
KNK-II Knowledge Preservation and Related Activities in Germany

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Abstract

Many of the scenarios describing possible energy futures, e.g., the World Energy Council and the Intergovernmental Panel on Climate Change (IPCC), foresee a role for nuclear power in meeting a growing world energy demand through 2050. While some scenarios explore the impact of a nuclear phase out, others envision a major growth in nuclear technology's share of the world energy mix. Given the forecasted growth in world population and in economic development, the environmental advantages of nuclear power, and concerns over climate change and the growth of greenhouse gas emissions, it is not unreasonable to expect an increased interest in nuclear power in the coming decades. Loss of nuclear knowledge is a serious concern, in particular with regard to areas where, for various reasons, nuclear technology development and innovation has been slowed down.

Knowledge can be preserved by archival techniques and by passing it on to new generations. In the case of the Federal Republic of Germany, in spite of the lack of funding and political support, both avenues are followed. Data retrieval and preservation by archiving activities for the German experimental fast reactor KNK-II were undertaken within the framework of IAEA's initiative on Fast Reactor Knowledge Preservation.

The paper will shortly introduce the IAEA initiative (scope, objectives, status, and outlook). The general approach to nuclear knowledge preservation in Germany will be presented, and the concrete archiving activities undertaken for KNK-II will be summarized.

1. Introduction

Many of the scenarios describing possible energy futures, e.g., the World Energy Council and the Intergovernmental Panel on Climate Change (IPCC) [1], foresee a role for nuclear power in meeting a growing world energy demand through 2050. While some scenarios explore the impact of a nuclear phase out, others envision a major growth in nuclear technology's share of the world energy mix. Given the forecasted growth in world population and in economic development, the environmental advantages of nuclear power, and concerns over climate change and the growth of greenhouse gas emissions, it is not unreasonable to expect an increased interest in nuclear power in the coming decades.

Loss of nuclear knowledge is a serious concern, in particular with regard to areas where, for various reasons, technology development and innovation has been slowed down. In particular, loss of the fast reactor¹ knowledge base should be taken seriously. In response to expressed

¹ It is reasonable to assume that meeting sustainability goals vis-à-vis natural resources and long-lived radioactive waste management will require systems involving several innovative reactor types and fuel cycles operating in symbiosis. Apart from cost effectiveness, simplification, and safety considerations, a basic

needs from Member States, the IAEA is implementing an initiative on fast reactor data retrieval and knowledge preservation. This initiative aims at supporting and coordinating data retrieval and interpretation efforts by the experts in the Member States. Most urgently, data must be saved from destruction, retrieved, its importance assessed, and the preservation of the valuable data initiated.

Knowledge can be preserved by archival techniques and by passing it on to new generations. In the case of the Federal Republic of Germany, in spite of the lack of funding and political support, both avenues are followed. Archiving efforts are presently concentrated on the German experimental fast reactor KNK-II, now under decommissioning. Apart from the physical disappearance of the reactor building and the adjacent offices, the situation at KNK-II is aggravated by the fact that almost all experts involved in its design, operation, and the various experimental programs have already retired. These data retrieval and preservation by archiving activities were undertaken within the framework of IAEA's initiative on Fast Reactor Knowledge Preservation [2].

The paper will shortly introduce the IAEA initiative (scope, objectives, status, and outlook). The general approach to nuclear knowledge preservation in Germany will be presented, and the concrete archiving activities concentrated on the German experimental fast reactor KNK-II will be summarized.

2. Why Fast Reactor Knowledge Preservation?

For almost four decades, several countries had large and vigorous fast breeder reactor development programs, which were at their peaks by 1980. Fast test reactors (Rapsodie (France), KNK-II (Germany), FBTR (India), JOYO (Japan), DFR (UK), BR-10, BOR-60 (Russia), EBR-II, Fermi, FFTF (USA)) were operating in several countries, with commercial size prototypes (Phénix, Superphénix (France), SNR-300 (Germany), MONJU (Japan), PFR (UK), BN-350 (Kazakhstan), BN-600 (Russia)) just under construction or coming on line. From that time onward, fast reactor development in general began to decline. By 1994 in the USA, the Clinch River Breeder Reactor (CRBR) had been cancelled and the two fast reactor test facilities, FFTF and EBR-II had been shutdown - with EBR-II permanently, and FFTF in a standby condition. Thus, effort for fast breeder reactor development essentially disappeared. Similarly, programs in other nations were terminated or substantially reduced. In France, Superphénix was shut down at the end of 1998; SNR-300 in Germany was completed but not taken into operation, and KNK-II was permanently shut down in 1991 (after 17 years of operation) and is scheduled to be dismantled by 2004; in the UK, PFR was shut down in 1994; BN-350 in Kazakhstan was shut down in 1998.

Loss of the fast reactor knowledge should be taken seriously. The delay and economic impact of restoring the fast reactor option a few decades from now without the present knowledge would be enormous. By that time, all the facilities needed to generate the information originally would be long gone, and the people who possessed the knowledge would have retired. Recently, renewed interest in fast neutron spectrum systems is coming from the efforts to investigate incineration and transmutation of long-lived radwaste in sub-critical hybrid systems (e.g., driven by spallation neutron sources). However, it must be stressed, that this

requirement to these reactor types and fuel cycles will be flexibility to accommodate changing objectives and boundary conditions. This flexibility can only be assured with the deployment of the fast neutron spectrum reactor technology, as was also recently recognized by the U.S. DOE led Generation IV International Forum initiative

renewed interest must be supplemented by an aggressive data retrieval and knowledge/technology preservation and archival effort.

3. The IAEA Initiative on Fast Reactor Knowledge Preservation

The Agency is in a good position to provide the framework for knowledge preservation efforts. Under Article III of its Statute, the IAEA is mandated to “encourage and assist research on, and development and practical application of atomic energy for peaceful uses throughout the world”. Obviously, an important aspect of this mandate is maintaining and increasing the knowledge that is necessary for the technological development.

In September 2003, in resolution GC(47)/RES/10.B, the IAEA General Conference recognized that preserving and enhancing nuclear knowledge and ensuring the availability of qualified manpower are vital to the continued and expanded safe and secure utilization of all nuclear technologies for peaceful purposes. The General Conference urged the IAEA Secretariat to continue to strengthen, subject to the availability of resources, its current and planned efforts in this area, recognizing the need for a focused and consolidated approach, and requested the Secretariat to assist Member States, particularly developing ones, in their efforts to ensure the preservation of nuclear education and training in all areas of nuclear technology for peaceful purposes. The General Conference further encouraged Member States to promote the networking of institutions for such nuclear education and training and requested the Director General to note the continuing high level of interest of Member States in the range of issues associated with nuclear knowledge in the process of preparing the Agency’s programme.

In the Agency’s ongoing Programme and Budget for 2004–2005, Programme C, Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development in Major Programme 1, reflects the increased importance of nuclear knowledge management activities. In response to operating paragraph 5 of GC(47)/RES/10.B, current preparation of Programme and Budget 2006-2007 further reflects its importance and focal point position in Major Programme 1 by redefining the missions of the International Nuclear Information System (INIS) and the Library in support of nuclear knowledge activities, and in addition by introducing dedicated knowledge management activities in other Major Programmes.

One of these dedicated activities is the Agency’s Fast Reactor Data Retrieval and Knowledge Preservation Initiative (FRKP) implemented within the Nuclear Power Technology Development Section, and within the framework and drawing on the wide expertise of its Technical Working Group on Fast Reactors (TWG-FR). The FRKP initiative is in response to expressed needs by Member States, prompting the Agency to undertake concrete steps towards the implementation of a fast reactor data retrieval and knowledge preservation project.

The objective of the initiative is to develop a Knowledge Base into which existing Knowledge Preservation Systems will fit, and which will complement and integrate future Member States’ efforts to preserve fast reactor data and knowledge. Its outcome will be an international Knowledge Base, widely used through a WWW-Portal established and maintained by the Agency. The initiative relies on both IAEA and Member States contributions. The Agency contributes its own data and knowledge accumulated over more than 35 years of activities performed within the frame of the TWG-FR (formerly International Working Group on Fast Reactors (IWG-FR)). It will further create a FRKP network among the interested Member States, and will support and coordinate FRKP activities in Member States. Last, but not least, it is developing means for precise and efficient knowledge retrieval through specialized taxonomies and classification systems. Fast reactor knowledge will be made accessible on suitable platforms, including an Internet based Knowledge Portal.

However, the responsibility for data retrieval and interpretation, as well as quality assurance, will rest with the individual Member States joining the initiative. The Member States' contributions can be summarized as follows:

- Identification of the location of fast reactor development, operation, and decommissioning data and knowledge
- Assessment of the quality and completeness of the data and information, as well as of the degree to which it is endangered
- Conversion of the data into a robust and secure digital form
- Development of interpretive documents that are defining the final state of affairs and its rationale
- Preparation of bibliographical records, including index/key words in cooperation with and using INIS resources
- Facilitation of the provision of access to the information (not necessarily open release if commercial) within the international Knowledge Base to be administered and preserved by the IAEA.

4. Knowledge Preservation Activities in Germany

The Alliance for Competence in Nuclear Technology in Germany (Kompetenzverbund Kerntechnik) is co-ordinating the knowledge preservation activities in Germany. The initial task of the Alliance is to summarise the present and to define the required future R&D activities in nuclear safety research in Germany, and to formulate a guideline for future collaborations between the involved institutions. Members of the Alliance are Research Centre Karlsruhe (FZK) having the chair, the Research Centre Jülich (FZJ), the Research Centre Rossendorf (FZR) and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and the associated universities in Karlsruhe, Stuttgart, Heidelberg, Aachen, München and Zittau/Görlitz, see *Fig.1*. The Federal Ministries BMWA (Economics and Labour), BMBF (Education and Research) and BMU (Environment, Nature Conservation and Nuclear Safety), the Project Agencies PTWt+E (Water Technology and Waste Management for BMBF and BMWA) and PT-R (Nuclear Reactor Safety Research for BMWA), and the Federal Institute for Geosciences and Natural Resources (BGR), the European Institute for Transuranium Elements (ITU) and the State Material Testing Institute (MPA) are guests of the Alliance. The members of the Alliance are embedded in a solid network of contacts and contracts with other research institutions, regulatory authorities, and universities.

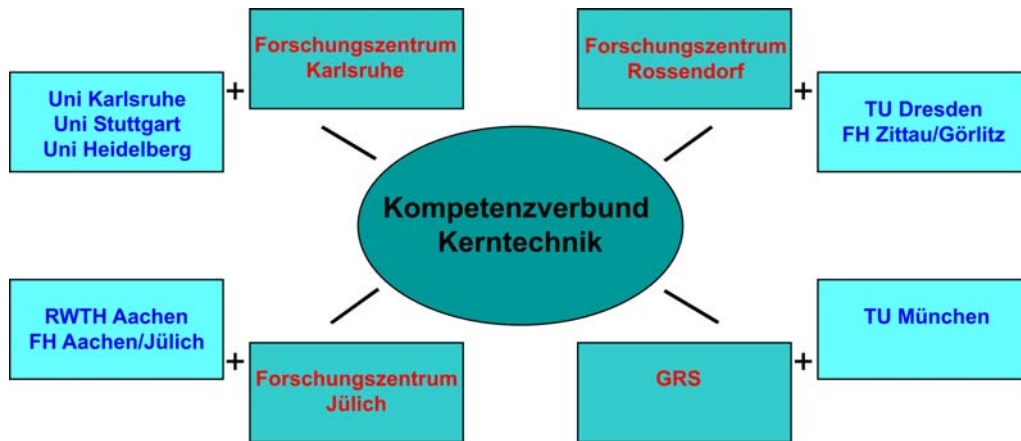


FIG. 1. Organisation of the Alliance for Competence in Nuclear Technology.

The major knowledge preservation activities of the Alliance for Competence in Nuclear Technology are:

- Each member of the Alliance has an internal PhD programme of its own, which has up to 10% PhD students out of the total base funded staff. According to the research-political boundary conditions the R&D efforts of the national research centres are limited to maintain the present state of the art, orienting the research work according to short-term operational needs. As a consequence, the national research centres examine current findings in safety technology or safety standards in the light of the state of the art for applicability to the nuclear power plants operated in Germany, and conduct appropriate long-term research projects.
- The German utilities and Framatome ANP GmbH are currently financing a total of about 15 PhD positions, focussing on industry-relevant topics or on safety-related topics of innovative reactor systems which have a feedback on the existing reactors.
- Within the Networking Fund of the Helmholtz Association (HGF) the foundation of a Virtual Institute on Competence in Nuclear Technology is funding six PhD students who are working on safety concepts of relevant reactor systems.
- The BMWA has a continuous initiative to fund topics which are relevant for the safety of the German nuclear reactors.
- Several German universities are member of the European Nuclear Education Network (ENEN), offering lectures in the nuclear field, and contributing to the degree of a European Master of Nuclear Engineering. The national research centres together with the universities offer a variety of special training courses, covering all major areas of nuclear technologies and nuclear waste disposal. In collaboration with international institutions, e.g., CEA and FZK are jointly organising the annual Frederic Joliot Otto Hahn Summer School in reactor physics.

5. Status of the IAEA Initiative

The initiative received support, among others, at a special technical session, entitled “Passing on Fifty Years of Fast Reactor Knowledge to a New Generation in Nuclear Research and Development”, which was held at the 2001 American Nuclear Society Winter Meeting, and co-chaired by Argonne National Laboratory (ANL) and IAEA staff [3]. In another, more general development, the IAEA Director General convened a meeting of senior officials from

around the world to address the more general issue of nuclear knowledge management (Vienna, June 17 – 19, 2002). At this meeting, there was strong agreement that the knowledge gained over the past 50+ years of reactor technology development must be preserved and transferred to future generations. There was also widespread agreement that, for sustainability reasons, long-term development of nuclear power as a part of the world's future energy mix, will require the fast reactor technology, and that, given the decline in fast reactor development projects, data retrieval and knowledge preservation efforts in this area are of particular importance. The actual kick-off of the initiative was at an international consultancy meeting convened by the Agency and hosted by the Argonne National Laboratory in Idaho Falls (ANL-West), 2 – 4 April 2002. The status of the initiative, with regard to both the Agency's contributions and the activities in Germany, is summarized below.

5.1. Status of the Agency Contributions

While the responsibility for data retrieval and interpretation, as well as quality assurance rests with the individual Member States joining the initiative, the Agency is responsible for coordinating the national efforts, ensure the collaboration with other International Organizations (mainly OECD/NEA), and eventually establishing and maintaining the access means to the ultimate goal of the initiative, the Fast Reactor Knowledge Base. More specifically, the Agency is supporting and coordinating data retrieval and interpretation efforts by the fast reactor experts (in many cases already retired or about to retire) in the various Member States. The most urgent tasks for these experts will be to identify the data and information that are in danger to be lost (destroyed), assess its importance and relevance, retrieve it, and ensure its preservation. As a concrete means for implementing these first tasks, the IAEA is implementing fact-finding missions to interested Member States joining the initiative, identifying the key experts, and helping focus the data retrieval and preservation activities. Provided funding is available, the IAEA is also securing, in some cases, the experts' collaboration under the provision of "Special Service Agreements". Further, to ensure effective follow-up of the actions and commitments, the IAEA is convening, in regular intervals, coordination meetings.

Over the last 12 months, the activities performed within the Agency's Nuclear Power Technology Development Section were focused on two issues: firstly, support for retrieval and archiving (using INIS capabilities) of data and information related to the German experimental fast reactor KNK-II, and, secondly, in collaboration with INIS, development of fast reactor taxonomies² and specifications of the Fast Reactor Knowledge Portal. With regard to the former activity, the Agency was in a position to secure, through a "Special Service Agreement", the essential collaboration of one of the authors. As regards the latter activity, a total of 264 documents were digitised (mostly from originals yielding very high quality electronic files, and a few from microfiches) and OCRed, thus ensuring full-text search capabilities. Moreover, work started on the specifications for the Fast Reactor Knowledge Portal, and a hierarchical structure, indexing, and taxonomy for the classification of fast reactor data and knowledge was established in collaboration between the Nuclear Power Technology Development Section and INIS, and with the support from the TWG-FR. Given the complexity of the subject matter, no one single classification facet might be able to cover appropriately all items of the data/knowledge collection. It was therefore decided to adopt a

² Taxonomies are classification systems, which enable the classification and retrieval of items by guiding the user from general subjects to more and more specific instances until a granularity is reached which matches the classification need of the item to be classified.

two dimensional classification matrix, which lists R&D aspects along one dimension and components along the other dimension.

5.2. *Status of KNK-II Data Retrieval and Preservation Activities*

The sources for the KNK-II data and documents included the KNK archive, still available in the KNK building, containing project related documents (e.g., operational history, operational experience and lessons learned documentation, etc), and personal archives from retired FZK and INTERATOM staff containing mostly R&D related documents and also scientific publications which were not yet stored in INIS. The information was retrieved, some 500 documents quality checked, and finally 191 were deemed worth preserving. For these, bibliographic records using the Agency FIBRE software with an updated INIS thesaurus were produced.

6. Conclusions and Outlook

The IAEA initiative on fast reactor data retrieval and knowledge preservation aims at providing an overall framework for the various programs being implemented in the Member States to stop data and information being destroyed, retrieve the data, assess its importance, determine what data and information should be retained, how information from different programs could be linked, how the quality of information should be assessed, and what standards should exist in software and hardware for preservation over the next 30 – 40 years. Provided adequate funding is ensured, it will support and coordinate data retrieval activities, and establish the Portal for accessing the Knowledge Base. By addressing issues of “institutional memory” (through, e.g., retrieval and preservation of the decision making processes, including the “false trails” followed and eventually rejected) and of passing information from one generation to the next, it aims at more than collecting information on static Web-based databases. The next concrete steps of the initiative will be directed towards retrieving and preserving SN-300 data, and supporting fast reactor knowledge preservation activities in Russia.

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