International Workshop on Prevention and Mitigation of Severe Accidents in Sodium-cooled Fast Reactors Tsuruga, Japan, 11–13 June 2012

> Keynote Address Fast Reactors and Closed Fuel Cycle: Safe Technologies and Sustainability

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IAEA Action Plan on Nuclear Safety

12 Actions:

- ✓ Safety Vulnerabilities
- ✓ Peer Reviews
- ✓ EPR
- ✓ Regulatory Bodies
- Operating Organisations
- ✓ IAEA Safety Standards
- ✓ Legal Framework
- Embarking countries
- Capacity Building

AEA

- Protection of People & Environment
 - Communication, Research & Development



Added Value of FRs in a Closed Fuel Cycle

- Sustainable nuclear power
- Effective utilization of uranium resources
- Burning of minor actinides: reduction of waste volume, radiotoxicity and heat load on the geological repository

"Closing the fuel cycle": Sufficient resources for thousands of years





Why Fast Reactors: Resource preservation

The high breeding ratio, combined with the multi-recycling of the spent fuel, allows fast reactors to fully utilize the energy potential of natural uranium, assuring a potential energy supply for thousand of years





Why Fast Reactors: Actinides' (Pu, Am, Np, Cm) Burning

Recycle of all actinides in fast reactors provides a significant reduction in amount, heat load and time required for radiotoxicity to decrease to that of the natural uranium ore used for the LWR fuel (from 250,000 years down to about 400 years)





General Framework - Safety of Fast Reactors

- Even current and future fast neutron reactors have to take into account the main lessons learned from the Fukushima Dai-ichi ccident
- In particular, extreme external events which may potentially lead to severe accidental scenarios such as Station Black Out, Loss of Ultimate Heat Sink as well as others have to be considered and analysed
- The introduction of advanced technical solutions and provisions for the prevention and mitigation of these scenarios (beyond design basis accidents) is a key factor to further increase the safety level
- Even if it is possible to identify common approaches, the safety characteristics of fast reactors are rather different than those of thermal reactors, and they require therefore appropriate and specific solutions



SFR-related International Initiatives Generation IV International Forum - GIF

4th Generation Nuclear Systems for Sustainable Energy Development

- Technical maturity around 2030
- Steady progress
 - Economic Competitiveness
 - Safety and reliability
- Significant progress:
 - Waste minimisation
 - Resource saving
 - Security: non proliferation, physical protection
- Opening to other applications:
 - High temperature heat for industry
 - Hydrogen, drinking water





Three main FR technology options depending on primary coolant





Lead-cooled Fast Reactor

Gas-cooled Fast Reactor

Nuclear Energy

IAEA - INPRO

International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

A collaborative and international project with 36 Members

- Goal: helping to ensure a sustainable nuclear energy supply to meet long term global energy needs
- Fostering a dialogue between nuclear technology holders and users to consider jointly international/national actions on innovations in nuclear reactors, fuel cycles and institutional approaches





6th GIF/INPRO Interface Meeting, March 2012



IAEA Technical Working Group on Fast Reactors

Members of the IAEA Technical Working Group on Fast Reactors

Members of the IAEA Technical Working Group on Fast Reactors



	Full Members
Belarus	Brazil
China	France
Germany	India
Italy	Japan
Kazakhstan	Korea, Republic of
Netherlands	Russian Federation
Switzerland	Ukraine
UK	USA
OECD/NEA	European Commission
	Observers
Argentina	Belgium
Spain	Sweden

Participants in the 44th Annual Meeting of the TWG-FR, Institute of Atomic Energy (CIAE), Beijing, China, 23-27 May 2011





IAEA Activities on Fast Reactors

Recent Technical Meetings

- Advanced Heat Exchangers & Steam Generators
- ISI&R
- Innovative FR with enhanced reactivity effects
- Lessons learned from Fukushima on safety of FR
- Identification of gaps for further FR development
- Knowledge preservation

International Workshops

E & T Seminars

- Different FR technologies
- Environmental degradation of materials and components under high flux fast neutron spectrum

CRPs

- Monju, Phenix
- New: Benchmark Analysis of an EBR-II Shutdown Heat Removal Test



Fast Reactors and Related Fuel Cycles: From FR09 in Kyoto to FR13 in Paris







International WS on Prevention and Mitigation of Severe Accidents in SFRs







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