International Workshop on

Prevention and Mitigation of Severe Accidents in Sodium-cooled Fast Reactors

Tsuruga, Japan, 11–13 June 2012

Overview of IAEA Activities in Support of SFR Development and Deployment

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Team Leader - Fast Reactor Technology Development
Division of Nuclear Power

IAEA
International Atomic Energy Agency

Main activities of the IAEA Programme on Fast Reactor (1/2)

- Organize regular Topical Technical Meetings for in-depth information exchange related to development, design, construction and operation of nuclear power plants with Fast Reactors (FR), as well as to R&D on Accelerator Driven Systems (ADS)

- Organize Large Conferences on different aspects of FR and ADS RTD (e.g. "*Conference on Fast Reactors and Related Fuel Cycles* - FR09, Kyoto December 2009; FR013 – Paris, March 2013)

- Establish a forum for broad exchanges on technical requirements for and characteristics of 4th Generation Fast Reactor Systems, in particular as far as safety and related issues

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Main activities of the IAEA Programme on Fast Reactor (2/2)

- Carry out Coordinated Research Projects (CRPs) of common interest to the TWG-FR Member States in the field of FRs and ADS
- Secure Training and Education in the field of fast neutron system physics, technology and applications
- Provide support to IAEA Nuclear Safety and Security Department for preparation of fast reactor Safety standards / requirements / guides
- Task #1 of the project “Support for Fast Reactor RT&D&D”: *Support Fast Reactor data retrieval and knowledge preservation activities in MSs*

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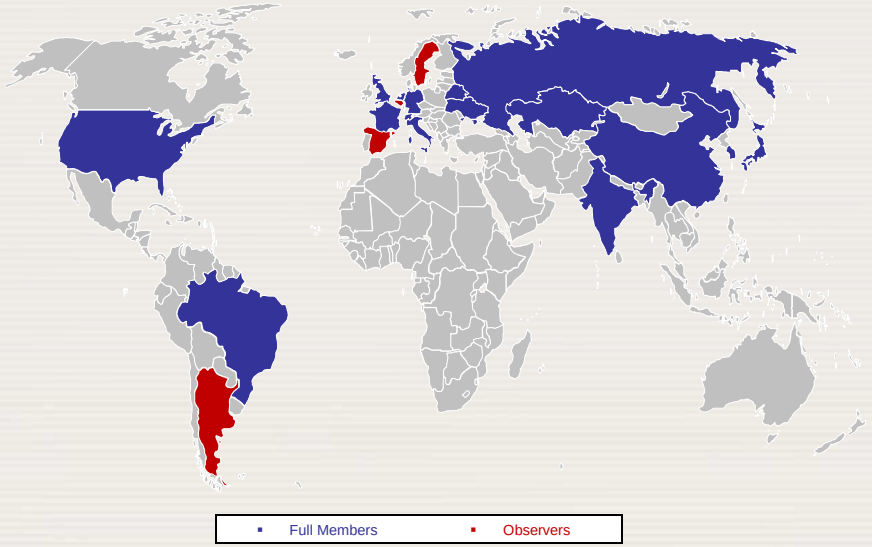
The IAEA Technical Working Group on Fast Reactors

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

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Recent TMs and WS in the Field of Safety of FR

- TM on “Fast Reactor Physics and Technologies”, Kalpakkam, 14-18 November 2011
- GIF-IAEA/INPRO Workshop on Safety Aspects of Sodium Fast Reactors, Vienna, 30 Nov. – 1 Dec. 2011
- TM on “Innovative FR Designs with Enhanced Negative Reactivity Feedback Effects”, Vienna, 27-29 February 2012
- GIF-INPRO Interface Meeting: cooperation in the area of safety of SFR, Vienna, 6 – 7 March 2012
- TM on “Impact of Fukushima event on current and future FR designs”, Dresden, 19 - 23 March 2012

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Technical provisions to be included in Future SFR concepts

(*from the conclusions of the GIF-IAEA/INPRO WS on Safety Aspects of SFR*)

- High reliability of the reactor shutdown system (RSS) based on two independent active RSS and one additional passive RSS
- Maintain coolant level in reactor vessel even in DECs (e.g. by means of guard vessel and guard pipes)
- Diversified and passive decay heat removal systems able to cool the core even in coolant leak conditions
- Seismic protection devices
- No impact of sodium leak on the containment vessel in DBE and reduced impact in case of extreme/severe DECs
- No energetic consequences (no large Na fire) in case of Core Disruptive Accident (CDA) through a combination of **prevention** and **mitigation**

Cross-cutting issue: improvement of performances and V&V&Q of modelling and simulation tools for the design and safety analysis of innovative SFRs

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Modelling, Simulation and V&V&Q

- Advanced Modelling & Simulation (e.g. multi-physics and multi-scale computer codes) with higher level of precision, key for:
  - ✓ *design optimization (e.g. reduce nominal pick temperatures);*
  - ✓ *drastically reducing uncertainty margins;*
  - ✓ *narrowing down the needs of expensive experimental tests (mock-ups, T/H and safety experiments, etc.)*
- Data and computer code verification, validation, and qualification (V&V&Q) through theoretical and experimental benchmarks, including severe accident analyses
- Comparative assessments of feasibility, performance, and safety characteristics

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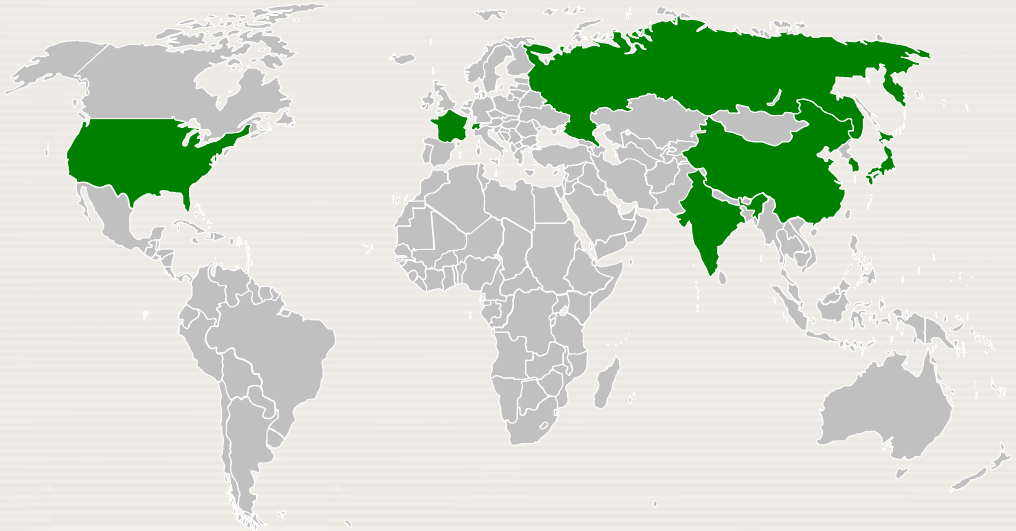
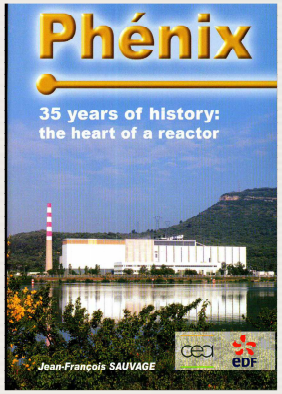
CRP on Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Tests (*special session at ICAPP-12)*



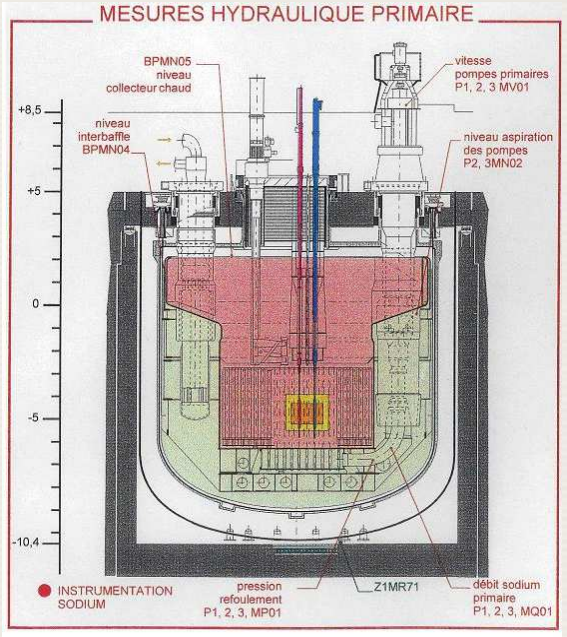
"Control Rod Withdrawal and Sodium Natural Circulation Tests Performed during the PHENIX End-of-Life Experiments"
Participants

China	France
India	Japan
Korea, Republic of	Russian Federation
Switzerland	USA



- Experimental benchmark exercises (*preparatory analyses, blind calculations, and post-experiment analyses)* based on the data obtained during the PHENIX End-of-Life tests

- V&V of methods and codes currently employed in the field of FR neutronics, thermal hydraulics and plant dynamics to achieve enhanced safety



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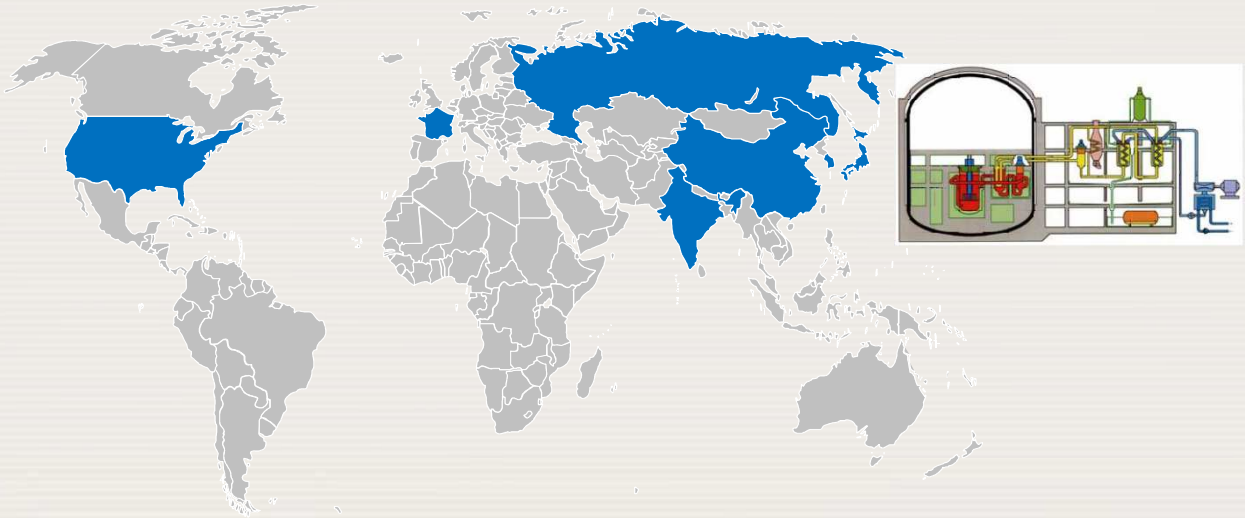
CRP on Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel (*4th RCM last April in Tsuruga*)

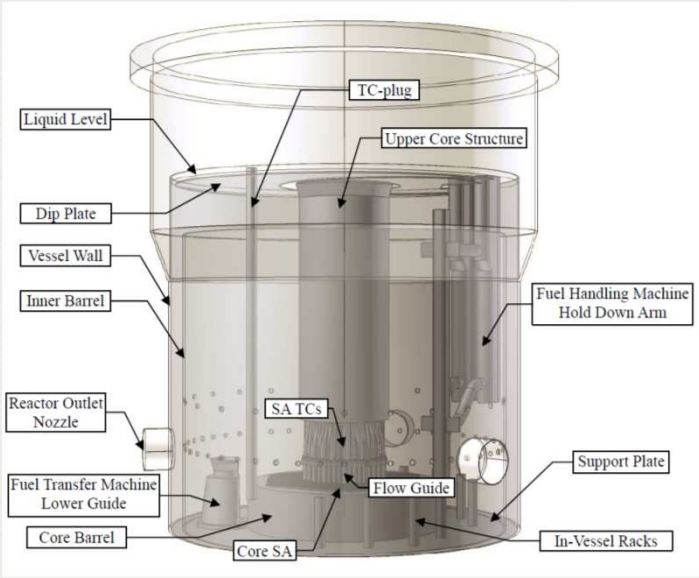


"Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel"

Participants

China	France
India	Japan
Korea, Republic of	Russian Federation
USA	

- Validation of CFD methods and turbulence models based on Na thermal stratification measurements performed in MONJU during a reactor turbine trip test conducted in December 1995 in the course of the original start-up experiments
- Thorough assessment of the calculation versus measured data comparisons



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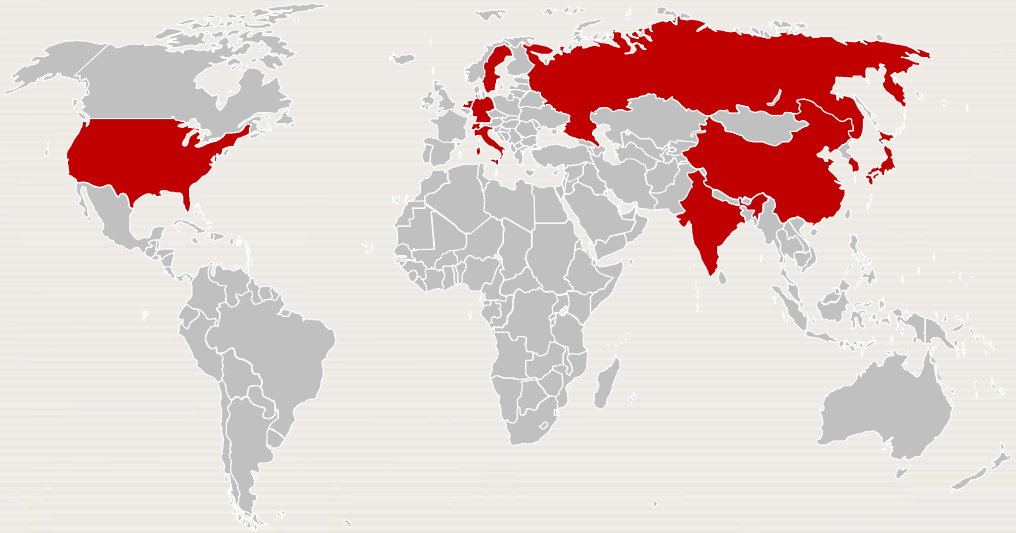
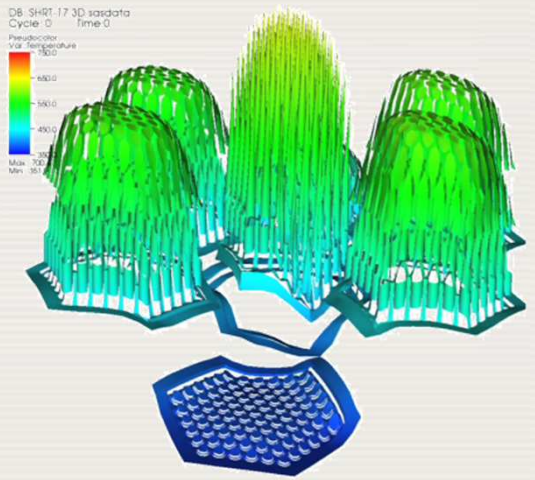
CRP on Benchmark Analysis of an EBR-II Shutdown Heat Removal Test (*1st RCM next week at US-ANL*)



"Benchmark Analyses of an EBR-II Shutdown Heat Removal Test"
Expression of Interest

China	Germany
Italy	India
Japan	Korea, republic of
Netherlands	Russian Federation
Sweden	Switzerland
USA	

- A comprehensive testing program (45 tests !) conducted between 1984 and 1987 → A unique set of whole-plant safety tests that demonstrated the potential for SFR to survive severe accident initiators with no damage
- Two EBR-II loss of flow tests chosen for this IAEA CRP:
  - ✓ *SHRT-17, the most severe of the loss of flow with scram tests*
  - ✓ *SHRT-45, the most severe of the loss of flow without scram tests*



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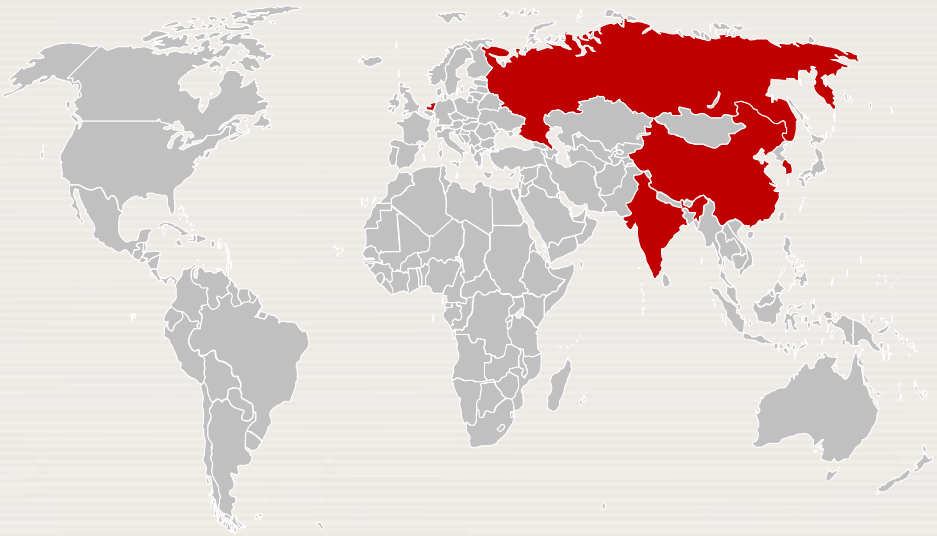
CP on Integrated Approach for the Modelling of Safety Grade Decay Heat Removal System for LMR (*Report under preparation)*

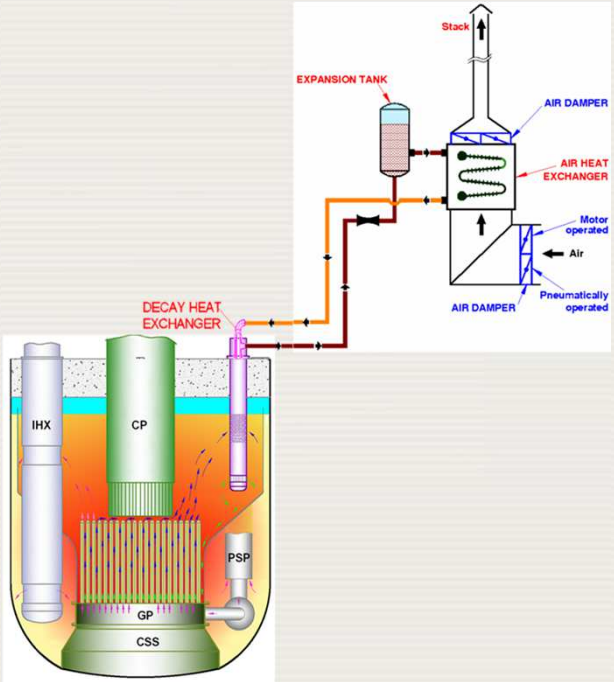


INPRO Collaborative Project:
"Integrated Approach for the Modelling of Safety Grade Decay Heat Removal System for Liquid Metal Reactors""

Participants

China	EU/JRC
India	Korea, Republic of
Russian Federation	

- Reference Design: *500 MWe pool type PFBR*
- Detailed analysis of a DHR system using different codes and modelling approaches to inter-compare the results obtained (7 case studies for different conditions)



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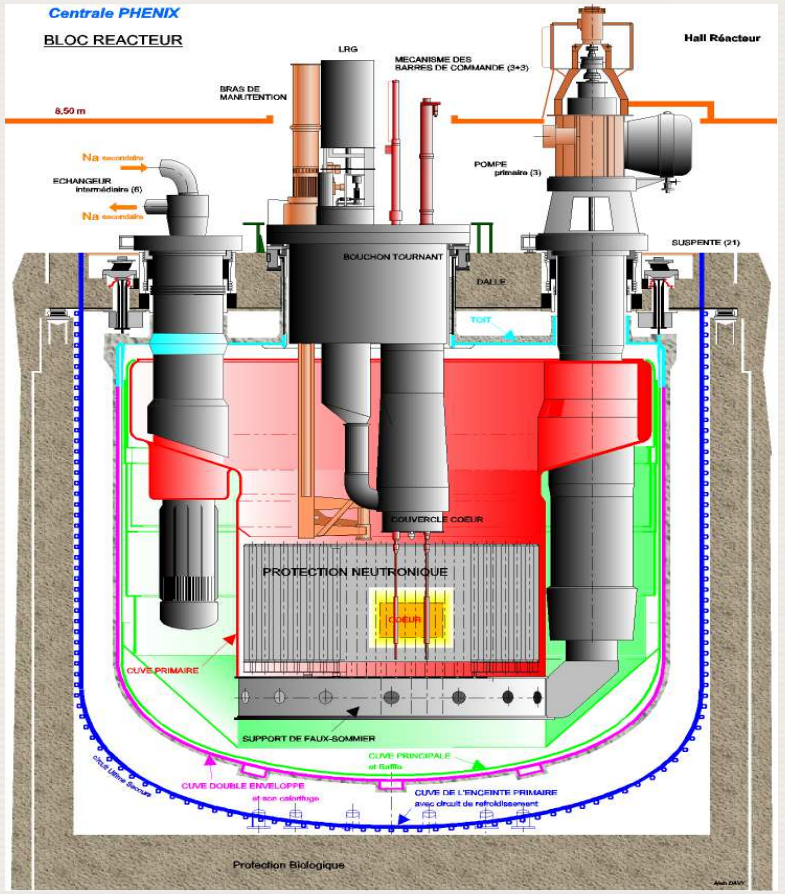
New CRP on SFR: Sodium Properties, Sodium Facility Design and Safety Guidelines (*to be launched in 2012-2013*)

- This CRP is proposed by France and it is intended to address the needs of standardization of Na physical and chemical properties, the main rules for designing experimental facilities, good practices and safety guidelines

- The CRP – making available validated data and correlations for Na coolant - will also improve the modelling and simulation capabilities in various fields of SFR technology

- The outputs of this CRP will contribute to an improvement of the future benchmark exercises and of the design of sodium facilities and their safe operation.



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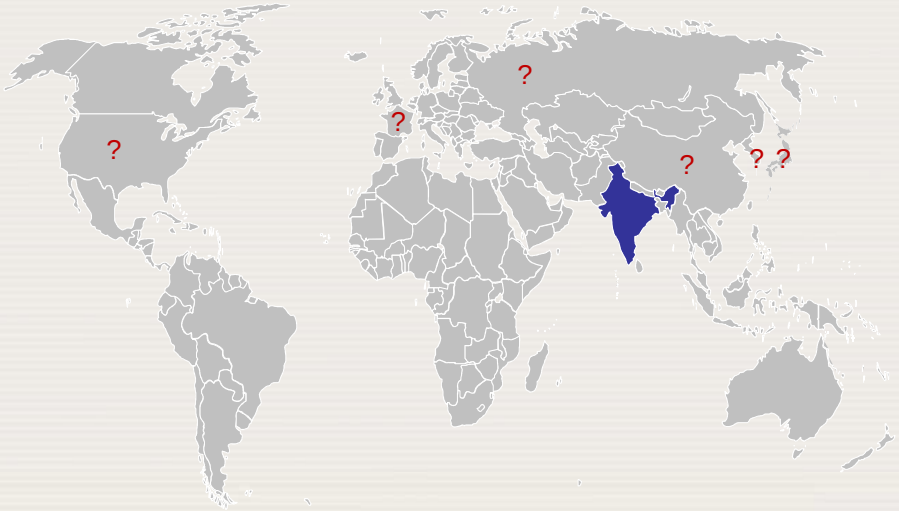
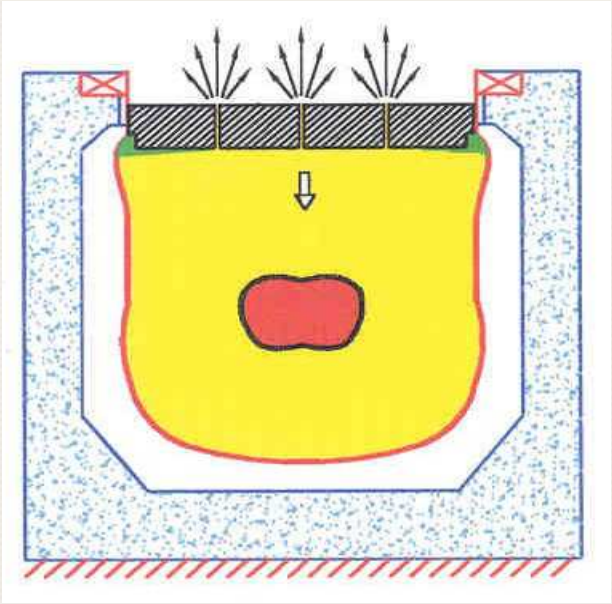
CRP on Source Term for Radioactivity Release under FR Core Disruptive Accident (CDA) Conditions



Reference design for the safety analysis:
500 MWe pool type PFBR

- Demonstrate through numerical simulations of FPs transport mechanisms that in future FBRs the radioactivity release to the environment is very low even in the extreme case of CDA
- Under whole core accident, the fission products and radioactive sodium are the basic source for the radioactivity release



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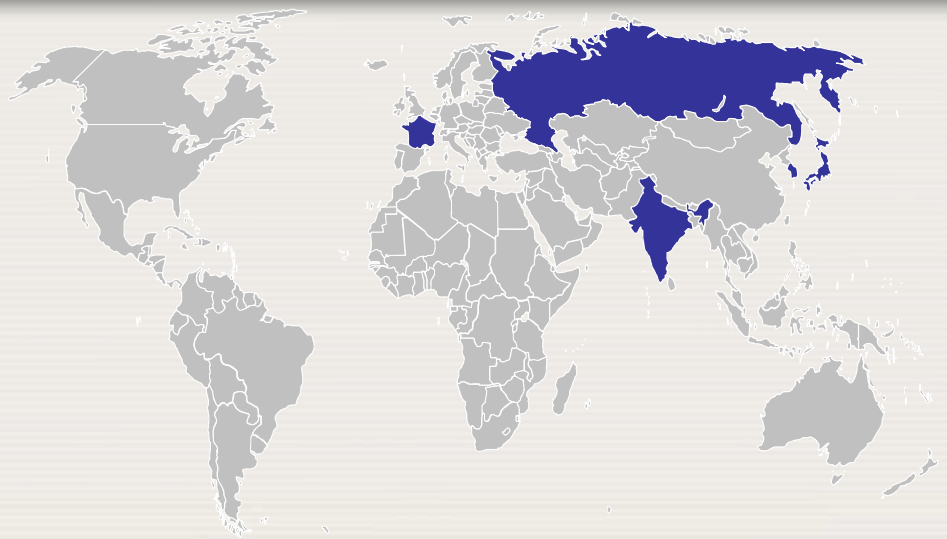
CRP on Analyses of, and Lessons Learned from the Operational Experience with Fast Reactor Equipment and Systems



“Analyses of and lessons learned from the operational experience with fast reactor equipment and systems”	
Participants	
France	India
Japan	Korea, Republic of
Russian Federation	

- Preserve the feedback from commissioning, operation, and decommissioning experience of experimental and power sodium cooled fast reactors
- Retrieve, assess, review and archive of all the relevant documentation and information
- Enable easy access to the information from this feedback
- Produce lessons-learned, synthesis reports of lessons learned and recommendations from the commissioning, operation, and decommissioning of experimental and power sodium cooled fast reactors

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Main Conclusions of the TM on Impact of Fukushima Event on Current and Future FR Designs

- Analysis of the Fukushima accident and its consequences on safety approach for FR development is still in progress. Comparison and possible harmonization of the safety approach in the different countries will be possible – and welcome – when this analysis will reach a more developed stage
- On the basis of this comparison, the IAEA should develop and recommend a common safety approach and safety standards / guide lines for innovative FRs
- As far as the safety characteristics of the innovative FRs under development worldwide, particular effort should be devoted to: diversification of safety systems, passive DHR systems, common mode failures of safety systems (also in the context of PSA), ultimate heat sink;
- Improved knowledge and consideration of extreme natural hazards should lead to enforcement of safety and implementation of effective countermeasures also for existing FRs. In particular member states operating FRs should revaluate seismicity of the site as well as resistance to earthquakes and tsunamis
- Increased knowledge on severe accidents and consequences come also from advanced modelling and simulation
- It is of paramount importance to develop suitable instrumentations able to monitor the essential safety parameters under severe accident conditions

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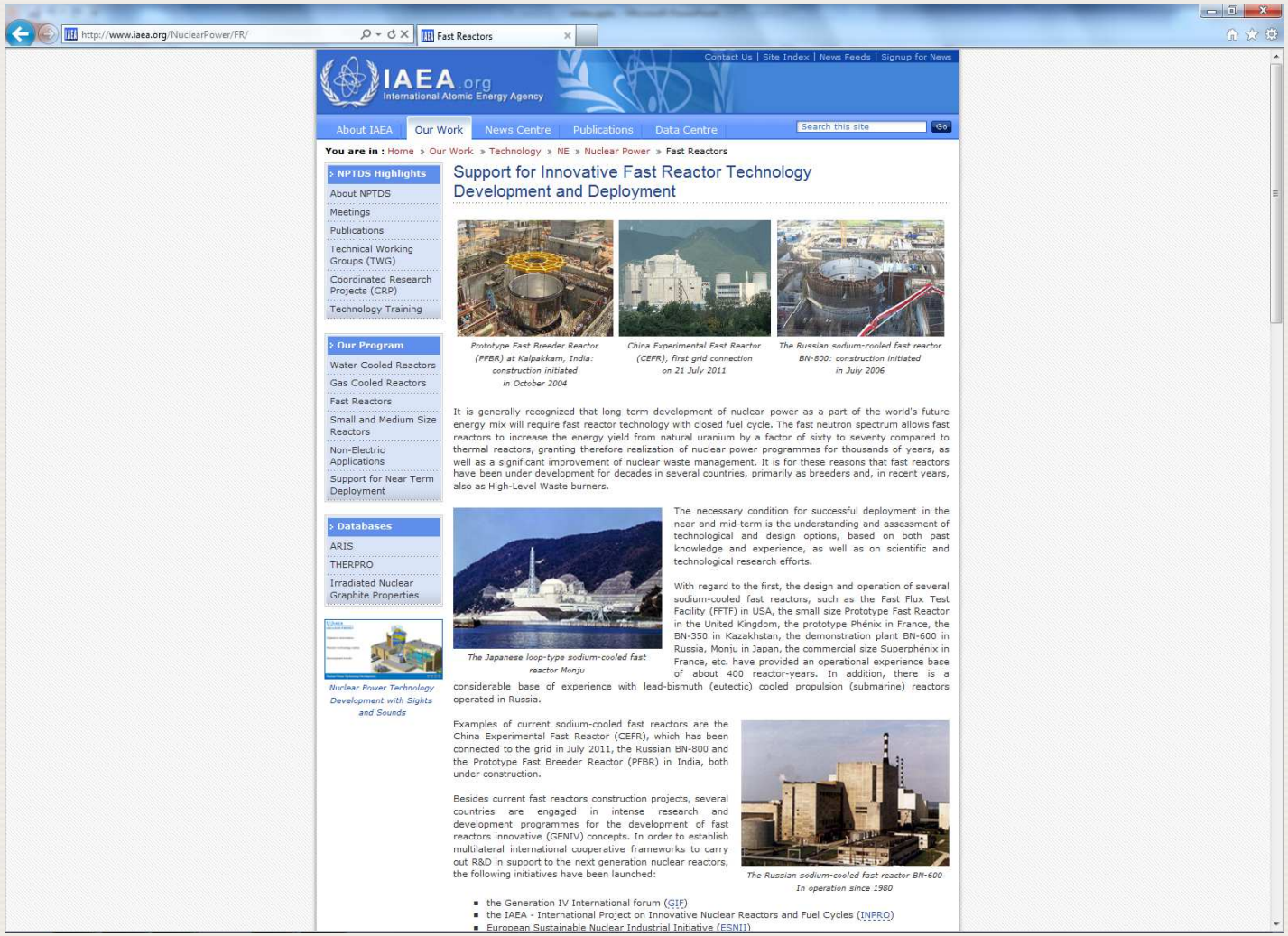
FR Project WEB-site: http://www.iaea.org/NuclearPower/FR/



TWG-FR WEB-site
http://www.iaea.org/NuclearPower/Technology/TWG/TWG-FR/

FR13 IAEA webpage:
http://www-pub.iaea.org/iaeameetings/41987/FR13

IAEA Meetings in 2013 »
Announcement Code: 41987 (T1-CN-199)

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- Hotel Information 2012
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IAEA International Atomic Energy Agency
Atoms for Peace

International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13)

Paris, France
4-7 March 2013
Conference ID: 41987 (T1-CN-199)

No further details are available at this time. Additional Information about this meeting will be posted here as it becomes available.

A. Introduction

The last major international conference on fast reactors, FR09, was held in Japan in 2009. The International Atomic Energy Agency (IAEA) now proposes, almost four years later, to bring the fast reactor and related fuel cycle community together again.

The nuclear industry has from its inception recognized the important role of fast reactors and related fuel cycles in ensuring the long term sustainability of nuclear power. Fast reactors operated in a closed fuel cycle help to improve the utilization of resources — both fissile and fertile materials — used in nuclear fuels. This improvement is possible because fast reactors can breed fissile materials and, using modern fuel cycle technologies, recycle materials bred in these reactors. In this way, fast reactors and related fuel cycle technologies can make an enormous contribution to the sustainability of nuclear energy production. They have the potential to produce a hundred times more energy from natural uranium resources. At the same time, fast neutrons favour fission of heavy atoms, instead of capture, so they can also be used to transmute minor actinides (MA) thereby reducing the demands on geological repositories for the final disposal of nuclear waste.

Many countries are actively developing reactor, coolant, fuel and fuel cycle technologies. Reactor technologies under development include sodium- , lead- , gas-, molten salt- and even supercritical water-cooled systems and technologies and accelerator-driven systems. In parallel, several demonstration projects, ranging from small to large scale, are under study or construction.

For such nuclear energy systems to become viable for industrial deployment in the coming decades, designers will have to increase their level of safety in order to gain public acceptance. Harmonization of safety standards at the international level could play a leading role in achieving these goals.

B. Objectives

The conference will provide a forum to exchange information on national and international programmes, and more generally new developments and experience, in the field of fast reactors and related fuel cycle technologies. A first goal is to identify and discuss strategic and technical options that may have been proposed by individual countries or companies. Another goal is to promote the development of fast reactors and related fuel cycle technologies in a safe, proliferation resistant and economic way. A third goal is to identify gaps and key issues that need to be addressed in relation to the industrial deployment of fast reactors with a closed fuel cycle. A fourth goal is to engage young scientists and engineers in this field, in particular with regard to the development of innovative fast reactor concepts.

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International WS on Prevention and Mitigation of Severe Accidents in SFRs

Thanks for Your Attention !

…Atoms for Peace

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Back-up

Main Deliverables

Forthcoming TWG-FR Technical Publications (1/2)

- Status of Fast Reactor Research and Technology Development (*850 pages IAEA TECDOC ! in print*):
  - ✓ Background and overview
  - ✓ Operating experience with SFR
  - ✓ Sodium-cooled FR Designs
  - ✓ HLM-cooled FR Designs
  - ✓ Gas-cooled FR Designs
  - ✓ Status of FR core R&D
  - ✓ Reactor plant engineering technology development
  - ✓ Reactor safety design and analysis
  - ✓ National strategies, international initiatives, public acceptance and final remarks

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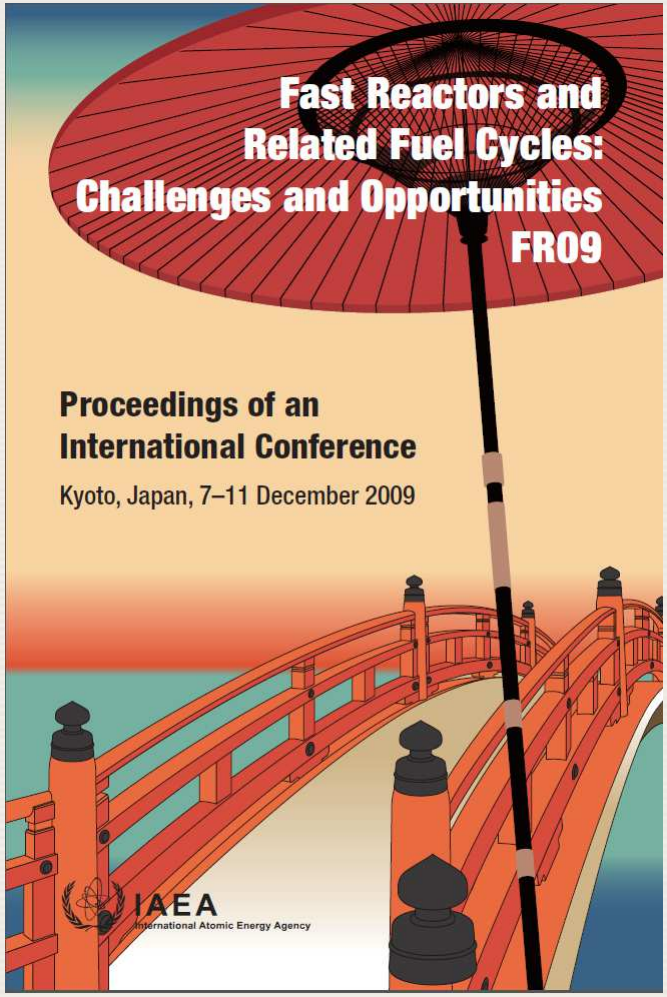
Technical Reports closed to Publication

- Liquid metal coolants for Fast Reactors: reactors cooled by sodium, lead and lead-bismuth eutectic (*in print*)
- Design Features and Operating Experiences of Experimental Fast Reactors (*in print*)
- Proceedings of FR09, Kyoto, December 2009



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Technical Reports and NES in Preparation

- BN-600 Hybrid Core Benchmark Analysis: methods to reduce calculation uncertainties of the LMFR reactivity effects (*under final editing*)
- Benchmark analyses on the Natural Circulation Test Performed During the PHENIX End-of-Life Experiments (*under final editing*)
- Status Report of Accelerator Driven Systems for waste transmutation and energy production (*under final editing*)
- Special issue of Nuclear Engineering & Design Journal devoted to the outcomes of the IAEA TM on Physics and Technology of Fast Reactors (*papers available and under review*)

Technical Reports and NES in Preparation

- Final Report of the CRP on Analytical and Experimental Benchmark Analyses of Accelerator Driven System
- Final Report of the CRP on Lessons Learned from the Operational Experience on Fast Reactors (*editing just started*)
- Final Reports of the CRP on Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Tests (*first report under review*)
- Final Report of the CRP on Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel (*editing just started*)

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