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

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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
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CEFR, Outside View and Net
India’s 500 MWe Prototype FBR (PFBR), Kalpakkam, Commissioning Planned for 2010-11

Safety Vessel (⌀ 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)
Safety Vessel Lowered into Reactor Vault (June 2008)
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
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)
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)
Membership of the TWG-NFCO
Currently 15 member states participate in the TWG-NFCO and we hope to include participation from the international organizations.
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)
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
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
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
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/

- 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

  - Participation from 27 institutions in 18 IAEA Member States
  - Papers at AccApp2007, and PHYSOR2008
Collaborative R&D, cont’d

  - 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
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

  
  - Research objectives of the CRP:
    - Contribute, though 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)

- 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 ⇒ spent fuel utilization and breeding returning to centre stage ⇒ fast reactor necessary linchpin
- Fast reactor deployment likely to be accelerated
- Necessary condition for successful deployment ⇒ 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!