Fast Reactor Knowledge Preservation: Implementation and challenges

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FR13, CN-199-406
IAEA Nuclear Knowledge Management Program

- Established in ~2001
- Main focus areas:
  - Fundamentals and Methodologies (publications)
  - Knowledge transfer (education networks, COPs)
  - Support to Member States (projects, peer assist)
  - Technology platforms (repositories, networks)
New Initiatives

- International joint collaboration programs in knowledge management:
  - KM in Non-power applications
  - KM in Nuclear Energy
  - KM in Humanitarian Projects
- Extra-budgetary, long-term strategic objectives
KM Collaboration in Power Applications

- Life-cycle knowledge management of design basis:
  - Requirements management
  - Data Inter-change standards
  - Applications of simulation and modelling
  - Management of reliability data
  - Operating experience data
  - Other topics (open to suggestions...)
KM Collaborations in Non-Power Applications

- Radiation technical
- Nuclear medicine
- Agriculture
- Environmental
- Industrial Applications
- Others (open to suggestions...)

Start-up Phase: 2013-2015 (scoping, definition)
FR-KOS

- Features
- Functions
# FR technologies in taxonomy

## Table 1. Target Function for each aspect of reactor technology

<table>
<thead>
<tr>
<th>General aspect of reactor technology</th>
<th>Target function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutronics</td>
<td>Assurance of controlled fission chain reaction under normal operating conditions</td>
</tr>
<tr>
<td></td>
<td>Assurance of protection of components and personnel against radiation</td>
</tr>
<tr>
<td></td>
<td>Assurance of subcriticality under required conditions</td>
</tr>
<tr>
<td>Thermal hydraulics and thermal physics</td>
<td>Assurance of heat transfer and removal from the core to the tertiary circuit</td>
</tr>
<tr>
<td></td>
<td>Assurance of required operating conditions of systems and components</td>
</tr>
<tr>
<td>Fuel</td>
<td>Assurance of fuel serviceability in the fuel elements</td>
</tr>
<tr>
<td>Coolant</td>
<td>Assurance of required coolant technology</td>
</tr>
<tr>
<td>Materials</td>
<td>Assurance of serviceability of various nuclear power plant elements and components</td>
</tr>
<tr>
<td>Structural materials</td>
<td>Assurance of serviceability of absorber element materials</td>
</tr>
<tr>
<td>Absorber</td>
<td>Assurance of serviceability of building structures, auxiliary systems and services</td>
</tr>
<tr>
<td>Other materials</td>
<td>Justification and assurance of safe nuclear power plant operation under abnormal operating conditions, design basis accidents (DBAs) and beyond design basis accidents (BDBAs)</td>
</tr>
<tr>
<td>Safety issues</td>
<td>Development and operation of safety systems</td>
</tr>
<tr>
<td></td>
<td>Elaboration of criteria and requirements on assurance of FR safety</td>
</tr>
<tr>
<td>Technological systems and components</td>
<td>Development and adoption of principal conceptual decisions on composition and arrangement of technological systems, components and elements of nuclear power plant with FR</td>
</tr>
<tr>
<td></td>
<td>Development, design and operation of technological systems and components of nuclear power plant with FR</td>
</tr>
<tr>
<td>Monitoring and control</td>
<td>Assurance of monitoring and control of various parameters and characteristics of nuclear power plant and maintaining these characteristics within required range of values</td>
</tr>
<tr>
<td>Ecology</td>
<td>Minimization of radiological and other effect on personnel and environment</td>
</tr>
<tr>
<td></td>
<td>Choice of nuclear power plant site, taking into account environmental impact</td>
</tr>
<tr>
<td>Mathematical modelling</td>
<td>Adequate modelling of FR elements and systems and processes taking place in these systems</td>
</tr>
<tr>
<td>Economic and other aspects</td>
<td>Comparative economic analysis of operation of nuclear power plants with FR</td>
</tr>
<tr>
<td></td>
<td>Preservation of data on FR history — memoirs, photos and newsreel</td>
</tr>
</tbody>
</table>
Fast Reactor Taxonomy

- Covers
  - all possible types of fast reactors
  - all aspects of fast reactors
  - all stages of implementation of fast reactor technology

- Based on 2 dimensional matrix (2 top levels):
  - stages of implementation
  - technology elements
Fast Reactor Knowledge Organization System: main characteristics

- Indexing, taxomizing, retrieving knowledge

- Knowledge categorization – Taxonomies
  - Building up a concept – taxonomy sub-tree (topic/subject)
  - A subject matter expert familiar with the subject of the search assigns weights to search terms

- Searching for subjects concepts rather than individual words or phrases

- Taxonomies have the ability to understand the context of the text and retrieve every document related to a ‘topic’ (or a taxonomy sub-tree) of interest

- Hierarchical structure of Repositories

- Taxonomy sub-trees and repositories are selectable
Meaning or Semantic

- Structured Information (20%)
  - Meaning of data element is explicit in structure
  - Relational Database
  - e.g., First column is the employee’s last name
  - | Jones | Dan | IBM |

- Unstructured Information (80%)
  - Meaning of data element is implicit in appearance and context
  - Text (human or natural language) image, audio, video
  - e.g., “My dad, Dan works for IBM. At work they call him Dr. Jones”

- Representing Information & Search Process
  - Structured finite – Search process is deterministic
  - Unstructured virtually unlimited, as language is ambiguous. Effect of Semantic Indeterminacy – Search process is probabilistic
## Concept Retrieval

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Advantages</th>
</tr>
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<tbody>
<tr>
<td><strong>Process of searching for subjects concepts rather than individual words or phrases</strong></td>
<td><strong>Topic trees have the ability to understand the context of the text and retrieve every document related to a ‘topic’ of interest.</strong></td>
</tr>
<tr>
<td><strong>In building up a concept (Topic tree), an expert familiar with the subject of the search assigns weights to search terms.</strong></td>
<td><strong>Retrieval results are presented in a relevance ranked order, giving users access to the most important information.</strong></td>
</tr>
<tr>
<td><strong>Topic tree provide a convenient means which can encapsulate in a hierarchical structure, the knowledge of an expert.</strong></td>
<td><strong>Topic trees are available to end users as a shared resource.</strong></td>
</tr>
</tbody>
</table>
Concept Retrieval
How to translate knowledge into Topic Trees

- Topic trees are predefined query in tree-like form that can be utilized for searching, data mining and taxonomy classification

- Topic Tree includes a definition of the relationship between indicators and provides rules for evaluating and scoring documents

- Topic trees mitigate the semantic ambiguity

- Topic Trees Properties
  - Structure: Establish the relations between the nodes
  - Weights: Define the relative importance of key-words and nodes
  - Operators: Interprets rules for the search engine
Translating concepts into Topic trees

*Topic tree provide a convenient mean which can encapsulate in a hierarchical structure the knowledge of an expert*
Fast Reactor Topic Trees are digital implementation (in knowledge organization system) of Fast Reactor Taxonomy.

Topic trees provide a convenient means which can encapsulate in a hierarchical form, the Fast Reactor Taxonomy structure.

By means of Topic trees the retrieval results are presented in a relevance ranked order, giving users access to the most important information.
Topic Trees – A knowledge representation of “Monju Nuclear Accident Concept”
FR-KOS Core Concept

- Taxonomies
- Repositories
Each node of the Topic tree is a possible query
Users can easily navigate through the Fast Reactor Taxonomy to find relevant information.

Documents are automatically classified into Fast Reactor Taxonomy.

Populated documents in 1-2-R-D node.

Selected Repository.
Overview
- My Documents
- My Saved Queries
- My Query History

My Documents
- Status of the fast breeder reactor development in the Federal Republic of Germany, Belgium and The Netherlands, February 1981
- Technical meeting on 'Operational and decommissioning experience with fast reactors'. Working materials

My Saved Queries
- Tax-Verification: Used 1, Change 9/9/2010, Save
- NOT-Ver-Taxonomy: Used 1, Change 9/9/2010, Save

List of documents previously saved in Search or Navigation mode
List of queries intentionally saved to be eventually utilised in future user-section
List of queries performed during an user-section
FR-KOS in 2013

- Proven technology
- Fast reactors taxonomy
- Populated repositories
- On-line access and user support

Future expansion to other nuclear area:
- VVER
- MNA (TMI, Chernobyl, Fukushima)
- etc.
Questions and Answers

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