing countries, in rupport of ● tudiea of the role of nuclear power, the Agency organized a technical committee mooting on "Energy, ● loctricity and nuclear power planning: UN and other international organizations' ● pproachaa" in co-operation with the Commission of the European Communities.

67, The Agency used its EDE[7] modal to carry out, on the basis of scenarios prepared by ECE, ● rtimater of energy demond for an ECE rtudy on the long-term impact of energy efficiency improvements in Europe.

(b) Promotion and financing of nuclear power in developing countries

68. Following discussions in the Board of Governors in February 1986, a Senior Expert Group comprising 20 experts drawn from 15 Member States ond the World Bank studied mechanisms to assist developing countries in the promotion and f inancing of their nuclear power programmer and recommended, in a report published in August 1987, a number of actions to be taken by the Agency in four areas: energy and nuclear power planning, public acceptance, project preparation and implementation, and nuclear power financing. In September 1987) the Board took note of the report and requested the Secretariat to prepare specif ic proposals regarding possible implementation of relevant recommendation8 made by the Senior Expert Croup,

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[4] VALORAGUA is a power system simulation model for carrying out detailed analyses of power systems with a large hydra-electric component,

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

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

[7] EDE: Energy Demand Evaluation,

(c) Assistance in thr planning and implementation of nuclear power programmes

69, Co-operation between the Agency and the World Bank in the planning of energy and electric systems in developing countries continued, with joint missions to Yugoslavia and Egypt.

70. A World Bank/UNDP energy planning project for a number of European and Arab countries was launched at a seminar hold at the Headquarters of the Agency , which is co-operating with the World Bank in this project, Through thr project, which includes country came studies, training courses and seminars , it is hoped to combine the World Bank's expertise in the field of financal analysis and planning and the Agency's expertise in electricity and nuclear power planning in developing countries.

71. In co-operation with the Jordan Electricity Authority and the World Bank, the Agency - using MAED and WASP - prepared a technical document entitled "Energy and electricity rtudy for Jordan up to the year 2010".

72. The report published, in 1985, at the end of the fir.'. phase of the small and medium power reactor (SMPR) project initiation study[8] was updated on thr basis of recommendationa made by an advisory group co.vened to analyse the technical information received from potential ruppliers and the constraints on the introduction of SMPRs. In the updated report it was concluded that further progress in the Agency's promotion of the introduction of SMPRs in developing Member States could come only through country-specific feasibility studies with the participation of potential buyers, potential suppliers and the Agency. However, up to the end of 1987 no interest had been rhown by any country which might benefit from such a study; also, no progress had been made in obtaining reliable coat-data on available designs from potential SMPR suppliers.

73. The Agency provided technical support, including five advisory missions, in connect ion with feasibility studies and infrastructure development planning projects in Morocco, Peru and Tunisia, In Malaysia, an industrial infrastructure assessment was completed with Agency assistance.

74, With the overall objective of assisting developing Member States to strengthen their project execution capabilities, support was provided to technical co-operation projects in ten countries. Also, large multi-year, UNDP-financed projecto in the area of manpower development for nuclear power were rupported in Argentina and China,

(d) Nuclear power training programmes

75. A national training course on nuclear power project management was held in China, a national training course on stress analysis was held in the Republic of Korea and a national seminar on nuclear power plant commissioning was held in Romania, Nine two-week notional workshop-seminars were organized on different aspects of nuclear power plant construction, commissioning, operation and maintenance management.

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[8] See pare. 82 of GC(XXX)/775.

76, The eighth session of an interregional training course on "Energy planning in developing countries with special attention to nuclear energy" was held in Rabat, Morocco, followed by a one-week technical visit to France.

77, Within the framework of a technical co-operation project having as its general objective the transfer tc Indoneria of the ENPEP[9] package and the computer hardware necessary for its use, Indonesian planners *were* trained on the ENPEP package at the Argonne National Laboratory, USA,

78. In co-operation with the World Bank, the Agency started to provide training in the combined use of *WASP* and VALORAGUA[10]. Training was given to planners from Morocco within the framework *of* the World Bank/UNDP project mentioned in paragraph 70 above.

79, An interregional training course on nuclear power plant instrumentation and control systems was held at the Karlsruhe Nuclear Research Centre, Federal Republic of Germany; it was the third such course offered by the Agency,

80. An interregional training course on irradiation embrittlement in steels used in the manufacture of reactor pressure vessels war held in Argentina for specialists from developing countries, as recommended by the International Working Group (IWG) on the Reliability of Reactor Pressure Components[11].

81. In the field of quality assurance (QA), the Agency organized - in Moxico - *a* seminar *for* local industry management and a national training course for managerial and *QA* personnel. *A* national training course on QA functions of nuclear power plant owners was held in China, Support was provided for technical co-operation projects in six Member States.

82, An advisory group finalized the contents of a guidebook entitled "Energy and Electricity Demand Forecaoting for Nuclear Power Planning in Developing Countries". This guidebook is intended to serve am a manual for interregional training courses, a8 background material during Agency advisory missions and as a reference source *for* persona responsible for energy, electricity and nuclear power planning in developing countries.

(e) Regional co-operation

83. Within the framework of RCA, the Agency - in co-operation with the Asian Development Bank and the UN Economic and Social Commission for Asia and the Pacific - held a regional workehop for WASP users in Jakarta, Indonesia,

Performance of nuclear power

(a) The Agency's *power* reactor information system

84. At the end of 1987, the Agency's Power Reactor Information System (PRIS) - to which all but two Member States with power reactors report routinely - contained data for a total of about 3400 years of power reactor operation and on about 24000 outages.

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[9] ENPEP: Energy and Power Evaluation *Program,*

[10] See pare. 63 above,

[11] *See pare.* 101 below.

85. During the year, about 40 data sets were supplied on request to contributing Member States and detailed background information was provided for Operational Safety Review Team (OSART) missions. The frequency of requests for PRIS data continued to increase.

86. Using PRIS data, the Agency publirhed a further edition of "Nuclear Power Reactors in the World" and completed a report on "Operating Experience with Power Reactors in Member States, 1986".

(b) Performance rtatur and trends

87. The Agency continued to co-operate closely with the World Energy Conference (WEC) and the International Union of Producerr and Distributors of Electrical Energy (UNIPEDE) in studies on the availability of electric power plants in general and with NEA in the study of nuclear power plant performance trends (a joint Agency/NEA report on the status of and trends in nuclear power plant performance was publirhed during 1987).

88. An analysis of nuclear power plant load and availability factor trends during the 1980s showed a steady increase both in world-wide average values and in the number of plants with good or excellent performance records (see Fig. 5). In order to determine the reasons *for* this encouraging trend, the Agency initiated a series of technical visits to individual plants and utilities selected on the basis *of* PRIS date,

(c) Performance and safety

89. An Agency conference on nuclear power plant performance and safety, held in Vienna and attended by about 500 participants from 41 countries and 14 organizations, provided an opportunity for a broad exchange of information and experience,

(d) Economic8 of nuclear power

90. The Agency continued work on testing FINPLAN, a microcomputer model for analysing the impact of various project financing procedures on the f inances of olectric utilities,

91, At the conference on nuclear power plant performance and safety mentioned in paragraph 89 above, preliminary results were presented of a comparative economic study of nuclear and coal power generation strategies for China.

(e) Quality management

92. Within the framework of a revision *of* the Agency's five NUSS Codes of Practice, a revised version of the Code on Practice on QA (Safety Series No. SO-C-QA) was prepared for submission to an advisory group (NUSSAG) in March 1988.

93. Work *was* completed on a manual on QA for computer software and one on regulatory inspection of the implementation of QA programmes, and work on a manual on QA for the installation and commissioning of instrumentation and control and electrical equipment and one on the management of QA *for* nuclear power plant operation reached an advanced stage.

Reactors with High Availability

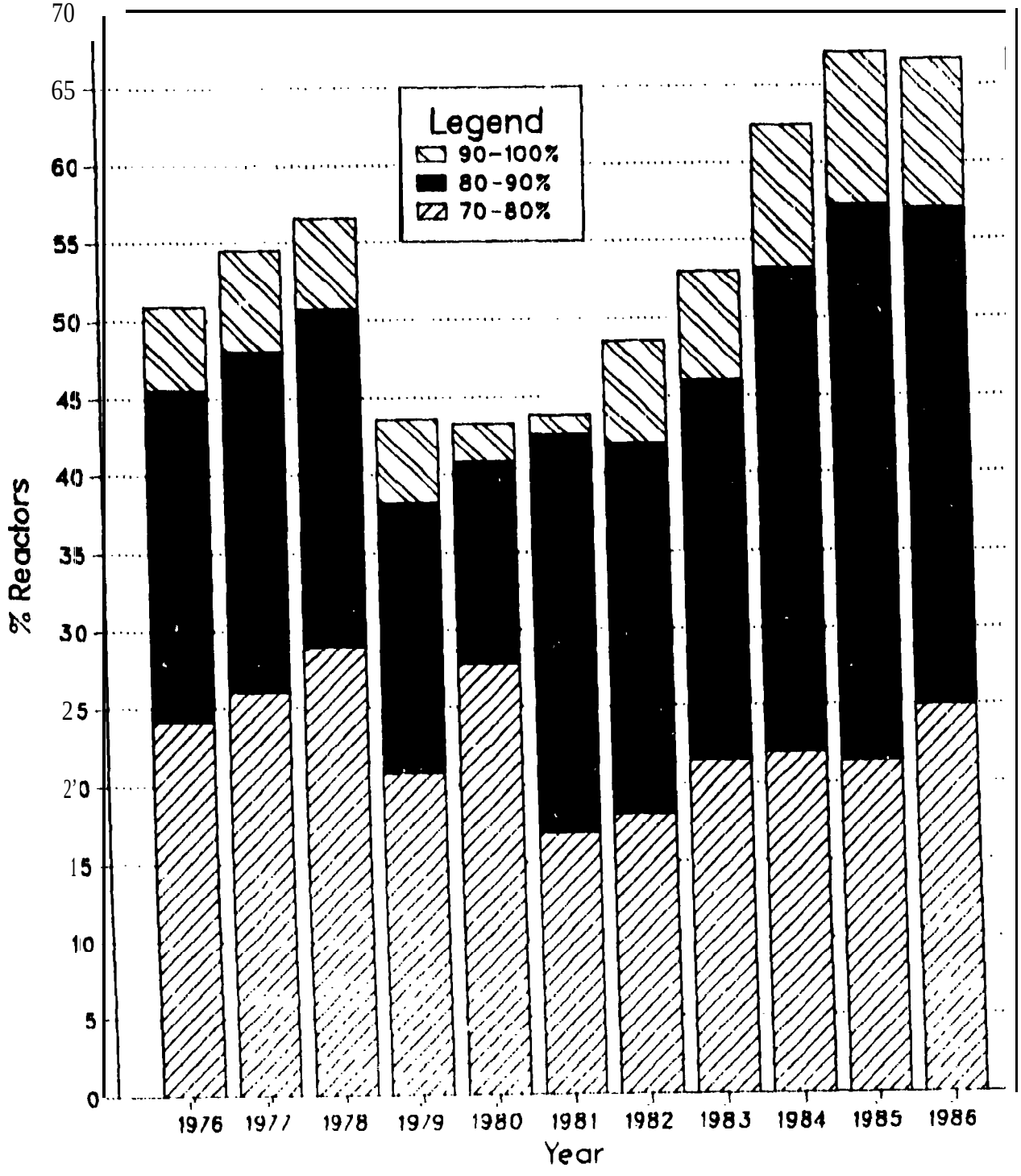

Fig. 5.

94. Activities related to the development of a methodology for measuring QA effectiveness continued,

(f) Ageing, life extension and reliability of nuclear power plants

95. A symposium on safety aspects of the ageing and maintenance of nuclear power plants was held and the proceedings published,

Nuclear power technologies

(a) Evolution of current technologies

96, The IWG on Advanced Technologies for Water-Cooled Reactors, established on the recommendation of an international expert working group following the Chernobyl accident to formulate recommendations for Agency activities relating to the technological development of water-cooled reactors (with emphasis on their safety and reliability), reviewed trends in national programmes and recommended that the Agency first focus on passive safety and accident management in the current generation of water-cooled reactors.

97, Work started on a report on the mtatum of advanced light-water reactor design and technology, to be published in 1988,

98, The IWG on Nuclear Power Plant Control and Instrumentation recommended two areas for future information exchange: improving the man-machine interface so am to minimize the probability and effects of human error; and the design and ume of different types of plant simulators.

99. Three specialists* meetings were held under the auspices of this IWG: the first, on "Human factor information feedback in nuclear power: implication6 of operating experience on systems analysis and operation", showed that there are problems in collecting human error data and that existing data banks need to be better oriented towards the collection of data on human errors - especially human errors at nuclear power plants; at the second, on "Training mimulatorm for nuclear power plants", there was a comprohenmive review of the state-of-the-art and recent progress in the development, design and manufacture of training s! ulators; and the main conclusion at the third, on "Operational experience with control and instrumentation systems in nuclear power plants", was that plant operational experience cannot be the only source of information for further improvements in reliability and that more emphasis should he placed on experience gained with plant simulators.

100. Work started on a report on the design of control rooms and the man-machine interface for the operation and surveillance of nuclear power plants, summarizing the steps which have been taken and are being planned world-wide to improve the man-machine interface for safe and reliable nuclear power generation.

101, A specialists' meeting on the irradiation embrittlement of reactor pressure vessel steels demonstrated the continuing interest in the effects of neutron irradiation on steels used in nuclear power generation, The specialists concluded that such meetings were valuable from the point of view of collecting data on the irradiation embrittlnment resistance of reactor pressure vessel steels and on proposed methods for ensuring the integrity and reliability of reactor pressure vessels.

(b) Technologies for better resource utilization

102. Current trends in national liquid-metal fast breeder reactor (LMFBR) development programmes were reviewed at the 20th annual meeting of the IWG on Fast Reactors, The IWG concluded that fast breeder reactors still offer an indimpenmable option for the future.

103. Specialists' meetings were organized on two topics closely related to the safe and reliable operation of fast reactors: fission and corrosion product behaviour in the primary circuits of LMFBRs; and fast breeder reactor block antiseismic design and verification.

104. Substantial progress was made in the co-ordinated research programme on "Sodium boiling noise detection", with work continuing on the preparation of a review report, and in the current (validation) stage of the co-ordinated research programme entitled "Intercomparison of LMFBR core mechanics codes", with the participants agreeing to study more complex problems ref lecting actual reactor operation conditions and to prepare data sets for the next (verification) stage.

(c) Nuclear heat applications

105. A technical document on small reactors for nuclear heat applications was prepared and one on the status of gas-cooled reactors and their role in electricity generation and in process steam and process heat production was published.

106. The status of the co-ordinated research programme on "Design codes for components of gas-cooled reactors" was reviewed and boundary conditions for the next step (bench-mark calculations) were established, and a review warn carried out of the technological status of coolant blowers and circulators for gas-cooled reactors.

(d) Nuclear fusion

107. The report of the technical committee meeting on "Fusion reactor design and technology" held in Yalta, USSR, was published; it describes the present status of and recent progress made in fusion reactor experiments, design and technology.

108. A co-ordinated research programme on lifetime predictions for plasma-facing components was initiated at a consultants' meeting held in Vienna.

Nuclear materials and fuel cycle technology

109. Sixty-five Member States were involved in Agency fuel cycle technology activities in 1987, with more than 750 specialists from 50 countries participating in meetings on eubjecte ranging from uranium geology to epent fuel management. Technical assistance in this broad area was provided to 33 Member States,

(a) Uranium resource8 and production

110. The ohort-term outlook for uranium continued to be influenced by over-oupply end low prices, With reactor requirements for uranium of about 39 500 t/year in 1986 and 1987, uranium production remained below requirements. Large inventories, estimated at three to four years of forward requirements, filled this supply gap and are expected to do so for the next eight to ten years.

111. Uranium production in 1986 (the latest year for which reliable figures are available at present) amounted to about 37 110 t in WOCA[12], the main producers continuing to be Australia, Canada, South Af rice and USA. Production in 1987 is expected to have been about 36 000 t.

112. Uranium contract prices continued to decline in 1986. In Australia, the average export price declined by about $5/kg U, to $71/kg U; in Canada it declined by about $3/kg U, to $64/kg U. In the EEC area, prices paid increased in US dollar terms by about $5/kg U, to $80.60/kg U, but declined in European currency unit (ECU) terms by about ECU 17, to ECU 81.90/kg U. In USA, the average price for domestic uranium declined from $81.70 to $78/kg U, while the prices of imported material remained at $52/kg U.

113. In 1987 spot prices for non-USA uranium remained at the $44/kg U level; spot prices for USA material were slightly higher, at $48/kg U.

114. Ae a consequence of the low prices, uranium exploration in 1986 and 1987 continued at a low level: $130-150 million/year. Host was expended in Canada, France and USA, but many developing countries in Asia and the Middle East continued their exploration efforts.

115. Reports were prepared on the following subjects: North American uranium geology and resources ; the metallogenesis of uranium deposits; and uranium mining (with emphasis on the planning of uranium mining operations, feasibility studies, operational aspects of uranium mining, uranium mining economics, and the regulation and safety of uranium mining),

116. Following the recommendation of an advisory group on the use of pre-existing airborne survey data to define the natural background radiation environment which met in 1986 (see paragraph 121 of GC(XXXI)/800), work began on a technical report entitled "The use of regional gamma ray data to define the natural radiation environment". A questionnaire on the amount and nature of such data was sent to all Member States.

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[12] World Outside the Centrally planned economies Area.

117. A report on uranium deposits in proterozoic quartz-pebble conglomerates was published, completing a series of reports on major uranium deposit types. Work was completed on a manual entitled "Radon in uranium exploration", on a technical report entitled '*Construction and use of calibration facilities for radiometric field equipment", on a "World atlas of uranium deposits and occurrences** and on a technical report concerning geological data integration and analysis.

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

119. The first issue was published of an annual Uranium Newsletter replacing the newsletter previously published by the NEA/IAEA Joint Group of Experts on R&D in Uranium Exploration Techniques; over 900 subscribers to the R&D newsletter requested copies of the first issue of the new newsletter, over 1200 copies of which were distributed.

120. Thirty-four technical co-operation projects concerning uranium exploration and resource development in 30 countries were supported; two of them were financed by UNDP and the UN Fund for Science and Technology for Development (UNFSTD). The projects covered a wide range of exploration methods, uranium laboratory activities and the university teaching of uranium geology and exploration methods, with emphasis on broad-reconnaissance resource appraisal surveys rather than detailed deposit surveys; at the same time, encouragement was given to the use of uranium exploration techniques and data in the assessment of other mineral resources, in the determination of the natural radiation background and in environmental and health studies.

(b) Processing and production of nuclear and reactor materials

121. Reports were prepared on (a) the present status of the technology of uranium recovery from phosphoric acid, in which many countries are interested as substantial amounts of uranium can – in principle – be recovered from phosphate rocks, and (b) the technical, economic and environmental aspects of in-situ uranium leaching, a technique which, although its use is limited to certain types of uranium deposit, is attracting considerable interest because of the lower capital and operating costs involved.

122. Following the publication of technical document IAEA-TECDOC-408, entitled "The Nuclear Fuel Cycle Information System – An international directory of nuclear fuel cycle facilities" (see paragraph 130 of GC(XXXI)/800), a second edition was prepared, incorporating information received from Member States through a questionnaire distributed in June 1987.

123. Work continued on the preparation of (a) a manual on analytical techniques in uranium exploration and ore processing, (b) a guidebook on the design, construction and operation of pilot plants for uranium ore processing, and (c) a guidebook on the development of uranium mining and ore processing projects.

124. The proceedings of technical committee meetings on the "Development of projects for the production of uranium concentrates" (STI/PUB/738) and on "Advances in uranium refining and conversion" (IAEA-TECDOC-420) were issued.

(c) Reactor fuel design, fabrication and performance

125, Work continued on the preparation of a guidebook on quality assurance in fuel fabrication and on updating the guidebook '*Quality control of water reactor fuel'* through the addition of chapters on gadolinium-bearing and mixed-oxide fuels (see paragraph 137 of GC(XXXI)/800).

126' In a report prepared on "Power ramping and cycling and the load-following behaviour of water reactor fuel", it was concluded that power ramping and cycling can, when necessary, now be carried out at water-reactor nuclear power plants without major constraints on fuel behaviour and performance'

127. A report was prepared on the "Underwater inspection, repair and reconstitution of water reactor fuel", a topic which is becoming increasingly important. in many Member States,

128. In a report prepared on "Advanced fuel for fast breeder reactors: fabrication and properties and their optimization", it was concluded that dense ceramic fuels are reliable as mixed-oxide driver fuels and that mixed nitride and carbide fuels and also metallic fuels can be regarded as promising fuels for future fast breeder reactor reloads' It was recommended that the Agency pay more attention to the design, fabrication, performance and reprocessing of these advanced fuels'

129. The proceedings of a symposium held in Stockholm in 1986 on "Improvement8 in water reactor fuel technology and utilization" and of technical committee meetings 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" were published' A technical document entitled "Review of fuel element development for water-cooled nuclear power reactors*' was prepared for publication'

130. The fins1 report of a co-ordinated research programme on "Fuel element cladding interaction with water coolant in power reactors" was issued and a f 01 low-up programme on "Water chemistry control and coolant interaction with fuel and primary circuit materials in water-cooled power reactors" (WACOLIN) initiated, the objective being to prepare a comprehensive manual of good practices relating to power reactor water chemistry (see paragraph 134 of GC(XXXI)/800).

131. In connect ion with the co-ordinated research programme entitled "Examination and documentation methodology for water reactor fuel" (see paragraph 136 of GC(XXXI)/800), work started on the preparation of a guidebook on the non-destructive examination of water reactor fuel, The final report of a co-ordinated research programme on the "Development of computer models for fuel element behaviour in water reactors" was issued.

132. A study of incentives for improving the design and utilization of nuclear fuel in iight-water reactors was initiated, the objective being to assess examples of improvements in – inter alia – fuel assembly design, in-core fuel management, the use of burnable absorbers and fabrication techniques from the point of view of the effects on nuclear fuel cycle costs, plant availability and capacity factors, reactor operational flexibility and the back-end of the nuclear fuel cycle,

133. Support was provided for technical co-operation projects on fuel manufacture and post-irradiation fuel examination in seven countries, the focus in the former field being on quality assurance and quality control programmes to ensure safety and materials reliability through the systematization of procedures and on upgrading the technical knowledge of plant personnel.

(d) Spent fuel management

134. An **Agency/NEA** symposium entitled "Back-end of the Nuclear Fuel Cycle: Strategies and Options", held in Vienna, provided a forum for an exchange of information on spent fuel management strategies and options (including incentives for international co-operation) and on various technical, safety, economic, environmental, legal and regulatory aspects of spent fuel and high-level waste management; the proceedings were published by the Agency.

135. Work on a report entitled "Survey of experience with dry storage of spent nuclear fuel and update of wet storage experience" (see paragraph 140 of **GC(XXXI)/800),** which provides spent fuel management policy-makers and the designers and operators of spent fuel storage facilities with recent information on the technology of spent fuel storage under dry and wet conditions and innovations in this field, was completed.

136. Work started on the preparation of a second edition of the "Guidebook on Spent Fuel Storage" (Technical Reports Series No. 240) and on the preparation of a technical report on safe spent fuel storage and possible ways of avoiding fuel damage.

137. In a report prepared on spent fuel surveillance and monitoring methods, it was concluded that, in order to ensure the safe storage of spent fuel, monitoring becomes more necessary as storage times increase.

138. Under the co-ordinated research programme on the behaviour of spent fuel and storage facility components during long-term storage (BEFAST-II, see paragraph 144 of **GC(XXXI)/800),** in which 16 organizations in 13 Member States are participating, recommendations were formulated for the preparation of a report entitled "Research, development and practices for the extended storage of spent fuel", with chapters on the long-term behaviour of spent fuel, surveillance programmes and the operation of storage facilities.

139. The preparation of a status report on the feasibility of the separation and utilization of palladium, rhodium and ruthenium from high-level nuclear waste was initiated.

140. In a study of the economics of spent fuel storage, work started on the development of a methodology for performing economic calculations and a questionnaire was distributed to 45 countries engaged in spent fuel storage activities or expected to become engaged in such activities in due course.

141. Technical documents on the following subjects were published: "Spent fuel management: current status and prospects of the IAEA programme" **(IAEA-**TECDOC-419); "Long-term wet spent nuclear fuel storage" (IAEA-TECDOC-418); "Behaviour of spent fuel assemblies during extended storage" (IAEA-TECDOC-414); and "Materials reliability in the back-end of the nuclear fuel cycle" (IAEA-TECDOC-421).

Waste management

142. The Agency co-opocrted with the University of California and the American Socfrty of Mechanical Engineers (ASME) in organizing two large conferences, hold in USA and Hong Kong respect i vrly .

143, At the Agency's Symposium on the Back-end of the Nuclear Fuel Cycle and at its Conference on Nuclear Power Performance and Safety, three sessions were devoted to warte management issues.

144, The national radioactive waste management programmes of four developing countries were reviewed under the Waste Management Advisory Programme (WAMAP - see paragr rph 151 of GC\XXXI)/800).

145, Support was provided for technical co-operation projects concerning radioactive warte management in Algeria, Bangladesh, Chile, China, Egypt, Indonesia, Mexico, Peru, the Philippines, the Republic of Korea, the Syrian Arab Republic, Thailand and Turkey.

146. The 18th annual edition of "Waste Management Research Abstracts" (containing nearly 800 abstracts from 32 countries) was finalized for publication,

147. An interregional training course on the management of radioactive waste held at the Karlsruhe Nuclear Research Centre, Federal Republic of Germany, was ottrnded by 30 participant8 from 25 developing countries.

148, At the request of the Swedish Government, a panel of experts convened by the Agency evaluated a Swedish report on the handling and final disposal of nuclear waste.

(a) Handling, treatment, conditioning and storage of radioactive wastes

149. Reports were published in the Technical Reports Series on the "Design of Off-gas and Air Cleaning Syatema at Nuclear Power Plants" (No. 276), the "Treatment, Conditioning and Disposal of Iodine-129" (No. 274) and "Techniques and Practices for the Pretreatment of Low- and Intermediate-Level Solid and Liquid Radioactive Wastes" (No, 272).

150. Reports on the treatment of alpha-bearing wastes, the solidification of organic radioactive wastes, the immobilization of low- an4 intermediate--level wastes with polymers, the design and operation of off-gas cleaning and ventilation systems at facilities handling low- and intermediate-level radioactive materials, and the design and operation of off-gee cleaning systems at hi&h-level liquid waste conditioning facilities were finalized for publication in the Technical Reports Series.

151. Work continued on reports on the treatment and conditioning of abnormal radioactive wastes at nuclear power plants and the treatment of off-gases f corn radioactive waste incinerators, and work started on reports on the conditioning of alpha-bearing wastes and technology and safety consideration in evaluating conditioned spent fuel as a final waste form. A report on the design and operation of off-gas cleaning and ventilation aystems at facilities handling low- and intermediate-level radioactive materials was prepared for publication.

152, Co-ordinoted research programmes on the evaluation of low- and intermediate-level solid waste *forma* and packages, tho retention *of* iodine and other airborne radionuclides during abnormal and accident conditions, and the performance of solidified high-level warte forms and engineered barriers under repository conditiona continued, A co-ordinated research programme on the use of inorganic sorbents for liquid waste troatment and as backfill at underground repositories was initiated,

(b) Radioactive waste disposal

153. 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 *(Safety* Series No. 85) wae published,

154. A technical report on in-situ experiments for the disposal of radioactive wastes in deep geological formations and an updated version of the Radioactive Waste Management Glossary were reviewed by the Technical Review Committee on Underground Disposal (TRCUD).

155. Work continued on reports dealing with international standards for the underground disposal of high-level radioactive wastes, acceptance criteria for the disposal *of* radioactive wastes in deep geological formations, the regulation *of* underground repositories for the disposal *of* solid radioactive wastes, and borehole plugging and shaft sealing in the underground disposal of long-lived radioactive wastes; all *of* the reports were reviewed by advisory groups or technical committees and by the TRCUD,

156. Work continued undsr a co-ordinated research programme on the geochemistry of long-lived transuranic actinides and *fission* products and one on the migration and biological transfer *of* radionuclides from shallow land burial sites.

157, A draft report on the role *of* natural analogues in performance assessments of high-level radioactive waste repositories was preparud by conrultantn and reviewed by an advisory group,

158. Work on principles for the exemption of radiation sources and practices from regulatory control continued (see paragraph 168 of GC(XXXI)/800). A draft report was prepared on the application of exemption principles to the recycling of slightly contaminated materials from nuclear facilities, and plans were made to review tha interim principles for exemption contained in IAEA-TECDOC-401 at a meeting to be organized by the Agency and NEA in 1988,

159. Work was completed on a report entitled "The Environmental Behaviour of Radium" containing contributions from more than 50 experts and constituting a unique work of reference on the worldwide distribution and the behaviour of environmental radium and on methods for determining and controlling it.

160, Work otarted on the development of a practical methodology for the assessment of individual and collective radiation doses, the aim being to produce a manual intended primarily for use in developing countries, and on a supporting document with data on radionuclide transfer in the terrestrial environment.

161. A report on methods for assessing the reliability of the predictions of environmental transfer models was prepared for publication.

162. During the continuing moratorium on the diepoeal at sea of low-level radioactive wastes agreed by the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention), the Agency - in its etatutory role - assisted the London Dumping Convention :.n answering certain questions raised by Contracting Parties and in performing studies intended to further clarify issues related to the radiological and environmental impact. of sea disposal. An Agency report on the potential impact of the sea disposal of low-level radioactive wastes on living marine resources was approved for publication,

163. A draft report on the establishment of upper bounds of individual radiation dose was revitaad in preparation for a technical committee meeting to be held in 1988. The report is generally applicable, but is expected to be particularly valuable in relation to the sea disposal of radioactive wastes.

164. A GESAMP [13] working group, with the Agency as the lead organization, continued work on the modelling of coastal marine environments,

Decontamination and decommissioning of nuclear facilities

165, A report on methods for reducing occupational exposures during decommissioning was published (Technical Reports Series No. 278). Two report8 were prepared for publication - one on the decontamination and demolition of concrete and metal structures during decommissioning and the other on factors relevant to the recycling and re-use o f component8 arising from decommissioning and refurbishment. A draft report on the development of regulatory procedures for decommissioning wee prepared for review by a technical committee,

166. A symposium on decommissioning epontaored by the US Department of Energy in co-operation with the Agency and NEA and held in Pitteburgh, USA, was attended by 625 participants from 19 countries.

167. An advisory group drafted a report on the clean-up and decontamination of very large areas contaminated as a result of nuclear accidents - the first report to take an integrated look at the planning and technology required for cleaning up such areas safely and efficiently.

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

Safety of nuclear installations

168, Ten OSART missions were conducted to enhance safety at nuclear power plants operating or under construction in seven countries - Canada, the Federal Republic of Germany, Italy, Mexico, the Netherlands, Spain and USA. Experts from 29 Member States (with 19 observers from 11 developing countries) carried out in-depth reviews of operating organizat ion management programmes, plant operation, maintenance, personnel training, technical support, chemistry, operating experience feedback, radiological protection and emergency preparedness, Preparatory work was done for 1988 missions to Italy, Hungary and Sweden. OSART guidelines were published and a first report on generic OSART findings, baaed on the result.8 of missions through May 1987, was prepared for publication,

169. Under the Operational Safety Indicators Programme (OSIP), plant-specif ic safety indicators, which help identify key areas for in-depth investigation, were developed in preparation for the OSART missions to Canada (Pickering), the Federal Republic of Germany (Philippsburg), Spain (Almaraz) and USA (Calvert Cliffs),

170. The number of reports to the Agency's Incident Reporting System (IAEA-IRS) on unusual operating, surveillance and maintenance events at nuclear power plants increased from 266 to 421. Representatives of CEC, CMEA, NEA and the Agency met to consider better ways of avoiding duplication and increasing international co-operation in operational experience feedback at all levels, The safety significance of recently reported events was assessed at three meetings of national and regional reporting system co-ordinatorr, account being taken of different users' points of view and of the difference8 in conditions between different plants and countries, Using the ASSET methodology, the IRS data base was reviewed for the purpose of identifying reported events on which in-depth exchanges of experience might be useful and poesible generic root causes of reported events, Work started on developing a mechanism to facilitate IRS data exchange by personal computer, Incident reporting system guidelines were prepared for publication as a Safety Series document, and work started on the preparation of guidelines concerning various aspects of operating experience feedback theory and practice.

171. A broad spectrum of the nuclear power community - operation and maintenance technical and managerial staff, regulatory body staff, architect-engineering and consulting organization staff, and vendor technical and managerial staff - attended the Agency's first symposium on safety aspects of the ageing and maintenance of nuclear power plants, On the basis partly of the symposium' a results, a state-of-the-art report on safety aspects of nuclear power plant ageing was completed for publication in 1988.

172, The Agency' s five NUSS Codes of Practice were reviewed and, where deemed necessary, revised in the light of Member States' comments, prior to submission of the Codes in 1988 to the NUSSAG advisory group and the Board of Governors.

173. A document on the management of severe accidents was drafted as part of continued efforts to assist Member States in understanding severe accident phenomena, in developing symptom-oriented procedures for handling such

accidents and in the organization of training related to severe accident management, At an information exchange meeting on the potential for severe reactivity-initiated accidents in reactors of all types, the participants identified a number of teaks which need to be performed in this area, A state-of-art report was completed on hydrogen generation in water-cooled nuclear power plant accidents.

174. Eleven nuclear facility siting missions were sent to eight Member States, and the Agency sponsored a four-week national workshop in Yugoslavia on special civil engineering requirements in the structural design and construction of nuclear power plants, Guidelines were formulated for the preparation of safety analysis reports on prospective nuclear power plant sites, Also in the context of nuclear facility siting, documents were prepared on seismic probabilistic *safety* assessment, hydrogeology, dose assessment and flooding due to dam breaks, Continuing its co-ordination of a project to collect historical circum-Mediterranean seismicity data, the Agency published a document on methodology and procedures, organized workshops in Madrid and Rome and started a quarterly newsletter,

175, Work continued on an in-service inspection manual (intended to supplement NUSS guide 50-SG-02) with practical examples *of* good management by Member State organizations with broad experience *of* nuclear power plant operations, Two training courses on operational safety were organised, one at Argonne, USA, and the other at Wejherovo, Poland, A set of guidelines for the selection of devices for helping reactor operators to reduce the chance of error was finalized.

176. Codes available on the Agency's computer were used by 25 experts in analysing the safety of nuclear power plants in four Member States. In co-operation with the Central Research Institute *for* Physics of the Hungarian Not ional Academy of Sciences, the Agency sponsored a second "standard problem exercise" relating to a loss-of-coolant accident simulated on the Institute's scale model of a WWER-440 reactor.

177. The International Nuclear Safety Advisory Group (INSAG) approached the end of its work on the formulation of basic principles for the safety of existing and future nuclear power plants. Also, INSAG issued a technical note on the importance of operating experience feedback,

170. The Secretariat sent to 64 Member States operating or planning to operate nuclear power plants a questionnaire on regulatory practices and began to analyse the replies received.

179, INSARR (Integrated Safety Aeaeeement of Research Reactors) missions visited research reactor facilities in Columbia, Finland, Norway, Peru and Thailand, the one in Norway being the first in a developed country to be visited by such a mission, Work continued on the preparation of documents on research reactor safety principles and criteria and the safety assessment of research reactors ; also, work started on a document on safety aspects of the modification of research reactors. A co-ordinated research programme on probabilistic safety assessment (PSA) case studies of safety characteristics of specific reactor types continued, To assist in analyses of research reactor thermal hydraulics, a microcomputer code was developed under Agency contract at a Greek research centre,

Reliability and risk assessment

180. Within the framework of an interregional project PSAs were carried out for nuclear power and research reactors in 18 Member States, a five-week training course was held in Madrid on PSAs in the operation of nuclear power plants, a PSA computer code library was established, and a personal computer taoftware package was developed for fault and event tree analysis.

181. The final report on a co-ordinoted research programme on nuclear fuel cycle risk criteria was completed. A co-ordinated research programme on PSA data collection and analysis and one on the probabilistic modelling of accident sequences were initiated,

182. The Agency, UNEP and WHO agreed to initiate a project on assessing and managing health and environmental risks from energy systems and other complex industrial systems. In preparation for this project, work started on the formulation of guidelines for Member State case studies and missions went to Thailand and the Philippines,

Radiation protection

183. Work continued on the formulation of guidance relating to: occupational radiation monitoring; personnel radiation doeimetry; external exposure monitoring; monitoring instrument calibration procedures; the systematic appraisal and the optimization of operational radiation protection programmes; radiation prctection services at nuclear power plants and research reactor facilities; and the cafe handling of tritium and of industrial and medical radiation sources. A study was initiated on the international comparison of personnel dosimeters.

184. Work also continued on the formulation of guidance relating to: the setting of effluent release limits; potential exposures from the disposal of radioactive wastes; the setting of global dose upper bounds; monitoring for radiation protection of the public; and the limitation of uranium mining and milling effluente, In addition, development work continued on real-time models for forecasting exposures in the event of a nuclear accident and on a data base for use in assessing individual and collective doses.

185. On the basis of propotaale made by a number of Member States and international organizations, changes to the Agency' s Regulationta for the Safe Traneport of Radioactive Materials were approved for publication in 1988 (eta a supplement to the Regulations). Supplements to the Regulations published in 1987 were: Explanatory Material on the Regulation8 for the Safe Traneport of Radioactive Materials (Safety Series No. 7), Advisory Material on the Regulation6 for the Safe Transport of Radioactive Materials (Safety Series No. 37), and Emergency Response Planning and Preparedness for Transport Accidents Involving Radioactive Materials (Safety Series No. 87).

186. A co-ordinated research programme on radiation protection implications of radioactive materials transport accidents began with a meeting in Japan. A technical document on uranium hexafluoride transport safety was issued.

187. The Agency and WHO co-taponeored meetings on epidemiological methodology (in connection with a Soviet study of possible long-term effects of radiation on persons exposed to radiation as a reeult of the Chernobyl accident) and on

biological dosimetry for accident8 causing the exposure of worker8 and of member8 of the public. A co-ordinated research programme on chromosome1 aberration analysis continued,

188. An Agency-sponsored meeting on the medical handling of skin lesions due to high-level accidental irradiation included the consideration of experience with such lesions following the Chernobyl accident, Work continued on ways to incorporate into basic and post-graduate medical and paramedical training the teaching of basic principles for assessing and treating radiation injuries.

189. Work continued under co-ordinated research programmes on chest phantoms for estimating plutonium in the lungs and on report8 on assessing and treating serious overexposures, A manual for occupational physicians on radiation protection in occupational health (Safety Series No. 83) and an issue of Health Physic8 Research Abetracts were published,

190. An overview of available guidance on emergency planning and preparedness was provided in a publication on technique8 for decision-making in - and for assessment of the off-site consequences of - an accident at a nuclear facility (Safety Series No, 86). Two one-month interregional course8 were held on planning and preparedness for and response to nuclear accidents and radiological emergencies.

191. Assistance was provided to Brazil in connection with the Goiania accident by the Agency, by several countries through the Agency and by several countries directly within the framework of the Convention on Assistance in the *Case of* a Nuclear Accident or Radiological Emergency, The Agency continued to develop its ability to perform it8 functions under that convention and under the Convention on Early Notification of a Nuclear Accident. Agreement was reached with WMO on the use of WMO's Global Telecommunication System for the transmission of data in a radiological emergency,

192, Guidance was developed on the rapid reporting, compilation and dissemination of voluminous post-accident data and on post-accident monitoring principles for public protection. From a review of Safety Series No. 72, on principles for establishing intervention levels for the protection of the public, it was concluded that the principles were valid for a major nuclear accident but that further guidance was needed on their application, particularly at locations remote from immediately affected areas and over extended periods. The Agency continued to co-operate with other international agencies in trying to achieve a more uniform approach to the setting of derived intervention levels, particularly for foodstuffs.

193. National radiological data provided in response to a joint request by the Agency and WHO were collated by the Agency for use by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) in assessing the radiological impact of the Chernobyl accident.

194. . adiation Protection Advisory Teams (RAPATs) reviewed infrastructure8 in eight countries (Colombia, Jordan, the Republic of Korea, Peru, the Philippines, Sudan, the Syrian Arab Republic and the United Republic of Tanzania) in order to determine priorities and recommend long-term programmes, Three other countries (Greece, Turkey and the United Arab Emirates) received mission8 limited to special topics,

195, In response to prior RAF'AT findings, regional environmental radioactivity monitoring and radiation protection service programmes were organized for some Middle East countries and work started on the formulation of a standardized radiation protection service programme; also, 12 Member States in Asia and the Pacific region initiated steps to co-ordinate their radiation protection activities.

196. During 1987, there were 94 technical co-operation projects under way in the field of radiation protection, Missions (other than RAPAT missions) visited Egypt, Jordan, Nigeria, Peru, the Philippines and Viet Nam to assist with radiation protection matters, Also, radiation protection was an integral part of the INSARR missions mentioned in paragraph 179 above.

197. Also during 1987, the Agency organised (in Yugoslavia) an international seminar on computer applications in radiation protection, (in the United Kingdom) an interregional training course on radioactive materials transport, and (in Argentina, the German Democratic Republic, Egypt and France) general radiation protection courses. In addition, four ARCAL meetings on radiation protection were sponsored.

198. Lecturers were provided by the Agency *for* international courses in the Federal Republic of Germany, USA and Yugoslavia organised to meet the training needs of other Member States.

Physical protection

199. A seventh international training course on the physical protection of nuclear facilities and material8 was held in Albuquerque, USA, and preparations were made for an eighth - planned for 1988,

Radiation protection services

200. Various environmental, food and human contamination measurements were done at the Seibersdorf Laboratories in connection with the Chernobyl accident. Personnel monitoring services continued to be provided on a routine basis to Agency radiation workers, to technical co-operation experts on mission and to trainees from Member States,

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

202. Technical co-operation missions visited six countries (Kenya, Morocco, Mauritius, Madagascar, the United Republic of Tanzania and Zimbabwe) to help establish or improve national radiation protection services. Fellows from five countries (Ghana, Kenya, Sudan, the United Republic of Tanzania and Zimbabwe) were trained in Vienna for 13 weeks in the provision of radiation protection services, and a radiation protection officer from Egypt spent some time as a scientific visitor at the Health Physics Laboratory located at the VIC.

Soil fertility, irrigation and crop Production

203. Assistance to Member States wan provided through 64 research contracts and agreements and 70 technical co-operation projects.

204. Work continued under the co-ordinated research programme *for* maximising crop yields in pasture systems through the increased utilization of atmospheric nitrogen instead of costly nitrogen fertilizers. Results were obtained indicating that most pasture legumes are able to derive from the atmosphere alnost all the nitrogen they require when they are grown together wi th traditi ona l grasses and that the mixture enhances the growth of the associated grasses, GO that there is no need for nitrogen fertilizers.

205. Research aimed at maximizing the benef its of Azolla-Anabaena symbiosis in the biological nitrogen fertilization Of rice paddies continued, nitrogen-15 being used in comparing nitrogen availability in different species of Azolla.

206. In recognition of the fact that inadequate water is the most important constraint on agriculture production, soil water measurement and management studies involving tna use of both nuclear and non-nuclear methods continued in many parts *of* the world, the emphasis remaining on helping irrigatior specialists, agronomists and other professionals to choose the methodology most appropriate to their needs,

207, Isotope- and radiation-aided studies of the biological amelioration of salt-affected soils continued, with the selection of a number of crop varieties which are salt-tolerant under various local soil and climatic conditions in eight different countries. The preparation of studies aimed at enhancing biological nitrogen fixation and fertilizer and water use efficiency, and thereby increasing crop yields under conditions *of* high soil salinity, continued.

208. Training course8 on the use of isotopes and nuclear techniques in studies of soil-plant relationships were hold at the Agency's Agricultural Laboratory at Seibersdorf, Austria, and in Leipzig, German Democratic Republic. In addition, nine fellows and seven scientific visitors received specialized training in this area at Seibersdorf for a total of 58.5 man-months.

209. Within the framework of the African regional project on biological nitrogen fixation, a workshop was held in Accra, Ghana,

Plant breeding and genetics

210. Assistance to Member States was provided through 34 technical co-operation projects.

211. The further development of mutation breeding technology was promoted through 64 research contracts, 35 research agreements and one technical contract,, with the focus on the use of in-vitro culture techniques in the mutation breeding of root and tuter crops and cereals. A co-ocdinated research programme aimed at improving the technology of breeding for disease resistance by means of in-vitro cultures was started.

212, In the field of mutation breeding, a number of in-vitro culture technique8 developed at the Agency's Agricultural Laboratory, such as the embryogenesis of banana and cocoa, were handed over to breeders in developing countries and some banana plants obtained with the help of in-vitro culture techniques were transferred on a trial basis to banana-growing countries for selection, A training course was hosted and a number of fellowship holders were given practical training in mutation induction and aseptic plant tissue culture at the Agricultural Laboratory, Radiation services for mutation induction were provided to Member States submitting seed samples for treatment,

213. A co-ordinated research programme on reducing the genetic vulnerability of Asian rice cultivars by identifying alternative germ plasm for short-culm, lodging-resistant cultivars was completed, More than 30 new mutant stocks of rice were made available to rice breeders, among them a semi-dwarf, high-yielding form of the very popular South Asian aromatic variety Basmati 370.

214. Within the framework of ARCAL, a training course was organized on the production of doubled haploids of cereals through anther culture, a biotechnological method which is very useful for accelerating mutation breeding, The course was attended by scientists from sight Latin American countries,

Animal production and health

215. Assistance to Member States was provided through 154 research contracts and agreements and 40 technical co-operation projects,

216, A co-ordinated research programme on the optimization of grazing animal productivity in the Mediterranean and North African regions and one on the study and control of parasitic diseases in livestock were completed and the results prepared for publication early in 1988.

217, Co-ordinated research programmes continued on tho reproductive efficiency of cattle, sheep, goats, buffaloes and cameloido in Latin America (within the framework of ARCAL), on the productivity of domestic buffalo in Asia (within the framework of RCA) and on the productivity of sheep and goats in Africa and Asia .

218. Work continued under a co-ordinated research programme on the use of radioimmunoassay and enzyme immunoassay procedures in monitoring reproductive efficiency and one on the diagnosis of diseases in livestock in developing countries - both funded from extrabudgetary resources provided by the Swedish International Development Authority (SIDA) and the Technical Asaietance Department of the Netherlands Ministry of Foreign Affairs.

219. An FAO/IAEA seminar for Latin America on improving the reproductive efficiency and health of livestock through radioimmunoassay and related techniques was held in Maracay, Venezuela. At Seibersdorf, an FAO/IAEA interregional training course was held on the use of isotope-aided techniques in ruminant nutrition studies and si.x fellows received training either in animal nutrition work or in the use of radioimmunoassay techniques. A training workshop on monoclonal antibody production, DNA labelling, hybridization techniques and ELISA techniques1141 was held in Uppaala, Sweden, for SIDA-funded researchers in disease diagnosis.

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[14] ELISA: enzyme-linked immunosorbent assay.

Insect and pest control

220, Assistance to Member States continued through 38 research contracta and agreementa and 16 technical co-operation projects.

221, The BICOT project [15] was concluded in June, with the eradication of Glossina P. palpalis from the 1500 km^2 project area. Following reduction of the natural population by means of insecticide-impregnated screens, radiation-sterilized males of the target species were released to mate with the remaining wild females, and eradication was achieved within 3-5 months in each zone of the project area, However, fly monitoring (including trapping) within and at the periphery of the project area continued as a precautionary measure in case the project area is re-invaded,

222, At the request of the Nigerian Government, plans were initiated for extending the project to cover an additional area of 10 000 km^2.

223. Through the BICOT project, significant progress was made in the use of artificial diets and locally collected blood for mass-rearing tsetse flies,

224, Fourteen fellows and one scientific visitor received a total of 72 man-months of training in the sterile-insect technique and in other, related insect control techniquee at Seibersdorf.

225, A significant achievement in genetic sexing research was the euccestaful isolation of a genetically sexed strain of the Mediterranean fruit fly (medfly) on the basis of pupal colour. The strain, which is being used in field trial releases during 1988, was reared through ten generations,

226, Co-ordinated research programmes continued on the genetic sexing of medflies through the manipulation of radiation-induced conditional lethals, on methodologies for using the sterile-insect technique in tsetse fly eradication or control, on the use of radiation-induced F-l sterility in Lepidoptera for area-wide control, and on the standardization of medfly trapping for use in sterile-insect technique programmes.

227. Recently initiated research indicated that media used in the rearing of medfly larvae could usefully be recycled.

Agrochemicals and residues

228. Assistance to Member States continued through 73 research contracts and agreements and 13 technical co-operation projects,

229. Co-ordinated research programmes continued on pesticide residues in stored grains, food plants and rice-fish ecosystems, on controlled-release pesticide formulations, on the fate of persistent pesticides in the tropics, on improving rural methane production from biomass, end on assessing the impact of bound pesticide residues on non-target organiams.

230. Research continued at Seibersdorf on the development of analytical methods, the development of improved pesticide formulations and the quality control of radioisotope-labelled pesticides. Also, radiotracer studies

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[15] FAO/IAEA/Government of Nigeria Project for the Biological Control of Tsetse Flies by the Sterile-Insect Technique.

continued at Seibersdorf in connection with an Italian-supported project, in Kenya, on developing methods for the determination of trypanocidal drug residues in cattle, [16]

231. An international symposium on "Changing perspectives in agrochemicals: isotopic techniques for the study of food and environmental implications" was held at Neuherberg, Federal Republic of Germany, It was attended by 70 participants from 40 countries, most of them from developing countries.

232. An interregional training course on the use of nuclear and associated techniques in pesticide research, held in Texas, USA, was attended by 21 scientists from developing countries.

Food preservation

233. Assistance to Member States continued through 48 research contracts and agreements and 25 technical co-operation projects.

234, Activities of the International Consultative Group on Food Irradiation continued to gain momentum in the areas of acceptance, process control and public information, Guidelines for major application: of food irradiation and a curriculum for food irradiation process control courses aimed at training irradiation facility operators and food control officials were prepared for circulation to national authorities for comment, A workshop on food irradiation was held for food control officials and one on the use of food irradiation as a quarantine treatment was held for Latin American and Caribbean countries. A video film to inform the general public about the safety and efficacy of food irradiation waa made.

235. Within the framework of the second phase of the Asian Regional Co-operative Project on E'ood Irradiation (see paragraph 254 of GC(XXXI)/800), commercial-scale multipurpose irradiators for servicing food and non-food industries were built in the Republic of Korea and Pakistan; also, the construction of demonstration irradiators started in Bangladesh, the Philippines and Thailand,

236. At the end of 1987, the number of countries in which one or more irradiated food items had been approved for human consumption was 33; the number of demonstration/commercial irradiators available for treating food was 30, in 20 countries. During 1987, Canada, China, Cuba and France installed at least one such facility, and others were under construction in China, France and USA.

237. Within the framework of ARCAL, a regional training course on food irradiation was organized in Buenoo Aires, Argentina. Economic feasibility assessments were carried out in Brazil, Colombia and Ecuador. A co-ordinated research programme for a number of countries in Europe and the Middle East was establishad with emphasis on the harmonization of legislation and the transfer of technology to the food industry.

238. A consultants' meeting on the use of irradiation in combination with other processes was convened to evaluate the possible role of irradiation in reducing dependence on chemicals and refrigeration in developing countries,

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[16] See pare. 329 below.

Medical applications

239, Within the framework of ARCAL, an EEC-supported programme was set up to promote the use of bulk reagents for radioimmunoassays. Under a similar programme being conducted within the framework of RCA, bulk reagents were supplied to ten countries; at the same time, some participating countries developed the capability of producting such reagents themselves. A regional train-the-trainers course on "Data processing in radioimmunoasoay" was held in Jakarta, Indonesia,

240. Research co-ordination meetings were held to review progretata in the following co-ordinated research programmes: (i) Use of irradiat ion and radioisotopic techniques for the development of defined waccines for schistosomiasis, (ii) Development of nuclear and related techniques for monitoring malaria vectors, (iii) Evaluation of nuclear medicine imaging procedures for diagnosis in liver disease and (iv) Quality control procedures for nuclear medicine instruments.

241. National workrhope were held on "Quality control of nuclear medicine instruments" in Colombia, Pakistan and Thailand'

242, A workshop related to the co-ordinated research programme on "Radioaerorol inhalation imaging for the diagnosis of respiratory diseases in developing countries" was held in Bombay, India,

243, An interregional training course on nuclear medicine held in Moscow was followed by a study tour of nuclear medicine centres in the Soviet Union.

244. A regional seminar on the use of nuclear techniques in dealing with parasitic infections was held in Nairobi, Kenya'

245. Technical advice and assistance in the field of nuclear medicine were provided within the framework of 110 technical co-operation projects,

Radiation biology and radiotherapy

246. A protocol of technical procedures for use in the sterility quality control of radiation-eterilieed biological tissue grafts for clinical use in Asia and the 'acific region was formulated under a co-ordinated research programme'

247, The latest version of the Agency's code of practice for the radiation sterilization of disposable medical supplies was prepared for publication,

248. At a research co-ordination meeting on the radiation sterilization of medical supplies held in Zambia, the progress achieved in Africa and the Middle East wata reviewed.

249. The results of two co-ordinated research programmes dealing with the improvement of cancer therapy by combining irradiation with chemical treatment and hyperthermia were reviewed at meetings held in India and Turkey,

250. The proceedings of the symposium on 'Radiotherapy in developing countries" were published.

251, A training course on brachytherapy of cancer of the cervix uteri using manual afterloading was held in Egypt, where an Agency/WHO technical co-operation project with particular emphasis on the early diagnosis and early brachytherapy of cervical cancer continued,

252. The use of nuclear techniquer in the fermentation of cassava was promoted through a co-ordinated research programme in which 12 Member States participated,

253, An interregional training course on applications of radiation-aided cytogenetic techniquer in the ● tudy of biomedical, environmental health and radiation protection problems was held in Japan and attended by participanta from 20 Member States,

254. Technical advice was provided in connection with 15 technical co-operation projects.

Radiation dosimetry

255, The scientific committee of the network of Secondary Standard Dorimetry Laboratories (SSDLs) recommended that the Agency's programme for improving thr coherence and accuracy of SSDL reference instrumentation (the CARE programme) be extended to include radiation protection dorimetry standards at SSDLs.

256, At an IAEA/WHO symposium on dosimetry in radiotherapy, held in Vienna and attended by participants from 33 Member Stater, it was concluded that the methods for determining absorbed doae had been significantly improved in recent years, but that at many hospitals the goal of delivering the tumour dose within an uncertainty range of ± 5% still could not be attained,

257, A workshop-seminar on calibration proceduree in SSDLs was held in Kuala Lumpur, Malaysia, and an RCA workshop on photon, electron and neutron dosimetry in radiotherapy was held in Seoul, Republic of Korea,

258. An international code of practice entitled "Absorbed dose determination in photon and electron beams" was published in the Agency's Technical Reports Series.

259, The number of radiotherapy hospitals participating in the cobalt-60 postal dose intercomparison service being conducted by the Agency and WHO rose to about 140,

260, A co-ordinated research programme on electron high-dose intercomparison for industrial radiation processing was completed, and one on the testing of the code of practice for absorbed doee determination in photon and electron beams (see paragraph 258 above) was initiated.

261. The development of a transportable reference-class ionization chamber doeimeter for use in radiation therapy was completed and its performance tested, and work on developing a transportable reference-class doeimeter for use in radiation protection was initiated,

262. Routine calibration services were provided by the Doeimetry Laboratory at Seiberedorf for Member States on request, and a training course on SSDL activities was held within the framework of an introductory course on radiation protection serv ices.

263, During the second year of operation of the international high-dose assurance service (IDAS - see paragraph 266 of GC(XXXI)/800), 72 dose checks were performed for 27 high-dose irradiation facilities used for food irradiation in 18 Member States,

264, The preparatory testing was initiated of reference dosimetry systems developed for an international dose assurance service for electron irradiation facilities,

265. Assistance to Member States continued through 27 research contracts and agreements and 25 technical co-operation projects,

Nutritional and health-related environmental studies

266, Research co-ordination meetings were held to review progress in a co-ordinated research programme on dietary intakes of nutritionally important trace elements as measured by nuclear and other techniques and in one on the significance of hair mineral analysis as a means of assessing internal body burdens of environmental pollutants,

267, A co-ordinated research programme (with 14 participants) on the use of nuclear-related techniques in the study of environmental pollution associated with solid waster was initiated,

268. A technical report on applications of short-lived activation products in the neutron activation analysis of bio-environmental specimens and a training manual on the use of nuclear techniques in health-related environmental research and monitoring were published. Also, publications dealing with analytical quality control and applications of nuclear techniques in human nutrition research were issued. Several newsletters and bibliographies were issued for participants in co-ordinated research programmes.

269, Various intercomparison materials (containing two stable isotopes deuterium, carbon-13, nitrogen-15 and oxygen-18) were prepared for use in human nutrition research (these materials are now available under the Agency's analytical quality control programme). A review article on this subject was published in the "International Atomic Energy Agency Bulletin",

270. Assistance to Member States continued through 58 research contracts and agreements and three technical co-operation projects.

Nuclear physics

271. The Agency continued to assist in introducing nuclear science programmes into the curricula of universities in a number of developing Member States, through the provision of advice on the organization of training/research laboratories and through the supply of equipment for laboratory demonstrations.

272. Training courses were organized entitled on nuclear instrumentation, on interfacing between small computers and nuclear experiments, and on X-ray fluorescence (XRF) spectroscopy, Software packages for XRF spectroscopy were developed for coat-free distribution to interested laboratories.

273. Within the framework of ARCAL, seminars, workshops and technical meetings on nuclear instrumentation were held and a spare parts project for Latin America was launched.

274, A technical document entitled "Troubleshooting in nuclear instruments" wan published.

Research reactor support programme

275, In the area of research reactor utilization, a symposium on the utilization of multi-purpose research reactors and on related international co-operation was held in Grenoble, France, Many examples or' international co-operation in solving scientific problems were presented at the symposium, which has subsequently led to a greater involvement of a number of developing countries in such co-operation.

276, A report was prapared on techniques used and practices followed in the neutron doping of silicon, the aim being to assist research reactor operators in developing the capability of producing doped silicon, which can be an important source of income'

277. A research co-ordination meeting on ways of improving radioisotope production in research reactors was held in Madrid.

278, Activities relating to the conversion of research reactors in order that they may use low-enriched uranium (LEU) fuels included: completion of a report on the standardization of plate-type LEU fuel specifications and inspection procedures; a training course on reactor calculations with small computere; and a co-ordinated research programme (within the framework of ARCAL) on the analysis of research reactor cores with a view to their conversion to LEU fuels.

279. Other research-reactor-related activities included: an RCA training course on the operation and meintnnance of research reactors; the preparation of a report on the upgrading of instrumentation and control systems for research reactors ; and updating of the publication "Nuclear research reactors in the world".

Fusion

280. The INTOR Workshop completed its work on the critical aepecta of a next-step tckamak reactor[17], helping to lay the scientific and technological foundation *for* the start of a conceptual design of an International Thermonuclear Experimental Reactor (ITER) - an international project which has just been initiated undrr the auspices of the Agency.

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

282. The Agency continued to assist developing Member States engaged in fusion and plaomo physics programmes with information exchange and the co-ordination of activities between them,

Industrial applications and chemistry

283, As part of the Agency's efforts to promote the transfer of nuclear techniquea employed in industry, rupport waa provided for 133 technical co-operation project0 in 47 countries,

284. The last research co-ordination meeting on the radiation fmmobilization of bioactive materials was held in Beijing, China, and preparation of the report on the co-ordinated research project in question started.

285. Work continued on the preparation of a manual on radiation technology in biomedical applications.

286. The first research co-ordination meeting under a co-ordineted research programme on the radiation degradation of organic materiels in radiation environments was held in Rome,

287, A technical document on the radiation processing of flue gases was published (IAEA-TECDOC-428) and an advisory group was convened to review the Agency's activities in this field,

288, An advisory group meeting on radiation technology in academic curricula and in Agency training programmes was held at College Park, Maryland, USA.

289. Three regional training courses and five national seminars on various topics relating to radiation processing were supported.

290. A technical document containing guidelines for training in non-destructive testing was published (IAEA-TECDOC-407).

291. Support was provided for RCA training courses in the following fields: radiography, ultrasonics, surface methods, radiation sterilization, sterility assurance, compatibility of materials, radiation engineering and electron beam facilities. Support was also provided for an interregional training course on

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[17] See para. 287 of GC(XXXI)/800.

non-destructive testing (NDT) held in Kenya and for two RCA workehopo - one on the qualification and certification of NDT personnel and the other on special NDT applications,

292. An advisory group assessed the application of isotopic tracers in the optimisation of industrial processes, and the preparation of a guidebook on isotope tracers in industry was finalized.

293, Support was provided for a regional training course on nucleonic control systems in the paper industry and for executive management seminars on nucleonic control systems in the steel industry and the coal industry,

294. The preparation of a technical report on practical aepecta of operating a neutron activation analysis laboratory was initiated, the aim being to assist with the utilization of neutron activation analysis in both science and technology,

295. A group of consultants which considered the role of nuclear analytical techniques and the need *for* analytical quality control in the electronics industry concluded that activation analysis techniques are uoeful in the routine analysis of bulk impurities and in calibrating non-nuclear depth profiling instruments,

296. An advisory group reviewed the use of nuclear analytical techniques for on-line elemental analysis in industry, and a group of coneultantr reviewed current trends in the use of nuclear logging techniques for elemental inalysis in borehole logging,

297. New developments in borehole logging instrumentation and in the determination of basic rock characteristics by means of borehole logging were considered at a research co-ordination meeting,

298. Recent advances in the development of alternative techniques for $^{99}Tc^{m}$ generation using low-power research reactors were reviewed at a research co-ordination meeting,

299. The results of a multi-country trial of the performance of low-temperature $^{99}Tc^{m}$ generators indicated that improvements were necessary before such devices could be fully endorsed for routine use in hospitals,

300. Techniques for the reactor production of fission ^{99}Mo for medical use (including their economic implications) were discussed at a technical committee meeting, It was concluded that, because of the high level of technology and the high capital investment and operational costs involved, developing countries wishing to produce ^{99}Mo by the fission route should carefully assess the economic and technical feasibility of such an enterprise before entering into commitments.

301. At a consultants' meeting, the present status of and future trends in nuclear chemistry and radiochemistry teaching and training were discussed and the need for qualified manpower assessed. It was concluded that a serious shortage of well qualified scientists is likely to occur in the near future as a consequence of the fact that fewer universities are offering courses in nuclear chemistry and radiochemistry.

Isotope hydrology

302, During 1987 the Agency supported 61 technical co-operation projects in 48 countries, assistance being provided with - inter alia - the evaluation of water resources, geothermal resources exploration, the strengthening of analytical capabilities, the establishment of environmental isotopic laboratories and the study of specific hydrological problems, In addition, support was provided in connection with the study of sediment transport problems,

303. Advisory or pre-project missions were undertaken in Argentina, Chile, Cuba, Haiti, Morocco, Nicaragua, Pakistan, Thailand and Turkey to review ongoing national programmes and to assist in determining future needs and outlining furture programme activities.

304. Through 53 research contracts and research agreements involving 33 countries, the Agency continued to support isotope--aided hydrological investigations and the development and improvement of isotope hydrology tachniquea, Of these 53 contracts and agreements, 29 formed part of three co-ordinated research programmes concerned with groundwater in Latin America, geothermal resources exploration in Latin America and the dating of old groundwater. The first of these co-ordinated research programmes was completed,

305. An IAEA/UNESCO symposium on the use of isotope techniques in water resources development held in Vienna was attended by 162 participants from 45 countries. The proceedings were published.

306, An IAEA/UNESCO seminar on the application of isotope techniques in hydrology in Latin America held in Mexico City was attended by 70 participants from 19 countries; it was organized with the co-operation of the Gesellachaft für Strahlen- und Umweltforschung, Nsuherberg, Federal Republic of Germany. The last research co-ordination meeting under a co-ordinated research programme on the same subject was held in Mexico.

307. A seminar for management executives on the use of isotope techniques in water resources development and management and a workshop on isotope hydrology were held in China. These meetings, which were the final ones under an RCA programme on hydrology and sedimentology, were attended by 56 participants from ten countries.

308. As part of the activities of a UNESCO-IHP (International Hydrological Programme) working group on nuclear techniques in hydrology, for which the Agency is providing the scientific secretariat, an editorial group financed by UNESCO examined draft reports on the use of isotopes in investigations relating to the hydrology of arid zones, to sediment transport and to groundwater.

309. The proceedings of an advisory group meeting on studies on sulphur isotope variations in nature were published,

310. Lectures were delivered by Agency staff members at post-graduate training courses in Graz, Austria, and Budapest, Hungary. Group training in isotope hydrology orgenized in Vienna was attended by 14 participants from 11 countries.

311. Courses on the use of isotope techniques in hydrology were hold in Ecuador, Peru and Bolivia, with the par :icipation of 74 hydrologists, A workshop on isotope hydrology held in Jordan was attended by 25 hydrologists,

312, An IAEA/UNESCO symposium on the use of isotope techniques in water resources devobopment was held in Vienna and the proceedings published, Also, Agency representatives participated in the following meetings: a national seminar on tha use of environmental and artificial isotopes in hydrology held in Malaysia; a UNESCO/WMO conference on hydrology and the scientific basis of water resources management held in Geneva; an advanced research workshop on estimating the national recharge of groundwater held in Turkey; and a national seminar on isotope and nuclear techniques in hydrology held in Turkey.

Nuclear data

313. The Agency continued to provide nuclear and atomic data services to Member Staten and to co-ordinate the activities of a worldwide network of data centres. During 1987 the Agency fulfilled more than 700 requests from 40 Member States for experimental and evaluated data, data processing computer codes and publications, The Agency continued to publish the Bulletin on Atomic and Molecular Data for Fusion on a semi-annual basis and the Computer Index of Neutron Data (CINDA). Also, the Agency published an updated index to the literature on atomic collision data relevant to fusion and a "Handbook on Nuclear Activation Data",

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 improved neutron data relating to the safety of fission reactor operations and to fusion reactor design. Also, apecialiats met to formulate the specific requirements for nuclear data to be used in fusion reactor calculations and for atomic data to be used in plasma edge studies.

315. In order to stimulate work on necessary new nuclear data and to improve the accuracy of existing data, the Agency convened a research co-ordination meeting on nuclear data needed for nuclear particle therapy and one on standard gamma-ray data needed for the calibration of gamma-ray detectors. A group of consultants reviewed the requirements for nuclear data to be used in the production of radioisotopes used in medicine.

316. A group of specialists laid the foundation for a meeting, to be held in 1988, on the influence of target and sample properties on nuclear data measurements. Another group reviewed the status of and requirements for atomic data in radiation research and biomedical applications.

317. A training course on neutron physics and nuclear data measurements with accelerators and research reactors was held in the Soviet Union. As part of its support for training in the performance of accurate measurements for nuclear applications, the Agency started an interregional project on nuclear measurement techniques. At Headquarters, two fellows received training in various aspects of bibliographic and numerical data processing.

Seibersdorf Laboratories

I. AGRICULTURE LABORATORY

Activities in support of the joint **FAO/IAEA** agricultural programme

Soil fertility, irrigation and crop production

318. **Cultivar** differences as regards **fertilizer** and water use and tolerance to deleterious soil conditions (acidity, salinity, etc.) were investigated using isotope techniques. Isotope-aided experiments relating to the nutritional requirements of and nitrogen fixation in Azolla species were carried out. Work continued on improving nitrogen fixation in grain and forage legumes with the help of nuclear and related techniques. Research aimed at maximizing the benefits of nitrogen fixation in tree species started. Soil water measurement studies using both nuclear and non-nuclear methods continued, the aim being to optimize soil water management practices.

319. Services to co-ordinated research programmes and technical co-operation projects continued through analytical assays of about 15 000 samples in connection with the determination of nitrogen-15 and other isotopes and with the dispatch of nitrogen-15 labelled fertilizers to research contract holders. Development work aimed at the improvement of routine nitrogen-15 analyses continued.

320. Support was provided to nine technical co-operation projects, and staff members carried out a number of pre-project and other missions to Member States.

Plant breeding and genetics

321. Radiation-induced genetic variability and somaclonal variation in tissue culture were studied in maize for the purpose of assessing their nature and their possible contribution to plant breeding. Mutation breeding technology was investigated for nine different cultivars of banana and plantain. Considerable phenotypical variation was observed among in vitro regenerated banana plants after mutagenic irradiation. The clonal offspring of a mutant plant was prepared for field testing under tropical conditions. Somatic embryogenesis and plant regeneration were induced in cell suspensions, whereby new possibilities for exploring somatic cell mutation in banana and plantain breeding were opened up. Induced mutagenesis was applied to the Azolla-Anabaena symbiotic system, and variants tolerant to high salinity and toxic levels of aluminium were selected.

322. About 800 seed samples and several tissue cultures were irradiated as a service to plant breeding institutes in Member States.

Animal production and health

323. In order to support scientists in developing countries with disease diagnosis and to complement existing facilities for animal nutrition and reproduction studies, a laboratory was established for the further development of techniques such as ELISA and of radioactively labelled DNA probes.

324. 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.

325. Sufficient ELISA plates for assessing 600 000 samples for the diagnosis and the epidemiological study of several viral, bacterial and parasitic infections and over 2 500 radioimmunoassay kits (equivalent to 250 000 assay units) were supplied to technical co-operation and research contract counterparts.

Insect and vest control

326. Tsetse fly pupae and freeze-dried blood for diets continued to be produced for the BICOT project in Nigeria. Colonies of various tsetse fly species were maintained for research and training and supplied, on request, to other laboratories. Research on the dietetics of tsetse flies continued.

327. Studies aimed at increased effectiveness and efficiency in the mass-rearing of medflies continued. A medfly strain in which sexing at the pupal stage is possible was developed and studied under mass-rearing conditions. An agent produced by the bacterium Bacillus thuringiensis which is pathogenic for adult medflies was identified.

Agrochemicals and residues

328. Analyses were carried out of samples of controlled-release formulations of carbofuran applied in rice paddies in Hungary.

329. Analyses were carried out also of trypanocidal drug residues in tissue and faeces samples from cattle experiments performed at the Kenya Trypanosomiasis Research Institute (KETRI) in connection with an Agency technical co-operation project.1181

II. PHYSICS-CHEMISTRY-INSTRUMENTATION (PCI) LABORATORY

Activities in support of the Life Sciences programme

Environment and nutrition

330. A group of consultants on the monitoring of fallout radioactivity in the environment and in food recommended the preparation of a guidebook for radioactivity measurements and that a co-ordinated research programme be established on rapid methods of radionuclide analysis. A draft of the guidebook was prepared for publicaton in 1988.

331. As part of efforts to strengthen the Agency's low-level radioanalytical capabilities, a laboratory was adapted for work with actinides and equipment was obtained for alpha spectrometry. Selected radiochemical procedures for actinide analysis were evaluated in the laboratory.

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[18] See para. 230 above.

332, A radiochemical method of ^{90}Sr determination was developed and then used in analysing samples of milk, whey powder and grass.

333. Eighty samples of food and biological materials were analysed for six Member States and FAO. Advice and assistance were provided to three Member States wishing to establish or improve capabilities for the analysis of radioactivity in food.

334. With the co-operation of the Division of Life Sciences, support was provided to two co-ordinated research programmes. On request by sect ions within the Secretariat and by Member States, about 3500 determinations were performed of various trace elements in 600 samples using analytical methods such as neutron activation analysis, the inductively coupled plasma technique, atomic absorption spectrometry, fluorimetry, liquid scintillation counting and photometry.

335, The analytical capabilities of the laboratory were enhanced through the introduction of a new, hydride system for the determination of arsenic, mercury, selenium and tin (elements which play an essential role in nutrition and in environmental chemistry). Also, improvements were made with regard to the determination of mercury, selenium and lead in diets and organic materials. Three trainees received a total of 20 man-months of training in the use of various analytical methods.

336, Co-operation continued with WMO in the analysis of precipitation and air-filter samples in support of WMO's background air pollution monitoring network; 1600 determinations of trace elements and radionuclides were performed, the results being reported to WMO, to the countries where sampling had taken place and to the US Environmental Protection Agency for evaluation.

337. Grass samples from 20 locations in European and Mediterranean countries were collected, processed and sent to laboratories in six Member States for the analysis of fallout radioactivity; the results were incorporated into a preliminary report and presented at a consultants* meeting, In addition, samples of grass, mat and soil were received, processed and distributed within the framework of a project entitled the "Grass Ecosystem Project".

Radiation dosimetry

338. The Agency's Secondary Standard Dosimetry Laboratory (SSDL) continued to provide postal dose intercomparison services for radiotherapy hospitals in co-operation with WHO, Four batches of thermoluminescence dosimeters (TLDs) were evaluated for a total of 150 hospitals. One batch of TLDs was dispatched to all SSDLs belonging to the IAEA/WHO network of SSDLs as part of a twice-yearly dose intercomparison exercise. Calibration and test studies of TLD chips were completed, and the results were made available for a radiotherapy quality assurance programme involving the use of semi-anatomical phantoms.

339. Calibrations and irradiations were performed continuously for the Agency's radiation protection services and, on request, for Member States.

340. A two-week calibration workshop was held at the Agency's SSDL as part of the Agency's Introductory Course on Radiation Protection Services; seven fellows from six countries participated,

341. Teat studies and calibrations were completed for a set of ionisation chamber dosimeters, providing base-line data for the CARE programme (see paragraph 255 above),

Activities in support of the Physical and Chemical Sciences programme

Chemistry and analytical quality control

342. Three intercomparisons were completed, while four intercomparisons were still running at the end of the year; laboratories in 34 countries took part in one or more of these intercomparisone. Three reference materials with recommended values for a variety of elements and radionuclides were added to the list of such materials available from the Agency, while stocks of four reference materials ran out; the list now contains 46 items. The Laboratory dispatched such materials in response to 748 orders from Member States. For the homogeneity testing and characterization of intercomparison samples, 708 trace element and 68 radionuclide determinations were performed. Samples of 20 biological and environmental materials, collected mainly after the Chernobyl accident, were processed; samples of eight such materials were in stock at the end of the year.

343. The catalogue of the Analytica! Quality Control Services (AQCS) programme was redesigned so as to contain more detailed information on the properties of the reference materials available (matrices, analytes, concentrations, confidence intervals).

Hydrology

344. In support of technical co-operation projects and research contracts and in order to obtain data for the global precipitation monitoring network, approximately 2100 water samples were analysed for oxygen-18, 1000 for tritium, 1400 for deuterium, 90 for carbon-14 and 140 for carbon-13. In addition, chemical analyses were performed on 134 water samples,

Soil water research

345. The analysis was completed of data from field and laboratory experiments carried out in' support of a co-ordinated research programme for comparing nuclear and non-nuclear methods in soil water studies.

346. The creation of a data base for use in selecting commercially available neutron moisture and gamma density probes was completed.

347. Three fellows received training for a total of 6 man-months in soil water studies; neutron moisture gauge maintenance training was provided at the same time.

Instrumentation

348. A soil sample density measurement system with dual X-ray sources for soil water studies was designed and constructed. A radiocarbon control unit was developed and sent to a Member State for initial greenhouse trials. A microprocessor tester was built and used in training.

349. About 40 nuclear measuring instruments of different types received from Member States and from various Agency laboratories were repaired and serviced.

350. A computer network for data acquisition, transfer and processing at research laboratories was installed and tested.

351. Group fellowship training in nuclear spectroscopy instrument maintenance for senior service technicians and engineers in developing countries was initiated; four fellows participated in such training in 1987.

352. Four fellows received a total of 36 man-months of on-the-job training in nuclear electronics and the servicing of nuclear instrumentation.

353. Support was provided for several technical co-operation projects, with staff members carrying out missions to Cameroon, Niger, Portugal and Uruguay.

III. SAFEGUARDS ANALYTICAL LABORATORY (SAL)

Activities in support of the Safeguards programme

354. SAL received 603 samples of uranium (648 in 1986), 265 samples of plutonium or mixtures of uranium and plutonium (207 in 1986) and 306 samples of spent fuel solutions (225 in 1986); 375 spent fuel solution samples were analysed, 189 of them at laboratories belonging to the Agency's network of analytical laboratories (NWAL). Twenty-six samples of heavy water were analysed by a laboratory belonging to the network.

355. Compared to 1986, there was on average a decrease of 8% in the total time needed to conclude verifications by the destructive analysis of spent fuel solution samples. The time was reduced by 10% for plutonium product samples and 23% for uranium samples.

356. SAL and NWAL analysed 23 uranium oxide and 24 plutonium or mixed plutonium-uranium oxide samples for the characterisation of non-destructive essay working standards. SAL performed, in addition, about 650 measurements in the course of testing or improving its procedures.

357. Methods for measuring fission and activation product radionuclides were considerably improved through Upgrading of the Laboratory's low-level gamma spectometry system. To facilitate the improvement of international data comparisons, a reference method for the radiochemical separation and measurement of transuranium elements in environmental and food samples was developed.

350. Samples of materials of marine origin were prepared for national laboratories in Hember States for use in ongoing quality control exercises. An Atlantic sediment was distributed to 60 institutions in 30 countries for tranruranic and f ission product radionuclide intercalibration purporee. Sampler of Hediterranean macroalgae, a Hediterranean seaplant and a Baltic sediment contaminated with Chernobyl fallout were prepared and tested for future distribution as reference materials.

359. Benthic organisms were exposed in the Laboratory to marine sediments which had been contaminated in the environment with Chernobyl fallout and watate from a nuclear power plant. Very little of the radioactivity in the contaminated sediments was taken up by the organisms, indicating a very low bioavailability of sediment-bound radionuclides.

360, In order to assess the extent to which marine organisms transport radionuclides in the Pacific Ocean and the Mediterranean Sea, natural and artificial radionuclidee were measured in sinking particulate matter collected by deploying sediment traps at different depths. In the Mediterranean, it was found that the excreta from plankton were instrumental in transporting Chernobyl fallout in surface waters to a depth of 200 m within a week - representing a rate of tranrport hitherto not thought possible.

361. Data on $^{210}Po/^{210}Pb$, $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios in a variety of midwater open-ocean organisms were used in making predictions about animal feeding habits and the food chain transfer of radionuclidee of interest. Both the radioactive and stable isotope tracers were useful in identifying different food regimes and food sources for animals occupying the same habitat.

362. Staff members of the Marine Environmental Studies Laboratory (MESL - see paragraph 367 of GC(XXXI)/800) were involved in missions to 20 Hember States in the Hediterranean region, the Gulf region, West and Central Africa, Southern Asia and South America.

363. The Laboratory also provided assistance to Member States through a programme for improving the quality of monitoring data on pollutants and potential pollutants such as pesticides, chlorinated and petroleum hydrocarbons, trace metals and organometallic compounds. The programme included the development and testing of guidelines and reference methods, the production of reference materials through intercalibration exercises, the training of marine chemists and the installation and servicing of analytical instruments.

364. The Laboratory conducted pilot and emergency surveys of specific marine pollutante in Hember States and conducted work on the transport, fate and effects of some of the pollutants in question. In this context, staff members participated in oceanographic cruises in the South Atlantic/Antarctic Oceans and in the Hediterranean,

365. The main fields of research and training-for-research at the Centre in 1987 were:

(a) Fundamental physics (high-energy and particle physics, cosmology and astrophysics);

(b) Condensed-matter physics (atomic and molecular physics, materials science, and surfaces and interfaces);

(c) Mathematics (geometry, topology, differential equations, mathematical physics);

(d) Physics and energy (nuclear physics and fission, plasma plysics and nuclear fusion, non-conventional energies);

(e) Physics and the environment (soil physics, climatology and meteorology, physics of the atmosphere, the magnetosphere, aeronomy);

(f) Applied physics (applicable mathematics, microprocessors, communications, instrumentation); and

(g) Physics and development.

366. Some 3700 scientists took part in the activities of the Centre, in three major projects outside Trieste and in the Programme for Training at Italian Laboratories, staying for a total of almost 3900 man-months. About 58% of them were from developing countries, accounting for 83% of the total man-months. One hundred and forty-nine of them were associated members from 45 developing countries and 576 of them were researchers from federated institutes in 56 developing countries.

Fundamental physics

367. Research in high-energy physics was carried out throughout the year, with the participation of 120 physicists from developing countries out of a total of 201. A two-week school and workshop on superstrings held in April was attended by 75 physicists from developing countries out of a total of 258. The now traditional Summer Workshop in High-Energy Physics (including, this time, a topical conference on scalar fundamental particles) was held in June-August, with an audience of 125 physicists from developing countries out of a total of 206; it was preceded by a meeting on new scale effects in low-energy precision experiments.

Condensed matter physics

368. Research was conducted throughout the year with the participation of 75 scientists from developing countries out of a total of 102. Three high-level training courses (the Winter College of Atomic and Molecular Physics, the Spring College of Metallic Materials and the School on Polymer Physics) were attended by 228 scientists from developing countries out of a total of 299.

369. The annual Research Workshop in Condensed Matter and Atomic and Molecular Physics, which was held from the end of June to the beginning of September, waa attended by 190 physicists from developing countries out of a total of 227. During the workshop, seven "Adriatico Research Conferences" were held, They dealt with: one-dimenaional organic conductors, vacuums in non-relativistic matter-radiation systems, scanning tunnelling in microscopy, interatomic forces in relation to defects and disorder in condensed matter, high-temperature superconductors, path integrals, and synchrotron radiation and free electron lasers. These meetings were attended by 133 scientists from developing countries out of a total of 503.

370. Other activities included: the Third International Workshop on Total Energy and Force Methods, a workshop on surface science and catalysis, a working party on the physics of porous media, and a workshop on non--linear charge density wave systems. They brought together 239 physicists, out of whom 99 were from develcping countries.

Mathematics

371. Research in mathematics, carried out throughout the year, brought together 36 mathematicians from developing countries out of a total of 47, The scientific meetings organized by the Mathematics Group included a topical meeting on fibre bundles and the College on Riemann Surfaces, attended by 88 scientists from developing countries out of a total of 141.

Physics and energy

372, The Third Workshop on Perspectives in Nuclear Physics at Intermediate Energies, organized by the Centre in collaboration with the Italian National Institute of Nuclear Physics (INFN, Rome), was attended by 22 scientists from developing countries out of a total of 115. The Spring College on Plasma Physics, which included an international conference on cometary plasma physics followed by a workshop on the same subjec t , was attended by 99 physicists from developing countries out of a total of 153. At the end of August and in September, the following activities took place: a Workshop on Material Science and the Physics of Non-conventional Energy Sources, co-sponsored by the Italian Department for Co-operation in Development and the Italian National Research Counci1; a Workshop on the Economics, Modelling and Management of Energy, co-sponsored by the Kuwait Foundation for the Advancement of Science; and a Workshop on the Interaction between Physics and Architecture in Environment-Conscious Design. Two hundred and fifty-four scientists from developing countries took part in these activities out of a total of 329.

Physics and the environment

373, The Spring College on Ceomagnetism and Aeronomy, the Third College on Soil Physics and the Second Workshop on Cloud Physics and Climate were attended by 226 scientists from developing countries out of a total of 286.

Applied physics

374. The Second Workshop on Mathematics in Industry and a Workshop on Remote Sensing and Resource Exploration were held in February-March. In June, the International Committee for Future Accelerators held a School cn Instrumentation in Elementary Particle Physics at the Centre, For the first time since its inception, the Centre organized a workshop on telematics, which

was followed by the Fourth College on Microprocessors - Technology and Applications in Physics. Five hundred and twenty-six scientists, of whom 351 came from developing countries, participated in these meetings.

Physics and development

375. As in the past, a number of the experts and leading scientists taking part in the activities at the Centre lectured on physics and its relevance to development. Forty-nine lectures were given in 1987.

Training at Italian laboratories

376. One hundred and four grants were awarded to scientists from developing countries for training et Italian academic and industrial laboratories under a programme which started in 1982 with the financial support of the Government of Italy.

External activities

377. A Workshop on Microcomputers in the Teaching of Physics and Mathematics was held in Sudan, a Workshop on the Fabrication of Low-cost Laboratory Equipment for Physics was held in Tanzania, and a workshop on the Applicability of Environmental Physics and Meteorology in Africa was held in Ethiopia. In the field of training for physics and mathematics teachers, the Centre sponsored 148 courses, workshops and symposia in 46 countries. In addition, the Centre sponsored five scholarships for scientists wishing to work at five research institutions in developing countries; this programme was financed by the Government of Italy.

Meetings hosted by the Centre

378. The Centre hosted a meeting of the Initiative Committee of the International Foundation for Survival and a Workshop on Scientific and Technological Applications of Synchrotron Radiation.

Books and equipment donation programme

379. In 1987, the Centre distributed 20 000 journals, 20 000 sets of proceedings and 10 000 books to more than 400 institutes in 97 developing countries.

380. Equipment from CERN (European Laboratory for Particle Physics1 was sent to several universities in various developing countries.

Awards

381. In 1987 Dirac Medals were awarded to Professors Bryce DeWitt of the University of Texas, USA, and Bruno Sumino of the University of California, USA, for their outstanding contributions to theoretical physics.

382. Professor Li Jia Ming from the Institute of Physics of the Chinese Academy of Sciences was awarded the 1986 Alfred Kastler Prize for his outstanding contribution in the field of atomic and molecular physics.

383. Dr. Abdullah Sadiq of Pakistan was awarded the 1987 Nikolaj N. Bogolubov Prize in recognition of his contributions to scientific knowledge in the field of solid-state physics.

Sofenuardo etatenent for 1987

384, In 1987, as in previous years, the Secretariat, in carrying out the oafeguarde 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 agreementa - for the manufacture of any nuc lear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown[19]. It is considered reasonable to conc lude that nuclear mate·ial under Agency safeguards in 1987 remained in peaceful nuclear activities or was otherwise adequately accounted for, This statement ohould be seen in the light of the following observations:

(a) Extensive safeguards activities in 1987 resulted in 2133 (2054 in 1986) inspections carried out at 631 (595) nuclear installations in 52 (53) non-nuclear-weapon States and four (four) nuclear-weapon States. In 44% (36%) of inspections nuclear material was verified by non-destructive assay (NDA). More than 320 (325) automatic photo and television surveillance systems operated in the field, and 12 500 (10 300) seals applied to nuc leer material were detached and subsequently verified at Headquarters. About 1340 (1030) plutonium and uranium samples were analysed, with some 3600 (2840) analytical results being reported, Accounting and other safeguards data comprising 1 146 000 (867 000) data entries were processed and etored in the Agency's computer;

(b) About 290 (270), mostly minor, discrepancies or anomalies were found, All cases were satisfactorily explained upon subsequent appraisal or investigation;

(c) The level of assurance associated with the Secretariat's findings 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 findings refer for each facility to the latest available State report, Agency inspection, analysis, etc. relating to that facility,

Safeguards coverage

385. As of 31 December 1987 there were 166 safeguards agreements in force with 97 States, compared to 164 agreements with 96 States at the end of 1986, a unilateral submission agreement with Chile having entered into force

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[19] 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,

in September and a safeguards agreement with Brunei Darussalam pureuant to the Treaty on the Non-Proliferation of Nuclear Weapone (NPT) having entered into force in November,

386. Subotantiol progress was made in the negotiation of a safeguards agreement pursuant to the voluntary offer by China to place some of its civilian nuclear facilities under Agency safeguards, the text of an agreement being agreed ad referendum.

387. In November, Spain acceded to NPT, bringing the total number of States party to the Treaty at the end of 1987 to 137[20], including three nuclear-weapon States. Steps have been initiated regarding the accession of Spain to the eafeguards agreement of 5 April 1973 between the non-nuclear-weapon States of the European Community, EURATOM and the Agency (INFCIRC/193).

388, As of 31 December 1987, 52 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 Colombia, Viet Nam and the Democratic People's Republic of Korea, none of these States has, as far as the Agency is awa: e significant nuclear activities.

389. Twenty-three Latin American States are party to the Treaty for the Prohibition of Nuclear Weapone in Latin America (Tlatelolco Treaty), Three other Latin American States have signed the Treaty, but have not yet ratified it or waived certain of its provisions. Under Article 13 of the Treaty, each State party has to conclude a safeguards agreement with the Agency for the application of eafeguards to that State's nuclear activities, Eighteen Lot in American States have concluded such agreements with the Agency, as hae one State with territories in the zone of application of the Tlatelolco Treaty,

390. Saf eguardta were being applied in 41 non-nuclear-weapon States under agreements ›ursuant to NPT or to NPT and the Tlatelolco Treaty, and in one non-nuclear-weapon State pursuant to the Tlatelolco Treaty,

391, The South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty) has been signed by eleven of the 13 members of the South Pacific Forum and ratified by nine of the signatories. Under Article 8.2(c) and Annex 2 of the Treaty, each Party accepts the application of safeguards by the Agency as set forth in an agreement, to be negotiated and concluded with the Agency, which shall be equivalent in its scope and effect to an agreement in connection with NPT based on document INFCIRC/153 (Corrected), NPT safeguards agreements have been concluded with ten of the eleven States signatories of the Rarotonga Treaty, and safeguards were applied in one of these States pursuant to an NPT agreement,

392. Thirty-one safeguards agreements baaed on INFCIRC/66/Rev.2 were in force with the following eight non-nuclear-weapon States not party to either NPT, the Tlatelolco Treaty or the Rarotonga Treaty: Argentina, Brazil, Chile,

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[20] The Agency wee informed in February 1988 by one of the NPT Depository Governments of the accession of Sao Tome and Principe on 20 July 1983 and the Republic of Guinea on 29 April 1985,

Cuba, India, Israel, Pakistan and South Africa, [21] Safeguards were applied in seven of the eight States pursuant to these agreements. Also, safeguards were applied pursuant to INFCIRC/66/Rev.2-type agreements in Spain, Viet Nam and tha Democratic People's Republic of Korea, all of which are party to NPT. [22]

393. In five of the eight 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.

394. All nuclear-weapon States have unsafeguarded nuclear fuel cycles, Voluntary-of Per agreements were in *force* with four of these States during 1987. In accordance with these agreements, certain facilitiee were designated by the Agency for inspection and were inspected. In addition, in one *of* these States safeguarda were applied to some facilities in accordance with INFCIRC/66/Rev. P-type agreements,

395. On 31 December 1987, there were 496 nuclear facilitiee under safeguards or containing safeguarded nuclear material in non-nuclear-weapon States *(485* in 1986); there were also 406 locations outside facilities containing small amounts of safeguarded material (414 in 1986) and two safeguarded non-nucleer installations (two in 1986). There were also nine facilities in nuclear-- weapon States under Agency safeguards pursuant either to voluntary-offer agreements or to safeguards transfer agreement8 (nine in 1986).

396. At the end of 1987, the nuclear material under Agency safeguards, including that covered by voluntary-offer agreements with nuclear-weapon States, amounted to 8.8 t of separated plutrnium outside reactor cores, 0.6 t of recycled plutonium in fuel elements in reactor cores (in 1986 the total amount for these two categories was 8.4 t) , 224.2 t (194.5 t in 1986) of plutonium contained in irradiated fuel, 12.2 t (13.2 t) of high-enriched uranium (HEU), 29 252 t (27 911 t) of low-enriched uranium (LEU) and 50 867 t (47 402 t) of source material, The greater part *of* this material was in those non-nuclear-weapon States where safeguards are being applied to all peaceful nuclear activities. Non-nuclear material under Agency aafeguards included 14.57 t (1470 t) of heavy water.

Safeguards implementation

397. The number of major facilities at which inspection goals were attained for the whole facility was 214 in 1987 (compared to 194 in 1986).

398. A total of 2133 inspections (compared to 2054 in 1986) were performed, representing 9556 man-days of inspection (compared to 8292 in 1986).

399. Inspection effort expended in 1987 amounted to 89.5% (86.2% in 1986) of the total planned actual routine inspection effort.

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[21] See also pares 37-41, which refer to resolutions concerning the application of safeguards in Israel and South Africa adopted by the United Nations General Assembly at its forty-second session and by the Agency's General Conference in September 1987,

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

400. The number of inspections where non-destructive array (UDA) measurements were performed was 952 (compared to 754 in 1986).

401. The average time between an inspection and the dispatch of the results to the State in which the inspection was performed was 83 days (85 dayo in 1986).

402. The technical provision8 of the facility attachment for a new, automated mixed--oxide (MOX) fuel fabrication plant were agreed. Safeguardo implementation will include the use of near-real-time accountancy,

403. The safeguards approach for a further major MOX fuel fabrication plant was modified in the light of experience, and work started on evaluating the modified approach.

404. Techniques involving the use of underwater cameras, telescopes and NDA equipment were developed for establishing the spent fuel inventory of a CANDU reactor without moving the stacks of stored fuel,

405. A new approach (including a sophisticated system of surveillance) for inspections at a critical assembly was tested with the co-operation of the State concerned.

406. The use of an independent system for checking the criticality of an otherwise inaccessible research reactor core was initiated.

407. The first trials of an automatic system for flow verification by means of on-line gamma measurements during the refuelling of a reactor were carried out successfully.

408. The use of advanced Cherenkov-glow night vision devices (CNVD) for the verification of spent fuel assemblies in light-water reactors (LWRs) waa introduced in some States,

409. Negotiations began on the revision of existing facility attachments covering two centrifuge enrichment plants, owing to the expansion of the plants in question.

410, Discussions on the implementation of safeguards at a semi-commercial uranium enrichment plant were suspended,

411. Design information verification of a small pilot uranium enrichment plant based on nozzle technology was completed.

412, The uae of an independent reactor power level monitor was introduced at a research reactor and successfully demonstrated at another research reactor and at a power reactor.

413, Following the implementation – at one plant in 1986 – of guidelines for safeguarding heavy water at nuclear power plants, steps were taken to implement them at similar facilities in other Status,

414, At a heavy water production plant subject to safeguards which is expected to commence operation in 1989, work continued on modifying the plant piping with a view to the installation of safeguards equipment.

415, Thr design review for a hot cell complex processing safeguarded fuel was completed and the facility attachment entered into force.

416. In one State, a simultaneous physical inventory verification covering unirradiated natural uranium at all facilities in the natural uranium fuel cycle was successfully carried out for the fifth consecutive year,

417. In one State, the feasibility of implementing recently developed safeguards conceptr and instrumentation at multi-unit nuclear power stations was evaluated and implementation initiated.

418, Safeguards implementation at a major LEU fuel fabrication plant was completed successfully in a nuclear-weapon State. In addition, a facility attachment was negotiated for another LEU fuel fabrication plant, with exceptionally large inventory and throughput coupled with complex and advanced production linen (safeguards to be initiated at the plant in 1988).

419. Discussions were initiated with another nuclear-weapon State on the application of safeguards at a font breeder reactor, for which the development of a proposed safeguards approach began.

420. The utilization of personal computers (PCs) in routine safeguards activities at a LEU fuel fabrication plant in a nuclear-weapon State provided positive preliminary indications for the wide utilization of PCs at other facilities.

421, Facilities and procedurea for developing and reviewing photo surveillance films were established in one State and at the IAEA Office in Toronto.

422. Transfers of spent fuel between primary and secondary storage were rucceetafully verified,

423. Work on the negotiation of facility attachment@ continued, with seven new facility attachments entering into force and 30 being renegotiated.

424. The IAEA Off ices in Tokyo and Toronto continued to make a signif icant contribution to effective and efficient safeguards implementation. More adequate office accommodation became available in Toronto, and the initial phase of an electronic communication link for the protected transmission of eafeguards confidential data to Headquarters was installed. Consultation8 continued on the conversion of the two offices into regional offices. Agreement was reached with Canada to extend the functions of the Toronto Office to cover othor Member States in the region.

425. The number of available inspector man-years (including inspection assistant man-years) rose from 175.9 to 179.7 (an increase of 2.2%), and there was an increase of 5.2% in the number of available man-years of designated inspectors (and inspection assistants) for carrying out inopectione at facilities.

Safeguards information treatment:

426. The nucleus of a departmental local area network for data processing devices was established with the installation of a Compact MicroVAX 2000 and the introduction of new software. A new front-end device provides the link between the network and the safeguards mainframe computer.

427. For international transfer reports received in 1987, the Agency was able during the year to match 83% (84% in 1986) of the notifications of shipments with notifications of receipts; 27% of the reports (28% in 1986) were totally processed by computer, while 73% (72% in 1986) required manual processing. For domestic transfers the corresponding figures were: 96% matched (97% in 1986), 85% (85% in 1986) processed by computer and 15% (15% in 1986) requiring manual processing.

428. With the help of a State's support programme, software was developed to assist in the manual matching of nuclear material shipment notifications,

429, The implementation of recommendations made by consultants for improving the ability of the Agency to confirm international transfers of nuclear material was facilitated by the distribution of facility codes to Member States. Efforts continued to resolve problems in this area by establishing regular bilateral consultations with a further Member State engaged in nuclear activities,

430, Intensive work was done on daveloping a more efficient computerised system for processing reports provided to the Agency pursuant to INFCIRC/66/Rev.2-type agreements, All data received by the end of 1987 were entered into the database, and computer programs for quality control of the data were implemented.

431. The computerized inspection report (CIR) system was revised in order to accommodate new reporting requirements. A main stratum authority file was established in support of inspection activities and safeguards evaluation, The implementation of a new central seals management system was completed.

432, The format of the eami-annual statement on the promptness of submission of State reports was modified so as to provide a more comprehensiv ; assessment of timeliness.

433. Support was provided to inspectors in the implementation of in-field information processing systems. A microcomputer system was implemented for the in-field comparison of facility record;: and State reports for a specific facility. Consultations were held with Member States on a modular approach to developing inspection field support systems involving the use of personal computers; prototypes of some components of these systems were developed.

434. A feasibility study for the further development of the IAEA Safeguards Information System (ISIS) was completed and a list of future requirements for safeguards information processing was prepared.

Safeguards development and technical support

435. Work continued on the development of enrichment monitoring systems for use in the inspection of cascade areas at centrifuge-type uranium enrichment plants. The testing of prototypes of such systems is in progress at the Safeguards Analytical Laboratory (SAL). Implementation of a monitoring system at one enrichment plant is planned for 1938.

436. The introduction of a new generation of NDA equipment continued; microprocessors were introduced to facilitate the setting up of equipment and the measurement of nuclear material, including data evaluation. Sophist icated

data evaluation requirements were met by employing more powerful portable computers,

437. Fifteen material-specific NDA measurement procedures for inspection use were drafted, and work started on reviewing five of the drafts.

438. Efforts continued to develop dedicated closed-circuit television (CCTV) systems and components with the aim of replacing obsolete photographic equipment.

439, Work started on developing means of authenticating surveillance and materials accountancy measurement systems installed by facility operators.

440. The feasibility of a modified system for detecting the discharge of spent fuel bundles from a CANDU reactor was experimentally demonstrated, and development work started on the design of an engineered system for continuous core discharge monitoring at CANDU reactors,

441, The feasibility of verifying light-water reactor and on-load refuelled reactor spent fuel assemblies in situ by NDA techniques was demonstrated at a small number of facilities,

442. Special attention was paid to the development and improvement of new safeguards approaches for:

Facilities where optical surveillance alone provides inconclusive results;

Facilities where the approaches currently being used do not provide for the full attainment of the inspection goals;

Other types of facilities, such as fast breeder reactors (FBRs), highly automated fuel fabrication facilities (where sample taking for analysis may be difficult) and long-term spent fuel storage facilities (where access for the verification of irradiated fuel will be difficult).

443. Safeguards approaches for specific long-term underwater storage facilities were developed, and work started on a safeguards approach for nuclear material in waste and spent fuel for which final disposal is envisaged. The development of improved safeguards approaches for LWRs with fresh MOX fuel and fuel assemblies designed for dismantling continued,

444. A comprehensive review of a decade of international research and development efforts concerned with safeguards at reprocessing plants was completed, The LASCAR (Large-Scale Reprocessing Plant Safeguards) project was initiated by a voluntary contribution from the Government of Japan, with the objective of developing a broad understanding of effective, efficient and practical safeguards techniques pertinent to the commercial-size reprocessing plants expected to begin operation by the year 2000.

445. The second phase of a United Kingdom-supported investigation of the use of probabilistic methods for assessing safeguards effectiveness (PASE) at a HOX fuel fabrication facility neared completion,

446. The following statistics provide an overview of the technical services provided in 1987 (1986 values in brackets):

Twin photo units in use	268	(260)
Photo cameras repaired and tested	364	(340)
Twin photo unit failures related to equipment	0.7%	(0.9%)
Surveillance films developed and reviewed at Headquarters	1 794	(1 946)
Seals verified	12 456	(10 300)
Shipments of equipment	237	(249)
Shipments of samples and sources	123	(113)
Procurement actions	679	(767)
Sampler analysed by SAL and NWAL	1 344	(1 036)

447, The number of STAR video surveillance systems in operation remained constant. The reliability of tho systems was improved, but maintenance requirements remained high,

448. A second multiplex TV surveillance system was installed, at an on-load refuelled reactor, and operating experience was acceptable,

449. The problems reported lart year with portable multichannel analysers (PMCAs) were solved. At the end of 1987 a total of 55 PMCAs were in utae and performing satisfactorily.

450. Two laboratories, one in the United States and one in Canada, joined the Network of Analytical Laboratories (NWAL).

Safeguards evaluation

451. Further improvements were made in the review and evaluation of inrpection reports and inrpection rtatrmentr to States purruant to agreements baaed on INFCIRC/153 (Corrected) and on INFCIRC/66/Rev.2. Altogether 2353 inrpection reports (2195 in 1986) and 2508 inrpection statements (2279 in 1986) were reviewed using computer-arrirted review procedures. To help in further speeding up the dispatch of statements to States, a system for monitoring the average duration of major steps in the processing of statements was initiated.

452. In the area of quality assurance, assessments of the reviewing of seals and surveillance films continued and further internal audits were performed - for example, of compliance with instructions during the preparation of inrpection reports by the three Divisions of Operations and the Division of Safeguards Information Treatment, The implementation of actions resulting from five previous internal audits of Agency safeguards in randomly selected States wee assessed in follow-up status reports.

453. The criteria used in evaluating goal attainment for the purposes of the Safeguards Implementation Reports were reformulated, Further work was done on elaborating guidelines for future safeguards activities in the light of the technological developments expected over the next 15 years. Preliminary discussions on this subject were held with the Standing Advisory Group on Safeguards Implementation (SAGSI).

454. Software improvementa resulted in a more standardized MUF (material unaccounted for) evaluation procedure for 38 material balance areas. Also, new sampling planning procedurea were drafted in order to batter accommodate

both non-destructive and destructive measurement methods of verifying material balances. Algorithms were written for this purpose and data files wore defined and tested. Data were analysed for the certification of NDA reference materials.

455, A direct protected computer link was installed between the Safeguards Analytical Laboratory and Headquarters, thereby permitting the more efficient transfer of mearurement results. Historical data relating to a number of bulk-handling facilities were used to estimate measurement errors reflecting the quality of the measurement systems ured in material balance evaluations. Assistance was provided in resolving measurement problems and discrepancies at several bulk-handling facilities. Exchanges of measurement data with EURATOM resulted in better ● atimater of mearurement errors.

456. Data from major tank calibration experiments and • ctual tank calibration activities were analysed.

Standardization, training and administrative support

457, In support of the Department's negotiation teams, approximately 80 facility-specific attachment6 and general parts of Subsidiary Arrangements were reviewed. Work on a new model facility attachment for foot breeder reactors neared completion, and the revision of other model facility attachments started.

458, Work continued on the refinement and revision of the Safeguards Manual. A third volume, containing reference material, was issued and preparation of a fourth volume, on managerial matters, was completed for issue in 1988, The preparation of a volume on safeguards equipment was initiated.

459. The CIR logsheets were revised and new procedures for the reporting of anomalies incorporated. Preparation6 for the introduction of a new stratification scheme were completed,

460. The Saf eguards Management Information System (SMIS) continued to provide management with regular reports on resource utilization, the status of inspector designations, scheduled meetings and administrative matters,

461. Two introductory courses on Agency safeguards were conducted for new inspectore; they included comprehensive inspection exercises and NDA and containment and surveillance (C/S) exercises in three Member States. Eleven advanced and refresher courses for Professional staff were held at Headquarters and in the field. Substantial eupport in the organization and conduct of training courses continued to be provided by Hember States.

462, Nine safeguards trainees participated in the fourth training programme for junior professionals from developing countries, which included classroom lectures, laboratory experiment8 and visits to nuclear facilities. The trainees attended a comprehensive inspection exercise in the German Democratic Republic and observed inspections in two Hember States. A fifth programme, with five safeguards trainees, began in February 1988.

463. Two training courses on State Systemta of Accounting for and Control of Nuclear Material (SSACs) were organized: an advanced course held in the United States of America and attended by participants from 21 Member States; and a regional course, for personnel from Member States in the Far Eaot,

South East Asia and the Pacific region, held in Japan and attended by participants from seven Member States.

Support by outside expert groups and by Member States

464. During 1987, SAGS1 began considering guidelines for future safeguards activities prepared by the Secretariat with a view to establishing a long-term Framework for the planning of such activities.

465. SAGS1 completed its discussion of CANDU reactor safeguard8 and came to the conclusion that the Agency's overall approach to the safeguarding of CANDU 600 reactors was soundly based, In particular, SAGSI concluded that the system of discharged bundle counters and other C/S measures is adequate for the purpose of core verification. SAGSI's advice regarding some implementation problems will be incorporated into a revision of the CANDU 600 model safeguards approach.

466. SACS1 provided advice on the role of C/S measures in safeguards, especially on considerations concerning the remeasurement of nuclear material. The Secretariat began examining this advice in the course of planning activities relating to the application and performance of c/s measures.

467. SAGSI also provided advice on the formulation of statements to be provided to States pursuant to sub-paragraphs 90(a) and 90(b) of INFCIRC/153 (Corrected).

468. Substantial contributions to the safeguards development programme were again made through national programmes in support Of Agency safeguards. 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. A formal support programme was established with Sweden. Other Member States (notably Australia, Austria, Bulgaria, Czechoslovakia, Finland, the German Democratic Republic, Hungary, the Netherlands and Switzerland) continued to contribute through research and development agreements, contracts and test programmes, Further testing and performance monitoring of safeguards equipment for CANDU reactors were 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.

469. An advisory group reviewed the status of NDA techniques for the verification of spent fuel assemblies from LWRs and made recommendations on existing technology and the implications of new trends in fuel design and management for the performance of NDA measurements.

470. Another advisory group reviewed the status of and future needs for the evaluation of the quality of safeguards analytical services and made recommendations relating to quality assurance, to the resolution of specific problems, to the operation of the NWAL and to future trends in areas such as on-site measurements and the use of robots,

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

Table 2

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

	Number of States		
	1985	1986	1987
NNW States with safeguards applied under NPT and/or Tlatelolco agreements	42	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	53	53	53
NW States with voluntary-offer agreements in force	4	4	4
Other NW States	1	1	1
Total number of States with significant nuclear activities	58	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 1987)

Type of material	Quantity of material (t) in NNW States	in NW States	Quantity in SQ
Nuclear material			
Plutonium [a] contained in irradiated fuel	171.1	9.9	22 631
Separated plutonium outride reactor cores	7.9	0.9	1 110
Recycled plutonium in fuel elements in reactor cores	0.6	0	78
HEU (equal to or greater than 20% uranium-235)	12.2	0	271
LEU (lees than 20% uranium-235)	23 053	1 352	7 748
Source material [b] (natural or depleted uranium and thorium)	35 397	0	2 969
Total significant quantities			34 807
Bon-nuclear material [c]			
Heavy water	1 457	0	- [d]

[a] The quantity includes an estimated 56.9 t (7107 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.

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 1987)

Type of nuclear material	Quantity of material (t)	Quantity in SQ
Plutonium contained in irradiated fuel	43.2	5 402
Separated plutonium	0	0
LEU (less than 20% uranium-2351	4 a47	892
Source material (natural or depleted uranium and thorium)	15 470	828
Total SQs		7 122

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 1987

Installation category		Number of installations			
		INFCIRC/153[a/]	INFCIRC/66/Rev.2	Total[b/]	
A.	Power reactors	157	28	185	(178)
B.	Research reactors and critical assemblies	146	26	172	(176)
C.	Conversion plants	4	3	7	(6)
D.	Fuel fabrication plantr	30	10	40	(36)
E.	Reproceasing plants	4	2	6	(6)
F.	Enrichment plants	5	1	6	(6)
G.	Separate storage facilities	32	2	34	(34)
H.	Other facilities	43	3	46	(43)
	Sub-total	421	75	496	(485)
I.	Other locet ions	378	28	406	(414)
J.	Non-nuclear installations	0	2	2	(2)
	Totals	799	105	904	(901)

a/ Covering safeguards agreements pureuant to NPT and/or Tlatelolco Treaty,

b/ Numbers for 1986 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 1987

	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 (1)
G	Separate storage facilities	2	1	3 (3)
	TOTAL	2	7	9 (9)

a/ Numbers for 1986 are indicated in parentheses for comparison.

Table 7

Situation on 31 December 1987 with respect to thr conclusion of safeguards agreements between the Agency and non-nuclear-weapon States in connection with NPT

Non-nuclear-weapon States which hrvr signed, ratified, acceded to or succeeded to NPT[a/] (1)	Date of ratification, accession or succession[a/] (2)	Safeguards agreement with thr Agency (3)	INFCIRC (4)
Afghanistan	4 yobrurry 1970	In force: 20 February 1979	257
Antigua rnd Barbuda	1 November 1981		
Australia	23 January 1973	In force: 10 July 1974	217
Austria	27 Juno 1969	In force: 23 July 1972	156
Bahamas	10 July 1973		
Bangladesh	27 September 1979	In force: 11 Junr 1982	301
Barbados	21 February 1980		
Belgium	2 May 1975	In force: 21 February 1977	193
Belize	9 August 1985	Approvrd by tho Board, Feb.1986	
Benin	31 Ootobrr 1972		
Bhutan	23 May 1985		
Bolivia [b/]	26 May 1970	Signed: 23 August 1974	
Botswana	28 April 1969		
Brunei Darussalam	25 March 1965	In force: 4 November 1987	
Bulgaria	5 September 1969	In force: 29 February 1972	178
Burkina Faso	3 March 1970		
Burundi	19 March 1971		
Cameroon	8 January 1969		
Canada	8 January 1969	In force: 21 February 1972	164
Cape Verde	24 October 1979		
Central African Republic	25 Ootobrr 1970		
Chad	10 March 1971		
Colombia	8 April 1986		
Con60	23 Ootobor 1976		
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 Juno 1972		
Democratic People's Republic of Korea	12 December 1965		
Democratic Yemen	1 Junr 1979		
Denmark [b/]	3 January 1969	In force: 21 February 1977	193
Dominica	10 August 1964		
Dominican Republic [b/]	24 July 1971	In force: 11 Ootobrr 1973	201
Ecuador [b/]	7 March 1969	In force: 10 March 1975	231
Egypt	26 February 1961	In force: 30 Junr 1982	302
El Salvador [b/]	11 July 1972	In force: 22 April 1975	232
Equatorial Guinea	1 November 1984	Approved by the Board, Juno 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 1971	277
German Democratic Republic	31 Ootobrr 1969	In force: 7 March 1972	181
Germany, Federal Republic of	2 nay 1975	In force: 21 February 1977	193
Ghana	5 May 1970	In force: 17 February 1975	226
Greece [b/]	11 March 1970	Accession: 17 December 1981	193
Grenada	19 August 1974		
Guatemala [b/]	22 September 1970	In force: 1 February 1962	299
Guinea	29 April 1965		
Guinea-Bissau	20 August 1976		
Haiti [b/]	2 Junr 1970	Signed: 6 January 1975	
Holy See	25 February 1971	In force: 1 August 1972	187
Honduran [b/]	16 May 1973	In force: 18 April 1975	235
Hungary	27 May 1969	In forom: 30 March 1972	174

(1)	(2)	(3)	(4)
Iceland	18 July 1969	In force: 16 Ootobor 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 yrbrurry 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 Juno 1976	In force: 2 December 1977	255
Jordan	11 February 1970	In force: 21 February 1978	251
Kenya	11 June 1970		
Kiribati	19 April 1985		
Korea, Republic of	23 April 1975	In force: 14 November 1975	236
Kuwait a/			
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 Ootobrr 1979	275
Luxembourg	2 May 1975	In force: 21 February 1977	193
Madagascar	8 Ootobor 1970	In force: 14 Juno 1973	200
Malawi	18 February 1986		
Malaysia	5 March 1970	In force: 29 February 1972	182
Maldives	7 April 1970	In force: 2 Ootobrr 1977	253
Mali	10 yrbrurry 1970		
Malta	6 Cobrurry 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 yrbrurry 1975	228
Nauru	? Juno 1982	In force: 13 April 1984	317
Nepal	5 January 1970	In force: 22 Juno 1972	186
Netherlands f/	2 May 1975	In force: 21 February 1977	193
Wow Zealand	10 September 1949	In force: 29 February 1972	115
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 Wow Guinea	25 January 1982	In force: 13 Ootobrr 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 Ootobrr 1971	In force: 16 October 1974	216
Poland	12 Juno 1969	In force: 11 Ootobrr 1972	179
Portugal a/	15 December 1977	Accession: 1 July 1986	193
Romania	4 February 1970	In force: 27 October 1972	110
Rwanda	20 May 1975		
St.Lucia	28 December 1979		
It. 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	
Sao Tome and Principe	20 July 1983		
Senegal	17 December 1970	In force: 14 January 1980	276
Seychelles	12 March 1985		
Sierra Leone	26 February 1975	Signed: 10 November 1977	
Singapore	10 March 1974	In force: 18 October 1977	259

(1)	(2)	(3)	(4)
Solomon Islands	15 Juno 1981		
Somalia	5 Nrroh 1970		
Spain	5 November 1987		
Sri Lanka	5 March 1979	In force: 6 August 1914	320
Sudan	31 October 1973	In force: 7 January 1977	245
Suriname h/	30 Juno 1976	In force: 2 Cobrurry 1979	269
Swaziland	11 December 1969	In force: 21 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: lb 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 1910	In force: 1 September 1911	295
Tuvalu	19 January 1979	Approved by the Board, Feb.1986	
Uganda	20 October 1982		
Uruguay h/	31 August 1970	In force: 17 September 1976	157
Venezuela h/	26 September 1975	In force: 11 Nrroh 1982	300
Viet Nam	14 Juno 1912		
Yemen Arab Republic	14 May 1986		
Yugoslavia	3 March 1970	In force: 21 December 1973	204
Zaire	4 August 1970	In force: 9 No mber 1972	113

g/ The information roproduood in columns(1) rnd (2) was provided to the Agency by depositary Governments of NPT, and an entry in column (1) door not Imply the ● rprrrnlon of any opinion on tho prrt of tho Secretariat concerning tho legalstatus of any oountry or territory or of its authorities, or concerning the delimitation of its frontiers. The Table door not contain information relating to the participation of Taiwan, China in NPT.

h/ The relevant safeguards agreement refers to both NPT rnd the Tlatelolco Treaty.

i/ tho NPT safeguards agreement with Denmark (INFCIRC/176), in force since 1 March 1971, has been replaced by the agreement of 5 April 1973 between thr non-nuclear-weapon States of EURATOM,EURATOM rnd the Agency (INFCIRC/193) but still applies to thr Faroe Islands. Upon Greenland's secession from EURATOM as of 51 January 1985, the Agreement between tho Agency rnd Denmark (INFCIRC/176) re-entered into force as to Greenland.

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

k/ Kuwait signed NPT on 15 August 1968 but has not yet ratified it.

l/ An agreement had ● lro boon ooncludod in respect of tho Netherlands Antilles(INFCIRC/229). thlm ● pmaarnC entered into force on 5 Juno 1975.

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

Situation on 31 **December 1987** wlth **respect** to **the** oonolurlon of

safeguards agreements botworn **the Agency and States** party to **the Tlatelolco Treaty** a/

States party to **the** tlrtololoo **Treaty** (1)	**Date** of **becoming a** Party **to the Tlatelolco Treaty** (2)	**Safeguards agreement** with **the Agency** (3)	**INFCIRC** (4)
Antigua and Barbuda	11 Ootobor **1913**		
Bahamas	**26 April 1977**		
Barbados	**25 April 1969**		
Bolivia b/	**18 February 1969**	**Signed** : 2 3 **August** 1974	
Colombia	**6 September 1972**	In **force**: 22 **December** 1912	306
Costa Rica b/	25 **August 1969**	In **force**: 22 **November** 1979	271
Dominican Republic b/	14 **Juno** 190	In **force**: **11 Ootober** 1973	**2'/1**
Iourdor b/	**11** Pobrurry **1969**	In **force**: **10 Marc**\ 1975	**231**
El Salvador b/	**22 April 1968**	In **force**: 22 **April 1975**	**232**
Grenada	20 **June** 1975		
Guatemala b/	**6 February** 1970	In **force**: 1 **February** 1912	299
Haiti b/	**23 May 1969**	**Signed** : **6** January 1975	
Honduras b/	**23 September 1968**	In **force**: **18 April 1975**	235
Jamaica b/	**26 June 1969**	**In force**: **6 November 1978**	**265**
Mexico b/ g/	**20 September 1967**	In **force**: 14 **September** 1973	197
Nicaragua b/	24 Ootobor **1968**	In **force**: **29 December 1976**	**246**
Panama	**11** Juno **1971**	In **force**: 23 **March 1984**	**316**
Paraguay b/	**19 March 1969**	In **force**: **20 March 1979**	279
Peru b/	4 **March** 1919	**In force**: 1 **August** 1979	273
Suriname b/	**10 June 1977**	**In force**: 2 Pobrurry 1979	**269**
Trinidad and Tobago	27 **June 1975**		
Uruguay b/	20 **August 1968**	In **force**: 17 **September 197**,	157
Venezuela b/	23 **March** 1970	In **force**: **11** nrroh **1982**	**300**

a/ **The information reproduced in columns(1)** and **(2) was taken** from thr **relevant** OPANAL **status report.**

In rddltlon to **the States listed in column(1), Argentina, Brazil** rnd **Chllr have signed the tlotololoo Treaty. However,** thry hrvo not **yet become parties** to **the Treaty as** thoy **have** ● lthrr not **yet ratified it or** not **waived** tho **requirements** for **its entry** Into **force as** provldrd for **in Article 28(2)** of tho **Treaty.**

b/ **The relevant safeguards agreement refers** to both **tlrtrlolco Treaty and NPT.**

g/ **The application** of **safeguards** undrr **an agreement with Mexico in** oonnoctlon wlth **the tlrtrlolco** Treaty **which** ● ntorvd **into force on 6 September 1968(INFCIRC/118) was suspended after the** oonolurlon of **an agreement with Mexico** ln connootlon **with** both **the tlrtmloloo Treaty and NPT (INFCIRC/197).**

Table 9

Agreements providing for safeguards, other than those in connection with NPT or **Tlatelolco** Treaty, approved by the Board as of 31 December 1987

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 Ray 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	207
Mexico[b]	TRIM-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 Rarch 1962	34
	Boaster rods for **KANUPP**	17 June 1968	116
Peru[b]	Research Reactor and fuel **therefor**	*9* **May** *1978*	266
Philippine&	PRR-1 Reactor	**28** September 1966	**88**
Romania[b]	**TRIGA** Reactor	30 Rarch 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 1966	
Argentina	Atucha Power Reactor Facility	3 **October** 1972	168
	Nuclear material	23 October 1973	202
	Rmbalae Power Reactor **Facility**	6 December 1974	224
	Equipment and nuclear material	22 July 1977	250
	Ruclear material, material, equipment and facilities	22 July *1977*	251
	Atucha II Ruclear Power Plant	15 July 1981	294
	Heavy water plant	14 October 1981	296
	Heavy water	14 October 1981	297
	Ruclear material	**8** July 1982	303
Chile	Nuclear material	31 December 1974	256
	Nuclear material	22 September 1982	304
	Ruclear material	**18** September 1987	350
Cuba	Nuclear research reactor and fuel **therefor**	25 September 1980	298
	Ruclear power plant and nuclear material	5 **May 1980**	281
	Zero-power nuclear reactor and fuel thercfar	7 October 1983	311
Democratic People's Republic of Korea	Research Reactor and nuclear material for this reactor	20 July 1977	252
India	**Nuclear** material. material and **facilities**	17 November 1977	260
Pakistan	**Nuclear** material	2 Rarch *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 Hay 1961	291 */
United Kingdom	**Nuclear** material	14 December 1972	175
Viet Ram	Research reactor and fuel **therefor**	12 June 1981	293

*/ 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
(c) Agreements concluded with nuclear-weapon States on the basis of voluntary offers			
France	Nuolrrr material in facilities submitted to safeguards	12 September 1981	290
Union of Soviet Socialist Republics	Nuolorr material In facilities selected from list of facilities provided by the U.S.S.R.	10 Juno 1915	327
United Kinqdom	Nuolrrr material in facilities designated by thr Agency	14 August 1976	263
United States of America	Nuclear material in facilities designated by the Agency	9 December 1910	288
(d) Other agreements			
Argenti a/United States of America		25 July 1969	130
Austriaa/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 1966	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 Ootobmr 1968	125
Korea, Republic of/United States of America		5 January 1968	111
Worm, 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
Sweden[d/]/United States of America		1 March 1971	165
Switzerland[d/]/United States of America[e/]		28 February 1972	161
Turkey[d/]/United States of America[e/]		5 Juno 1969	123
Venezuela[d/]/United States of America[e/]		27 Nrrch 1968	122

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

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a/ An entry in this column does not imply the ● rprrnrion of any opinion whatsoever on the part of the Secretariat concerning thr legalstatus of rny 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 ● atlrflmd by the application of safeguards pursuant to the agreement of 12 Juno 1901 (INFCIRC/293).

d/ Application of Agency safeguards under this agreement has been suspended in thr State indicated as thr Statehas ooncludod an agreement In connection with NPT.

e/ Application of Agency safeguards under this agreement has barn suspended in thm United States of America In order to comply with a provision of INFCIRC/288.

Table 10

Facilities under Agency safeguards or containing safeguarded material on 31 December 1917

A. Power reactors

State[a/]	Abbreviated name of installation	Loortlon	Subsidiary arrangements in force
Argentina	Atucha NPB	Lima	x
	Embalse PR	Embalse	
Austria	Tullnerfeld	Zwentendorf	x
Belgium	BR3	Mol	x
	DOEL-1	Doml	x
	DDBL-2	Doel	x
	DOEL-3	Doel	-
	DDRL-4	Doml	
	Tihange-1	Tihange	x
	Tihange-2	Tihange	
	Tihange-3	Tihange	
Brazil	Angra-1	Angra dos Reis	x
Bulgaria	Korloduy-I, Unit 1	Korloduy	x
	Korloduy-I , Unit 2	Kotloduy	x
	Korloduy-II, Unit 1	Korloduy	x
	Korloduy-II, Unlt 2	Korloduy	x
	Korloduy-III, Unit 1	Korloduy	x
Canada	Bruce A , Unit 1	Tivmrton	x
	Bruce A, Unit 2	Tivrrton	x
	Bruce A, Unlt 3	Tivmrton	x
	Bruce A, Unlt 4	Tiverton	x
	Bruce B, Unlt 5	Tlvmrton	x
	Bruce B, Unit 6	Tiverton	x
	Bruce B, Unit 7	Tlvmrton	x
	Bruce B, Unlt 8	Tivmrton	x
	Darlington A, Unit 2	Bowmanville	
	Douglas Point	Tiverton	x
	Gentilly-2	Omntllly	x
	NPD G.S.	Rolphton	x
	Pickering-1	Pickering	x
	Pickering-2	Pickering	x
	Pickering-3	Pickering	x
	Pickering-4	Plckrr. .g	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	Bohun i cm	x
	Dukovmny-2, Unit 1	Dukovany	
	Dukovany-2, Unit 2	Dukovmny	
	UDU-1, Unit 1	Dukovmny	x
	IDU-1, Unlt 2	Dukovmny	x
	V-l, Unit 1	Bohunicm	x
	V-l, Unit 2	Bohunicm	x
	V-2, Unlt 1	Bohunlcm	x
	V-2, Unit 2	Bohunicm	x
Plnlmnd	Loviisa-1	Loviisa	x
	Loviimr-2	Loviisa	x
	TVO-1	Olkl luoto	x
	TVO-2	Olkiluoto	x
German Democratic Republic	Bruno Lmurohnmr-I, Unit 1	Greifswald	x
	Bruno Lmurchnor-I, Unit 2	Greifswald	x
	Bruno Leuschner-II, Unlt 1	Greifswald	x
	Bruno Leuschner-II, Unit 2	Greifswald	x
	Rheinsberg PWR	Rheinsberg	x

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Germany, Federal Republic of	AVR	Jülich	-
	GKW Grohnde	Grohnde	
	KKW Biblis-A	Biblis	x
	KKY Biblis-B	Biblis	x
	KKY Brokdorf	Srokdorf	-
	KKU Brunsbüttel	Brunsbüttel	x
	KKY Emsland	Lingen	
	KKW Grafenrheinfeld	Grafenrheinfeld	-
	KKW Isar	Ohu	a
	KKW Irrr-2	Essenbach	
	KKW Krümmel	Geesthacht-Krümmel	
	KKW Mülheim-Kärlich	Mülheim-Kärlich	
	KKW Neckarwestheim	Neckarwestheim	a
	KKY Obrigheim	Obrigheim	x
	KKW Philippsburg-1	Philippsburg	a
	KKW Philippsburg-2	Philippsburg	
	KKU RWE-Bayernwerk	Gundremmingen	a
	KKU RWE-Bayernwerk II, Block B	Gundremmingen	
	KKU RWE-Bayernwerk II, Block C	Gundremmingen	
	KKU Stade	Stade	a
	KKU Unterweser	Stadland	a
	KKY Würgassen	Würgassen	a
	KFK-MZFR	Eggenstein-Leopoldshafen	a
	KKU SNR-300	Kalkar	
	KNK	Eggenstein-Leopoldshafen	a
	Thorium Hochtemperatur Reaktor	Hamm	
	VAK-KAHL	Kahl	a
Hungary	PAKS-I, Unit 1	Paks	a
	PAKS-I, Unit 2	Paks	X
	PAKS-II, Unit 1	Paks	
	PAKS-II, Unit 2	Paks	
India	RAPS Unit 1	Rajasthan	a
	RAPS Unit 2	Rajasthan	a
	TAPS Unit 1	Tarapur	x
	TAPS Unit 2	Tarapur	a
Italy	ENEL	Borgo-Sabatino	a
	C.N. d r l Garigliano	Sessa Aurunca	x
	C.N. Caorso	Caorso	a
	C.N. Enrico Fermi	Trino-Vercellese	x
Japan	Fugen	Tsuruga-Fukui	a
	Fukushima Dai-Ichi-1	Okuma-Fukushima	a
	Fukushima Dai-Ichi-2	Okuma-Fukushima	x
	Fukushima Dai-Ichi-3	Okuma-Fukushima	a
	Fukushima Dai-Ichi-4	Okuma-Fukushima	x
	Fukushima Dai-Ichi-5	Okuma-Fukushima	a
	Fukushima Dai-Ichi-6	Okuma-Fukushima	a
	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	I
	Genkai-1	Kyumhu	I
	Genkai-2	Kyushu	x
	Hamaoka-1	Hamaoka-cho	X
	Hamaoka-2	Hamaoka-cho	x
	Hamaoka-3	Shizuoka-ken	x
	Ikrtr-1	Nishiuwa-gun	a
	Ikata-2	Nishiuwa-gun	a
	JPDR	Tokai-Mura	x
	Kashiwazaki-1	Niigata	a
	Mihama-I	Mihama-Fukui	x
	Mihama-2	Mihama-Fukui	x
	Mihama-3	Mihama-Fukui	a
	N.S. Mutsu	Minato-Machi Mutsu	a
	Ohi-1	Ohi-cho, Fukai-ken	a
	Ohi-2	Ohi-cho, Fukai-ken	x
	Onagawa-1	Tsukahama	a
	Sendai-1	Sendai	x
	Sendai-2	Sendai	a

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Japan (cont'd)	Shimane-1	Kashima-cho	x
	Shimane-2	Kashima-cha	x
	Takahama-1	Takahama	x
	Takabama-2	Takahama	x
	Takahama-3	Takahama	x
	Takahama-4	Takahama	x
	Toksi-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
	Korea Nuclear Unit 9	Uljin	
	Wolsung-1	Ulsan	x
Mexico	Laguna Verde 1	Alto Lucero	x
Netherlands	Borssele	Borssele	x
	Dodewaard NPP	Dodewaard	x
Pakistan	KANUPP	Karachi	x
Philippines	PNPP-1	Morong, Bataan	x
South Africa	Koeberg-1	Cape Tom	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
	Jose Cabrera	Almonazid de Zorita	x
	Lemoniz-1	Lemoniz	x
	Lemoniz-2	Lemoniz	x
	Santa Maria de Garona	Santa Maria de Garona	x
	Trillo-1	Trillo	
	Vandellos	Vandellos	x
	Vandellos 2	Vandellos	
Sweden	Barsebäck I	Malmö	x
	Barsebäck 11	Malmö	x
	Forsmark I	Uppsala	x
	Forsmark II	Uppsala	x
	Forsmark 111	Uppsala	x
	Oskarshamn I	Oskarshamn	x
	Oskarshamn II	Oskarshamn	x
	Oskarshamn III	Oskarshamn	
	Ringhals I	Göteborg	x
	Ringhals II	Göteborg	x
	Ringhals 111	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, Yew Jeraey	x
	Turkey Point 4	Dada 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 Bet.	Ganakbari Savar Dhaka	x
Belgium	BR1-CEN	Mol	x
	BR2-CEN	no1	x
	BR02	Mol	x
	CBN-Venus	Mol	x
	Thetis	Gent	x
Brazil	IEAR-1	Sao Paul0	x
	RIEN-1	Rio de Janeiro	x
	Triga-CDTN	Belo Horizonte	x
Bulgaria	IRT-2000	Sofia	x
Canada	McMaster	Hamilton	x
	NRX	Chalk River	x
	NRU	Chalk River	x
	PTR	Chalk River	x
	Slowpoke-AECL	Ottawa	x
	Slowpoke-Dalhousie Univ.	Halifax	x
	Slowpoke-EcolePolytechnique	Montreal	x
	Slowpoke-Saskatchewan	Saskatoon	x
	Slowpoke-Toronto University	Toronto	x
	Slowpoke-Univ. 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
	Univ. Training Reactor VR-1P	Prague	
	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	Rossondorf	x
	RRR	Rossendorf	x
	Training Reactor AKR	Dresden	x
	Training research reactor	Zittau	x
	WWR-S M	Rossendorf	x

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Germany, Federal Republic of	FMRB	Braunschweig	x
	FRP-2	Frankfurt	x
	FRM	Carching	x
	GKSS-FRG1	Ceesthacht	x
	GKSS-FRG2	Geesthacht	x
	KFA-FRJ1	Jiilich	x
	KFA-FRJ2	Jiilich	x
	KFA-NEA	Jiilich	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	Carching	x
	SUR 100	Furtwangen	x
	SUP 100	Darmstadt	x
	SUR 100	Aachen	x
	Triga	Mainz	x
	Triga	Hannover	x
	Triga II	Heidelberg	x
	BBR-2	Berlin (West)[b/]	x
	SUR 100	Berlin (West)[b/]	x
Greece	GRR-1	Attiki	x
Hungary	Training reactor	Budapest	x
	WWR-S M	Budapest	x
	ZR-6	Budapest	I
Indonesia	Gama	Yogyakarta	x
	MPR-30	Serpong	x
	PPTN	Bandung	x
Iran. Islamic Republic of	TSPRR	Teheran	x
Iraq	IRT-5000	Baghdad Tuwsitha	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	
	RB-3	Montecuccolino	x
	RTS-1	San Piero a Grado	x
	TAPIR0	Santa Maria di Calorie	x
	Triga-RC1	Santa Maria di Galeria	x
	Triga-2	Pavia	x
Jamaica	Centre for Nuclear Sciences	Kingston	I
Japan	DCA	Oarai-Hachi	x
	FCA	Tokai-Mura	x
	HTR	Kawasaki-shi	x
	JMTR	Oarai-Machi	x
	JMTR-CA	Oarai-Hachi	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

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements In force
Korea, Republic of	Triga II	Seoul	x
	Triga III	Seoul	x
	Kyung-Hee Univ.	Seoul	x
Libyan Arab Jamabiriya	IRT-Tajura	Tajura	x
Malaysia	Puapati	Bangi, Selangor	x
Mexico	Trigs	Ocoyoacso	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
Pakiatan	PARR	Rawalpindi	x
Peru	UP-O	Lima	x
Philippinea	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	Hargurele	x
	Triga II	Pitasti-Colibasi	x
	WR-s	Hargurele	x
South Africa	SAFARI-1	Palindabe	x
Spain	ARBI	Bilbao	x
	ARGOS	Barcelona	x
	CORAL-1	Madrid	x
	JEW-1 and JEW-2	Madrid	x
Sweden	R2	Studsvik	x
	R2-O	Studsvik	x
	RO	Studsvik	x
Switrsrland	AGN 201P	Geneva	x
	ACN 211P	Easel	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	Rontavideo	x
Venezuela	RV-I	Altos de Pipe	
Viet Nam	Da-Lat Research Reactor	Da Lat	
Yugoslavia	RA	Vinca	x
	RB	Vinca	x
	Trigs II	Ljubljana	x
Zaire	Trigs-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	
	Uranium Powders Fabrication Plant	Constituyentes	-
Canada	Eldorado Resources Ltd.	**Port** nope	x
Japan	Japan Nuclear **Fuel** Conversion Co. Ltd.	Tokai-Hura	**x**
	Ningyo R + D	**Ningyo**	**x**
	PCDF	Tokai-Hura	

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
	Research Reactor Fuel Fab. Plant	Constituyentes	-
Belgium	Belgonucléaire-BN-MOX	Dessel	x
	FBFC	Dessel	x
	FBFC MOX Assembling Facility	Dessel	-
Brazil	Fuel Fabrication Plant Resende	Resende	x
Canada	CGE	Peterborough	x
	CGE	Toronto	x
	CRNL Fuel Fabrication	Chalk River	x
	WL	Port Hop.	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	Experimental Fuel Element Installation (IEBE)	Serpong	-
	Research Reactor Fuel Element Production Installation (YPEBRR)	Serpong	x
Iraq	ERLFF	Baghdad Tuwaitha	x
Italy	Comb.Nuc.	Pollcoro	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
	PFPF	Tokai-Mura	-
	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
Sweden	AIM - ATOM	Västeras	x
United States	Westinghouse Electric Corp.	Columbia, S.C.	x

E. Chemical reprocessing plrntr, including pilot plrntm

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Germany, Federal Republic of	WAK	Eggenstein-Leopoldshafen	a
India	PREFRE	Tarapur	x
Italy	EUREX ITREC-Trisaia	Saluggia Rotondmllr	x 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	Sop, Nor. Enrichment Plant	Resende	..
Germany, Federal Republic of	Uranit* URRNCO Deutschland, UTA-1	JÜlich Gronau	x
Japan	PNC Pilot Enrichment Plant	Ningyo	x
Netherlands	URRNCO Nederl and Ultra-Centrifuge*	Almrlo Almelo	x -
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	Loartion	Subsidiary arrangements in force
Argentina	Storage *of* 20% enriched uranium	Cac	
Belgium	BN UF_6 store	Dessel	x
	Belgoprocess	no1	x
	FBFC	Dessel	
Canada	Bruce A	Tiverton	x
	Bruce B	Tivrrton	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	Risé Storm	Roskilde	x
Finland	Long term storage f o r TVO	Olkilouto	-
France	COGEMA UP? spent furl storage pondr	La Hague	
German Drmocrrtic Republic	Interim storage facility *for* spent fuel assemblies	Lubmin	
Germany, Federal Republi c 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 I I Leese	Landesbergen-Leese	-
	Transnuklear Halle	Hanau	-
	Urananlage	Birkenfeld	x
Iraq	Separate storage facility	Baghdad Tuwaitha	x
Italy	Avogadro	Saluggia	
	Deposito Prodotti Uraniferi	Bosco Marengo	x
	Ispra Central Storage	Ispra	x
	Lab. d i Misura Nucleare Perla	Ispra	
Japan	KUFFS	Kyoto	x
Luxembourg	International Metals S.A.	Luxembourg-Dommeldange	
Pakistan	Storage at Government depot	Karachi Malir	x
Portugal	Instalacao d e Armazenagens	Sacavem	
Sweden	Central long term storage	Oskarshamn	
Switzerland	Diori t Storage	WÜrenlingen	x
Unl trd Kingdom	Sellafield Pu-storage	Sellafield	x
	Oxide Fuel Storage Pond	Sellafield	x

State[a/]	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Labo. da Calificacion	Constituyentes	.
Australia	Research Laboratory	Lucas Heights	x
Belgium	BCMN	Geel	x
	CEN-Labo	no1	x
	CEN-WASTE	no1	-
	I.R.E.	Fleurus	x
	PULAB	Mol	x
Canada	Physics, Chemistry, Fuel Eng., Health Phys., R+D	Chrlk River	x
Czechoslovakia	Nuolrrr Fuel Inst. (UJP)	Zbraslav	x
	Research Laboratories	Rez	x
Denmark	Hot0011 Plant	Roskilde	x
German Democratic Republic	Urrn 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	CNIN-LAB. PU.	Santa Maria di Galeria	x
	CNEN-LAB .TIC.	Santa Maria di Galeria	x
	Joint Research Centre	Ispra	
Japan	JAERI-Oarai R&D	Oarai-Machi	x
	JAERI-Tokai R&D	Tokai-Mura	x
	MHI-FL	Tokai-Mura	-
	Mitsubishi Atomic Power Industries	Tokai-Mura	..
	NERL, University of Tokyo	Tokai-Mura	x
	NPD	Oarai-Machi	x
	NFI Tokri II	Tokai-Mura	x
	NRF Neutron Radiation Facility	Sakura-Mura	x
	PNC FMF	Oarai-Machi	
	PNC IRA?	Oarai-Machi	
	PNC-Oarai R&D	Oarai-Machi	
	PNC Tokai R&D	Tokri-Mura	x
Korea, Republ to of	PIEF	Daejeon	
Netherlands	ECN+JRC	Petten	x
	Komr Lab.	Arnhem	x
Norway	Research laboratories	Kjeller	x
Pol rnd	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

State[a/]	Abbrevi ated name *of* inrtrllrtion	Loortion	Subsidiary arrangements in force
Argent ina	Heavy water plant Hrrvy water storage	Arroyito Buenos Aires	

a/ An entry in this oolumn does not imply the ● xproxrion *of* any opinion whatsoever on the part of the Secretariat concerning thm legal status *of* any country or territory or of its authorities, or concerning thr delimitation of its frontiers

b/ The interests of Berlin (West) are represented within the United Nations system by thr Federal Republ ic *of* Germany.

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

International Nuclear Information System (INIS) [23]

472. In 1987, the input to the INIS data base totalled 101 118 documents, the highest annual input so far. Non-conventional literature accounted for 24.7% of this input. The size of the data base had reached 1 159 156 records by the end of the year. The fraction of the input supplied by INIS members in machine-readable form increased from 99.2% to 99.4%.

473. The INIS data base was distributed in magnetic tape form to 42 Member States.

474. The INIS Clearinghouse distributed around 500 000 microfiches. The number of full microfiche subscriptions remained at 37. By the end of the year, the collection of microfiche masters numbered over 200 000 documents (280 000 microfiches).

475. A new, high-speed microfiche camera led to greater quality, efficiency and reliability in the production of non-conventional literature on microfiche. A computer-output-on-microfiche (COM) system was installed for use in producing semi-annual, annual and 15-year (1972-86) cumulative indexes and back issues of "INIS ATOMINDEX" and INIS Reference Series publications on microfiche.

476. A read-only memory in compact disk form (CD-ROM) containing about 400 MB (megabytes) of data from the INIS data base was prepared for evaluation by INIS Liaison Officers with a view to its introduction as a new type of INIS output product which will allow all INIS members (and especially developing countries) to have access to the INIS data base, eliminating dependence on direct access to mainframe computers.

477. Revised versions of "INIS: Authority List for Corporate Entries and Report Number Prefixes**, "INIS: Authority List for Journal Titles" and "INIS: Thesaurus'* were issued in the INIS Reference Series.

478. A lo-year "Cumulative Report, Standard and Patent Number Index", covering "INIS ATOMINDEX" Volumes 8-17 (corresponding to the period 1977-86), was published.

479. The 15th annual consultative meeting of INIS Liaison Officers was held in Hay. The 6th session of the Advisory Committee for INIS took place in December.

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[23] After more than 17 years of operation, INIS has grown into a uniquely comprehensive bibliographic data base in the nuclear field. It now covers 75 Member States and 14 international organizations, as shown in Fig. 6. The growth of the data base is illustrated in Fig. 7, and the 1987 input is shown by literature type in Fig. 8. The number of hours of direct access by external users to INIS during the period 1981-87 is shown in Fig. 9.

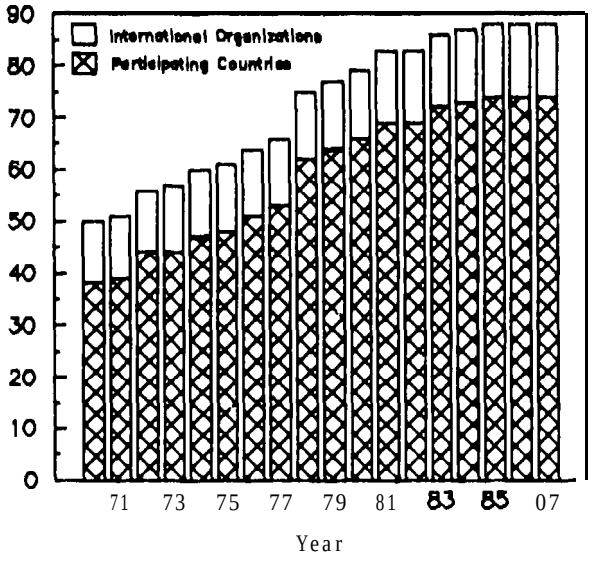

Fig. 6. Participation of Member States and international organizations in INIS

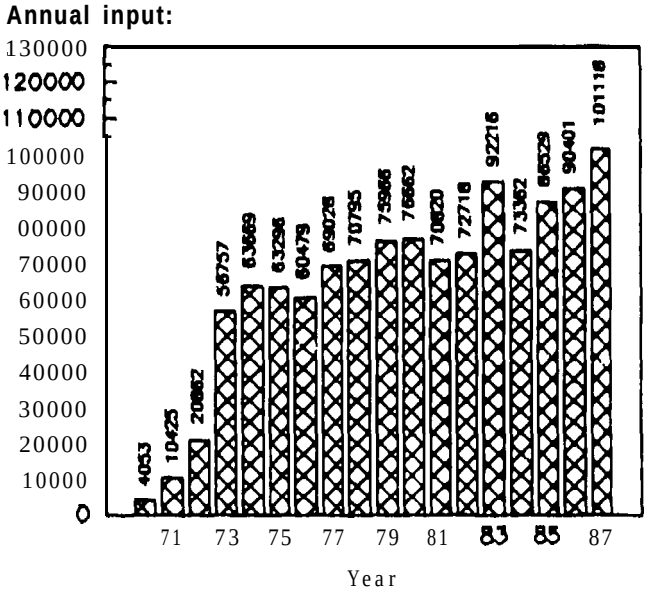

Fig. 7. Growth of the INIS data base

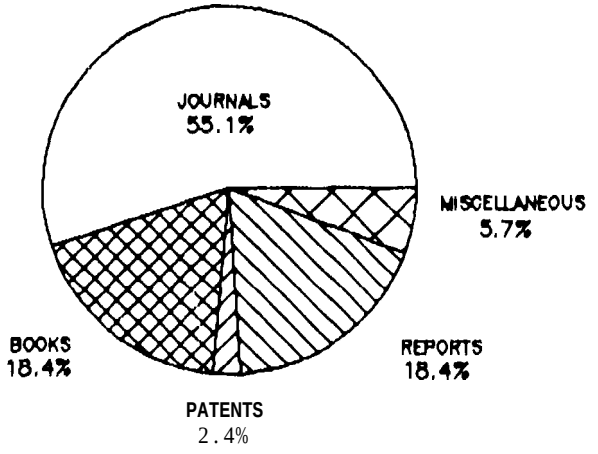

Fig. 8. INIS input broken down by litera turo type (1987)

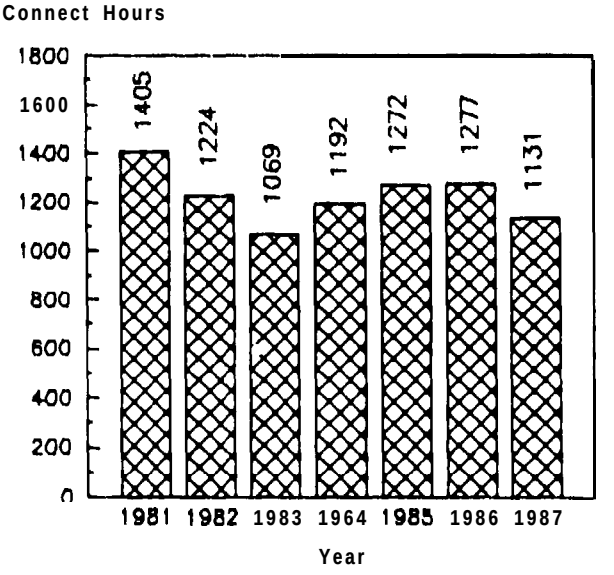

Fig. **9. Direct access by external users to INIS**

480. A workshop for experienced users of INIS, attended by 24 participants from 19 Member States and two international organizationo, and an INIS training seminar for beginners, attended by 26 participants from 18 Member States and one international organization, were held in Vienna,

481, A promotional brochure entitled "Presenting INIS", replacing an earlier brochure entitled "INIS Today", was published.

Agricultural Information System (AGRIS)

482, By the end of 1987, the data base totalled 1.4 million references, and 128 countries and 14 international organizations were participants in AGRIS,

483. Some 120 000 documents were received, 15% with abstracts. All documentr were indexed with AQROVOC deecriptoro in English, French or Spanish (see paragraph 446 of GC(XXXI)/800).[24]

484. Owing to the increased use of microcomputers, AGRIS received fewer records on input sheets, the input from more countries being provided on diskettes - a development which the Secretariat welcomes,

485. Retrieval services continued to be provided, with about 600 retrospective searches and 600 SDI (Selected Dissemination of Information) searches.

Computer services

486. At the central computer site, utilization of the IBH 3083 computer (dedicated to safeguards data processing) and of the IBH 3081 (shared by other users) during prime operating hours increased by 5% and 30% respectively. In April, the IBM 3081 computer memory was upgraded from 24 MB to 32 MB in order to handle the increasing demand *for* on-line processing.

407, To eliminate delays in central printing, a second laser printer was acquired and the around-the-clock service started in November 1985 was continued,

488. By the end of the year, approximately 850 work stations (word processors, personal computers, local printers and terminals connected to the central computer) were available in user areas - about 200 more than at the end of 1986, As the first stage of a multi-year project, six floors of the Agency's Headquarters were cabled with horizontal networks offering at least one outlet per office for connection to any of the standard work stations.

489. The direct telecommunications line between United Nations Headquarters in New York and the Agency's central computing facility became operational, and direct access to the UN International Computing Centre in Geneva via New York was instituted.

490. As a result of an office automation pilot project carried out in the Division of Technical Assistance and Co-oporation, users in the Division started to transmit telexes via the Agency's central computing facility.

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[24] Since January 1987, "Agrindex" is being published in three languages (English, French and Spanish),

491. In the application area, development of the Technical Co-operation Management System war completed; a data bare was established for radioactivity measurements made by Member States following the Chernobyl accident (in co-operation with UNSCEAR and the Division of Nuclear Safety); and the first phase in the establishment of a data bare for Board of Governors summary records (covering the period from 1980 onwards) was completed.

Library services

492. Over 3000 persona attended an exhibition organized by the VIC Library on the occasion of the Agency's thirtieth anniversary.

493, The Library initiated a "book talk" programme under which new books of particular professional interest to staff serving at the VIC are presented in lectures by the authors or other specialists.

494. A Current Awareness Bulletin on Animal Sciences was added to the Library's bulletin series at the request of the Joint FAO/IAEA Division (it is being distributed monthly to over 100 researchers in Member States).

495. Equipment was acquired so as to begin conversion of the Library's nuclear energy film collection from 16 mm film to video cassette format.

496, The number of active exchange agreements with other institutions increased to 143, with the result that 1963 journal titles and 300 bookr *were* received by the Library free of coat.

497. The number of fellows and new staff members for whom training and demonrtratione were organized increased substantially. Technical assistance projects in Latin America and Viet Nom involving microcomputer-bared library automation were supported,

498, The number of volumes in the book collection increased by 2595 to 73 730. The number of current titles in the journal collection otood at 4118 at the end of the year. The collection of United Nations documents increased by 36 300 to 1 024 338 and that of technical reports by 15 900 to 551 304,

499. The Library lent 9169 books and 234 films, dealt with 3328 reference questions and circulated 26 724 journal issues to users. Waiting times for material in demand were reduced through use of the Library's automated circulation system, Through its inter-library loan programme, the Library borrowed books and journal articles to meet 3735 user requests. It prepared and distributed over 15 0 copies of current awareness bulletins i n 14 subject series to a monthly average of 1279 roquestors.

Scientific journals

500. Twelve regular issues of "Nuclear Fusion" were published, each containing results of important experiment8 with the large tokamake recently put into operation.

501. A subject catalogue was prepared of the approximately 3000 articles published in "Nuclear Fusion" since ite inception,

502. A special supplement to "Nuclear Fusion", "Atomic Date for Fusion, I: Iron", was published in December.

Legal Affairs

Amendment to Article VI.A.1 of the Statute

503. An amendment to Article VI.A.1 of the Agency's Statute providing for the designation by the Board of Governor8 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 50 Member States by the end of the year [25]. The amendment will come into force when it has been accepted by two thirds of the Member Staten in accordance with their respective constitutional requirements,

Conventions relating to nuclear accidents

504. Tha Convention on Early Notification of a Nuclear Accident[26], which entered into force on 27 October 1986, was signed by 14 States end ratified by 14 State8 during 1987. Altogether, there were 72 signatories and 19 parties by the end of the year.

505. The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency[27] entered into force on 26 February 1987 following the deposit of instruments of ratification by the Ukrainian Soviet Socialist Republic and the Byelorussian Soviet Socialist Republic, having been signed earlier by Norway without reservation as to ratification, By the end of the year, there were 70 signatories and 16 parties,

506. The proceed ings of the development of these two conventions were prepared for publication as *Legal* Series No, 14,

507. A Joint IAEA/NEA Working Group of Governmental Experts met to continue work on the harmonization of the Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention) and the Convent ion on Civil Liability for Nuclear Damage (Vienna Convention) and adopted by consensus the text of a Joint Protocol relating to the application of the Paris Convention and the Vienna Convention . The Joint Protocol is intended to exte I mutually the special liability regime established under each Convention to the parties to the other Convention for the wider protection of victims of a nuclear accident and to prevent conflicts of law arising from the simultaneous application of the two Coventions[28].

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[25] 53 Member States had accepted the amendment by the end of May 1988.

[26] Reproduced in document INFCIRC/335.

(271 Reproduced in document INFCIRC/336.

[28] In February 1988, the Agency's Board of Governors endorsed the Joint Protocol and agreed to the convening of a one-day conference to be organized jointly by the Agency and NEA in conjunction with the thirty-second regular session of the Agency's General Conference for the purpoee of adopting the Joint Protocol and opening it for signature. The Joint Protocol and the convening of such a one-day conference were endorsed by NEA's Steering Committee for Nuclear Energy in April 1988 and by the OECD Council in June 1988,

Agreements relating to nuclear safety

508. Member States were requested by the Secretariat to provide it with copies of bilateral, regional and multilateral agreements on co-operation in the field of nuclear safety to which they are parties so that a compilation of the texts may be published in the Agency's Legal Series.

Nuclear legislation advisory services

509. Advice on nuclear legislation, covering - inter alia - nuclear liability and compensation for nuclear damage, the physical protection of nuclear material and the safe transport of nuclear material - was provided to China.

510. In addition, advice on nuclear legislation and regulatory activities was provided to Morocco and Tunisia to supplement the advice provided in 1986 (see paragraph 468 of GC(XXXI)/800).

Physical Protection Convention

511. The Convention on the Physical Protection of Nuclear Material[29] entered into force on 8 February 1987. By the end of the year, 47 States and EURATOM had signed the Convention and 22 States were party to it.

Regional Co-operation Agreement

512. On 12 June 1987, a new Regional Co-operation Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) entered into force[30], replacing the 1972 RCA as extended in 1977 and 19821311. By the end of the year, 12 States had notified their acceptance of the new (1987) RCA.

Finance

513. On the basis of an exchange rate of 19.50 Austrian schillings to one United States dollar, the General Conference appropriated an amount of $103 899 000 for the Regular Budget. This amount had to be adjusted in accordance with the adjustment formula presented in the attachment to resolution GC(XXX)/RES/458 in order to take into account the exchange rate actually experienced during the year - 12.64 Austrian schillings to one United States dollar.

514. The Regular Budget for 1987 at an exchange rate of 12.64 Austrian schillings to one United States dollar amounted to $145 913 000, of which $136 378 959 was to be financed from contributions by Member States on the basis of the 1987 scale of assessment, $4 894 000 from income from work for others and $4 640 041 from other miscellaneous income.

515. The actual expenditures in 1987 amounted to $133 334 992, resulting in an unencumbered balance of $12 578 008.

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

[30] Reproduced in document INFCIRC/167/Add.13 and Mod.1.

[31] Reproduced in documents INFCIRC/167, INFCIRC/167/Add.8 and 167/Add.11.

516. The target for voluntary contributions to the Technical Assistance and Co-operation Fund in 1987 was established at $34 million, At the end of the year, $29 736 469 had bren pledged by Member States in support of the technical assistance programme. Net new obligations incurred during 1987 ● mountod to $26 167 698.

517. A total of $15 880 774 was offered in extrabudgetary contributions by Member States, the United Nations and other international organizations during 1987, Of this amount, $8 640 860 was *for* technical assistance projects, $1 467 147 was in support of safeguards, $1 091 026 was for projects in the field of food and ● Ericulturo, and $580 139 was in aupport of Regional Cooperative Agreements. The remaining $4 101 602 was in rupport of various other projects implemented by the Agency.

518. In addition, extrabudgetary resources amounting to $15 103 783 were donated for the International Centre for Theoretical Physics and $506 310 for the International Laboratory *of* Marine Radioactivity.

Public Information

519. Public and media interest in the Agency and its work remained high in 19117) principally in connection with international efforts to strengthen nuclear safety and radiation protection. Several press briefings were held in Vienna on remedial actions taken in response to the Chernobyl accident. A background report concerning the international response to the accident and entitled "One Year after Chernobyl*' was produced and disseminated to a broad audience of journalists and opinion-leaders,

520. The Agency's 30th anniversary was marked by – inter alia – commemorative exhibits mounted at United Nations Headquarters during the *first* month of the General Assembly's forty-second regular session, at the Austria Center Vienna during the General Conference's thirty-first regular session and in Geneva during the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (UNCPICPUNE). Feature articles on the history of the Agency and its contributions to international development were prepared for publication in magazines and newspapers,

521. The Agency's main wide-circulation periodicals – the "International Atomic Energy Agency Bulletin" and "IAEA Newsbriefs" – were produced at quarterly and monthly intervals respectively, [32] A special, 30th-anniversary edition of tha "International Atomic Energy Agency Bulletin" was distributed at the Gener. 1 Conference's thirty-first regular session; also distributed

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[32] The "International Atomic Energy Agency Bulletin ' is published in five languages (Chinese, English, French, Russian and Spanish) and distributed to about 33 000 readers (including government and industry officials, journalists and scientists) in over 160 countries; a Japanese version was published (in Japan) for the first time in October 1987. "IAEA Newsbriefs" is published in English for the news media and ths general public (about 9000 copies of each issue are distributed) ; abridged versions *of* "IAEA Newsbriefs" are published separately in China and Japan,

were two specie1 issues of "IAEA Newsbriefs" with graphs, tables and charts illustrating the historical development of nuclear energy and its ● pplicationr and the Agency's activities in safeguards, technical co-operation and other areas,

522. Information material (brochures, pamphlets and press releases) were distributed in response to more than 2000 requests from thr public, and staff members of the Division of Public Information lectured on thr work *of* the Agency to nearly 50 groups of visitors to the VIC.

523, Six films, mainly *for* the training of experts, wore produced with the help of technical Divisions and Member States.

Gen. al Services

524, 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.

525, A technical study wan carried out with a view to upgrading the training facilities at the Agency's Laboratories *at* Seibersdorf through an expansion of the main laboratory building. The construction *of a* new glasshouse was completed and expansion of the "barn" (where such things au agricultural equipmsnt and products *are* stored) was initiated.

526, Safety and security ● rrrn8ements at the *VIC* and Seibersdorf continued to be improved.

527, Telecommunication services were improved through the development of decentralized computerized telex transmission combined with central cost and traffic control.

528, Purchases of scientific and non-scientific rquipment and supplies and expenditures in connection with scientific and maintenance contracts amounted to around $13.3 million; nearly 2900 procurement *actions* were involved.

529, Assistance in finding accommodation and advice relating to housing problems were provided to stuff members of the international organizations located at the VIC and persons accredited to these organizations. Over 360 lease contracts were concluded with the help of tha VIC Housing *Service,*

530, The Commissary, with a range of around 6000 articles, *served* about 8000 households. Total sales amounted to approximately AS 282 million.

Publishing and Printing Services

531, Almost 160 separate books or journal issues were published. The net income to the Agency from the sale of Agency publications *was* $1 400 184 in 1987, compared with $1 152 114 in 1986 and $884 492 in 1985.

532, The Common Printing Service continued to provide document and publication printing services *for* the Agency and also for UNIDO and the United Nations bodies based at the *VIC,* The income from work for other organizations was $1.55 million in 1987, compared with $1.10 million in 1986,

533, Thr output of thr Common Printing Service was 199 million page impressions in 1987, compared with 224 million in 1986, Through furthrr rtaff reductions, thr capacity of the Sorvico was reduced in line with thr declining level of output,

Personnel

534. At the end of 1987, thr number of members of thr Secretariat was 2026 - 771 in thr Professional and higher categories, 1121 in the General Service category and 134 in the Maintenance and Operatives Service category[33].

535. Among t h r 5 9 4 staff members i n posts subject *t o* geographical distribution, 78 nationalities were represented.

536. Thr fourth traineeship programme for graduates and junior professionals from developing areas, which began in January 1987, was completed in December 1987, Fifteen trainees participated.

537. As a result of improvrmontr in recruitment procedures introduced in 1985-86, vacancies as *a* percentage of total man-months represented by established portr were furthrr rrducad - to 6.77% (in 1986 the figure was 8.5%).

538. An ● ♎❖✂❒□❒⍓ committee on improvrmontr in thr advancement of women within the Secretariat was ● rtablirhrd in order to monitor progress made by thr Agency in thr ● dvancomont of womrn staff members.

539. Commom classification standards f o r General Service a n d related categories prepared by and for the Vienna-based organizations and promulgated by the International Civil Service Commission (ICSC) wore implemented in January 1987.

540, A survey of best prevailing conditions of employment in Vienna for the General Service and Maintenance and Operatives Service (GS/M&O) rtaff categories was carriud out by ICSC and the Vienna-brood organizations. Revised salary scales for Agency staff in these categories were implemented with effect from 1 October 1987, Work started on establishing an ● d-of-rorvico ● llowmco system for GS/M&O staff as recomm nded by ICSC.

541. Thr Secretariat contlnurd to participate in ths work of United Nations bodies ● rtrblirhrd *for* the purpose of co-ordinating or regulating conditions *of* ● lnploymotlt - f o r example, the ICSC, t h r Consultative Committee o n Administrative Questions (CCAQ) and the United Notions Joint Staff Pension Board (UNJSPB).

542. Thr following organizational chart shows the structure of the Secretariat.

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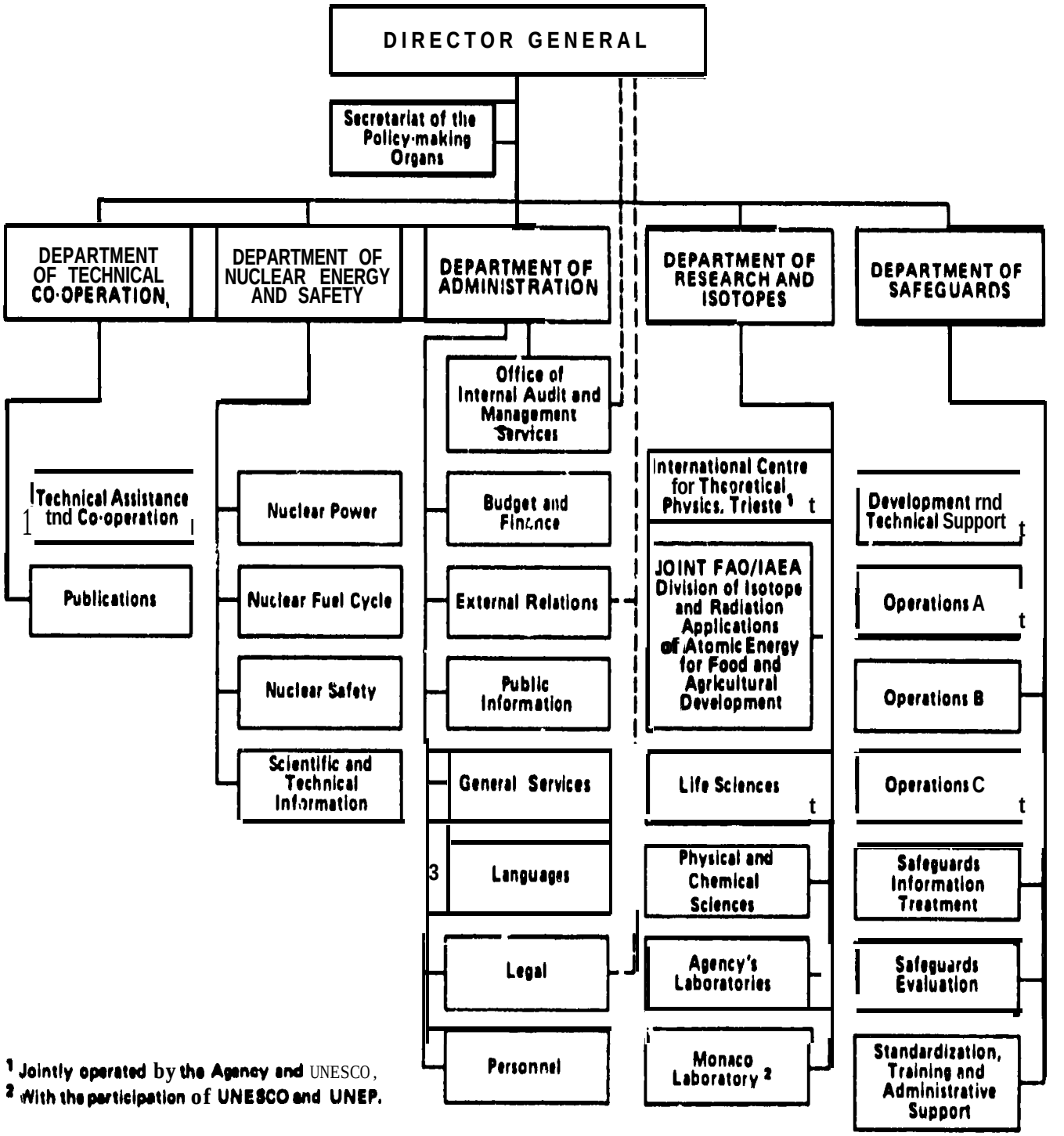
[33] These figures represent: members of the Secretariat occupying manning table posts (1569) or charged to manning table posts (99) or to the temporary ● rrirtmco fund (113); officials serving on a reimbursement basis (178) or on secondment (6); and Commissary *rtaff* (61).

ORGANIZATIONAL CHART

(as of 31 December 1987)



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