XA04C0097

STATUS OF RESEARCH REACTOR SPENT FUEL WORLD-WIDE

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Abstract

Results complied in the research reactor spent fuel database are used to assess the status of research reactor spent fuel world-wide. Fuel assemblies, their types, enrichment, origin of enrichment and geological distribution among the industrialised and developed countries of the world are discussed. Fuel management practices in wet and dry storage facilities and the concerns of reactor operators about long-term storage of their spent fuel are presented and some of the activities carried out by the International Atomic Energy Agency to address the issues associated with research reactor spent fuel are outlined.

1. Introduction

Activities in the area of management, interim storage and ultimate disposal of spent nuclear fuel from research and test reactors are dominated at the present time by two important programmes. The first, the subject of this meeting, is the Reduced Enrichment for Research and Test Reactors (RERTR) programme, and the second is the take-back of spent research reactor fuel by the country where it was originally enriched. In the minds of most research reactor operators, these two programmes are closely linked because a spent fuel take-back programme is the only tangible benefit to be gained from the conversion of their reactor cores from burning highly enriched uranium (HEU) to low enriched uranium (LEU), other than the altruistic goal of non-proliferation. The RERTR programme has already limited and will, if it becomes global, eventually eliminate all trade in HEU for research reactors to the ultimate benefit of all mankind.

Unfortunately, at the time of writing, there is no take-back programme of spent research reactor fuel by a supplier country in operation. However, there is a great optimism that a successful completion of the Draft Environmental Impact Statement (EIS) on a Proposed Nuclear Weapons Non-proliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, released for public comment by the United States Department of Energy (DOE) earlier this year, will lead to the immediate resumption of the take-back programme by one of the world's two major supplier countries, the United States of America. It is hoped that other supplier countries and partners in RERTR will follow suit and implement their own take-back programmes for foreign research reactor spent fuel.

Although the IAEA has been involved with and has fully supported RERTR since its inception through its Department of Research and Isotopes, it was not until 1993 that the Nuclear Fuel Cycle and Waste Management Division extended the scope of its spent fuel management programme to include programmes which focused specifically on spent fuels from research and test reactors. These activities cover the collection, analysis and dissemination of information on storage, management and related experience with spent fuels, formulation of norms and provision of technical assistance to developing Member States. A number of concerns were immediately apparent at the beginning of 1993. Many research reactors were in a crisis situation or rapidly approaching a crisis situation and in every case, this was due to spent fuel storage and management problems and the constraints of national laws. It was clear that the capacity for spent fuel storage had been reached or was close to the limit at many research reactors and there were concerns from a materials' science point of view about ageing materials in ageing storage facilities. The IAEA's activities in this area have been formulated to address these concerns, but the first step was to obtain an overall picture of spent fuel management and storage world-wide. This has been attempted by the circulation to research reactor operators of questionnaires specifically designed to form the input to the Research Reactor Spent Fuel Database (RRSFDB). Construction and maintenance of this database is an ongoing activity and this report provides a snapshot at the time of writing of the salient information gleaned from the infant RRSFDB supplemented by information from the more established Research Reactor Database (RRDB). In addition, an outline of activities in the subject area planned by the IAEA in 1995 and 1996 is presented.

2. General Overview

Most of the information presented in this section is taken from the RRDB, specifically from the IAEA publication "Nuclear Research Reactors in the World" December 1994 Edition [1]. The RRDB was first published in 1989 [2] and has been maintained ever since. As of December 1994 there was information on 589 reactors stored in the RRDB. Of these, 296 were operational, 12 under construction, 8 planned, 272 shut-down and 1 for which the information was not completely verified.

The evolution of the number of countries with at least one research reactor is shown in Figure 1. This distribution peaked for developing countries in 1985 but remained almost constant for industrialised countries from 1965 to the present. The IAEA divides the world into seven regions and the those countries with at least one research reactor are listed by region in Table 1.

Table 1

North America	Western Europe	Eastern Europe	Industrialized Pacific	Asia	Latin America	Africa & Middle East
CANADA	AUSTRIA	BELARUS	AUSTRALIA	BANGLADESH	ARGENTINA	ALGERIA
USA	BELGIUM	BULGARIA	JAPAN	CHINA	BRAZIL	EGYPT
	DENMARK	CZECH REPUBLIC		INDIA	CHILE	GHANA
	EUROPEAN UNION	GEORGIA		INDONESIA	COLUMBIA	IRAN, ISLAMIC REP. OF
	FINLAND	HUNGARY		KOREA, DPR	CUBA	IRAQ
	FRANCE	KAZAKEISTAN		KOREA, REP.	ECUADOR	ISRAEL
	GERMANY	LATVIA		MALAYSIA	JAMAICA	LIBYAN ARAB JAMAHIRIYA
	GREECE	POLAND		PAKISTAN	MEXICO	MADAGASCAR
	ITALY	ROMANIA		PHILIPPINES	PERU	MOROCCO
	NETHERLANDS	RUSSIAN FEDERATION		SRI LANKA	URUGUAY	NIGERIA
	NORWAY	SLOVAK REPUBLIC		TAIWAN, CHINA	VENEZUELA	SOUTH AFRICA
	PORTUGAL	SLOVENIA		THAILAND		SYRIAN ARAB REP.
	SPAIN	UKRAINE		VIETNAM		TUNISIA
	SWEDEN	UZBEKISTAN				ZAIRE
	SWITZERLAND	YUGOSLAVIA				
	TURKEY					
	UNITED KINGDOM					

The status of research reactors in RRDB is shown by region in Figure 2.

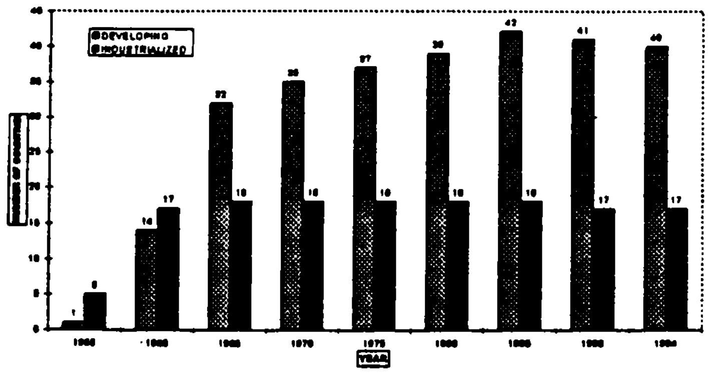

Figure 1:- Countries with operational research reactors

The age distribution of operational research reactors in the RRDB is shown in Figure 3. It peaks in the range of 25 to 35 years. In fact, 32.8% of the reactors are in the age range of 20 to 29 years and 42.3% in the range 30 to 39 years.

As shown in Figure 4, a large fraction of operational research reactors are low power with 46.8% or 139 reactors with a thermal power of 100 kW or less.

Finally, as shown in Figure 5, while the number of research reactors in industrialised countries peaked in 1970, the number in developing countries appears to be still gradually rising. Although the RRDB has a section on fuel, it dose not address the details of spent fuel storage and management. For this reason, a questionnaire on spent fuel management and storage was designed and circulated to research reactor operators for the first time in February 1993. Responses to this first questionnaire and subsequent revisions sent to selected research reactors revealed a number of deficiencies in the design of the questionnaire, which have been rectified in the current version (Appendix 1). This latest version will be circulated to research reactor operators world-wide early in 1996. An overview of the responses received to date, compiled in the RRSFDB, is presented in the next section.

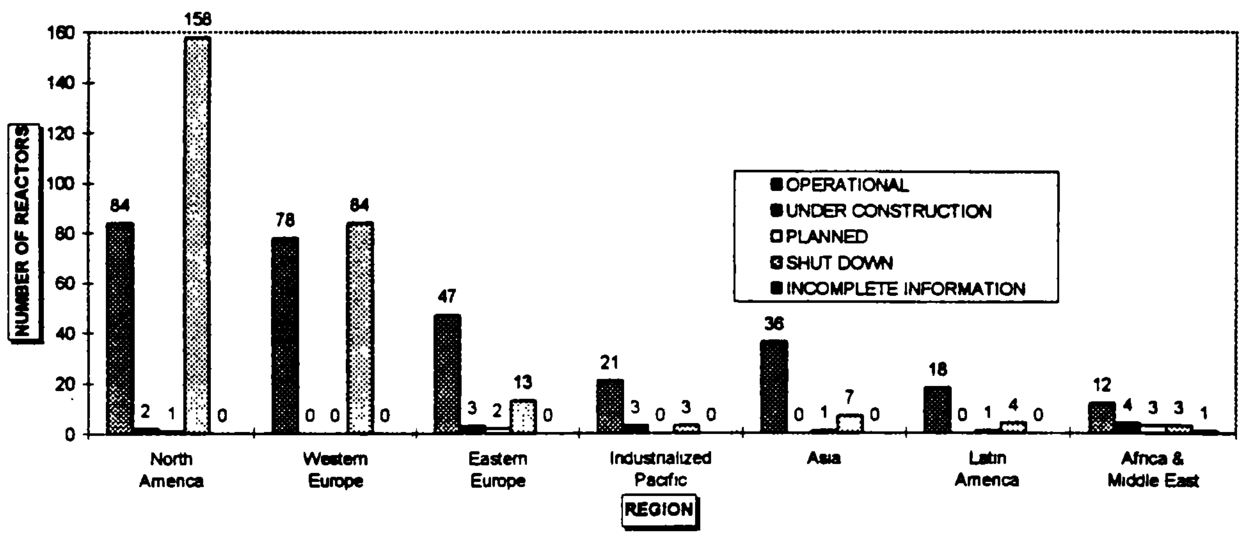

Figure 2:- Research reactor status.

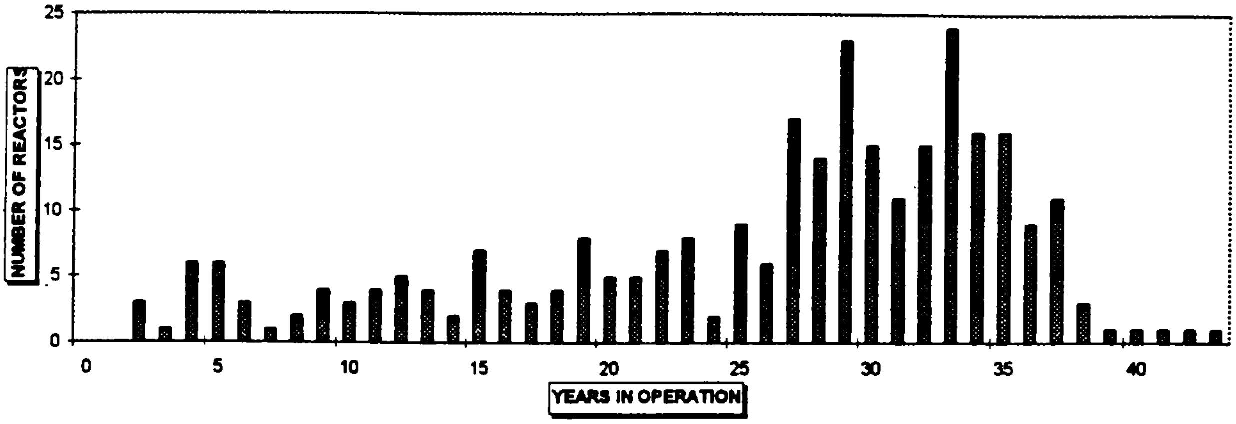

Figure 3:- Number of reactors versus years in operation

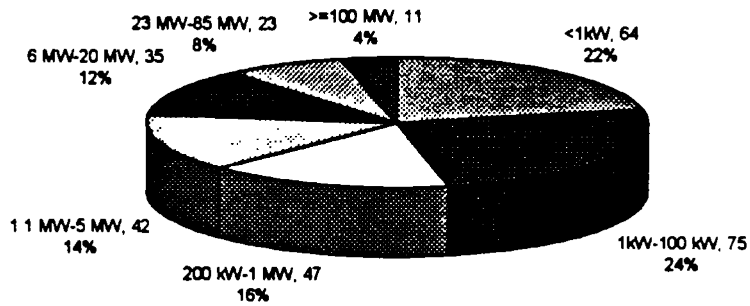

Figure 4:- Power distribution of operational research reactors.

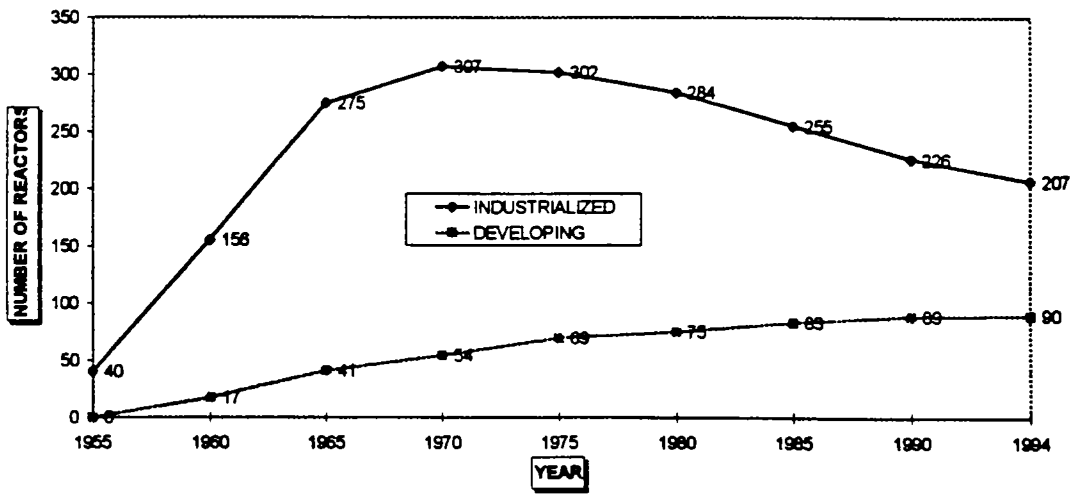

Figure 5:- Reactors in industrialised and developing countries.

3. Spent Fuel Management and Storage

At present, the RRSFDB contains 177 entries dealing with the fuel from 179 reactors, since in two instances the fuel from two reactors is stored at the same location. Of these research reactors, 23 are permanently shut down, 5 are temporarily shut down for refurbishment and the remaining 149 are operational. Spent fuel is usually an ongoing liability after a reactor is shut down and the IAEA would like to include details of spent fuel from all of the known 272 shut-down reactors reported in RRDB. In addition, there is a large discrepancy between the 296 operational reactors in RRDB and the 149 reactors that have so far responded to the questionnaires for RRSFDB. Clearly, research reactor operators are fed up of filling-in questionnaires, especially if they cannot see the usefulness of the end result. Nevertheless, it is essential for the IAEA to get a clear and accurate picture of the problems faced by research reactor operators and their concerns about management, storage and ultimate disposal of spent fuel, in order to be able to address them and to exert pressure internationally for the implementation of spent fuel take-back programmes by supplier countries and to begin a dialogue about possible regional repositories as an ultimate solution for countries with no nuclear power programme.

The remainder of this section is divided into two parts. The first deals with numbers of fuel assemblies, their types, enrichment, origin of enrichment and geological distribution among the industrialised and developed countries of the world. The second is devoted to fuel management practices in wet and dry storage facilities and the concerns of reactor operators about long-term storage of their spent fuel.

3.1. *Accumulated Spent Fuel*

Figure 6 shows cross-sections of the main Western research reactor fuel assembly geometries [3], while Figures 7a to 7d show the cross-sections of the main Russian types [4]. The assembly types shown in Figure 6 are MTR box-types containing 10-24 fuel plates per assembly, involute core assemblies containing 280 plates (High Flux Reactor, Grenoble France), tubular fuel assemblies with 4-6 fuelled tubes per assembly (BR-2, Belgium and Dido, UK), Triga fuel rod clusters with 1-25 rods per cluster (Triga, Republic of Korea - single rods, Triga, Romania - 25 rods per cluster), and pin assemblies with 1-12 pins per assembly (Slowpoke, Canada - single pins, NRU, Canada - 12 pins). All of these assemblies are about 60-90 cm long, except for NRU (275 cm) and Slowpoke fuel pins (30 cm). In Russian designed research reactors, a large variety of fuel assembly geometries have been used. Four of the more important types are shown in Figure 7a to 7d and can be divided into two groups; multi-tube assemblies (IRT-3M and WWR-M) and multi-rod assemblies (CM-2 and RG-1M). The active parts of these assemblies vary in length from 35-200 cm.

Most research reactor fuels are shipped in assembly form. For this reason, in RRSFDB spent fuel numbers are recorded in assemblies, where a fuel assembly is defined as "the smallest fuel unit that can be moved during normal reactor operation or storage". Even so, questions regarding numbers of fuel assemblies obviously caused confusion to respondents to the questionnaires. Consequently, the data received has been reviewed and corrected by a panel of experts who know the details of the various fuel assembly designs. At any particular facility, several different spent fuel types or spent fuels of different enrichments are usually stored. For example, the store may contain one or more types of HEU from prior to core conversion and one or more types of LEU following conversion.

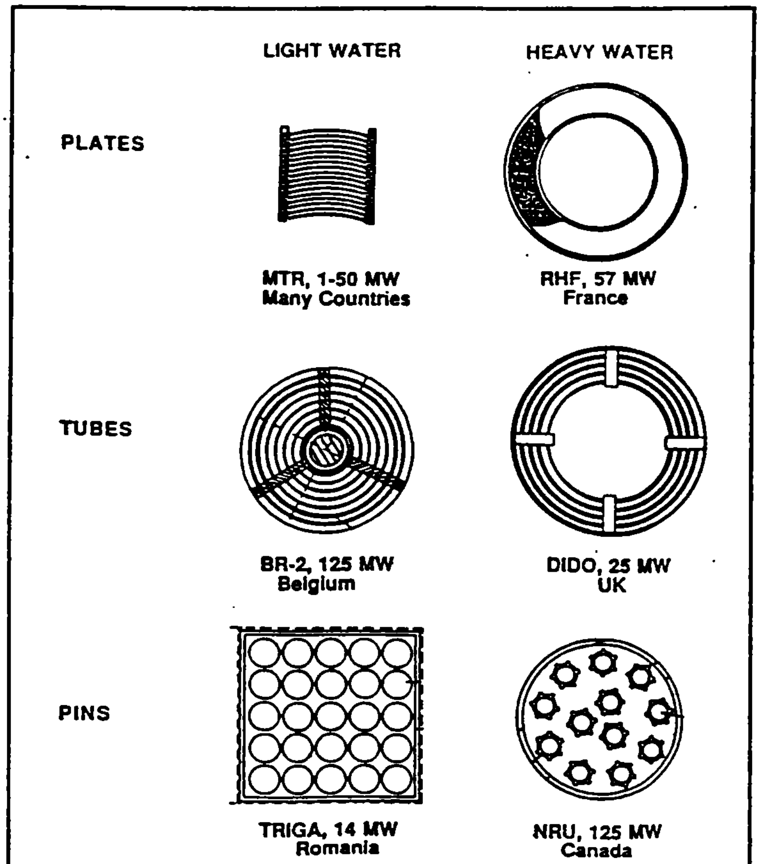

Figure 6:- Selected Western fuel geometries.

Very few facilities report more than three types of spent fuel and for this reason the records in RRSFDB store up to three fuel types per facility. Strictly speaking, fuels enriched to ≥ 20% ^{235}U are classified as HEU. Since many facilities with LEU cite a nominal enrichment of 20%, we have modified the definition of LEU to be ≤ 20% ^{235}U for the purposes of RRSFDB.

The distribution of fuel types among the reactors in the RRSFDB is shown in Figure 8. Although the majority are of MTR or Triga types, a significant percentage (25%) are classified as other types which underlines the fact that many experimental and exotic fuels exist at research reactors around the world, posing problems for their continued storage, transportation and ultimate disposal.

The regional distribution of spent fuel, with a distinction made between developing and industrialised countries, is shown in Figure 9. As might be expected, the majority of spent fuel assemblies are stored in the industrialised countries. The origins of the enrichments of the RRSFDB spent fuel inventory is broken down into fuel of US, Russian, Chinese or other origin in Figure 10. In this case, others include France, UK, South Africa, natural uranium fuels and those cases where the origin of enrichment was not known or simply left blank on the questionnaire. As expected, the US supplied all of the enriched fuel in North America and most of that in the Industrialised Pacific, while Russia (or the former Soviet Union) supplied most of the enriched fuel in Eastern Europe. Somewhat surprisingly, the US was not the major supplier of enrichment in Western Europe.

The breakdown between HEU and LEU is shown in Figure 11. Of interest in this Figure is the fact that HEU outweighs LEU in North America, whereas the reverse is true in Western Europe. To some extent this is because more research reactors in Western Europe have undergone core conversion than is the case in North America. HEU also outweighs LEU in Africa and the Middle East, Eastern Europe and the Industrialised Pacific. It is worth noting that a significant fraction of Russian-origin HEU was originally enriched to only 36%, while most US-origin HEU was originally enriched to ≥90%.

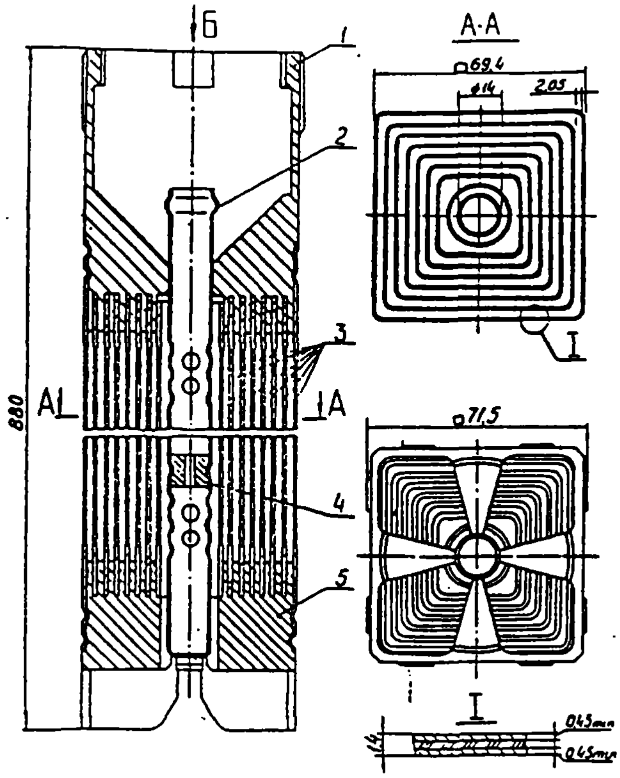

Figure 7a:- Fuel assembly of the IRT-3M type; 1 – cap; 2 – displacer; 3 – fuel elements; 4 – throttle; 5 – ending part.

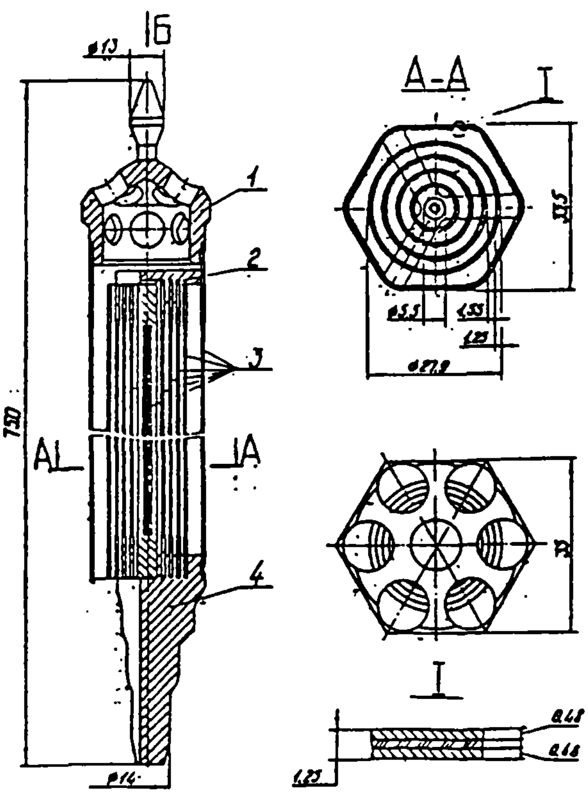

Figure 7b:- Fuel assembly of the WWR-M reactor; 1 – cap; 2 – upper grid; 3 – fuel elements; 4 – ending part.

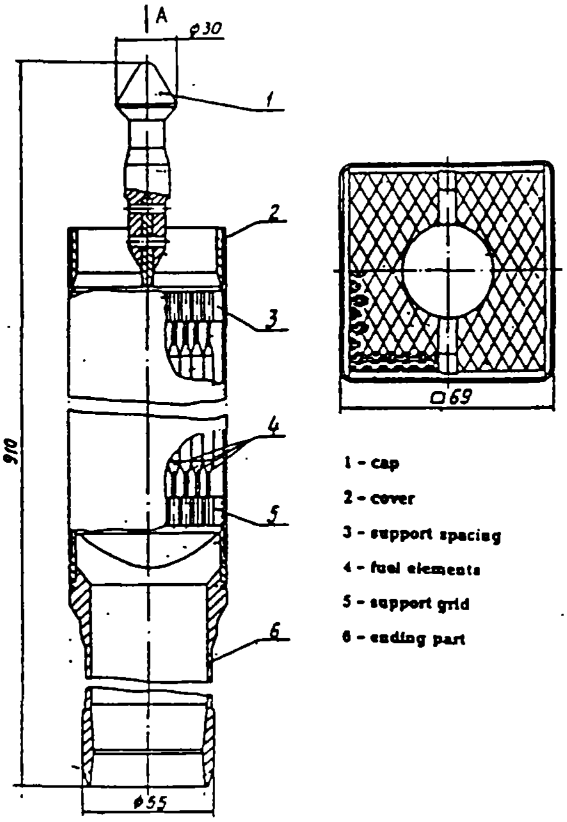

Figure 7c:- Fuel assembly of the CM-2 reactor.

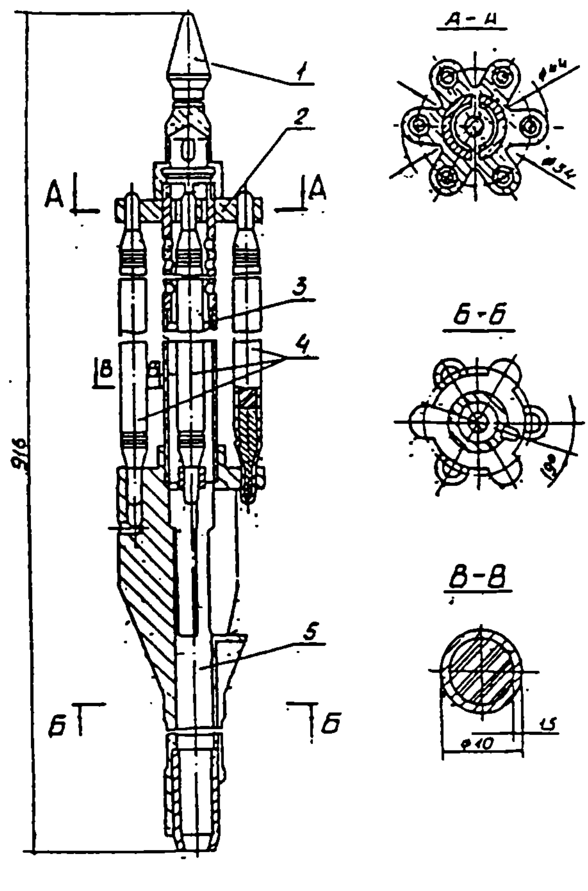

Figure 7d:- Fuel assembly of the RG-1M reactor, 1 – cap; 2 – upper grid; 3 – tube; 4 – fuel elements; 5 – ending part.

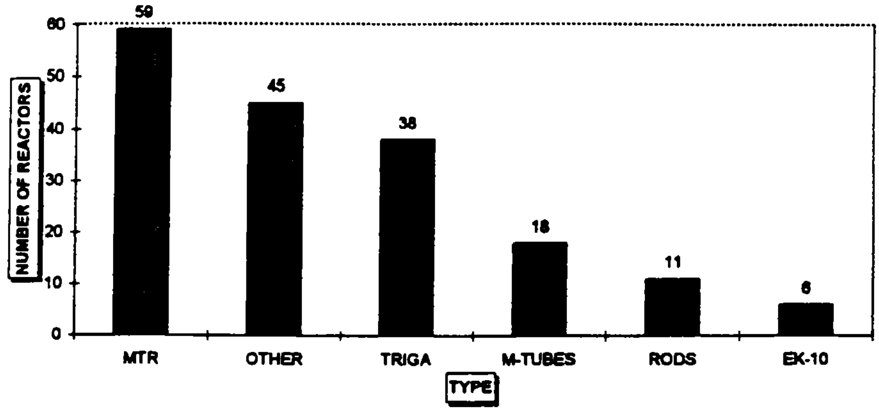

Figure 8:- Distribution of fuel types.

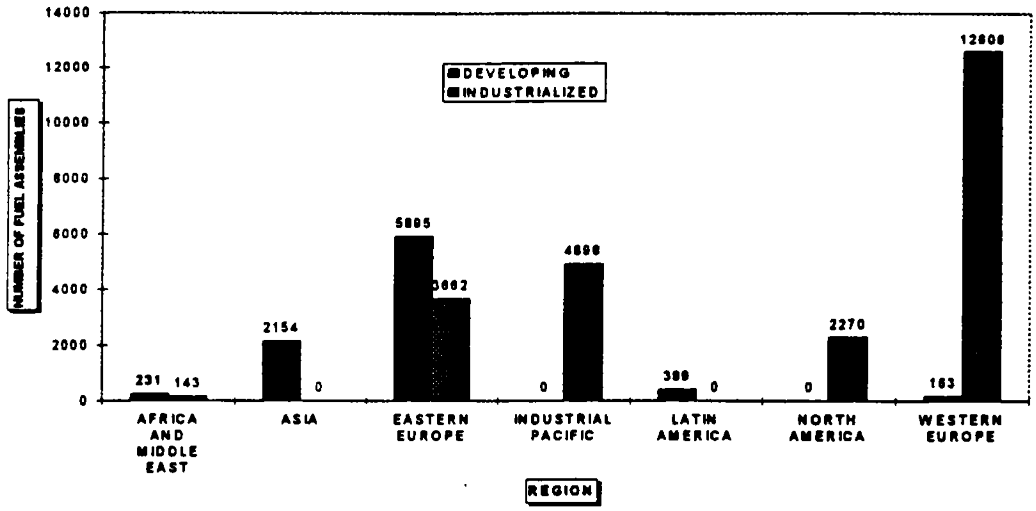

Figure 9:- Geographical distribution of spent fuel assemblies.

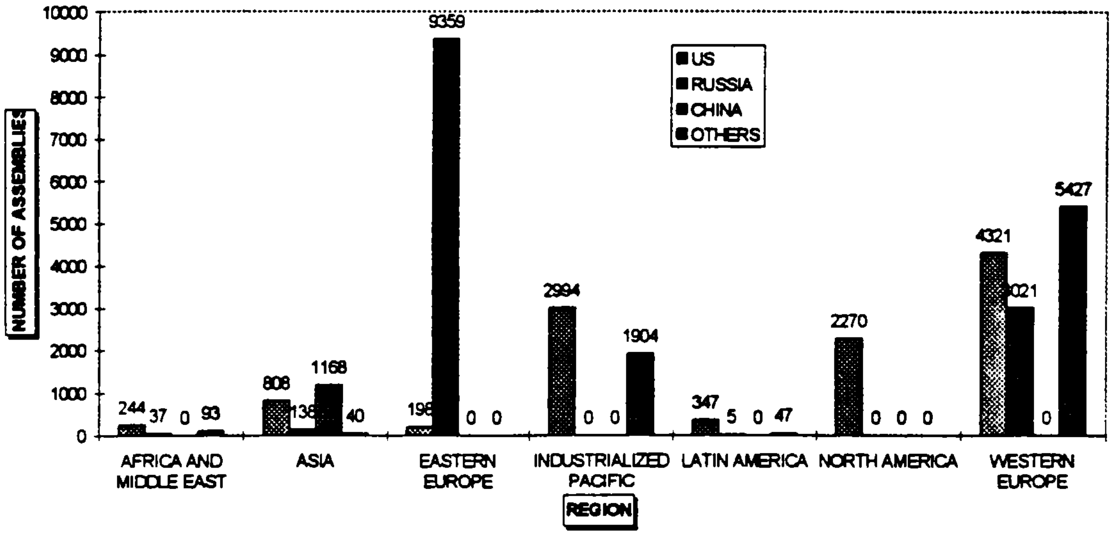

Figure 10:-Geographical distribution of spent fuel by supplier country.

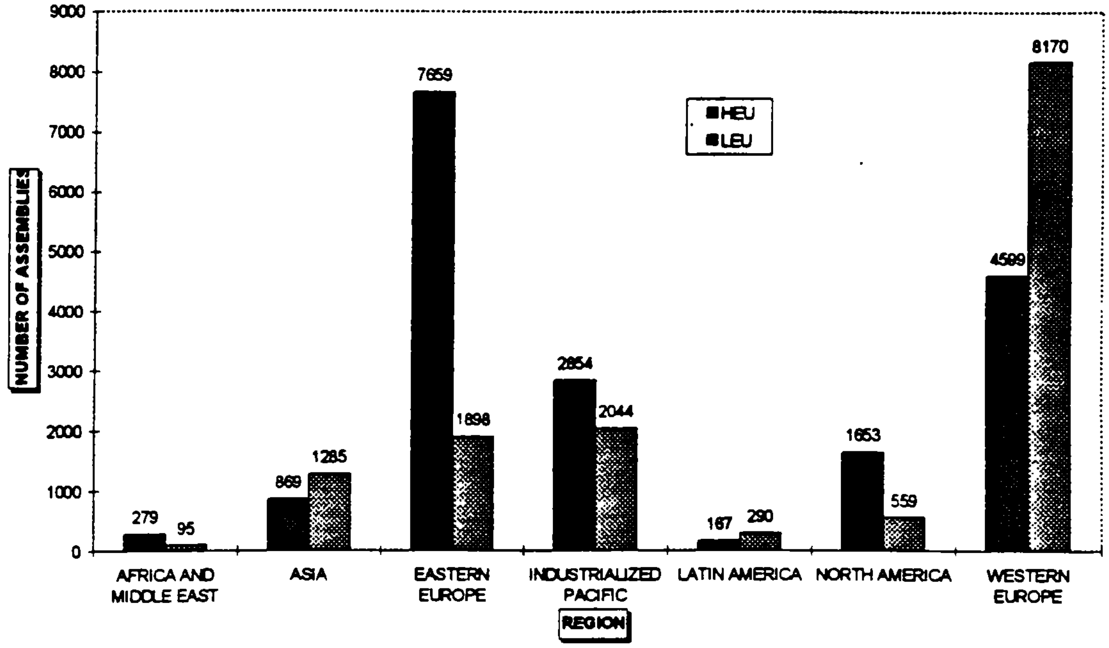

Figure 11:- Geographical distribution of spent fuel by enrichment.

The breakdown of US-origin fuel, classified as HEU or LEU, is shown in Figure 12. This involves totals of 6,861 HEU and 4,321 LEU assemblies. A similar chart of Russian-origin fuel is shown in Figure 13 and involves totals of 9,683 HEU and 2,877 LEU assemblies. The numbers of US-origin and Russian-origin HEU and LEU spent fuel assemblies at foreign research reactors which might be involved in take-back programmes are compared in Figure 14.

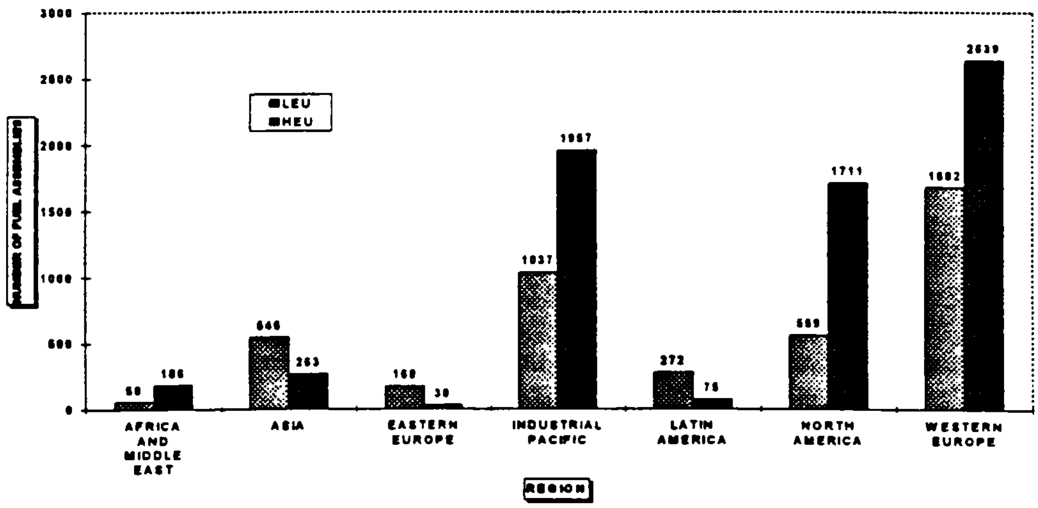

Figure 12:- Geographical distribution of US-origin fuel.

Overall, there are 32,421 spent fuel assemblies stored in the facilities that have responded to the RRSFDB questionnaires to date and another 9,950 assemblies in the standard cores. Of these 32,421, 23,576 are in industrialised countries and 8,842 are in developing countries, while 18,080 are HEU and 14,341 are LEU. At present 7,560 spent fuel assemblies of US-origin are located at foreign research reactors, while the equivalent number of Russian-origin is 8898. As mentioned above, RRSFDB involves only a limited number of the known research reactors in the world, nevertheless these data give an idea of the scope of the problem represented by research reactor fuels. On the basis of these data and a rough knowledge of the numbers of assemblies used each year, it would be possible to make projections for the numbers of spent fuel assemblies that will be accumulated in the future. However, this task is deferred until RRSFDB is more complete, so that any projections eventually made will be more meaningful.

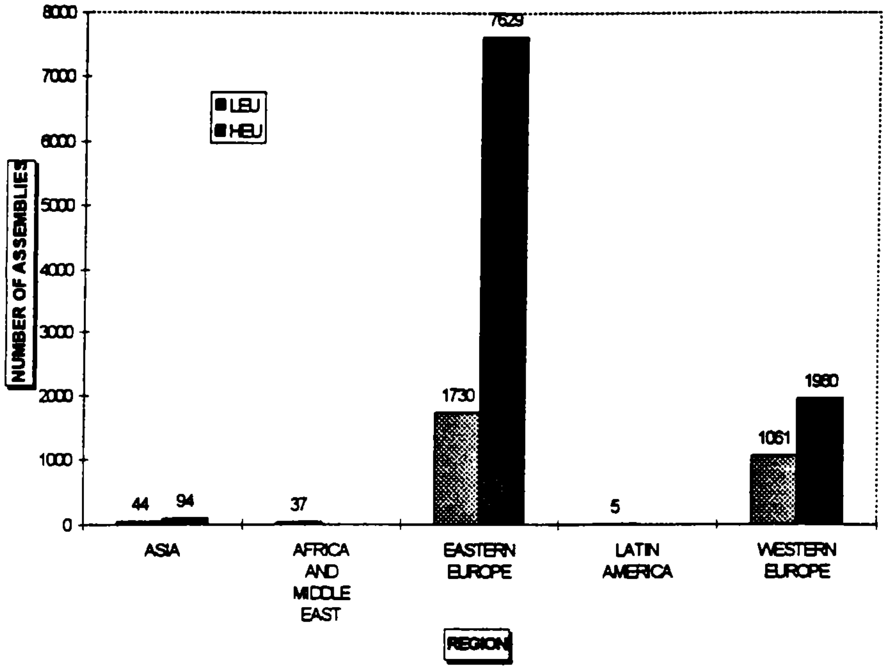

Figure 13:- Geographical distribution of Russian-origin fuel.

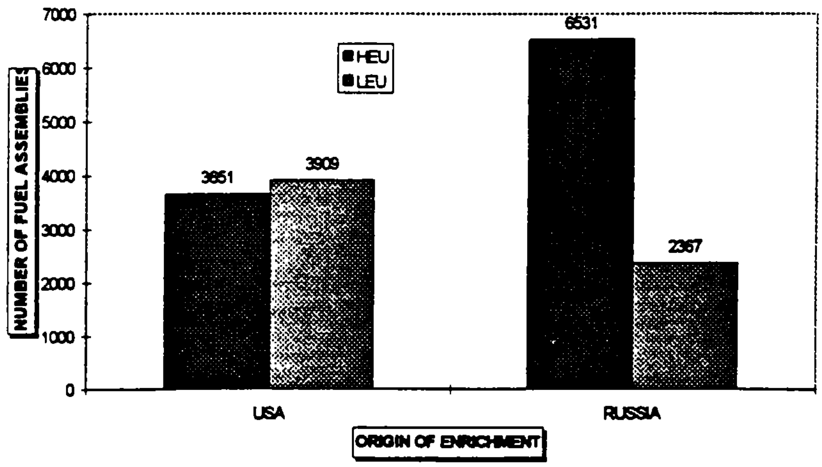

Figure 14:- Spent fuel at foreign research reactors.

3.2. *Wet and Dry Storage*

As shown in Figure 15, by far the most commonly used form of spent fuel storage is the at-reactor pool, pond or basin. Since the average age of these facilities in the RRSFDB is 23 years, the success of wet storage where the water chemistry has been well controlled is remarkable. In fact, many aluminium clad MTR fuels and aluminium pool liners show few, if any, signs of either pitting corrosion or general corrosion after more than 30 years of exposure to research reactor water. As shown in Figure 16, many facilities also have an auxiliary away-from-reactor pool or dry well. At away-from-reactor facilities, the trend is to transition fuel from wet storage to dry storage, which avoids some of the expense of water treatment facilities and their maintenance.

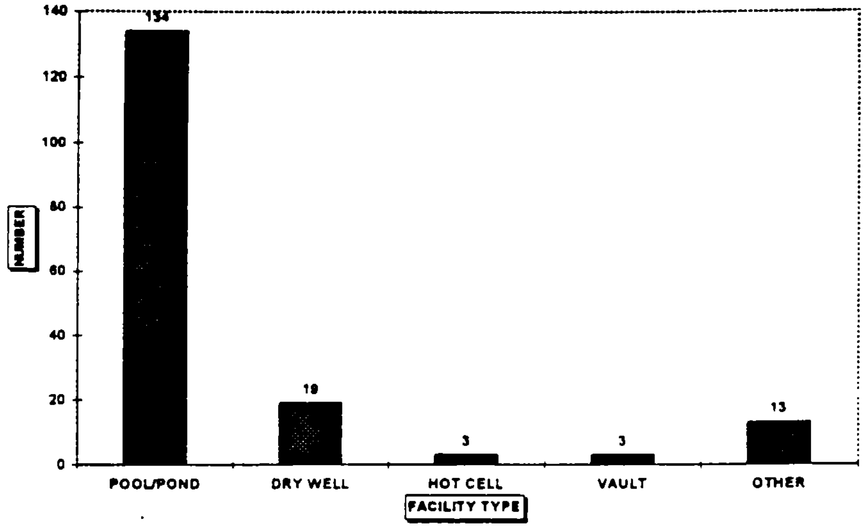

Figure 15:- At-reactor spent fuel storage facilities.

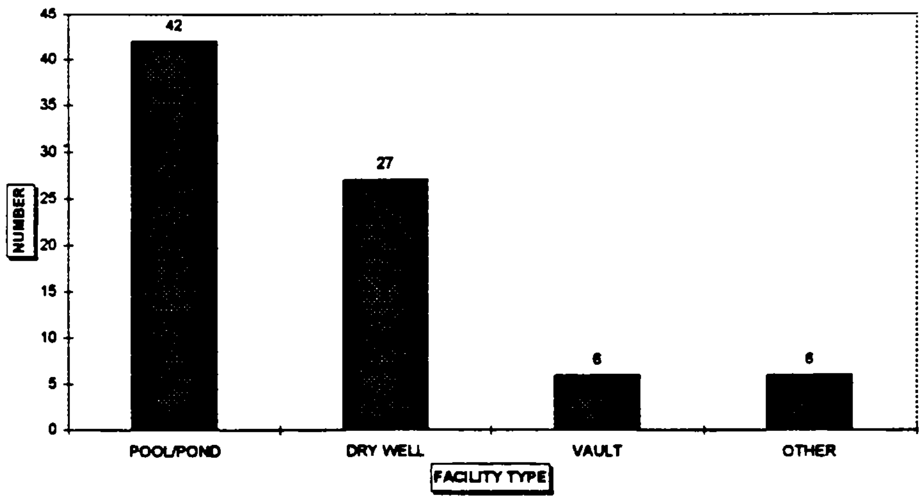

Figure 16:- Away-from-reactor spent fuel storage facilities.

The parameters typically monitored at wet storage facilities are shown in Table 2. Details of the frequency of monitoring and/or control of these parameters are contained in RRSFDB. They show a remarkable variation from continuous monitoring to "routine" or "occasional". Because of some inconsistencies in this data and some obvious confusion over the questions asked in the original questionnaire, further analysis of the data must await the responses to the next round of questionnaires.

Similar results for dry storage are shown in Table 3. Clearly, dry storage requires less monitoring and maintenance than wet storage and at most dry storage facilities the operators are content to monitor the activity continuously. Again, more detailed analysis of the dry storage data should await the responses to the next round of questionnaires.

Table 2

WET STORAGE PARAMETERS MONITORED	
PARAMETER	**NUMBER OF FACILITIES**
pH	104
Conductivity	127
Temperature	104
Activity	72
Analysis	17

Table 3

DRY STORAGE PARAMETERS MONITORED	
PARAMETER	**NUMBER OF FACILITIES**
Activity	26
Pressure	4
Moisture	8
Temperature	4
Other	1

The concerns expressed by reactor operators about their spent fuel are listed in Table 4. Not surprisingly, the majority are concerned about the final disposal of their fuel. This is followed by concerns about limited storage capacity, finances, cask availability, interim storage diminishing self-protection of the spent fuel as it ages and the age of facilities and equipment with the consequent degradation of materials. Some expressed only a single concern but many expressed several concerns.

Table 4

CONCERNS	
FINAL DISPOSAL	134
INCREASING STORAGE CAPACITY	34
FINANCIAL	26
CASK AVAILABILITY	23
INTERIM STORAGE	20
SELF-PROTECTION	19
MATERIALS' DEGRADATION	16
AGEING FACILITIES	15
CORE UNLOAD	11
CRANE CAPACITY	9
SHUT DOWN	8
WASTE RETURN FROM REPROCESSING	6
WATER QUALITY	5

Plans for increasing either the number of spent fuel racks, facility size or both are charted in Figure 17. These numbers reflect the concerns about storage capacity, interim storage and emergency core unload listed in Table 4. Crane capacity is another area of concern, especially for some facilities who hope to ship fuel back to its country of origin in the near future, as is the availability of suitable transport casks.

Finally, the availability of an internal transfer flask at the facilities in RRSFDB is charted in Figure 18. Surprisingly, 27% of the facilities have no internal transfer flask.

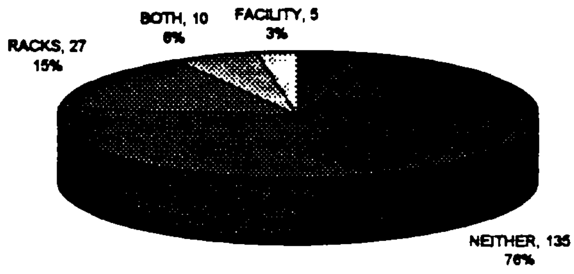

Figure 17:- Planned expansion at spent fuel facilities.

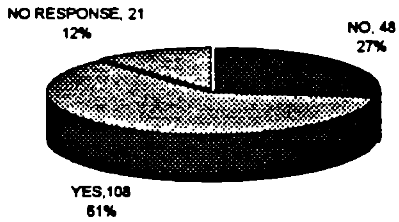

Figure 18:- Internal transfer flask availability.

4. IAEA Activities on Research Reactor Spent Fuels

Besides compiling and maintaining the RRSFDB, which is the subject of this paper, and supporting RERTR, the Agency has been involved as an observer in almost all of the meetings of the "ad hoc" group of research reactor operators, known as the Edlow Group, which seeks to return US-origin spent fuel from foreign research reactors. Towards this same end, the Director General of the IAEA has written letters to Secretary O'Leary of the US DOE (1 July 1993) and Mr. Victor Michailov, Minister of Atomic Energy of the Russian Federation, (2 February 1995) suggesting that these major partners in RERTR could facilitate the non-proliferation goal of RERTR by taking back foreign research reactor fuel.

In anticipation that the US take-back programme will be implemented in the near future with the completion of the EIS mentioned in Section 1, the Agency plans activities to help Member States to prepare their spent fuel for shipment back to its country of origin. The subject will be discussed at a Workshop/ Technical Committee Meeting (TCM) to be held at GKSS, Geesthacht, Germany during the week beginning 20 November 1995. However, the main activity in this area will be a training course to be held at Argonne National Laboratory, USA during the latter half of 1996.

The preparation of a Safety Guide on Design, Operation and Safety Analysis Report for Spent Fuel Storage Facilities at Research Reactors is well underway. During 1996 the IAEA plans to convene a TCM to collect and evaluate information on procedures and techniques for the management of failed fuels from research reactors. Also, the Agency offers advice through IFMAP, the Irradiated Fuel Management Advisory Programme, to operators of spent fuel storage facilities and more tangible assistance to developing Member States through the IAEA's Technical Assistance and Co-operation programmes.

Recognising that the degradation of materials, equipment and facilities through ageing is becoming of more concern to many operators, the Agency organises several activities in the materials' science field. Prominent among these is the preparation of a document on the durability of nuclear fuels and components in wet storage which is nearing completion. This draft document contains information on aluminium clad fuels used in research reactors compiled by the participants in a Co-ordinated Research Programme (CRP) on Irradiation Enhanced Degradation of Materials in Spent Fuel Storage Facilities. Another CRP just starting up is devoted specifically to research reactor fuel cladding and will focus on the monitoring and control of corrosion in wet storage. These programmes are supplemented by a series of Regional Workshops organised by the IAEA to deal with all aspects of spent fuel handling, management, storage and preparation for shipment.

5. Conclusions

In recent years the problems of spent fuel from research reactors have received increasing attention as concerns about ageing fuel storage facilities, their life extension and the ultimate disposal of spent fuel loom larger. The overall scope of these problems can be gauged by examination of the databases compiled and maintained by the IAEA. It is clear that more exposure of the problems and concerns and more international co-operation will be necessary to resolve the outstanding issues. It is also clear that any take-back programmes of foreign research reactor fuels, if and when they are implemented, will not continue indefinitely. At some stage in the not too distant future, research reactor operators will be faced with the permanent disposal of their spent fuel. For countries with no nuclear power programme, the construction of geological repositories for the relatively small amounts of spent fuel from one or two research reactors does not seem practicable. For such countries, access to a regional repository for research reactor fuel would be an ideal solution. The time is ripe for serious discussion of regional repositories and to begin planning for the day when neither take-back programmes nor the reprocessing option might be available.

References

[1] Directory of Nuclear Research Reactors, IAEA, Vienna 1989.

[2] Nuclear Research Reactors in the World, IAEA Reference Data Series No. 3, December 1994 Edition.

[3] J. E. Matos, Foreign Research Reactor Spent Nuclear Fuel Inventories Containing HEU and LEU of US-origin, Proceedings of RERTR 1994, Williamsburg, USA.

[4] N. V. Arkhanguelskij, The Problems of Treatment of Irradiated Fuel at Russian Research Reactors, IAEA-TECDOC-786, Experience with Spent Fuel Storage at Research and Test Reactors, 1995.

APPENDIX 1

IAEA
QUESTIONNAIRE
Irradiated Fuel Storage At Research and Test Reactors

o Name of Reactor ____________________ Date Form Completed__________

o Location __________________________ IAEA Reference I D______

o Power (MW)

o Status: Operating ☐ Planned Shut Down (date) ☐ ___________

Temporarily Shut Down ☐ Permanently Shut Down ☐

Please read the instructions for filling in this form carefully and refer to the sample filled-in form

1 (a) DESCRIPTION OF FUEL

Fuel Type	Description	Enrichment (w%)	Enrichment supplier	Cladding material	Cladding Thickness (mm)
1.					
2.					
3.					

1 (b).

Fuel Type	Assembly length (mm)	Assembly Cross-section (mm x mm)	Elements (plates, rods or tubes) per Assembly	U-235 in Fresh Fuel Assembly (g)	Average Burnup (%) per Assembly
1.					
2.					
3.					

2. FUEL USAGE

Fuel Type	Number of Assemblies in Core	Average Number of Assemblies used per year	Number of Irradiated Assemblies in Storage	Oldest (years)	Number Failed During Operation*	Number Failed During Storage*
1.						
2.						
3.						

*If so, please specify the failure(s) briefly.____

____

____

3. Do you have a transfer cask or flask? YES ☐ NO ☐

4. What is the maximum weight of cask you can handle in your fuel storage area?

____

5. Check types of storage, At-Reactor (AR) and /or Away-From-Reactor (AFR) used and their capacities in number of assemblies.

Type of Storage	At-Reactor			Away-From-Reactor		
	Yes	No	Capacity (# of assemblies)	Yes	No	Capacity (# of assemblies)
Pool/pond	☐	☐		☐	☐	
Dry Well	☐	☐		☐	☐	
Vault	☐	☐		☐	☐	
Cask	☐	☐		☐	☐	
Other*	☐	☐		☐	☐	

* Please specify briefly: ____

____

____

6. Do you plan to expand your storage capacity in the next five years?

AR ☐ AFR ☐ Neither ☐

* If so, please explain briefly: ____

____

7. STORAGE RACKS

Were your spent fuel storage racks supplied by the reactor vendor ☐
or custom designed and built? ☐

Was the design based on spacing without an absorber ☐
or with an absorber? ☐ e.g. Cd ☐; B ☐ or other* ☐

* Please specify: ____

____

Was the design based on calculation ☐ ; experiment ☐ ; or both? ☐

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8. PARAMETERS MONITORED

What parameters are monitored in your storage facilities and at what frequencies?

a) Pool/Pond - At-Reactor

PARAMETER MONITORED	FREQUENCY OF MONITORING				
	Continuously	Hourly	Daily	Weekly	Other*
pH	☐	☐	☐	☐	☐
Conductivity	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐
Activity	☐	☐	☐	☐	☐
Other*	☐	☐	☐	☐	☐

* Please specify: ______________________________

____

Pease describe briefly the way your pool/pond water is treated. For example, the rate at which it is purged, filtered or deionized:- ______________________________

____

____

b) Pool/Pond - Away-From-Reactor

PARAMETER MONITORED	FREQUENCY OF MONITORING				
	Continuously	Hourly	Daily	Weekly	Other*
pH	☐	☐	☐	☐	☐
Conductivity	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐
Activity	☐	☐	☐	☐	☐
Other*	☐	☐	☐	☐	☐

* Please specify: ______________________________

____

____

Please describe briefly the way your pool/pond water is treated. For example, the rate at which it is purged, filtered or deionized:- ______________________________

____

____

APPENDIX 1

c) Dry Storage - At-Reactor

PARAMETER MONITORED	FREQUENCY OF MONITORING				
	Continuously	Hourly	Daily	Weekly	Other*
Moisture	☐	☐	☐	☐	☐
Pressure	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐
Activity	☐	☐	☐	☐	☐
Other*	☐	☐	☐	☐	☐

* Please specify:- ______________________________

____

____

d) Dry Storage - Away-From-Reactor

PARAMETER MONITORED	FREQUENCY OF MONITORING				
	Continuously	Hourly	Daily	Weekly	Other*
Moisture	☐	☐	☐	☐	☐
Pressure	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐
Activity	☐	☐	☐	☐	☐
Other*	☐	☐	☐	☐	☐

* Please specify:- ______________________________

____

____

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9. CONCERNS

What are your major concerns about spent fuel management and disposal?
Please rank them as 1, 2, 3 and other.

Concern	First	Second	Third	Other
Storage capacity	☐	☐	☐	☐
Interim storage	☐	☐	☐	☐
Final disposal	☐	☐	☐	☐
Waste return from reprocessing	☐	☐	☐	☐
Self-protection of fuel	☐	☐	☐	☐
Reactor shut down	☐	☐	☐	☐
Core unload capacity	☐	☐	☐	☐
Crane capacity	☐	☐	☐	☐
Cask availability	☐	☐	☐	☐
Aging of facilities	☐	☐	☐	☐
Materials degradation	☐	☐	☐	☐
Water quality	☐	☐	☐	☐
Financial	☐	☐	☐	☐
Other*	☐	☐	☐	☐

* Please specify:- ____

____

10. Please take this opportunity to list any other special characteristics of your irradiated fuel storage that would help the IAEA to assess the overall picture of the storage of irradiated fuels from research and test reactors.

____
____
____

11. Who is the correct person to contact for your site? Please give name, address, telephone number, fax number, and E-mail address.

____
____
____

Telephone: __________________ Fax: __________________

E-mail: ____________________