"NPP Design Basis Handover and Knowledge Preservation from Subcontractors, Vendors and EPC"

Interregional Knowledge Management Workshop on Life Cycle Management of Design Basis Information — Issues, Challenges, Approaches

28 October–1 November 2013, Vienna, Austria

Kent Freeland, P.E.
WorleyParsons Nuclear Services
"NPP Design Basis Handover and Knowledge Preservation from Subcontractors, Vendors and EPC“

The theory and application of PLM methods to achieve better Configuration Management at Nuclear Power Plants (NPP’s), then integrating Knowledge Management into the PLM infrastructure to “fill in” the latent information and data so often lost. Nuclear Power has only started to embrace the concept of PLM to manage events, processes, workflow, design changes, requirements, and knowledge systems, as part of the implementation for a CM program.
"NPP Design Basis Handover and Knowledge Preservation from Subcontractors, Vendors and EPC“

CM Information Systems (CMIS), Nuclear Knowledge Management (NKM), and other NPP work control and MRO/ERP systems are major sources of CM data, but currently are not always PLM-oriented, and anyway cannot enforce plant configuration alone.

PLM can be utilized to reduce unsynchronized plant CM design and “slipstreaming” in installation events, as well as compliance and regulator requirements management. With the addition of the Nuclear Knowledge Engine, these processes may be enriched and enhanced, while laying the groundwork for systematic information turnover, process refinement and human resource accession betterment.
Implementing PLM-based Workflow for Configuration Management (CM) in the Nuclear Power Industry

- Overview of CM and Design Basis in Nuclear Power Plants (NPP’s)
- NPP configuration management and business/work control systems as a principal source of data for PLM.
- How PLM ensures NPP CM by the management of events, process, workflow, design changes, requirements.
- Applying PLM and SE across subcontractors, vendors and off-site fabrication during construction for CM.
- Selection of software to support implementation of PLM-based NPP Configuration Management.
Overview of CM and Design Basis in Nuclear Power Plants (NPP’s)

Terms

**Configuration Management** – the synchronizing of Plant Equipment and Parts, Documents and Engineering Design Basis according to a defined process of change and documentation, normally the engineering change process.

**Maintenance Resource Optimization** – Maintenance Resource Optimization (or, sometimes, Maintain, Repair, Overhaul). CM controls require Work Management plus, today, also Parts, Inventory, Documents, Equipment, Engineering Change Control, Purchasing/Procurement, and other functions.

**Integrated Management System** – the based on IAEA Safety Series GS-R-3, a quality system design that incorporates plant process, procedures and business rules into standardized templates for nuclear business.

**Enterprise Resource Planning** – or “ERM”, Enterprise Resource Management. The complementary side of MRO that tracks projects, costs, asset life, unit retirement, labor time and purchasing expenditures. These data are based upon the input of the MRO system, and only

**Nuclear Knowledge Management** – Method and technology to capture, assess, verify, record and publish tacit information and knowledge about plant engineering, operation, requirements and maintenance.

**Design Basis Document** – How the nuclear plant design basis and references for technology decisions are stored, revised and published in accordance with the engineering design change process.
Configuration Management ensures that the design basis for any NPP plant system or component is satisfied and maintained over plant life, as installed in the plant, and as reflected in documents. Three basic management tools are used for this process.
PLM controls for typical Design Basis Lifecycle

The Nuclear Industry is just starting to understand the purpose of PLM, as an Integrated Management and Change Management tool for Configuration Management. Overall, nuclear power operators are becoming more aware of “lifecycle” in the design, building, operation and decommissioning of NPP’s.
The program is not part of the original plant as-built design basis, and repairs or tube plugging likely have no basis in plant licensing or design documents, startup testing or turnover packages, since it is not an anticipated event.

None of these aspects have an explicit, documented design basis, although it is implied with major modification to a large NSSS component.

**U-Tubes** – subject to cracking or failure

**Tubesheet** – crack or separation where tubes joins tubesheet
Knowledge of the actual design basis for the project will likely rest with:

- Senior engineers (close to VSP or retirement) who will likely design the changes.
- Vendors and contractors engaged by the NPP owner to support the project.

Both of these sources of expertise are volatile from a Knowledge Management viewpoint, since they can disappear with basic design basis information with little notice. They may also be reluctant to share information based upon propriety or “job security”.
Design Basis Capture and Reconstitution for Steam Generator Tube Plugging

Implicit Design Basis
- Additional Design Requirements for SG Tube Plugs

Plant Baseline (As-Built) Design Basis

Engineering Design Change Packages

Work Orders to Implement Design Change

Where does this come from … and how do you find it in the Plant Configuration? Not in the Plant Design Basis, this is a Knowledge Base Issue.
Design Basis Capture and Reconstitution for Steam Generator Tube Plugging

How Configuration Management Facilities Capture Design Basis Data
Elements for CM - Basics about Classic CM and Nuclear Design Basis Management

- CM is the Preservation, Verification and Recording of NPP Plant Design Basis
- CM is supported by NPP IMS, NKM, PLM and MRO NPP Programs and Processes, and CM should be integrated as a part of the IMS Program.
- CM and IMS Programs for New Builds or Operating NPP’s have most characteristics in common, with special considerations for EPC and supplier relationships

Data Generation
CADD, construction data, Intergraph PDS, simulation, CAE, engineering data sheets, Action Items, CARs, project management, etc.

Data Review/Approval
Document Manager (EDMS), Engineering Workflow & Routing (eProcess EDR), Action Tracking.

Enterprise CM
MEL, DCM, ECC, Materials, Work Management, etc.

Data is as complete as possible

Data is validated as much as possible
Elements for CM - Reasons for CM in Nuclear Power

- Assure Safety by Preventing Mismatches in Plant Design Basis, Documents and Equipment Content Resulting in Shutdowns, Accidents, Exposure
- Prevent Losses of Regulator and Public Faith
- Establish and Maintain Responsible Engineering Practices
- Achieve Operational Excellence Goals
- Step Increase in Efficiency, by Reduction of Shutdowns, Maintenance Rework, and Materials Spend
- Smooth and Refine NPP MRO and Nuclear Business Processes

**Design Basis**

**Understanding the Design** - CM will facilitate to prevent losses of regulator and public faith and achieve Operational Excellence goals, and ultimately, avoid expense and risk of shutdown and/or performing a costly design basis reconstitution.

**Equipment and Engineering Design**

**Understanding the Equipment** – The Engineering Design Process will specify and place the proper equipment for the Design Basis needed – for Safety and Operation

**Controlled Documents**

**Understanding the Documents** - Nuclear Power Plants, in particular, have CM requirements that go beyond commercial or efficiency considerations. Nuclear Power deals with the requirement for 100% safe operation and positive design control, as represented in Controlled Documents.
NPP configuration management and business/work control systems as a principal source of data for PLM.

**Work, Data and Cost Flow Integrating Legacy Systems**

- Collection → Analysis-Review-Approval → Production (MRO) → Reconcile (ERP)

- **CAD/CAM**
  - Design Review Manager
  - Accept New Documents and Data
  - Control Review and Revision
  - Stage Controlled Documents
  - Deliver Approved Documents to PLM

- **Engineering Data**
  - PLM-based Enterprise CM
  - Enterprise Process Control
  - Create and Maintain P.O.'s
  - Setup Work Order Accounts
  - Create Material Request/Return (MR)
  - Performance/Condition for Asset Life
  - Data Lifecycle Management
  - Source Configuration Control
  - Labor Entry and Equalization
  - Work Lifecycle and Completion
  - Design Lifecycle
  - Parts Lifecycle

- **Vendor and Other Data**
  - ERP Financials
  - Open and Reconcile Project Accounts
  - Charge Work Orders
  - Asset Capitalization and Retirement
  - Invoicing/Accounts Payable to P.O. Lines
  - Voucher and A.P. to Non-P.O. Items
  - Material Request (MR) and Parts
  - Labor Reconciliation and Payroll
  - Reconcile Issue/Return

Data Sources from Design Activities, Correspondence, Local Databases, CADD Drawings, GAE, etc.
PLM-Based Knowledge System for Configuration Management

How PLM ensures NPP CM by the management of events, process, workflow, design changes, requirements while capturing data sourced from Knowledge-based activities.
PLM-Based Knowledge System for Configuration Management

How PLM ensures NPP CM by the management of events, process, workflow, design changes, requirements while capturing data sourced from Knowledge-based activities.
Selection of software to support implementation of PLM-based NPP Configuration Management.

- Consider the nuclear design- and supply-chain: EPC, vendors, Owner’s engineer, Owner. Contract data requirements, handover of design document/data custody, understanding of design authority.

- Most nuclear power facilities select software according to design engineering purposes, with CM functionality perceived as being more important for operation. CM, however, must be considered from the very first day an NPP is even considered.

- The concepts of process controls, integrated management and PLM for CM and SE comes in a too-distant third-place.

- This is mainly due to lack of understanding and experience with PLM and PLCS concepts and processes.
Traditional 3rd/4th Generation RDBMS Architecture

LEGACY DATA SOURCES

FIXED RELATIONAL (RDBMS) DATA REPOSITORY

PROGRAMS AND LEGACY CODE

PROCESS

Table Keys and RDBMS Cardinality Controls

Manual or e-mail-based Collaboration and CM processes
Plant Lifecycle Management (PLM) Architecture

XML DATA REPOSITORY

IDE PROCESS MODELING

PLM & CONFIGURATION INFRASTRUCTURE

Lifecycle Visualization  Collaboration & Configuration  Document Management  Supplier Relationship  Enterprise Knowledge

Typical NPP Business Processes

Data

XML Data Messaging and Linking

Client Interaction and Business Rules

EQUIPMENT & BOM  NPP DOCUMENT CONTROL  ENGINEERING CHANGE CONTROL  CATALOG & MATERIALS  WORK MANAGEMENT  NPP BUSINESS RULES

Typical NPP Business Processes
Information Technologies for PLM-enabled Nuclear CM, KM and SE
Applying PLM and System Engineering across subcontractors, vendors and off-site fabrication during construction for CM for Handover.
NPP Configuration Management Information Systems

Selecting Software for PLM

For those NPP’s purchasing software, these are the leading Commercial NPP CM Software packages (by NPP market share and market trend). The red arrow indicates the general trend of growth (or shrinkage) in the product’s market share. **None of these Solutions are PLM enabled.**

- ABB Ventyx PASSPORT (65%)
- MRO/MAXIMO V5.0 (20%)
- IFS (5%)
- MPAC (4%)
- MPRO/CHAMPS (<2%)
- SAP (<2%)
- INTERGRAPH SPO (<2%)

Passport, MPRO and PIMS are specifically Nuclear products. Maximo and IFS have nuclear versions under development.
Information Technologies for PLM-enabled Nuclear CM, KM and SE

Basic Document Management technology package for focused on technical, non-nuclear and nuclear deployment applications. The Archmed EDMS features an advanced but simple to use while providing a document and extract data-based Requirements Management system.

Archmed e-DOCS Suite plus e-Process Nuclear Design Control for nuclear power plants empower process management during plant creation and design, designing safety into the NPP and reducing risks following the requirements of IAEA GS-R-3 safety standard. Document and Data Management System, as well as an advanced Content and Issue Resolution facility, known as the EDR.

Capturing and relating the nuclear related content to a flexible and extensible knowledge networks, Archmed Knowledge Management & Distribution preserve the critical nuclear power engineering and operation knowledge and ensures trusted foundation for efficient training to the existing and future engineering staff – both for existing and to be built nuclear power stations.

Adding the powerful GIS module for asset, document and data geo referencing, this configuration helps the asset and facility managers to plan, track and manage efficiently the critical information through the entire plant lifecycle, yet not losing insight about initial design basis and configuration changes.

Complete world-class Nuclear Configuration Management and MRO Functionality with IAEA-recognized Nuclear Power business model combined with PLM plant lifecycle support infrastructure.
Electric Power Research Institute (EPRI) Advanced Nuclear Technology (ANT) Program and Plant Information Model (PIM)

- Standard Handover Methods
- Standard Data Dictionary and XML Schema
- Alignment to ISO-15926
- Introducing Time and Lifecycle concepts to Knowledge Handover
- Understanding of transfer of Knowledge custody to Design Authority (NPP Owner/Operator)
- The relationship of EPC, Engineer, vendors and NPP Owner
- Periodic Safety Margin Review
- NPP Lifecycle Management of Information and Knowledge – life of design, life of component, etc.

ISO-15926 fundamentals; advantages and shortcomings.
Not a cure-all for data mobility and agnosticism.
Electric Power Research Institute (EPRI) Advanced Nuclear Technology (ANT) Program and Plant Information Model (PIM)

### Plant Information Model (EPIM)

<table>
<thead>
<tr>
<th>UID</th>
<th>Property Name</th>
<th>Group</th>
<th>SubGroup</th>
<th>Description</th>
<th>Data Case</th>
<th>Data Type</th>
<th>Choice List</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Required By Initial Fuel Load</td>
<td>Handover</td>
<td>Electronic File Requirements</td>
<td>Business Critical</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Safety Related</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>Business Critical</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Design Authority Control Required</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>Business Critical</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Design Information</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Design Information Subject to Revision</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Design Information Status</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>string (P</td>
<td>List)</td>
<td>Verified, Unverified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Another Design Information Status</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>string (P</td>
<td>List)</td>
<td>Preliminary, Final, Released</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>Open Items</td>
<td>Document Management</td>
<td>Document contains open items</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Design Information Status Comment</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Design Document</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>Design documents, studies, analyses, calculations, and design output documents that specify the design of an SSC. There are the design documents which specify that an SSC has been designed to perform its intended function.</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Controlled Document</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>A document that specifies quality requirements or prescribes activities affecting quality such as instructions, procedures, and drawings</td>
<td>boolean</td>
<td>Yes, No</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Document Development Status</td>
<td>Configuration Management</td>
<td>Design Control</td>
<td>Final, Preliminary, Preliminary with Unverified Assumptions, Superseded, Voided</td>
<td>string (P</td>
<td>List)</td>
<td>Final, Preliminary, Preliminary with Unverified Assumptions, Superseded, Voided</td>
</tr>
</tbody>
</table>
Using PLM-based Workflow for Configuration Management (CM) in the Nuclear Power Industry

Advantages – some work to do!

- NPP’s must adapt to using PLM-based solutions to support CM and to synchronize design changes to asset or product changes, and reduce “slipstreaming”. In the NPP world, this often appears as events that circumvent CM – for example, non-approved parts substitutions and “temporary” plant modifications that are never removed.

- PLM serves as the method for unifying the application of requirements to design changes, processes and workflow. In NPP’s, requirements are generally considered only relevant to designs – not process and workflow.

- PLM supports Configuration Management and Design Basis in Regulator Action Tracking for NPP’s, and application of PLM-based CM to regulator action and compliance systems. This is a poorly-understood application of CM in NPP’s, yet these elements control large parts of the NPP design basis.

- Suppliers, EPC’s and Technology Vendors must also understand the role of CM, SE and PLM in construction of new standards-driven NPP designs (like EPR and Westinghouse AP-1000 NPP designs), as well as understanding the role and handling of Knowledge Systems.