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**THE IAEA PROGRAMME ON
RESEARCH REACTOR SAFETY
-AN UPDATE**

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Abstract

There are close to 270 operating research reactors (RR) worldwide. Only four of these reactors are new (i.e., commissioned in 1995 or later), while 23 reactors have been shutdown in this period. Technical and safety problems, lack of strong utilization programmes and of adequate budgets and concern about ageing are the primary causes for this situation. Indeed, over 50% of the operating RRs are over 30 years old, and 25% are between 20-30 years old. On this background, decommissioning programmes gain increasing importance beside plans for refurbishment of old reactors.

The IAEA's programme on RR Safety entails three major projects: (1) The development of guidance documents on research reactor safety, covering both general aspects and special topics of current concern; (2) rendering advisory & other services related to RR safety to Member States, such as safety review missions, training courses, and other technical assistance through Technical Co-operation Projects; and (3) promotion of the sharing and exchange of information on RR safety through the organization of conferences and topical seminars and of coordinated research programmes and through the establishment and maintenance of an Incident Reporting System for RRs (IRSRR).

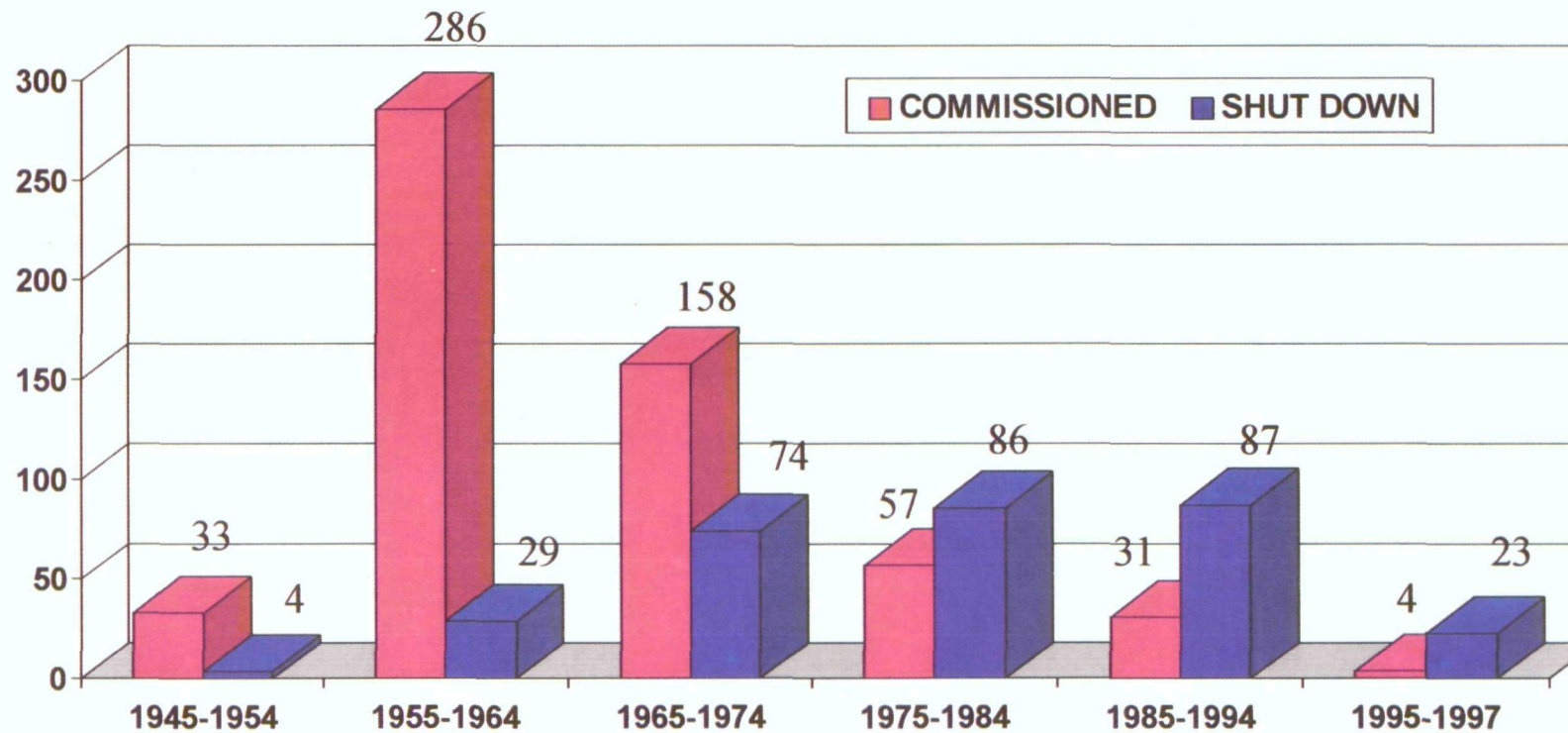
Essentially, the actual programme is constantly modified to reflect current needs and concerns. Thus, among the new documents developed are guidelines for the determination of source terms for RR safety analyses & emergency planning, a guide on RR core and fuel handling, and another guide on extended shutdowns and mothballing of RRs.

Among the new services envisaged are extension of the NPP ASSET service (Assessment of Safety Significant Events Teams) to RRs, conducting trainings on self assessments, and providing specific assistance to regulatory bodies. An expansion of the number & types of technical assistance regional and country projects & training courses is also planned. The new Incident Reporting System for RRs launched last year is an example of a new effort in the experience-sharing area.

In this context, it is worthwhile to mention the Agency's programme on the enhancement of the safety of nuclear installations. The Agency started in this framework, in 1997, an extrabudgetary programme in some countries of South East Asia, the Pacific and the Far East intended to assist these countries to strengthen nuclear safety and, in particular, to enhance the technical capabilities of regulatory authorities and supporting technical organizations. This programme includes the preparation of country profiles for prioritizing the developed action plans, and encompasses research reactors as well as nuclear power plants.

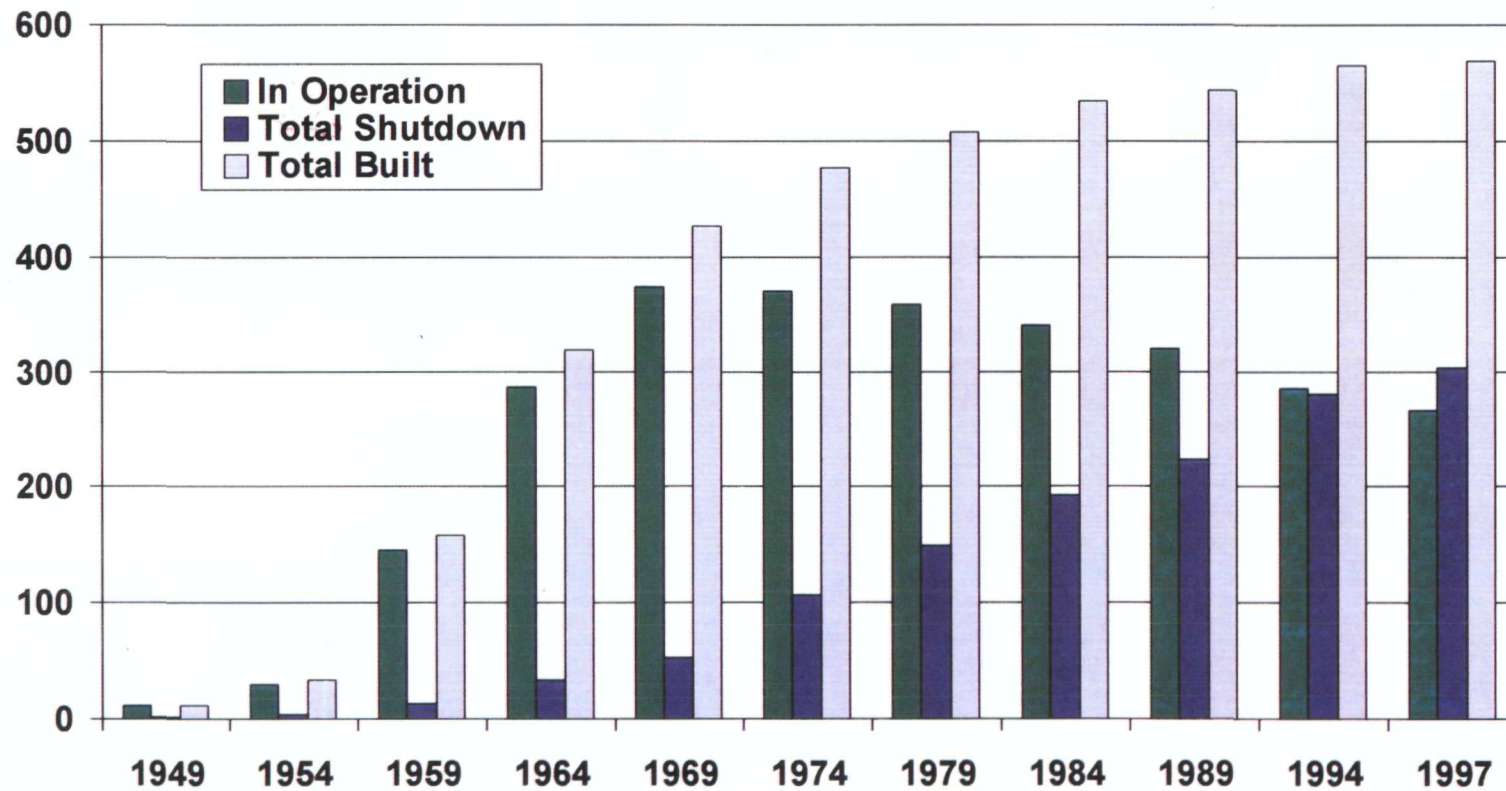
This paper surveys briefly the RR situation worldwide and provides a brief yet fairly complete picture of the Agency's current and planned activities in this area.

NUMBER OF RESEARCH REACTORS COMMISSIONED AND SHUT DOWN (1945 - 1997)



- 5 -

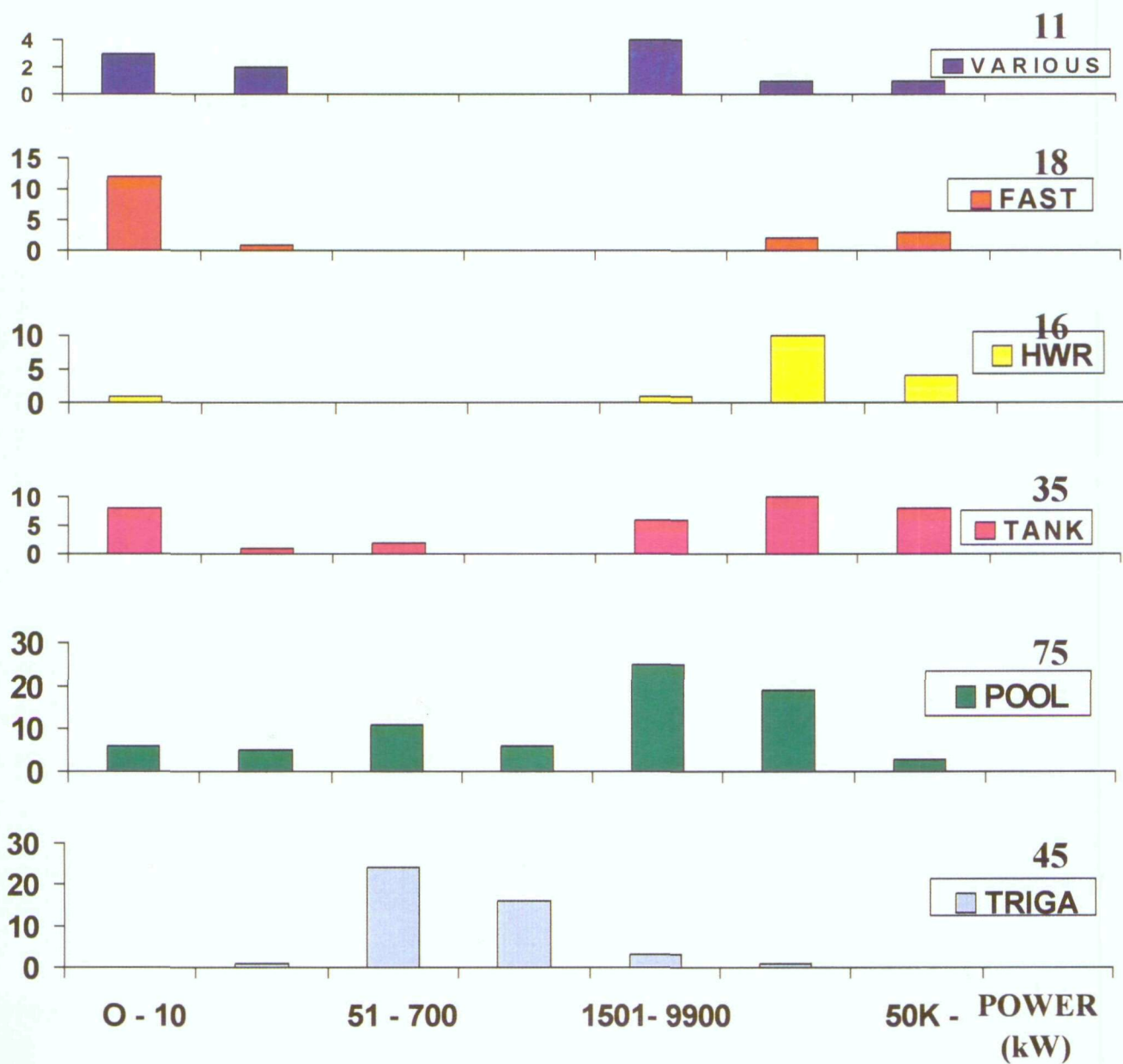
CUMULATIVE NUMBER OF RESEARCH REACTORS COMMISSIONED AND SHUT DOWN (1949 - 1997)



RESEARCH REACTOR TYPES (1)

(WIDE POWER RANGE TYPES)

-1996-

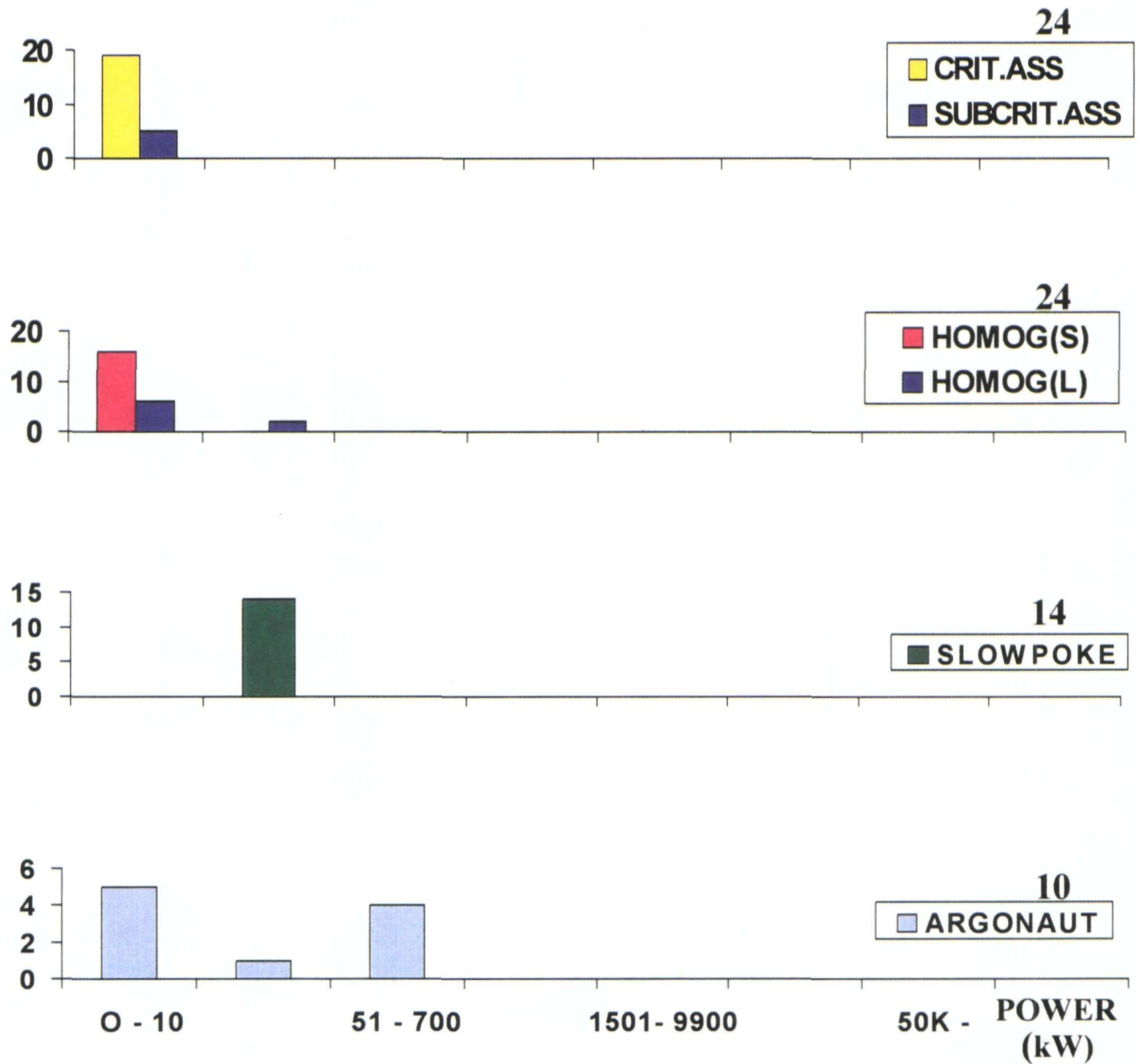


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RESEARCH REACTOR TYPES (2)

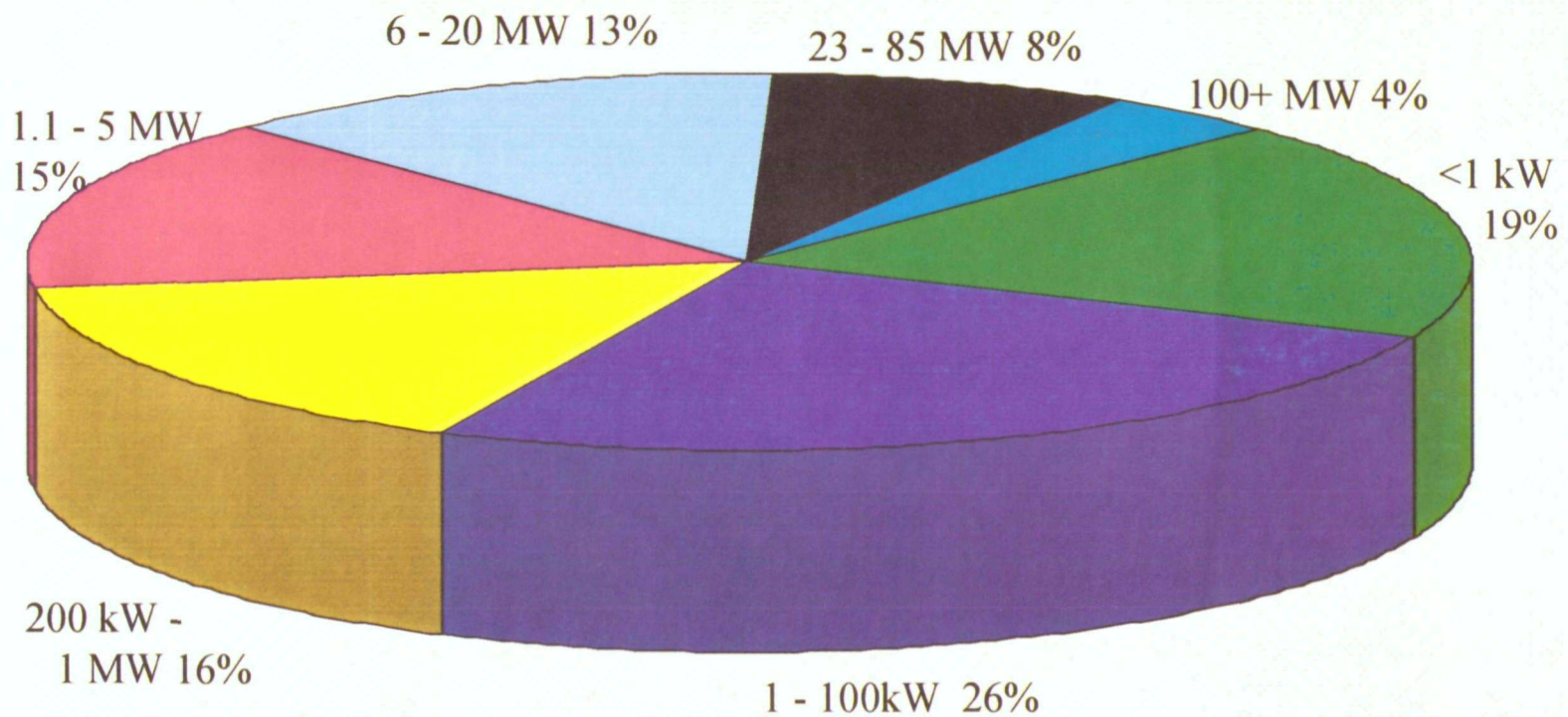
(LOW POWER RANGE TYPES)

-1996-

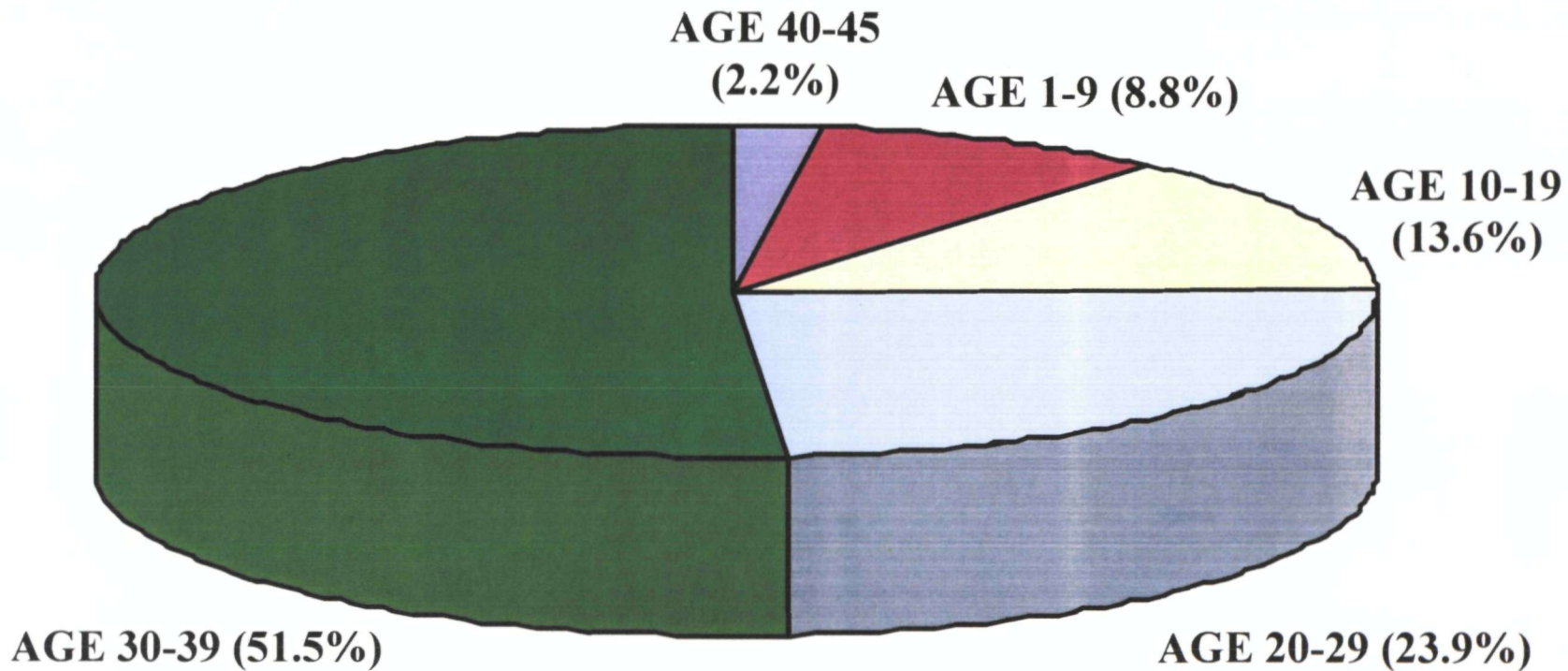


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POWER DISTRIBUTION OF OPERATING RESEARCH REACTORS



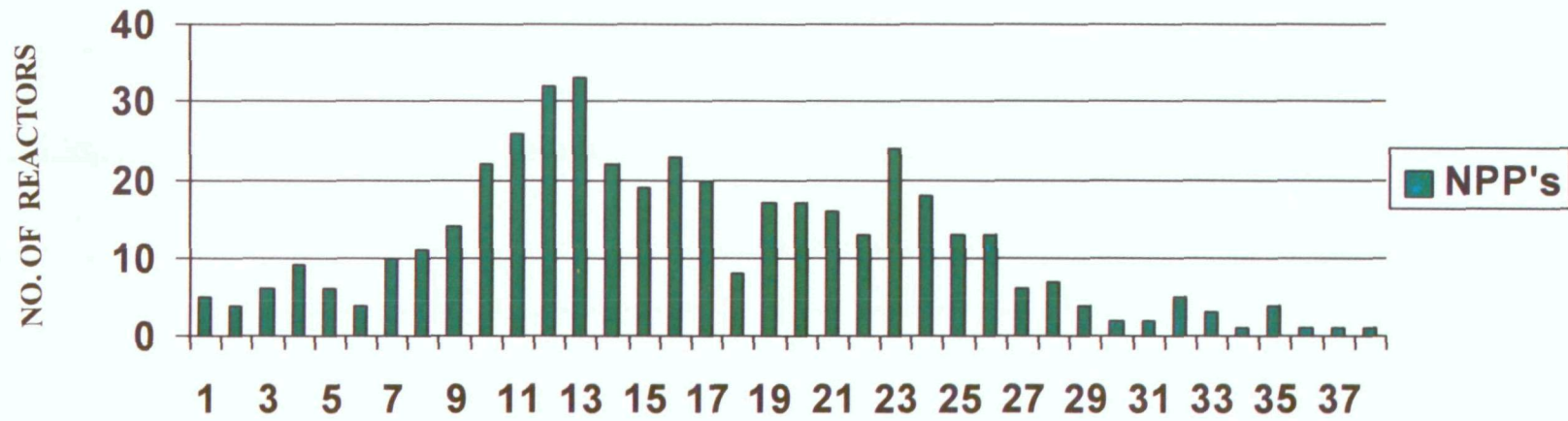
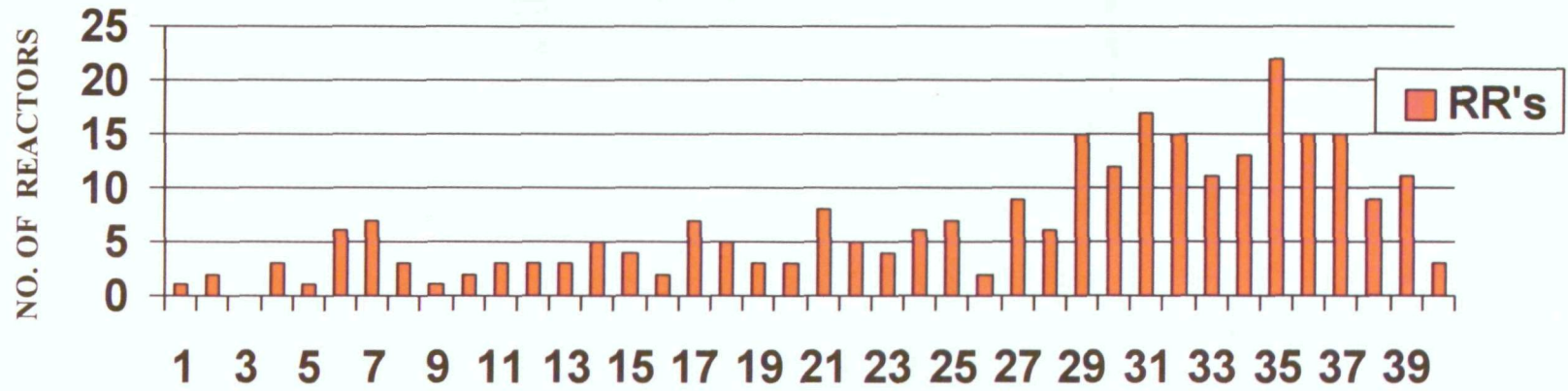
- 9 -



Age Distribution of Research Reactors in the RRDB : Age and Percentage.

NUMBER OF REACTORS BY AGE

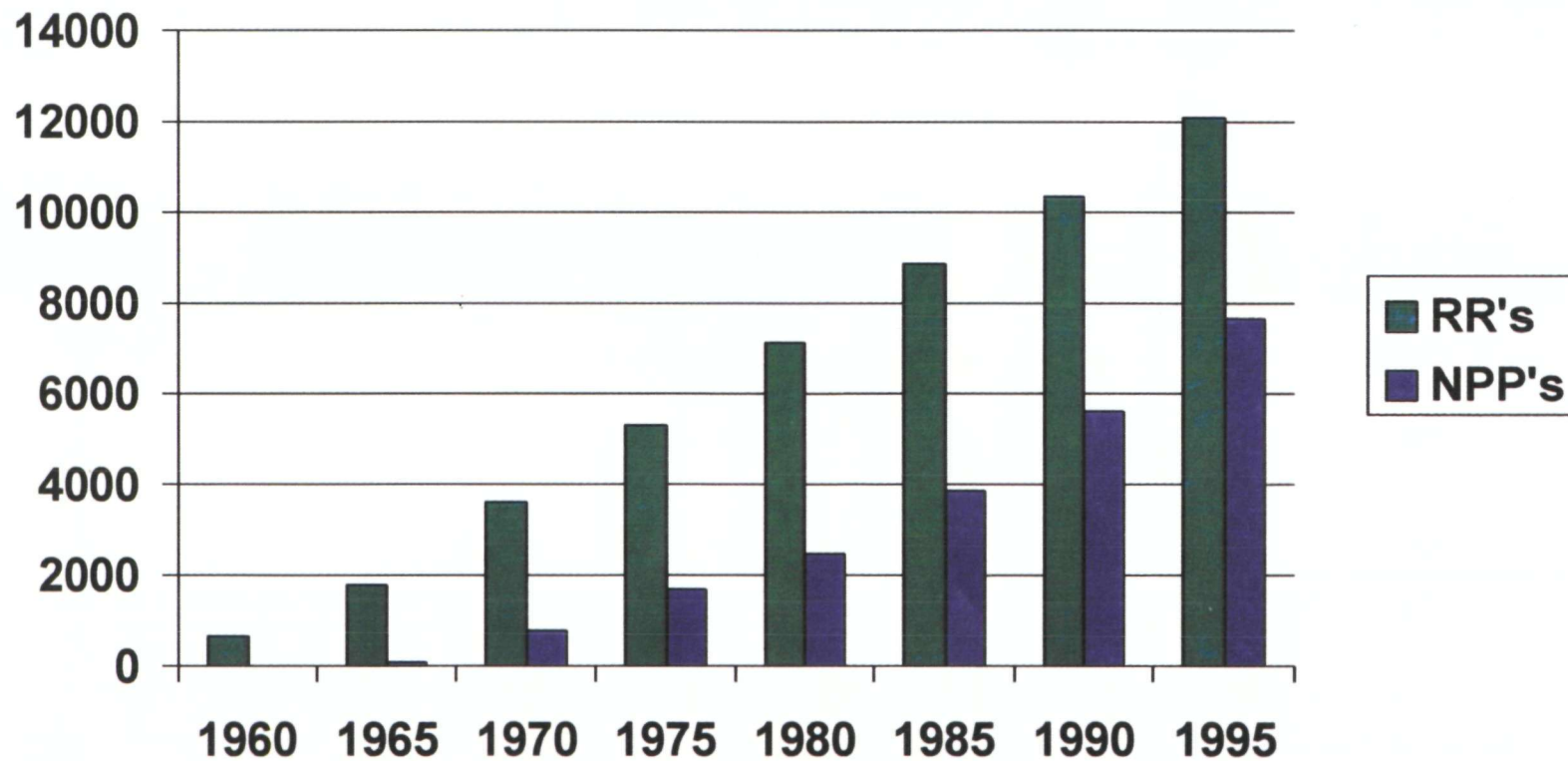
December 1996



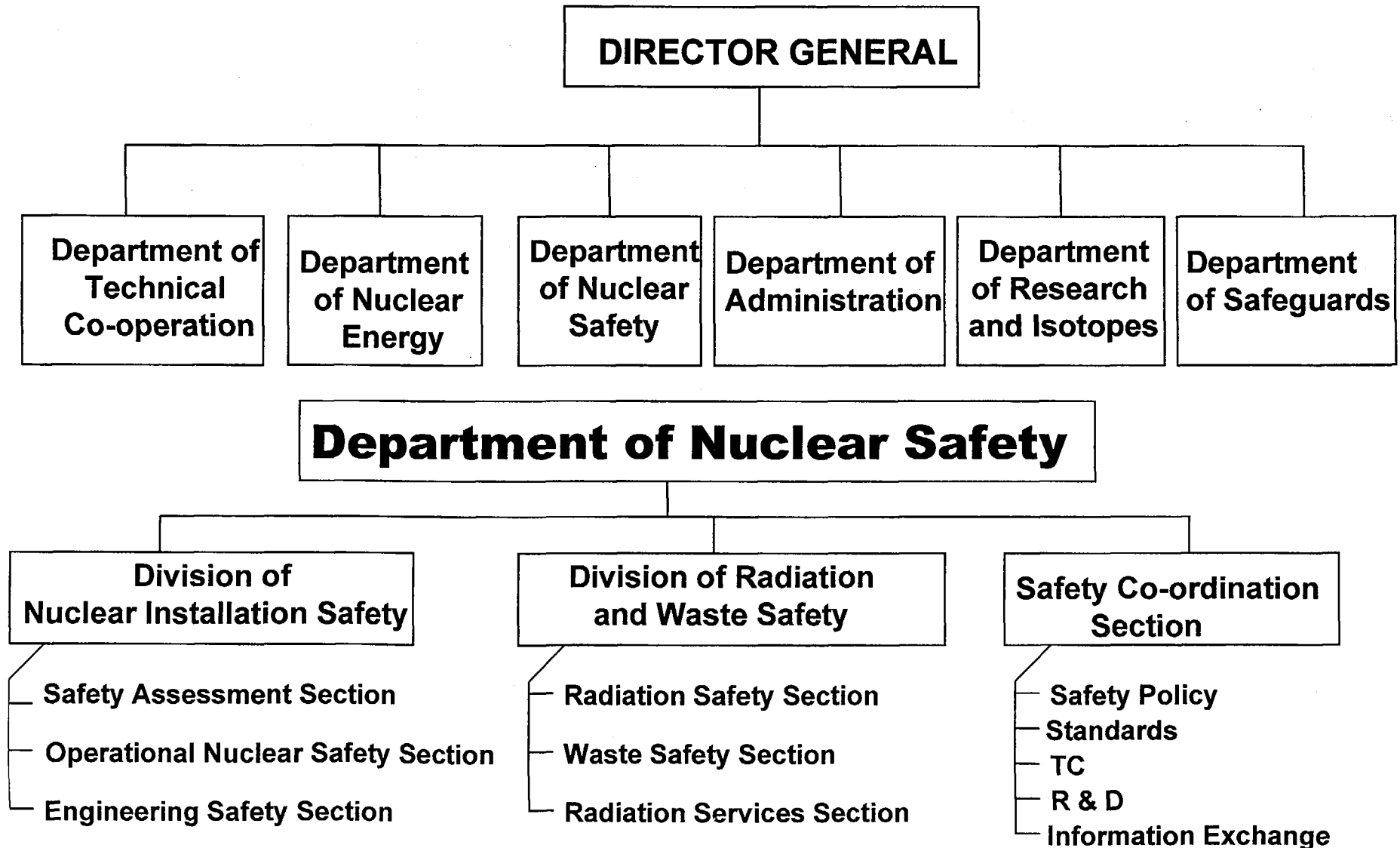
Reactor Age (years)

- II -

CUMULATIVE EXPERIENCE (*REACTOR-YEARS*) FOR RESEARCH REACTORS AND NUCLEAR POWER PLANTS



INTERNATIONAL ATOMIC ENERGY AGENCY



IAEA PROGRAMME ON RESEARCH REACTOR (RR) SAFETY

- 1. DEVELOPMENT OF GUIDANCE PUBLICATIONS ON RESEARCH REACTOR SAFETY**
 - SAFETY SERIES PUBLICATIONS
 - PUBLICATIONS OUTSIDE OF SAFETY SERIES

- 2. RENDERING OF SERVICES RELATED TO RR SAFETY TO MEMBER STATES**
 - SAFETY (INSARR) MISSIONS TO RRS
 - SUPPORT TO TC PROJECTS DEALING WITH RR SAFETY ISSUES
 - REGIONAL AND INTERREGIONAL TRAINING COURSES (WITH TC)

- 3. PROMOTION OF THE EXCHANGE OF INFORMATION ON RR SAFETY**
 - ESTABLISHMENT & MAINTENANCE OF THE INCIDENT REPORTING SYSTEM FOR RRS (IRSRR)
 - ORGANIZATION OF CONFERENCES AND SEMINARS
 - ORGANIZATION OF COORDINATED RESEARCH PROGRAMMES

INSARR = Integrated Safety Assessment of Research Reactors.

THE HIERARCHY OF IAEA SAFETY STANDARDS DOCUMENTS (Present Status)

- **Safety Fundamentals**
- e.g. **The Safety of Nuclear Installations: SS-110**
- **Safety Standards (Regulation)**
- e.g. **Code on the Safety of Nuclear Research Reactors:
Operation (SS-No. 35-S2, 1992)**
- **Safety Guides**
- e.g. **Safety in the Utilization and Modification of Research
Reactors (SS-No. 35-G2, 1994)**
- **Safety Practices (Safety Reports)**
- **TECDOCs**

IAEA RESEARCH REACTOR SAFETY SERIES
September 1997

SAFETY FUNDAMENTALS

**THE SAFETY OF NUCLEAR INSTALLATIONS:
A SAFETY FUNDAMENTAL, SS NO. 110**

SAFETY REQUIREMENTS

**SAFETY REQUIREMENTS FOR THE DESIGN AND
OPERATION OF RESEARCH REACTORS**

**REVISE & COMBINE
SS-35-S1 AND S2**

SAFETY GUIDES

**SAFETY ASSESSMENT OF RRs & PREPARATION OF
THE SAR**

**SS-35-G1
(1994)**

**SAFETY IN THE UTILIZATION AND MODIFICATION
OF RRs**

**SS-35-G2
(1994)**

SAFETY IN THE COMMISSIONING OF RRs

SS-35-G4

OPERATIONAL LIMITS & CONDITIONS FOR RRs

SS-35-G6

MAINTENANCE, PERIODIC TESTING & INSPECTION OF RRs

SS-35-G7

**DESIGN, SAFETY ASSESSMENT AND OPERATION OF
STORAGE FACILITIES FOR RR SPENT FUEL**

SS-35-G5

IAEA RESEARCH REACTOR SAFETY PUBLICATIONS

STANDARDS/REQUIREMENTS

Code on Design of RRs	SS 35-S1	Published, 1992
Code on Operation of RRs	SS 35-S2	Published, 1992

SAFETY GUIDES

Safety Assessment & Preparation of SAR	SS 35-G1	Published, 12/1994
Utilization & Modification of RRs	SS 35-G2	Published, 12/1994
Decommissioning of RRs	SS No: 74	Published, 1986

IAEA SERVICES REPORTS

Guidelines for Safety Reviews of RRs	SVS-01	Published, 1997
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TECDOCs

Siting	No: 403	Published, 1987
Earthquake Resistant Design	No: 348	Published, 1985
Specification & Inspection of Plate type MTR RR Fuels (*)	No: 467	Published, 1988
Management of RR Ageing	No: 792	Published, 1995
Instrumentation & Control (*)	No: 448	Published, 1988
Core Conversion Guidebook (*)	No: 233	Published, 1980
Core Conversion Guidebook (5 volumes) (*)	No: 643	Published, 1992
Application of PSA to RRs (*)	No: 517	Published, 1989
PSA for RRs (*)	No: 400	Published, 1986
Manual on Reliability Data Collection for RR PSAs (*)	No: 636	Published, 1992
Generic Component Data for RR PSA (*)	No: 930	Published, 1997
RR Renewal & Upgrade Programmes (*)	No: 214	Published, 1978
Management & Storage of Spent Nuclear Fuel at Research & Test Reactors (*)	No: 900	Published, 1996

(*) not an NSNI/ESS Publication.

**IAEA RESEARCH REACTOR SAFETY PUBLICATIONS UNDER DEVELOPMENT
(Status, April 1998)**

		Present status	Work needed to complete task
<u>REQUIREMENTS</u>			
Safety Requirements for the Design and Operation of Research Reactors	SS-35-S	Revision and merging of SS-35-S1 and S2 started in 1997, to be completed 1999	TCM98, and CS 99.
<u>GUIDES</u>			
Safety in the Commissioning of RRs	SS 35-G4	Draft 8/1997. Approved by NUSSAC. Pending publication.	(None) Work completed.
Operational Limits and Conditions for RRs	SS 35-G6	Draft 8/1997. Approved. Pending publication.	(None) Work completed.
Maintenance, Periodic Testing & Inspection of Research Reactors	SS 35-G7	Draft 1/1997. Approved by NUSSAC. Pending publication.	(None) Work completed
Design, Safety Assessment and Operation of Storage Facilities for Research Reactor Spent Fuel	SS 35-G5	Draft exists. Developed by NENF. Approved by NUSSAC. Pending publication.	(None) Work completed
<u>SAFETY REPORTS (Practices)</u>			
Instrumentation and Control Systems in RRs	SS 35-P2	Draft 8/1995, modified in 10/96, reviewed by AGM in 11/1996.	(1 or 2 more meetings needed) 60% complete.
Provision of Radiation Protection Services in RRS	SS 35-P3	Draft reviewed by TCM 6/95. Re-edited by a CS 10/96.	(None) 90% complete. Work needed on Annexes only.
Operating Procedures for RRs	SS-35-P5	Draft 1/94. To be reviewed internally and published shortly.	(None) Work completed.
Training and Qualification of Operating Personnel		First draft developed by a CS in 3/96. Reviewed by TCM in 11/1996. To be submitted for publication shortly.	(None) Work completed.
Safety of Core Management and Fuel Handling		Draft developed by CS 7/97.	CS and TCM 1998. (50% done)
Source Terms & Radiological Impact Analysis for RR Accidents		Draft developed by a CS in 10/96 and 7/97. Reviewed by AGM 12/97. To be completed in 1998.	CS 1998 (50% completed).
<u>TECDOCs</u>			
Experience with RR Incidents	TECDOC	Draft completed. Under final editing prior to publication.	(None) 95% complete.
Review of INSARR Results	TECDOC	Started/1995. Draft improved by AGM 9/97.	70% complete. To be completed in 1998.
Extended Shut-downs and Mothballing of Research Reactors	TECDOC	Draft developed by CS 7/97. To be completed in 1999.	AGM or TCM in 1999.

TABLE I: STATISTICS ON SAFETY REVIEW MISSIONS TO RESEARCH REACTORS

	1972-1976	1977-1981	1982-1986	1987-1991	1992-1996	1997
REVIEWS CONDUCTED PURSUANT TO PROJECT AND SUPPLY AGREEMENTS						
Argentina	1973(2)	1978 (2)			1992(2)	
Chile	1973	1977	1986	1991		
Congo, Dem.Rep.of		1979	1984		1996	
Finland	1976	1981		1987		
Ghana						1997
Greece	1972, 1976		1982, 1986		1993	
Indonesia	1972, 1974	1978, 1979	1982, 1986		1994	
Iran, Islam. Rep.of	1972, 1976			1990		
Jamaica			1986		1994	
Japan	1976					
Malaysia		1977	1982, 1986			1997
Mexico	1972,1973(3)	1977(4),1981(4)	1986(4)		1994(3)	
Norway				1987		
Pakistan	1976		1985			
Peru		1978,1981		1987	1992	1997
Philippines	1972,1973,1975	1978	1983			
Romania			1983		1992	
Spain			1982,1986			
Thailand	1974	1978	1982	1987		1997
Turkey		1977	1986		1992	
Uruguay	1974	1978,1979	1984			
Venezuela	1975	1979	1984	1988		
Viet Nam			1985	1989	1995	
Yugoslavia (Slovenia)	1976		1985		1992	
REVIEWS CONDUCTED AT THE REQUEST OF MEMBER STATES						
Bangladesh					1995	
Brazil	1973	1977		1991		
Bulgaria				1990		
Chile				1991		
Colombia		1997	1983	1987		
Egypt			1985			
Hungary			1983	1989	1993	
Indonesia		1979	1982,1986		1994	
Iraq				1988(2)		
Kazakstan					1993	
Korea, Rep. of	1976		1982(2)	1988(2)		
Norway				1988		
Peru					1992	1997
Portugal					1992	
Russia				1990(2)		
Turkey					1992	
Ukraine				1991		
Uzbekistan					1993	
Yugoslavia			1985			
TOTAL NUMBER OF REACTORS VISITED	25	27	32	21	23	5

TECHNICAL ASSISTANCE TO MEMBER STATES (1)

AREAS IN WHICH ASSISTANCE IS COMMONLY REQUESTED BY MEMBER STATES:

- ~ PREPARATION & REVIEW OF SAR FOR NEW RESEARCH REACTOR**
 - ~ LICENSING REVIEW OF A NEW RESEARCH REACTOR**
 - ~ COMMISSIONING OF NEW OR MODIFIED RESEARCH REACTOR**
 - ~ REVIEW OF THE FACILITY'S SAFETY & RECOMMENDATION OF REMEDIAL ACTIONS**
 - ~ REVIEW OF 'CONDUCT OF OPERATION' & RECOMMENDATION OF IMPROVEMENTS**
 - ~ PROCUREMENT OF EQUIPMENT & REVIEW OF ITS SUCCESSFUL INSTALLATION**
 - ~ SITING STUDIES FOR NEW RESEARCH REACTORS**
 - ~ TRAINING OF PERSONNEL (COURSES, FELLOWSHIPS, SCIENTIFIC VISITS)**
 - ~ UTILIZATION RELATED PROJECTS**
 - ~ DECOMMISSIONING OF SHUTDOWN FACILITIES**
-

THE INCIDENT REPORTING SYSTEM FOR RESEARCH REACTORS (IRSRR)

- 1. Similar in purpose and scope to IRS for NPPs**
- 2. Manual on reporting incidents in standardized format issued January 1997**
- 3. Ca. 60 Member States operating RRs invited to participate in IRSRR (circular No. J7.10 of 3 June 1997)**
- 4. Until 31 December 1997, 13 Member States accepted the invitation and confirmed their participation:**

Argentina	Chile	Hungary	Turkey
Austria	Egypt	Pakistan	Yugoslavia
Brazil	Finland	Slovenia	China
Canada	France	Tunisia	Portugal
- 5. More countries expected to join in**
- 6. Joining countries are asked to include selection of historical incidents with important (and still valid) lessons in their first report(s).**
- 7. Database expected to be very useful on the basis of the accumulated experienced of 12,500 reactor-years with research reactors.**

**RECENT AND PLANNED IAEA MEETINGS, CRPs, COURSES
ON RESEARCH REACTOR SAFETY**

TYPE OF ACTIVITY	1995	1996	1997	1998	1999	2000	2001
COORDINATED RESEARCH PROGRAMME (CRP)	NDT AND ISI IN RESEARCH REACTORS (1994-1999)						
					UPDATING & EXPANSION OF THE IAEA RELIABILITY DATA FOR RR PSAS (1999-2004, INCO-OPERATION WITH SAS)		
MEETINGS	SEMINAR ON MANAGEMENT OF AGEING IN RESEARCH REACTORS 8-12 MAY GEESTHACHT, GERMANY				INTERNATIONAL SYMPOSIUM ON UTILIZATION, SAFETY AND MANAGEMENT OF RESEARCH REACTORS, LISBON, PORTUGAL (24-28 May)		
REGIONAL COURSES		TRAINING COURSE ON SAFETY DOCUMENTATION FOR RESEARCH REACTORS 9-20 MARCH, CAIRO, EGYPT (AFRICA)	PSA FOR RESEARCH REACTORS 27-31 OCTOBER, PELINDABA SOUTH AFRICA (AFRICA)	SAFETY OF RESEARCH REACTOR FACILITIES 28 SEPT. - 16 OCT. REŽ, CZECH REPUBLIC (EUROPE)	1. SAFETY OF RESEARCH REACTOR FACILITIES (E. ASIA) 2. TRAINING COURSE ON SAFETY INSPECTION TECHNIQUES (AFRICA)		
INTERREGIONAL COURSES	SAFETY IN THE OPERATION OF NUCLEAR RESEARCH REACTORS 8 MAY - 2 JUNE ARGONNE, USA + CHALK-RIVER, CANADA			REGULATORY ASPECTS & SAFETY DOCUMENTATION OF RESEARCH REACTORS 18 MAY - 5 JUNE ARGONNE, USA + CHALK-RIVER, CANADA		REGULATORY ASPECTS AND SAFETY DOCUMENTATION OF RESEARCH REACTORS	OPERATIONAL SAFETY OF RESEARCH REACTORS (?)

SELECTED ISSUES IN RESEARCH REACTOR SAFETY (PROPOSED TOPICS)

- 1. *On-site accident management in research reactor facilities***

types of accidents; triggering events; detection & altering; approach to management (diagnosis, mitigation, source assessment, notification); radiation protection considerations on and near site.
- 2. *PSAs for on-going evaluation of research reactor facilities***

experience with PSAs in research reactors; scope of application, problems (lack of reliability data, human reliability).
- 3. *Human reliability issues in research reactors***

problem: loss of thorough knowledge, loss of alertness, automatic performance of daily routines.
treatment: retraining, drills, multitasking, “projects”.
- 4. *Self assessment of research reactor safety***

approach to self assessment; use of TECDOC questionnaire for this purpose.
- 5. *Guidelines for the preparation of environmental assessments and safety analysis (Ch. 14 and 16 of the SAR, SS 35-G1)***

design basis scenarios and their analyses for small and intermediate RRS.
- 6. *Site related considerations for existing research reactors***

environmental changes: population distribution, external risks; improved knowledge: geoseismology, other natural events, identified weaknesses in facility, modern design criteria.
- 7. *The application of the principle of safety culture in small facilities***
- 8. *Regulatory practices related to research reactors (strengthening of)***
- 9. *QA issues in research reactors***
- 10. *Risk oriented ‘classification’ of research reactors***

by potential for overheating and meltdown, potential for reactivity transients, safe shutdown capabilities, ‘riskiness’ of experimental practices, robustness of containment /confinement, overall security.