INPRO Dialogue Forum on Generation IV Nuclear Energy Systems

IAEA Headquarters, Vienna. 13-15 April 2016

**NPTDS E&T Activities**
in support of innovative nuclear systems development

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*Nuclear Power Technology Development Section*

*Department of Nuclear Energy*
Outline

- **Education and Training Activities:**
  - Fast Reactors
  - High Temperature Gas cooled Reactors
  - Super Critical Water Reactors

- **Knowledge Preservation Activities:**
  - Fast Reactors
  - High Temperature Gas cooled Reactors
IAEA Education and Training Seminar/Workshop on Fast Reactor Science and Technology

Feb 2011 & Oct 2012, Argentina

July 2015, Mexico
Upcoming Training Course

- 29th August – 2nd September 2016
- Trieste, Italy

The broad areas of workshop will include:

- Global scenario for nuclear energy;
- Innovative reactor concepts and fuel cycle options,
- Reactor physics of innovative NES
- Status of advanced primary components and development and qualification of new structural materials,
- New safety approaches, safety requirements and safety design criteria;
- Passive safety systems and other enabling safety technologies;
- Safety analysis including severe accident scenarios;
- Advanced modelling and simulation.
- Status of research and technology development in support of innovative reactor and fuel cycle technologies.

Apply: http://indico.ictp.it/event/7632/
E&T: Fast Reactors (3)

Development of 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

Final Detailed Technical Specifications prepared by IAEA: ready by April 2016
Plan to eventually develop a comprehensive course on HTGRs

1st course hosted by INET
22-26 October 2012, Beijing, China

More than 40 participants from 17 Member States discussed the technological features of modular HTGR designs, including inherent safety characteristics, and how these impact the design choices and safety evaluation of this reactor type.

2nd course hosted by BATAN
19-23 Oct 2015, Serpong, Indonesia
Basic principles nuclear power plant simulators

- A draft specification was developed
  - Four simulator configurations identified
  - Power conversion cycle options defined
  - To be send for review to interested Member States / organizations
  - No funding currently available to develop
E&T: SCWR

- Organized by IAEA or the host organizations in cooperation with IAEA.
- The 4th Course being planned by The University of Ontario Institute of Technology (UOIT), Oshawa, Canada, 4-8 July 2016.

International Centre for Theoretical Physics (ICTP), Trieste, Italy, 27 June - 1 July 2011

McMaster University, Hamilton, Canada, 16-21 July 2012

Shanghai Jiao Tong University (SJTU), Shanghai, China, 26-30 August 2013
Knowledge organization systems
IAEA Nuclear Knowledge management activities

- Fast Reactor knowledge portal
- High temperature Gas Cooled Reactor knowledge base
Knowledge Organization Systems

All types of systems for organizing information and promoting knowledge management: term lists, classifications, thesauri, topic maps, ontologies, semantic networks, etc.
Methods and tools, such as vocabularies, thesauri, taxonomies, or ontologies, used to describe a knowledge domain.

*The special tool according to international Web Standards as defined by the W3C (the World Wide Web Consortium) allows for developing and editing KOS’s, for publishing them as Linked Data in different media (foremost the Internet), and for deploying them in various scenarios where extraction of important concepts from text is required.*

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KOSs in Nuclear

- Glossaries and taxonomies in the IAEA:
  - Published:
    - INIS Thesaurus; Safety Glossary; Radioactive Waste Management Glossary; Safeguards Glossary; Fast Reactor Taxonomy, etc.
  - Under development:
    - NE Glossary; ("common" IAEA) OPIC Taxonomy; NA Taxonomy; VVER Taxonomy, etc.
Utilizing Semantic Technology

Semantic-based applications

- K-portals & Smart search
- Data mining & K-discovery
- Glossaries management
- Standards harmonization
- Communities of Practice
- Business intelligence
CLP4NET Fact Sheets

- All IAEA departments have e-learning materials in CLP4NET
- > 8000 registered users from more than 70 countries
- ~ 200 new users every month
- > 700 learning hours / month
- > 50 unique courses
- CLP4NET has been recognised as the Agency standard and single eLearning platform

http://elearning.iaea.org
Knowledge portals as application of Knowledge Organization System (KOS)

Created by the IAEA for the following purposes:

• To provide a cloud-based infrastructure for Member States to store, retrieve, and share information and documentation.
• This cloud-based infrastructure is based upon Sharepoint Server 2013 and is provided free of charge to the Member States
• Member States can use this infrastructure as their sole means of storing, retrieving, and sharing information and documentation or in conjunction with Member States existing infrastructure
Nuclear Knowledge Bases and Portals - Application to Fast Reactors (FR) and High Temperature Gas Cooled Reactors (HTGR)

• Objectives
  • Knowledge Sharing
  • Knowledge Preservation
  • Knowledge Development
  • Search and Discovery
  • Collaboration and Communication

• Knowledge bases user interfaces
  • Portal, Wikis, Web Sites, Applications …

• Method:
  • Knowledge Representation and Knowledge Modeling
Fast Reactor Knowledge Preservation Portal (FRKP) - joint activity of NKM and NPTDS

• Any fast reactor related documentation that MS wish to share
• Full papers of consultancies and technical meetings;
• Old reports will remain available through INIS repository
• Document repositories on SharePoint
  • Uploads by MS themselves possible
  • Principle for Rights Management: Documents provided by MS will be in control of MS (e.g. definition of rights for other parties)

FRKP will become part of the IAEA tools. In this regard the MS are expected to trust the classified users. However the MS will be in power to define the level of access for various users.
FRKP Users

The target audience: experts and general users of fast reactor data and documentation

The FRKP Users’ group
- Data providers
- Taxonomy users
- Readers
The Member States are currently providing fast reactor related information to existing IAEA knowledge management systems. We encourage continued supply of documents to populate these systems. In order to favor this process the IAEA is requesting the Member States to identify if there is any specific requirement or pre-requisite (beyond what is already in place) that may be needed to fully support providing both publicly available and protected information to the FRKP Portal.

Your assistance in providing the response by is highly appreciated.

The IAEA responsible officer is Ms Monti (Email: smonti@iaea.org) and Mr Mkhosana Khosana (Email: mkhosana@iaea.org) of the Nuclear Power Technology Development Section (Tel: +43 1 2600 ext: 22850). For direct communication between the responsible officer and the expert(s) designated to work on the Portal from your country the full name and complete contact details including postal address, telephone/fax numbers and e-mail address of the expert(s) should be provided.

Yours sincerely,

DIRECTOR,

DEPARTMENT OF NUCLEAR ENERGY
**TECHNICAL WORKING GROUP ON ADVANCED TECHNOLOGIES FOR FAST REACTORS (TWG-FR)/ Replies to ERKRP Letter/ Nomination of focal points**

**LIST OF MEMBER STATES and OBSERVERS (as of November 2015)**

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Fast Reactor Knowledge Preservation Portal (FRKP) - joint activity of NKM and NPTDS

Data, Information and Knowledge Holders

IAEA
JAPAN
USA
INDIA
GERMANY
FRANCE
RUSSIA
UK
CHINA

Information and/or metadata

IAEA FR KOS
KNOW WHAT
and
KNOW WHERE

END USERS
experts and general users of fast reactor data and documentation

Users' group:
Data providers
Taxonomy users
Readers

General Principles:
Document repositories on SharePoint. Access to fast reactor related documentation that MS wish to share
• Confidentiality and Intellectual property rights
• Sharing and access
  Uploads by MS themselves possible
  Documents provided by MS will be in control of MS (e.g. definition of rights for other parties)

Links to other Knowledge Resources
FR KOS development

Phase 1
1. Creation of FRKP network.
2. Support and coordination of FRKP in MS – TWG FR

Phase 2
1. Development of fast reactor taxonomies
2. Knowledge Mining and Knowledge Analysis capabilities

Phase 3
Fast Reactor information collection, System development and maintenance
Fast Reactor Knowledge Organization System (FR-KOS)

It is generally recognized that long term development of nuclear power as a part of the world’s future energy mix will require fast reactor technology with closed fuel cycle. The fast neutron spectrum allows fast reactors to increase the energy yield from natural uranium by a factor of sixty to seventy compared to thermal reactors, granting therefore realization of nuclear power programmes for thousands of years, as well as a significant improvement of nuclear waste management. It is for these reasons that fast reactors have been under development for decades in several countries, primarily as breeders and, in recent years, also as High-Level Waste burners.

The necessary condition for successful deployment in the near and mid-term is the understanding and assessment of technological and design options, based on both past knowledge and experience, as well as on scientific and technological research efforts.

With regard to the first, the design and operation of several sodium-cooled fast reactors, such as the Fast Flux Test Facility (FFTF) in USA, the small size Prototype Fast Reactor in the United Kingdom, the prototype Phénix in France, the BN-350 in Kazakhstan, the demonstration plant BN-600 in Russia, Monju in Japan, the commercial size Superphénix in France, etc. have
Fast Reactor taxonomy

- a model of Knowledge Organization System
- in the field of Fast Reactor Technology

- Covers
  - all possible types of fast reactors
  - all aspects of fast reactors
  - all stages of implementation of fast reactor technology
NE Series Report NG-T-6.3 defines Taxonomy Basic Requirements
The taxonomy of fast reactors is the key element of designing the FRKP portal.

originally developed almost 10 years ago.

revised and essentially restructured in 2015 taking into account new capabilities of semantic search in the Agency wide tools, in particular, auto-tagging and searching documents allocated in the portals.

in the new FR taxonomy new concepts have been introduced and interlinks have been incorporated. Alternate concepts to already existing and newly introduced concepts were included as appropriate.

The new FR Taxonomy is still under development.
IAEA Contribution

- 3 collections: KNK-II, IAEA-TECDOCS, INIS Fast Reactors records
- 50 000 metadata records, 9 000 full texts

Member States

- China, France, Germany, Japan, Russia, UK, USA
- Russia collected and submitted to the IAEA over 500 metadata records – national publications
Future KOS Opportunities

Nuclear Power Knowledge System

IAEA

GCR

PWR

FR

WWER

CANDU
The HTGR (High Temperature Gas Cooled Reactor) is a sustainable and fundamentally safe nuclear reactor technology. These reactors have recently gained global interest, due to their promising features of enhanced safety and improved economics.

There are two main types of HTGRs: pebble bed reactors (PBR) and prismatic block reactors (PMR). The prismatic block reactor refers to a prismatic block core configuration, in which hexagonal graphite blocks are stacked to fit in a cylindrical pressure vessel. The pebble bed reactor (PBR) design consists of fuel in the form of pebbles, stacked together in a cylindrical pressure vessel, like a gum-ball machine.

Safety enhancement includes the following characteristics to avoid release of radioactive materials:

- Extreme high temperature capability of the ceramic coated and carbon-based fuel and core structure.
- Reactor materials including the reactor fuel are chemically compatible and, in combination, will not react or burn to produce heat or explosive gases. Helium is inert and the fuel and materials of construction of the reactor core and the nuclear heat supply system preclude such reactions.
- Plant design features limit intrusion of air or water so that the reactor remains shutdown and containment of radio-active materials is maintained.
- Single phase and low heat capacity minimizes stored energy in the helium coolant.
- Inherent nuclear and heat transfer properties of the reactor design that are continuously functional to ensure that the fuel temperatures remain within acceptable limits under all conditions.
- Inherent properties of the reactor core that regulate nuclear power so no electrical power, coolant flow or any other active systems or operator actions are required to limit nuclear power levels and fuel temperatures under any condition.

There are currently various related projects around the world and the IAEA is following their progress, coordinating research and facilitating information exchange among its Member States.

More about HTGRs
Thanks for Your Attention!

...Atoms for Peace & Development