

IAEA Programme on Fast Reactor, Related Fuels, and Structural Materials Technology

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IAEA

International Atomic Energy Agency

Outline

- **Background**
- **Framework for IAEA Activities**
- **Information Exchange**
- **Collaborative R&D**
- **Outlook**

WORLDWIDE CLOSE TO 400 FR-YEARS CUMULATED OPERATION

□ China

- CEFR (23 MWe) 2010

□ India

- FBTR (13 MWe) 1985
- PFBR (500 MWe) 2010/11

□ Japan

- Joyo (140 MWth) 1977
- Monju (280 MWe) 1994

□ Russia (USSR)

- BR10 (8 MWth) 1958 – 2003
- BOR60 (12 MWe) 1968
- BN350 (130 MWe) 1972 – 99
- BN600 (600 MWe) 1980
- BN800 (870 MWe) 2012

□ EU (D, F, UK)

- Rapsodie (40 MWth) 1967 – 83
- DFR (15 MWe) 1959 – 77
- KNK-II (20 MWe) 1972 – 91
- Phénix (250 MWe) 1973 – 2009
- PFR (250 MWe) 1974 – 94
- SNR300 (300 MWe) not started
- Superphénix (1200 MWe) 1986 – 98
- EFR Proj. (1580 MWe), cancelled 98

□ USA

- EBR-I (a few 100s We) 1951 – 64
- EBR-II (20 MWe) 1961 – 1998
- FFTF (400 MWth) 1980 – 1996
- CRBR Proj.(380 MWe), cancelled 83

Fast Reactors Today ...

China, India, Japan, Russia

China's 25 MWe Experimental Fast Reactor (CEFR), Criticality Planned for 2009



China's 25 MWe Experimental Fast Reactor (CEFR), Criticality Planned for 2009



CEFR, Outside View and Net



India's 500 MWe Prototype FBR (PFBR), Kalpakkam, Commissioning Planned for 2010-11



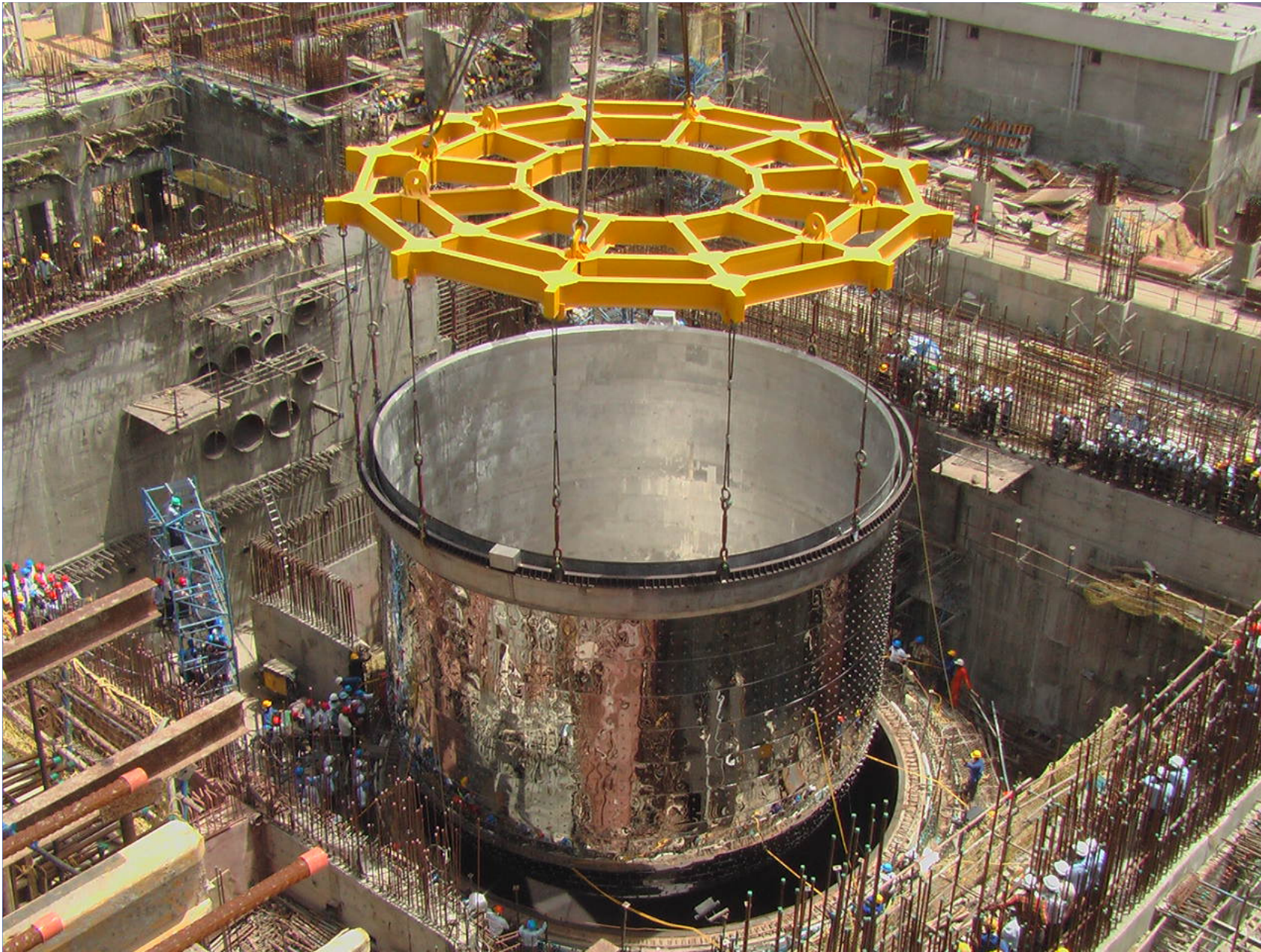
Safety Vessel (\varnothing 13.5 m, H 13.5 m, 160 t) Transported from On-site Shop to Reactor Building (June 2008)

Safety Vessel Heaved Towards Reactor Vault

(June 2008)



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Safety Vessel Lowered into Reactor Vault (June 2008)

FR09, Kyoto, 7 - 11 December 2009

10

PFBR, Kalpakkam, Safety Vessel Installed (June 2008)



Monju, Tsuruga, Japan: Restart Planned in First Quarter of 2010



Russia's BN-800, Beloyarsk Site in September 2008

Commissioning Planned for 2012-13



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Framework for IAEA Activities

□ Technical Working Group on Fast Reactors (TWG-FR) working tool to

- Promote in-depth scientific and technical information exchange on advances in fast spectrum systems research and technology development
- Stimulate and facilitate collaborative R&D (Coordinated Research Projects, CRPs)
- Coordinate activities with other Agency departments (e.g. Nuclear Safety), projects (e.g. INPRO), and international organizations (EC, ISTC, and OECD/NEA)

Framework for IAEA Activities, cont'd

□ Membership of the TWG-FR

Belarus, Brazil, China, France, Germany, India, Italy, Japan, Kazakhstan, Republic of Korea, Russia, Switzerland, United Kingdom, and United States of America, as well as the EU (EC), ISTC, and OECD/NEA

Observers: Belgium, Sweden

Framework for IAEA Activities

□ Technical Working Group on Nuclear Fuel Cycle Options (TWG-NFCO) working tool to

- Promote in-depth scientific and technical information exchange on current and future, advanced fuel cycles and their associated technologies (e.g. closed FR fuel cycles, P&T, etc.)
- Stimulate and facilitate collaborative R&D (Coordinated Research Projects, CRPs)
- Coordinate activities with other Agency departments (e.g. Nuclear Safety), projects (e.g. INPRO), and international organizations (EC, and OECD/NEA)

Framework for IAEA Activities, cont'd

□ Membership of the TWG-NFCO

Currently 15 member states participate in the TWG-NFCO and we hope to include participation from the international organizations.

Framework for IAEA Activities

□ Technical Working Group on Fuel Performance Technology (TWG-FPT) working tool to

- Promote in-depth scientific and technical information exchange on current and advanced fuel modelling, design, development and fabrication capabilities
- Stimulate and facilitate collaborative R&D (Coordinated Research Projects, CRPs)
- Coordinate activities with other Agency departments (e.g. Nuclear Safety), projects (e.g. INPRO), and international organizations (EC, and OECD/NEA)

Framework for IAEA Activities, cont'd

□ Membership of the TWG-FPT

Typically 25 member states and 2 international organizations participate in the TWG-FPT.

Information Exchange and Training Activities

Share and preserve scientific and technical information

□ Topical technical meetings, e.g.

- Design Features of Advanced Sodium Cooled Fast Reactors with Emphasis on Economics
- Fuel Handling Systems of Sodium Cooled Fast Reactors
- Decommissioning of Fast Reactors After Sodium Draining

Information Exchange and Training Activities, cont'd

- Large International Conferences, e.g. Fast Reactors and Associated Fuel Cycle – Challenges and Opportunities (FR09), 7 – 11 Dec 2009, Kyoto, Japan



Information Exchange and Training Activities, cont'd

□ Education and training, e.g.

- School on *Physics, Technology and Applications of Innovative Fast Neutron Systems*, Organized by IAEA's Department of Nuclear Energy, Department of Nuclear Sciences and Applications, in collaboration with ICTP, 9 – 20 November 2009, Trieste, Italy

Information Exchange and Training Activities, cont'd

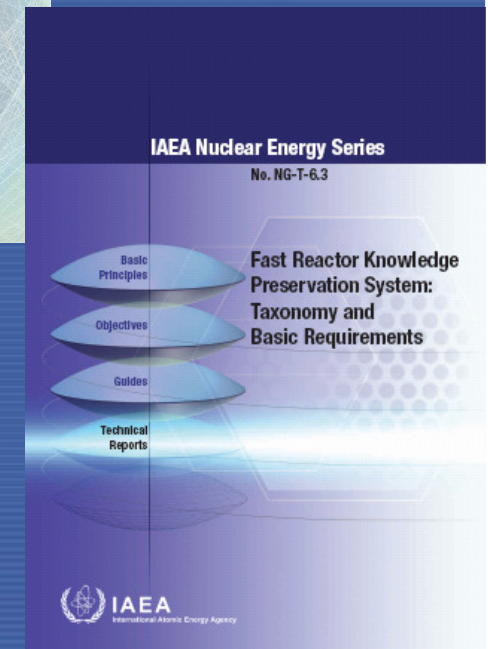
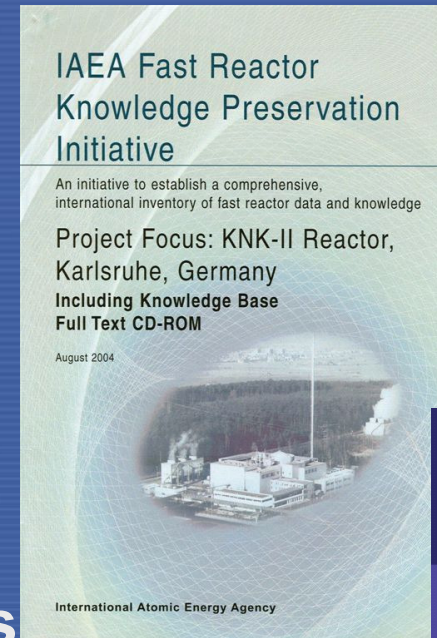
Knowledge and data preservation, reference databases

□ IAEA Fast Reactor Knowledge Preservation (FRKP) Initiative, with IAEA contributing

- Own FR data and knowledge: 40+ years of activities (IWG-FR/TWG-FR)
- Creation of FRKP network
- Support and coordination of FRKP in MS through and with the help of the TWG-FR
- Coordinated Research Projects (CRPs), and technical coordination meetings
- Development of FR taxonomies, creation and maintenance of the FRKP WWW-Portal

Information Exchange and Training Activities, cont'd

- Support for retrieval and archiving of data and knowledge in Member States
- IAEA FRKP WWW-Portal
 - *Fast Reactor Knowledge Preservation System: Taxonomy and Basic Requirements*, IAEA NE Series Report NG-T-6.3 (2007)



Information Exchange and Training Activities, cont'd

□ R&D and technology status reports, e.g

- **Status of fast reactor research and technology development**
- **Status report on ADS research and technology development**
- **Status report on liquid coolants for fast reactors**
- **Status and Trends of Nuclear Fuels for Sodium Cooled Fast Reactors**
- **Status of Developments in the Back End of the Fast Reactor Fuel Cycle**
- **Status and Trends in Advanced Partitioning Methods**

Information Exchange and Training Activities, cont'd

□ Reference databases

- **Fast Reactor Database (2006 Update)**
www.iaea.org/inisnkm/nkm/aws/frdb/index.html
- **ADS Database** www-adsdb.iaea.org/index.cfm
- **Integrated Nuclear Fuel Information System (iNFCIS)** provides one-stop access to the Minor Actinide Database, Nuclear Fuel Cycle Simulation System and other fuel cycle information <http://www-nfcis.iaea.org/>

Collaborative R&D

□ *Coordinated Research Project (CRP) on Studies of Innovative Reactor Technology Options for Effective Incineration of Radioactive Waste (2003 – 2008)*

- 17 institutions in 13 Member States & EC (JRC)
- Transient behaviour of advanced transmutation systems, both critical and sub-critical
- Papers at PHYSOR 2006, ICENES 2007, and GLOBAL 2007
- Final CRP report to be published in 2009

Collaborative R&D, cont'd

□ *Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (2005 – 2010)*

- Participation from 27 institutions in 18 IAEA Member States
- Papers at AccApp2007, and PHYSOR2008

Collaborative R&D, cont'd

□ *Analyses of, and Lessons Learned from the Operational Experience with Fast Reactor Equipment and Systems (2007 – 2010)*

- **Three Work Domains**
 - **Steam Generators**
 - **Fuel & Blanket Subassemblies**
 - **Structural Materials**
- **Retrieval of the documentation and feedback information**
- **Producing bibliographic catalogues of these documents**
- **Publishing national synthesis reports**
- **Publishing joint synthesis (lessons learned)**
- **Contributes to the IAEA Fast Reactor Knowledge Preservation Initiative**

Coordinated Research Projects (CRPs), cont'd

□ **Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel (2008 – 2012)**

- **First stage based on thermal stratification measurements performed in MONJU (1995 trip tests)**
- **Specific research objectives for first stage**
 - **Validation of multi-dimensional fluid dynamics codes**
 - **Identification of weaknesses (e.g. turbulence models, reactivity feedback models etc), and of the R&D needs to resolve them**
- **Possibility to extend CRP activities to similar tests during MONJU start-up experiments in 2009**
- **Participants: China, India, France, Japan, R. of Korea, Russia, USA**

Collaborative R&D, cont'd

- ***Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Experiments (2008 – 2011)***
 - **Research objectives of the CRP: perform preparatory analyses, blind calculations, and post-experiment analyses for two PHENIX EOL tests**
 - **Control Rod Withdrawal Test**
 - **Sodium Natural Circulation Test**
 - **Participants: China, India, France, Japan, R. of Korea, Russia, Switzerland, USA**

Collaborative R&D, cont'd

□ *Accelerator Simulation and Theoretical Modelling of Radiation Effects (SMoRE)* (2008 – 2012)

- **Research objectives of the CRP:**
 - **Contribute, through sharing the best practices in accelerator irradiation and theoretical modelling, to better physical understanding of radiation damage in different irradiation environments**
 - **Enhance simulation capabilities of accelerators for development and testing of radiation-resistant materials**
- **Participants: Belgium, China, France (2), India, Japan, Kazakhstan, Rep. of Korea, Netherlands, Poland, Russia (2), Slovakia, Spain, Switzerland, Ukraine, USA (3)**

Collaborative R&D, cont'd

□ ***Advanced Core Structural and Fuel Materials for Fast Reactors (2010 – 2014)***

- **Research objectives of the CRP: Facilitate international exchange of irradiation data and initiate collaborative experimental projects aimed at the development of new materials for fast reactors**
- **Consultants Meeting is tentatively planned for June 2010 in Russia**
- **Participants: IAEA Member States with on-going FR programmes**

Fast Reactors Looking Ahead ...

- ❑ Renewed interest in nuclear energy
- ❑ Sustainability \Rightarrow spent fuel utilization and breeding returning to centre stage \Rightarrow fast reactor necessary linchpin
- ❑ Fast reactor deployment likely to be accelerated
- ❑ Necessary condition for successful deployment \Rightarrow understanding and assessment of technological and design options (based on past knowledge and experience, as well as on renewed research and technology development efforts)
- ❑ IAEA assists Member State fast reactor development, design and deployment activities by providing an umbrella for knowledge preservation, information exchange and collaborative R&D to pool resources and expertise

For more information, please visit
www.iaea.org/inisnkm/nkm/aws/fnss/index.html and
http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_home.html

Thank You !

