

IAEA databases and R&D infrastructures for innovative reactors

Experimental Facilities in Support of Liquid Metal-Cooled Fast Neutron Systems

M.Khoroshev

Nuclear Power Technology Development Section (NPTDS)

Department of Nuclear Energy

Joint ICTP/IAEA Workshop

“Research Reactors for Development of Materials and Fuels for Innovative
Nuclear Energy Systems” 6-10 November 2017, ICTP, - Trieste, Italy



IAEA

International Atomic Energy Agency

Fast Reactor Knowledge Preservation:

FRKP Portal

FAST REACTORS IN THE WORLD	
Number of units in operation/non-permanent shutdown	6
Number of units under commissioning	2
Number of countries with/constructing fast reactors	4

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

LMFNS Experimental Facilities Database

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

IAEA.org NUCLEUS

IAEA Catalogue of Facilities in Support of LMFNS

Home LMFNS Facilities Database Overview of SFR Overview of LFR LMFNS Compendium

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

MYRRHABELLE facility - Belgium

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 150 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

End-users of the Compendium

› Governmental and private sector organizations responsible for the development and/or deployment of innovative fast neutron systems, including designers, manufacturers, vendors, research institutions, academia, TSO and other organizations directly involved in technology development programmes on liquid metal fast neutron systems and, more generally, on advanced nuclear energy systems

Member States / Institutions Contributing to the Study and the Catalogue

➤ Participating Institutions

- Belgium: SCK.CEN
- China: CIAE & INEST-CAS
- Czech Republic: CVREZ
- France: CEA
- Germany: KIT & HZDR
- India: IGCAR
- Italy: ENEA
- Japan: JAEA
- Republic of Korea: KAERI & KINS
- Russian Federation: IPPE
- USA: ANL

Two main groups:

- **Experimental facilities devoted to the SFR development;**
- **Experimental facilities devoted to the LFR system development**

- *Cross cutting facilities (dual application for SFR&LFR), capable to support LMFNS development, presented in both categories.*

TEMPLATE for facilities presentation

GENERAL INFORMATION

NAME OF THE FACILITY, ACRONYM, COOLANT(S), LOCATION, OPERATOR, CONTACT

STATUS OF THE FACILITY (*in operation, standby, under construction, under design, planned and to be operated by 2020*)

MAIN RESEARCH FIELD(S) (*see section 3.4*)

TECHNICAL DESCRIPTION

Description of the facility

Acceptance of radioactive materials (yes/no)

Scheme/diagram

3D drawing/photo

Parameters table

Coolant inventory

Power

Number of test sections

Test sections

Characteristic dimensions

Static/dynamic experiment

Temperature range in the test section (Delta T)

Operating pressure and design pressure

Flow range (mass, velocity, etc.)

Coolant chemistry measurement and control (active or not, measured parameters)

Instrumentation

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

PLANNED EXPERIMENTS (*including time schedule*)

EDUCATION ACTIVITIES (students and researchers from other organizations, etc.)

TRAINING ACTIVITIES

REFERENCES (*specification of availability and language*)

.Status of the LMFNS Compendium and related NES publication

- Inputs received from 14 countries and EU
(more than 1000 template pages)
- 150 templates reviewed and accepted up till now:
 - Na-based facilities 79 templates
 - Pb-based facilities 71 templates
- Draft NES document – 45 pages overview &
1000 pages templates

Inputs from Member States to LMFNS COMPENDIUM

Country	Number of facilities involved		Dual- Na & Pb based	TOTAL by country
	Na-based	Pb-based		
Belgium		14		14
China	8	7		15
Czech Republic		4		4
EU		1		1
France	19	2	2	21
Germany	5	11		16
India	14			14
Italy		10		10
Japan	6	6		12
Korea	4	1		5
Latvia	3	1		4
Russia	11	10	8	21
Spain		2		2
Sweden		1		1
USA	9	1	4	10
TOTAL by purpose	79	71	(14)	TOTAL: 150

Experimental facilities in support of SFR

79 facilities

•Zero power facilities for V&V and licensing purposes	0
•Design Basis Accidents (DBA) and Design Extended Conditions (DEC)	14
•Thermal-hydraulics	42
•Coolant chemistry	11
•Materials	29
•Systems and components	30
•Instrumentation & ISI&R	34

Experimental facilities in support of LFR

71 facilities:

- Zero power facilities for V&V and licensing purposes 5
- Design Basis Accidents (DBA) and Design Extended Conditions (DEC) 15
- Thermal-hydraulics 34
- Coolant chemistry 25
- Materials 37
- Systems and components 28
- Instrumentation & ISI&R 33

The LMFNS Compendium development

The Compendium would support future international collaborations and cooperation in the frame of FNS development, starting on the available facilities worldwide.

Later on, will produce also a living database of the same experimental facilities, to be regularly updated (first update to be published by 2019) by the IAEA and the interested Member States.

LMFNS Experimental Facilities Database

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

IAEA.org NUCLEUS

IAEA Catalogue of Facilities in Support of LMFNS

Home LMFNS Facilities Database Overview of SFR Overview of LFR LMFNS Compendium

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

MYRRHABELLE facility - Belgium

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 150 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

LMFNS catalogue (database)

The newly developed catalogue of experimental facilities in support of development and deployment liquid metal-cooled fast neutron systems (LMFNS catalogue) is a **living database**,

Easy searchable in the internet by the key words “**LMFNS catalogue**”

An overview as well as detailed information on:

150 experimental facilities under design, construction or operation

19 institutions of 14 IAEA Member States.



LMFNS catalogue (database)

Contains detailed data and information on

- **79 facilities in support of the development of SFR,**
- **72 facilities in support of LFR (lead and lead-bismuth eutectic cooled fast reactors).**

14 facilities are applicable to both SFR and LFR technologies.

The detailed facility profiles are categorized according to their most relevant research fields (main application).

Multiple-choice filtering options by main research fields, by reactor type (SFR, LFR, cross-cut SFR/LFR application) and by country are available.

LMFNS Catalogue

Will be useful for a wide range of governmental and private sector organizations responsible for the development and/or deployment of innovative fast neutron systems in countries with active programmes on these nuclear energy systems, including designers, manufacturers, vendors, research institutions, academia, technical support organizations (TSOs) and other organizations directly involved in technology development programmes on fast neutron systems and, more generally, on advanced nuclear energy systems.

By providing the end-users with detailed information on existing and future experimental facilities the open LMFNS database is aimed at facilitating cooperation between organizations with an active programme on fast neutron systems.

It is expected that it will enhance the utilization of these facilities within the associated experimental programmes, and motivate the involvement of young engineers and researchers to be educated and trained in the field of advanced reactors.



LMFNS Experimental Facilities Database

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



IAEA.org NUCLEUS

IAEA Catalogue of Facilities in Support of LMFNS

Home LMFNS Facilities Database Overview of SFR Overview of LFR LMFNS Compendium

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

MYRRHABELLE facility - Belgium

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 150 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
- [Type in Google: LMFNS catalogue](#)

Thanks for your Attention!



Mikhail KHOROSHEV

Nuclear Power Technology Development Section

Department of Nuclear Energy

International Atomic Energy Agency

Vienna International Centre, PO Box 100, 1400 Vienna, Austria

Email: M.Khoroshev@iaea.org

Tel: (+43-1) 2600-22850