IAEA Activities in Support of Fast Reactor Technology Development and Deployment

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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***
  - **6 May 2010: restart of the industrial prototype Monju (Japan)**
  - **Commissioning of China Experimental Fast Reactor (CEFR) in 2010**
  - **Commissioning, at the time horizon 2011 – 2023, of six 500 MWe fast reactors in India (in addition to PFBR)**
  - **Planned construction by 2020 of the prototype fast reactor ASTRID (France)**
  - **Construction projects (prototype and commercial fast reactors) in India, Russia, Japan, and the Republic of Korea**

Challenges For Fast Reactor Deployment

- ***Economic competitiveness***
- ***Continuous safety enhancements***
- ***Closing of fuel cycle***
- ***Public acceptance***
- ***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 Activities And Role

Framework for IAEA Activities

- Understanding and assessment of technological and design options (based on past knowledge and experience, as well as on renewed research and technology development efforts) is the necessary condition for successful Fast Reactor deployment
- Technical Working Group on Fast Reactors (TWG-FR) provides considerable leverage for IAEA activities
- TWG-FR is a 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 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, the Netherlands, Russia, Switzerland, Ukraine, United Kingdom, and United States of America, as well as the EU (EC), ISTC, and OECD/NEA

  Observers: Belgium, Sweden

Specific Role of TWG-FR

- *Excellent platform for the FR specialists to share the experience related to design, development, construction and operation of nuclear power plants with FR*
- *Organize regular topical technical meetings for in-depth information exchange*
- *Organize large conferences on different aspects of fast reactor research and technology*
- *Establish a forum for broad exchanges on technical requirements for 4th generation FR systems*
- **Improve information, understanding and public acceptance of fast reactor and closed fuel cycle technologies**

Specific Role of TWG-FR, cont'd

- *Carry out Collaborative Research Projects (CRPs) of common interest to the TWG-FR Member States*
- *Secure training and education in the field of fast neutron system physics, technology and applications*
- *Provide technical support to NS for preparation of fast reactor safety requirements/standards/guides*

Some Examples of TWG-FR Activities

Collaborative R&D
Coordinated Research Projects (CRPs)

- ***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
Coordinated Research Projects (CRPs), 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
Coordinated Research Projects (CRPs), 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**

Collaborative R&D
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
Coordinated Research Projects (CRPs), 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**

Large International Conferences: Fast Reactors and Associated Fuel Cycle – Challenges and Opportunities

- Kyoto, 7-11 December 2009, hosted by JAEA
- FR09 after 18-year hiatus in response to strong Member States demand
- 622 participants from 20 Member States and 3 international organizations
- 150 oral papers
- 154 posters
- 2 panels, special young generation event, and special Tsuruga/Monju session

Information Exchange and Training Activities, cont'd

- **Education and training, e.g.**
  - **IAEA/ICTP School on *Physics, Technology and Applications of Innovative Fast Neutron Systems*, 9 – 20 November 2009, Trieste, Italy**
  - **IAEA/ICTP Workshop on *Nuclear Reaction Data for Advanced Reactor Technologies*, 3 – 14 May 2010, 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

- 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

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

TWG-FR: The Road Ahead

Information Exchange and Training Activities

Share and preserve scientific and technical information

- Topical technical meetings
- Large international conferences (FR12)
- Education and training (Workshops/Schools)
- IAEA Fast Reactor Knowledge Preservation (FRKP) Initiative

Societal Aspects

Public acceptance of fast reactor and closed fuel cycle technologies

- Building up cross-cutting capabilities to deal with societal aspects

  → Improving information, understanding and public acceptance

Modelling and Simulation of Fast Reactor Phenomena

Facilitate collaborative research and technology development (Coordinated Research Projects, CRPs)

- Neutronics, thermal hydraulics, thermal mechanics
- Data and computer code verification, validation, and qualification (V&V&Q) → theoretical and experimental benchmarks (e.g. based on Monju and PFBR experiments and operating experience), including severe accident analyses
- Enhancing links with academia (master and PhD opportunities, internships)

Realization of Fast Neutron Spectrum Experimental (Irradiation) Facilities

- Condition for fast reactor R&D&D is availability of fast neutron experimental (irradiation) facilities
- TWG-FR has the potential to foster the development, realization and utilization of such facilities through international collaboration
- Two concrete projects
  - *XT-ADS (MYRRHA) experimental facility: 50–100 MWth, mixed Pu-U oxide fuel, Pb-Bi eutectic cooled, SCK•CEN project within the framework of Euratom*
  - *MBIR fast experimental reactor: ~100 MWth/50 MWel, Na cooled, Pu-U oxide (alternatively Pu-U nitride) fuel, BOR-60 replacement project*

Thank You For Your Attention !

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