Plant lifecycle information management

Managing project risk and regulatory compliance for CAPEX build projects, design through decommission

Highlights

Energy companies must create and manage engineering information and records in a clear and demonstrable fashion through the entire lifecycle of a power and process plant project: from construction to turnover, throughout the long life of the plant.

An integrated and collaborative lifecycle strategy should establish effective information sharing, mitigate risk, and bridge the gaps between the design, build and operation phases.

Companies that understand what information is required over the whole lifecycle can effectively manage the flow of information and reap significant benefits in maintaining the value of their information assets.

The US Energy Information Administration projects that world energy consumption will grow by 56 percent[1] and US electricity demand will increase 28 percent[2] by 2040. Worldwide, new power and process plant construction is necessary to meet this demand. The new construction and life extensions of existing plants present a need for systems, procedures and infrastructure that support management of risks, safety, costs and regulatory compliance for plant projects. This is especially important for nuclear power plants, where stringent licensing and high cost, complexity and safety requirements demand strict plant data integrity. With stakes so high, a small overrun in cost can make nuclear energy uneconomical compared to alternative fuel sources. In today's markets, capital-intensive projects are constructed using a global supply chain, heightening the need to collaborate more effectively, electronically and securely for any project.

Valid, trusted and up-to-date information is one of the most valuable assets of an energy company. Traditionally, most plant information is controlled within documents that were used to design and construct plants and subsequently used in operations. This information is often spread over a number of documents and records which are then managed by multiple IT systems, including those for enterprise asset management (EAM), enterprise resource planning (ERP), computer-aided design (CAD) and enterprise document management systems (EDMS).
The configuration of information representing as-required, as-built,

as-operated and as-modified data is performed through very labor- and time-intensive manual practices, and results are not available in real time. As plant operators look to standardize and optimize their fleets and the related supply chains, from plan to operations, developing a single view of a plant and a fleet is a major imperative. Existing toolsets for information services do not adequately provide the single view that owners and operators require. In addition, the increase in plant data and the availability of new technologies require a smarter approach to information management that will enable deeper insights into the plant and fleet. This is the challenge and opportunity that plant lifecycle information management (PLIM) addresses.

PLIM uses a sophisticated configuration management system coupled with a defined information model to tightly control the flow of information along the entire lifecycle. PLIM manages design changes, tracks and resolves design issues, ensures requirements conform to applicable specifications, and serves as an operational portal that provides a single view of configuration-controlled plant information during the entire plant lifecycle. As the physical plant is being built, a 3D virtual plant is also built in the digital world to represent the current project state. The virtual plant, which depicts both the current state and its evolution over time, becomes part of the decision-support tools that back up all activities related to the physical plant.

Orchestrating the orderly management of system information

It is easy to understand the need to formalize configuration management (CM) principles in a PLIM system when considering the safety, complexity, regulatory requirements and cost of a plant's design and build phase, and the entire lifecycle of the plant assets. The plant will be in operation for decades after the initial commissioning. To conduct maintenance, repairs and major system upgrades to the plant during its lifetime, supporting engineering and other applicable technical information about the plant must correctly represent its current physical state. Understanding the impact of change within a plant and across the fleet is also critically important. Being able to quickly assess the impact to a particular asset can ensure the safety and economic impact is understood—before a change is initiated. CM is critical in building the virtual plant, managing the plant information lifecycle and optimizing a handover.

Traditionally, power and other process-type plants have been operated by maintaining piping and instrumentation diagrams and drawings (P&ID), using instrumentation and control systems, and the warehousing of hard copies of original data. The concept of ensuring consistency among multiple sets of related information was not a standard practice. CM helps to maintain equilibrium among the three key areas of information: the design requirements, the facility configuration information (drawings, plans and specifications) that detail how the plant is built, and the actual physical configuration of the plant itself. Much of this information is available today in mixed electronic formats, but they need to be aggregated to provide a single view of a plant and fleet.

The nuclear energy industry is leading the way:

"Configuration management is the systematic approach for identifying, documenting and changing characteristics of a facility's structures, systems and components, and ensuring that conformance is maintained between the design requirements, physical configuration and facility configuration information."

Nuclear Information and Records Management Association (NIRMA)

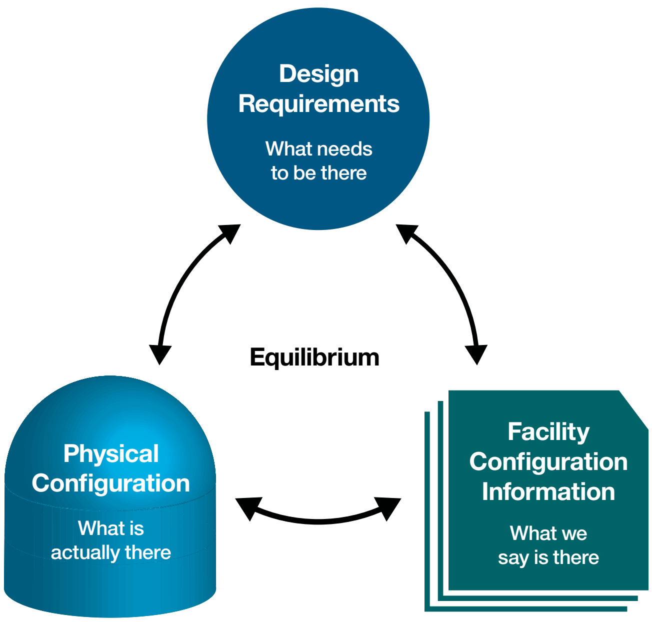

Figure 1. Configuration management equilibrium.

Key CM concepts for nuclear new build and life extension projects

CM equilibrium is achieved when there is complete set of verified and validated information about the plant and when there are established links between related content, so that if a piece of information changes in one area, the linked information will have to be revalidated to reestablish equilibrium. Key CM concepts include:

- CM development starts early in the design phase and is represented in the virtual plant
- Design is essentially complete prior to construction
- Computer technology is used extensively in design with 3D, 4D and 5D modeling and virtual construction planning
- Computer technology supports development of a detailed design that can be built
- The plant is built as designed, with changes made only if there are design errors
- Variation across the fleet can be viewed and understood

A CM system is not purely an IT solution; it must be a technology-based business solution with capabilities that instantiate rigorous processes and procedures to ensure that equilibrium is maintained among the three key areas of information. A well-designed CM system supports change management through impact analysis and identification of potentially impacted items. These capabilities apply to all phases of the plant information life cycle.

Complex projects such as new nuclear construction and life extension projects rely on multi-vendor, modular design and multi-discipline concurrent engineering. Individual design changes can have widespread impacts across the plant and fleet, and effect changes in multiple plant systems, related documentation and databases. Today's CM systems make use of information models to identify and illustrate associations between equipment, systems and documents, and to manage the impacts to those items as a result of changes.

An information repository and configuration control system

PLIM uses a plant information model to organize both assets and associated information about assets. An effective PLIM tool must be able to support any predefined information model, from industry standards-based to the proprietary standards companies wish to use. The Electric Power Research Institute (EPRI) has started to develop the plant information model (PIM), which is gaining traction within the nuclear industry. This model extends the ISO15926 model. Since the model is still under development, companies will adopt and extend the EPRI model or develop their own. The PLIM toolset should support both approaches.

With this reference semantic model, asset information can be organized into a structures systems components (SSC) hierarchy that serves two purposes:

1. It allows associations or entity relationships between assets or groups of assets to be created, and identifies when in the process the information is required—which enables PLIM's ability to detect and orchestrate engineering changes and subsequent return to equilibrium.

2. It allows for a more logical navigation of huge amounts of plant information, and facilitates retrieval of required information through a single portal to record systems. A common complaint of having only document management systems is that the right information is extremely difficult to find and the accuracy must always be painstakingly verified.

In addition to PLIM serving as an information repository and configuration information control system during the plant's operational life, it is also designed to be a collaboration platform for the owner, constructor and sub-contractors. It is the portal to collect evidence that will subsequently be provided to regulators during the plant's design, build, commission and handover phases. This is particularly important because a high degree of rigor is required in plant licensing—"as-designed" must be the same as "as-built." For the US, this is defined under the Nuclear Regulatory Commission (NRC) regulations 10CFR Part 52, which ultimately rely on verification and validation methods being applied against the plant configuration, data and requirements.

One of the benefits of PLIM is that this collaboration and exchange of information does not occur only once at handover or turnover. This would be extremely difficult and time-consuming. Rather, it occurs incrementally and in a collaborative fashion between participating parties. But in order for this to work, PLIM must also ensure that individual data contributions are synchronized, which is a difficult task as engineering changes take place right up to and through plant commissioning. Having a system such as PLIM instills confidence that the engineering and design information is accurately reflected in the "as-built" plant installation, which can streamline regulatory reviews and the licensing process.

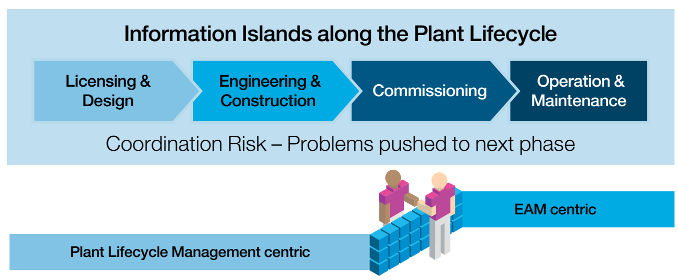

Figure 2. New build information challenges: Projects are characterized by extensive time and cost overruns and meeting regulatory requirements.

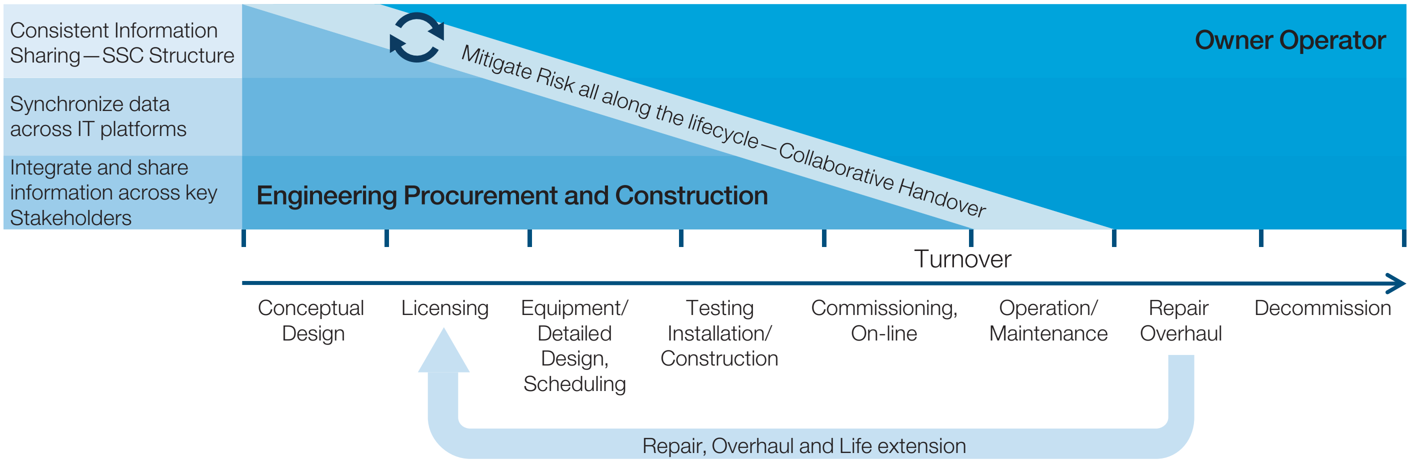

Figure 3. PLIM: Bringing the information together, demonstrating the importance of managing the plant information early and throughout its 80-plus year lifecycle.

Effective information sharing

Having a single interface between participants, engineering systems, applications and business systems helps ensure effective collaboration. PLIM should be the system of systems which orchestrates information and processes across multiple toolsets. There are four types of interfaces that are important in the PLIM architecture:

Intra- and inter-user interfaces: This includes the interfaces between participants of the PLIM system. Core business processes for new plant build projects are performed by many participants who are scattered across different companies, locations and time zones. PLIM provides the participants with the foundation to collaborate along with the CM-related processes through web-based access.

System interfaces: One of the core functions of PLIM is to create and maintain a set of CM information, which conforms to the CM equilibrium. This requires data exchange interfaces between multiple systems such as engineering, procurement and corrective action systems. But PLIM is not intended to edit, replace or otherwise revise the source information itself, for instance document, drawing and CAD data from the engineering authoring systems. Instead, PLIM maintains links to the source work products, as organized by the PLIM information model. Therefore, PLIM maintains the CM information model separately from the work products.

Application interfaces: This includes the supporting applications interfaces. PLIM is built on an IT architecture which is composed of several middleware products. Middleware are software components which provide base functions to run

PLIM on the computer systems, and support the open system standards widely adopted by the IT industry. By using standards-based middleware products, development and maintenance costs can be optimized, and connectivity and interoperability with other applications is increased.

Enterprise business system interfaces: This includes the interfaces between business systems such as enterprise resource planning, project management and enterprise asset management applications.

A client implementation: Mitsubishi Nuclear Energy Systems

Mitsubishi Nuclear Energy Systems (MNES) is a fully integrated nuclear power plant and steam generator supplier, providing planning, design, manufacturing, construction and plant maintenance for its utility customers. The configuration management information system (CMIS), designed and developed by a global IBM team, has been used by MNES since April 2011 to manage their design information and their metadata during the licensing process with the Nuclear Regulatory Commission, and during the plant engineering, procurement and impending construction phase.

In the creation of the present configuration management information system, IBM established itself as a trusted advisor, subject matter expert and systems integrator to MNES. Building a CMIS for new nuclear power build projects is a risky endeavor, because of the complexity and quantity of data involved. With IBM as a partner, this was a risk MNES was willing to take.

Getting started

What steps should be taken internally to prepare for PLIM? First, quantify and understand the value of an information management program by performing a business value assessment. Understand the “as-is” situation and define a “to-be” view. Consider the costs of plan deviations and project delays. Recognize that to be successful a program must be in place at the beginning of the new construction or life extension project. Get buy-in from all stakeholders, including the owner-operator, EPC and sub-suppliers. Establish the PLIM program and governance at the requirements stage. Ensure that the use of PLIM and the information required to support it are clearly defined in contracts with all third parties. Recognize that there is a cost for the EPC and sub-suppliers that needs to be built into the project to achieve the rigor and benefit of the program, but that this is balanced against the lifetime value of good information management processes, knowledge capture and information asset retention. An effectively architected PLIM system should not be burdensome to third parties or affect the toolsets they use internally.

Energy companies considering nuclear new power and process plants face many common industry challenges such as managing a highly complex project, disparate systems, changing stakeholders, a highly regulated environment, and potential cost and schedule overruns. A study by Booz Allen Hamilton shows that 40 percent of complex projects above USD1 billion frequently exceed budget and cycle time by more than 10 percent.[3]

Instead of creating information in silos and sharing only from phase to phase, a smarter information management system such as PLIM can help:

- Establish effective information sharing and mitigate risk across the entire project lifecycle.
- Avoid unpredictable plan deviations and project delays.
- Maintain high quality data for work projects.
- Bridge the gaps between the design, build and operation phases through effective handover.
- Establish common information models to help ensure consistent and relevant exchange.
- Provide precise tracking and monitoring of project progress and deliverables.
- Increase future project efficiency through the accumulation of project knowledge.

IBM is actively helping companies in a range of industries with new plant lifecycle information management initiatives that incorporate configuration management principles. IBM is ready to partner with energy companies to help evaluate their needs and deploy intelligent, technology-based business solutions that manage the risks, costs and regulatory compliance for new plant projects.

For more information

To learn more about plant lifecycle information management, please contact your IBM representative or IBM Business Partner, or visit: **ibm.com**/energy

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Produced in the United States of America
February 2014

[1] US Energy Information Administration, International Energy Outlook 2013 (IEO2013). http://www.eia.gov/forecasts/ieo/

[2] US Department of Energy, Annual Energy Outlook 2013. http://www.eia.gov/forecasts/aeo/MT_electric.cfm

[3] Booz Allen Hamilton. “Capital Project Execution in the Oil and Gas Industry”. March 2006. http://www.boozallen.com/media/file/Capital_Project_Execution.pdf

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