



IAEA

60 Years

Atoms for Peace and Development

International Conference on
Fast Reactors and Related Fuel
Cycles (FR17)
Yekaterinburg, 26-29 June 2017

YGE Workshop, 29 June 2017

The Role of the IAEA in Fast Reactor Development and Knowledge Transfer

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Fast Reactor Technology Development Team
Nuclear Power technology Development Section
Division of Nuclear Power, Department of Nuclear Energy
International Atomic Energy Agency

<http://www.iaea.org/NuclearPower/FR>



IAEA Fast Reactor Technology Development Team

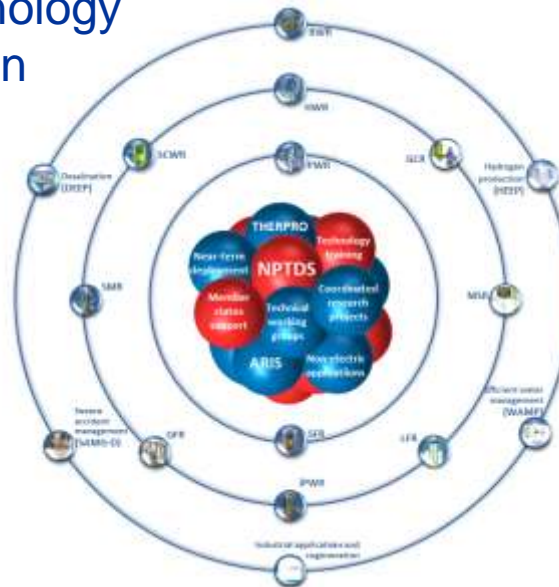


DDG: Mr M. Chudakov

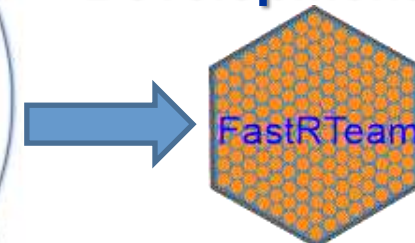


DIR: Mr D. Hahn

Nuclear Power Technology
Development Section
NPTDS
Head: Mr S. Monti



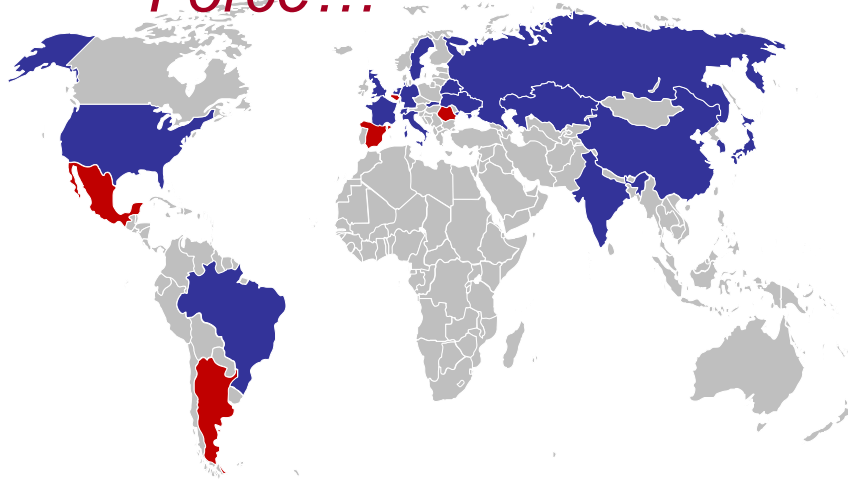
Fast Reactor Technology
Development Team



FR Team: Objectives

- Create an effective **platform for exchange of information**
- Produce **technical reports** on Fast Reactors and Accelerator Driven Systems
- Support **R&D activities** focused on main FR issues
- Agree and converge on **safety** approaches, **design criteria and guidelines** at international level
- **Share data** on experimental facilities
- Develop, verify and validate advanced **simulation tools** through experimental **benchmarking**
- Provide opportunities for **Education and Training**
- **Collect, retrieve, preserve and make available** existing documents, data and information on fast reactors

“The Driving Force...”



Members of the IAEA Technical Working Group on Fast Reactors

Full Members

Belarus
China
Germany
Italy
Kazakhstan
Netherlands
Slovakia
Switzerland
UK
European Commission

Brazil
France
India
Japan
Korea, republic of
Russian Federation
Sweden
Ukraine
USA
OECD/NEA

Observers

Argentina
Czech Republic
Romania
Generation-IV International Forum (GIF)

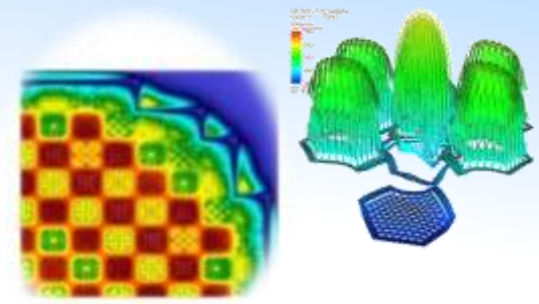
Belgium
Mexico
Spain

- a) Provide advice and guidance
- b) Forum for information and knowledge sharing
- c) Link between IAEA activities and national communities
- d) Provide advice in planning and implementing CRPs
- e) Develop and review selected documents
- f) Contribute to status report, technical meetings, topical conferences
- g) Identify important topic for SAGNE
- h) Encourage participation of young professionals in IAEA activities

Programmatic Areas

Modelling and Simulations

- Coordinated Research Projects (CRPs)
 - *EBR-II (Shutdown Heat Removal Tests)*
 - **NAPRO (Sodium properties)**
 - PSFR Source Term
 - CEFR Start-Up Tests
 - FFTF (ULOF Tests)



Knowledge Preservation

- Fast reactor knowledge preservation portal (**FRKP**)
- Liquid metal cooled fast neutron system database (**LMFNS**)



Education and Training

- **SFR Simulator** for Educational Purposes
- **ICTP-IAEA Workshop** on the Physics and Technology of Innovative Nuclear Energy Systems



Safety

- Joint **IAEA-GIF Technical Meeting** on Safety of SFR
- **Passive Shutdown Systems** for Fast Neutron Systems – NES Publication



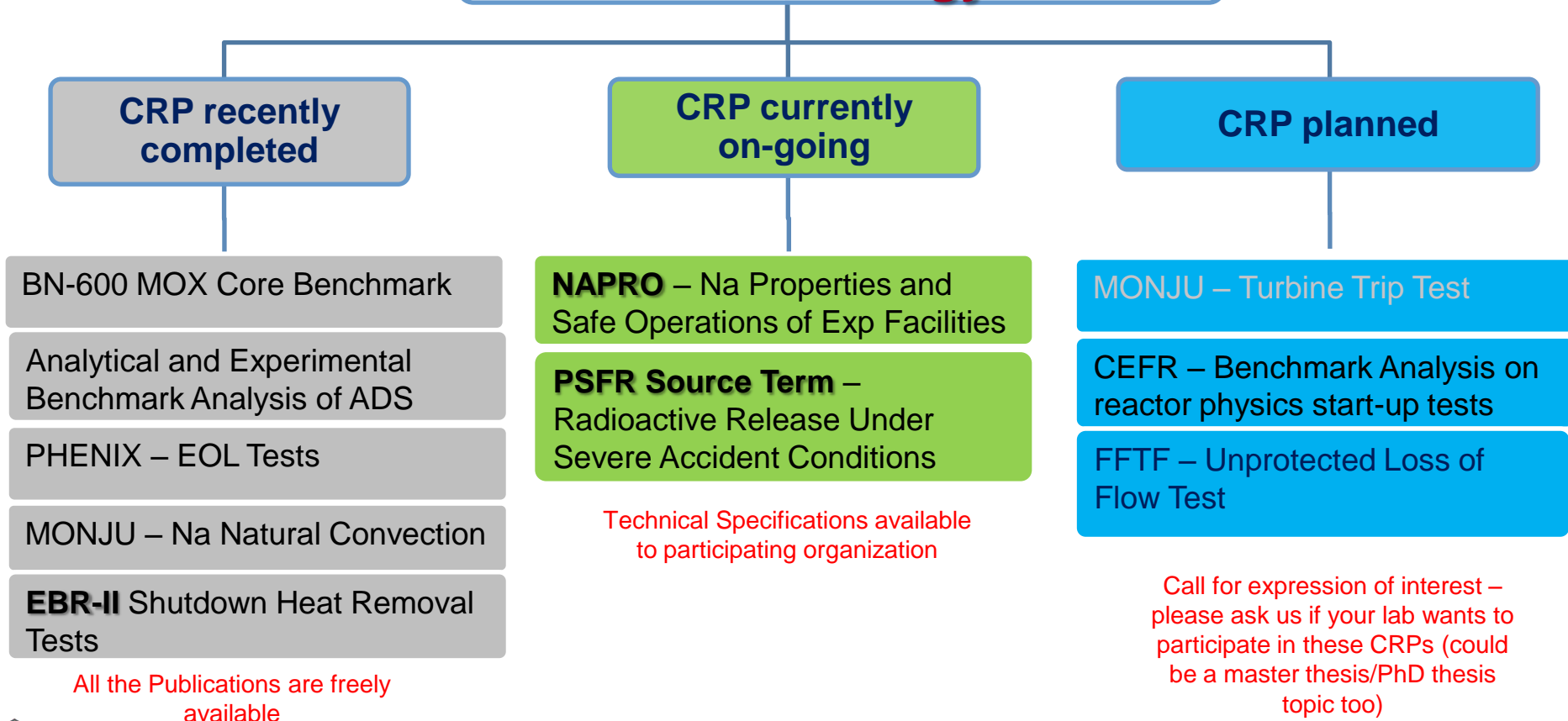
Technology Support

- **NAPRO**: CRP
- **LMFNS** Catalogue



CRP: Coordinated Research Projects

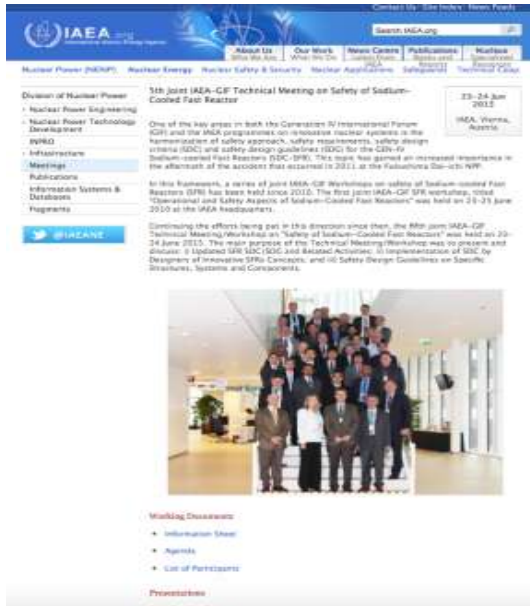
CRPs on Fast Reactors Technology



New CRPs Under Consideration

- Monju-TTT (Turbine Trip Test) (cancelled)
- **CEFR**: proposed by CIA, China
 - Expression of Interest:
 - 10 MSs; 12 Organizations; 6 months delay
- **FFTF**: proposed by ANL, U.S.
 - Confirmed at 50th Meeting of TWG-FR meeting in May 2017
 - Expression of Interest: Expecting Participants
- **HLMT**: Heavy-Liquid Metal Technology
 - New CRP on heavy liquid metal technology: Italy and Romania will coordinate with other interested countries/organizations (e.g. NIKIET and INEST) in order to submit a first pre-proposal at the next TWG-FR meeting; Italy/Romania proposed for discussion; postponed
- On Structural Materials Italy/Romania preparing proposals
- **BN-800** ? expected soon

GIF-IAEA Workshops on Safety of SFR



- 1st : June 2010
- 2nd : Dec 2011
- 3rd : Feb. 2013
- 4th : June 2014
- 5th : June 2015

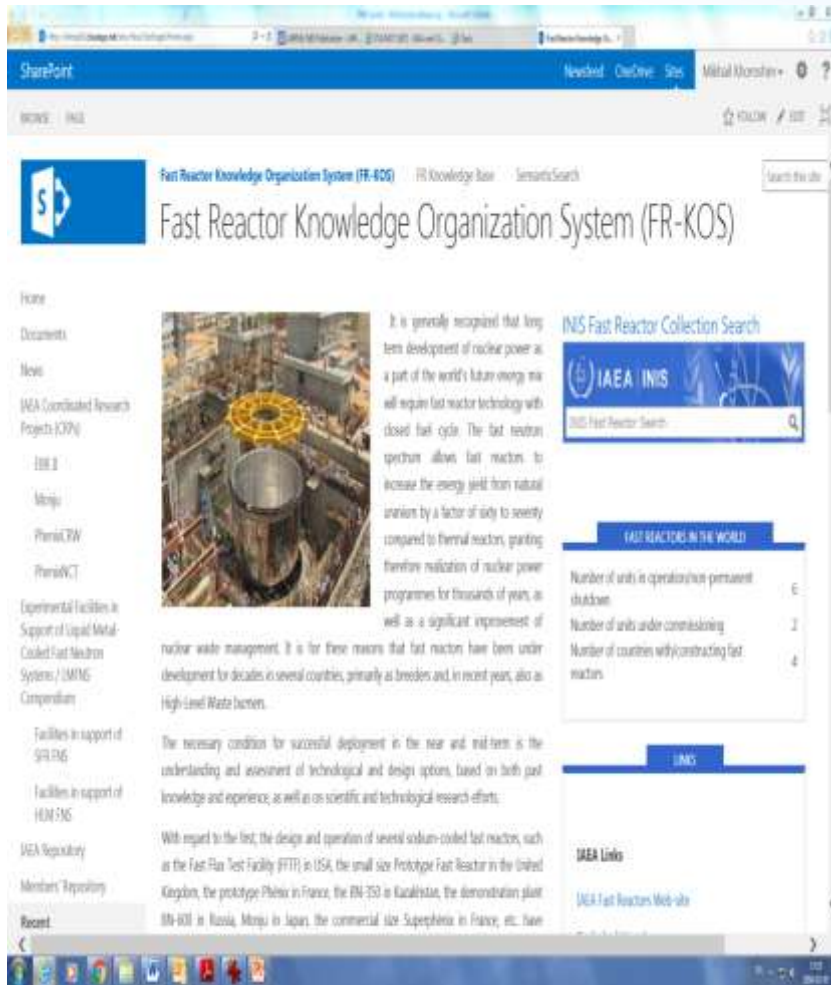
6th GIF-IAEA Workshop on Safety of SFR: 14-15 November 2016

- Review of Recent GIF Report on Safety Design Guidelines on Safety Approach & Design Conditions for GEN-IV SFRs
- Continuous in-depth discussions on the development of SFR SDC/SDG

Passive Shutdown Systems for Fast Neutron Reactors

- NES document draft is under preparation
- SharePoint site is used for collaboration and knowledge preservation
- CM in February 2017: First Draft is Ready
- December 2017: Submit for publishing

Fast Reactor Knowledge Preservation: FRKP Portal



CRPs data uploaded: (Designed and ready for use by projects' participants)

1. EBR-II Shutdown Heat Removal Test Analysis
 2. **Monju_UPNC**: Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel
 3. **Phenix_CRW**: Control Rod Withdrawal Tests Performed During the PHENIX End-of-Life Experiments
 4. **Phenix_NCT**: Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Experiments
- New CRP on "Radioactive Release from the Prototype Fast Breeder Reactor (PFBR) under Severe Accident Conditions "
 - Passive Shutdown Systems for Fast neutron reactors

Available also on the web:

- Experimental Facilities in support of Development and Deployment of Liquid Metal Cooled Fast Neutron Systems (LMFNS). [LMFNS catalogue](#) is a live database
- FR 17 conference

FR Taxonomy was revised in 2015 and applied in the FRKP portal

Ask us to get access

LMFNS Experimental Facilities Database

Experimental Facilities in support of Development and Deployment of Liquid Metal cooled Fast Neutron Systems



Catalogue of Facilities in Support of Liquid Metal-cooled Fast Neutron Systems (LMFNS Catalogue)



This LMFNS catalogue is a living database, which is, in its current form, presents an electronic version of section 4 of the IAEA Nuclear Energy Series publication (in progress) "Experimental Facilities in Support of Liquid Metal Cooled Fast Neutron Systems. A Compendium".

[LMFNS Compendium. Summary of the IAEA publication](#)

To overview the potential capabilities of 160 experimental facilities in 14 IAEA Member States to support the development and deployment of the innovative Liquid Metal cooled Fast Neutron Systems (LMFNS) and navigate yourself through the "LMFNS Facilities Database" click on the below buttons:

[Overview of SFR](#)

[Overview of LFR](#)

For detailed information on these facilities 1) click on the below button "LMFNS Facilities Database" (also on top of this page), 2) select the Coolant technology - SFR, LFR or both in the search box, 3) use other search and filtering tools as appropriate, 4) click on the Facility Profile you are interested in.

[LMFNS Facilities Database](#)

- A comprehensive **Catalogue** providing detailed information on experimental facilities currently designed, under construction or operating
- Facilities Designed to support the development and deployment of innovative liquid metal-cooled (**sodium, lead and lead-bismuth**) fast neutron systems (LMFNS), both critical and subcritical
- Identifies existing or future operational experimental facilities able to support innovative LMFNS
- Expected to facilitate cooperation using existing and planned experimental facilities for LMFNS, and enhance their utilization by providing end-users with detailed information
- Encourages international collaborations

**Freely Accessible at
iaea.org:
Search for "IAEA LMFNS"**

SFR Simulator

Development of PC based SFR Simulator for Educational Purposes

- ❑ Funded by IAEA RB + MEXT-Japan + in-kind contributions from other interested MSs
- ❑ 1st CM to finalize specs: January 2016

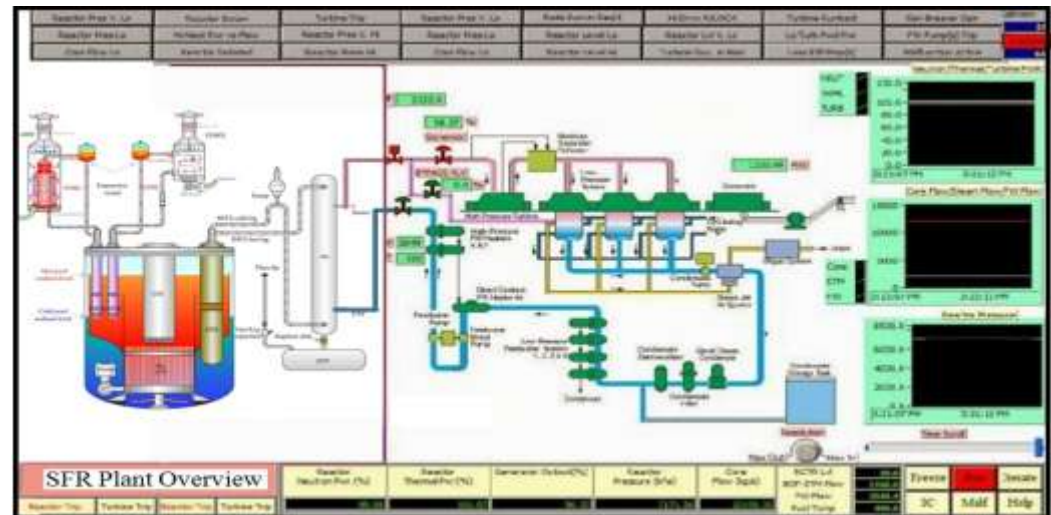
Requested by the TWG-FR to support better understanding of fast reactor physics and technology

Final Detailed Technical Specifications
prepared by IAEA: Ready

Extra Funding is needed

*“I hear and I forget.
I see and I remember.
I do and I understand ...”*

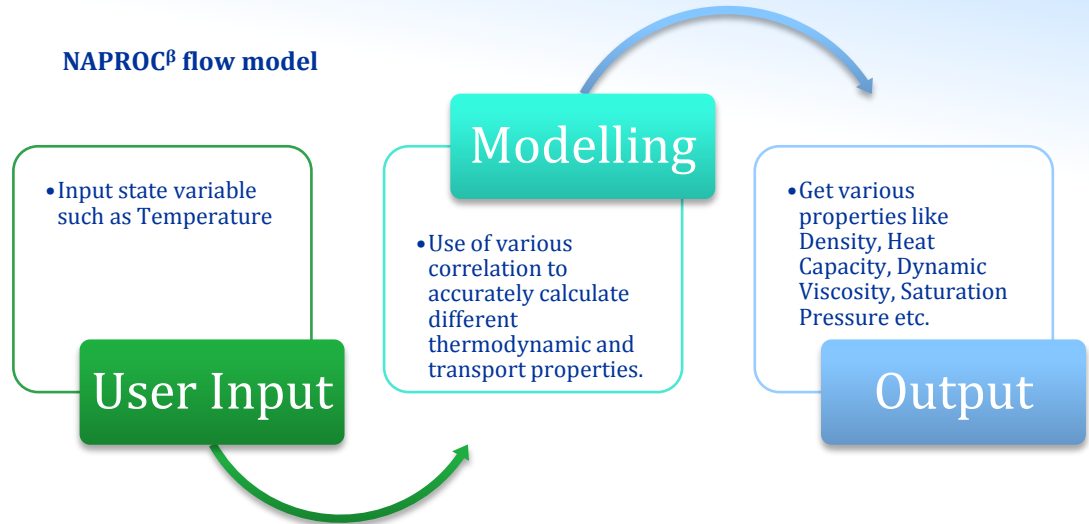
- Confucius



NAPROC β : The Sodium Properties Calculator

Will use NAPRO CRP results

- Easy to use software to get the thermophysical of liquid sodium.
- Input the required state variables and get all desired properties.
- Beta version under development.
- Modelling based on the use of various correlations.
- If possible, benchmarking against available database.



Current Development



NAPROC β : Calculate the Liquid Sodium Thermal Properties

Please enter the following:

Temperature (K): (valid range: 473-2000K)

Density (kg m⁻³):

Specific Heat (kJ K⁻¹):

Reference: Thermody. (2010) 4 (1)

THERMODYNAMIC AND TRANSPORT PROPERTIES OF SODIUM LIQUID AND VAPOR.

Reactor Engineering Division

Used for Benchmarking

Used for software modeling

Database of thermophysical properties of liquid metal coolants for GEN-IV

Sodium, lead, lead-bismuth eutectic (and bismuth)

Vinay Seshalev

November 2010 (rev. Dec. 2011)

SCK-CEN
Boeretang 200
2400 Mol
Belgium

IAEA International Conferences on *Fast Reactors and Related Fuel Cycles*

560 Abstracts Submitted
460 Tech. Papers Accepted



Background Information and Statistics – role of YGE

	FR09	FR13	FR17
Total Participants	622	642 (400 abstracts)	~800 registered 488 contributors
Officially designated	569	612	685
Observers	53	30	
Countries	20	27	32
International organizations	3	4	7
Presentations	150 (oral); 6 (opening); 3 (closing); 9 (panels); 11 (YGE)	208 (oral); 5 (opening); 7 (closing); 15(panels); 7 (YGE)	243(oral); 206 (posters) 4 (opening) 12 (keynotes); 11(panels) 12 (YGE)
Posters	154	157	210 (approx.)
YGE	1	1	Panel + Workshop
Panel Discussions	2	2	2
Keynote Speakers		9	12
Invited Speakers	27	57	50

Training Courses and Workshops

- IAEA Workshops and Schools on Innovative Nuclear Energy Systems
- Recent Course: *Joint ICTP-IAEA Workshop on the Physics and Technology of Innovative Nuclear Energy Systems for Sustainable Development*, 29 Aug – 02 Sept 2016, Trieste, Italy
 - Imparted theoretical foundation of all aspects of innovative nuclear energy systems
 - Familiarized students with models and codes for design and safety analysis
 - Provided an active forum for sharing new ideas

“Preparing the next generation...”



NPTDS-FR Team: Major Outputs



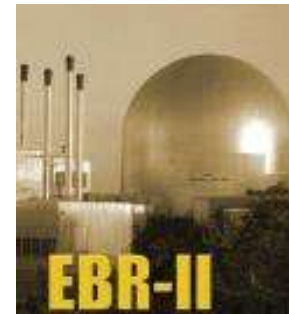
FR 17
Conference

FRKP
portal

SFR
Simulator

EBR-II
Benchmark
Results

Handbook on
Sodium
Properties



Publications

7 Publications in 2017/2018

3 NES documents 4 TECDOCs

TECDOCs and NES Reports:

- Analytical and Experimental Benchmark Analysis of ADS –
 - In Publishing
- Catalogue of Experimental Facilities for Liquid Metal Cooled FNSs –
 - In Publishing; Database is available online
- Benchmark Analyses of EBR-II Shutdown Heat Removal Tests
 - In Publishing
- *NAPRO CRP*
 - WP1: Handbook on Sodium Physical and Chemical Properties
 - final draft in June 2017; Internal Review: July 2017; Ext Review: Nov 2017
 - WP1: Handbook on Thermal Hydraulics Correlations for Sodium-Cooled Reactors
 - final draft in June 2017; Internal Review: July 2017; Ext Review: Nov 2017
 - WP2/3: Design, Operation and Safety of Sodium Experimental Facilities - NES Report: end 2018
 - first draft Nov 2017; final: 2018
- Passive Shutdown Systems for Fast Neutron Reactors
 - draft NES is in preparation; expected in mid 2017



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Thank you for your attention!