

Data-centric configuration management

By Kenneth Barry, Robert Renuart, and Thomas Esselman

While other process industries have realized significant benefits by moving from primarily document-centric asset management systems to data-centric systems, the nuclear power industry has yet to embrace the change. A recent Electric Power Research Institute (EPRI) study suggests that it may be time to do so.

Managing and maintaining all of the diverse pieces of information that relate to the physical configuration of a large industrial facility such as a nuclear power plant is no simple task. The implementation of an advanced configuration management information system (CMIS) can provide significant operational and economic benefits. An integrated CMIS encompasses data and information for all phases of the plant life cycle, including licensing, design, procurement, construction, testing, operations, maintenance, and decommissioning. Figure 1 shows that the requirements, the facility information (including data), and the physical plant need to be in conformance. Changes to the configuration of the plant are managed so that they can occur throughout the life of the plant using integrated processes.

The EPRI study estimated an opportunity for savings of \$8 billion for the 100 (through 2014) operating U.S. nuclear power plants over the next 20 years of operation by implementing a data-centric CMIS, and more than \$1 billion for the four U.S. new nuclear plants under construction over their projected 80-year life.

At a typical nuclear plant today, data exist in many siloed databases, each maintained with different levels of change con-

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An advanced configuration management information system can provide operational and economic benefits, encompassing all phases of a nuclear plant's life cycle.

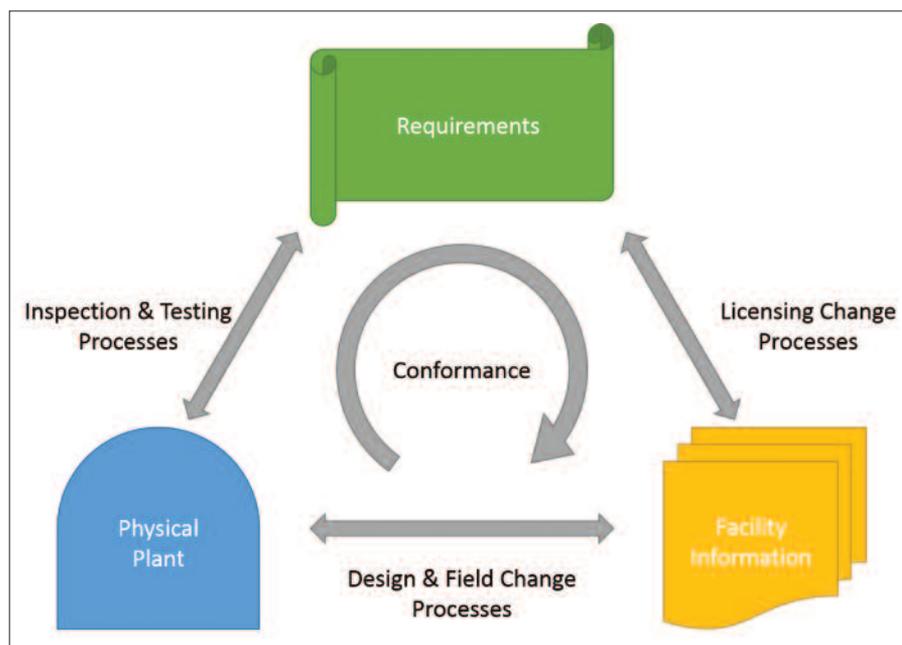


Fig. 1. Configuration management

trol. The database for managing the flow-accelerated corrosion program, for example, is not the same as the one for managing the equipment reliability program. With much of the data overlapping, keeping the siloed databases up to date in a consistent manner is challenging when the plant design or operation changes. Having the same data resident in multiple databases results in plant staff spending additional time verifying the accuracy of data prior to use. It can also lead to a lack of confidence when the data are in conflict.

The premise of data-centric configuration management is that decisions are made on data, not documents. Documents are still maintained as the record of the source of the data, but to support effective decision making, critical operating data need to be centralized, accurate, change-controlled, and easily retrievable. A typical nuclear

plant has approximately 300,000 controlled documents and millions of historical plant records. Moving to a modern data-centric, object-relationship database can add another 250,000 equipment records per unit that also must be change-controlled.

A CMIS that is not data-centric requires the plant staff to find a relevant piece of information in a document or siloed database and then verify that it is accurate and updated. Before the data can be used, plant staff frequently must resolve document revisions and naming discrepancies and ensure consistency with the design basis and compliance with licensing commitments. EPRI has found that nuclear plant personnel spend 30 to 40 percent of their time searching and validating information in multiple documents to ensure that the data to be used for plant operations or engineering assessments are accurate.

The challenge lies in identifying the data that are needed to support the testing, inspection, engineering, maintenance, and operating processes that maintain the plant in conformance with the design basis. Software tools have emerged to assist the document-centric plant transition to more “intelligent” information. These tools reduce the amount of time required to cross-reference data as compared to a manual search within documents based on established rules. The new tools can identify equipment tag numbers and document references that can be related to the document for faster identification and retrieval.

Data-centric end states

The EPRI project examined the extent of electronic conversion and movement to data-centricity for a range of beginning and end states for both operating plants and new builds. Specifically, the study identified the potential benefits for different stages of conversion relative to the cost of upgrading to a higher end state (as defined below). Data were obtained through the benchmarking of more than 20 nuclear power plants and facilities in other regulated industries. These data were then input into a probabilistic return on investment (ROI) model to compare the net present value derived from moving to different end states.

The study evaluated six end states, each of which builds on the previous one. That is, End State 1 needs to be largely achieved before embarking on End State 2, and so on. For example, a facility that is trying to centralize all critical data (End State 3) should ensure that it has electronically converted all critical documents (End State 1) first.

■ **End State 1, Electronic Document Centralization**, involves identifying critical documents, locating these documents, and converting them to electronic media. It also includes consolidating multiple document indexes for electronic documents, filmed documents, and paper documents into a Master Document List (MDL).

■ **End State 2, Critical Documents Cross-Referenced to Plant Tags**, involves expanding the Master Equipment List (MEL) to include other tag groupings—such as fuse lists, relay lists, and weld number lists—and cross-referencing the tag numbers to the supporting documents.

■ **End State 3, Data Centralization**, involves centralizing data into a single repository and eliminating the 20 to 30 siloed databases in use at a typical operating plant. The central repository is referred to as a “single source of truth.”

■ **End State 4, Object-Relationship Model**, involves developing an object-relationship database for the data-centric CMIS. An object-relationship model adds “knowledge” to the data so that they can be used to perform robust change-impact reviews when the plant configuration is changed.

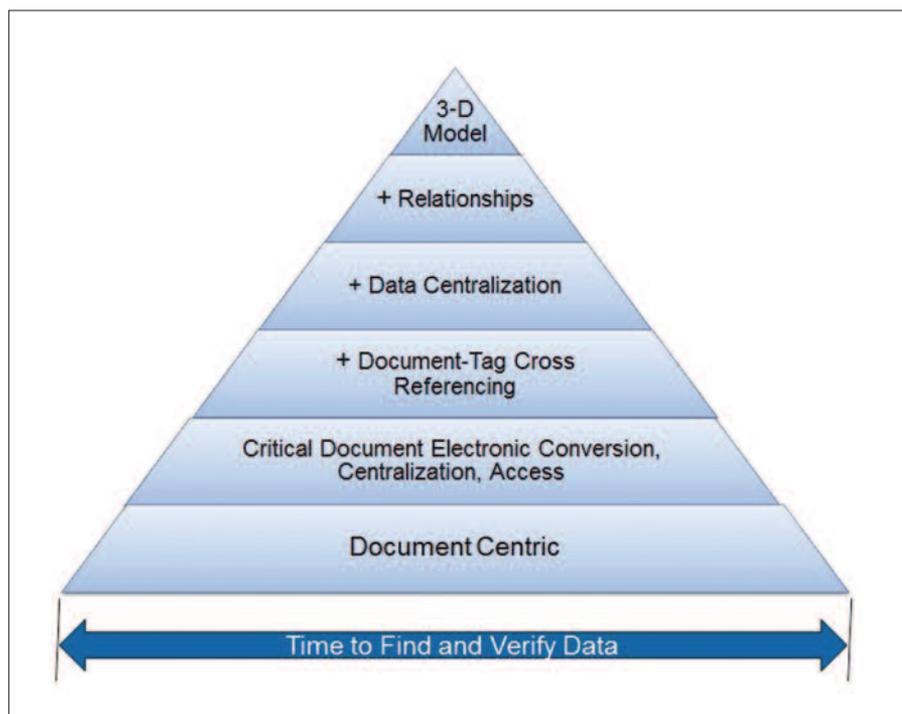


Fig. 2. End states build on each other to reduce data access time.

■ **End State 5, 2-D/3-D Model Integration**, involves integrating 2-D and 3-D models, if they exist, with the data-centric CMIS to provide visual access to the data from the tag number on a drawing. If a 3-D model does not exist, the end state evaluates the cost to generate a laser-scanned 3-D model with component hyperlinking to the MEL.

■ **End State 6, 2-D/3-D Model Analytical Tool Integration**, involves integrating the 2-D/3-D models with analytical tools and maintaining the models after the plant goes into operation. For example, the model can be directly linked to piping or HVAC analyses. End State 6 would apply only to plants that have existing “intelligent” 3-D models, not a laser-scanned 3-D model like that generated in End State 5.

The end state progression is shown in Fig. 2. The width of the pyramid is related to the relative time required to obtain and verify data. The investment to move up the pyramid will likely be based on an ROI analysis, where the investment represents the cost to implement and maintain a system, and the return represents the reduction in operations and maintenance (O&M) costs.

The analysis should consider the possible variations in both the investment and the possible savings. The EPRI-developed ROI modeling software can be used to conduct this analysis, giving users flexibility in defining their own use cases and establishing cost and benefit assumptions. The probabilistic model permits variations for each input element in the model, based on how much confidence is given to each input assumption.

EPRI analyzed the major steps to achieve each end state. The costs were broken down by capital cost (one-time payments for

hardware, software, and contract labor), startup labor cost (utility worker hours to support the end state development), ongoing software costs (annual cost for software vendor support and software upgrades), and ongoing labor cost (annual utility worker hours to support the maintenance of the system).

The expected savings also will depend on the end state and can be categorized as hard savings and soft savings. Hard savings are defined as reductions in the time required to perform tasks. Soft savings are less direct, but can include reductions in planned or unplanned outage durations and risk reduction for regulatory reviews.

The probabilistic model considers variations in both investments and savings. By enabling the model to evaluate investments larger or smaller than the initial estimate, users can calculate by how much the savings exceed (or don’t exceed) the investment. The model also calculates the likelihood that the payback (when savings are equal to investment) will occur in a given period of time and the net present value after 15 or 20 years of operation for an operating plant and up to 80 years for a new build.

An example use case

The benchmarking data EPRI obtained were used to analyze several use cases and to validate the model. The example use case assumes that the utility is beginning on the low end of electronic document conversion (End State 1) and MEL content (End State 2) and wants to upgrade to a centralized database (End State 3).

The beginning point is referred to as End State 1* to indicate that some upgrades, such as the following, have been performed:

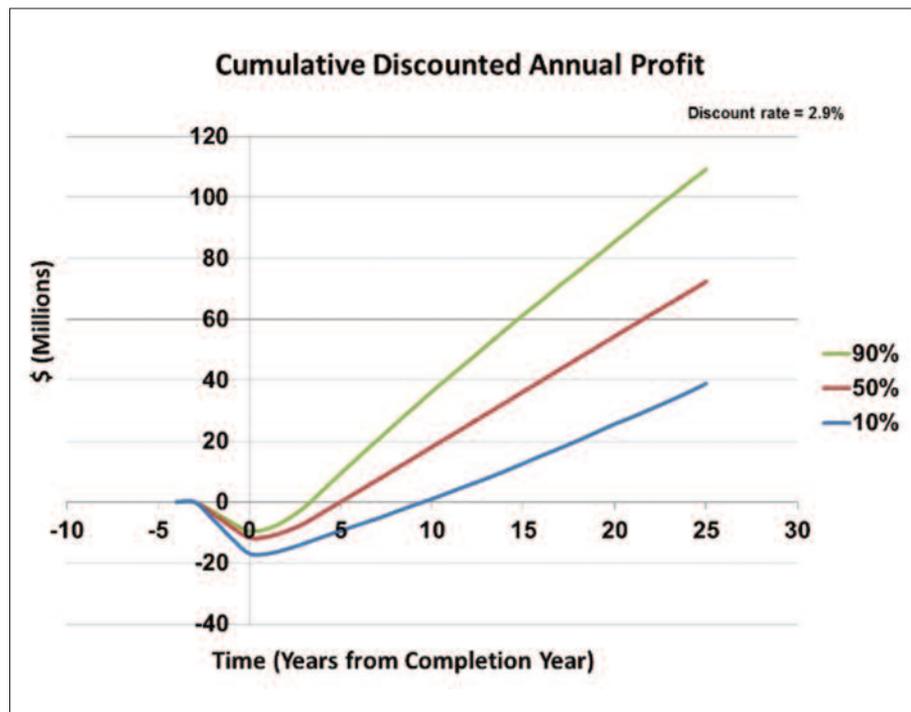


Fig. 3. Results for transition from End State 1* to End State 3

- High-use O&M controlled documents (about 25 percent of all controlled documents) have been scanned and converted to text by optical character recognition.

- Advances have been made in digitizing some other files, but up to 75 percent of the controlled documents are still maintained on paper and microfilm.

- The physical “site library” is active and is where many site personnel go to get information that is not electronically retrievable at their desktop.

- Drawings can be accessed online, but many are still in paper or microfilm aperture cards.

In addition, the electronic, paper, and microfilmed records are not indexed in a centralized MDL that is electronically accessible. To achieve End State 1, the utility will electronically convert all high-use documents and records and index all documents and records, regardless of media, into one MDL.

The utility has a standard MEL with approximately 150,000 tagged items per unit. To achieve End State 2 (as a step to End State 3), the utility will expand the MEL to more than 200,000 tagged items. This will be accomplished by merging tag lists independently maintained in separate databases, such as fuse lists, relay lists, and weld number lists. The utility also will electronically mine tag number references from electronic documents and enter the tag-document cross-references into the MEL.

The utility has 20 siloed databases that will be merged with the MEL and MDL to achieve End State 3. The utility will also mine additional properties not in the siloed databases from design and vendor documents and enter that data into the consoli-

dated MEL.

This use case does not take credit for improvements in work processes that would be expected to accompany advances in data storage and retrieval. The EPRI study identified electronic work process improvements that would provide savings in addition to those included here.

The total initial investment based on EPRI benchmarking for hardware, software, and labor was estimated at \$11.4 million for this example. The inflation rate and discount rate were set at 2.9 percent.

Figure 3 shows the modeling results for this use case, incorporating both hard and soft savings. Breakeven times are calculated at various likelihood percentages. For this use case, the 50 percent likely time to break even is 5.0 years after the completion year, while the 10 percent likelihood breakeven time is 3.3 years and the 90 percent likelihood breakeven time is 9.5 years.

Following the payback year, the savings accumulate. This case shows that by 20 years following Year 0 (the year of implementation), it is 50 percent likely that the savings will total more than \$50 million.

The analysis demonstrates that nuclear plant owners may have an economic incentive to implement a data-centric CMIS. The investment model software was designed so that it can be easily used by a utility or any process industry to input its specific investment and savings data and calculate its expected returns.

EPRI Report 3002003126, *Data-Centric Configuration Management for Efficiency and Cost Reduction*, December 2014, and the associated investment model software are available at EPRI’s website, at <www.epri.com>. **EN**