THE SYSTEM 80+^{TM} STANDARD PLANT INFORMATION MANAGEMENT SYSTEM

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ABSTRACT

Historically, electric nuclear power plant owners, following the completion of construction and startup, have been left with a mountain of hard-copy documents and drawings. Hundreds of thousands of hours are spent searching for relevant documents and, in most cases, the documents found require many other documents and drawings to fully understand the design basis. All too often the information is incomplete, and eventually becomes obsolete. In the U.S., utilities spend millions of dollars to discover design basis information and update as-built data for each plant. This information must then be stored in an easily accessed usable form to assist satisfy regulatory requirements and to improve plant operating efficiency.

ABB Combustion Engineering Nuclear Systems (ABB-CE) has an active program to develop a state-of-the-art Plant Information Management System (IMS) for its advanced light water reactor, the System 80+TM Standard Plant Design. This program is supported by ABB's Product Data Management (PDM) and Computer Aided Engineering (CAE) efforts world wide. This paper describes the System 80+ plant IMS and how it will be used during the entire life cycle of the plant.

I. INTRODUCTION

The System 80+ Information Management System is a data-centered system, applicable to the entire plant and covering all phases of the plant life cycle: design, construction, operation and maintenance, and decommissioning. Data from all disciplines are shared in common databases and integrated with a standard set of CAE design and information processing systems to ensure that accurate information is readily available for making safe, knowledgeable, timely and cost-effective decisions. The main objectives of the System 80+ IMS are as follows:

- Automate functions involving the storage, access, maintenance, and management of data and documents necessary to support all phases of the plant life cycle.
- Facilitate implementation of the Configuration Management Plan (CMP) throughout the entire plant life cycle, in accordance with project procedures and requirements.
- Develop a logical breakdown of plant information into systems and systems groups with an identification standard for all structures, systems, equipment, components, facilities and documents.
- Provide a common data network and computer hardware system infrastructure for users to access the same data; thereby facilitating project information exchange between widely-spread locations.
- Assure that data and information needed for the safe, efficient, and accurate plant design, construction, operation and maintenance are always available to facilitate accurate and complete turnover to the plant owner.

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The System 80+ IMS uses commercially available, proven technologies for all hardware, software and networking. It includes all necessary data handling software, communication software and supporting hardware. The System 80+ IMS provides a computer-aided engineering environment for the design and documentation of the proposed design. But more importantly, it provides the basis for plant configuration management and plant wide operations and maintenance activities for the life of the plant through decommissioning. The scope is total-plant oriented and divided into functional modules covering the scope and capabilities required in EPRI's ALWR Utility Requirements Document (Reference 1). Applications are designed around a logical integrated plant-wide data model guided by EPRI's report NP-5159 (Reference 2). This present paper describes the Plant IMS and how it will be used during the entire life cycle of the System 80+ Standard Plant.

II. APPROACH

Since new plant orders require complete information management from the very beginning of the plant design to assure all information is provided at plant turnover, System 80+ IMS data from all disciplines are shared in common databases with a standard set of integrated Computer-Aided-Engineering (CAE) tools and a Document Management System (DMS). The data centered approach offers the advantages of (1) concurrent engineering, (2) immediate access to the latest data, (3) a change process that effects only the specific data, (4) a single entry of data, and (5) practical data traceability.

ABB-CE's IMS strategy focuses first on concurrent engineering database development, then integrating CAE and DMS applications with the database. Rapid commercial software development and Internet technology advancements support this strategy. The engineering database (EDB) is the focal point of the IMS because it not only facilitates the concurrent engineering design process but also stores the results. ABB-CE uses office automation desktop personal computers, local area network (LAN), wide area network (WAN), e-mail, work flow management, international communication using Internet, and WEB browser technology. In an important corporate initiative, Product Data Management (PDM) technology, using commercial software (Metaphase™) provides state-of-the-art product structure and data integration.

III. PLANT LIFE CYCLE PHASES

There are three major IMS functions: (1) information generation, (2) information storage, and (3) information access. These functions must meet the needs of the following plant life cycle phases:

A. Design

The IMS facilitates the concurrent, electronic design of the plant. All design information is developed in an integrated manner and input into the IMS database. Data are generated and stored in the database by direct input to data entry screens from desktop workstation or through the specific CAE tool(s) desktop workstation graphic user interface. Data are available to all IMS users as soon as it is entered The CAE tools build intelligent design databases. Drawings are created much like "reports" from the database. The DMS uses concurrent engineering database data for document creation. These documents are then reviewed, approved and stored using DMS facilities. This provides all team members with access to current design data to aid in completing their respective tasks.

B. Construction and Installation

The project team construction members use the IMS data created during the design phase for detailed construction drawings, bills of material, vendor data and installation procedures. Construction scheduling and material tracking is also facilitated through the IMS. The IMS data are constantly updated by project team users to accurately reflect field routed and "as-built" conditions of installed components.

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When construction begins, the IMS will contain a logically defined database for construction personnel to plan and construct the plant. In addition to traditional drawings and installation lists, ad-hoc database queries, plant visualization, construction sequencing applications and ad-hoc 3-D model viewing clarify construction issues.

C. Operations and Maintenance

At plant turnover, the owner receives the IMS with complete design and construction data, including related documentation. In addition, the owner receives the revision history of the plant and the design tools to continue documenting the plant technical history. The IMS has the complete information to support plant modifications and licensing reviews. In addition to the design and construction information the owner would require, the IMS include applications such as:

- Component Isolation and interlock identification
- Health Physics and ALARA applications for operations and maintenance activities
- Technical Specifications compliance, Limited Conditions for Operation
- Tag-Outs
- Troubleshooting
- Operational Procedures/ Emergency Operational Procedures development
- Work control and maintenance work package development
- Maintenance Procedures

IV. SYSTEM 80+™ IMS ARCHITECTURE

The System 80+™ IMS uses commercially available technologies for all hardware, software and networking. The IMS architecture satisfies three major functions: (1) information storage - achieved with the EDB which is comprised of multiple application databases connected via the LAN, (2) information generation - achieved with office automation and CAE applications connected via the LAN, and (3) information access - achieved with commercial applications integrated via the LAN and work flow management applications coordinating all IMS functions. Data are shared, not duplicated, between IMS applications (Figure 1).

A global network is provided for the project team as well as the plant owner. This network allows continuous communication of data between all team members. Team members share access to all design, construction and schedule information. The network also facilitates electronic mail for messaging and document and drawing approval and distribution.

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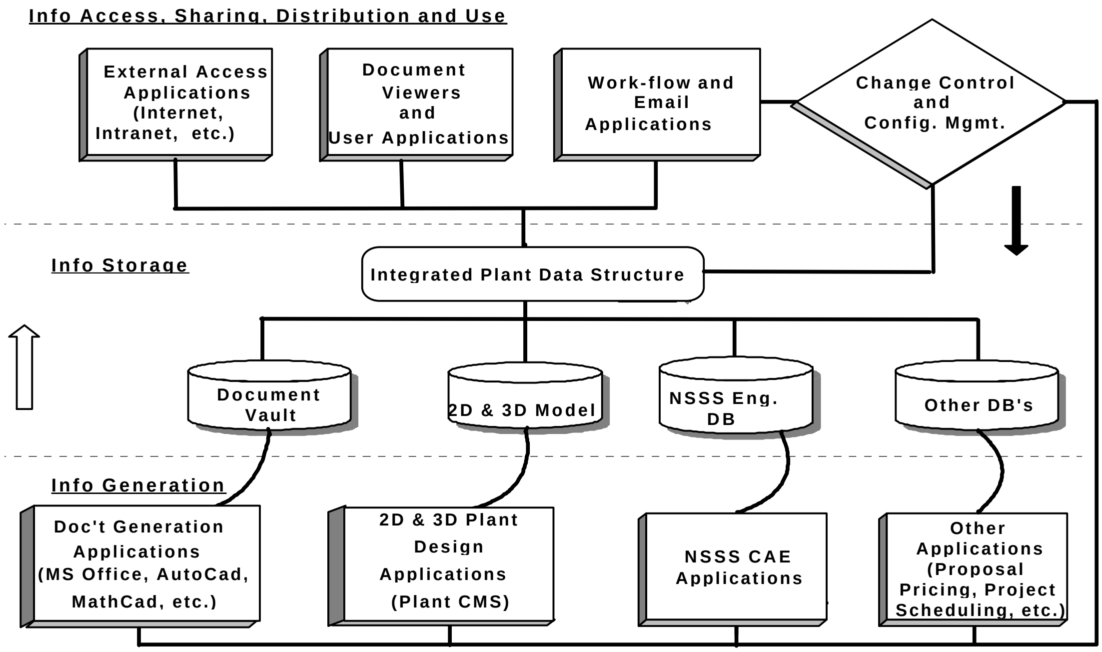

Figure 1 IMS Architecture

V. IMS COMPONENT DESCRIPTIONS

A. Concurrent Engineering Database

The System 80+ concurrent engineering database is an Oracle™ application with a custom user interface. The Oracle™ database employs a client-server architecture in which networked database servers store the IMS information. This database also supports the project management, procurement, inventory tracking, and document management and control applications.

The following computed aided software engineering (CASE) tools are used to provide access to the IMS data. PowerBuilder™ is a graphic user interface (GUI) design software package that supports user interaction with the Oracle database. This is used to specify the data model information and for entering and accessing data in the database (Figure 2).

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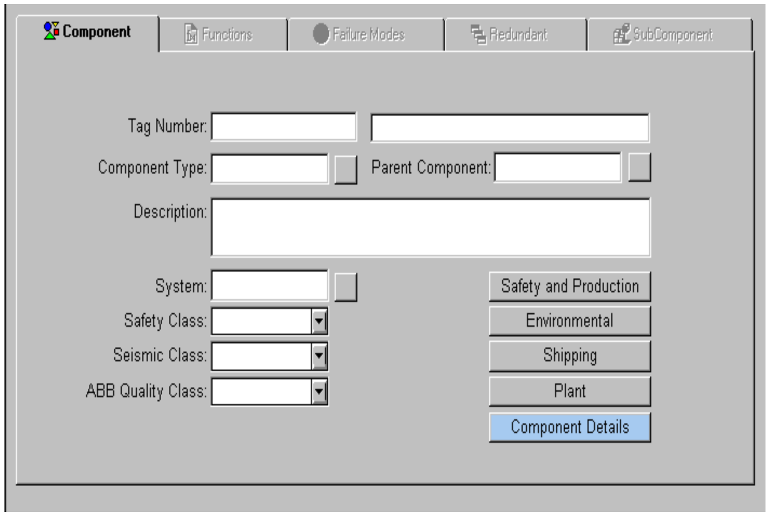

Figure 2 Component Data Entry Screen D

PowerDesigner™ is a CASE tool designed specifically for data modeling. Through its use, the entity relationship diagram which defines the conceptual data model (CDM) is constructed (Figure 3). The CDM is the "blue print" of the database structure. The CDM is used to initially plan the database and any modifications to the database after implementation. PowerDesigner interfaces directly with Oracle to create database tables.

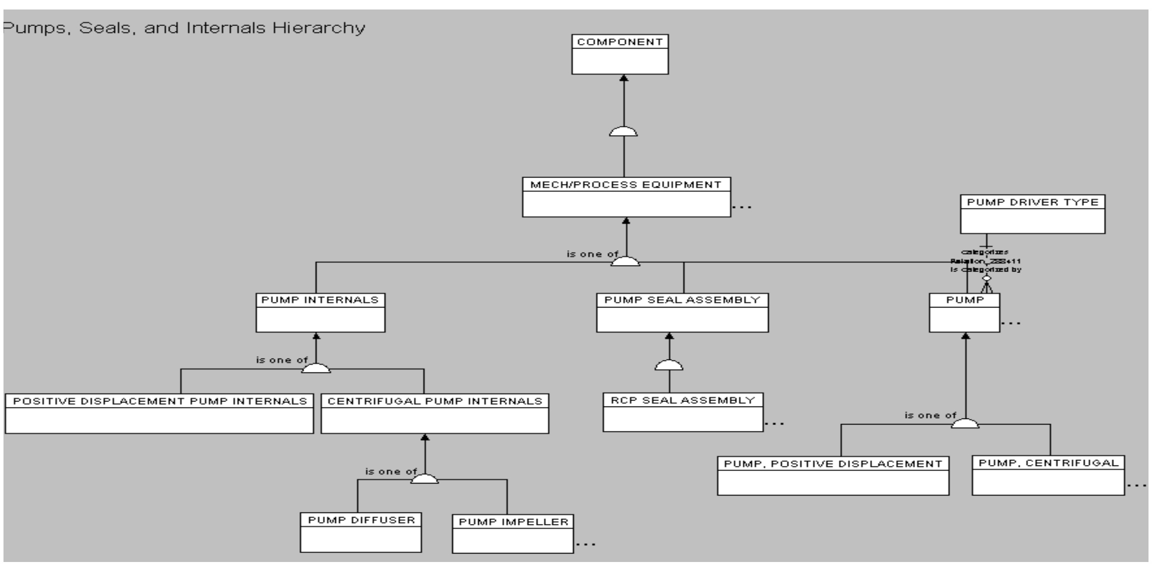

Figure 3 Example Entity Relationship D Diagram

InfoMaker™ is a screen design and report generation application. It is used to create the database data entry screens and standard output reports that are linked to the PowerBuilder GUI application. It communicates directly with the Oracle database for report generation. Standard reports are used as input to the document creation and management application. Additionally, designers can create ad hoc reports to aid in conducting their design tasks (Figure 4).

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INSTRUMENT LIST FOR PROCESS INSTRUMENTATION

SYSTEM DESIGN INFORMATION					COMPONENT DESIGN INFORMATION		
CE Tag No.	System Functional Description	Component Description	Range	ENGR UNITS	ENV CAT	Q CLS	SEISMIC CAT
1-PT-201	Instrument 22	Pressure Transmitter	to			I	3
FI-222	Letdown Line Flow Indicator	D/P Indicator/Switch	0 to 1016	cm H2O			2
FT-202	Letdown Flow Indicator	Pressure Transmitter	0 to 1905	CM H2O		I	2
FT-210X	RMW Flow Controller	Pressure Transmitter	0 to 1905	CM H2O		I	2
FT-212	Charging Line Flow	Pressure Transmitter	0 to 2000	CM H2O		I	2
FT-241	Seal Injection Flow	Pressure Transmitter	0 to 1905	CM H2O			2
FT-242	Seal Injection Flow	Pressure Transmitter	0 to 1905	CM H2O			2
FT-243	Seal Injection Flow	Pressure Transmitter	0 to 1905	CM H2O			2
FT-244	Seal Injection Flow	Pressure Transmitter	0 to 1905	CM H2O			2
LI-228	Volume Control Tank Local Level Ind	D/P Indicator/Switch	330 to -1	cm H2O		I	2
LT-201	Refueling Water Tank Level	Pressure Transmitter	0 to 1905	CM H2O			2
PDIA-202	Purification Filter D/P	D/P Indicator/Switch	0 to 7000	CM H2O		I	2
PDIA-203	Ion Exchanger/Letdown Strainer D/F	D/P Indicator/Switch	0 to 3000	cm H2O		I	2
PDIA-206	B/A M/U Pump D/C Press Switch	D/P Indicator/Switch	0 to 3000	CM H2O			2
PDIA-241	Seal Injection Filter D/P	D/P Indicator/Switch	0 to 1500	cm H2O			2
PDIA-245	I/X Drain Header Strainer D/P	D/P Indicator/Switch	0 to 3000	cm H2O			2
PDIA-258	RX Drain Filter D/P	D/P Indicator/Switch	0 to 3000	cm H2O		Y	2
PDIA-261	RMW Filter D/P	D/P Indicator/Switch	0 to 3000	cm H2O			2
PDIA-265	Pre-Holdup IX D/P	D/P Indicator/Switch	0 to 2000	cm H2O			2

Figure 4 Example Standard Database Report

These applications automate many repetitive tasks and facilitate work flow by creating logical interface points in the database for other users. For example; when a mechanical engineer specifies a particular pump motor combination, it creates a table entry in the database for the motor. With this information, an electrical engineer can then determine the control and power requirements for the same motor.

B. Plant CAE Tool

The CAE tool is an integrated database used for all physical three-dimensional (3-D) modeling applications. This system facilitates the concurrent design of an integrated physical data model by combining geometric modeling functions with a database manager for storing the plant data design. The 3-D modeler is specification driven from a complete catalog of

standard plant components such as steel, pipe and HVAC. The CAE tool provides for physical space allocations, dynamic interactive interference detection and 3-D hidden views.

3-D Physical applications include, but are not limited to:

- Civil Design
- Structural Concrete Layout/Design
- Structural Steel Layout /Design
- Structural Steel Analysis
- Piping Design
- Piping Layout/Design
- Piping Analysis
- Architectural Design
- Architectural Layout/Design
- Plant Arrangement
- Equipment Design
- Equipment Layout/Design

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An important feature of the CAE tool is the change log function A change log performs a comparison between the approved database and current working database where design changes are worked out. This list is used in the checking process to verify the accuracy of database changes that affect the functional design. As mentioned earlier, the CAE tool allows concurrent work flow by permitting all users to view the plant model as it is being generated. A person routing pipes, for example, can see a new steel platform just committed by a civil steel designer. Three dimensional windowing allows any user to identify and view any spatial area of the plant. All components committed to the database are displayed if they reside within the boundaries of the spatial area regardless of the discipline that "owns" the component. This concurrent modeling environment minimizes interferences as the plant layout design progresses.

C. Document Management System

The Document Management System (DMS) is used for review, approval and control of all documents produced by project personnel. The DMS provides an easy way to electronically store, manage, review/comment, change, approve and distribute drawings and documents.
It provides document imaging capabilities with integration of data from computer-aided design (CAD), word processing, database spreadsheet, and other critical applications. These functions dramatically improve the design and construction work flow processes reducing the review, change, approval and distribution processes.

The DMS performs a critical role in facilitating project work processes or work flow. All formal documents, drawings and correspondence are maintained in the DMS "vault". "Work-in Progress" for a new revision is controlled by the DMS until formal approval is achieved. Once the document is approved, it will replace the current revision as the new revision. Earlier revisions will be archived to an optical disk system with revision control and revision tracking. A user is capable of reviewing the revision history of any document at any time.

D. Project Work Flow

Electronic Mail

Lotus Notes® provides the Project team with electronic mail to all sites. The document and drawing review, comment, approval and distribution processes are facilitated from the DMS through Lotus Notes.

Traceability

A traceability module defines component, attribute, and document relationships. This module provides applications to identify the associated dependencies and relationships between plant information and plant documents. For example, when a user defines the line pressure from the database as input to a calculation, and the result is then described in a specification, these dependent relationships are recorded by the traceability module. If, at a later date, a study is required on the effects of a proposed pressure change on the line, the user can query the traceability module for all documents, calculations, and plant data that might be affected by the change.

Configuration Management

The IMS provides many applications and functions that both automate and facilitate the many configuration management requirements within the engineering and construction processes. The IMS provides data security by defining who can view or change data. In addition, capability is provided to permit independent review of data and to create multiple versions of design data. All data versions are recallable and reports are linked to the data version that are their source of information.

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VI. SUMMARY

Clearly, commercial nuclear power plant owners require efficient methods to store, access, and modify plant information throughout the life of their plant. A nuclear power plant's life begins with the design phase and continues until the plant is decommissioned. Throughout the multiple decades of a plant's life, there is a constant need to ensure its licensing basis is maintained and the plant is operated as efficiently as possible. The information required to achieve those goals must be created and managed in an efficient, systematic manner from initial plant design throughout the plant's life time. The IMS design described in this paper provides efficient means to do this. The IMS is used by the designer, constructor, and ultimately the owner/operator to assist in meeting the plant operation and maintenance information needs. Delivered at plant turnover, it includes the complete plant design, construction history, and functions necessary to support plant information management throughout the remainder of the plant's life cycle.

REFERENCES

EPRI Advanced Light Water Reactor Utility Requirements Document, Volume II, ALWR Evolutionary Plant, Chapter 1—Overall Requirements, Section 11.12 - Information Management System, revision 6, 12/93

EPRI Report NP-5159, "Guidelines for Specifying Integrated Computer-Aided-Engineering Applications for Electric Power Plants" Final Report; May 1987.

KEY WORDS

System 80+, Information Management System, Computer Aided Engineering, Document Management System, Engineering Database.

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