IAEA Activities in the Field of NPP Life Management

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INTRODUCTION

Nuclear energy contributes largely to the electricity supply in the world today. In order that the expansion of nuclear power continues to be competitive and an environmentally benign and viable option for electricity generation, the continued demonstration of safe and reliable operation of existing NPPs during their design life time is imperative. Thus, NPP life time management is an important task for nuclear power plants.

The susceptibility and tendency of NPPs to undergo performance and property changes during their operational lifetime, causes a growing concern regarding technical and economic aspects of operating them reliably and safely.

Changes in physical and mechanical properties of NPP structures and components due to ageing and degradation play an important role in lowering safety margins and therefore in the achievement of the reliable operation of the plant as a whole.

According to the IAEA PRIS (Power Reactor Information system) as of December 1996 there are 442 NPPs in operation around the world out of which 183 have reached over 15 years of operation. Figure 1 shows the distribution of two of the most wide spread reactor types, PWR and WWER, by age.

More than 30 countries have nuclear power plants in operation or under construction and in 14 countries the share of nuclear generated electricity exceeds 30%. Future energy and electricity consumption will depend on a number of factors. Population growth, industrial development and enhancement of the quality of life together with re-capitalization of electricity generating plant will be driving forces for increasing demand.

The major goal of every national nuclear programme is to safely and economically operate the NPPs during their design life. The second goal for utilities/operators could be to extend design life to the optimum technical and economical life using life management programmes with scientific and technological backgrounds.

Though the NPP life management programme can have some general features it should be taken into account that every NPP has a unique design and therefore specific feasibility study related to a concrete plant, should be performed within the adopted PLIM strategies.

There have been difficulties with the terminology used in these studies. Fortunately, the term PLEX (Plant Life Extension) is now rapidly disappearing from use. While there are some national programmes which look at the period beyond the licensing life, generally plant lifetime is now taken as the technical life of the plant. But this may be overly simplistic approach because the current list of 'life' definitions includes:

- Technical
- License
- Re-license

- Economic
- Political
- Financial
- Design

The assessment of 'lifetime' usually involves more than one of these definitions. In this presentation 'lifetime' means the technical life of the plant.

The IAEA has established programmes in the field of Nuclear Plant Lifetime in the Division of Nuclear Power and the Fuel Cycle (NEPF) and also in the Division of Nuclear Safety. In the Division of NEPF the International Working Group on Life Management of Nuclear Power Plants carries out its activities within the IAEA Project A2.03 "Nuclear Power Plant Life Management". Activities under this project have produced a wealth of information by organizing specialists meeting, preparing technical publications on related topics and arranging co-ordinated research programmes with good results. The most recent development is a database which has been developed and is being maintained.

IWG-LMNPP

Its main objective is to provide Member States with information and guidance on design, materials, testing, maintenance, monitoring and mitigation of degradation with regard to major components, with the aim of assuring high availability and safe operation of NPPs.

Results of the IWG activities are being revised during the IWG regular meetings almost every two years. Future tasks could be easily reoriented towards serving more directly the needs of the end-users and with a view of assisting major decisions concerning main plant components refurbishment/replacement and cost effectiveness assessment of continued operation versus earlier retirement.

Attention to emerging technology issues is continuing through promotion of specialists meetings, technical committee meetings and co-ordinated research programmes as advised by the IWG-LMNPP members at is regular meetings. Within the scope of the Project A2.03, experts' advice and consultancy is also explored by the Secretariat.

In accordance with the Terms of Reference for the IWG-LMNPP which were revised at the last IWG regular meeting in September 1995 and approved by the Director General, the scope of the IWG activities include the following aspects:

Design
Material
Fabrication
Monitoring, testing, inspection and databases of their results
Information on service and test conditions
Degradation mechanisms, their significance and mitigation
Assessment and means of plant life management

Within these areas certain topical priorities have been set up. These are as given below (as approved at the IWG meeting 30.08 - 01.09.1995):

1. RPV Integrity

   - radiation damage
   - fracture mechanics
   - optimization of surveillance programmes
   - annealing and other mitigation methods
   - material databases
   - surveillance databases
   - PTS analysis
   - inspection procedures validation/qualification
   - monitoring processes of material degradation and plant operation
   - pressure tubes integrity.

2. Reactor Internals Operation and Integrity

   - corrosion, IASCC
   - wear
   - NDE and inspection qualification
   - irradiation ageing
   - replacement and repair.

3. Primary Circuit Integrity and Operation

   - corrosion/erosion and water chemistry
   - fatigue
   - material ageing and its monitoring
   - monitoring of loads and water chemistry
   - inspection procedures validation/qualification
   - LBB concepts and leak monitoring
   - repairs.

4. Steam Generator Life Management

   - corrosion and water chemistry
   - wear/mechanical problems (internals)
   - inspection procedures validation/qualification
   - monitoring
   - replacement/repair.

5. Secondary Circuit

   - erosion/corrosion
   - water chemistry (optimization and monitoring).

Operating experience has shown that NPPs life time is affected by components degradation and ageing and therefore highlighted the need to develop the methodology allowing for an improvement in the understanding of these processes.

Better understanding in turn will provide a possibility to manage ageing effects in a timely and planned way and also to create a strategy in the NPP Life Management with the aim to achieve economic viability of the plant while observing necessary safety and operational margins. These processes are schematically presented in Figure 2. The IWG-LMNPP activities can be easily traced within this scheme. They mainly look at technological and phenomenological aspects of ageing and degradation processes and take into consideration practical advice on maintenance, mitigation, repair, replacement and refurbishing.

Recent considerations of the scheme by the IWG provided a recommendation that economic aspects of those countermeasures should also be a point for attention.

To give a clear picture of the IWG-LMNPP involvement in the PLIM studies it would be useful to look at the list of its activities during the recent past and for the period of 1997-1998. The latter period is adopted by the IAEA biannual programme and is under implementation now. Also included in the activities is the organization of Training Courses for developing countries. The following table shows the list of Meetings and Training Courses organized by the IWG-LMNPP from the year 1995 to approximately beginning of 1997. The proceedings of some of these meetings were published by the Agency and widely distributed.

SPM on "Cracking in PWR Pressure Vessel Head Penetrations"	Philadelphia, USA 2-4 May 1995	Working Material IWG-LMNPP 95/1
Regional Training Course on "Ageing Phenomena and Diagnostics for WWER Type Reactors"	Trnava, Slovak Republic, May-June 1995	
SPM on "Irradiation Embrittlement and Mitigation"	Espoo, Finland, 23-26 October 1995	Working Material IWG-LMNPP 95/5
IWG Meeting (regular) on Life Management in NPPs	Vienna, Austria, 30 August to 1 September 1995.	Working Material IWG-LMNPP 95/6
SPM on "Steam Generator Repair and Replacement, Practices and Lessons Learned"	Ostrava, Czech Republic, 15-18 April 1996.	Working Material IWG-LMNPP 96/1
Research Co-ordination Meeting (final) on the CRP "Management of Ageing of Reactor Pressure Vessel Primary Nozzle"	Erlangen, Germany, 15-16 October 1996.	

Research Co-ordination Meeting on the CRP on "Assuring Structural Integrity of Reactor Pressure Vessel"	Vienna, Austria, 9-11 September 1996	
Meeting of National Liaison Officers to the "International Database on Reactor Pressure Vessel Materials"	UK, 14-15 November 1996	
Interregional Training Course on "Ageing Phenomena and Diagnostics for PWR Type Reactors"	Karlsruhe, Germany, 25 November to 13 December 1996.	
Joint EC/OECD/IAEA Specialists Meeting on NDE Techniques Capability Demonstration and Inspection Qualification"	JRC Petten, Netherlands, 11-13 March 1997.	

Some future meetings also organized in the framework of the IWG-LMNPP are:

SPM on "Methodology for Pressurized Thermal Shock Evaluation"	Esztergom, Hungary, 5-8 May 1997
SPM on "Irradiation Effects and Mitigation"	Vladimir, Russian Federation, 15-19 September 1997
IWG Meeting (regular) on NPP Life Management	Vienna, Austria, 6-8 October 1997
Research Co-ordination Meeting on the CRP on "Assuring Structural Integrity of Reactor Pressure Vessel"	Vienna, Austria, 8-10 October, 1997
SPM on "NPP Condition Monitoring and Maintenance"	1998, dates and venue to be defined at the IWG meeting
SPM on "Loadings Outside the Design Base"	1998, dates and venue to be defined at the IWG meeting
SPM on "Ageing Effects in NPP Metallic Materials other than RPV and SG"	1998, dates and venue to be defined
Meeting of Liaison Officers to the International Database on "Reactor Pressure Vessel Materials"	February 1998, venue to be defined

Apart from the information exchange and collection via Specialists Meetings and Co-ordinated Research Programmes, the IWG takes part in a number of Advisory Group

Meetings and Consultants Meetings to specify further activities of the IWG.

Some items of current priority are important to the IWG-LMNPP even though they are not included in the list of top priorities. These activities are usually co-ordinated with other sections or the department of the IAEA. For example the IWG has recognized that more importance should be given to economic aspects in relation to plant management, safety and maintenance. This activity is carried out jointly with the Planning and Economic Studies Section of NEPF as well as with some other international organizations such as OECD/NEA. Another example would be power assisted equipment. In this case the Co-ordinated Research Programme (CRP) on "Management of Ageing of Motor Operated Isolating Valves" (MOV) was started jointly with the NS Department of the IAEA with primary objectives being:

- understanding of MOV ageing
- monitoring of MOV ageing
- risk and reliability analysis
- MOV qualification methods and guidelines
- guidelines for MOV maintenance.

Though it was not possible to achieve some of the goals, the work is being continued. This CRP will be completed in mid 1998.

PUBLICATIONS

In addition, the IWG also takes part in producing publications. There are several publications which are expected to be released during this year. They are:

1. TRS on CRP "Optimizing Reactor Pressure Vessel Surveillance Programmes and Their Analysis"

2. TECDOC on CRP "Management of Ageing of RPV Primary Nozzle".

3. TRS on "Nuclear Power Plant Life Management - Owner's Point of View".

This year the IAEA has also started work on the preparation of the TRS on "PTS Methodology for all Reactor Concepts".

DATABASE

Data availability is the key aspect in evaluation of the components state and therefore in the decision making process related to their life management. Data sets required for NPP life management may differ from reactor type, however it may be categorized in general as follows:

- component specification data
- operating history
- current plant state
- maintenance
- technology developments
- material properties

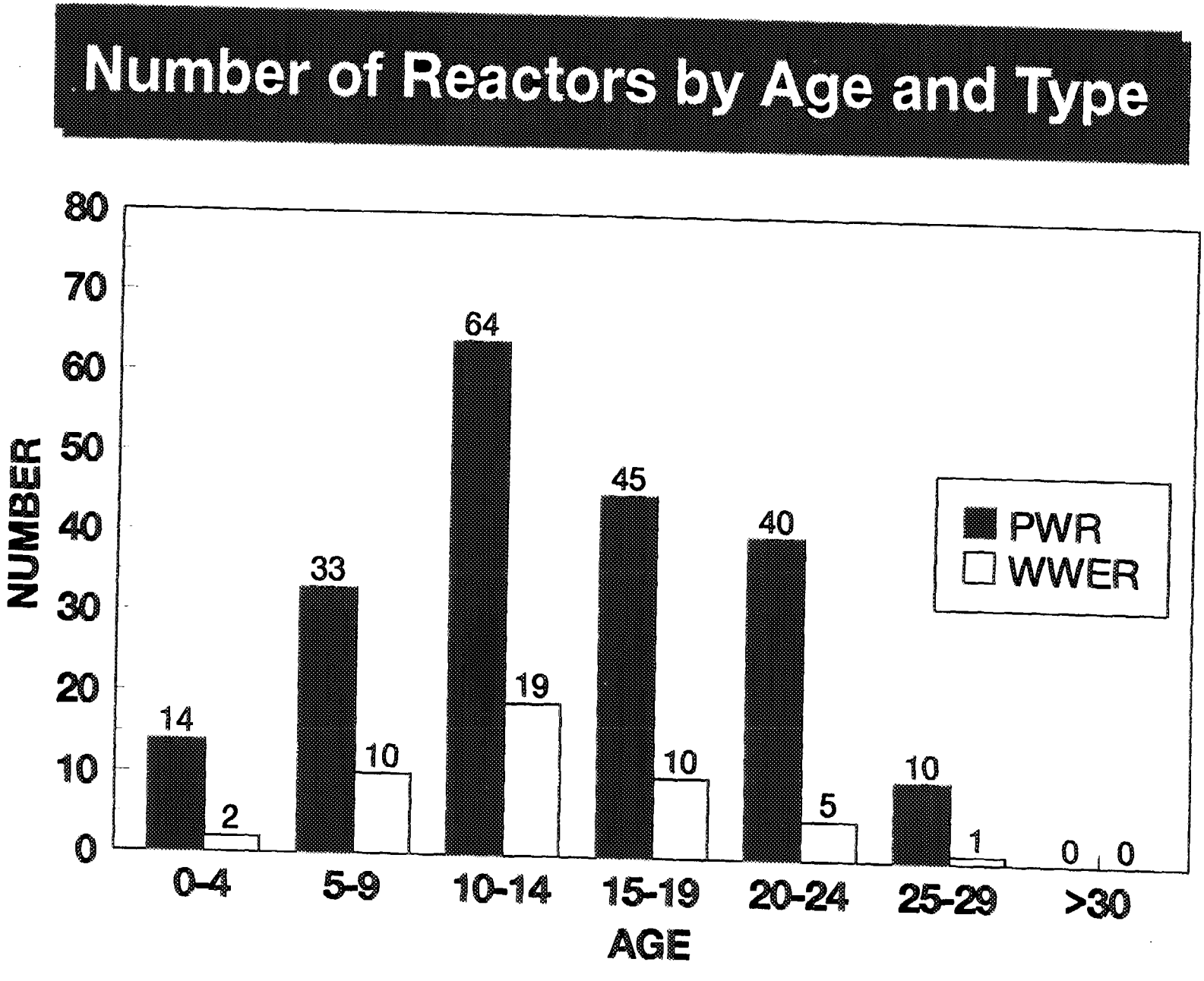
- relevant generic data.

This list can be developed and extended further with regard to specific component. It has been recognized that for effective management of ageing and degradation related processes a large amount of data is needed. To supplement inadequate data, a systematic collection and screening of the information available provides a viable and powerful aid. This approach leads to the idea of the development of databases which could assist in research and decision making process.

Several years ago the IAEA started work on the International Database on NPP Life Management. This is a multi module Database (Fig. 3) first of which is called the International Database on Reactor Pressure Vessel Materials and it was completed last year. After the specification of the Database on RPV materials had been completed the IAEA developed a software and called for international participation. At present the IDRPVM comprises of 10 participants and we expect some more countries to join the Database in the near future. Current membership to the IDRPVM is shown in Fig. 4.

The next step, which is under way now is the elaboration of specifications for the Steam Generator Database and the development of the software for the Primary Piping Database.

Some results on the elaboration of the International Database on NPP Life Management were presented in the IAEA Working Material, IWG-LMNPP-95/4. This document has been revised by the Agency's consultants and its final version is expected to be issued in May-June this year. The updated version will include a detailed description of the Database structure as well as the legal framework for the Database.



Source: IAEA PRIS
1997-04-11

FIG. 1.

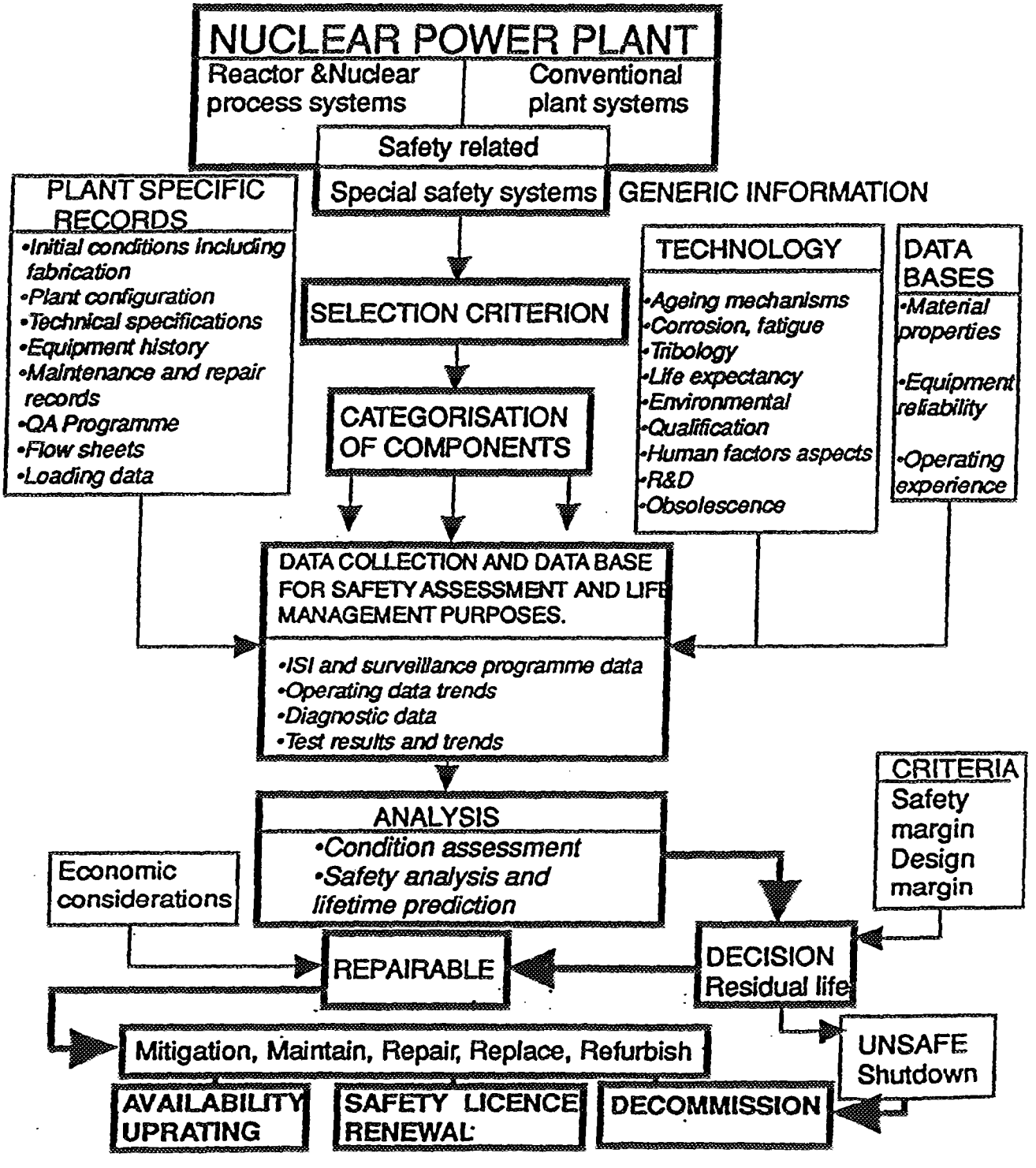
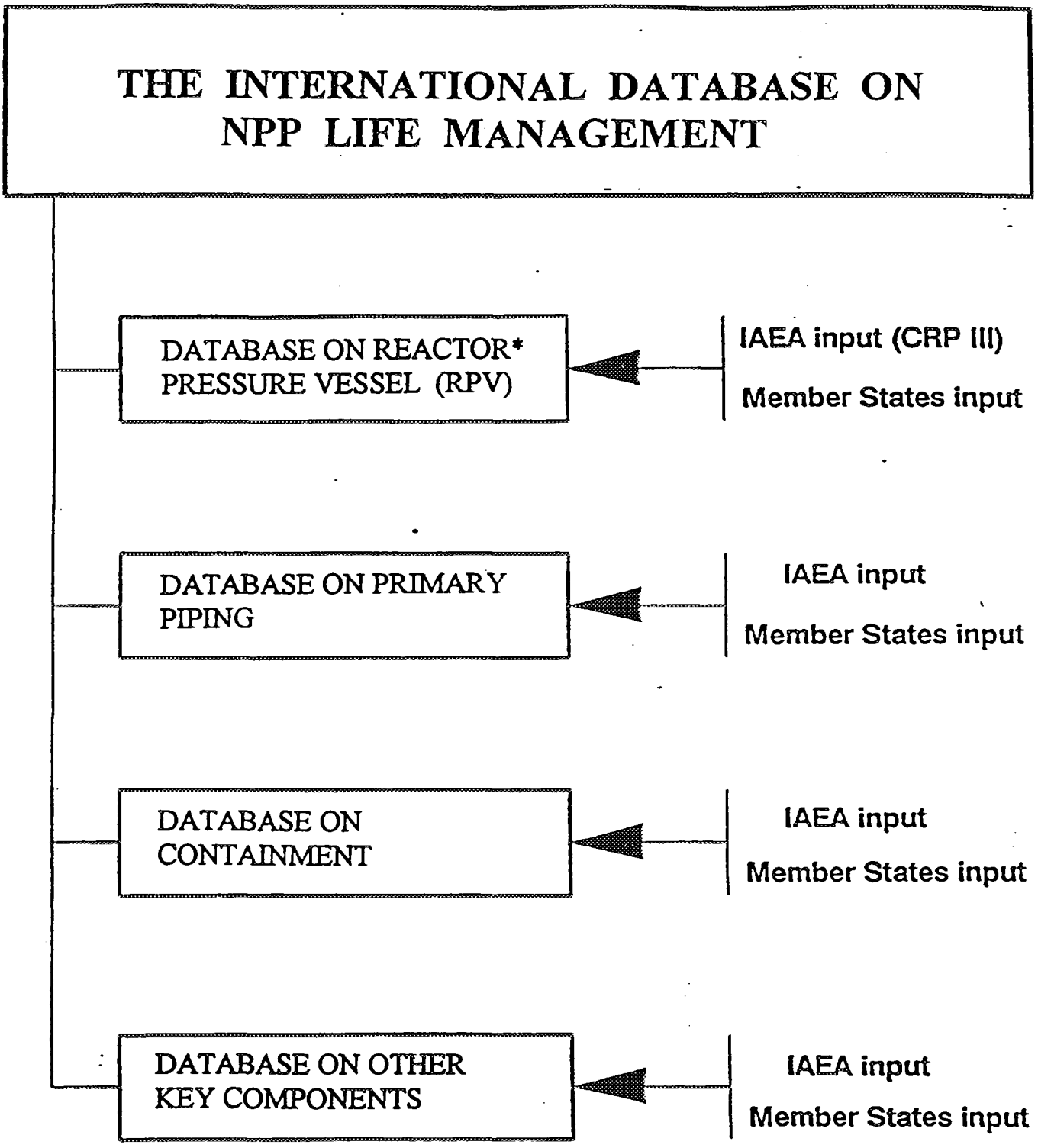


FIG. 2 *Nuclear power plant life management processes*



* at present time the database refers only to material properties data (thermal and irradiation effects)

Fig. 3. Structure of the Database on NPP Life Management

INTERNATIONAL DATABASE ON REACTOR PRESSURE VESSEL MATERIALS

MEMBERS

1. BELGIUM
2. BRAZIL
3. FRANCE
4. HUNGARY
5. ITALY
6. KOREA
7. RUSSIA
8. SPAIN
9. UKRAINE
10. USA

FIG. 4