EPRI

AIMS Architectural System Description and Implementation Plan

Technical Report

AIMS Architectural System Description and Implementation Plan

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Technical Progress Report, November 2001

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REPORT SUMMARY

This report describes progress made in EPRI's support of information technology for advanced nuclear plants (ANPs). The high-level architecture for an Advanced Information Management System (AIMS) is defined and described based on design requirements and future life-cycle needs for AP1000, a power uprate for the AP600 nuclear plant design certified under 10 CFR Part 52.

Background

Duke Engineering & Services (DE&S) and Westinghouse Electric Company Nuclear Systems, in cooperation with EPRI, are researching use of a commercially available Collaborative Product Commerce (CPC) System to act as the backbone of an Advanced Information Management System (AIMS). CPC solutions are built on a Web architecture where all project personnel at various locations as well as customers and suppliers can work together and exchange information. With CPC infrastructure, AIMS supports successful licensing, construction, and operation of ANPs by providing the means to acqEuire, store, retrieve, and manage data, analyses, documents, and data relationships over the full life cycle of a nuclear power plant. Fundamental to new advanced nuclear plants are the related issues of avoiding rework and waste, meeting safety goals, and maintaining the regulator's confidence. AIMS has a role in not only managing operations and maintenance expenditures for advanced nuclear plants, but most importantly ensuring that the nuclear asset is maintained in a manner that meets regulatory requirements at all times.

Objective

To provide an overall description of the AIMS implementation for Westinghouse’s AP1000 advanced nuclear power plant.

Approach

The project team outlined requirements for the AIMS system to provide a guideline for planning its implementation. The team’s work represents a significant extension of prior AIMS work, which provided a proof of principle in a stand-alone environment, focusing on one process with a limited data set. The team intended this iteration of AIMS to be implemented within the larger information technology infrastructure currently used by Westinghouse. Consequently, the team examined substantial new areas of software architecture and data exchange. Work was conducted primarily through a series of workshops to first develop the architectural system description and then the implementation plan.

Results

The architectural system description and implementation plan for AIMS includes a high-level architectural structure of the proposed solution for AP1000, referencing all key systems that will be included in or integrated with AIMS. It also identifies high-level actions for implementation and a phased execution approach. The document outlines what key systems are new, existing, modified, or replaced in the defined solution and when and how those actions will be accomplished. Among other items, this document describes functional integration among key systems, data flow/control within and between key systems, and the phased implementation approach.

EPRI Perspective

Implementation of AIMS will be conducted in a phased approach. This approach reflects the dual needs of not adversely impacting the ongoing AP1000 design and licensing activities while also providing experience for Westinghouse personnel as they work within an enterprise-wide architecture. This aspect of AIMS was untested in the previous proof of principal.

Keywords

Advanced nuclear plants
Collaborative product commerce system
Document management system
Enterprise resource planning system
Plant design system

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INTRODUCTION

1.1 Purpose

Duke Engineering & Services (DE&S) and Westinghouse Electric Company Nuclear Systems, in cooperation with the Electric Power Research Institute (EPRI), are researching the use of commercially available Collaborative Product Commerce (CPC) System[1] to act as the backbone of an Advanced Information Management System (AIMS). The purpose of this document is to provide an overall description of the AIMS Implementation for Westinghouse' AP1000 Advanced Nuclear Power Plant (ANP). The AP1000 ANP is being developed based on the earlier work, which resulted in US Nuclear Regulatory Commission Certification of the AP600 ANP.

The purpose of AIMS is to support the successful licensing, construction and operation of advanced nuclear plants. Fundamental to new advanced nuclear plants are the related issues of:

- avoid rework and waste,
- meeting safety goals, and
- maintaining the regulator's confidence.

AIMS has a role in not only managing the operations and maintenance expenditures for advanced nuclear plants, but most importantly ensuring that the nuclear asset is maintained in manner that meets regulatory requirements at all times.

Specifically this description will outline the requirements for the AIMS System in such a manner that it provides a guideline for planning the implementation. The AIMS will provide the means to acquire, store, retrieve and change manage the data, analyses, documents and data relationships over the full life cycle of a nuclear power plant (i.e., design, construction, startup, operation, maintenance and de-commissioning phases). This specification represents a significant extension of the prior AIMS work[2], which provided a proof of principle in a stand-alone environment, focusing on one process with a limited data set. This iteration of the AIMS concept will be implemented within a larger information technology infrastructure currently used by Westinghouse to show the scaling to a full set of plant data, integration with other applications and expansion to a large number of processes. As such, there are substantial new areas of software architecture and data exchange that will be examined in this specification versus the earlier work. The *Windchill* software product provided by PTC, Inc. has been selected by WEC for the CPC application

Implementation of AIMS will be conducted in a phased approach described in a Section 6 of this document. The phased approach reflects the dual needs of not adversely impacting the ongoing AP1000 design and licensing activities while also providing experience building for the Westinghouse personnel as they deploy within an enterprise wide architecture. This aspect of AIMS deployment was untested in the previous proof of principal.

1.2 Scope

The Architectural System Description and Implementation Plan for AIMS includes a high level architectural structure of the proposed solution for AP1000, referencing all key systems that will be included in, or integrated with AIMS. Additionally it identifies high level actions for implementation and a phased execution approach. This document will outline what key systems are new, existing, modified, or replaced in the defined solution and when and how those actions will accomplished. Among other items, this document will describe:

- Functional integration among key systems
- Data Flow/Control within and between the key systems.
- Phased implementation Approach

1.3 AP600 and AP1000

Westinghouse is currently in the process of up rating the capacity of a licensed Advanced Nuclear Plant AP600 from 600 MWe to at least 1000 MWe. Although the AP600 design met industry technical and cost objectives defined in EPRI ALWR Utility Requirements Document, the cost environment of electrical generation has significantly changed over the last decade. Original ALWR targets were < 4.3 cents/kW-hr. while the current target is < 3.0 cents/kW-hr. The AP1000 will meet the current target through increasing the plant power rating as previously stated. The AP1000 is a logical extension and scaling of the design & licensing bases developed for the AP600. Westinghouse has undergone an assessment of the AP600 Design Control Documents (DCD) indicating that near 80% of the DCD will be unchanged not withstanding the name change from AP600 to AP1000.

The design of AP600 used information and CAD systems circa 1990. Specifically the plant design was modeled using Intergraph PDS with an associated Oracle Database and linked with standalone Microsoft Access databases in a client server architecture. With the emergence of web based technologies and commercially available integrated engineering packages, it is apparent that there advantages to upgrading the information technology systems for AP1000.

1.4 AIMS Background

The need for accurate and efficient control of a nuclear power plant's configuration has been made evident from both a regulatory and a business perspective over the last decade and a half[3]. During construction and through the operating and maintenance phases of the plants life, modifications to the plant are made; new regulatory requirements come into effect etc. These

changes must be identified and reviewed to ensure that the License Bases of the plant are not changed.

Traditional hard copy or imaged format based configuration management systems have had a significant negative impact on the costs and quality of operations for present day nuclear facilities. The document management focus of these systems and the inherently complex implied and overt relationships between License/Design Bases data have been an issue. Many plant owners have been prompted to respond by adding layers of programs to augment control and understanding of the original design along with additional staff to manage the layers, often without improving the plant information bases.

The ALWR Utility Requirements Document first specified the requirements from a plant owner's perspective in terms of then current technologies in 1987[4]. The needs to assure quality and cost objectives for the plant owner have become more acute as events; insights, regulatory oversight and time have progressed. Technology has progressed at a rapid pace over the last decade and a half. Key technologies have been developed and commercialized which simplify and reduce the overall cost of developing and maintaining such an IMS. The birth and maturation of the Internet, object oriented architectures and web enabling of data management tools to name a few.

A study by EPRI successfully demonstrated a proof of approach for the management of License Bases for Advanced Nuclear Plants[5]. This study was carried out using web enabled Commercial Off The Shelf (COTS) PDMS software as the backbone of the system and was loaded with approximately 6,600 files of varying formats i.e. drawings (image files), and documents in varying formats. A dual search engine (native PDMS and CCM) was employed in order to demonstrate the ability to retrieve all pertinent documents and files for a given search criteria. In addition, the 10 CFR 50.59 Review Process was modeled and demonstrated for a proposed plant modification. The proof of approach was deemed highly successful (see the project report for additional detail).

1.5 Approach

The work was conducted primarily through a series of workshops to first develop the Architectural System Description, and then the Implementation plan. The workshops were:

1. Introduction and planning
2. Requirements
3. Existing System review
4. Interfaces and Integration
5. Process
6. Implementation
7. Review and Wrap up

The approach to the development of the AIMS Architectural System Description and Implementation Plan is illustrated in Figure 1-1.

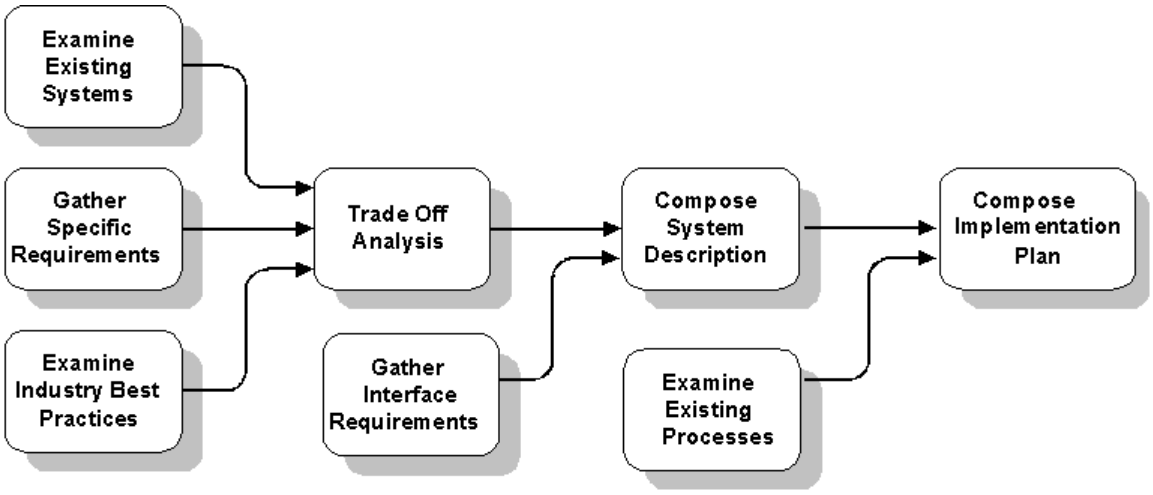

Figure 1-1
Architectural System Description and Implementation Plan Approach

Specific elements in developing the document are described below:

1. Examine Existing Systems - AP600 legacy systems were first examined at a level of detail granular enough to determine its fitness for inclusion or exclusion and replacement in the overall solution.

2. Gather Specific Requirements - Specific plant design requirements were gathered and filtered into the overall solution. These requirements have a strong influence on the strength of the overall solution as the plant design and license bases as well as data relationships and workflows are first established here.

3. Examine Industry Best Practices – Evaluation of other industries by a related Department of Energy project for the reduction of plant construction time and capital cost has identified that large assembly operations have many similar characteristics as do nuclear power plant construction sites[6]. The level of complexity is similar, the total capital costs are similar and the need to bring all the major components together at a single site is the same. While a power plant construction site may differ in appearance from a shipyard or aircraft manufacturing environment, there are the similarities of massive operations being performed repeatedly to produce a product.[7] Thus, there are a number of best practices to be observed from these other industrial settings.

4. Trade Off Analysis – Output from steps 1 through 3 were examined and weighed. Tradeoffs will be made which tend to strengthen the overall solution.

5. Compose System Description – As a result of the trade off decisions, the system description document was completed through a series of iterations.

6. Examine Existing Processes – AP600 processes were studied to identify major functional requirements. The key objective was to verify that the planned design of AIMS would support these established industry practices.

7. Compose Implementation Plan - An implementation plan was developed that balances the needs of the users with the technical requirements of the software. In order to provide frequent milestones and facilitate risk management, seven separate phases are envisioned.

1.6 Acronyms

ALWR – Advanced Light Water Reactor

ANP – Advanced Nuclear Plant

CPC – Collaborative Product Commerce

EPRI – Electric Power Research Institute

MWe – Megawatts Electric

PDMS – Product Data Management System

PIN – Plant Information Network

WEC – Westinghouse Electric Company

2
AIMS REQUIREMENTS

The following requirements were gathered during phase 3-1 of the AIMS implementation project. It is expected that these requirements will be refined during subsequent phases.

2.1 General Requirements

The AP1000 AIMS shall:

- Apply current information technologies (such as Product Data Management (PDM) and Collaborative Product Commerce (CPC)) to support the design and supply, construction, operation and maintenance and decommissioning of the plant. The management of the information, data and application programs shall be consistent with the functions identified in Chapter 1, Section 11, Attachments 1 and 2 of Volumes II and III of the Utility Requirements Document (URD).
- Appear to the user as single "logical" database, although it may be composed of multiple physical databases.
- Accommodate different forms of plant-information, including tabular data, CAD files, text, images, and other forms of information like video and audio that may be developed during the life of the plant.
- Be built upon industry standards to support migration of underlying data and relationships as technology and product offers evolve.
- Protect the value of the underlying data by ensuring that suitable standards are imposed to allow for the migration of data as the system evolves.

2.2 Design Production Upgrade Requirements

The AP1000 AIMS shall:

- Support the design and licensing activities of the AP1000 providing a unified and integrated information source. This should be accomplished through the migration of certain existing AP600 information sources to AIMS and interface and integration of other information sources with AIMS. Specifically, AIMS should assist the effort of review, modification and/or upgrading of the approximately 27,000 AP600 legacy documents.
- Alleviate existing process complexities avoiding the necessity for duplication of data entry in multiple data bases (correspondence database, technical document database, EDMS 2000 4i

document management database, design change control database, drawings, SSAR reference database)

- Simplify navigation to the desired data input screen in a manner easily understood by the user.
- Revise data input screen design to include all the required information for the particular entity. This is to avoid problems such as: The valve specification sheet is used as the input screen to populate the valve database but all the valve database information cannot be entered from this screen. Other information about the valve is on other input screens. Therefore, the particular component database is distributed among various input screens.
- Ensure output document formats (reports) are not used as data input screens.

2.3 Configuration Management Requirements

The AP1000 AIMS shall:

- Provide the means to ensure all representations of data – schematics, 3D models, drawings, and document types – specifications, performance data, correspondence, calculations, analysis codes etc. are synchronized throughout each of the plants' lifecycles.
- Permit the management of all project-related information, including electronic files, paper files, and database records, through the entire lifecycle of a project.
- Provide efficient, controlled, and automated access to development and production applications and processes and to the related documents and data.
- Allow project files to be centrally controlled, but be physically distributed.
- Allow separate business units within a project (or among client/vendors) to operate independently while participating in each other's business processes when required.
- Allow the management of a plant configuration across multiple engineering, manufacturing, and supplier and customer locations.
- Support data security measures to allow for authorized access to information.
- Satisfy the need to control who changes plant parameters and know how and where the plant parameters are used.

2.4 System Integration and Interface Requirements

The AP1000 AIMS shall provide modular interfaces to application program modules as to allow the addition and replacement of application programs with minimal development of custom interface programs.

2.4.1 Plant Design System

The AP1000 AIMS shall:

- Provide the means to interface/integrate with the schematic and 3D arrangement representations of the AP1000 throughout each of the plants lifecycles.
- Allow the project flexibility in defining the locations where design and review activities will take place.
- Provide the ability to capture and retrieve material specifications with a high degree of accuracy and control.

2.4.2 Plant Documentation System

The AP1000 AIMS shall:

- Support electronic approvals to allow managed electronic view and approval of plant data and other information through various release levels.
- Support document markup capabilities to allow for electronic comment on the design and other data thus insuring data can be viewed by all members of the team, as needed.
- Support identification of the objects defining business units and non-unique external names across business units.

2.4.3 Project Management System

The AP1000 AIMS shall provide for bi-directional communication between Windchill and the project management system. Activity planned start and completion requirements shall be read from the project management system by AP1000 AIMS and actual activity start and completion status shall be transmitted to the project management system.

2.4.4 Enterprise Resource Planning System

The AP1000 AIMS shall provide for bi-directional communication between Windchill and the enterprise resource planning system.

2.4.5 MS Access Databases

The AP1000 AIMS shall:

- Provide the means to incorporate data now contained in a series of Microsoft Access Databases.
- Prevent duplication of data entry in its database (i.e., correspondence database, technical document database, EDMS 2000 database, design change control database, drawings, SSAR reference database)

- Address the following problems in the current design:
  - No linkage from "search" database (such as Correspondence Tracking System or Technical Document Control) to the copy of the document (in EDMS 2000)
  - Each system has its own primary key that is manually entered
  - Attachments are not referenced to original document
  - Automate metadata entry of documents not provided
  - No batch import or loading from user (load from engineering database exists and is used)
  - The user interface can not be configured to cut/paste/copy data and/or batch load the same information about different components.
  - All of the separate "database environments" are not linked (some are linked).
  - Forwards and backwards requirement traceability is not available electronically.
  - All referenced documents are not accessible.

2.4.6 Communications Systems

The AP1000 AIMS shall provide the means to interface/integrate with the two native email systems in use by all participants – Microsoft Exchange and Lotus Notes.

2.5 Collaboration Requirements

The AP1000 AIMS shall:

- Integrate applications across many users and allow people who are geographically dispersed to work together.
- Share data and release information with a variety of other business enablers (especially CAD/CAM/CAE, DMS, Parts Classification and MRP/ERP) independent of file format.
- Allow a business unit that is responsible for a portion of a final product to keep other units up-to-date with respect to changes to the plant definition.

2.5.1 NRC Interaction

The AP1000 AIMS shall:

- Provide a means by which to interact with the NRC for AP1000 licensing activities. NRC access to AIMS would be limited to specific data only – to be defined.
- Permit electronic retrieval of licensing/external commitments and bases – for example, a means is needed to catalog, track, keyword search, and retrieve NRC originated Requests for Additional Information (RAIs) and their responses.

2.5.2 Supplier/Customer Interaction

The AP1000 AIMS shall:

- Provide the means by which to collaborate with external suppliers/constructors and future customers during the construction phases of the plant as well as ongoing consulting and problem resolution during operation and maintenance phases.
- Provide, with each plant sold, a complete AIMS file for each power plant, including documents provided by vendors as well as by WENS, will be. Owners will have access to their AIMS file but not to Westinghouse's archives.

2.6 Comprehensive Document Search/Archival Requirements

The AP1000 AIMS shall provide the means to search for documents in both in the AIMS plant document management system and the Westinghouse corporate document management system (EDMS 2000).

2.6.1 Search Function

The AP1000 AIMS search function shall:

- Accurately display to the user all files, their location, and affected text that meets the search criteria.
- Find the information independent of file format including drawings, slide presentations, tables, spreadsheets, etc. Including symbolic representations on drawings.
- Eliminate duplicate hits and display results in such a fashion that it is transparent to the user that more than one search engine or database is involved.
- Be able to repeat the original search query prominently on the results pages so that the user will reminded of his original search query. This will be especially helpful if the user desires to refine the search or search within the results.
- Have the ability to save search queries
- Have the ability to specify which servers, directories, or virtual libraries (such as used by Excalibur) to include in the search (within the limits of authorized access to servers/directories).
- Perform all of its basic function on a standard networked desktop PC capable of running Windchill; however, the system will be optimized for use on multiple display systems such as the Panoram 230DSK display device driven by single or preferably multiple PCs.

2.6.2 Search User Interface

The AP1000 AIMS search user interface shall:

- hide complex and exhaustive search technologies behind a front-end that will reduce boredom, improve accuracy, and will not be exhausting to the user.
- consider that end users are not primarily information professionals. There will be no typical end user for AIMS. There will be a spectrum of users ranging from novice to expert that might well include engineers, administrative personnel and information professionals.
- be capable of meeting the needs of all users by providing several search options including crisp Boolean, pattern and concept.
- have an HTML front end (or other language suitable for a thin client web based application).
- On each result page, show the total number of hits. Each hit should be numbered.
- include the ability to start a new search on every result page, search within the present hit list, and revise the current search strategy without reentering the search string.
- display the search results as hyperlinks listed in order of relevance, with a brief summary of the metadata of the document.
- open the document in the browser when a document is selected from the hit list through the use of plug-ins or viewers. For unsupported file types or when browser plug-ins are not available the document should be launched in its native application.
- display the search query, wizards on a separate window while Windchill continues to run in its window.

2.7 Workflow Requirements

The AP1000 AIMS shall:

- Provide a common platform for managing data for all its data and workflows in other Westinghouse systems such as EDMS 2000 and WORKM.
- Provide a suite of defined business processes for managing plant configurations and their changes. These should include:
  - Communicating a request or a problem;
  - Identifying and tracking work to be performed;
  - Reviewing deliverables prior to releasing a portion of the plant configuration;
  - Releasing and distributing and retrieving relevant information to and from other systems.

2.8 System Scalability

The AP1000 AIMS shall be capable of rapid deployment to new locations and expansion as the business grows.

2.9 System Adaptability

The AP1000 AIMS shall:

- Provide that the application programs and information required to support design activities that are capable of being transferred to the plant owner, including a complete package of computerized data which provides a physical and engineering model and those functions required to support plant modifications.
- Application programs and information for design activities that are not required to support plant turnover shall be able to be isolated from the turnover package.
- Provide a flexible model for representation of parts, plant configurations and related documents and data.

3
WESTINGHOUSE EXISTING SYSTEMS

The following sections describe the key system components currently in place at Westinghouse supporting the design/analysis, documentation, planning and collaboration requirements of the AP600/1000 effort.

3.1 Plant Design System

The plant design system currently in place uses the Intergraph PDS system described in Section 3.1.1 working in conjunction with a series of Microsoft Access Technical Databases described in Section 3.1.2. PDS holds the Westinghouse specific base data of the components in Oracle. The Microsoft Access technical databases hold extended data about each component. The Microsoft Access databases are periodically updated (synchronized) via a unidirectional transfer of data from PDS' underlying Oracle database. Figure 3-1 illustrates the current relationships.

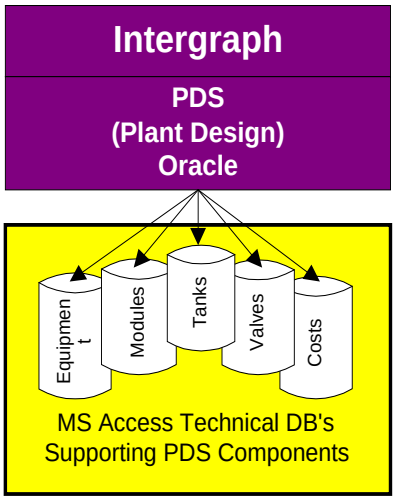

Figure 3-1
Technical Databases Updated From Intergraph PDS

3.1.1 Intergraph PDS System

The Intergraph System is composed of a number of separate software modules. The system has a wide variety of multi-discipline modeling tools in both the 2D Schematic and drawing realm as well as the 3D plant arrangement realm. Many of the 2D applications integrate with each other

and the corresponding 3D model. The following lists the application specific packages currently in use at Westinghouse:

2D Realm (Schematic)

- PDS Process Flow Diagrams (PFDs)
- Multi-Discipline Model
- PDS Piping & Instrumentation Diagrams (P&IDs)
- PDS Instrumentation
- Wireworks

3D Realm (Arrangement)

- PDS
- Smart Plant

4D Realm (Time Phasing)

- Smart Plant

The Modeling tools listed above are supported by an underlying Oracle Database, containing non-graphical attribute information linked through ODBC for periodic updates of the Microsoft Access Technical Databases described in Section 3.1.2. The Smart Plant package links the construction schedule as entered in the Primavera project management tool with the 3D Plant model & module representations in a time dependent manner to yield a 4D Plant construction build sequence. MicroStation is used to generate discipline based design, arrangement and construction drawings from the 3D model and for importing drawings from external suppliers and partners.

The overall 3D plant mockup is assembled from a number of separate model files broken down by plant area. These models contain discipline specific entities – equipment, piping and in-line components, HVAC and in-line components, electrical raceways, structural steel, concrete etc. Each item receives a number of default attributes as it is placed such as the library symbol from which it is derived, spatial coordinates, the area model to which it belongs, etc. Additional attributes are associated after placement such as the tag number uniquely identifying instances of like items.

3.1.2 MS Access Technical Databases

The Microsoft Access Technical Databases contain detailed information defining all components called for in the design process. Each database represents a family/category of components such as Tanks, Valves etc. Each component defined in any of these databases has two elements:

- Data used and supplied by PDS and refreshed via the Intergraph Object Model (Oracle), and
- Data entered through Microsoft Access data entry screens.

The data supplied by a download from PDS represents component/part data, Westinghouse specific, used for design modeling, component identification, etc. The data entered using the data entry screens, in Microsoft Access, represents extended information relating to external equipment suppliers, identification codes, etc. which does not exist in the Intergraph Object Model. Information is both catalogued and retrieved under the Westinghouse AP600 Numbering System.

3.2 Plant Documentation System

The AP1000 Plant documentation system currently in place involves Microsoft Access databases (described in Section 3.2.2) for tracking metadata and the Westinghouse corporate document management system, EDMS 2000 (described in Section 3.2.1). EDMS 2000 functions as the Westinghouse corporate document archive. The Microsoft Access databases hold extended data about each document allowing it to function as the plant documentation system as shown in Figure 3-2. The key for linking data between EDMS 2000 and the Microsoft Access Databases is the CAT ID number. The Westinghouse AP600 numbering system is utilized for the cataloging and retrieval of information in the Microsoft Access databases as described in Section 3.5.

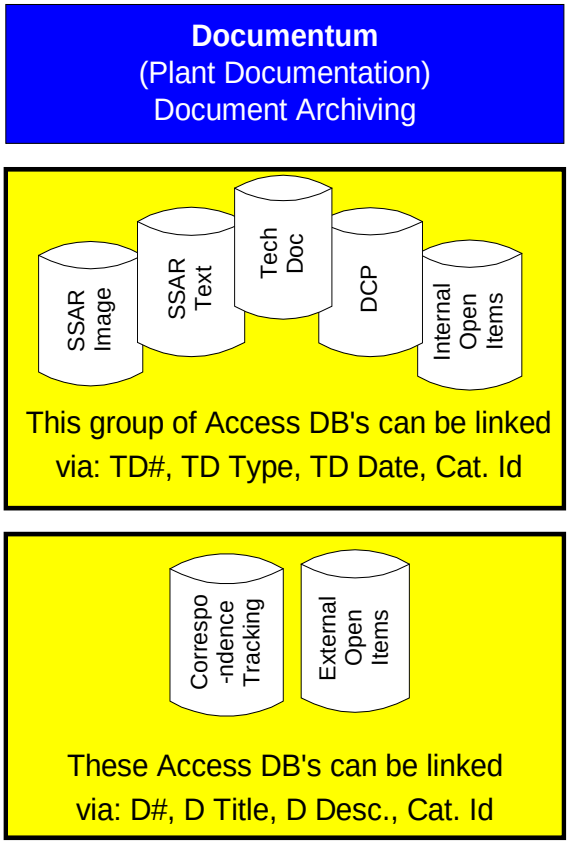

Figure 3-2
Databases of Document Information

3.2.1 EDMS 2000

EDMS 2000 is the repository for all Westinghouse documents and currently houses approximately 27,000 AP600 documents. Users are creating many of the AP1000 documents by retrieving similar AP600 documents from the EDMS 2000 archive and modifying and renaming them. Once an AP1000 document is released, it is archived in EDMS 2000, and must be accessible by other members of the WEC staff who do not have access to AIMS. Specific paper based workflows have been developed to assist in ongoing change management of those documentation sets. This requires independent queries of the access data base using a plant numbering system and EDMS 2000 documents which are catalogued and retrieved under a CAT ID number.

3.2.2 MS Access Administrative Databases

The Microsoft Access Administrative Databases administers the metadata for all documentation, pertaining to the specification, design and safety reporting, as it relates to the AP600 power plant. Relationships between the databases are shown in Figure 3-3.

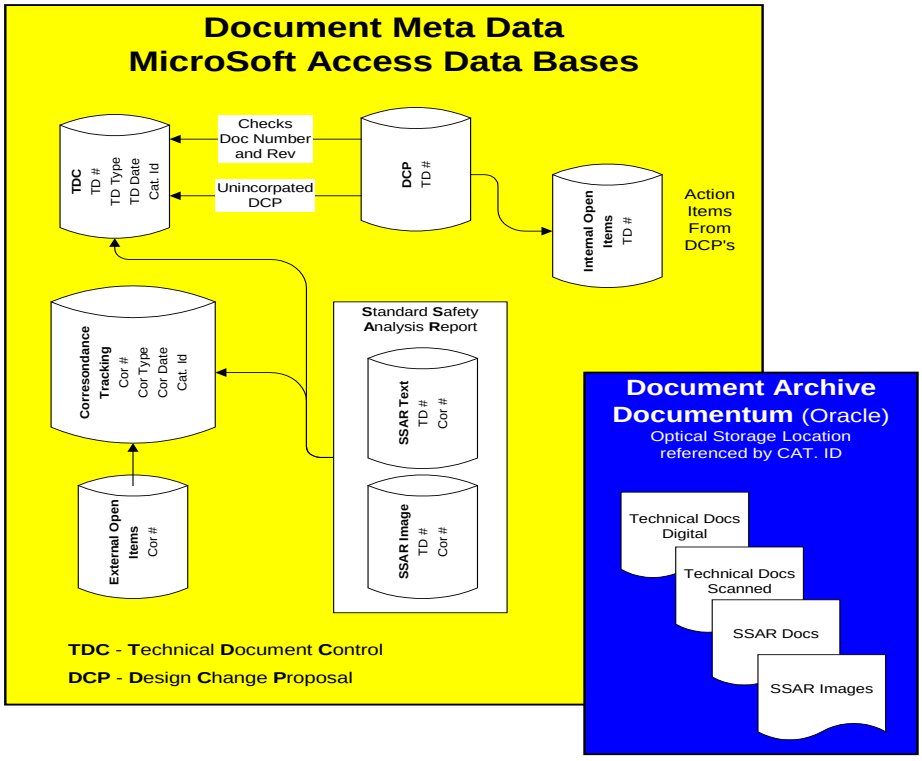

Figure 3-3
MS Access Databases and Document Metadata Management System

The "Technical Document Control" (TDC) Database manages documents, both digital and physical, after document control numbers have been assigned from a catalog. Document revision codes are managed by the TDC Database, however the "Design Change Proposal" (DCP)

Database manages and qualifies the nature of the revision and approval of the revision. The DCP system also contains methods that validate the revisions against which the “Change Proposals” apply to. As the documents proceed through the change process the “Internal Open Items” Database tracks those documents that are yet to be acted on. The Correspondence Tracking Database manages issues (correspondence) with entities outside of Westinghouse via the "Corr" number; the key entity being the NRC. The closure of external issues is managed, via the "Corr" number, by the “Open External Items” Database.

3.2.3 Database Concerns

After a review by Westinghouse specialists the following observations were noted concerning the current state of the system and will have to be addressed in the AIMS implementation:

- Documentation relating to the data structure, code, etc. is inadequate;
- Duplicate information is stored in the various database files;
- There is no referential integrity at the database level
- Table data (typing) is not consistent throughout the many database tables
- There are no entity relationships defined at the database level
- There is no easy way to determine corresponding database table for a link table

3.3 Project Management System

The AP600 / AP1000 Project Construction Schedule is currently contained in Primavera. This project management tool will be used to manage the Work Breakdown Structure (WBS) for the AP600/1000 engineering, fabrication and construction schedules. The PDS Application “SmartPlant” has been utilized to link 3D model data elements contained in PDS to the construction schedule as contained in Primavera. This provides a time phased visualization (i.e., 4D) of plant construction sequencing[8].

3.4 Communications Systems

Westinghouse is currently utilizing both Microsoft Outlook (MS Exchange) and Lotus Notes as electronic mail systems. It is assumed at a minimum that Windchill workflows will provide notification to responsible personnel of active tasks requiring their attention in the native email system as well as other notifications not requiring active participation. Communication systems used by other parties will be determined as part of the fact finding portion of this work.

3.5 AP600 Numbering System

Westinghouse currently uses a significant numbering system to tie all plant related information sources together. The system provides the keys for all current information source data searches. It spans the plant and project and is additionally used by all design agents. The system provides

control for all component numbering (things), document numbering (paper) and account coding (project control). It has been assumed, due to its widespread use and understanding, that the numbering system will be retained for the AP1000. Reference 4 describes this numbering system in greater detail. A view of the numbering systems reach into the existing AP600 data sources is shown in Figure 3-4.

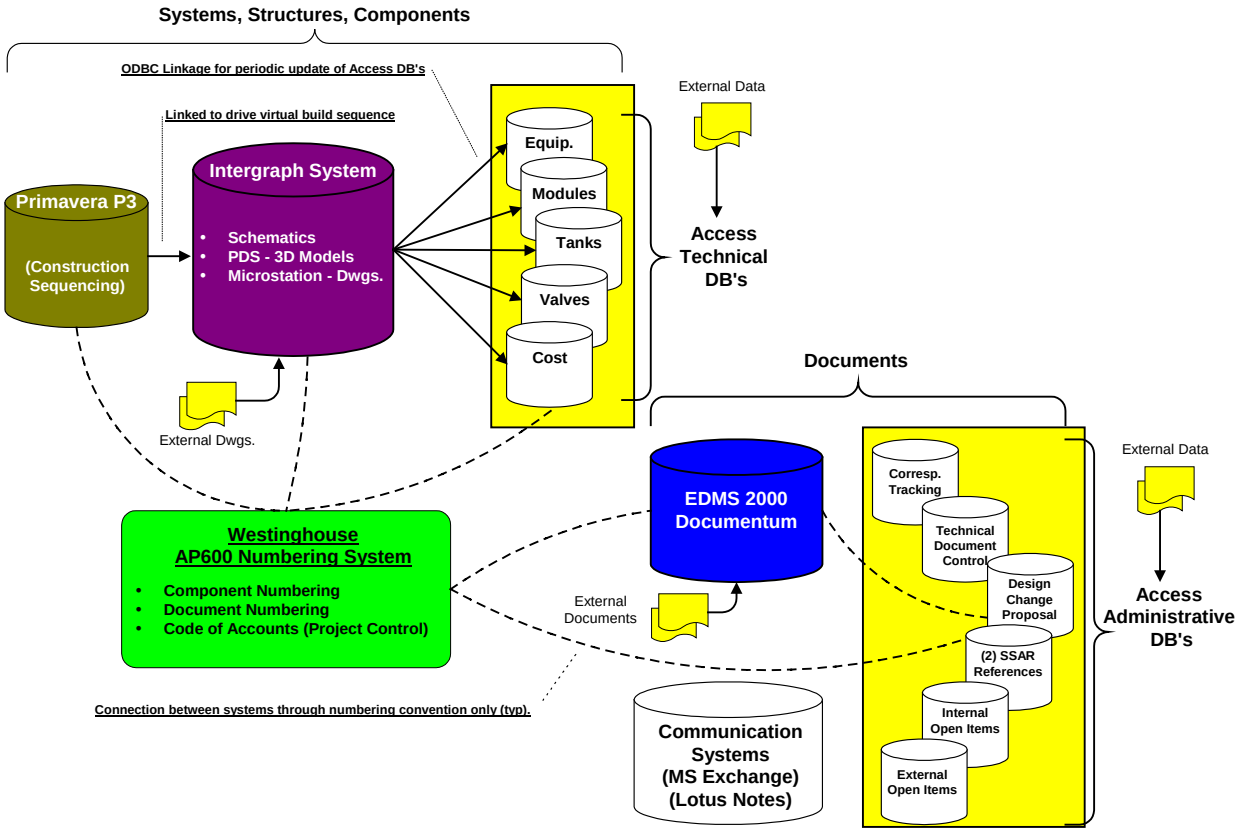

Figure 3-4
AP600 Numbering System and Relationships

4
AIMS ARCHITECTURE

The previous phase of the AIMS research concluded that:

“ANPs should consider using a PDMS as a basis for their plant design-related information. The ranges of capabilities, scalability, and flexibility of modern PDMSs appear to make them directly suitable for these applications. In addition, emerging concept searching tools can be used in conjunction with PDMSs to deal with the ambiguity inherent in text information. The twin engine approach also “learns as it goes" by turning recently exercised concepts into key words, thus scaling up its capabilities with ever growing and more complex LBs over the life of the plant.”

The AIMS as envisioned for AP1000 will provide a multi-discipline suite of integrated applications made available using the next generation of PDMS, now being referred to as Collaborative Product Commerce (CPC) Systems, as a backbone. The AIMS will provide a comprehensive view of all plant related data regardless of its lifecycle. From a user perspective all related data is made available in a single logical view gathered from multiple physical files and functionally specific databases.

The AIMS configuration proposed for the AP1000 project will be based on PTC’s Windchill product, selected by WEC. Although this is a different product than that used in the earlier work, the concepts are fully applicable. The Windchill CPC System is an advanced, full function Product Data Management System (PDMS). It has an object oriented, web centric architecture making it well suited to act as the backbone of the planned AIMS. Windchill has production proven capabilities as exemplified in the following areas:

- Configuration Management
- Product Structure Management
- Document Management
- Change Management
- Workflow Modeling & Process Management
- Integration w/ existing engineering and business systems

The general overview of the architecture and relationship of enterprise software is depicted Figure 4-1. Specifically the AIMS implementation rests on a graphical user interface (GUI) which accesses information using search tools embedded in Windchill. All design functions are intended to the modeled and executed in Windchill. Some typical functions have been depicted in the figure as well. Windchill is both a data repository and governing tool, however

information is created or accessed from a number of enterprise systems through a Windchill adapter tool called Info*Engine. Info*Engine is the conduit through which Windchill communicates with the application specific systems requesting and receiving data as needed.

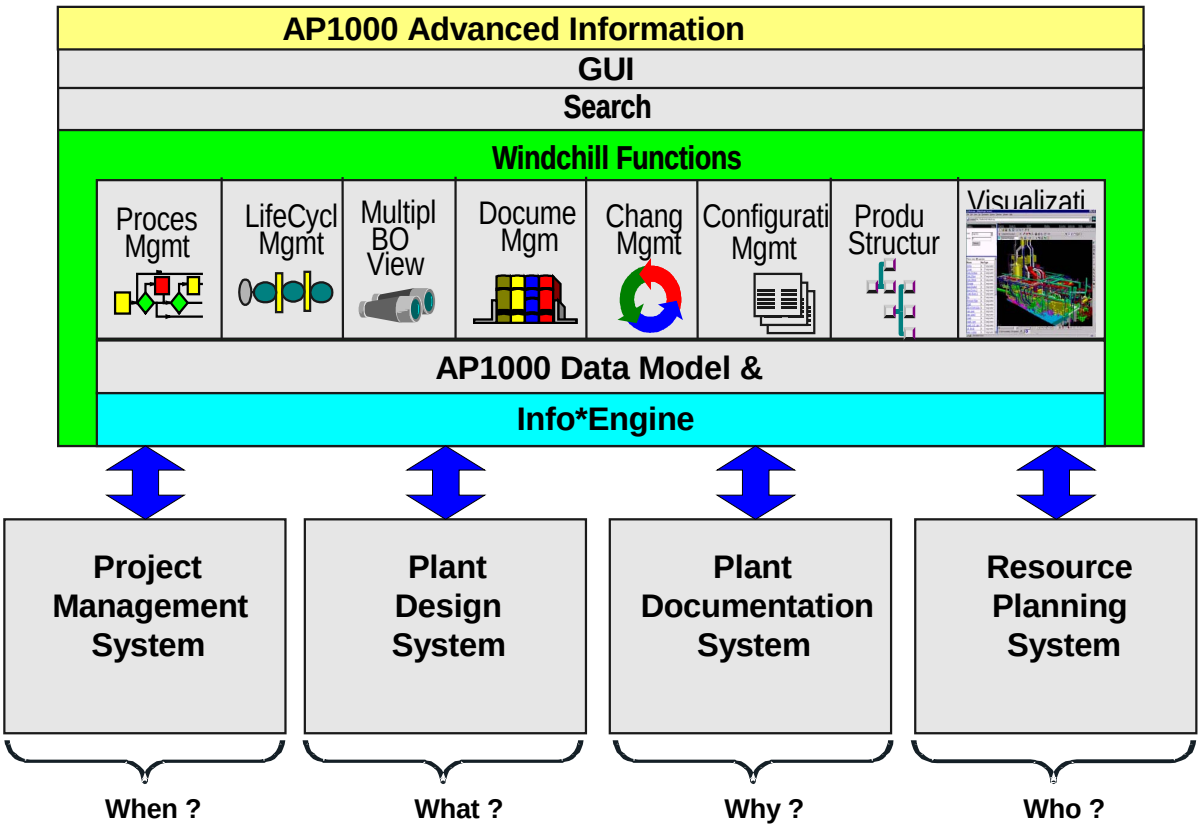

Figure 4-1
General Overview of the AIMS Architecture Envisioned for AP1000

Figure 4-1 illustrates some key points.

- Each of the systems depicted including Windchill are available commercially and are tuned to optimally perform their specific functions.
- Due to the extended operational life (40-60 years) of a Nuclear Plant and its associated data, the AIMS architecture requires the ability for on-line replacement of the key systems from which it is comprised. A plug-and-play architecture has therefore been selected to minimize the risk associated with dependence on any one of these key systems as it is well known that vendors do retire product offerings and newer, more task appropriate packages do become available.
- An Info*Engine adapter provides a commercially available integration to CAD, ERP, PM and DM Systems.

Whereas Figure 4-1 illustrated the general case for the Windchill implementation, Figure 4-2 illustrates specific implementation. The architecture is now shown with the specifics of the Windchill implementation taking into consideration a multi-entity team, Westinghouse's as well

as other team members' legacy computing systems, and the specific design tools now planned for use on AP1000.

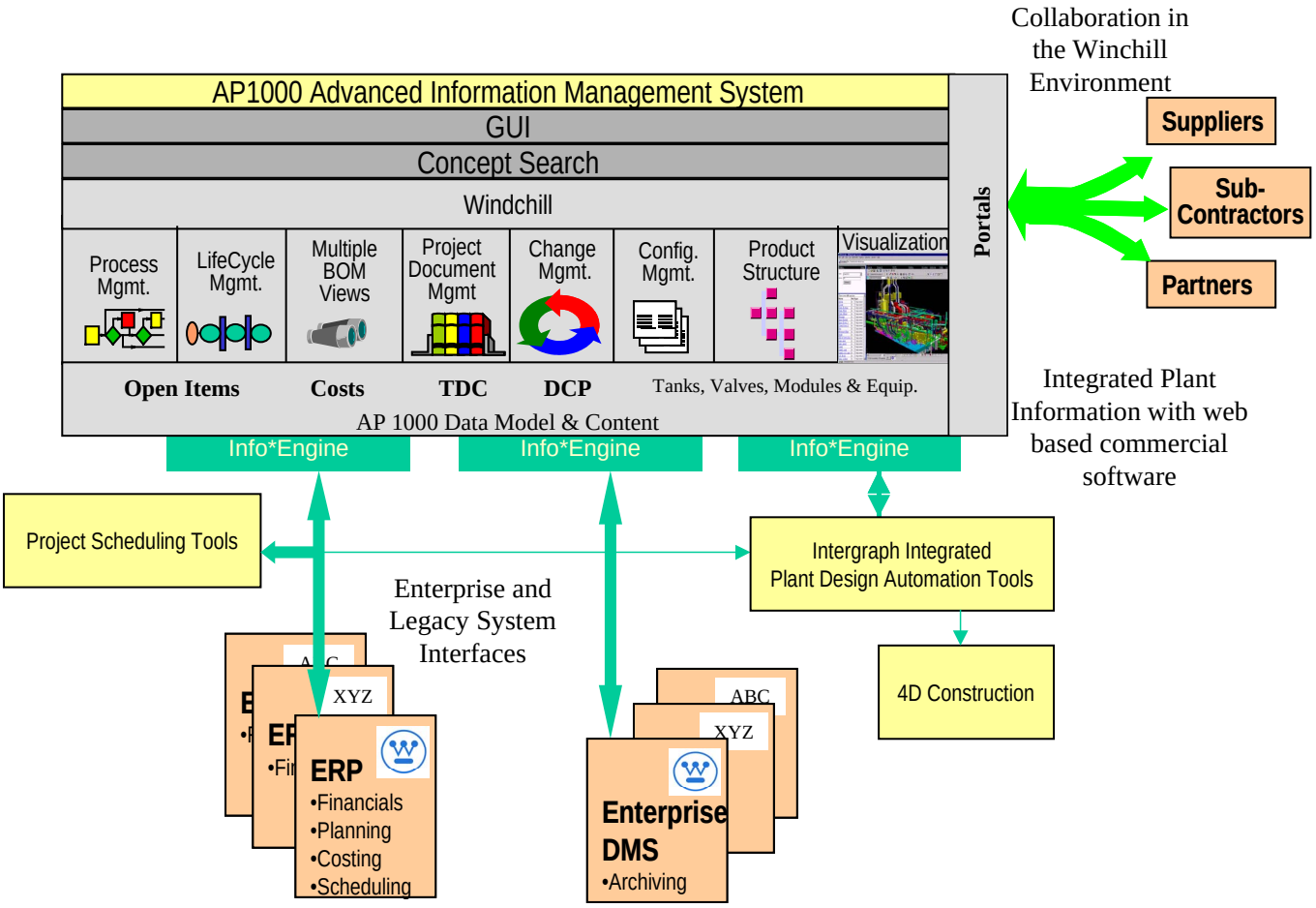

Figure 4-2
Windchill-Based Overview of the AIMS Architecture Envisioned for AP1000

Figure 4-2 builds on the high level concept depicted in Figure 4-1 and illustrates some additional key points:

- The AP1000 project scheduling tool (Primavera) will share WBS data with the Westinghouse corporate ERP system (SAP) for those items which are within Westinghouse' scope
- A key requirement of the AIMS is that of enabling the extended project enterprise. Partners, sub-contractors and suppliers require the ability to collaborate on the evolving plant definition. This is accomplished through web-based portals, which can enable bi-directional access to the data at any level as controlled by the established access rights defined in the AIMS organizational schema.
- As the extended project enterprise is enabled, key team members ERP and DMS integration can be enabled.

Figure 4-3 depicts the recommended architecture of the AIMS solution. Each aspect is detailed in the following sections.

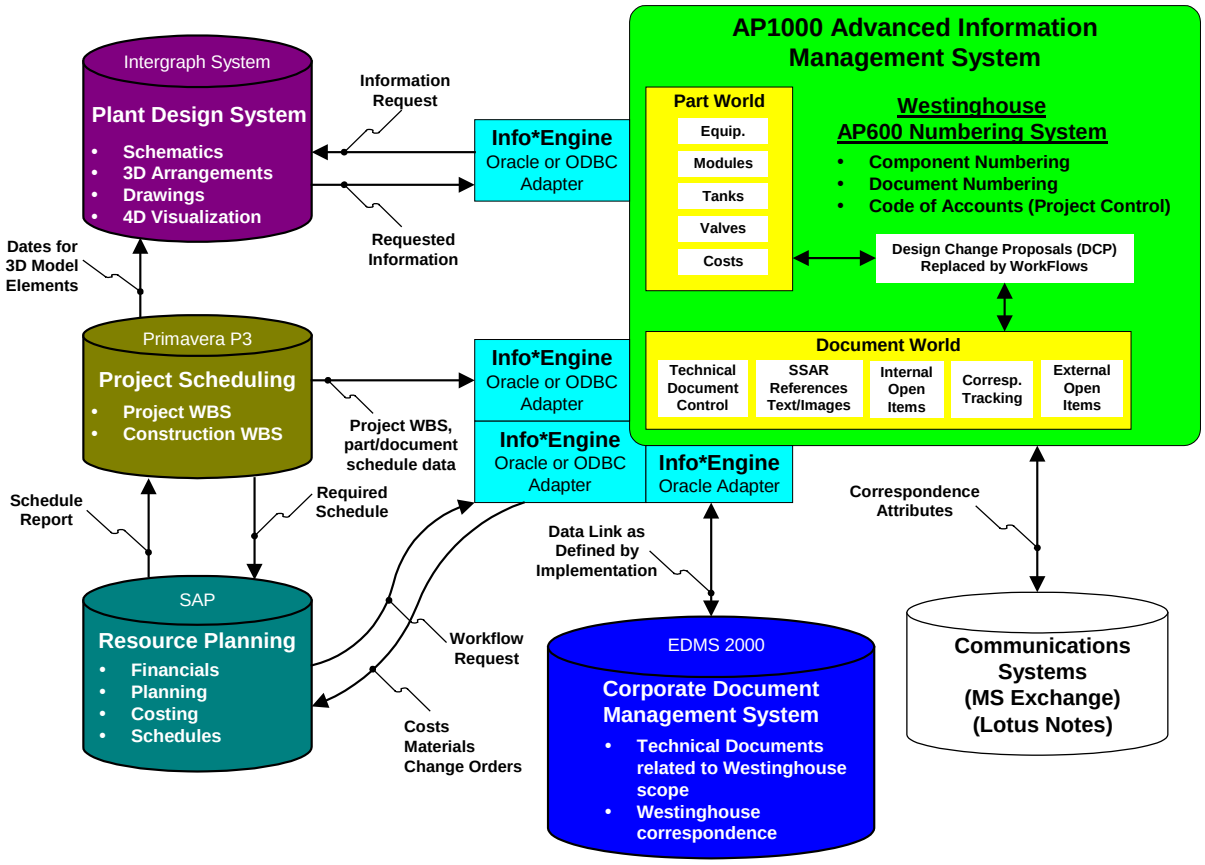

Figure 4-3
Overview of the Recommended AIMS Architecture for AP1000

4.1 Plant Design System

A key aspect of the planned AIMS Implementation is that the Microsoft Access Technical Databases are to be migrated to the Windchill Data Model. This will take advantage of the inherent integration of parts structure, CAD data and documentation afforded by PDMS in general and the Windchill backbone in particular. The intention is to allow for use of the out of the box information management functions and avoid future problems associated with the legacy system as described in Section 2. The extended component information will be stored as attributes with the specific part object instance – Tank123, Valve456 etc. Each of these objects live in the part world of the data model. A more complete data characterization will be assessed upon receipt of the necessary data from both PDS and the Microsoft Access Technical Databases.

Figure 4-4 depicts the recommended integration between the Plant Design System (PDS) and Windchill. The manipulation and reporting of data between the two physical databases using this

architecture will become transparent to the user. The S/W maintenance aspects of this architecture are also favorable.

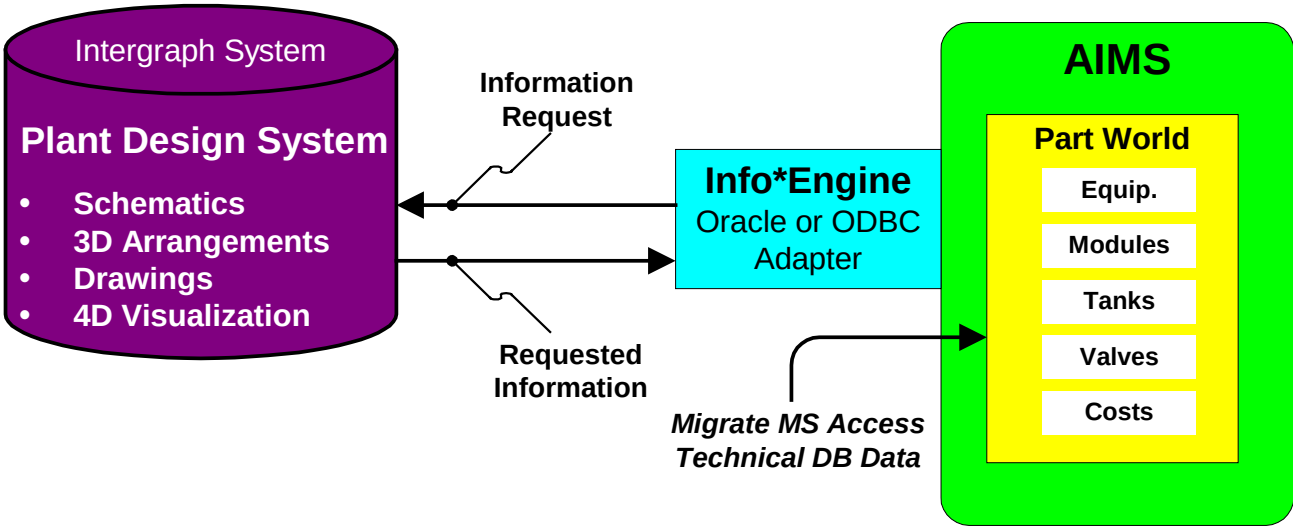

Figure 4-4
Recommended Integration Between the PDS and Windchill

4.2 Plant Documentation System

4.2.1 Document System Interfaces

One of the primary elements of the CPC solution is the integrated document management capability that is provided in a collaborative environment. In AIMS, for the same reasons as is the case for the Technical data bases, the Microsoft Access Administrative Databases which contain the document metadata, will be migrated to the Windchill Data Model. The extended document information will be stored as attributes with the specific document instance – Doc123, Doc456 etc. Each of these objects live in the document world of the data model. The Info* Engine will provide linkage to EDMS 2000 as shown in Figure 4-5.

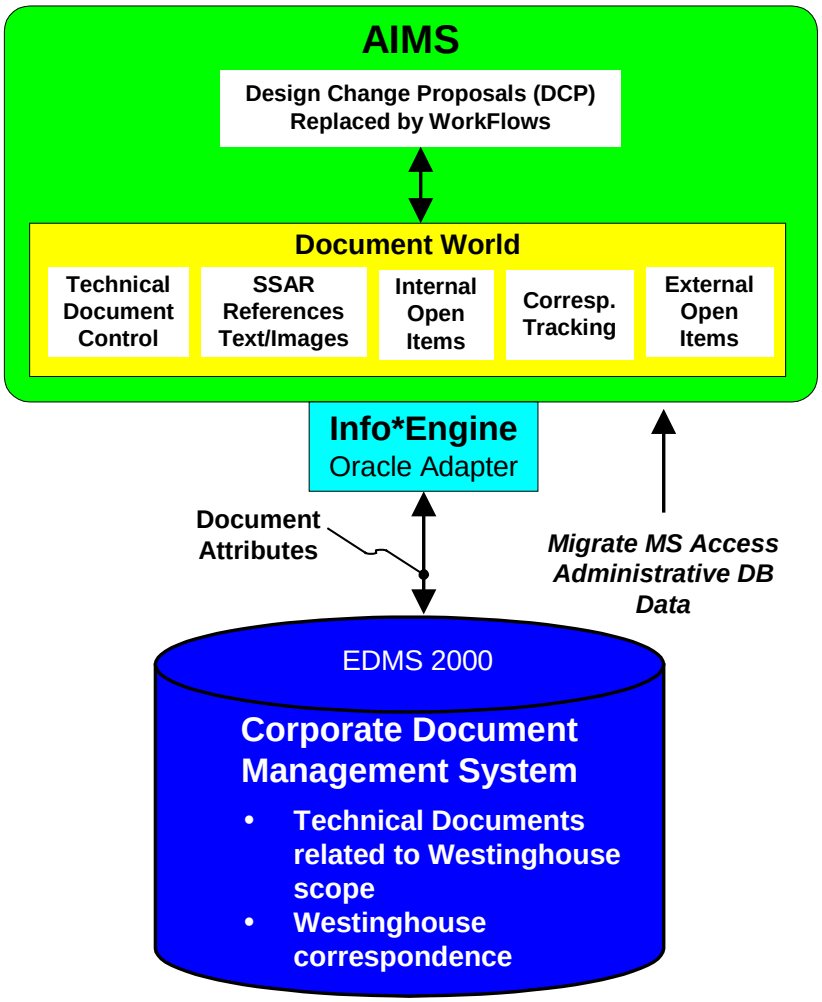

Figure 4-5
Info*Engine Links AIMS To EDMS 2000

Key to the implementation then, is the manner in which AIMS is interfaced with the corporate document management and archive systems of the contributing organizations. In the case of AP1000 and WEC this is EDMS 2000. This interface requires that certain document management functions be distributed across the systems. There are several options with regards to the EDMS 2000 interface which differ in regards to the overall work process and what functions are accomplished in which system. These options are summarized in Table 4-1 and Table 4-2.

Table 4-1
Functions Versus Options

	System for Function		
Document Function	**Option 1**	**Option 2**	**Option 3**
AP600 Metadata	AIMS	AIMS	AIMS
AP600 storage and retrieval	EDMS	EDMS	AIMS
AP1000 creation	AIMS	AIMS	AIMS
AP1000 Metadata	AIMS	AIMS	AIMS
AP1000 storage and version control	EDMS	AIMS	AIMS
AP1000 Search	EDMS	AIMS	AIMS
AP1000 Owner Turnover	EDMS	AIMS	AIMS
WEC Archive	EDMS	EDMS	AIMS

Table 4-2
EDMS 2000 Interface Options

Option Description	Pros	Cons
Option 1 Data Life Cycle managed in/by AIMS TDC migrated to AIMS to enable read-only retrieval of AP600 docs Data Archived in EDMS and AIMS: the two systems are synchronized AP1000 docs stored and version controlled in EDMS Assumptions: 1. *Bi-directional link established between AIMS and EDMS* 2. *All Documents would be retrieved from EDMS, for revision or Development, by AIMS* 3. *AIMS Doc Attributes Equal to EDMS Attributes* 4. *Content indexing done at point of archiving into* EDMS	• No changes made to Documentum Object Model • Documentum used as it is today	• Complexity/risk of synchronizing the two systems and managing access privileges

Option Description	Pros	Cons
Option 2 • Data Life Cycle managed in/by AIMS • TDC migrated to AIMS to enable read-only retrieval of AP600 docs • AP1000 docs stored and version controlled in AIMS • On release, AP1000 documents are copied into EDMS • WEC archive is EDMS Assumptions: 1. *AP600 Documents will be retrieved from EDMS to be modified under AIMS as AP1000 documents* 2. *Released AP1000 Documents will be loaded into EDMS as a parallel snapshot*	• No changes made to Documentum Object Model • Documentum used as it is today • Minimizes concurrency problems, as AP1000 documents are not modified in EDMS and AP600 documents are not modified in AIMS	• Need to maintain AIMS-EDMS interface • Need to reconcile results of two separate searches
Option 3 • Data Life Cycle and Archiving managed in/by AIMS • AP600 data migrated into AIMS; catalog ID maintained for reference • Document searches are performed in AIMS • WEC archive is AIMS	• Search can be performed in one database only • Synchronization problem is avoided, as all documents are in AIMS • Lower internal Westinghouse resources required to implement system due to lack of Documentum updates. • Portal Access managed as groups in one system instead of two systems • Able to add new attributes to facilitate retrieval of documents	• WEC archive is changed; latest documents are now in AIMS rather than EDMS • WEC personnel without AIMS software will not be able to access AP1000 documents

4.2.2 Recommended Documentation Interface

Option 2 provides a balanced approach to support the AP1000 design while retaining the investment in the enterprise document management system. Briefly, option 2 reflects the AP1000 product lifecycle managed in and by AIMS, with documents archived in EDMS 2000. Specific characteristics are:

- The AP1000 documents should be created and managed in/by AIMS.
- The new AP1000 documents created and managed in AIMS should be archived in EDMS 2000 only when the document is in the released state (i.e. the document has transitioned from work in progress to a record).
- The AP600 documents should not be modified/stored in AIMS except as detailed below.
- The AP600 documents should be loaded into AIMS only when being used as a basis for AP1000 documents.

The AIMS-EDMS 2000 adapter will have the following functionality:

- The adapter will be able to search and retrieve the archived AP600 documents from EDMS 2000 when a search request is made using the AIMS user interface. In this case the one-way data transfer is made from EDMS 2000 to AIMS.
- The AP1000 documents will be created and managed in and by AIMS. The adapter would be used to archive a copy of the new AP1000 documents in EDMS 2000 when a document reaches a released state in AIMS. In this case the result is a one way data transfer is made from AIMS to EDMS 2000 with only a subset of metadata being loaded into EDMS 2000 as supplied by AIMS.
- The AP600 documents will not be modified or stored in AIMS.

Some of the currently unresolved issues for implementation of Option 2 are:

- Access provisions for owners, suppliers, and external design groups have not yet been defined.
- The AP1000 documents will reside in both AIMS and EDMS 2000. The choice of master copy of these documents has not been decided. If both the systems have will have the ability to modify AP1000 documents, a synchronization strategy needs to be defined. These issues will be addressed in the subsequent phases of implementation.

Design considerations for file storage and linkage are suggested below:

- A simple handoff of files using a commonly accessible shared network drive will be implemented. The handoff by Windchill of metadata, and content files (Archive Operation) will be automatic, as will the processing of these files on the EDMS 2000 side of the link (Polling Process). An AIMS-EDMS 2000 adapter with archival functionality has been already developed for the WEC Newington Canister project, and efforts will be made to reuse this adapter for AIMS.

- Because documents will be stored in both EDMS and AIMS, it will be necessary to search both databases. For searching in AIMS, the built-in search engine of Windchill, called Excalibur, will be used. This search engine already includes the required full-text search capabilities. Documentum does not support Excalibur but includes a sophisticated search engine. Because of this, an AIMS-EDMS 2000 adapter will be built to invoke the search functionality of Documentum through the API's, however a single user search screen will be used to show all searches.

Figure 4-6 illustrates the architectural characteristics of AIMS co-existing with EDMS 2000. Windchill uses Info*Engine as the conduit to and from EDMS 2000.

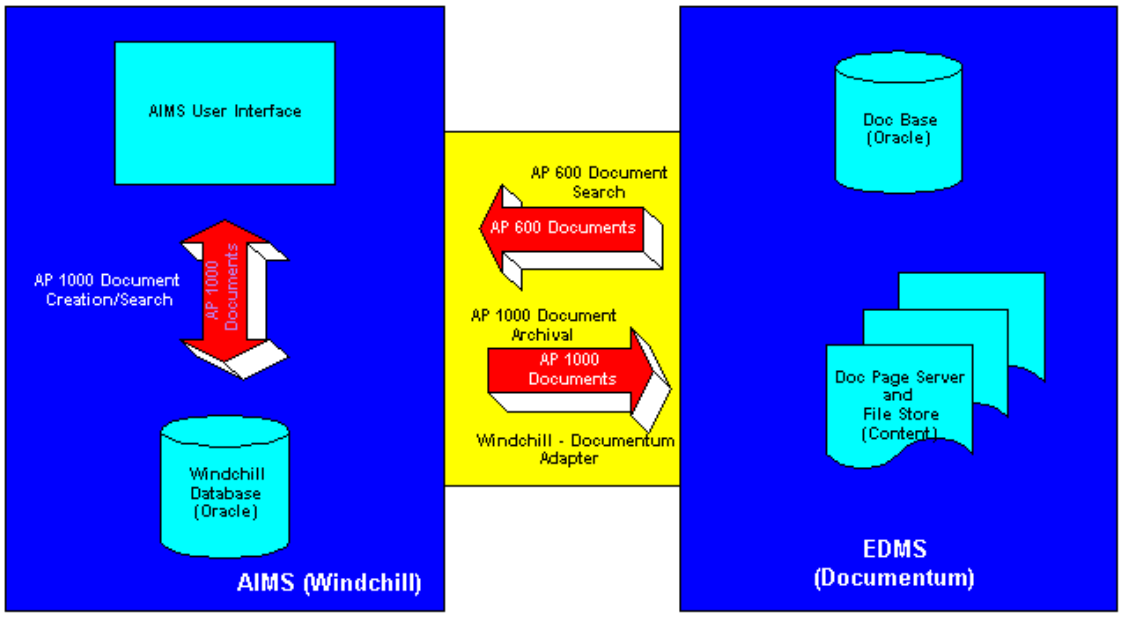

Figure 4-6
Windchill Interface With EDMS 2000

4.2.3 Document System Searches

The AIMS concept as described in prior report on proof of approach utilized a dual approach called the twin engine approach to the finding of relevant design information. This approach was conceived to deal with the inherent limitations of metadata based approaches to marking data for retrieval. The augmentation method in the Proof of Principle for the AIMS project utilized a "concept " search engine. Figure 4-7 illustrates our intent in utilizing metadata stored in the PDMS as well as concepts that are "stored" in text documents.

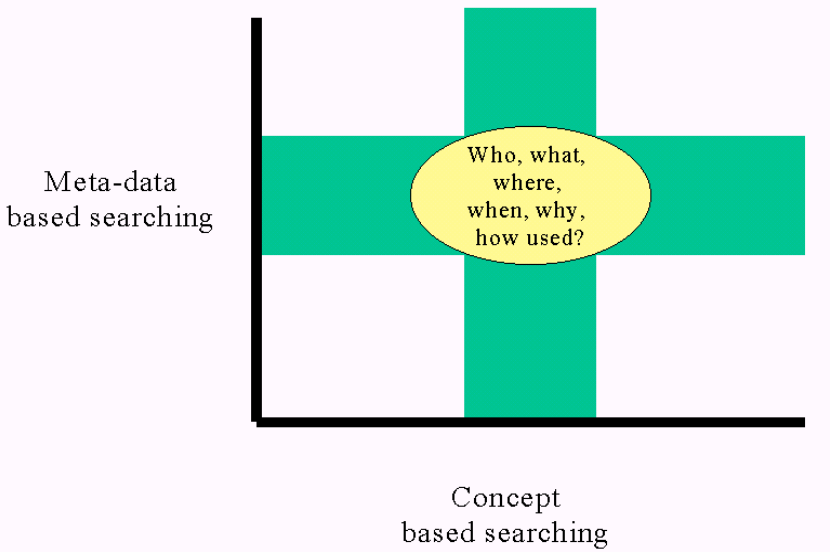

Figure 4-7
Twin Engine Approach For Searching

In the previous iteration of AIMS, a commercial product provided by Applied Technical Systems known as the Contiguous Connection Model (CCM) was used to provide the "concept" search function. In contrast to the earlier PDMS that used during the proof of principle demonstration, PTC's Windchill product comes with Convera's Retrievalware (previously marketed under the Excalibur Technologies name) as an embedded search engine. A preliminary review of the Retrievalware indicates that it has advanced capabilities to facilitate searches that circumvent word usage issues. Thus, it was concluded that for the interim, Retrievalware could serve as the "concept search" technology for AIMS. Since the twin engine approach is marked by the use of the complementary search strategies of a PDMS' schema and a specialized search engine, the use of Retrievalware will probably obviate the need for the previously used CCM based concept search technology.

Due to the need to retain the Westinghouse enterprise wide document management system, called EDMS 2000 within Westinghouse and based upon Documentum's technology, we will need to blend search and retrieve with the Documentum capabilities. Thus, in the implementation of AIMS for the AP1000 design we expect to use both Documentum's search capability in concert with that of Excalibur. This should result in ensuring a robust search and retrieval method might be to search using both engines, eliminate duplicate hits and display results in such a fashion that it would be transparent to the user that more than one search engine is involved. While the likelihood of finding more relevant hits does increase by using the twin engine approach, overall accuracy of the search might suffer. Recall that search accuracy is a function of finding the right information and excluding non-relevant information. Excalibur and Documentum use different methods to select relevant hits. By combining their hit lists we could be increasing the number of extraneous hits to the sum of both search methods.

One option mentioned above—combining the results of both engines and eliminating duplicates—may now be more easily facilitated. In order to simplify "plug-and-play" search engine integration, PTC has just complete a new interface modeled after the Retrievalware

EasyFE Java API. This interface allows the merging and filtering of results from both local and external searches. Because each engine uses different search criteria and presumably some different documents, then returning the documents that were the closest matches from each engine and filtering the duplicates may return the best document set.

There will be no typical end user for AIMS. There will be a spectrum of users ranging from novice to expert that might well include engineers, administrative personnel and information professionals. Our interface should be capable of meeting the needs of all users by providing several search options including crisp Boolean, pattern and concept. The interface will allow the user to select client default search methods. The client default search method will allow use of other search methods via hyperlinks.

Two interfaces are required. First, searching as a standalone application outside of Windchill, and second, searching from within Windchill for data related to a selected object. The interface will have an HTML front end (or other language suitable for a thin client web based application).

For searches executed from within Windchill, the interface will use the selected object's metadata as input to the search engine and present the user with a recommended search string that can be modified by the user before executing the search. When an object is selected in Windchill a right click menu will include an option to search. Selecting that option will bring up the search page (depending on hardware configuration, the search page will appear on a separate monitor or window) with the selected object's relevant metadata (probably noun name, manufacturer, system name, specification name or number etc.) as the default search string. As an alternate approach it will bring up a search query wizard that allows the user to select from the object's metadata as input to the search string, then bring up the search window and allow the search string to be further modified. All of the search engine's options will be available at this point just as if it had been initiated in the standalone mode.

4.3 Project Management System

This description will clarify and then demonstrate general methods of interfacing the Primavera products to Windchill.

Primavera provides two products for project management. The Primavera flagship product, "P3", is a multi-user, server managed, enterprise level, Oracle based product. The second product, "SureTrak", is a single user, stand-alone product that applies a multi-file construct to manage the project data.

For the purpose of defining and then clarifying access to Primavera products it will be important to identify:

- Which Primavera application will be integrated into the Windchill environment. (SureTrak, P3, or Both).
- What degree of automation will be required between Windchill and the Primavera products:
  - Unidirectional or bi-directional communication;

- Will changes in the project management tool affect the life cycle of Windchill objects;
- Will the status of life cycle managed objects in Windchill be reflected in or be used to update the project management tool.

Currently, as a result of the Westinghouse Newington Canister project, access to project data in Primavera's SureTrak product is available as a one way solution; SureTrak to Windchill as shown in Figure 4-8.

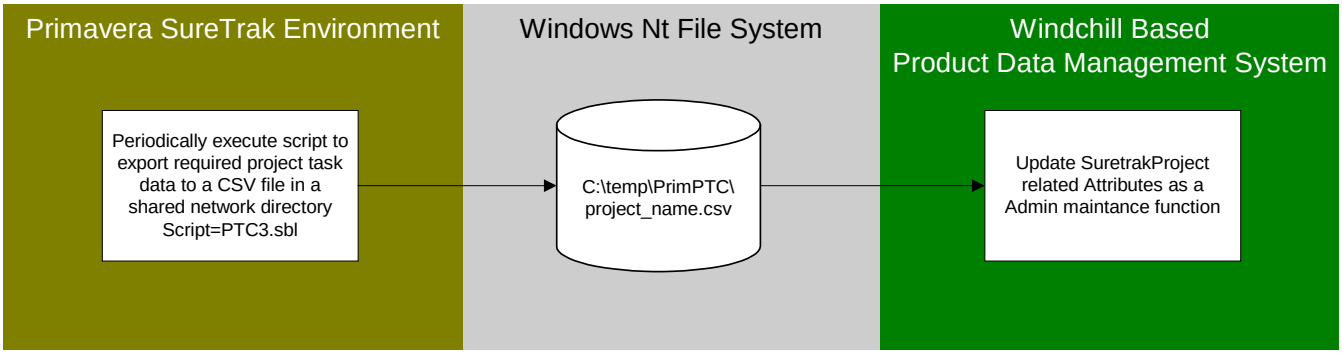

Figure 4-8
Exporting Primavera SureTrak Data to Windchill

Project Attributes such as "TaskID", "Description", "Early Finish Date" are exported out from "SureTrak", via a visual basic script, and saved to a file in a predetermined directory. The file is read and the attribute data loaded into Windchill via a user activated Admin routine.

Support for access to Primavera's product "P3" would most likely take place using Info*Engine as the conduit as shown in Figure 4-9.

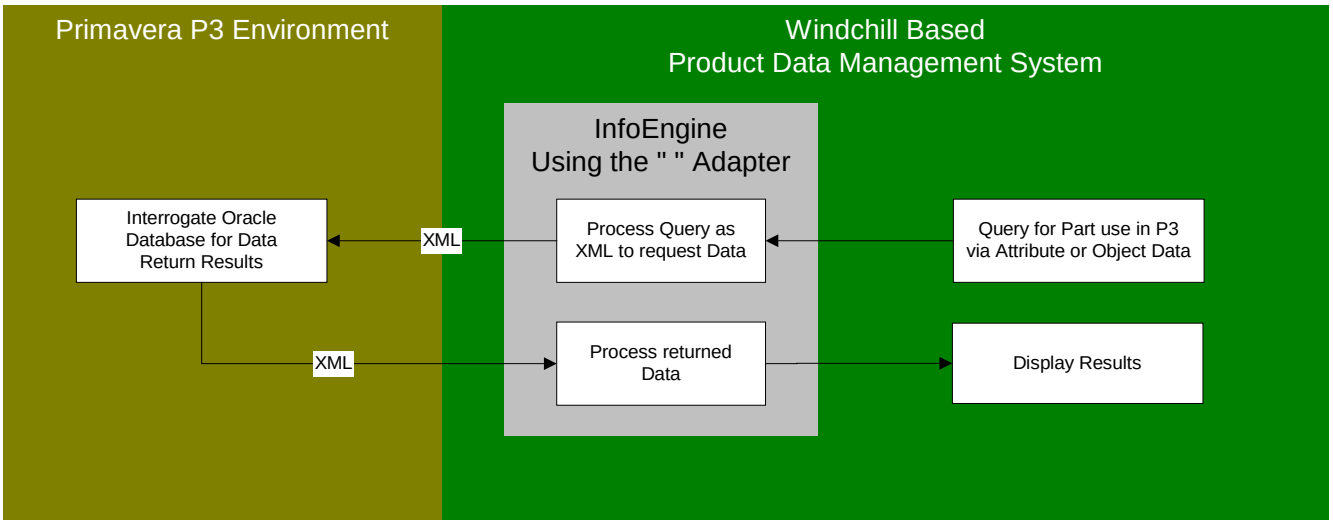

Figure 4-9
Exporting Primavera P3 Data To Windchill

The schedule will be maintained in Primavera . The interface with Windchill will be one of accessing schedule data relative to parts and document objects. Significant integration of WBS with SAP will be accomplished with an existing interface available from Primavera.

4.4 Resource Planning System

The Westinghouse Resource Planning System – SAP will be integrated with AIMS (Windchill) to accommodate Engineering/Design changes and Project Scheduling changes. The data flow to incorporate Engineering/Design change data exchange, between AIMS and SAP, is represented in Figure 4-10.

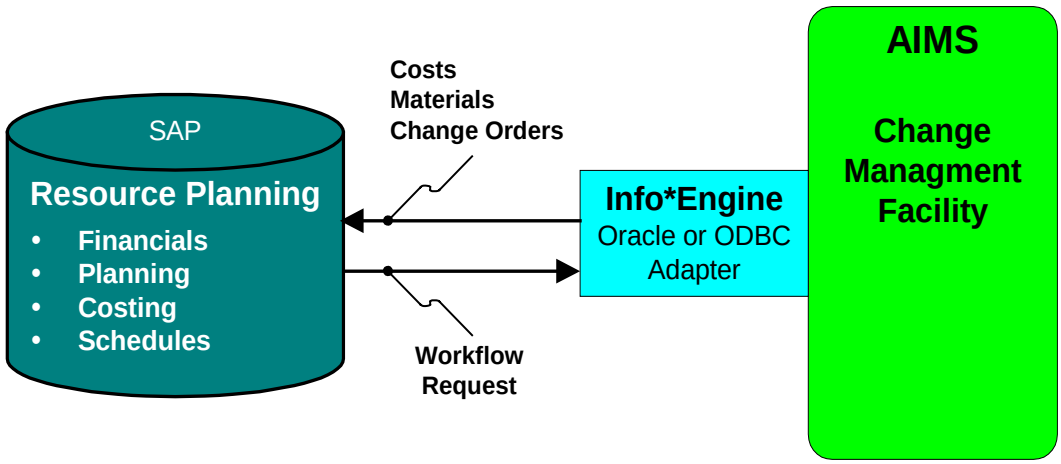

Figure 4-10
Interface Between SAP and AIMS For Engineering/Design Change Data

The data flow to incorporate Project Scheduling changes, between AIMS and SAP, is represented in Figure 4-11. The actual system integration description requires further details.

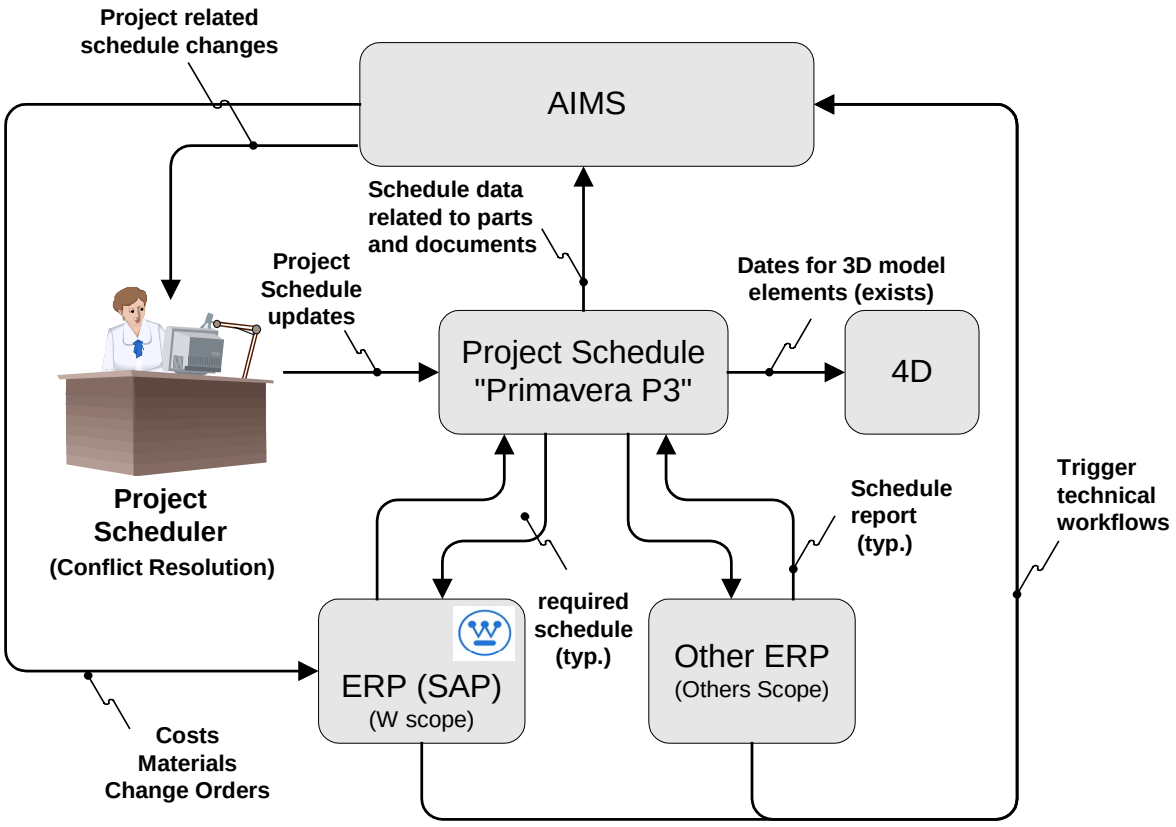

Figure 4-11
Interface Between SAP and AIMS For Project Scheduling Changes

4.5 Enterprise Open Items

As with any integration of commercial off the shelf software, there are a number of details that are key considerations for design of the AIMS. Some of them have been recorded below for consideration as the project moves forward:

- What connectivity is currently available between Primavera's "P3" product and SAP.
- What dependencies are required, give an example, to trigger a schedule change, in SAP, from a Change Activity in AIMS (Windchill).
- What is required to characterize parts as being managed by SAP?
- Is every object in AIMS represented/managed by SAP?
- Is this a direct bi-directional link, as shown in Figure 4-10?

5
PROCESS EVALUATION

5.1 Introduction

A major functionality of PDM / CPC Technology is the lifecycle process information management. Nuclear power plants pass through four major lifecycle phases: Plant Supply, Construction, Operation, and Decommissioning. AIMS will manage information that will be valuable during all of these phases. However, the most immediate need focuses on the application of AIMS to the Plant Supply phase.

Major activities within the Plant Supply phase include:

1. Proposal
2. Design
3. Licensing
4. Procurement
5. Manufacture/Fabrication

These activities tend to overlap, as design flows naturally into licensing and procurement.

5.2 Process Improvement Goals

The ultimate objective of AIMS is to make nuclear power more cost-effective, and to reduce the time required to bring new power plants on line. AIMS will achieve this by attacking the cycle time and cost associated with *designing new plants and procuring manufactured components.*

Much of the time and cost is devoted to the creation, approval, transmittal, and storage of information regarding the design. Many of these information processing steps are paper-based, which leads to a number of problems:

- difficulty in retrieving information, due to the volume of documents involved and the fact that documents need to be referenced in multiple ways: by the name of the installation, the year of construction, the component name, the operational problem, the supplier, and so on. A particular problem, critical to licensing and maintenance of design basis, is the difficulty of identifying and retrieving all documents that may reference a subject within the text of the document but not in the title.

- difficulty in determining where a given document may be in the process. This leads to lost time and effort in trying to identify why a process is delayed or to retrieve a document for further revision.
- inability to adjust resources or procedures to improve the process. Because management cannot easily tell where delays or backlogs are occurring, it cannot adjust resources to address these problems.
- administrative cost in controlling the version of each document, due to the need to record, stamp, distribute, and store new documents and to retrieve and destroy old versions.
- risk of lost information, or the need to re-create a document if the paper is mislaid.
- slow cycle times in design, supplier communications, and licensing due to delays in moving paper from one location to another.
- incomplete or inefficient knowledge management. Much of the information about a given design rests in the heads of the people who were involved, which makes it difficult to bring new staff up to speed and leaves the design firm vulnerable when key personnel retire.

These inefficiencies are seriously detrimental as they impact vital management issues such as:

- Engineering Cost

It has been found that engineers in simple discrete manufacturing industries spend 25-40% of their time in non-value added activities, particularly looking for information and working on the incorrect version of a document. The higher figure is likely correct for the nuclear power industry, due to the complexity and longevity of the projects.

- Time to Commercial Operation

The plant supply phase is the single greatest barrier between the decision to proceed and the time when a plant can begin to generate positive cash flow.

- Escalation Costs

With escalation costs being built into most construction projects, delays will be reflected directly in the cost of the plant. An escalation clause of 0.3% per month on a billion dollar facility, for example, means that each month of delay costs $3 million.

- Responsiveness to Market Conditions

As recent events have shown, there can be tremendous pressure from rate payers and government agencies to bring new sources of power on line rapidly in response to market requirements. The perception that nuclear plants require an inordinately long time to come on line may lead utilities to opt for alternative energy sources.

- Political Opposition

Every delay before a nuclear plant is commissioned provides additional opportunity for protesters and political opponents to try to prevent the start-up, and additional turmoil for the management of the utility.

- Field Rework Expense

Corrections that must be made once construction has begun are typically several times more expensive than corrections during the design phase. The root cause of this problem is that design information is not available, or not readily visualized, by all stakeholders early enough in the process.

The goal of the AIMS project is to reduce these times and costs by:

- Improving response time and productivity during both the design and the permitting processes by enabling engineers and regulatory personnel to identify and retrieve relevant documents based on a variety of attributes or search terms.
- accelerating the flow of information by enabling electronic workflows
- providing management with information to identify bottlenecks and manage the processes
- reducing the number of design changes by sharing information with stakeholders and soliciting their feedback earlier in the process
- providing a secure repository for all documents that can be used by newcomers and experienced engineers alike, using intuitive, user-friendly screens

5.3 Process and Sub-process Analysis

Major sub-processes within the Plant Supply phase, as documented in the AP600 Operating Procedures, are:

- Prepare System Specification Documents
- Implement Design Changes
- Perform Design Analyses
- Prepare Functional Specifications
- Perform Design Reviews
- Update/Revise Standard Safety Analysis Reports (SSARs)
- Prepare Probabilistic Risk Assessments
- Prepare Tier 1 Documentation
- Release Documentation to NRC for Design Certification
- Determine and Assign Numbers to Documents

- Release and Control Technical Documents
- Prepare, Review, and Approve AP600 documents
- Evaluate, Audit, and Approve Suppliers
- Control Subcontractor Submittals
- Control Contributed Labor
- Obtain Equipment Design Information from Suppliers
- Prepare and Distribute RFPs
- Prepare and Distribute Purchase Orders
- Respond to Supplier Questions and Requests for Variations
- Control Subcontractor Submittals
- Control Contributed Labor
- Obtain Equipment Design Information from Suppliers

Figure 5-1 shows an example of the RAI sub-process map.

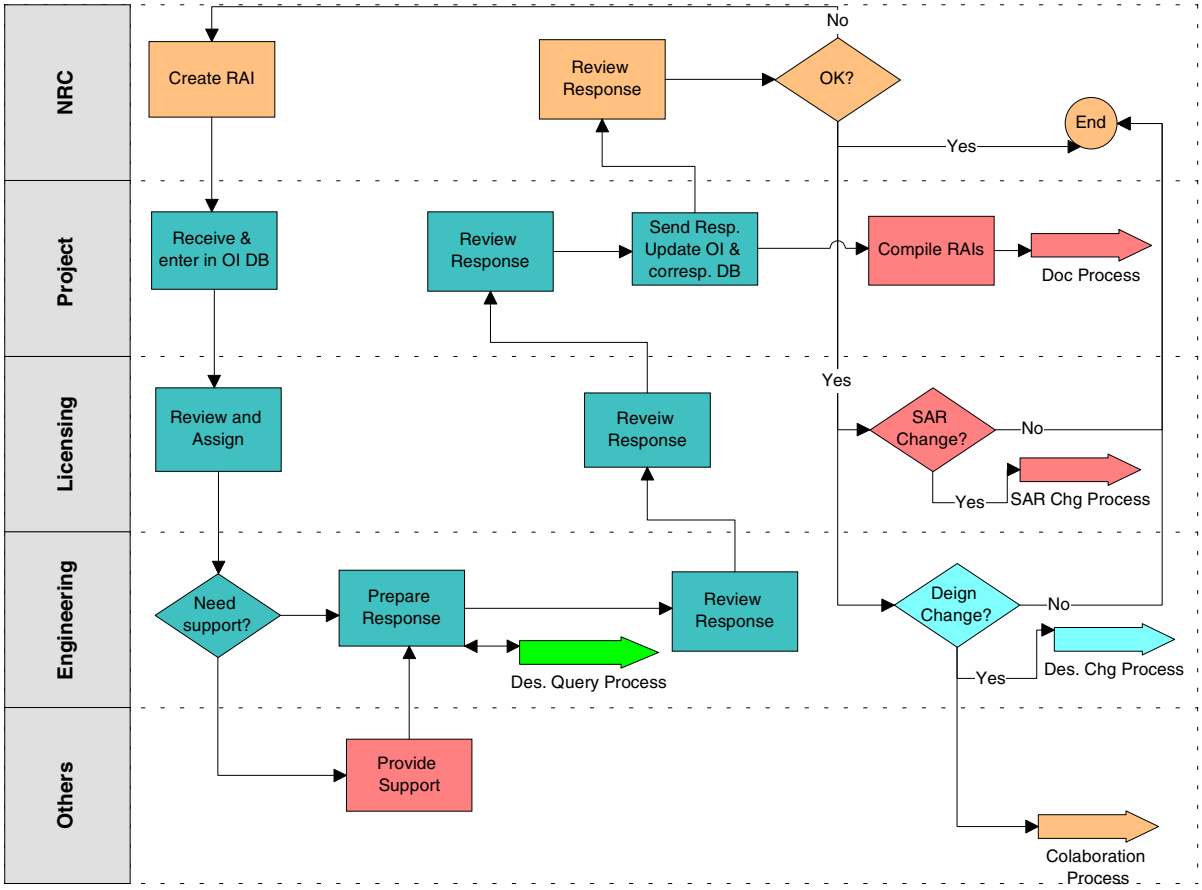

Figure 5-1
RAI Sub-Process Diagram

6
IMPLEMENTATION PLAN

6.1 Introduction

The system description document provides a view of the ultimate goal: the way that AIMS will operate when it is fully implemented. In this section we present a plan for achieving that goal in manageable phases. The plan is flexible in that phases may be accelerated or postponed to respond to commercial conditions. This section describes the rationale that was used in developing the plan, followed by a high level summary, a more detailed description of each phase, and a high-level schedule. A more detailed schedule is presented in the appendix.

6.2 Rationale for the Design of the Plan

- AIMS will be implemented in several phases, to enable basic capabilities to be tested and proven and then used as the foundation for subsequent enhancements. In designing the phases, the team had a number of objectives:
- Break the work up into activities lasting no more than 6 months, to facilitate monitoring of cost, schedule, and performance
- Provide benefits to the users early in the implementation, to promote acceptance of AIMS
- Introduce changes gradually, to avoid overwhelming the users
- Protect the established databases, by implementing “read-only” capabilities during the early phases
- Protect and upgrade the quality of the information in the Administrative and Technical databases, now in an early version of Access
- Avoid disruption of the Design Control Document (DCD) process currently underway for AP1000
- Support the next set of activities in the AP1000 design and licensing process – the “Request for Additional Information” process
- Automate and refine internal processes before involving customers and suppliers in integrated workflows

With these objectives in mind, a seven-phase plan was developed. This plan is summarized in the following section and described in more detail thereafter.

6.3 High Level Summary

In brief, the phases of the plan are as follows:

- Phase 1 - Enable users to retrieve text documents from EDMS; implement automatic numbering of documents; begin migration of administrative data
- Phase 2 - Enable the RAI process to be handled via electronic workflow
- Phase 3 - Enable users to retrieve CAD files and technical data
- Phase 4 - Enable processing of most other document types via electronic workflow; Enable users to store text documents back into EDMS
- Phase 5 - Enable an automated engineering change management process, and management of product structure
- Phase 6 - Build interfaces to two other key WEC systems: SAP and Primavera
- Phase 7 - Use the web-based capabilities of AIMS to include outside design firms, suppliers, owners, and regulatory agencies in the design and supply process

The phases are summarized in Table 6-1 and supporting information for each phase is provided in Table 6-2.

Table 6-1
Implementation Plan Summary

Phase	Processes	Rationale for this phase	User Capabilities	Key Elements	Key Features
1	Engineering Document Query and Retrieval process	Provide access to AP600 docs in support of AP1000 design certification Maintain current document integrity via one-way link only	Search and retrieve docs from TDC and EDMS 2000 archives via transparent interfaces	Review/Validate Admin DBs, develop document object model and mapping and migration strategy. Migrate TDC; Develop Bi-directional Link (implementing only retrieval capability) to EDMS 2000, Develop Phase 2 Requirements	Info Engine, Documents World Data Model
2	Internal RAI Process	Trial workflow with simple process, immediately useful for AP1000, Create foundation for AIMS document management.	Create, review, approve & revise RAI via automated Workflow. Query and report RAI status and content.	Create RAI document object and workflows, adapt administrative DBs Develop Phase 3 Requirements, Review/validate Tech. DBs, develop object model and mapping and migration strategy, Document Intergraph interface requirements	Automated workflow, Parts World Data Model
3	Engineering data Query	Builds foundation for AIMS parts management. Protects Intergraph via one-way link only	Search and retrieve data from Intergraph and Technical Data bases via transparent interfaces	Migrate Technical Data Bases, Develop link to Intergraph, Develop Phase 4 Requirements	Info Engine, Product view

Phase	Processes	Rationale for this phase	User Capabilities	Key Elements	Key Features
4	Document creation and archiving process, External Contribution process	Expand document management capabilities, increase efficiency with partners	Create, review, approve, revise & archive (to EDMS) major document types using automated workflow, External users will be able to provide content and comments via Web	Activate bi-directional link to EDMS, Add additional documents and workflows, structured documents, version control. Build project portal	Project Link
5	Engineering Change process	Expand part and configuration management capability	Automated Engineering change management, configuration control	Engineering change workflow, product structure	Change Objects
6	Primavera/SAP Linkage	Integrate with other important IT systems	View cost and schedule data within AIMS, manage cost estimates	Link to SAP for cost data and Primavera for schedule info. Consolidate work lists	Info*Engine
7A	Design Collaboration process	Extend Engineering Change process to external designers	Include external designers in web-enabled workflow		ProjectLink
7B	Supplier Collaboration process	Add procurement workflow and supplier communications	Include suppliers in web-enabled workflow		ProjectLink
7C	Owner and NRC Collaboration processes	Integrate with customers and NRC once internal processes are proven	Include customers and NRC in web-enabled workflow		ProjectLink

Table 6-2
Implementation Plan Support Information

Phase	Process	Data Sources	Object Types	Procedures Impacted	Trigger	Existing Capability
1	Engineering Document Query and Retrieval process	EDMS, Technical Doc Control DB	AP Doc	3.4 5.4 6.1	SAR Submittal	Newington archive process, WEC database assessment
2	Internal RAI process	Internal and External OI DBs, Correspondence log	RAI document	5.4 6.1 6.2		Newington Document Review and Report
3	Engineering data Query	Technical DBs, Intergraph files	part objects	3.2, 3.5		
4	Document creation and archiving process, External Contribution Process	EDMS, SSAR databases	SSAR, DCD, other key documents	3.1, 5.1, 5.2, 5.3, 5.5, 6.1, 6.2, 6.3		Newington, Windsor ProjectLink
5	Engineering Change process	Intergraph files, product structure	part objects	3.2, 3.5	Funding for detailed Engineering	Newington RCP
6	Primavera/SAP Linkage	Primavera, SAP		3.2, 3.5		Newington Primavera link
7A	Design Collaboration process	Designers		3.2, 3.5, 7.4		Windsor ProjectLink
7B	Supplier Collaboration process	Suppliers		7.1, 7.2, 7.3, 7.4	Contract or LWA	Windsor ProjectLink
7C	Owner and NRC Collaboration processes	Owners, potential customers, NRC		5.2, 5.4, 5.6, 6.2		Windsor ProjectLink

6.4 Implementation Plan Assumptions

The plan that follows is based on a number of assumptions:

- Hardware and infrastructure will be provided to support adequate development and production environments. Servers will be at least 800 MHz with recent operating systems and peripherals. One development and one production environment, in Windsor, will be implemented.
- Westinghouse will provide timely access to key process stakeholders who can help to define required functionality, and who can evaluate the modules prior to roll-out.
- The team will adopt a timely and effective issue resolution process such that issues can be resolved within five business days
- Systems Administrators and key users will be provided with basic training in Windchill software prior to their participation in user testing. The plan allows for training users in the customized/configured aspects of Windchill but not in the basic software foundation.
- For each phase, one day of user training in Pittsburgh and another day in Windsor has been allowed.
- The RAI phase includes a workflow of no more than 25 steps, 5-10 GUI screens, and two custom reports.
- Phase 4 (Document Creation and Archiving) is based on 10 additional documents, each with a workflow of no more than 25 steps.
- The amount of time required to construct interfaces to Primavera and SAP is dependent on the exact functionality needed, which is yet to be defined. The amount of time allowed for these interfaces is reasonable, based on our experience, but may vary substantially depending on system requirements.

6.5 Description of Implementation Phases

6.5.1 Phase 1 – Engineering Query and Document Retrieval Process

Users have expressed interest in having an improved ability to search and retrieve documents from EDMS as soon as possible. (Many of the documents that will be needed for AP1000 will be created by modifying similar documents from the AP600 design.) Therefore the fundamental purpose of Phase I is to build this capability. To support this functionality, AIMS must also capture the metadata about these documents, which now resides in seven Access databases. Finally, in this phase the planning and design work for the subsequent phase, the RAI process, will be performed. This will provide WEC and EPRI with a more detailed description of the path going forward.

The initial phase of AIMS development has two major stages:

1. Designing the interface to Documentum and the automatic document numbering system, validating the Administrative data model
2. Implementing the interface to Documentum and the automatic document numbering system, migrating four of the administrative databases into AIMS, and planning for the next phase of work

Key tasks in designing the interface to EDMS are:

- Work with AP1000 users to determine and document the functional requirements for a bi-directional interface to Documentum
- Develop the integration strategy between AIMS and Documentum
- Develop a detailed design for the AIMS-Documentum interface
- Develop an implementation plan for development, testing, and roll-out of the interface

In designing the automatic part numbering system, input will be obtained from key users and from the numbering administrator to document the functionality required from an automatic system. The system will be designed and reviewed with stakeholders to obtain approval prior to coding. Accuracy in this numbering system is vital as it is the key by which WEC stores and retrieves documents.

As part of this initial phase, the technology roadmap will also be reviewed and updated, taking into account the changing versions of Windchill. (Westinghouse's work to date has been based on Windchill Version 5.1. A new version of the software, 6.0, has just been released (early August 2001), and a further upgrade to version 6.2 is planned for January 2002.) The objective is to define a plan that will enable AIMS to keep pace with evolving technology. Current plans are to stay with the existing version, 5.1, until the second quarter of 2002. This will allow time for the technology to stabilize while the AIMS team is working on functional requirements definition and system design.

Preparations will be made to migrate essential data from the seven Administrative Access databases: Internal Open Items, External Open Items, Correspondence Log, Technical Document Control, Design Change Proposal, and two Standard Safety Analysis Report references. This information is now in an early version of Access and requires cleaning and upgrading.

Our preparation tasks will include:

- Work with users to document how they use the Administrative data
- Define the Windchill object model for this data
- Validate the data model
- Develop the migration and validation strategy for moving Access data into Windchill
- Install Windchill and configure a development environment in Windsor
- Finalize the migration plan

In the second stage of work, an interface to Documentum will be built and implemented, and selected data from the Administrative databases will be migrated. Specific tasks include:

- Define and implement basic access provisions
- Migrate the Technical Document Control, Internal Open Items, External Open Items, and Correspondence databases into AIMS, and validate the data
- Build the interface to Documentum
- Build and validate the automatic numbering system
- Perform unit and integrated tests of the interface
- Conduct user evaluations of the numbering system and Documentum interface, and rectify issues identified
- Set up a production environment for AIMS, and implement the interface in this environment
- Train teams of AP1000 users in retrieving documents only from EDMS

This phase will create the foundation for document management within AIMS. Furthermore, it will provide immediate tangible benefits for users by automating the Technical Document Control process, which now requires manual switching between Access Databases and EDMS 2000. AP1000 users will be able to search for and retrieve AP600 (and new AP1000) documents from within the AIMS application, using either the attributes of the documents or a full-text search. The search capability will be based on the Excalibur text search engine of Windchill. An additional benefit is that it will automate the generation of document numbers, making the numbers more readily accessible and eliminating the potential for human error.

Although a bi-directional interface will be designed and developed in this phase, only a one-way linkage to EDMS will be activated; that is, the users will be able to retrieve documents from EDMS but not to return revised documents to EDMS. The reason for this is to protect the integrity of the database. The ability to store documents will be activated in a subsequent phase once the users have had time to become more familiar with the system.

6.5.2 Phase 2 – Internal RAI process

The second phase of AIMS development will automate the “Request for Additional Information” (RAI) process. The workflow will be limited to those steps which occur within WEC, for simplicity and risk management. Key tasks include:

- Create an RAI object
- Define and implement the workflow used within WEC to create and approve the RAI
- Train WEC engineers in the use of the system
- Migrate the remaining administrative databases into AIMS

At the end of this phase, WEC engineers will have the ability to process RAI documents automatically through the creation and approval process. Users will also be able to search EDMS for relevant documents to support the Request for Additional Information, to modify these documents as required, and to attach the documents to the RAI document. The automatic workflow will not extend to suppliers or to the NRC in this phase. In addition to facilitating the RAI process, this phase will provide an operating example of the document management capabilities of AIMS, which will enable users and management to better visualize the full capabilities of the system and to clarify the requirements for future phases.

In addition, in the latter half of this phase the AIMS team will define functional requirements and undertake detailed design for the next phase – the interface to the 3D CAD system, Intergraph. Object models and data migration strategies will be developed to enable information in the Technical Access databases to be brought into AIMS.

6.5.3 Phase 3 - Engineering Data Query

In contrast to the previous phases of work, which focus on the management of documents, this phase, will expand the system to manage parts and part data. Key tasks include:

- Build an interface to WEC's Intergraph system, enabling the viewing of 3-D drawings within AIMS
- Migrate the five technical databases (now in Access) into AIMS. These databases include tanks, valves, modules, equipment, and cost.
- Develop part objects
- Implement appropriate access control provisions and workflows for part management.

At the conclusion of this phase, users will be able to retrieve and view 3D drawings, perform "where used" searches to identify all applications of a given part, and view bills of materials and product structures. This capability will extend only within the walls of WEC, and will not yet be visible to suppliers or customers.

Functional requirements for Phase 4: Document Creation, will also be developed in this phase. Key tasks will be identifying the documents and determining the required workflows for each.

6.5.4 Phase 4 – Document Creation and Archiving Process and External Contribution Process

This phase has three objectives:

1. Expand the document management capability to cover additional documents
2. Activate the archiving feature of the interface to EDMS
3. Enable suppliers to share documents with WEC over the web

6.5.4.1 Expand the document management capability

The document management system created in Phases 1 and 2 will be expanded to encompass a number of other documents and workflows used in the Design and Licensing Process. These include such documents as Safety Analysis Reports, System Specification Documents, and Design Change Proposals. The timeline in the plan is based on ten such documents each with its own separate, unique workflow. It is anticipated that users will be better able to envision the required workflows because of the example of the "look and feel" of the RAI process enabled in the earlier phases.

6.5.4.2 Activate the archiving feature of the interface to EDMS

Previously, a bi-directional link to EDMS will have been designed and coded, and the retrieval capability will have been implemented. In this phase, the capability to return documents from AIMS back into EDMS will be activated. This task will require careful version control, to avoid creation of overlapping versions in the two systems.

6.5.4.3 Enable suppliers to share documents with WEC over the web

ProjectLink will also be activated in this phase. ProjectLink is a module of Windchill that has the out-of-the-box capability to create an access-controlled project site on the web. Using this capability, suppliers will be able to post files to this site for review by WEC. Business processes will not be linked in this phase, and suppliers will not have access to see WEC documents. This task will build on the automated "Request for Approval and Review" system already under development at WEC.

6.5.5 Phase 5 - Engineering Change Process

The key aspect of this phase is the creation of an electronic Engineering Change Process. Key tasks include:

- Define the required Engineering Change process, including Change Notices, Change Requests, and Change Orders.
- Develop access rules and business processes to manage product changes
- Develop a product structure for the power plant
- Enable configuration control of assemblies

Because the Engineering Change process is closely linked with the design of a plant for a specific site, this phase will commence once funding for detailed engineering has been authorized. At the conclusion of this phase, users will be able to route Engineering changes through the request, design, and approval stages, perform "where used" searches to identify all applications of a given part, and manage bills of materials and product structures. This capability will extend only within the walls of WEC, and will not yet be visible to suppliers or customers.

6.5.6 Phase 6 – Primavera/ SAP linkage

The object of this phase is to link AIMS with two other key systems within Westinghouse: Primavera and SAP. The purpose of linking to Primavera, a project scheduling software package, is to provide users with information on the required due date for each task as it is passed to participants via the automated workflow. A prototype link to Primavera has already been developed by WEC at its facility in Newington, NH, and this will be used as the foundation for a more extensive linkage within AIMS.

SAP is now being implemented within WEC to manage financial and manufacturing information. It will be essential to link AIMS to this system, because the Bill of Material for each system will be created within AIMS and then will be a critical determinant of the cost in SAP. Until this phase is complete, the Bill of Material will be updated manually in SAP. Linkages to SAP are now under development on other projects. The extent of the SAP linkage, and the amount of effort involved, will be clarified during Phases 1, 2, and 3. An allowance for this work has been made in the budget and will be refined over time.

6.5.7 Phase 7 – Collaboration Processes with Outside Designers, Suppliers, Owners, and the NRC

In Phase 7, WEC will use AIMS to enhance communications with its customers and suppliers over the web. This important capability will be implemented after the internal WEC processes have been tested and proven, to take maximum advantage of lessons learned.

Phase 7 activities primarily involve extending the capabilities of ProjectLink. Key tasks include setting access rules and revising workflows to include new participants. The work plan assumes that this work will be done by Westinghouse staff.

At the end of this phase, WEC will have the ability to pass documents across the extended enterprise seamlessly and to include customers, suppliers, and regulatory agencies in daily workflows.

6.6 Schedule

The complete implementation of AIMS is a substantial project, estimated to take roughly two and a half years. The scope of work planned for the remainder of 2001 and during 2002 is shown in Figure 6-1. The schedule will be accelerated by including in each phase of work the planning, design, and scheduling for the next phase. This approach has multiple advantages:

- it will provide WEC and EPRI with a more detailed understanding of cost and schedule before they decide to proceed with each phase
- it will provide more continuity of staff for the project, by allowing Project Managers and Business Process Consultants to remain on the project steadily

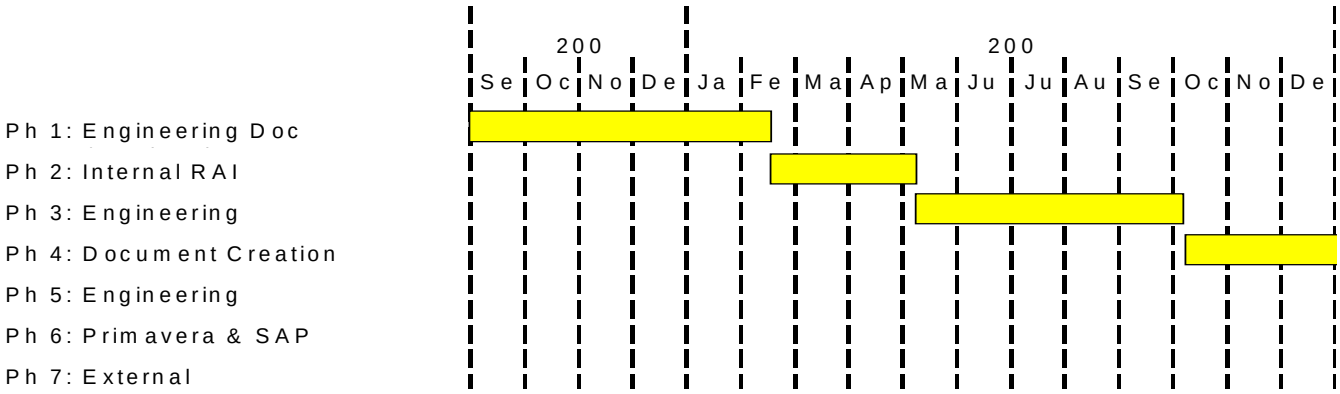

Figure 6-1
AIMS Implementation Schedule for AP1000 for 2001 and 2002

7
ISSUES ADDRESSED

This section a listing of the issues we confront and discuss during the development of the AIMS Architecture and implementation plan. In some cases the issue has been fully addressed in others the issue has been left open for later resolution.

Specific issues are:

7.1 Ease of Use Issues

- Existing systems do not allow users the capability to extract information in a form that they can work with.
- The end user community spends a lot of time and effort extracting different types of data from many existing IT systems just to organize it into a form that provides them with the information to do their job.
- Communication of plant data is critical both within the project and the extended supply chain. The notification of design changes requires considerable effort to maintain using current systems and practices.

7.2 New Functionality Issues

- The existing systems do not provide the ability to navigate across data to locate drawings, parts, documents, and other plant data.
- The knowledge of how designs evolve as they progress through the project lifecycle is currently not being captured consistently.
- The project needs the ability to project a common view of its CAD data across all members of its virtual team during design and construction phases.
- The project does not currently have the ability to manage its projects in the proposed 4D environment.

7.3 Process Issues

- Automated workflow and data management technologies are not being addressed effectively
- Much could be gained if multiple views of the plant could be managed, such as- as-designed, as-planned, as-built, as-sold, as-installed, as-maintained, etc.

- The current work environment has resulted in incomplete data being delivered to downstream users, suppliers and customers, which causes many to spend more time recreating and looking for all of the data they require. This is especially true regarding the drawings that are provided to manufacturing and the suppliers.
- The project will need to provide access to the right data to the right supplier/customer at the right time in order to take advantage of the market opportunity.
- The current flow of information between designers, manufacturing, customers and between engineering groups is not seamless.
- The degree and manner in which formal Quality Requirements (App B of 10 CFR 50; ISO9000 will be addressed

7.4 Architecture Issues

- The adoption of a Web Centric technology with appropriate security measures will be essential to manage the project.
- The project could do a much better job leveraging and managing 3D CAD data throughout the extended enterprise. Doing this properly will greatly enhance the ability to reduce the design cycle and approval time.
- The advantages / disadvantages of umbrella system vs. platform migration.

8
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