

ACTIVITIES
OF
THE IAEA INTERNATIONAL
WORKING GROUP
ON
LIFE MANAGEMENT OF
NUCLEAR POWER PLANTS
(IWG-LMNPP)

LIANKO

SCIENTIFIC SECRETARY

DIVISION OF NUCLEAR POWER

31/32

**General Conference
All Member States**

→ **Board of Governors
35 Member States**

→ **Director General
(Secretariat)**

← **Department of Administration**

← **Department of Nuclear Energy
and Safety**

← **Department of Safeguards**

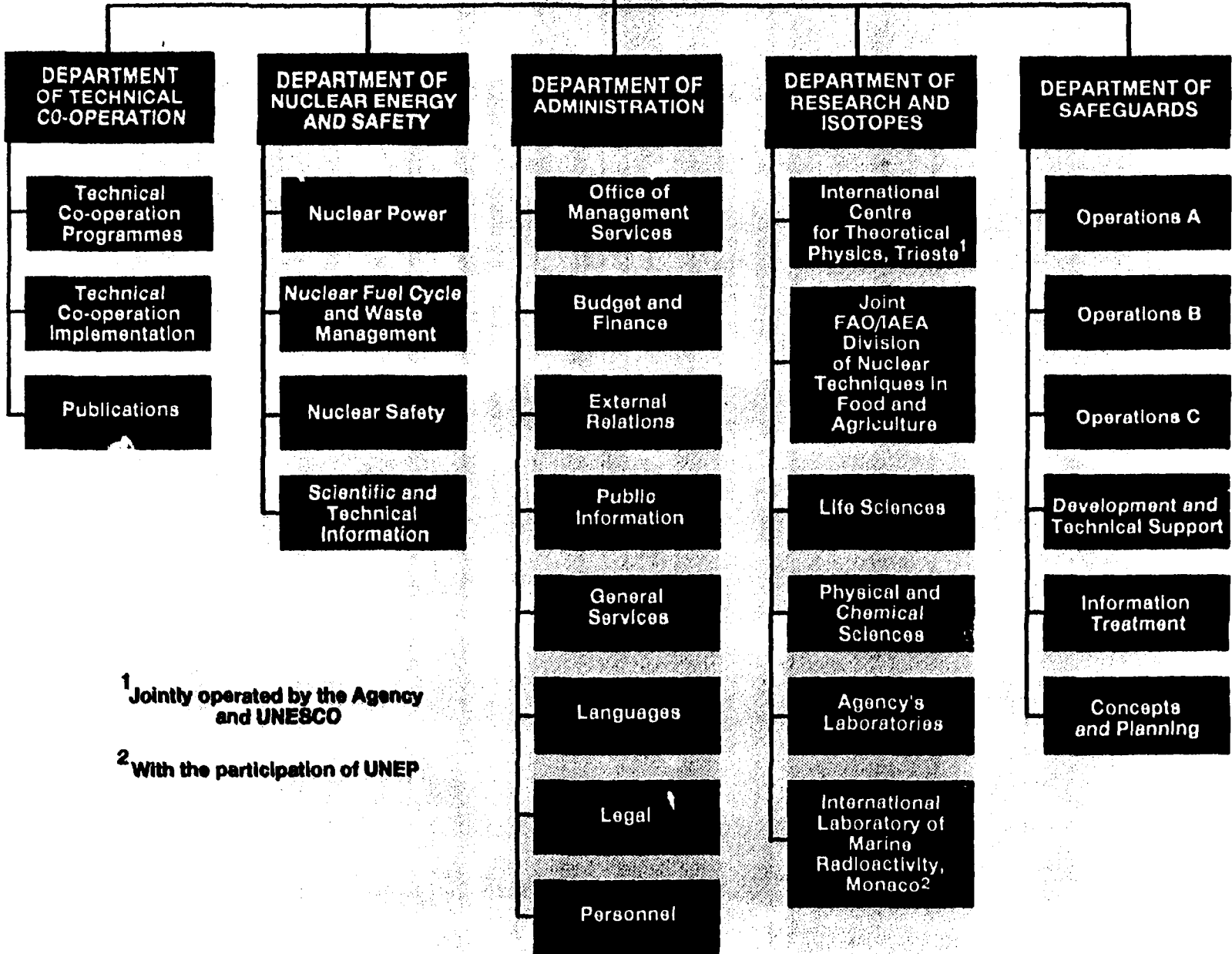
← **Department of
Technical Cooperation**

← **Department of
Research and Isotopes**

→ **International Centre for
Theoretical Physics, Trieste
Seibersdorf & Headquarters
Laboratories
International Laboratory of
Marine Radioactivity, Monaco**

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DIRECTOR GENERAL

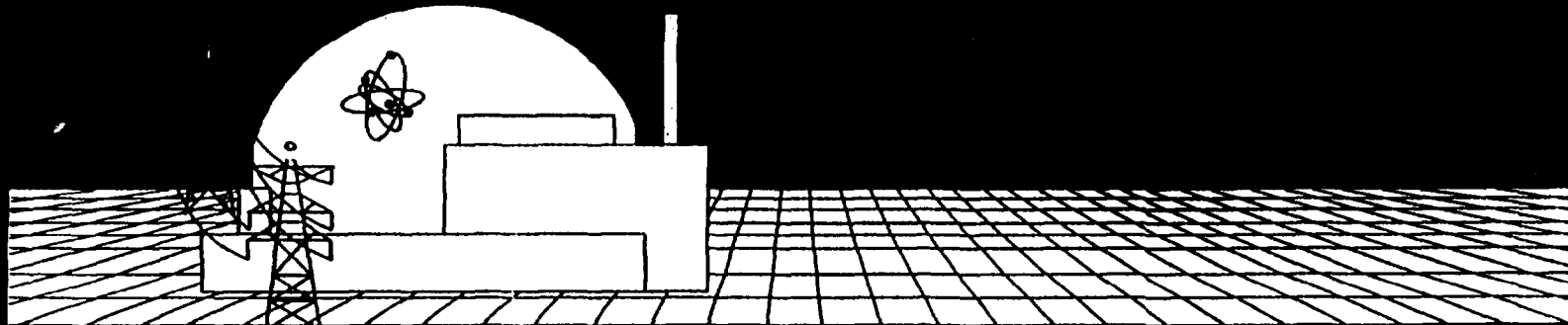


¹ Jointly operated by the Agency and UNESCO

² With the participation of UNEP

34

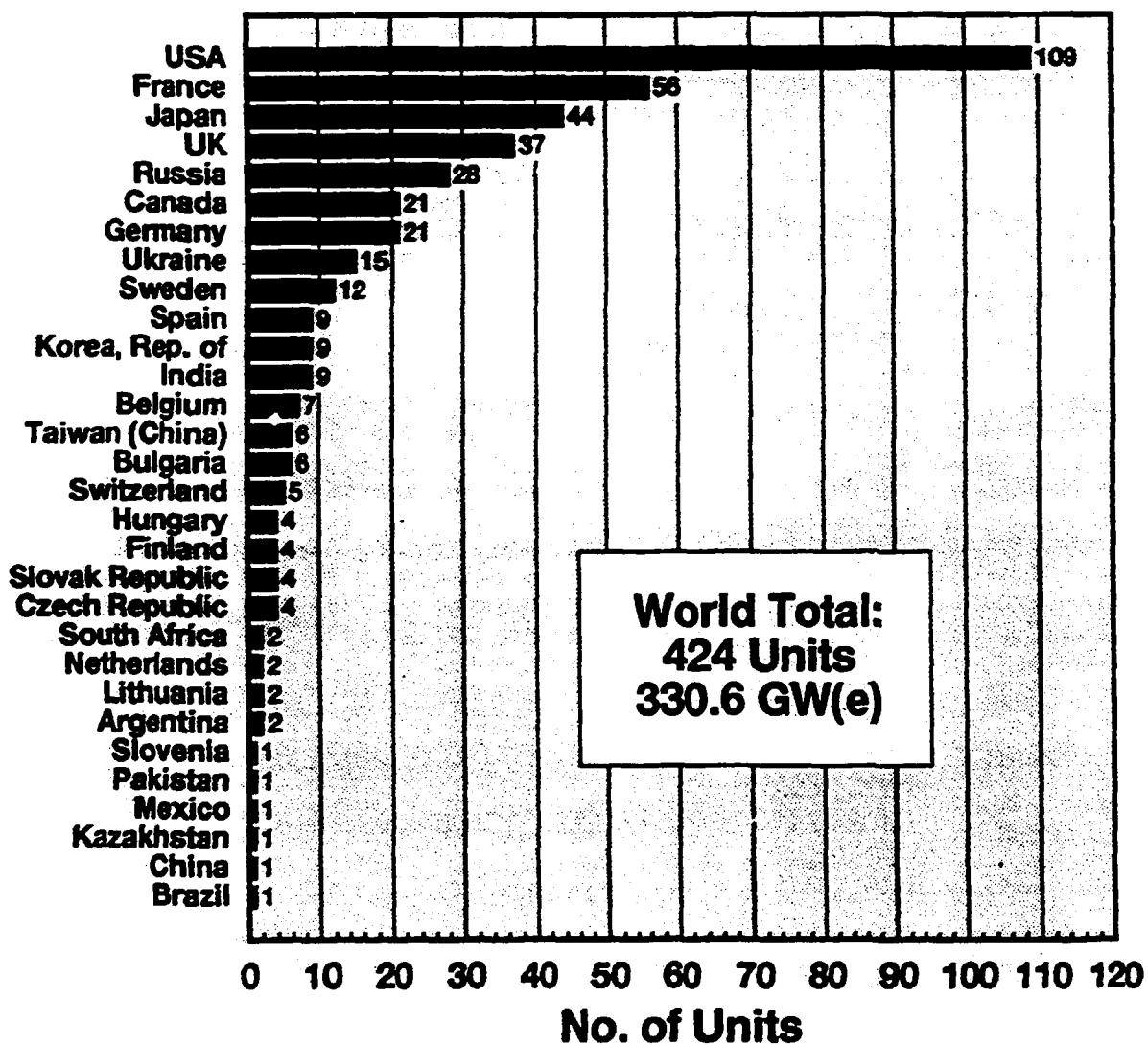
Nuclear power reactor types in operation and under construction as of 31 December 1992



35

	In Operation		Under Construction		
	Units	MW(e)	Units	MW(e)	
PWR	239	209142	PWR	48	43494
BWR	89	72858	BWR	6	5437
GCR	24	4441	GCR	0	0
AGR	14	8090	AGR	0	0
PHWR	32	17856	PHWR	13	6388
LWGR	20	15754	LWGR	4	4155
FBR	5	2362	FBR	1	246
Other	1	148	Other	0	0
Totals	424	330651	Totals	72	59720

No. of Nuclear Power Units in Operation at End of 1992



Source: IAEA Power Reactors Information System (PRIS)



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA



INTERNATIONAL ATOMIC ENERGY AGENCY

INTERNATIONAL WORKING GROUP ON LIFE MANAGEMENT OF NUCLEAR POWER PLANTS (IWG-LMNPP)

Chairman

Scientific Secretary

National Representatives

- | | |
|------------------|---------------|
| - Argentina | - Spain |
| - Austria | - Sweden |
| - Brasil | - Switzerland |
| - Belgium | - U K |
| - Canada | - U S A |
| - Czech Rep. | |
| - France | |
| - Germany | |
| - Hungary | |
| - India | |
| - Italy | |
| - Japan | |
| - Korea, Rep. of | |
| - Netherlands | |
| - Russia | |
| - Slovenia | |

Terms of Reference for the International Working Group on
Life Management of Nuclear Power Plants (IWG-LMNPP)

These Terms of Reference were originally approved by the IWG-RRPC at its Meeting on 17-19 February 1975, modified on 14-16 March 1990 and serve as a basis of the IWGs. They will be reviewed on the request of working group members or the Scientific Secretary and recommendation will be made to the Director General of the IAEA on any modifications.

1. Objectives

- 1.1 To assist the International Atomic Energy Agency to provide its Member States with information and comments on design aspects, material selection, fabrication, testing, operational, maintenance, monitoring, and mitigation of degradation aspects related to "major critical components" with the aim to manage lines (design life as well as extended life) of nuclear power plants by having due regard for effects of components ageing and thus assuring their long-term reliable function.
- 1.2 To promote exchange of information on national and international - programmes and new developments and, if necessary, to stimulate co-ordinated research in the field of reactor plant and components in Member States and Organizations.

2. Scope of activities

The IWG-LMNPP should provide the Secretariat of the IAEA with advice and recommendations on the Agency's activities, forward programmes in this area by means of specialists' meetings, training courses, etc., when they have particular relevance to reliable plant life management, and, specifically, on priority, scope and content of publications in form of guides and manuals, and meetings to be organized and sponsored by the Agency. The scope of the IWG activities include the following topics:

- 2.1 Design
- 2.2 Materials
- 2.3 Fabrication
- 2.4 Monitoring, testing and inspection
- 2.5 Information on service and test conditions
- 2.6 Degradation mechanisms, their significance and mitigation
- 2.7 Plant life management

3. Methods of work

The working group will determine its own methods of work, including frequency of regular and other meetings, preparation of Agenda, establishment of special groups, keeping of records and other procedures. The work of the working group between the regular meetings is carried out and coordinated by the Scientific Secretary taking into account the working group's recommendations. The working group normally meets at the IAEA Headquarters. It may meet from time to time away from the IAEA Headquarters to familiarize itself with activities in a member country. Special arrangements will be made to provide Secretariat services for such meetings in cooperation with the host country.

4. Organizational matters

4.1 Membership

In appointing the membership of this International Working Group the Director General will be guided by the following considerations:

1. The Working Group will include one member and not more than one alternate from each Member State which is an expert actively working in the field of life management of NPP and wishes to participate;
2. Each member and alternate will be appointed after consultation with the member's government; and
3. Members and alternates will normally serve on the Working Group for a period prescribed by their governments, preferably for a period of at least three years.

The Director General may from time to time co-opt members and invite observers from other Member States on an ad-hoc or continuing basis.

A limited number of advisers or specialists from member countries may be invited to attend regular meetings of the working group but the representation of a member country should include the member and/or his alternate.

International Organizations with interest in the same field could be invited as observers to the IWG meetings.

4.2 Chairmanship

A Chairman of the IWG is nominated by the Director General from the members of the Working Group. The chairmanship will be rotated among the members of the IWG periodically, not less frequently than every three years. The Chairman should with the assistance of the Scientific Secretary determine subjects of the meetings, chair the meetings, and conduct them along the lines of the subject. Reports on IWG activities should be reviewed before distribution.

4.3 Secretariat

The Agency provides the administrative and secretarial services required by the Working Group, including translation services, when necessary, meeting rooms, maintenance of records, publication and distribution of documents. The Agency also provides the service of a permanent Scientific Secretary of the Working Group, who is to be in charge of the above mentioned matters.

4.4. Expenses

The respective Governments provide the Agency with experts for the IWG-LMNPP free of cost. Travel and subsistence expenses for experts are borne by the respective Governments or Organizations. Travel cost and subsistence for consultants invited to prepare a draft document or advise the Agency on special aspects of its programme will normally be borne by the Agency.

IWG-LMNPP Current Priorities

1. **Radiation Damage and Annealing of RPV**
 - surveillance data base
 - optimization of surveillance programmes
 - annealing
 2. **RPV Integrity Assessment**
 - fracture mechanics
 - NDE
 - material data bases
 3. **Integrity Assessment of Primary Circuit**
 - LBB
 - NDE
 - corrosion and water chemistry
 - monitoring (loads, water chemistry)
 4. **SG Life Management**
 - corrosion and water chemistry
 - NDE
 - replacement and repair
 5. **Reactor Internals Integrity**
 - radiation damage
 - corrosion (IASCC)
 6. **Concrete Structures Ageing**
 - degradation
 - NDE
 7. **Secondary Circuit Integrity**
 - erosion corrosion
 - water chemistry (optimization and monitoring)
 8. **Plant Life Management of Other Components - Cables etc.**
- Other Important Items**
- guidelines
 - codes and standards
 - quality (assurance)
 - economics

List of Meetings Held Within the IWG-LMNPP (former IWG-RRPC)

1. 3-7 October 1966 Panel on "Recurring Inspections of Nuclear Reactor Steel Pressure Vessels"
2. 2-4 October 1967, Austria IWG on "Engineering Aspects of Irradiation Embrittlement of Reactor Pressure Vessel Steels"
3. 21-25 July 1969, Japan "Development of Advanced Reactor Pressure Vessel Materials"
4. 9-13 February 1970 Panel on "Basic Structural Design Philosophy, Criteria and Safety of Concrete Reactor Pressure Vessels"
5. 10-12 May 1971, Austria IWG on Reactor Pressure Vessels "Effect of Radiation and Other Time-Dependent Phenomena on Steel Pressure Vessel Integrity"
6. 29 Nov. - 3 Dec. 1971, Austria Panel on "Non-Destructive Testing for Reactor Core Components and Pressure Vessels"
7. 2-4 May 1972, Germany Specialists Meeting on "Assessment of Engineering Significance of Embrittlement Effects in Pressure Vessels"
8. 17-18 October 1972, Austria IWG Consultancy on "Reliability of Reactor Pressure Components"
9. 27 Nov. - 1 Dec. 1972, Austria Panel on "Experience and Techniques in Repair of Reactor Components"
10. 28 May - 1 June 1973, Austria Panel on "Methods of Assessment for Assuring Nuclear Power Stations' Reliability"
11. 23-25 October 1974, Austria CRP on "Irradiation Embrittlement of Reactor Pressure Vessel Steels"
12. 17-19 February 1975, Austria Meeting of International Working Group on Reliability of Reactor Pressure Components (IWG-RRPC)
13. 3-5 December 1975, Switzerland SPM on "Fracture Mechanics Applications: Implications of Detected Flaws"
14. 29-31 March 1976, USA TCM on "Stress Corrosion Cracking Problems in the Primary System of Nuclear Power Plants"

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| 15. | 17-18 May 1976, Czech Rep. | TCM on "Reactor Vessel Surveillance: Results of Programmes Conducted and Proposals for Revision" |
| 16. | 19-21 May 1976, Czech Rep. | IWG on "Reliability of Reactor Pressure Components" |
| 17. | 25-27 April 1977, Japan | TCM on "Use of Non-Destructive Testing Techniques for In-Service Inspection of Reactor Pressure Components" |
| 18. | 20-22 June 1977, Sweden | TCM on "Operating Experience Relating to Reliability of LWR Pressure Components" |
| 19. | 14-15 October 1977, Austria | IWG on "Reliability of Reactor Pressure Components" |
| 20. | 13-15 September 1978, Denmark | TCM on "Repair Aspects and Procedures" |
| 21. | 21-25 October 1978, Sweden | SPM on "Periodic Inspection of Nuclear Reactor Steel Pressure Vessels" |
| 22. | 20-21 November 1978, Austria | TCM on "Time and Load Dependent Degradation of Reactor Pressure Bounding Materials" |
| 23. | 5-8 March 1979, Spain | Meeting on "Trends in Reactor Pressure Vessel Development" |
| 24. | 20-22 October 1980, Austria | SPM on "Environmental Factors Causing Pipe Cracks and Degradation in Primary System Components" |
| 25. | 1-3 December 1983, Austria | SPM on "Reliability Engineering and Lifetime Assessment of Primary System Components" |
| 26. | 13-15 May 1981, Germany | SPM on "Subcritical Crack Growth" |
| 27. | 19-21 October 1981, Austria | SPM on "Radiation Embrittlement and Surveillance of Reactor Pressure Vessel Steels" |
| 28. | 4-5 December 1981, Austria | IWG-RRPC Meeting |
| 29. | 14-16 September 1982, Denmark | SPM on "Repair Aspects and Procedures" |
| 30. | 22-26 November 1982, Austria | Int. Symp. on "Water Chemistry and Corrosion Problems of Nuclear Reactor" |

Systems and Components"

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| 31. | 14-16 December 1982, Austria | IWG-RRPC Meeting |
| 32. | 21-25 March 1983, Germany | Int. Symp. on "Reliability of Reactor Pressure Components" |
| 33. | 12-15 May 1983, Italy | SPM on "Defect Detection and Sizing" |
| 34. | October 1983, Finland | SPM on "Corrosion and Stress Corrosion of Pressure Boundary Components" |
| 35. | February 1984, Austria | SPM on "Radiation Embrittlement and Surveillance of RPV Steels" |
| 36. | May 1984, Italy | SPM on "Crack Initiation and Arrest Control during Thermal Transients" |
| 37. | 15-17 May 1985, Japan | SPM on "Sub-Critical Crack Growth" |
| 38. | 3-5 September 1985, Austria | IWG-RRPC Meeting |
| 39. | 25-28 November 1985, Austria | SPM on "Recent Trends in the Development of Primary Circuit Technology" |
| 40. | January 1986, Hungary | SPM on "Time and Load Dependent Material Performance other than Irradiation Effects" |
| 41. | 27-30 May 1986, Czech. Rep. | SPM on "Reactor Pressure Vessel Behaviour under Transient Conditions Caused by Thermal Shock" |
| 42. | February 1987, Austria | IWG-RRPC Meeting |
| 43. | May 1987, USA | SPM on "Irradiation Embrittlement of RPV Steels and Ageing" |
| 44. | 25-27 May 1988, Germany | SPM on "Fracture Mechanics Verification by Large Scale Testing" |
| 45. | 27-29 June 1988, Finland | SPM on "Inspection of Austenitic Dissimilar Materials and Welds" |
| 46. | 12-14 September 1988, Austria | SPM on "Corrosion and Erosion Aspects of Pressure Boundary Components of LWR's" |
| 47. | October 1988, Austria | IWG-RRPC Meeting |

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| 48. | 5-9 June 1989, Czech. Rep. | SPM on "Experience and Further Improvement of In-Service Inspection methods and Programmes of NPPs with Particular Emphasis on On-Line Techniques" |
| 49. | 24-26 October 1989, Argentina | SPM on "Residual Stresses in Structural Materials and Components of NPPs" |
| 50. | 14-18 May 1990, Russia | SPM on "Sub-Critical Crack Growth" |
| 51. | 26-28 Sept. 1990, Hungary | WPM on "Radiation Embrittlement of Nuclear Reactor Pressure Vessel Steels" |
| 52. | 10-12 October 1990, Sweden | SPM on "Nuclear Power Plant Lifetime Assurance" |
| 53. | 24-25 September 1990, Hungary | CRP on "Optimization of Reactor Pressure Vessel Surveillance Programmes and Their Analysis" |
| 54. | 23-26 Sept. 1991, Spain | SPM on "Nuclear Power Plant Components Maintenance, Repair and Replacement for Plant Life Management" |
| 55. | 19-21 November 1991, UK | SPM on "Thermal and Mechanical Degradation" |
| 56. | 17-19 February 1992, Austria | Meeting of the International Working Group on "Life Management of NPPs" |
| 57. | 25-29 May 1992, Hungary | SPM on "Integrity of Pressure Components of Reactor Systems" |
| 58. | June 1992, Czech Rep. | SPM on "Experience in Monitoring Ageing Phenomena for Improving NPP Availability" |
| 59. | 26-29 October 1992, USA | SPM on "Fracture Mechanics Verification by Large Scale Testing" |
| 60. | 20-23 Sept. 1993, France | SPM on "Irradiation Embrittlement and Optimization of Annealing" |
| 61. | 18-22 October 1993, Spain | SPM on "Steam Generator Problems and Replacement" |
| 62. | 22-23 November 1993, Austria | CRP on "Optimization of Reactor Pressure Vessel Surveillance Programmes and Their Analysis" |

- 63. 7-9 February 1994, Austria Meeting of the International Working Group on "Life Management of NPPs"
- 64. 8-10 March 1994, The Netherlands SPM on "Non-Destructive Examination Practices and Results"
- 65. 14-18 March 1994, Argentina SPM on "Advanced Structural Integrity Assessment Procedures"

PROGRAMME FOR 1994

1. **IWG-LMNPP Meeting**
7 – 9 February Vienna

2. **SPM on Non-Destructive Examination Practices and Results (joint with OECD and CEC).**
8 – 10 March Petten (Netherlands)

3. **SPM on Advanced Structural Integrity Assessment**
14 – 16 March Bariloche (Argentina)

4. **SPM on Corrosion and Erosion of NPP Components**
Kiev (Ukraine)

5. **SPM on Sub-Critical Crack Growth**
Japan

6. **Development of Data Base on NPP Components Life Management.**
 - Pressure Vessel
 - Primary Pipings
 - Steam Generators
 - Concrete Structures

7. **CRP on Optimizing of Reactor Pressure Vessel Surveillance Programmes**

8. **CRP on Reactor Pressure Vessel Primary Nozzle**

9. **TRS on Irradiation Effects in RPV Steels and Weldments.**

Tasks Planned for 1995-96

1. Performance of and Issues on LWR Vessel Heads, Internals and Pressure Tubes.	SPM	1995
2. Primary Piping Experience and Issues including Leak-Before-Break.	SPM	1995
3. Irradiation Embrittlement and Mitigation Practices (including internals)	SPM	1995
4. Technical Document on International Reactor Materials Surveillance Data Base	CS	1995
5. Technical Document on Lifetime Management of Nuclear Power Plants	CS, AGM	1995
6. Experience and Issues with In-Service and Condition Monitoring of NPP Components	SPM	1996
7. Steam Generator Lifetime Management, including Replacement and Repair	SPM	1996
8. Fracture Mechanics Applications and Verifications	SPM	1996
9. Sub-Critical Crack Growth	SPM	1996
10. CRP on Management of Ageing of Reactor Pressure Vessel Primary Nozzle (coordinated with NENS)	CRP	1996
11. IWG-LMNPP Meeting	TC	1996
12. Technical Document on Lifetime Management of Nuclear Power Plants	CS	1996

Proposed Study to Follow: CRP IV

Assuring Structural Integrity of Reactor Pressure Vessels

Phase III of the irradiation embrittlement studies focussed mainly upon enhancement of reactor vessel surveillance for future programmes. However, the catastrophic consequences of the failure of a primary pressure vessel (as by pressurized thermal shock - PTS) of any currently operating reactor in the world, dictates a most serious effort to gain the knowledge to preclude such a failure. Because of the limited surveillance materials within these reactors plus knowledge uncertainties or limits in areas critical to understanding factors key to vessel integrity over its anticipated life, the IAEA CRP-III specialists agreed that we must seize this unique opportunity and advance our critical knowledge base. Accordingly, it was unanimously agreed by representatives of all 15 participant nations to extend their studies to a Phase IV which capitalizes, with minimal cost, on unique materials and knowledge to aid nuclear safety of existing reactors.

Considering the severe limitation inherent to current surveillance programmes several goals were accepted. First, to extend the scope of current limited surveillance specimens there is a need to multiply available data through reconstitution of broken or tested specimens. Available irradiated materials could be used to validate or qualify techniques now being developed to reconstitute typical surveillance specimens. Secondly, this multiplied base of irradiated specimens would aid greatly the goals of structural integrity assurance as well as demonstrating the necessary insight for vessel annealing to ameliorate irradiation embrittlement and the mechanisms inherent to this procedure. Thus, structural integrity as well as optimal vessel life may be assured through knowledge generated by a coordinated research effort so directed. Another valuable goal related to this use of irradiated material is to meet the urgent need to develop data from simple fracture specimens now in reactor for understanding the mechanics of fracture using small irradiated specimens. This part of the proposed programme may require additional irradiation of specimens. Two nations, Argentina and Russia, have offered free neutrons for such efforts. If deemed necessary, such added irradiations would require funding for irradiation assemblies and instrumental documentation of exposure parameters.

One major result of CRP-III, was that of aiding the understanding of the mechanisms of irradiation embrittlement in terms of microstructural or micro-metallurgical parameters. The diverse chemistries of Phase 3 materials provide a unique opportunity to study the role of diverse compositions and structures on embrittlement propensity. These special materials have been irradiated by several national specialists and may be studied using already irradiated steels or may be included with any added irradiations cited above.

It should be stressed that interest in the various CRP programmes has increased progressively the years both in terms of participation and content. This is an important assessment criterion for judging the actual need for such successful IAEA programmes and suggests the importance of continuing further support, for the proposed development.