Plant Information Models
Supporting the Management of Design Knowledge throughout the Nuclear Power Plant Life Cycle

Third International Conference on Nuclear Knowledge Management
Vienna, Austria, 7–11 November 2016

Maxim GLADYSHEV
Nuclear Knowledge Management Section
Department of Nuclear Energy, IAEA
Nuclear Knowledge and Safety

• The success of peaceful nuclear technologies is directly tied to safety
• Specific and advanced levels of knowledge are needed to achieve and maintain the high levels of safety
• Without required technical knowledge, a full understanding of the consequences of our decisions and actions may not be possible, and safety may be compromised!
Threats to Nuclear Knowledge

- Employee Life-cycles
- Economic Cycles
- Facility Life-cycles
- Design Life-cycles
- Project Life-cycles
- Organizational Life-cycles
Design Knowledge

- **Design knowledge** - the sum of the design rationale, specifications, criteria, supporting research, codes, standards, analyses, constraints, etc. which affect the design of a nuclear facility and which is developed and maintained during all phases of a facility’s lifecycle
- It includes both explicit and implicit knowledge
Design Knowledge Transfer

![Diagram showing stages of design knowledge transfer across design, construction, operation, and decommissioning phases.](image)

- **Design Knowledge**
  - Not transferred

- **Design Construction**

- **Operation**
  - Not transferred

- **Decommissioning**
  - Not transferred

100+ years
Information Management Issues

- Existing NPPs use multiple information systems and databases from different vendors and for different purposes.
- Most of these systems are not integrated with each other and do not share plant data throughout an NPP’s life cycle.
- This results in redundancies in capturing, handling, transferring, maintaining and preserving plant data.
New NPPs

• New NPPs are being designed, procured, and constructed using modern computer technologies with multidimensional modelling along with data, databases, and electronic document sources.

• This computer technology forms a computer-based information-modelling environment containing the interlinked facility information, relationships, rules, constraints, etc. that represent NPP.
A Plant Information Model (PIM) is an organized set of interlinked facility information, relationships, rules and knowledge frameworks forming a representation of the plant throughout its lifecycle.

### Tabula Data
(weights, dimensions, dose rates etc.)

<table>
<thead>
<tr>
<th>Component</th>
<th>Type (Index)</th>
<th>Mass [kg]</th>
<th>Volume [m³]</th>
<th>Number</th>
<th>Full Mass [kg]</th>
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</thead>
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<td>NPP Component</td>
<td>UCPM 36-176</td>
<td>630.0</td>
<td>8,1 m³</td>
<td>1</td>
<td>21,0 m³</td>
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<td>NPP Component</td>
<td>TDB 15</td>
<td>5,7</td>
<td>0,1 m³</td>
<td>1</td>
<td>0,1 m³</td>
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<td>1.6</td>
<td>0,1 m³</td>
<td>1</td>
<td>0,1 m³</td>
</tr>
</tbody>
</table>

### Design Drawing

### P&ID

### 3D Model
Limitations of existing PIM

• Most current concepts of a PIM solution are unique to a given organization or business environment.
• There is no real focus on the preservation, integrity, and transfer of the complete NPP design and design knowledge information within and across the NPP life cycle phase.
• Currently, there are no agreed-upon best practices and industry standards for a knowledge-centric framework that describes design information and design knowledge management over the NPP life cycle.
A Knowledge-centric Plant Information Model is a semantically organized set of interlinked information about plant structures, systems and components, incorporating plant data, relationships, rules and knowledge frameworks that collectively form digital representations of the plant throughout its life cycle.
Semantic Technologies
Advantages

- Provide a common language in form of a vocabulary agreed upon by the many parties involved in the design and use of the (K)PIM.

- The set of concepts and the relations between the concepts may be described in form KOS such as taxonomies or ontologies.

- Data may be published and interlinked with other data from heterogeneous data sources, a method denoted as Linked Data, permitting unified search and complex queries.
Opportunities with KPIM

Design Knowledge is more than just knowing what the plant is made of.

Rationale

Design traceability
PIM throughout NPP Life Cycle
PIM Challenges

• Optimal amount of data to be stored in PIM for each of NPP lifecycle stage
• Technologies and tools to create, use, maintain, and store PIM at different stages of NPP lifecycle
• Risks related to the long term storage and use
• Legal significance of PIM
• Lack or absence of standards and regulations
• Design knowledge is not being effectively communicated, understood or efficiently shared, or transferred within and across all NPP life cycle phases
Planned IAEA Publications Related to DKM/PIM in 2017

• Managing Nuclear Design Knowledge over the Life Cycle – Stakeholder Perspectives, Challenges, and Approaches
• Application of the Modern Plant Information Models to Support and Manage Design Knowledge throughout NPP Life Cycle
• Exploring Semantic Technologies and their Application to Nuclear Knowledge Management
International Cooperation on PIM

• Working together to develop a roadmap and direction for PIM Models
• Drive innovation through the development and promotion of best practices and adoption methodologies for the use of PIM Models
• To influence other similar forums or international technical working groups to work together to harmonize efforts where it makes sense and is reasonably achievable
• Develop a generic prototype PIM Model
Managing design knowledge over the nuclear lifecycle and the Plant Information Model (PIM) concept

Tuesday - 8 November  
16:30 - 18:00

Organizer: Maxim Gladyshev (M.Gladyshev@iaea.org)  
Location: Board Room B  
Type: Workshop and live demo

Description:  
The IAEA has been requested to assist Member States in strengthening and maintaining the effective management and use of nuclear design knowledge (DK) and design basis information (DBI) over the entire life cycle for licensed nuclear facilities. Management of the risks of design knowledge loss and the on-going need to ensure the integrity and validation of a nuclear facility design basis is essential to support effective decision-making and the achievement of plant safety and economics. New NPPs are being designed, procured, and constructed using modern computer-aided design and engineering systems with multidimensional modelling along with data, databases, and electronic document sources. As a result, new NPPs will be designed and delivered with a plant information model (PIM) containing interlinked information about the facility that is comprehensive, detailed and able to be integrated and interoperable with plant design, operations, and maintenance processes, as well as databases, document systems, and records systems of organizations that own and operate them. These technologies provide an opportunity to radically improve knowledge capture, integration and seamless transfer between stakeholders if industry-wide standards are developed and widely used.
Thank you!

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