March 29, 1996

96-0001134

Department of Energy
Washington, DC 20585

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DNF SAFETY BOARD

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Conway:

Enclosed is the "UF_6 Cylinder Program Systems Engineering Management Plan" dated March 1996. This document represents the second deliverable due to you as detailed in Secretary O'Leary's October 16, 1995, Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 95-1.

The system requirements document (SRD), the first deliverable under the Recommendation 95-1 Implementation Plan, established cylinder management program requirements. The Systems Engineering Management Plan (SEMP) describes and documents how these requirements are to be satisfied. SEMP defines the systems engineering approach outlined in the implementation plan and specifies the methods for planning and controlling the actions within the program.

This document is unclassified and is suitable for placement in the public reading room.

Sincerely,

Ray A. Hunter

Ray A. Hunter, Deputy Director
Office of Nuclear Energy,
Science and Technology

Enclosure

96/1134

K/TSO-017

LOCKHEED MARTIN

UF$_6$ CYLINDER PROGRAM

SYSTEMS ENGINEERING MANAGEMENT PLAN

MARCH 1996

EM AND ENRICHMENT FACILITIES
TECHNICAL SUPPORT ORGANIZATION

MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

UCN-13675 (6 6-95)

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UF_6 CYLINDER PROGRAM

SYSTEMS ENGINEERING MANAGEMENT PLAN

EM AND ENRICHMENT FACILITIES
TECHNICAL SUPPORT ORGANIZATION

MARCH 1996

Prepared by:
Lockheed Martin Energy Systems, Inc.,
for the
U. S. Department of Energy
under contract
No. DE-AC05-84OR21400

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ACRONYMS

CCB	Configuration Control Board
CDR	Conceptual Design Report
CI	Configuration Item
DAD	Detailed Activity Directives
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
EDP	Engineering Development Plan
FFBD	functional flow block diagram
FSR	Feasibility Study Report
LMES	Lockheed Martin Energy Systems, Inc.
LMUS	Lockheed Martin Utility Services, Inc.
NMC&A	Nuclear Materials Control and Accountability
PHA	Preliminary Hazard Assessment
PJ	Project Manager
PMP	Project Management Plan
SEMP	Systems Engineering Management Plan
S/RID	Standards/Requirements Identification Document
SRD	System Requirements Document
TAD	Task Assignment Directive
UCLIM	UF_6 Cylinder Location, Inspection, and Measurement
UF_6	uranium hexafluoride
USQD	Unreviewed Safety Question Determination
WBS	work breakdown structure
WCS	work control structure

EXECUTIVE SUMMARY

The Department of Energy (DOE) manages the UF_6 Cylinder Program. The program addresses a finite inventory of uranium hexafluoride (UF_6). The UF_6 is of less than 5% enrichment and is stored in cylinders at DOE sites. This program's mission is to safely store the DOE-owned UF_6 inventory until ultimate disposition of the material. The bulk of the inventory is 560,000 metric tons of depleted UF_6. The inventory is stored as a crystalline solid under vacuum, principally in steel cylinders having capacities of 10 or 14 tons. The cylinders are maintained at three sites: Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. In storage, cylinders are stacked two high in double rows, outdoors on concrete and gravel. The UF_6 cylinders are managed under DOE Orders and Directives derived from the Atomic Energy Act and under other relevant legislation and regulations.

On October 16, 1995, DOE submitted an Implementation Plan to the Defense Nuclear Facility Safety Board (DNFSB). The Implementation Plan incorporated completed and near-term actions in response to DNFSB Recommendation 95-1 on Depleted Uranium. The Implementation Plan committed to using a Systems Engineering approach, which was to be developed concurrent with responsive field actions and enhanced by an open dialogue among DNFSB staff and personnel from DOE and Lockheed Martin Energy Systems, Inc., (LMES). The Systems Engineering commitment provides the assurance that integration of the program actions will be improved. The Implementation Plan specified several interim and final deliverables to establish an operative Systems Engineering process for the continued improvement of UF_6 management. These deliverables, with due dates and status, are:

- System Requirements Document (SRD): November 30, 1995 (submitted and accepted);
- System Engineering Management Plan (SEMP): March 31, 1996 (this document);
- Engineering Development Plan (EDP): June 1, 1996 (in development);
- DUF_6 Cylinder Program Management Plan (PMP): July 31, 1996 (in development); and
- Safety Analysis Reports: March 31, 1997 (in development).

This SEMP defines the Systems Engineering approach outlined in the Implementation Plan and specifies the methods for planning and controlling the actions within the program. These methods are used to integrate today's configuration of the system managing the UF_6 inventory. The SEMP includes the specific actions necessary to define, upgrade, and maintain a system configuration. The upgraded configuration developed through this approach is termed the ***baseline configuration*** for which the program will assess and manage the system.

Key Systems Engineering tools used to integrate program actions include: traceability of requirements from the program mission to implementing documentation; verification of action development and completion; optimization of the configuration; and identification and control of interfaces between system functions (e.g., the interface of periodic cylinder inspections with maintenance and containment integrity forecasting). Verification techniques are instituted within the system to ensure that development actions contribute to defining baseline configuration and that field implementation of actions meets the requirements.

The planning and control methods defined in the SEMP include risk management, a work control structure, performance measurement, and configuration management. Risk identification and management are accomplished through development of and adherence to a safety envelope, which is documented in a Safety Analysis Report. The concept of developing, implementing, and adhering to a baseline configuration is controlled through configuration management.

Actions essential to developing the baseline configuration and complying with requirements are documented in Appendix D. These actions were identified through the requirements analysis process performed by about thirty subject matter experts in the fields of UF_6 cylinder operations; Environmental, Safety, and Health; Systems Engineering; and program management. Actions derived from the requirements analysis demonstrate progress in applying Systems Engineering to the UF_6 Cylinder Program. The development actions are managed through the EDP, and actions that are ready for implementation are managed through the PMP. Appendix D identifies whether each action is to be managed through the EDP or PMP. The SEMP also provides guidance for the sequencing and scheduling of actions.

Systems Engineering is an iterative process. The requirements analysis to identify actions documented in this SEMP has identified improvements in the major objectives and requirements documented in the previously published SRD. In general, no requirements or objectives stated in the SRD have been eliminated. Rather, the improvements include the addition of a major objective "administer the system" and the delineation between system-level requirements and subordinate technical requirements. System-level requirements represent a comprehensive list of essential characteristics with which the program must comply to achieve the mission. Technical requirements provide specificity to the system requirements, but as a whole do not represent the comprehensive characteristics necessary to achieve the mission.

The SEMP is a process-oriented plan to be used by all program personnel for applying Systems Engineering principles to an ongoing UF_6 Cylinder Program. Emphasis is on establishment and documentation of appropriate actions including identification of development activities. In concert with the SEMP development, the UF_6 Cylinder Program has accomplished significant near-term actions including removing cylinders from ground contact, cleaning and painting accessible skirted ends, constructing storage yards, and restacking cylinders; improving cylinder inspection and handling procedures; and procuring best available cylinder coating and application services. The Systems Engineering process is expected to continue to enhance the management of UF_6 cylinders in storage.

1. INTRODUCTION

1.1 BACKGROUND

The Department of Energy (DOE) manages the UF_6 Cylinder Program, which is responsible for a finite inventory of uranium hexafluoride (UF_6). The UF_6 is of less than 5% enrichment and is stored in cylinders at DOE sites. The gaseous diffusion uranium enrichment process produced this inventory while the plants were operated by DOE and its predecessors. The bulk of the inventory is 560,000 metric tons of depleted UF_6. It is expected that the quantity of depleted UF under DOE's ownership will increase (less than 15%) in 1996 with the acquisition of depleted UF_6 produced by the United States Enrichment Corporation (USEC) since June 1993.

The inventory is stored as a crystalline solid under vacuum. The material is stored principally in 48-inch-diameter, steel cylinders with capacities of 10 or 14 tons. The cylinders are 5/16-inch thick pressure vessels manufactured to the American Society of Mechanical Engineers (ASME) code. The cylinders are maintained at three sites: Paducah (28,351 cylinders); Portsmouth (13,388 cylinders); and Oak Ridge (4,683 cylinders). These cylinders are stacked two high in double rows, outdoors, on concrete and gravel. The cylinders are managed under DOE Directives and Orders derived from the Atomic Energy Act and other relevant laws.

During the development and operation of the enrichment process, containers, support equipment, and support facilities were designed, constructed, and used as a system to store, transport, and process the UF_6. The congressional adjustment of DOE's mission from uranium enrichment to uranium inventory management (storage and utilization) has transformed the previous system beyond the design, construction, and operation phases to the storage or standby phase. Because of this transition, the system for which DOE is responsible has been realigned to containment and utilization of a finite inventory of UF_6. Subsequent phases of the system include dispositioning of the uranium, decontamination of hardware and facilities, and decommissioning of hardware and facilities.

On May 5, 1995, the Defense Nuclear Facility Safety Board (DNFSB) issued to DOE a recommendation regarding the storage of depleted UF_6 in cylinders. DNFSB "Recommendation 95-1 on Depleted Uranium" recommended the following:

- Start an early program to review the protective coating of cylinders containing the tails from the historical production of enriched uranium.
- Explore the possibility of additional measures to protect these cylinders from the damaging effects of exposure to the elements, as well as any additional handling that may be called for.
- Institute a study to determine whether a more suitable chemical form should be selected for long-term storage of the depleted uranium.

On June 29, 1995, DOE accepted Recommendation 95-1 and emphasized five focus areas for DOE response:

- removing cylinders from ground contact and keeping cylinders from further ground contact;
- relocating all cylinders into adequate inspection configuration;
- repainting cylinders as needed to avoid excessive corrosion;
- updating handling and inspection procedures and site-specific Safety Analysis Reports; and
- completing an ongoing study that will include an analysis of alternative chemical forms for the material.

On October 16, 1995, DOE submitted an Implementation Plan that incorporated completed and near-term actions in accordance with these five focus areas. The Implementation Plan also committed to managing the UF_6 Cylinder Program using a Systems Engineering approach. The approach was developed concurrent with field response actions and was enhanced through an open dialogue among DNFSB staff and DOE and Lockheed Martin Energy Systems, Inc., (LMES) personnel. The Implementation Plan specifies the following interim and final deliverables and defines their respective content to establish an operative Systems Engineering process for the continued improvement of depleted UF_6 management through the UF_6 Cylinder Program.

- System Requirements Document (SRD);
- System Engineering Management Plan (SEMP);
- Engineering Development Plan (EDP);
- UF_6 Cylinder Program Management Plan (PMP); and
- Approved Safety Analysis Reports.

1.2 SYSTEM OVERVIEW

The ***mission*** of the UF_6 Cylinder Program is to safely store the DOE-owned UF_6 inventory until its ultimate disposition. The ***system*** established to meet the program mission is the means by which containment is achieved. The system comprises ***components*** (such as the UF_6, cylinders, cylinder yards, cylinder-handling equipment, personnel, and financial resources) and ***activities*** (such as operations, management processes, and administration).

The existing cylinders used to contain the UF_6 inventory are typically constructed with 5/16-inch-thick, mild steel walls and have a capacity of 10 or 14 tons. A bounding assumption identified in the Systems Requirement Document (SRD) is that the system can and will continue to use the existing cylinders. Because of this assumption, the current phase of the system is focused on maintaining the containment integrity of the existing UF_6 cylinders. The containment integrity of the cylinders must be maintained to progress the system from the current storage phase to the subsequent UF_6 dispositioning phase.

The system includes several ***operational functions*** to maintain the containment integrity of the cylinders. These operational functions are:

- Surveillance and Maintenance,
- Handling and Stacking,
- Contents Transfer, and
- Off-site Transport.

The system encompasses facilities, hardware, support systems, and/or subsystems for each of these operational functions. The flow of the operational functions is illustrated in Fig. 1.1. In addition to the operational functions, the system requires ***development and administrative support functions*** such as engineering development to realign and sustain the system effectiveness in meeting the program mission.

Major objectives for the program, as derived from the situation analysis documented in the SRD, provide the emphasis areas of the program. These major objectives have been used to facilitate identification of system and technical requirements. The major objectives are:

- Achieve and maintain acceptable risks,
- Achieve and maintain cylinder integrity,
- Improve conduct of operations,
- Evaluate and monitor containment integrity, and
- Administer the system

These objectives segment the safe storage mission of the program in response to the current condition of the system and the projected life cycle schedule for completing the last phase of the system (Decontamination & Decommissioning). These major objectives reflect the necessary focus areas to progress the system from the current phase to the subsequent phases.

1.3 PURPOSE OF THE SEMP

The SEMP documents the analysis of system requirements identified in the SRD. The system requirements were analyzed to identify actions to meet the requirements. These actions demonstrate the progression of the Systems Engineering approach adopted by the UF_6 Cylinder Program. The SEMP also identifies and organizes controls for integration of the program and system parts. The organization and identification of these controls demonstrate the decision-making process program personnel will use to guide development and implementation activities.

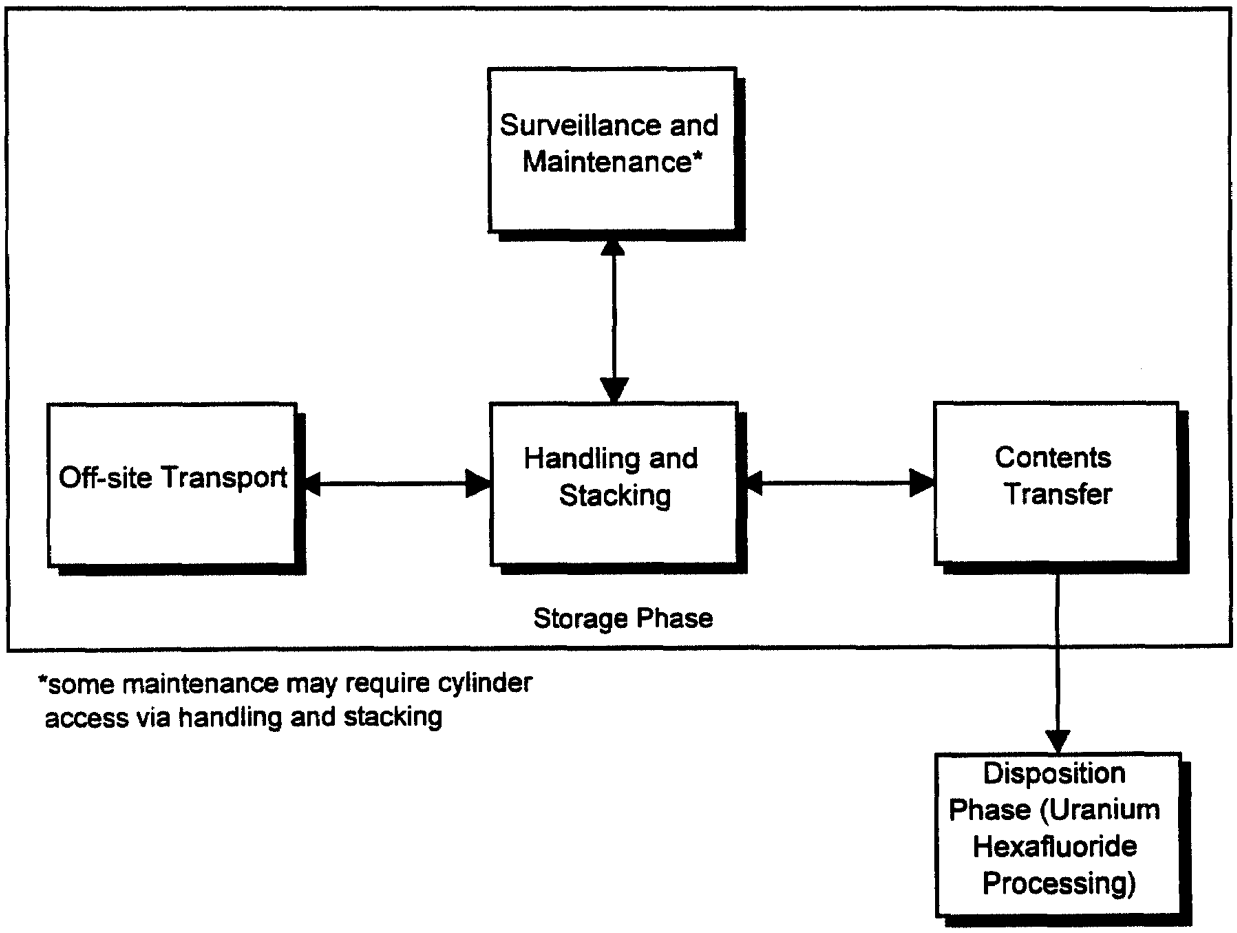

Fig. 1.1. Functional Relationship of Operations

Program personnel will use this SEMP to integrate the efforts of the UF_6 Cylinder Program. The integration will be accomplished by:

- implementing controls identified in this SEMP,
- carrying out actions specified in the Requirements Analysis section of this SEMP and verifying to ensure compliance with system requirements, and
- revising information contained in this SEMP as the UF_6 Cylinder Program Systems Engineering approach progresses.

These revisions will be controlled through the configuration management system identified in this SEMP. Systems Engineering–driven configuration management will begin upon completion of PMP. Existing configuration management will continue and will be integrated with the Systems Engineering–driven configuration management.

1.4 ORGANIZATION OF THE SEMP

This SEMP adopts the standard SEMP format identified in the Defense Systems Management College Systems Engineering Management Guide[1] and is reflective of most Systems Engineering efforts. This SEMP has four sections:

- *Systems Engineering Approach*–Describes the Systems Engineering approach taken by the program. The Systems Engineering approach is determined based on the complexity of the system and necessary rigor for developing and integrating the complexity. The approach is also based on the understanding that there is an existing UF_6 cylinder system in place and the task is realignment and integration of the existing system.
- ***Organization, Planning, and Control***–Describes the organization, planning, and control mechanisms to be used within the program to manage the system for attainment of cost, performance, and schedule objectives. This section establishes the tools and system processes for developing and adhering to the baseline configuration established by the Systems Engineering effort. The detail and rigor associated with these tools and processes are also reflective of the complexity of the system and are intended to correct the inherent deficiencies within the current system configuration.
- *Specialty Engineering*–Describes the specialty engineering disciplines to be used in the Systems Engineering process. Typical SEMP specialty engineering sections discuss the integration of engineering disciplines that may not drive the development of a particular hardware or software item but are necessary in order that the end product meets interactive requirements. Specialty engineering disciplines typically include areas such as human factors, safety, logistics, reliability, and maintainability. The system tasks for this mission do not emphasize the development of hardware or software items but rather the improvements to the existing system components and activities. The Specialty Engineering section of this SEMP reflects the appropriate application of specialty engineering to UF_6 cylinder management.

[1]*Systems Engineering Management Guide*, Defense Systems Management College, United States Department of Defense, January 1990.

- *Requirements Analysis*–Identifies necessary actions for meeting each requirement in the SRD. This section also discusses the scheduling and sequencing of the identified actions necessary to progress the system from its current configuration to the baseline configuration established through the Systems Engineering approach.

The last section focuses on the analysis to identify actions. Subsequent revisions of the requirements and actions will be subject to configuration control and can be accomplished without publishing the first three sections of the SEMP.

2. SYSTEMS ENGINEERING APPROACH

The Systems Engineering approach for managing the UF_6 Cylinder Program is outlined in the DOE Implementation Plan (IP) responding to DNFSB Recommendation 95-1. The approach is depicted in Fig. 2.1 and consists of four controlling documents:

- System Requirements Document–identifies the system requirements;
- Systems Engineering Management Plan–identifies organization, direction, and controls for system integration;
- Engineering Development Plan–identifies development actions, costs, and schedules for technical improvements; and
- UF_6 Cylinder Program Management Plan–identifies costs, schedules, and controls for operating the system and implementing required actions.

2.1 REQUIREMENTS IDENTIFICATION

Requirements from the previously published SRD have been revised. They are expressed as ***system requirements*** and more detailed ***technical requirements***. The system requirements represent a comprehensive list of essential characteristics necessary to successfully meet the program mission and major objectives. Technical requirements are subordinate to system requirements and provide the specificity necessary for safe operation of the system.

The system and technical requirements were determined by analyzing the primary system functions. This system functional analysis is documented in the SRD (see Fig. 2.1). Subsequent and more detailed consideration by UF_6 cylinder operations personnel and subject matter experts led to a set of revised requirement statements that enabled identification of responsive actions. The population of requirements specified in the SRD is incorporated in the technical requirements language provided in Section 5, List 1.

Requirements, where applicable, are linked to existing standards adopted by or imposed on the program. This link provides reference to DOE Directives and Orders, external regulations, and governing organizations. This link also provides the program with nationally proven methods and specifications for components and activities within the system. If necessary standards are non-existent, internal standards will be developed by the program. If nationally accepted standards are not readily adapted, the program will develop exemptions (or constrained exceptions) to those standards.

2.1.1 Functional Analysis Tools

Functional analysis begins with the identification of primary functions within the system and ends with the allocation of subfunctions. Functions are identified through use of functional flow block diagrams (FFBDs) to depict task sequences and relationships of requirements. FFBDs concentrate on *what* must happen, not *how* a function will be performed.

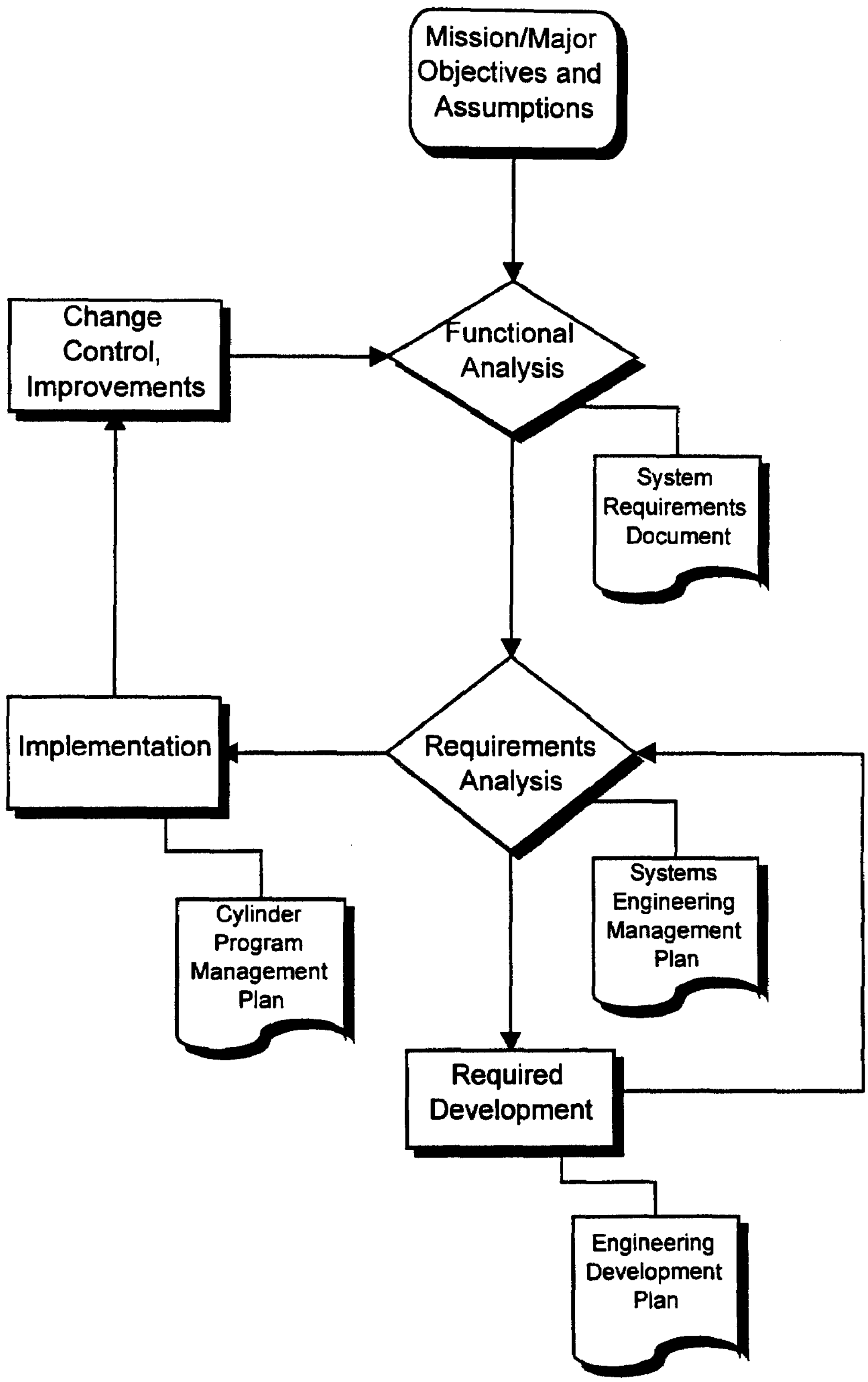

Fig. 2.1. Systems Engineering Development

FFBDs are developed in a series of levels. They show the same tasks identified through functional decomposition and display them in their logical, sequential interrelationship. FFBDs provide an understanding of total operational sequencing of the system, serve as a process basis for development of operational and contingency procedures, and pinpoint areas in which operational procedures could be changed to simplify and improve the quality of overall system operation. FFBDs are used for areas identified as deficient by program assessments (such as DNFSB Tech Report 4) where functional flow needs improvement.

The N2 diagram where N represents the number of functions under analysis (see Fig. 2.2) is used to identify data interfaces. The system functions are placed on the diagonal, and the rest of the squares in the N2 diagram represent the interfaces (inputs and outputs). Where a blank square exists, there is no interface between the functions horizontally or vertically aligned with the box. Data flow in a clockwise direction between functions. The data being transmitted can be defined in the appropriate squares. The N2 diagram can be broken down in successively lower levels to the hardware component functional level. In addition to defining the data and materials that must be supplied across the interface, the N2 diagram can also be used to pinpoint areas where conflicts (for example, lack of a procedure) could arise. N2 diagrams are developed for areas needing improvements in integration.

2.1.2 Requirement Identification Tools

Once the functional flows and interrelationships are determined, an assessment of the functions identifies the requirements for successful operation and execution of the task. This assessment includes the identification of risks and desired performance. Risks are identified through the risk management program, analysis of job tasks, analysis of current operational experience, and other analyses that will reveal key elements leading to the identification of requirements.

2.2 SYSTEM CONTROLS AND DECISIONS

After the initial functional analysis is complete and the system requirements are identified, the first iteration on the requirements analysis is performed to determine the necessary system planning and controls to integrate the system and maintain adherence to requirements. In addition, a requirements analysis is performed to identify the necessary actions for complying with the pre-established requirements.

2.2.1 Integration Controls

The decision-making process integrates hazard and risk associated with UF_6 storage, with the cylinder condition information and operational constraints. The method for ensuring this integration is to adopt a systematic approach to the development and operation of the system. This approach first requires the identification of appropriate integration controls for the inherent complexity and hazards in the system. The complexity of the system is identified in the functional analysis documented in the SRD. The probability of system hazards is documented in safety analyses.

input

output

SURVEILLANCE AND MAINTENANCE	cylinder location, condition, contents, need for moving	cylinder location, condition, contents, storage failure report	cylinder location, condition, and contents
handling acceptance criteria, access requirements, move authorization	**HANDLING AND STACKING**	handling acceptance criteria, handling constraints, move authorization	handling acceptance criteria, handling constraints, move authorization
transfer acceptance criteria	location and position of transfer operation	**CONTENTS TRANSFER**	location of transfer operation
transport acceptance criteria	location of transport vehicle, transport constraints, authorization to transport		**OFF-SITE TRANSPORT**

output

input

Fig. 2.2. N2 Diagram, Functional Flow of Operations

The integration controls and their specified rigor are documented in the Planning and Control section of this SEMP. The organization of the controls is:

- Risk Management;
- Work Control Structure (WCS);
- Interface Control;
- Performance Measurement; and
- Configuration Management, including change control and records management.

Risk Management

Risk management establishes the method and tools used to identify hazards and risks; identify appropriate controls; establish a safety envelope; monitor activities for compliance; and identify reductions in risks. The methods and tools used for risk management are in accordance with identified standards.

Work Control Structure

The WCS encompasses the use of:

- a work breakdown structure (WBS),
- a specification tree,
- a performance tree, and
- verification.

The ***WBS*** is used to segregate and organize the system development and ongoing activities into manageable elements. The WBS is defined in a WBS dictionary that describes the task(s), responsible individuals, costs, and schedules.

The ***specification tree*** contains the hierarchial breakdown of requirements and controls for which the corresponding task will be accomplished. These requirements identify the technical specifications and work controls, such as organizational agreements specifying performance. The specification tree is used in developing the costs and schedules defined in the WBS dictionary.

The ***performance tree*** establishes the performance measures for the WBS elements to be tracked at the project, program, business unit, and customer levels. Guidelines for the development of these performance measures are provided in the Performance Measurement Section of the SEMP.

Verification actions are key to demonstrating the successful completion of tasks and compliance with system requirements. Verification tests and evaluations are specified in the work control structure. The verification method for determining when the task is complete and that the results met the authorization intent is determined prior to task initiation.

Interface Control

Interface controls establish and document the integration of organizational functions, functional flow, and technical parameters. The tools used to define cylinder program interfaces include contracts, memoranda of understanding, organizational charts, delineation of roles and responsibilities, functional allocation, working group charters, and procedures. Interface controls include performance reviews, interface working groups, integrated product teams, and work authorization procedures.

Performance Measurement

Performance measurement delineates quantitative characteristics of the tasks and the system. Performance is monitored at various system levels to accommodate information needs of project, program, business unit, and customer levels. The various levels are evident in the WBS, where work is defined and controlled. The UF_6 Cylinder Program Manager, cognizant of WBS element interrelationships, is enabled to focus on areas of concern revealed by this ongoing quantitative review of progress.

Configuration Management

Configuration management involves identifying the system configuration baseline, controlling the baseline, and providing the status of the baseline. Configuration management provides a formal integration control mechanism. Tools to accomplish configuration management include:

- functional and requirements analyses and allocation to identify the configuration baseline and technical basis;
- configuration change control to maintain an operable baseline (actions, costs, and schedule);
- change control boards to review and authorize changes;
- various developmental milestones to control the development of configuration items including feasibility studies, certification for construction, and project validation;
- periodic reviews to compare actual system to documented baseline; and
- records management to control documents.

2.2.2 Specialty Engineering

Specialty engineering disciplines include areas such as human factors, safety, logistics, reliability, and maintainability. These disciplines are limited to problem-solving tasks in the system. Specialty engineering involvement is identified from the evaluation criteria in development plans and specified in charter statements for interface working groups and integrated product teams used to resolve issues.

2.2.3 Requirements Analysis

Requirements analyses are performed at each iteration of the functional analysis, to define subsequently more detailed levels of the system. The requirements analysis determines two categories of actions:

1. Actions that can be incorporated directly into the program operations–These actions are referred to as "implementing actions" and are managed through the WBS as part of the UF_6 Cylinder PMP.
2. Actions that need technical development before actions implementation–These actions are referred to as "development actions" and are managed through the EDP.

A detailed description of the first iteration requirements analysis process used on the UF_6 cylinder storage system requirements is documented in Section 5 of this document. This process involved requirement-related subject matter experts, operations personnel, program personnel, and system engineers.

2.2.4 Verification

Verification is critical to program quality assurance. Verification is both the first and final step for ensuring that an authorized task will and does meet the requirement. When a task is developed, its description must meet the intended purpose and a verification method must be established to ensure the results will meet the intended purpose. When a task is accomplished, it is verified as complete through the pre-established verification method. Standardizing the verification process appropriately streamlines this necessary function. To ensure the purpose of verification is not compromised when applying a standard method, consequences of improper verification will be considered. The four methods for verification are defined as follows:

Inspection–Inspection is a method used to determine characteristics by examination of engineering drawings (or flow diagrams) and computer program listings during product development to verify conformance with specified requirements. Inspection is generally nondestructive and consists of visual examinations or simple measurements with the use of precision measurement equipment.

Test–Test is a method used to verify conformance of functional characteristics with specified requirements. The test process will generate data, and test data are normally recorded by precision measurement equipment or procedures. The data derived from the testing are then analyzed or evaluated. Analysis as described here is an integral part of this method and should not be confused with the "analysis" described below.

Demonstration–Demonstration is a variation of the test method that is used to verify conformance of functional characteristics with specified requirement by go/no go criteria with the use of elaborate measurement equipment.

Analysis–Analysis or evaluation of simulation data is a study method resulting in data used to verify conformance of characteristics with specified requirements. Worst-case analytical data may be derived from design solutions if it is not possible to cost effectively test and demonstrate quantitative performance.

2.3 SYSTEM DEVELOPMENT

Systems engineering provides various tools and methods for developing an integrated system from the conceptual phase through implementation. The development context for the cylinder program is to evaluate the current system configuration and develop modifications to meet the program mission, objectives, and requirements. Many of these are program improvements focused on integrating the system operational and support functions existing today.

The identification of needed development is determined by the requirements analysis process. Requirements are analyzed to determine necessary actions to meet each requirement. These actions can be developmental or implementation-oriented actions. Actions that require technical development before being implemented in the field are managed through the EDP. The EDP is the management tool for implementing and tracking development progress. For this reason, the EDP is controlled through configuration management. The EDP is a subplan to the UF_6 Cylinder PMP. The EDP focuses on the costs, schedules, and work plans for development actions. Subordinate documents to the EDP include plans to complete the required development for specific actions.

Development may include analyses to determine the technical basis to which the current system is operating. This retro-analysis is necessary to reduce program risks or to integrate the current cylinder storage phase with the anticipated configuration of subsequent phases of the system life cycle. Development may also include new functions within the system that provide UF_6 containment. Developmental actions currently include:

- cylinder surface preparation decisions and demonstrations;
- exploration of additional engineering controls for the cylinder transport, autoclave, handling, and stacking operations;
- comprehensive evaluation of corrosion mechanisms;
- development of Safety Analysis Report(s); and
- other aspects of the DNFSB "Tech 4" Report.

The end objective of the development is to provide a technical basis for system realignment. The development may modify the actions documented in the SEMP. Thus, the results of development are subjected to a requirements analysis for assurance that expectations for the proposed implementing action will be met and that the implementing actions will comply with requirements. Decisions on the baseline configuration will be made by reviewing the products of the development. The revised configuration will be controlled through configuration management. The SEMP and other documents will be revised as necessary.

2.3.1 Analysis of Options

The analysis of options results in the selection of an option that meets pre-established criteria. The basic approach to analysis of options is first to identify the evaluation criteria used in the selection process. This includes standard criteria (e.g., risk, cost, integration, reliability) made specific to the study option. The criteria identify desired characteristics as well as involvement of speciality engineering disciplines. Development plans are then created and authorized, and optional solutions are identified, studied, evaluated, and tested to enable selection of an alternative.

2.3.2 Optimization

As an ongoing developmental activity, optimization and reoptimization of the system configuration is performed to reduce risks, lower costs, and adjust the configuration in response to revisions in the subsequent system phases (i.e., disposition of the UF_6). Reoptimization studies are justified based on the program mission and are performed as new technologies that could reduce risks or costs are identified.

Optimization ensures maintainability and reliability. Optimization tasks are also needed to improve quality and streamline the functional tasks and determine logistical flow of the functions. Examples of planned tasks that require optimization are:

- *Cylinder coating operations*–Prioritize which cylinders to paint first. Determine logistical flow of cylinder access, inspection, evaluation, characterization, surface preparation, and coating.
- *Cylinder storage array*–Optimize in-situ access with cylinder relocation operations for maintaining coating, and performing inspections.
- *Inventory consolidation*–Relocation of cylinders at K-25 to other sites versus upgrading K-25 storage facilities to meet required specifications.

2.4 PROGRAM MANAGEMENT

System operation is achieved by implementing the actions specified from the requirements analysis and the controls documented in the SEMP. The PMP is the management tool for implementing system operations. The PMP shows the links between the mission statement and specific actions within the program. The PMP documents implementation of the coordinated three-site UF_6 Cylinder Program, and the organizational roles and responsibilities within DOE and LMES for technical management, integration, and resources. The PMP documents the integration of the SRD, the SEMP, and the EDP.

The PMP also provides the WCS; establishes actions, schedules, and costs; and is used to control the program. To facilitate this control and monitoring aspect of the program, the PMP includes milestones and measures for performance, such as the schedule for painting the entire cylinder inventory. The PMP relates the engineering development activities with the actions implemented in the program operations. The PMP is controlled through the configuration management process specified in the SEMP.

The basic process of program management derived from Systems Engineering is:

- Define a baseline configuration for how the system is to operate.
- Establish expected performance, milestones, and accomplishments.
- Monitor the system performance.
- Resolve issues related to performance that falls below expectations.

2.4.1 Establishment of a Baseline Configuration

Establishment of the baseline configuration for the UF_6 Cylinder Program consists of defining the system components and arranging the system activities to establish management processes and functional flow of the overall system. The baseline provides a detailed description of the system, including actions, performance, cost, risk, specifications, requirements, and methods. The baseline configuration comprises a financial configuration and a technical configuration (see Fig. 2.3).

Financial Configuration

Standard cost estimating methods are used to develop financial needs for WBS elements of the UF_6 Cylinder Program. These estimates roll up to provide the budget demand for the program to operate the system. Level of effort and associated financial needs are prioritized to support the budget cycle and contingency planning. Once budget authorization is provided for a corresponding level of performance, the financial baseline documentation is implemented and controlled under configuration management. Funding allocations may need to be adjusted on an annual basis. Detailed allocation of budget to WBS will be included in the PMP.

Technical Configuration

The technical configuration is divided into a physical configuration and a functional configuration.

Physical Configuration. The baseline configuration consists of a physical architecture that identifies the physical components (hardware, software, personnel, facilities, etc.) necessary to sustain the system. The physical configuration identifies the location of hardware and real estate within the system and provides the design and performance specifications for these features. The performance specifications are integrated with these design specifications. Performance specifications are then integrated with the functional configuration of the system.

Functional Configuration. The functional configuration consists of the flow of information, operations, and management processes. The functional configuration identifies the functional interface specifications to maintain an integrated system. The functional requirements are analyzed and developed in conjunction with the functional configuration. These analyses expand and extend the functional flow to lower levels of detail. System objectives are analyzed, functions and subfunctions are identified, and technical performance specifications are developed for each function. Collectively, these performance specifications describe the complete system at each level. As the functions are detailed to the next lower level, the number of subfunctions increases, each with its own interfaces. This process is continued until the process reaches the lowest level at which discreet tasks can be identified and defined in the WBS.

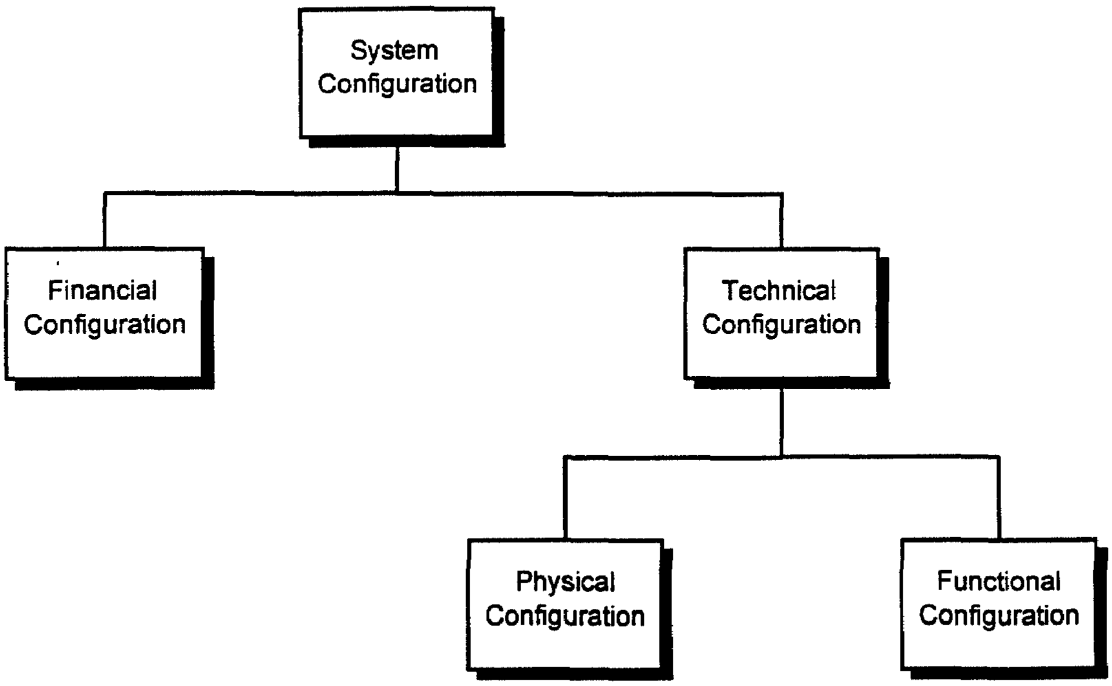

Fig. 2.3. System Configuration

2.4.2 Configuration Management

Configuration management for the system focuses on the control of baseline configuration, including performance plans and the technical basis for the system configuration. Configuration management includes the control of associated documentation. The technical basis is controlled through a formal configuration change control board. The performance plans are managed through a pre-established authorization basis. This authorization basis establishes the boundaries for changes permitted by the LMES manager, the DOE field office manager, and DOE headquarters manager of the UF_6 Cylinder Program. Configuration management also includes actions to monitor the status of the system configuration to ensure that the system maintains compliance with the established baseline.

2.4.3 Performance Monitoring

The performance parameters are considered when planning and scheduling all major activities. By so doing, the parameters provide UF_6 Cylinder Program management with a quantitative tool to measure and evaluate progress of technical events and milestones. The performance parameters provide expectations of system tasks. Monitoring performance against parameters provides technical input into engineering and program decision points, demonstrations, reviews, and other identified events. The performance parameters are described in detail in the overall PMP. The performance parameters are used to predict the future technical configuration of the system and, as such, serve to identify verification needed to ensure that program objectives are achieved.

As the program progresses, verification test results will be reviewed, evaluated, and compared to the established performance parameter boundaries. Trend analyses will be conducted. Resultant reports will include performance achievements or performance deviations. For performance in excess of requirements, opportunities for resource reallocation will be evaluated.

2.4.4 Issues Resolution

Issues–which consist of performance that is below expectations, off-normal operations, or impact from external forces–are identified by monitoring the system activities and interfaces. Issues are preferably identified as soon as possible while simple course corrections are still possible and significant problems can be avoided. Simple course corrections include the reallocation of funds or other resources to achieve milestones. Other issues that arise may require investigation, identification of root cause, and implementation of corrective actions per standards. The implementation process for identifying, resolving, and documenting issues will be in the PMP.

3. ORGANIZATION, PLANNING, AND CONTROL

3.1 RISK MANAGEMENT

Administration of the UF_6 Cylinder Program necessitates a strategy to identify and control risks associated with the storage of UF_6. Risk management is an organized means of identifying and measuring risk and of developing risk controls. The risk management strategy of the program is to establish a boundary for risk through a safety envelope and to control the program activities within that boundary. The following schematic (Fig. 3.1) demonstrates how the program includes various inputs from circumstance and ongoing studies. For the example provided, release of material is the occurrence leading to exposure of workers, the public, and the environment to hazards of UF_6. In establishing a safety envelope, the principles of ALARA (as low as reasonably achievable) are applied.

Risk controls are identified in the safety basis with a listing of preventive and mitigative systems, structures, components, and operator actions for each event evaluated during the risk analysis. Overall operational controls to mitigate risk through safety management programs and procedures, and other administrative controls are also identified. The risk management strategy seeks to expand on the hazard identification process of the safety basis; determine methods to further prevent, mitigate, or control risk; and determine methods to institute defense in depth.

3.1.1 Analysis and Assessment Tools

Risk analysis encompasses evaluation of both probability and consequence of events to define the perceived risk magnitude. The program has further defined risk by formulating both fault and initiating event trees (logic diagrams) to describe the cause and effects of events leading to hazard exposure. These logic diagrams will be used by the program to develop and examine alternatives in order to reduce or control risk. A risk matrix has been designed to evaluate the effects depicted by the event trees regarding both probability and consequence. An example of a preliminary risk management matrix for toxic hazards (shown in Fig. 3.2) demonstrates its potential as a tool to be used in aligning risk controls with hazards through risk management. Hazard grading is an integral function of the safety basis and establishes which hazards pose the greatest risk and where multiple controls (defense in depth) are required and most beneficial.

3.1.2 Risk Planning

To define the safety envelope for the program, the hazards associated with UF_6 cylinder storage and associated risks must be identified and evaluated, and controls necessary to manage the risks must be determined. This safety envelope is the boundary for safe operation of all ongoing and planned program activities.

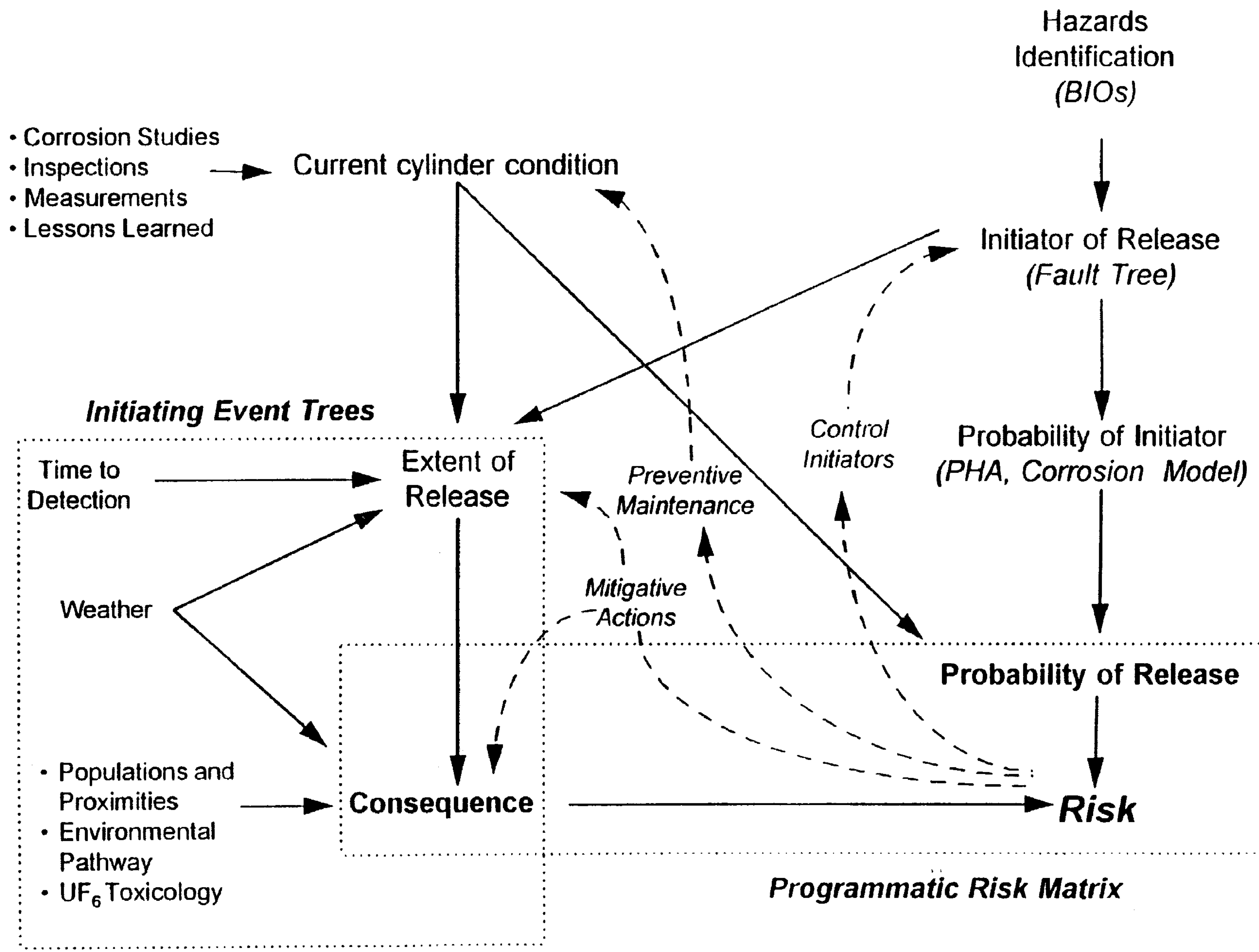

Fig. 3.1 Risk Schematic

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Hazard Components/Basic Hazard	Consequence and Frequency Components	Possible Controls	Program Approach	Program Measures
toxic material				
exposure	pathways to the worker, public, and environment	containment, reduce toxicity, container design	container integrity	
			control degradation	maintenance coating
				concrete yards and saddles
				engineering control, handlers
				skirt maintenance
			control impact sources	administrative vehicle control/access
				engineering controls
			control heat/energy sources	administrative control
			monitor containment	inspections and evaluations
				access/storage array
			mitigate hazard access to worker	worker emergency response training
				site emergency preparedness
				see rad. hazard measures
				valve monitoring
				inspections and evaluations
			mitigate hazard access to environment	concrete yards
				run-off control

Fig. 3.2 Preliminary Risk Management Matrix of Toxic Hazard

As an integral part of bounding the system risk, a Basis for Interim Operations (BIO) for the UF_6 Cylinder Storage Yards has been issued for each storage site. These BIOs document risk assessment analysis and control, and they provide the current safety basis. A standard hazard assessment method consistent with the guidance of DOE-STD-3011-94 was used to identify hazards associated with storage of UF_6 in steel cylinders. The hazards were prioritized using a Process Hazards Analysis, which examined the operations in the cylinder yards to identify the mechanisms for exposing facility workers, plant workers, and the environment to the hazards. It further characterized risk by analyzing the cause, effects, and magnitude of accident scenarios leading to hazard exposure. The types of accident scenarios identified include operational events, external events, and natural phenomena. The events were categorized according to the estimated frequency of occurrence (anticipated, unlikely, or extremely unlikely) and consequence (negligible, low, or high), which resulted in the assignment of an overall risk category. To more rigorously define the safety envelope and risk boundary, a Safety Analysis Report is being prepared for cylinder yard operations at each of the three sites.

Identification Methods

The system is monitored to identify changes in risk. These changes are analyzed to determine their impact on the system and the resulting risks associated with meeting the program mission and major objectives. The following methods are used to identify risks within the UF_6 Cylinder Program.

Corrosion Risk Assessment Modeling. A systemic risk within the program is corrosion of the mild-steel cylinders to failure. A corrosion model has been developed to forecast cylinder conditions over time. The results from this analysis are used as input into models for estimating risks and hazards associated with the cylinders in various conditions. This is part of the overall cylinder program risk assessment and serves as a basis for establishing preventive measures and for management decisions on corrective actions.

Technical Performance Monitoring. The performance within the program will be monitored to identify risks associated with performance that does not meet expectations. Performance to be monitored includes such aspects as: drainage from storage facilities, coating adherence to cylinders, cylinder configuration, valve and plug integrity, etc.

Operational Performance Assessments. Procedures are the primary controls of initiators within the program and are necessary to ensure that all tasks are performed safely and achieve the intent of the operation. The performance of operations personnel will be periodically monitored and assessed to ensure that procedural steps and stated precautionary measures are followed and unsafe activities are identified. The safety basis will be periodically reviewed and updated to reflect changes within the program. If the safety basis is in question because of changes in procedures, work scope, and/or storage configuration, then appropriate assessments and updates will be conducted to ensure consistency among actual operations, the documented configuration, and the safety basis.

Facility Safety Walk-Throughs. Facilities and operations must be monitored to determine the presence of hazards and potential initiators for comparison to the safety basis. This ensures that facilities will be managed in compliance with the safety basis and identifies any necessary actions to maintain that compliance. Facility safety walk-throughs will be conducted regularly, to identify initiators and determine ameliorative actions.

3.1.3 Risk Control

System risks are controlled by managing the system within the risk boundary identified in the safety basis. The monitoring methods listed in Section 3.1.2 are essential to controlling the overall system within the safety envelope. This monitoring identifies instances when additional analyses and actions are needed to ensure current and planned risks are within the safety envelope. Management systems for flagging the need for analysis include the Unreviewed Safety Question Determination (USQD) process and the readiness review process for new operations.

Specific hazards are controlled by invoking Safety Management Programs, which include:

- Radiation Protection and Industrial Hygiene programs for cylinder yard surveys;
- Nuclear Criticality Safety program to control the storage of cylinders containing fissile material, including the Implementation Plan for DOE Order 5480.24;
- Emergency Response program to respond to fires and material releases;
- Surveillance and maintenance programs to ensure cylinder integrity;
- Maintenance program for the cylinder handling equipment;
- Procedures program to ensure that procedures exist for all cylinder yard operations;
- Training program to ensure operators are trained in all operating procedures; and
- Fire protection program to respond to fires.

Additional administrative controls that may be required to further minimize the risk of operation include:

- Flammable Materials Control to disallow the storage of flammable materials in the cylinder yard and to prevent refueling operations in the yards or on adjacent roads,
- Vehicle Access Control to allow only DOE-recognized cylinder handling and moving equipment in the cylinder yards, and
- Emergency Notification program to require operators to be equipped with communication devices to communicate with the plant fire department and/or Emergency Response.

Engineered controls are also used within the program in a "defense in depth" sense to control or eliminate risk. Engineered controls are physical barriers to mitigate or prevent the occurrence of an incident. For the cylinder program they include the coating of cylinders, designed drainage capacity of storage facilities, and speed controls on handling equipment. Additional engineering controls are to be considered as the baseline configuration of the system is developed.

3.1.4 Risk Reduction

Reduction of current risks within the program stems from the major objective of the program to ensure risk are low. The ALARA concept will serve as a guide to all risk management and reduction efforts within the program. The current configuration of the system contains inherent risks that could be reduced or eliminated. Risk reduction measures–such as reducing the corrosion rate on cylinders through applying paint, eliminating gravel yards, and facilitating drainage from cylinder skirts–are part of a risk reduction matrix. This matrix is developed to prioritize the system operations and is integral to the logistics planning. A preliminary risk reduction matrix is shown in Fig. 3.3.

Other risk reduction or avoidance tools for the UF_6 Cylinder Program include:

Periodic Job Hazards Analysis. When the baseline configuration of the system is changed or technical assumptions within the program are revised, job hazard analyses are performed to determine if a change in risk is inherent.

Off-Normal Occurrences. Incidents are investigated to determine the causes and recommend solutions.

Lessons Learned. "Lessons learned" within operations similar to the cylinder program are monitored and addressed in order to avoid incidents and reduce risks or potential risks.

3.1.5 Responsibilities

Risk management is integrated with the development of the system; planning of new, additional activities; decisions; and monitoring of the system performance. Risk management is performed by experienced system personnel with a knowledge of the risks within the program. Risk management personnel are responsible for monitoring the development and performance of the system, identifying changes in risk, and recommending further analysis, assessments, and controls. Upon approval from UF_6 Cylinder Program management, risk management personnel perform these additional analyses and assessments. Risk management personnel are represented on the Configuration Control Board to ensure the risks associated with proposed changes have been considered. Risk management personnel are responsible for developing the risk management matrix and the risk reduction matrix into the overall logistics planning of systems operations.

3.2 WORK CONTROL STRUCTURE

This section defines the tasks within the system and how they are organized into manageable elements, from both technical and financial standpoints. To effectively manage a system, it must be apportioned into elements that can be readily assigned to specific organizations and individuals for development, implementation, and control. A standard hierarchy is used from the system level down to the component and activity levels. A standard hierarchy includes: system, segment, function, subfunction, component, and activity.

Hazard/Program Measure	Preliminary Risk Reduction Prioritization		
exposure (toxic/radioactive)	**High Risk** ===>		**Low Risk**
paint skirts	▲ accessible skirts	▲ inaccessible skirts	
paint bodies	▲ heavily corroded cylinders	▲ cylinders without paint	▲ balance of inventory
no gravel yards	▲ ground contact/ water retention	▲ deteriorating yards	▲ balance of yards
no wood saddles	▲ ground contact/water retention	▲ deteriorating saddles	▲ balance of saddles
implement additional controls on handlers	▲ non-marring controls		
upgrade handling procedures	▲ degraded, in-ground-contact factors	▲ systems engineering factors	▲ SAR upgrade factors
clean skirts	▲ accessible skirts	▲ inaccessible skirts	
implement heat/energy source controls	▲ implement policy/procedures, training		
implement inspection improvements	▲ redline	▲ systems engineering factors	▲ SAR upgrade factors
make cylinders accessible	▲ inaccessible skirts	▲ balance of inaccessible	
improve emergency preparedness	▲ table top exercise		
improve valve monitoring	▲ standardize procedure		
inspect 100% of surfaces	▲ heavily corroded, suspect cylinders	▲ inaccessible cylinders	▲ balance of inventory
criticality (radioactive)			
eliminate	▲ sale	▲ disposal	
segregate	▲ consolidate fissile		
improve mitigation	▲ implement actions from evaluations		

Fig. 3.3 Preliminary Risk Reduction Matrix

3.2.1 Elements of the Work Control Structure

The system hierarchy is established through the use of a WCS. This structure (illustrated in Fig. 3.4) consists of a WBS, a specification tree, and a performance tree. The WCS identifies all the hardware, software, processes, and other resources under the UF_6 Cylinder Program. The WBS apportions the system into segments (Program Administration, Operations, and Development). Segments are apportioned into functions, which are further broken down until individual actions are identified.

Successive lower levels are developed to the point where Program Management can sufficiently develop budgets, control the costs, and successfully manage progress. This breakdown is illustrated in Fig. 3.5. Each segment, function, subfunction, and action represents a WBS element that is defined in the WBS dictionary.

Work Breakdown Structure

The WBS dictionary identifies the required resources, schedule to task completion, end products or accomplishments, responsible organization, and interfacing WBS elements to be integrated within the progression of the task. The work description is sufficient for the performing organization to develop budgetary and schedule requirements. Each WBS element has an assigned number that identifies its position in the WBS tree. Each WBS element references associated elements in the specifications tree and the performance tree.

The basic function of the WBS is to isolate costs to the lowest meaningful level in order that the costs associated with a single hardware component or activity can be identified. With additional data, such as allocated budgets and detailed task milestones, it provides the basis for the cost/schedule control system implementation. The WBS is defined and controlled in the UF_6 Cylinder PMP.

Specification Tree

The specification tree is subordinate to the WBS. It identifies the hardware; software; and work control documents (contracts, work plans, procedures, etc.) necessary to accomplish the associated WBS element. The specification tree also references the hardware and software design criteria and subsequent "manufactured to" specifications. This information is contained in the baseline configuration documentation. The specification tree is separated from the WBS as different factors necessitate its revision. The specification tree is used to convey how work is to be performed. Pre-established verification method is another part of the specification tree.

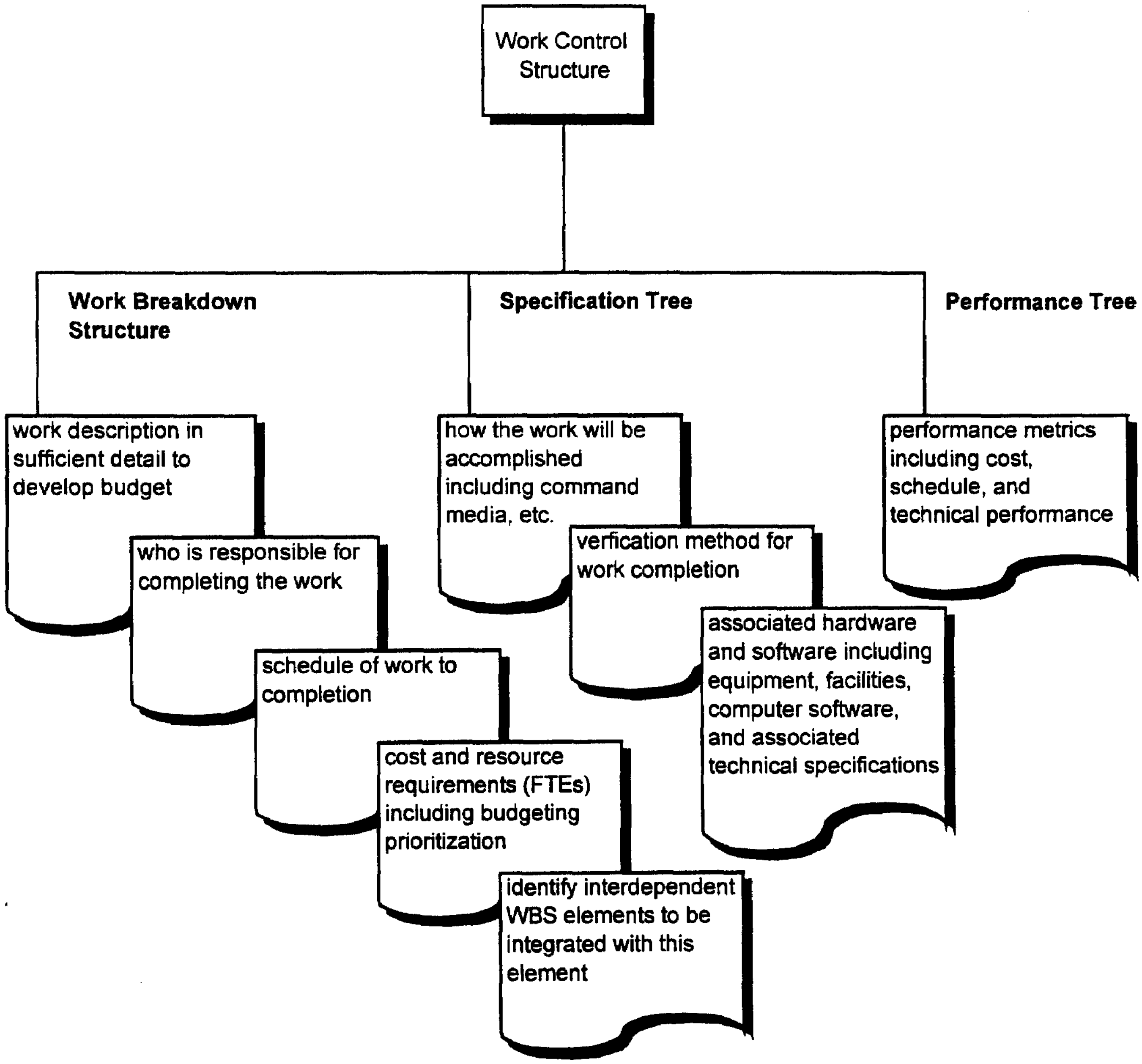

Fig. 3.4. Work Control Structure Definition

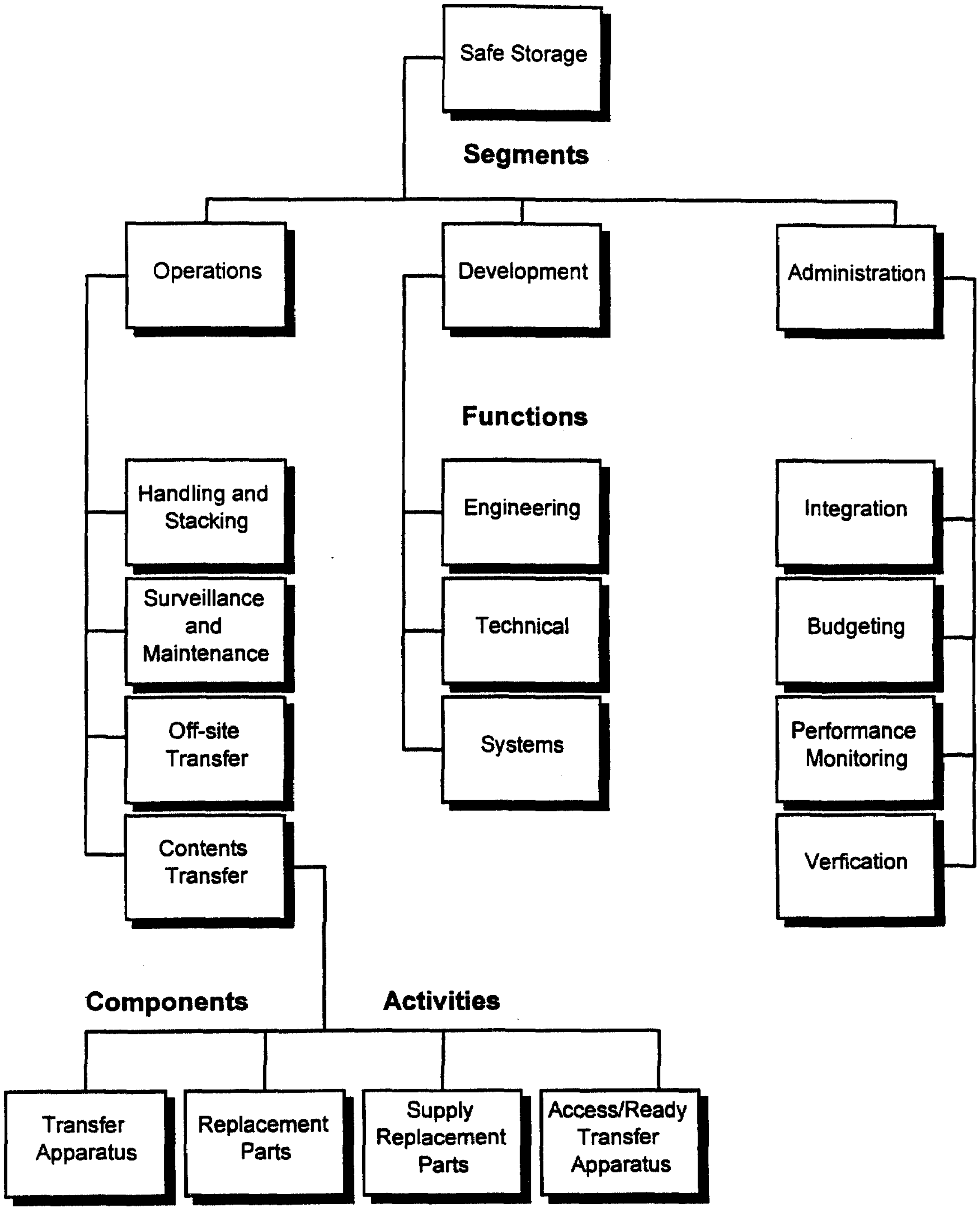

Fig. 3.5. Work Breakdown Structure Hierarchy

Performance Tree

The third component of the WCS is the performance tree, which is also subordinate to the WBS. The performance tree contains the metrics for the system, identifying performance indicators such as actual vs. planned costing and actual vs. planned technical progress. Not all WBS elements have associated performance tree elements. The performance tree is summarized at various levels within the system hierarchy to monitor the status at the project, program, business unit, and customer levels with relevant information on the condition of the system. Management uses the performance tree as a tool to identify where additional resources may be necessary. Risk Management uses the performance tree to identify risks outside the baseline risks for the program.

The example below provides the hierarchial performance measures monitored by various management levels for cylinder painting:

DOE-HQ:
- Procurement of painting services
- NEPA documentation completion
- completion of cylinder painting for specified populations

DOE-ORO: Above plus:
- completion of surface preparation and coating demonstrations
- initiation of cylinder coating
- monthly coating rate

LMES Three-Site: Above plus:
- completion of the logistical flow for cylinder movements, evaluations, coating, and placement back into storage facilities
- weekly coating rate
- technical performance of the coating

LMES Site-Specific: Above plus:
- technical and schedule performance of cylinder evaluations, surface preparation, and coatings on a weekly basis
- daily coating rate
- cylinder movements (logistics performance)

3.2.2 Specific Uses of the WCS

The WCS conveys sufficient information to support management needs for schedule and cost planning and control. The WCS provides both a basis and an integrating mechanism for managing key functions of the program. The WCS is used to support management control in the areas of Planning, Funding, Cost Estimating, Scheduling, Performance Measurement, Configuration Management, Integrated Logistical Support, and Test and Evaluation.

Planning and Budgeting

The WBS identifies products and relates work effort necessary to meet the program objectives. By breaking the total product into its parts, the Program Manager can ensure that required work efforts are identified and actually contribute to the objective.

Funding

The WBS, along with the schedule for each element, aids the Program Manager in establishing, justifying, and allocating program funds for the next and future fiscal years. Through defining cost content, management priority, and status for each WBS element, there is a baseline for planning, controlling, and accounting for program funds. Management priority is developed from risks within the program and system requirements. Management priority relates directly to funding allocation where fund availability is less than projected costs for operation and development tasks.

Cost Estimating

The WBS provides a systematic, comprehensive approach to cost estimating that ensures relevant costs are not omitted. A "bottom-up" cost estimate, using WBS elements, aids the manager in monitoring, coordinating, and controlling the various activities of the program. Additional cost estimating controls are identified in the configuration management section of the SEMP. The specification tree is an integral part of cost estimating. The specification tree provides information regarding the quality and extent to which the tasks should be performed.

Scheduling

Through scheduling of the individual elements of the WBS, and the integration of those schedules into the next higher level of the WBS, the Program Manager is enabled to build an integrated approach to the entire program. This allows expedited review of the program and readily points to problem areas for concentrated management attention. The specification tree is an integral part of scheduling. The specification tree provides information regarding the quality and extent to which the tasks should be performed.

Performance Measurement

Since the performance tree and accompanying WBS dictionary fully define the work to be accomplished, they provide the basis for performance measurement with a product orientation. The Program Manager, knowing the interrelationship of the WBS elements, focuses on areas of concern through an ongoing review of progress. Various levels of performance measurement are extracted from the WBS to report progress at the project, program, business unit, and customer levels.

Configuration Management

The Program Manager identifies the level to which Configuration Management will be used. The WBS elements are mapped onto the discrete work packages that relate to the system baseline configuration and where the Configuration Management process is applied. Verification methods are identified as part of the specification tree.

Integrated Logistical Support

Through the identification of all elements of the program–including support functions such as maintenance plans, facilities, support and test equipment, spares and repair parts, technical data, and training–the WBS provides the ideal format for identifying the functions of integrated logistical support. The WBS is mapped to the baseline configuration, where interfaces between component and activities are specified.

Test and Evaluation

The WCS provides specifically for testing systems, subsystems, and components in the development segment. Through the test and evaluation elements of the WBS, the Program Manager breaks the elements into the planning, conduct, support, data reduction, and report functions of testing. This section of the WBS relates to the tasks in the EDP.

3.3 INTERFACE CONTROL

The following sections describe the interface methods and controls within the system.

3.3.1 Organization Interfaces

Interfaces between organizations are primarily established by identifying the roles and responsibilities of each performing organization relative to the system activities. The organizations that interface with the system are shown in Figs. 3.6 and 3.7. The roles and responsibilities for organizations shown in Fig. 3.6 for which the system is responsible are the interfaces with DOE, LMES, and Lockheed Martin Utility Services, Inc., (LMUS). In accordance with specified roles and responsibilities, no individual or organization is assigned responsibility beyond his, her, or its expertise and qualifications. The interfaces are controlled through documentation including contracts with outside organizations and interorganizational agreements between the program organization and support organizations. These documents are controlled by configuration management. The program organization is illustrated in Fig. 3.8.

Appendix A establishes the guidelines for developing roles and responsibilities for the business management and engineering functions within the program. The information is provided for example only. Memoranda of agreement and statements of work for each organization will be included in the PMP.

3.3.2 Functional Interfaces

Various functions are necessary to support the system. These functions process hardware, software and information to accomplish tasks within the system. These processes are determined through the functional analysis via the use of FFBDs and N2 diagrams. These N2 diagrams identify the data

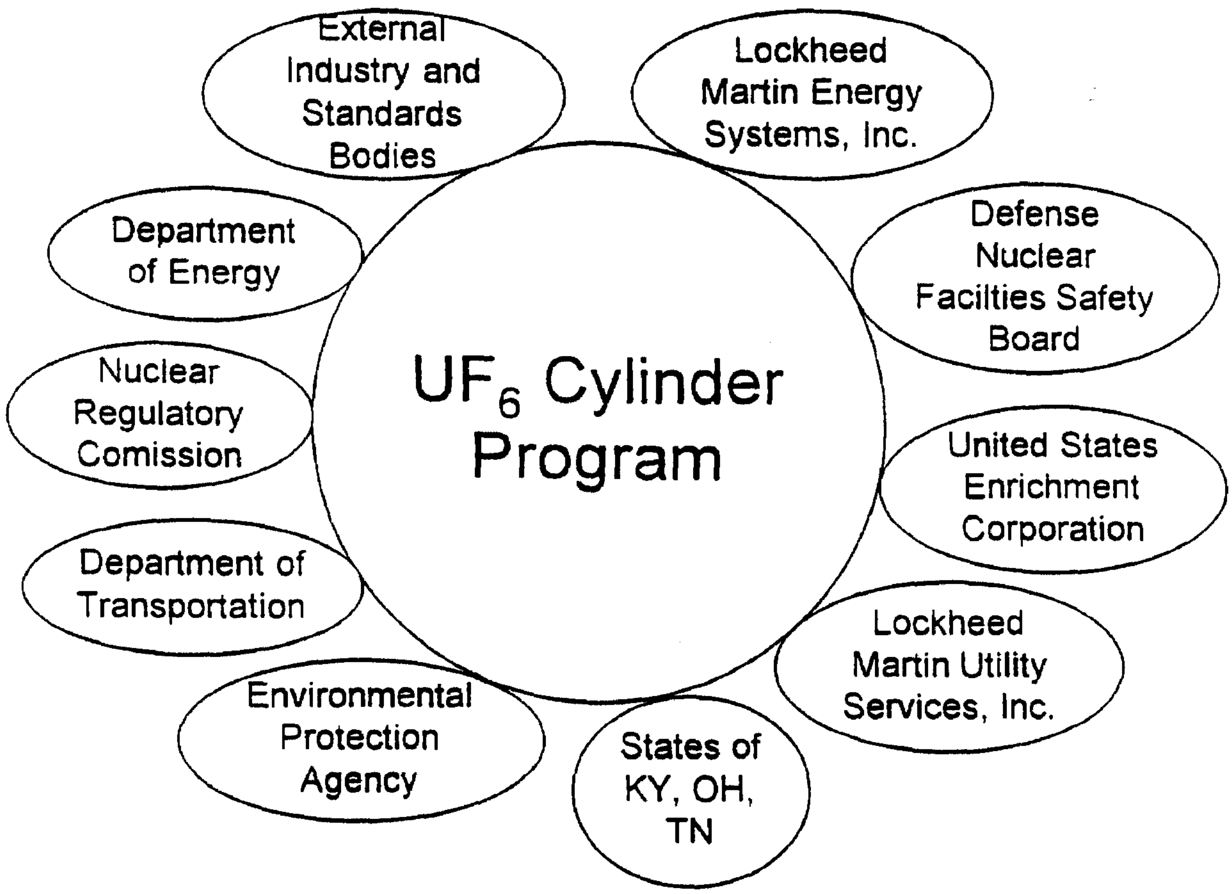

Fig. 3.6. External Organization Interfaces

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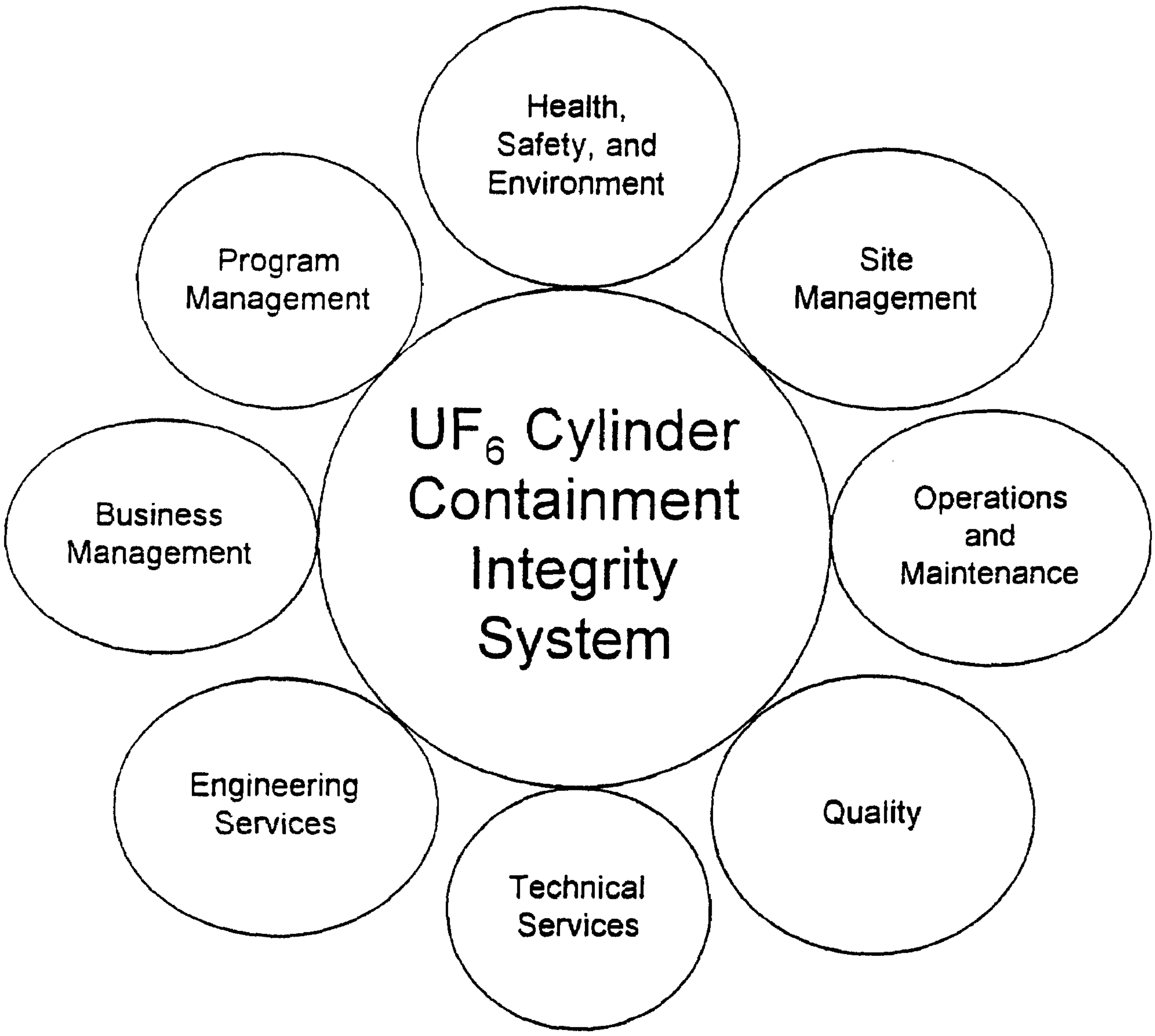

Fig. 3.7. LMES Interorganizational Interfaces

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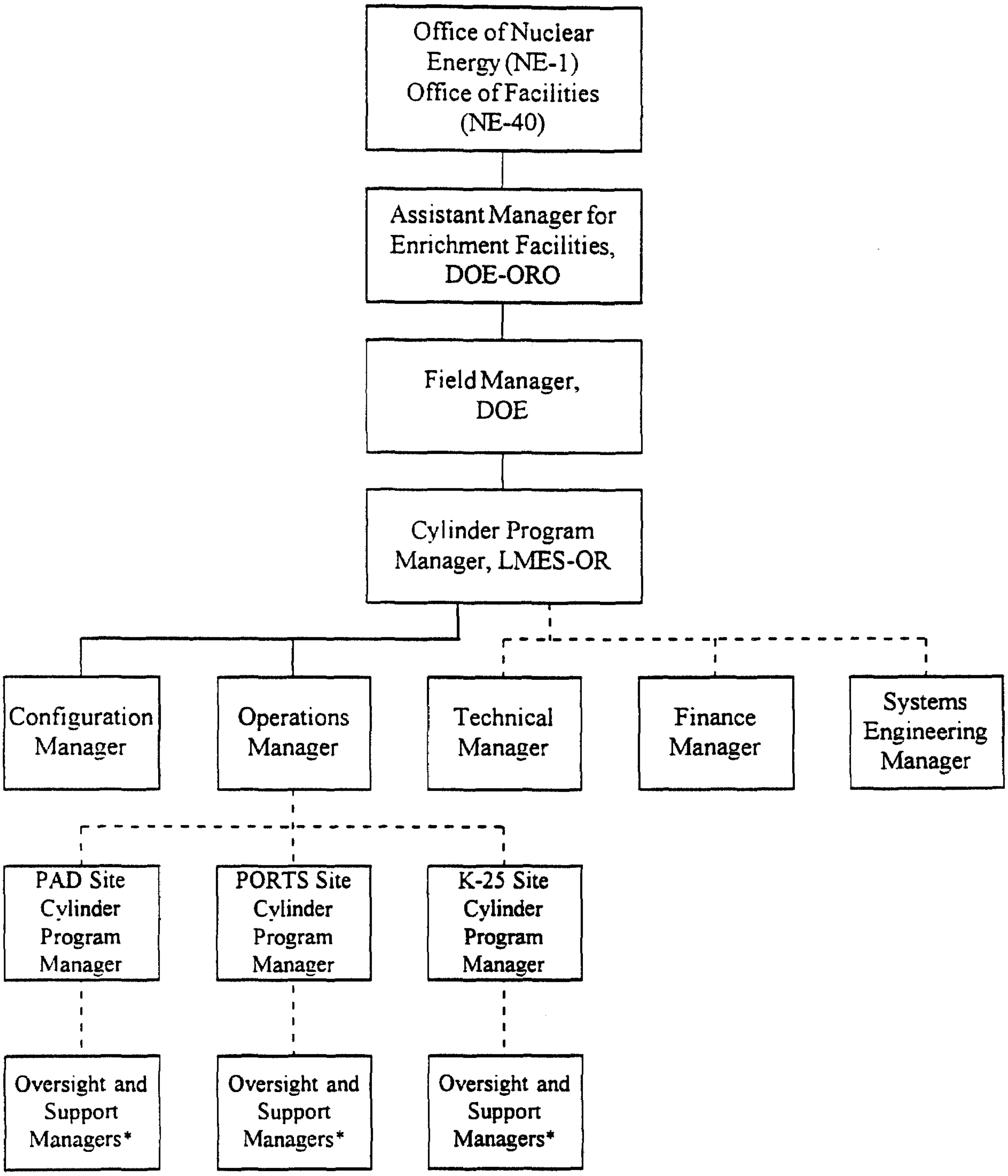

*Oversight and Support includes Environmental, Health, Safety, Risk, and Quality Assurance

Fig. 3.8. Program Organization Chart

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input and output of one function to other functions. As the successive iterations of the functional analysis are performed to lower level subfunctions the interfaces are comprehensively identified. The definition of an N2 diagram is depicted in Fig. 2.2. Functional interface requirements are contained in the appropriate segment, function, activity, or component WBS element.

Systems engineering and configuration management personnel must coordinate the design and modifications efforts to ensure compatibility of critical interfaces. For this purpose, interfaces are identified and coordinated, as needed, by Interface Working Groups and Integrated Product Teams headed by the Systems Engineering Manager. The Interface Working Groups are composed of several individuals handling specialized interface areas such as cylinder yard maintenance, computer resources, and field inspections. The Systems Engineering manager organizes these groups as necessary, ensuring that the proper specialists are identified. The Interface Working Groups are established when integration issues arise or new tasks are being planned.

3.3.3 Technical Interfaces

Technical interfaces are identified and defined to ensure operations are successfully integrated. The identification of technical interfaces is used in the development of a comprehensive performance objective for each interactive component. Technical interfaces can be hardware interfaces (where one component interacts with another component or activity) or software interfaces (where one computer program interfaces with another computer program). A systematic approach is used to identify technical interfaces. This systematic approach requires:

- identification of components in the system through a system description;
- identification of the applicability, if any, of each component in system function;
- identification of the interfaces of all the components within each function;
- identification of the interfaces of each component throughout applicable functions;
- evaluation of the interfaces for technical aspects;
- allocation of performance to each component or activity based on identified technical interfaces; and
- encompassing of the interface related performance with functional and other performance requirements for design of a component.

Because most components already exist within the system, the opportunity to initiate an integrated redesign of each component is limited (i.e., the assumption is made that, within the system, existing cylinders will be used to store the solid UF_6). Decisions for instituting a redesign are based on the risks imposed by the lack of technical integration at identified interfaces, life-cycle costs, and the ability to accomplish major objectives within the program.

The technical interfaces are used as part of the development of the baseline configuration for the program. Allocating performance specifications to components defines the physical architecture baseline for the system and establishes constraints on the baseline. For this reason technical interfaces are defined and documented to the extent necessary in component performance specifications. Examples of possible technical interfaces within the system identified through preliminary application of the above process are as follows:

Hardware Technical Interfaces in the Surveillance and Maintenance Function

- Cylinder surface–coating (time-of-wetness protection)
- Cylinder–saddle (cylinder drainage)
- Saddle–yard (yard drainage)
- Time of wetness (rain, humidity, condensation)/storage configuration (tiering, rows, saddle, yard, cylinder design)
- Color of coating–reaction products (visual inspections)
- Cylinder inspection–storage configuration (cylinder surface accessibility)

Hardware Technical Interfaces in the Handling and Stacking Function

- Cylinder coating–handler tines
- Cylinder coating–saddle
- Cylinder wall thickness–contact points (structural integrity)
- Cylinder handling equipment lowering rate–toughness of the cylinder
- Cylinder handling equipment operator–visibility of cylinder (stacking operation)

Software Technical Interfaces in the Administrative Function

- UF_6 Cylinder Location, Inspection, and Measurement (UCLIM) database–Nuclear Materials Control and Accountability (NMC&A) database (revisions of cylinder content and location)
- Cylinder Program relational database–LMES Standards/Requirements Identification Document (S/RID) database (revisions)
- Cylinder Program accounting system–LMES accounting system

3.3.4 Document Interfaces

The program has several document interfaces. Figure 2.1 identifies the relationship and interface of the Systems Engineering documents for the program (the SRD, SEMP, EDP, and the PMP). Other program documentation flows down from the Systems Engineering documents as specified in the Systems Engineering documents. Key program documentation that flows down from these Systems Engineering documents includes the physical architecture, the component and functional performance requirements, and the cost and schedule plans. Other key flow-down documentation includes program control policies and procedures, subcontracts, and resultant change and progress reports. Program documentation also interfaces with documents that compile information on other programs and systems outside the UF_6 Cylinder Program (e.g., the Uranium Program Enrichment Facilities fiscal year baseline plan, and Site Safety Analysis Reports).

To express the interface between program and program-related documents, documents generated by the program must include the purpose, scope, and key document interfaces (what documents respond to information in the subject report and how). These parameters are identified in the subject documents generated by the program. In addition, the Systems Engineering documentation identified above will identify supplemental (flow-down) documentation that supports the intent and objectives of the program. Documents generated by the program are subject to configuration management.

3.4 PERFORMANCE MEASUREMENT

Performance measurement is a Systems Engineering management tool that is used to quantify performance and communicate system performance evaluations. Parameters to be measured reflect mission objectives, more specific critical requirements, and WBS elements that should be periodically or constantly verified. Performance measurement may also be used to predict, adjust and control system performance to ensure objectives are achieved.

Communication of actual vs. planned performance verifies compliance and conformance and identifies problem areas that need management attention. Control of system effectiveness can be executed by responding to performance measures. The impact of changes to the system can be estimated. As the program progresses, identified performance measures will be quantified, evaluated, and compared to boundaries and standards. Trending analyses will be conducted. Reports to program management (LMES and DOE) will include performance achievements (verification) or deviations (problem resolution opportunities). Opportunities for resource reallocation or requirement recalibration will be identified based on performance in excess of quantified expectations.

Specific performance measures in use are expected to change as the system matures. Initial performance measures for the cylinder management program would include:

- number of cylinders in ground contact;
- number of cylinders 100% inspectable;
- number of cylinders in compliant storage;
- frequency of cylinder inspections conducted (annual, quadrennial, ultrasonic);
- number of cylinder skirts cleaned;
- number of cylinder skirts painted; and
- number of cylinders recoated.

Subsequent performance measures may include:

- maintenance cost per cylinder;
- rate of corrosion;
- rate of depleted uranium disposition;
- conforming/nonconforming cylinders; and
- leaking valves.

In implementing performance measurement, values are defined as follows:

Planned value–The anticipated value of parameter at a given point in the development cycle. A plot of planned value vs. time is known as a profile. A tolerance band or range of acceptable values versus time may be indicated.

Demonstrated or actual value–The value estimated or measured in a particular test, monitoring event, or analysis.

Specification–The value or range of values contained in requirements, standards, or design and performance specifications.

Current estimate–The value of a parameter predicted for a certain point in time or as the end product of a defined task.

Demonstrated or actual variance–The difference between the planned and demonstrated value of a parameter.

Predicted variance–The difference between the specification and the current estimate.

Performance measures to be reported and tracked are determined through identification of critical areas from review of Systems Engineering documentation, development specification requirements, and planned performance incentives. Results are recorded for comparison with planned values. Variances are analyzed including evaluation of their effect on risk, schedule, and cost. Summary reports will be prepared and provided to site, program, LMES, and DOE management at a frequency determined by the respective recipient.

3.5 CONFIGURATION MANAGEMENT

Configuration Management ensures that consistency is established and maintained among the physical, functional, and financial configuration, the requirements, and the related documentation throughout the systems' life cycle with special emphasis on control of changes. Configuration Management is an integral part of the Systems Engineering process for system definition and control. Its role is to:

- identify the configuration items (CIs) to be maintained throughout the system's life cycle;
- control changes to those CIs (including documentation); and
- assess development and implementation status of the baseline.

Configuration Management ensures that the continuity of design, engineering, trade-off decisions and performance are recorded, communicated, and controlled by the program. Configuration Management is initiated early in the Systems Engineering process and will continue throughout operations as the system develops and is modified. Changes are expected to occur throughout the life of the system as (1) more knowledge of the system design, operation, and maintenance concepts is gained; (2) mission requirements change or are refined; or (3) non-technical factors such as cost and schedule influence design, operations, or maintenance. These changes must be controlled to ensure that they are technically acceptable, consistent with applicable requirements, and cost-effective. Changes must be properly documented so that all users are aware of the current system configuration. Configuration Management provides traceability to previous baseline configurations of the system. Configuration Management also documents the rationale for configuration changes permitting analysis and correction of deficiencies when they arise.

3.5.1 Elements of Configuration Management

The following sections describe the elements of the UF_6 Cylinder Program Configuration Management. These elements and their relationships are shown in Fig. 3.9. A separate configuration management plan will be developed to describe the details of Configuration Management for the UF_6 Cylinder Program.

Administration and Organization

Administration and Organization is the element that organizes and administers Configuration Management for the program. These activities will ensure that the other Configuration Management elements are implemented effectively in a consistent, cost-effective, and timely manner.

This will be accomplished by defining and communicating the responsibilities, authorities, and interfaces among organizations to managers and personnel responsible for implementing Configuration Management. The configuration items (CIs) to be included in the scope of Configuration Management will be identified and documented. Key Configuration Management activities will be identified and monitored to ensure conformance with system requirements. Configuration Management training will be provided for personnel to improve communication and understanding of important Configuration Management concepts, terminology, and requirements. Also, adequate staffing and resources will be provided; necessary data bases will be developed; and Configuration Management weaknesses will be identified, tracked, and resolved in a timely manner.

Requirements

Requirements is the element that identifies the essential characteristics that must be satisfied to meet the program mission and major objectives. Requirements interface with the change control element to provide a basis for deciding whether a change is acceptable. Likewise, they interface with the documentation element to ensure the requirements are documented and available. Over time, new requirements may be identified or developed.

Documentation

The Documentation element ensures that documents affected by a change are identified, updated to reflect the change in a timely manner, distributed appropriately, and are readily available when work is performed or decisions made. Control ensures that documentation is consistent with the physical and functional configuration and with the applicable requirements. This control process identifies those documents to be included under Configuration Management and tracks document status, especially during revision. The program recognizes two types of documentation: (1) documents essential to sustaining the system and (2) documents non-essential to sustaining the system. The distinction between essential and non-essential information will be defined in the UF_6 Cylinder Program Configuration Management Plan. Documents considered essential to sustaining the system include the baseline configuration documentation, system controlling documentation, and documentation recording data that affects the baseline configuration. These documents are identified in Fig. 3.10. Essential documentation is placed under Configuration Management.

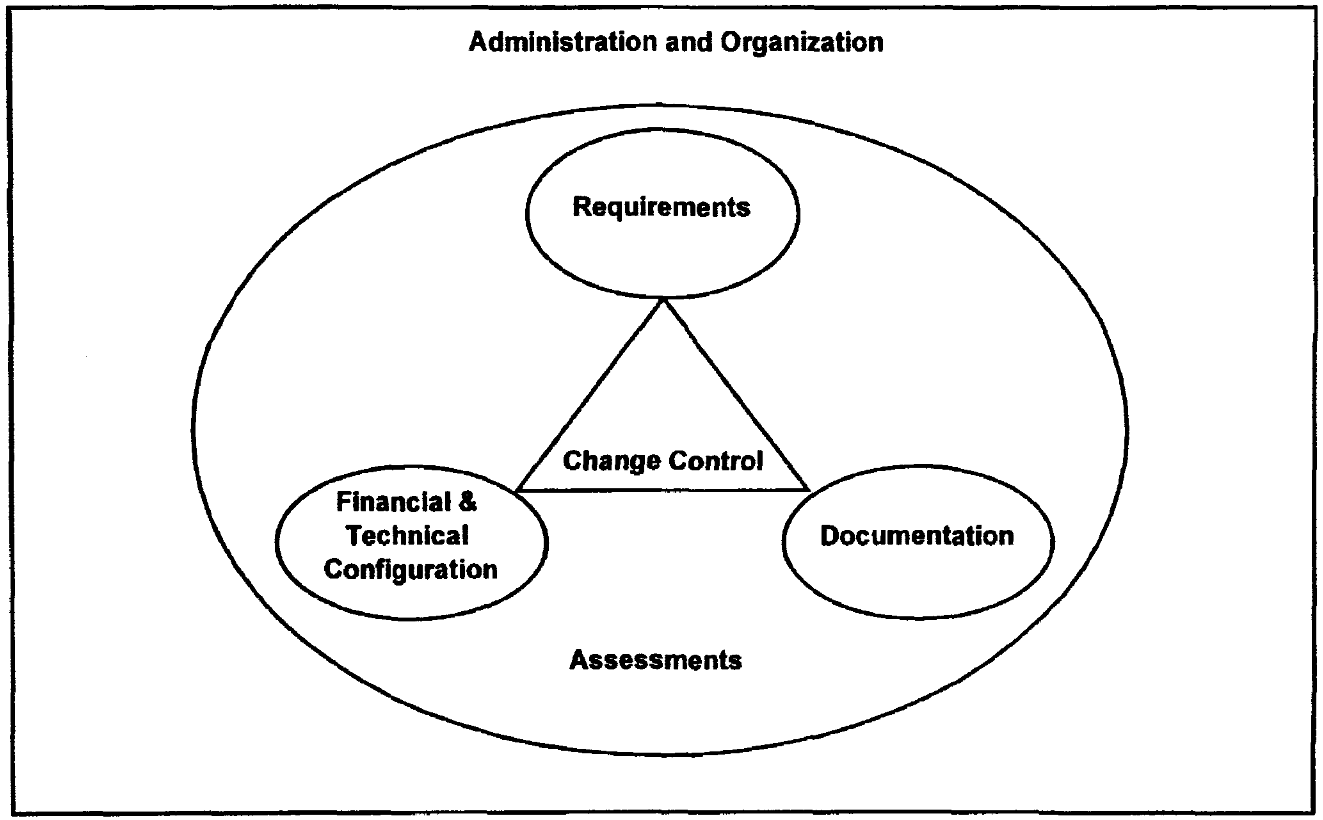

Fig. 3.9 Configuration Management Process

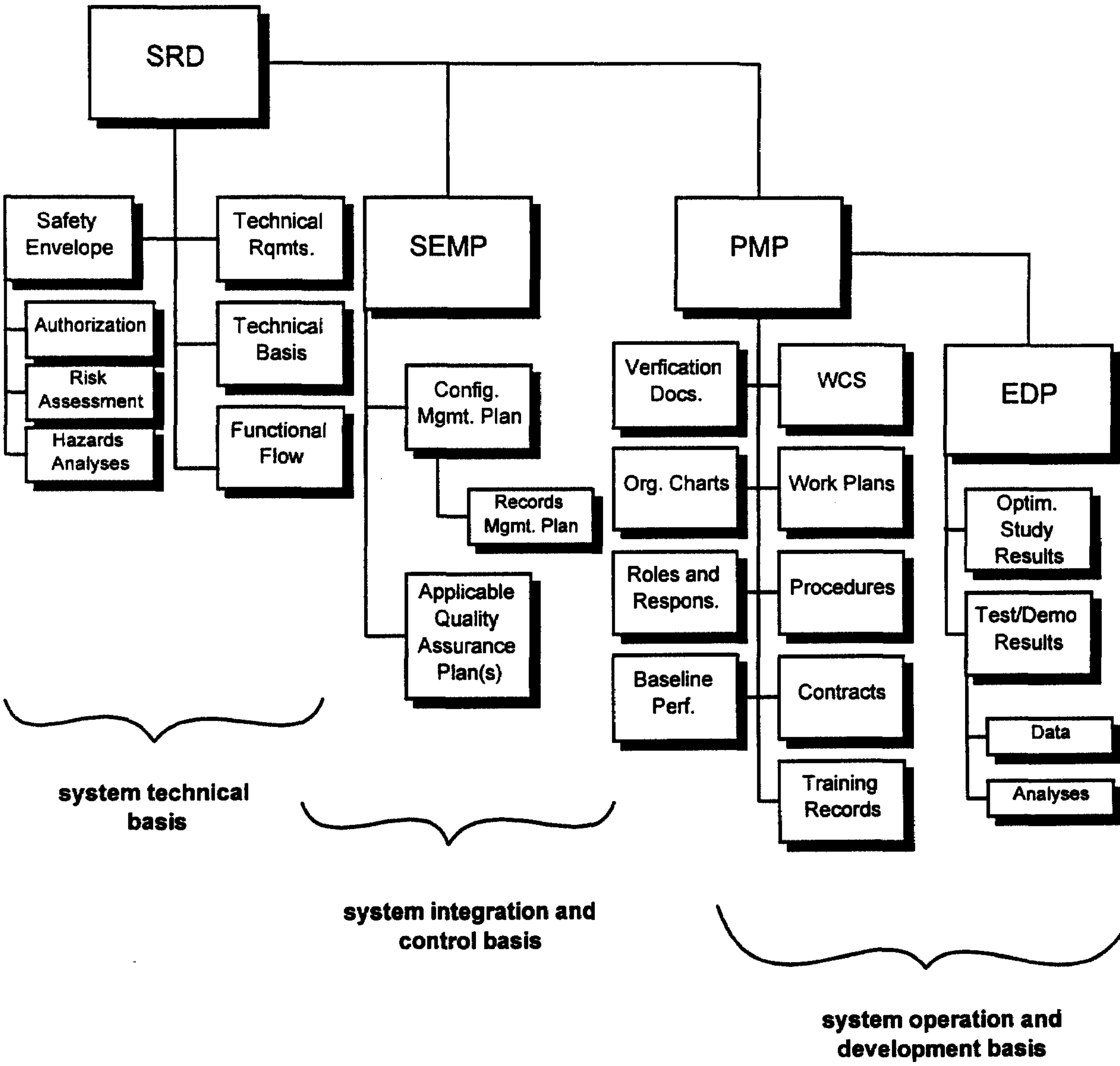

Fig. 3.10. Essential Documents

Document control identifies essential documents with unique numbers, uses controlled-copy management, and uses a change/addendum control system. Unique numbers provide traceability of the documents, reports, manuals, drawings, etc. Controlled-copy management ensures the most currently approved procedures and the specific definition of the system are available to personnel assessing, managing to, and developing the system configuration. Copies of documentation containing non-essential information are retained, distributed, and revised outside of Configuration Management.

Configuration

The baseline system configuration is established through the Systems Engineering process by developing the performance objectives of subsystems, functions, components, integration specifications, and supporting budget and resource needs. Figure 2.3 depicts the system configuration structure. The initial assessment will identify the configuration items for the program. CIs are the family of components and activities that describe the system and are necessary for the system to operate. This family of terms and descriptive documents provides the basis for development, testing, operation, and support throughout the total system life cycle. CIs are identified through allocation of the system requirements into technical requirements that subsequently become the performance specifications. The identification of CIs becomes more precise as the program development progresses. Program managers will use the graded approach in selecting CIs. CIs for the UF_6 Cylinder Program are defined as system components (such as cylinders) and system functions (such as the procedure development process) that, if not in compliance with applicable requirements, could lead to a loss of life or health; and/or noncompliance with the law, regulations, or orders. CIs will include only items essential to the safe and successful performance of the system. CI identification numbers are used on physical components and documents to provide a permanent reference number.

Change Control

The Change Control element comprises control processes to ensure consistency among the financial and technical configuration, the requirements, and the associated documentation. The change control process ensures that changes are properly identified, reviewed, approved, implemented, validated, and documented. To accomplish this, the change control element is integrated with the requirements element and the documentation element. The mechanisms for change within the program will be identified and controls established to prevent unauthorized changes. Technical reviews are performed by a Change Control Board (CCB) made up of qualified personnel to ensure that each proposed change is consistent with the requirements. A proposed change will be implemented only after it is approved by the CCB.

Assessments

Assessments is the Configuration Management element that systematically evaluates the effective implementation of the other Configuration Management elements. Assessments also ensure continued consistency between the requirements and the system configuration, between the system configuration and the documentation, and between the requirements and the documentation. The program uses a variety of assessments (e.g., technical reviews, inspections, performance-based evaluations, and document audits) to ensure adherence to the baseline configuration and to ensure adherence to program mission and objectives.

An initial assessment will be performed to identify the CIs for the program. Ongoing assessments will be conducted periodically after Configuration Management is established to ensure continued effectiveness and consistency with the objectives of Configuration Management. The assessment function will include both independent and self-assessments as well as development and implementation of corrective and preventive actions.

3.5.2 Financial Configuration

The financial configuration is the system operational milestones and associated financial requirements. The financial configuration provides the business management baseline expectations of the program that operates the system.

Financial Configuration Identification

The financial resources for the UF_6 Cylinder Program are allotted by DOE Headquarters to the DOE Field Office in Oak Ridge. Once the financial resources have been allotted to the DOE Field Office, the Operations Office Manager becomes the allotment holder. Authority for obligation–defined as a binding written agreement for specific goods to be delivered, real property to be purchased or leased, or work services to be performed–is then delegated to the Field Office Chief Financial Officer and then to the Director of Planning and Budget. Using Uranium Program Baseline Program and the Work Authorization Directives signed by the DOE Contracting Office Representative as controlling documents, the Director of Planning and Budgets then issues Contract Modifications (Financial Plans) to the Performance-Based Management Contractor (LMES). The Financial Plan contains specific information on the obligated funds, including the authorized upper limit of the amount of matured commitment or cost (Budget Outlay) and matured plus unmatured commitments (Budget Authority). Financial Plans are site specific and detailed by site by Budget and Reporting Classification (B&RC) codes. The B&Rs for the UF_6 Cylinder Program are CD 10 15 01 0 and CD 10 15 02 0 for Operating Expense and 35 CD 10 15 for a Capital Equipment and 39 CD 10 15 for Line Item Construction Projects.

The financial configuration is developed annually according to the required performance of the system in conjunction with the WBS and work control structure. The financial configuration is established through a process that ensures that the financial resources that Uranium Programs is given to operate with are used in the most cost effective manner. All of the activity that is required to be performed for a certain fiscal year is broken down into work packages entitled Detailed Activity Directives (DADs). A fact sheet is prepared for each DAD. The fact sheets describe the work scope to be performed, any significant changes from previous years, and the estimated cost of the tasks. Management decisions are made during this step to determine the best, most appropriate method to use to accomplish the identified work scope that needs to be performed (i.e., in-house vs. subcontract, etc.). The fact sheets also include a section for describing the impact of not funding this DAD, referencing specific laws, regulations, and orders that would be violated. These DADs are then prioritized and a listing prepared that ranks Uranium Program requirements. This list is kept current throughout the year as new or revised requirements become known.

Once DOE Headquarters allots the financial resources to the DOE Field Office in Oak Ridge, the available funding is known. This allows DOE to authorize the work that is on the prioritized listing to be performed, down to the level of funding that is available. Each of the funded DADs is assigned to a Task Assignment Directive (TAD), and a monthly spend plan is established. Also negotiated at this time are the deliverables that will be used to measure actual performance. There are three levels for deliverables: Major Milestones, Milestone, and Markers.

The information is collected into an annual Baseline Program Plan. The Baseline Program Plan is consistent with the PMP and indicates how the work scope, deliverables, and funding relate to each other. This document provides the authorization and direction necessary to allow work to be performed. The actual monthly performance and the actual amount spent each month are reported, problems explained with recommended solutions, and cost variances explained. As the year progresses, overruns or underruns because of revised work scope or the pace at which work is performed may be identified. As these become known, changes to the financial configuration may be necessary. Financial configurations are forecasted for out year to provide continuity in operations within the system. The financial baseline is documented in the Uranium Programs Baseline Program Plan for Oak Ridge Operations.

Financial Change Control

The change control process for the financial configuration is identified in the Uranium Programs Baseline Plan for Enrichment Facilities. A description of the financial change control process is provided in Appendix B.

Financial Status Assessments

Financial status is routinely monitored by the Program Manager and the DOE-ORO Assistant Manager for Enrichment Facilities. Financial status is also reviewed biannually to assess the performance and make recommendations to baseline realignment. Ad hoc review meetings are held to discuss financial and baseline-related issues that may develop.

3.5.3 Technical Configuration

The system's technical configuration comprises functional and physical configurations (see Fig. 2.3).

Technical Configuration Identification

The system functional configuration is established by the approved system level specification or performance objectives that define the technical program requirements. In the development stages, a draft system specification may be used for initial system development. The final system specification provides the basis for controlling the system during its life cycle and once approved, formal Configuration Management is initiated.

The individual specifications are developed from the technical approaches used to satisfy the objectives of the system functional configuration. These objectives are translated through the Systems Engineering process into subsystem and particular performance requirements for the physical configuration. The performance requirements establish the design basis for CI detailed design and development of the system.

The physical configuration is the arrangement of physical components (e.g., hardware, software, real estate, etc. including associated material specifications, engineering drawings, and detailed design documentation) necessary for the system to operate. The physical configuration is integrated with the functional configuration.

Technical Change Control

The technical change control process applies to all physical, functional, or requirement changes made to CIs. Change control will, as a minimum, be applied to:

- hardware (e.g., structures, systems, and components) changes;
- maintenance, process, or operation changes;
- temporary or emergency modifications;
- document (e.g., plans, procedures, and drawings) changes; and
- computer software changes.

Some configuration items (e.g., procedures and nuclear criticality safety approvals) are controlled by established change control processes and procedures of other organizations. The program Configuration Management Manager will establish interfaces with these other organizations. The program Change Control Board (CCB) will review and approve changes and identify impacts to CIs controlled by other organizations.

A change control board is established to control changes to either the functional or physical configurations. The UF_6 Cylinder Program Change Control Board (CCB) is responsible for reviewing and approving changes to these configuration. The CCB reviews all change requests to determine if the change is needed and to evaluate the total impact of the change. The CCB consists of a representative from each of the following organizations: Program Management (Chairman), Systems Engineering Manager, Operations Manager, Environmental Safety and Health Manager, Quality Assurance Manager, Technical Manager, and Risk Manager. Changes to the physical or functional configuration can be authorized only by the CCB. Proposed changes to design are classified as either Class I, Class II, or Class III changes. Class I changes are those pertaining to the system safety basis and system requirements and need DOE approval. Class II changes affect form, fit, function, or three-site consistency and do not alter the system's safety basis. Class I and Class II changes must be approved by the three-site CCB. All other changes are Class III changes; site CCBs generally authorize Class III changes. Changes are prioritized as "emergency, urgent, or routine" and processed according to the priority of the change. Emergency changes should be processed before urgent changes and routine changes.

CCB review and approval of a change is initiated by submitting a change package to the Configuration Management Manager for distribution to the CCB members. The change package includes, as a minimum, the following:

- statement of the problem and description of proposed change;
- alternatives considered;
- analysis showing that the change will solve the problem;
- analysis to ensure that the solution will not introduce new or integration problems;
- verification of interface compatibility including test, operations, safety, and reliability;
- estimate of cost and schedule impact;
- proposed specification performance, or integration revision;
- implementation plan for accommodating the change; and
- impact if not implemented.

After individual review by the CCB members, the CCB formally meets to discuss the proposed change and approves or disapproves the change or recommends alternative actions. After the CCB approves the change, the implementation plan is issued and implementation status is monitored through the assessment process.

Technical Reviews and Assessments

Reviews and assessments to be performed include review of the physical configuration, performance-based observations, and documentation reviews. Configuration items may be assessed to determine if the as-built item and its performance comply with requirements and specifications. Performance of program activities relative to requirements and procedures will be assessed for activities such as cylinder handling and cylinder inspections. Documentation will be reviewed for consistency with system requirements and system-prescribed actions.

To ensure the engineering and technical development within the system is adhering to the baseline configuration and CI performance requirements, assessments, reviews, and controls are instituted for the Configuration Management of the system. A project undergoes several reviews during its development. The following sequential milestones are used as control points for project development ensuring the project meets all performance requirements and is optimized financially.

Feasibility Study Report (FSR). An FSR examines several alternatives to attaining the mission objectives. Each alternative is evaluated as to cost, technical feasibility, environmental impacts, etc. in the report and a preferred alternative is usually identified. After the FSR is completed and submitted to DOE, a decision is made as to which (if any) alternative is to be pursued.

Conceptual Design Report (CDR). The CDR process is an in-depth look at the preferred alternative determined from the FSR. The documents comprised by the CDR will contain sketches, specification outlines, schedules, descriptions of design features by engineering disciplines, and a detailed cost estimate. The cost estimate is the basis for congressional funding requests. The CDR is validated by DOE about 18 months prior to projected design start. After reviews at the DOE-OR and HQ organizational levels, a meeting is held to validate the CDR and to subsequently request congressional funds.

Design Criteria. Previous to design start, the design criteria document is developed. The design criteria document describes design constraints, regulations, design standards, performance requirements, etc. This document is primarily used by the design Architect-Engineer.

Design Reviews. At the discretion of the project engineer, several design reviews are held during the course of the design; 30, 60, and 90 percent of completion are typical design review milestones. Drawings, specifications, schedules, test plans, and estimates are circulated for review by the contractor and DOE project team members and comments returned to the performing organization. Adherence to the design criteria, cost, constructability, and environmental impacts are the primary factors under review.

Certified for Construction. When design is complete and has been approved by the project team and program management, the design documents are issued as certified for construction. When design is complete and before construction starts, a readiness review is held in which the project team presents the project to the site readiness review board. The board consists of various managers in LMES, the construction manager, and DOE who judge whether a project is ready to proceed to construction. The board determines if all permits, approvals, test plans, and authorizations to proceed have been obtained. Construction is started only upon approval.

4. SPECIALTY ENGINEERING

In the development of a system, many secondary factors must be integrated into the design and construction of the physical components and activities that the system comprises. Secondary factors are those aspects that do not drive the development or purpose of the activities or components in the system, but rather, support them, making the component or activity interactive with other system elements. These secondary factors are incorporated into the system design and construction through the Systems Engineering process via engineering specialty integration. Engineering specialities for this system include reliability, maintainability, human factors, environmental issues, and safety. The general status of the UF_6 Cylinder Program is beyond the design and construction phase of the system. The Systems Engineering effort for the UF_6 Cylinder Program focuses improving and integrating the existing elements of system program. Therefore, the establishment of rigorous specialty engineering integration plans is not justified. Some system elements are not fully integrated within the system and must be modified. Specialty engineering aspects for these elements will be integrated into the analysis of options by way of the evaluation criteria. Evaluation criteria for the selection of modifications to the system will include criteria for the following specialty engineering disciplines:

- Reliability,
- Maintainability,
- Human Factors,
- Environmental Issues, and
- Health and Safety.

Other engineering aspects typically considered specialty disciplines from a Systems Engineering perspective are integrated into the program as major factors for the establishment and control of the system. These other engineering aspects include safety, performance measurement, contamination control, corrosion control, and quality assurance. For example, quality assurance is integrated with the Systems Engineering approach through the verification requirements set forth in the previous sections of this SEMP.

5. REQUIREMENTS ANALYSIS

5.1 PROCESS DESCRIPTION

The system requirements structure is illustrated in Fig. 5.1. The requirements analyzed are provided in List 1. The list of requirements has been revised from the requirements identified in the November 1995 SRD. The revisions are a result of the requirements analysis process to identify necessary actions. Appendix C provides the cross-reference from the requirements stated in the November 1995 SRD to the technical requirements in List 1.

The requirements in List 1 include both system and subordinate technical requirements. They are organized by Major Objectives 1 through 5 and Requirement Categories 1.1 through 5.2. System requirements are in bold, italic type (e.g., ***1.1.1***). Applicable technical requirements are denoted by alphanumerical characters following applicable system requirements numbers (e.g., 1.1.1a).

The requirements analysis process is illustrated in Fig. 5.2. This process is initiated with a review of information that identifies the applicable elements of the system for the requirement. This step is accomplished by reviewing the components and activities within each system function. Once the applicability of the requirement is understood, evaluation criteria to determine if actions meet the requirement are defined. These evaluation criteria are established by responding to key elements as shown in Fig. 5.2 (risk; cost; reliability; performance; and maintainability, including any requirement-specific elements).

The next step in the requirements analysis process is the identification of alternative actions or methods to meet the requirement. These alternatives are then evaluated against the criteria and technical requirements. In the analysis of system requirements, the actions to meet requirements are general and provide little opportunity to identify alternatives. Detailed analysis of these requirements and general actions will result in beneficial alternatives.

Consideration of the alternative actions determines if sufficient information is known about the alternatives. When an alternative is selected for implementation, a verification method is documented to demonstrate compliance with the requirement. Implementation is accomplished through integration with the existing program. This implementation task is managed by the PMP. If an alternative cannot be selected for implementation, actions are initiated to further develop the alternative concepts. Development of alternatives is managed by the EDP.

The process described above is iterative for the purpose of developing a comprehensive set of actions to meet each requirement. This iterative process also provides the opportunity to revise the requirement as necessary if 1) there are no feasible actions to meet the requirement, or 2) the requirement scope is not properly focused on the program objectives. For the analysis of system requirements, disciplines used to accomplish the first iteration included operations personnel, system engineers, and requirement-related subject matter experts. The second iteration was accomplished by system engineers, and a final integration was accomplished by program representation and subject matter experts. Subsequent requirements analyses will necessitate the use of Systems Engineering, program management, and appropriate subject matter personnel.

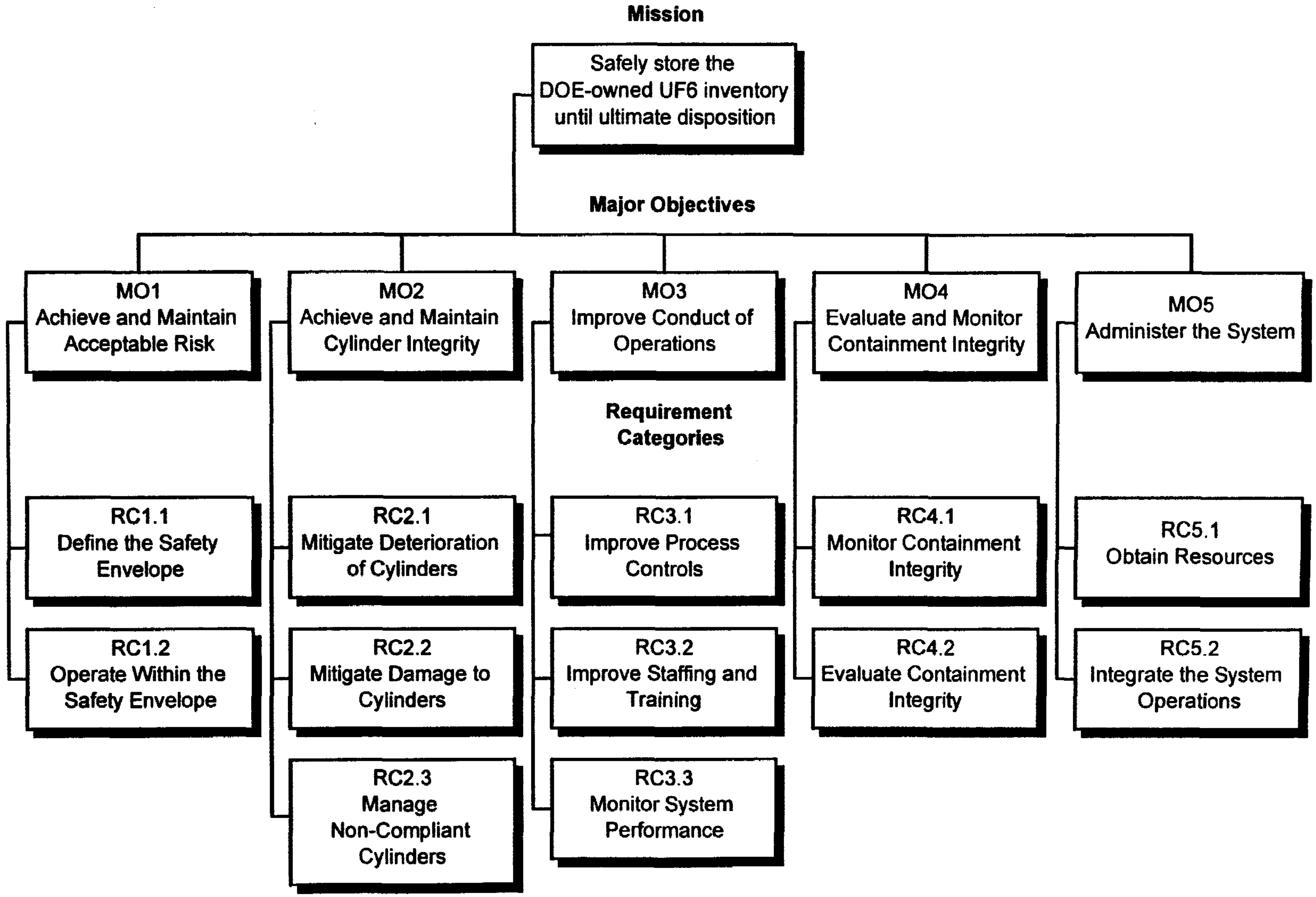

Fig. 5.1 System Requirement Structure

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List 1. System and Technical Requirements

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISK

1.1 Define the Safety Envelope

1.1.1 The program technical configuration shall be defined and documented.

1.1.1a The functional relationships shall be identified to establish continuity of the system. [DOE 5480.19]

1.1.1b Storage history for each cylinder shall be documented and maintained for the service life of the cylinder. [10 CFR 835, DOE 5633.3B]

1.1.1c Controls to maintain functional relationships shall be implemented. [DOE 5480.19]

1.1.2 Program hazards shall be identified and documented.

1.1.2a The system hazards shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.23, 5480.22, 5480.24, 5480.7A, 6430.1A]

1.1.2b The hazards documented in the safety basis shall be periodically reviewed and updated to reflect a current definition of hazards within the system. [DOE 5480.21, 5480.23, 6430.1A]

1.1.3 The program risk(s) and required controls shall be documented.

1.1.3a Maintenance and verification activities within each operational function shall be documented. These activities are to compensate for cylinders in the system that do not meet all functional acceptance criteria. These activities ensure the risks of processing cylinders from one function to another are sufficiently controlled.

1.1.3b The system risks and minimum controls shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.7A, 5480.22, 5480.23, 5480.24, 6430.1A]

1.1.3c The safety basis shall be periodically reviewed and updated, to reflect a current safety analysis and risks within the system. [DOE 5480.23, 6430.1A]

1.1.3d Appropriate evaluations of compliance with the safety envelope shall be conducted when the safety basis in question due to changes in procedures, work scope, and/or storage configurations. [DOE 5480.21]

1.1.3e Appropriate reviews and assessments shall be performed to ensure the preparedness of new activities and facilities, and the restart of activities as appropriate. [DOE 5480.31]

1.1.3f The concept of as low as reasonably achievable (ALARA) shall be incorporated in the risk management and reduction efforts within the program. [10 CFR 835, DOE 5400.5, 5480.10, 5480.11, 6330.1A]

1.2 Operate Within the Safety Envelope

1.2.1 Required risk controls shall be implemented.

1.2.1a An industrial hygiene program shall identify and administer controls to ensure proper management of industrial hazards. [10 CFR 830.120]

1.2.1b Accountability of the inventory shall be managed through a nuclear materials control and accountability program. This program provides the assay and mass quantities necessary for controlling fissile material relative to criticality concerns. [10 CFR 835, DOE 5633.3B]

1.2.1c Cylinders containing fissile material shall be segregated from non-fissile inventories and spaced in accordance with nuclear criticality control guidelines. [10 CFR 835, DOE 5480.24, 5633.3B]

1.2.1d The security of the UF_6 inventory shall be maintained in accordance with a safeguards and security program. This program specifies and maintains the periodicity of routine patrols and physical boundaries. The program also specifies other security specification including lighting, as determined necessary. [DOE 5633.3B]

1.2.1e Cylinder storage in ground contact shall be prevented. Temporary placement of cylinders on the ground during relocation and staging operations is acceptable, but should not exceed specified duration. [10 CFR 835]

1.2.1f Contracted organizations shall operate within an established safety envelope. [10 CFR 830.120, DOE 5480.23]

1.2.1g Prioritization of deficiencies shall be used in the optimization of actions taken to reduce risks within the program.

1.2.2 Performance shall be monitored and evaluated to identify potential risks within the program.

1.2.2a Facility safety walk-throughs shall be conducted regularly to identify initiators and determine ameliorative actions. [10 CFR 830.120, 10 CFR 835, DOE 5700.6C, ORO-651]

1.2.2b The program shall establish system performance indicators in critical areas to determine the effectiveness of activities. [DOE 4700.1, 5480.26, 5700.6C]

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

2.1 Mitigate Deterioration of Cylinders

2.1.1 A barrier between the cylinder mild steel containment surfaces and wetness shall be maintained.

2.1.1a A cylinder maintenance coating program shall be instituted to maintain cylinder coatings throughout the storage phase of the system. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]

2.1.1b The coating application and maintenance shall be prioritized and scheduled based on the knowledge of the present condition of the cylinder, the forecasted deterioration of wall thickness, and operational logistics with yard refurbishment, cylinder access, and location /density of priority cylinders. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]

2.1.1c Toughness, durability, and repair qualities shall be criteria in the review and acceptance of coatings and replacement coatings. [DOE 6430.1A]

2.1.2 Water retention on cylinders caused by cylinder structural features shall be minimized.

2.1.2a Skirt region drainage shall be promoted, to minimize corrosion. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]

2.1.3 Water retention on cylinders caused by cylinder support structures shall be minimized.

2.1.3a Cylinder saddles shall provide ventilation between the cylinder and the load-bearing surface. [10 CFR 830.120, 10 CFR 835, DOE 5480.19]

2.1.3b Cylinder saddles shall facilitate proper drainage from the cylinder and storage facility. [10 CFR 830.120, 10 CFR 835, DOE 5480.19]

2.1.4 Water retention on and adjacent to storage facilities shall be minimized.

2.1.4a Storage facilities shall be designed for the expected life of the storage phase of this program and for the expected operational activities. [10 CFR 830.120, 10 CFR 835, DOE 5480.28, 6430.1A]

2.1.4b Cylinders shall be stored on load-bearing surfaces that, when in use, drain properly (as determined by the program) and rigidly support handling equipment during operations. [10 CFR 830.120, 10 CFR 835]

2.1.4c Cylinders and supporting saddles shall be configured on storage facilities to facilitate proper drainage. [10 CFR 830.120, 10 CFR 835]

2.1.5 Cylinder valve and plug integrity shall be maintained to program standards.

2.1.5a A valve and plug integrity management program shall be established to minimize potential hazards, through monitoring and corrective actions, associated with presence and failure of these components. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B, ORO-651]

2.1.5b Failed valves and plugs including intermittent leaking shall be detected and corrected. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B, ORO 651]

2.1.5c Valves with missing or damaged parts shall be replaced or the parts replaced to meet functional criteria. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B, ORO-651]

2.2 Mitigate Damage to Cylinders

2.2.1 Cylinder containment integrity shall be maintained during handling, processing, and transport operations.

2.2.1a A viable means to transport cylinders off-site that do not meet DOT standards shall be determined for foreseeable shipments.

2.2.1b Maintenance and verification activities shall be implemented within each operational function to compensate for cylinders in the system that do not meet the storage vessel criteria. These activities ensure the risks of processing cylinders from one function to another are sufficiently controlled.

2.2.1c Cylinder handling and stacking configurations that minimize potential impacts between cylinders shall be established. [10 CFR 830.120, ORO-651]

2.2.1d Engineering controls to reduce potential cylinder damage using existing equipment during stacking operations shall be evaluated. [29 CFR 1910, DOE HDBK-1090-95]

2.2.1e The design of new handling equipment shall consider additional controls to prevent coating damage on the body of the cylinder and cylinder damage by operator error when lowering cylinders for placement. [ORO-651]

2.2.1f New saddle design shall include the protection of cylinder coating. [DOE 6430.1A]

2.2.1g Operational controls for handling cylinders shall incorporate additional precautionary measures for handling degraded cylinders.

2.2.1h An NMC&A program shall control, through authorization, the movement and processing of the UF_6 inventory. [10 CFR 835, DOE 5633.3B]

2.2.2 Cylinder handling, processing, and transporting equipment operators shall be proficient.

2.2.2a Operators shall be qualified to verify their proficiency in the use of such equipment. [DOE 5480.20A]

2.3 Manage Non-Compliant Cylinders

*2.3.1 **Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated service life and configuration.*** [ANSI N14.1, DOE 6430.1A, ORO-651]

*2.3.2 **Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions.*** [10 CFR 830.120, DOE 5480.23]

2.3.2a Operators shall be trained on the risks and hazards of handling UF_6. [10 CFR 830.120, DOE 5480.20A, 5480.23]

*2.3.3 **Non-compliant cylinders shall be repaired or replaced to meet program standards.*** [ORO- 651]

2.3.3a The functional capacity to safely manage non-compliant cylinders shall be established in order to minimize the impact on the surveillance and maintenance function.

2.3.3b Methods for processing non-compliant cylinders shall be established as necessary. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, 5481.1B]

MO3: IMPROVE CONDUCT OF OPERATIONS

3.1 Improve Process Controls

3.1.1 ***The system configuration (physical components, functions, and documents) shall be controlled through a formal process.***

3.1.1a A configuration management process shall be instituted to control configuration items. [10 CFR 830.120]

3.1.2 ***Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process.***

3.1.2a Procedures and work plans shall incorporate all the pertinent information (e.g., safety precautions, emergency response, lessons learned, and site specific requirements). [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.20A, 5480.23, 5633.3B, 5700.6C]

3.1.2b Procedures shall be reviewed and updated, to ensure three-site consistency and elimination of any procedural contradictions to ensure sufficient and uniform risk management within the program. [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.23, 5633.3B]

3.1.2c Any site-specific documentation requirements shall be identified and taken into consideration in the procedure process. [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.23, 5633.3B]

3.1.2d Performance shall be periodically monitored and assessed to determine procedures are being followed. [10 CFR 830.120, DOE 5700.6C]

3.2 Improve Staffing and Training

3.2.1 ***Personnel shall be selected, trained, and developed through a structured process.***

3.2.1a Personnel shall be trained to provide understanding of the safety documentation. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910, DOE 5480.19, 5480.18A, 5480.20A, 5480.23, 5700.6C]

3.2.1b Personnel shall be trained and retrained at frequencies determined by the training organization considering the potential consequences of the task, the complexity of the task, and the frequency with which it is performed. [10 CFR 835, 29 CFR 1910.120, DOE 5480.20A, 5480.23]

3.2.1c A database shall be utilized to cross-link training requirements (including training to procedures and training intervals) to training records. The data base shall be used to maintain training records current with procedure revisions. [10 CFR 835, DOE 5480.20A, 5480.23]

3.2.1d A performance-based methodology shall be used for training. [10 CFR 830.120, DOE 5480.18A, 5480.20A, 5480.23]

3.2.1e Training modules shall incorporate all pertinent information (e.g., safety precautions, hazards, emergency response, lessons learned, and site specific requirements. [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.20A, 5480.23, 5633.3B, 5700.6C]

3.2.1f Performance shall be periodically monitored and assessed to determine the effectiveness of training. [10CFR 830.120, DOE 5700.6C]

3.3 Monitor System Performance

3.3.1 System functions shall be monitored to reinforce expectations for work performance and facility condition.

3.3.1a Conduct of Operation principles shall be applied to functions and operations within the system, to ensure the performance of actions accomplishes the intent. [10 CFR 830.120, DOE 5480.19]

3.3.1b Performance shall be periodically monitored and assessed, to determine that the intent of the operation is being fully met. [10 CFR 830.120, DOE 5700.6C]

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

4.1 Monitor Containment Integrity

4.1.1 Exposure to the environment shall be monitored.

4.1.1a Environmental monitoring actions within the storage phase shall be balanced with potential environmental remediation in the decommissioning phase.

4.1.1b Facilities shall be regularly surveyed for radiation and release of UF_6 and reaction products tp evaluate program risks. [10 CFR 835, DOE 440.1, 5400.5, 5480.10, 5480.23]

4.1.2 Cylinder condition shall be monitored.

4.1.2a Cylinder functional acceptance criteria shall be defined to ensure safe operations within each system function. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, ORO- 651]

4.1.2b The applicability of industry standards, including ANSI 14.1 and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code to operational functions shall be established. [10 CFR 830.120, 10 CFR 835, 49 CFR 173.420, DOE 5480.23, ORO-651]

4.1.2c Exceptions, as necessary, shall be obtained to maintain adherence with industry standards. [ASME Boiler and Pressure Vessel Code]

4.1.2d Inspection/evaluation methods for verifying compliance with functional acceptance criteria shall be developed and implemented to identify unsafe cylinders. [10 CFR 830.120, ORO-651, ASME Boiler and Pressure Vessel Code]

4.1.2e Cylinders shall be inspected on a risk-based periodicity to detect loss of containment. [ACD]

4.1.2f Cylinders shall be properly spaced to facilitate inspection. [10 CFR 835, 10 CFR 830.120, ORO-651]

4.1.3 Factors that affect cylinder condition shall be monitored.

4.1.3a Environmental and other factors affecting cylinder integrity shall be identified and evaluated to determine their effect (e.g., localized corrosion mechanisms that involve crevice, galvanic, packing nut, and hydrogen fluoride–related corrosion; corrosion under channel-type stiffeners and head/skirt region; impact of brittle fracture on cylinder storage). This evaluation determines what factors need to be monitored for proactive management and preventive measures. The rigor of this comprehensive evaluation is based on the degree of effect on the containment integrity. [DOE 5480.23, 5480.28, 6430.1A]

4.1.3b Cylinder degradation factors shall be monitored to collect forecasting and trending data. [10 CFR 830.120, DOE 5480.26]

4.2 Evaluate Containment Integrity

4.2.1 Cylinders shall be categorized to ensure that risks are identified.

4.2.2 Cylinder conditions shall be forecast to direct surveillance and maintenance resources.

4.2.2a Specific information, as determined by the program, shall be tracked to project the current and future conditions of the system. [DOE 4700.1, 5480.26, 5700.6C]

4.2.2b Mechanisms to consolidate information for summary level decision-making determinations shall be developed. [DOE 4700.1, 5480.26, 5700.6C]

MO5: ADMINISTER THE SYSTEM

5.1 Obtain Resources

5.1.1 Financial resources to sustain the system shall be obtained and utilized.

5.1.2 Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured.

5.2 Integrate the System Operations

5.2.1 System and technical requirements shall be traceable from the program mission to implementing documentation.

5.2.2 The system configuration shall be optimized in accordance with life-cycle projections.

List 1. System and Technical Requirements (cont.)

5.2.2a Impact on the subsequent program phases shall be considered in changes to the system configuration including modifications to accommodate regulatory changes. [10 CFR 830.120, DOE 5480.19]

5.2.2b The planning for UF_6 dispositioning shall take into consideration the condition of cylinders and compensatory actions to accomplish disposition operations. [10 CFR 830.120]

5.2.2c As part of continuous improvement, other methods for reducing time of wetness and cylinder degradation shall be evaluated. [10 CFR 830.120, 10 CFR 835]

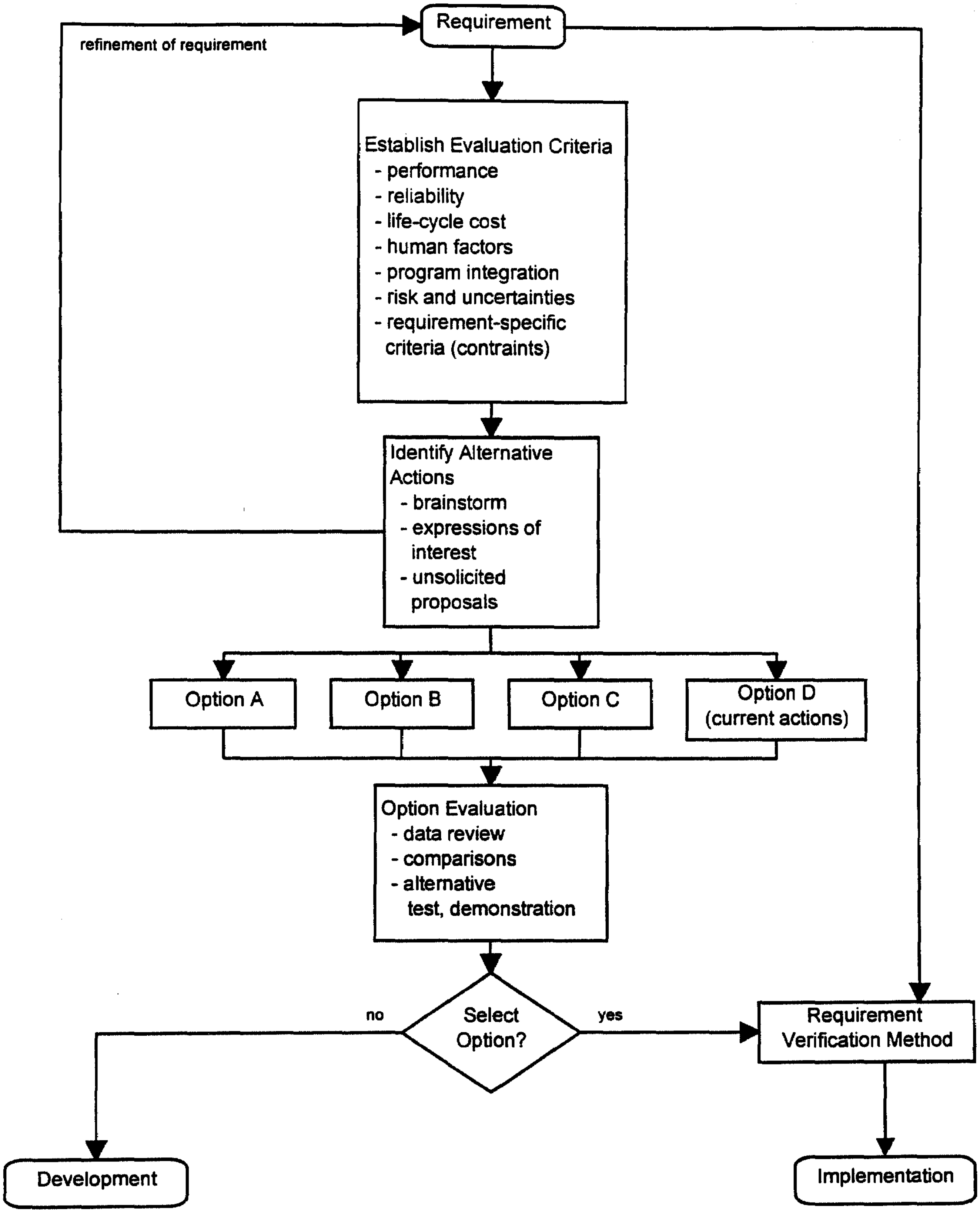

Fig. 5.2. Requirements Analysis Process

To ensure comprehensive response to system and technical requirements, five standard actions were identified:

1. Analyze the optional methods for meeting the requirement.
2. Define the baseline configuration.
3. Implement the baseline configuration.
4. Verify compliance with the requirement.
5. Adjust the baseline to meet the requirement.

The first standard action may not be applicable to every requirement. Actions are organized by system requirements. When a specific action is key to achieving compliance with a technical requirement, the applicable technical requirement is so noted.

5.2 REQUIREMENTS HIERARCHY

There are two types of requirements for the program. The highest level requirements are the system requirements. The system requirements are derived from the analysis of the major objectives for the program. Technical requirements for the system functions are the second level. These requirements are derived by the analysis of the system functions through a functional analysis and program assessments, including the DNFSB "Tech 4" Report. Technical requirements are traced up to the system requirements as shown in List 1. All requirements are traced back to standards for the program including DOE Orders, and federal, state, and local regulations as identified in the LMES Standard/Requirements Identification Documents. The hierarchy for the major objectives and requirement categories is illustrated in Figs. 5.3 and 5.4.

5.3 REQUIREMENTS ALLOCATION

Requirements are allocated to specific functions, subfunctions, activities, and components within the system. The allocation of system requirements to operational functions is identified in the Needed Actions tables in Appendix D following the requirement statement. Allocation of system and technical requirements will be illustrated in the WCS under the specification tree.

5.4 NEEDED ACTIONS

The results of the system requirements analysis are provided in Appendix D. The product of the requirements analysis is a list of comprehensive actions necessary to meet the system and technical requirements. The tables in Appendix D trace the system requirements and associated standards from the major objectives to required actions. The tables also provide the following information:

- *Requirements Allocation*–After the requirement statements in ( ) are the operational functions for which the requirement is allocated.

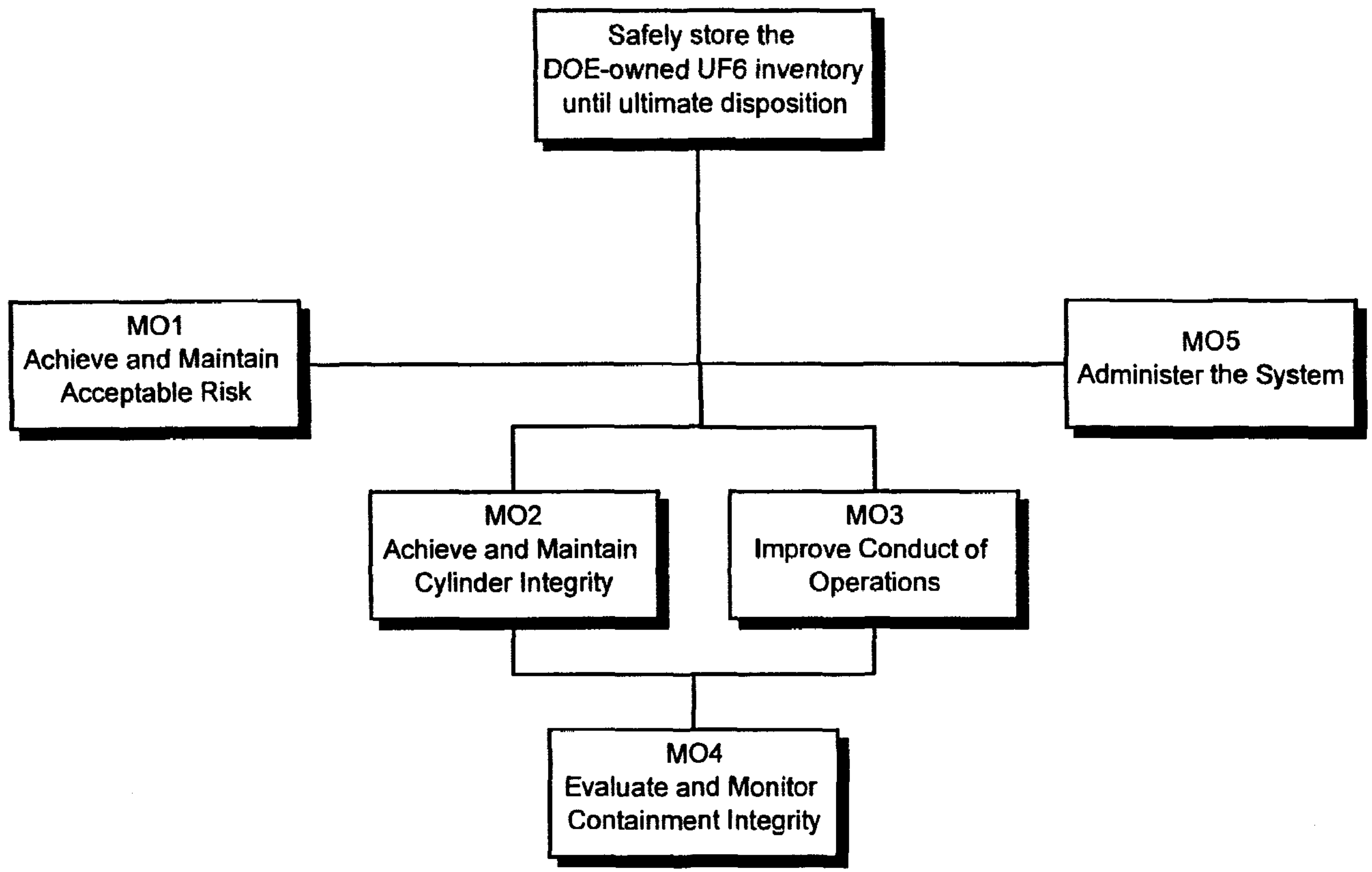

Fig. 5.3 Major Objective Hierarchy

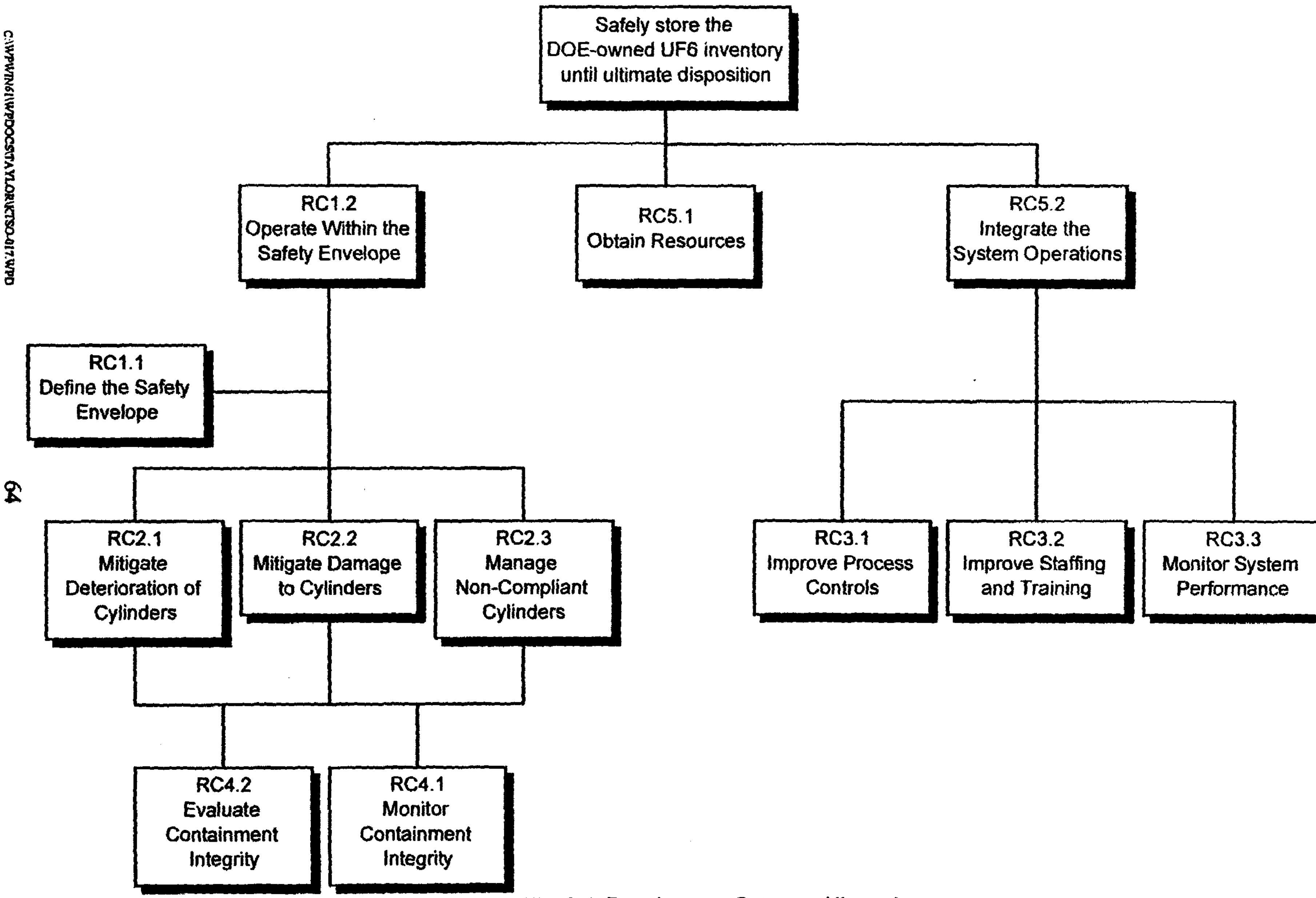

Fig. 5.4 Requirement Category Hierarchy

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- *Evaluation Criteria*–These criteria are used in evaluating more detailed actions to be developed by the program management. The criteria ensure that the actions to be further detailed meet the intent of the requirement. Many criteria were developed from the issues identified in the DNFSB "Tech 4" report, to ensure the program is responsive to DNFSB's concerns.
- *Action Allocation*–Each action has been allocated to either the EDP or the PMP for completion. This designation is shown in the last column of the table in Appendix D.
- *Related Actions*–To assist in the development of work packages under the WBS in the PMP and EDP, actions potentially related to a stated action are identified. The related actions are assigned a numeric identifier. The first three digits of this identifier correspond to the system requirement number. The rest of the digits correspond to a particular action.

5.5 ACTION SCHEDULING

This section provides the general guidelines for sequencing and scheduling the SEMP actions. To implement the SEMP stated actions, action sequencing constraints need to be identified. In addition, specific work plans need to be developed, prioritized, and scheduled for completion. Current actions within the existing system need to be integrated with the SEMP stated actions. This planning exercise is accomplished in the development of the PMP and EDP. To aid in the planning exercise, relationships among SEMP actions have been identified (see Appendix D).

5.5.1 Prioritization

The general guidelines identify the factors to be considered as constraints and priorities for completing the SEMP stated actions. These guidelines are based on the assumptions established in the SRD. The primary bounding assumption is that the current containment integrity of cylinders presents no imminent risk to the environment, the public, or plant workers. This assumption permits the program to initiate some degree of planning, testing, and evaluation prior to the implementation of corrective actions. However, because past practices have resulted in reduced containment, it is necessary that the program initiate some degree of immediate and interim measures to reduce current risks. This situation establishes the need for staging and prioritizing actions as follows:

1. Implement actions to mitigate obvious unacceptable risks.
2. Define/develop a preferred system configuration.
3. Implement the preferred configuration.

Specific prioritization is based on risk management decisions through the use of the risk reduction matrix. The hierarchy of major objectives and requirement categories (shown in Figures 5.3 and 5.4, respectively) is also used in prioritizing action schedules. As a result, immediate actions specified in the SEMP (such as actions 2.1.1.3.1, 2.1.2.3.1, 2.1.3.3.1, 2.1.4.3.1, and 2.1.5.3.1) are priority actions.

5.5.2 Constraints

Constraints on the program are established in the bounding assumptions within the SRD. More specific constraints are identified as follows:

- near-term funding allocation to the program;
- near-term equipment and facility resources to move cylinders, store them in proper facilities and remove non-compliant cylinders from the system;
- limited technical basis documentation for the current technical configuration;
- the degree of hazards and risk analyses in the BIOs;
- cylinder-specific corrosion knowledge limited to characterization to date and industry-related experience and expertise; and
- knowledge of solid UF_6 physical characteristics (dynamics) in stored cylinders.

These constraints are integrated in the decision-making process for progression of the system to define and comply with the preferred system configuration. They apply to near-term scheduling, including the development activities and activities to mitigate current risks that are unacceptable. Out-year scheduling is not constrained, because resources are not solidified to date and time-dependent technical data can be gathered. Out-year financial resources are secured through the congressional budget cycle.

5.5.3 Sequencing

The sequencing of actions is generally provided in the systematic approach used to identify the actions. For each requirement, actions are identified to analyze the optional methods for meeting the requirement, define the method and subsequent configuration to achieve requirement compliance, and implement the configuration. This systematic approach provides the basis for logical sequencing of actions. For sequencing actions outside a specific requirement, the same logic will be used in sequencing. During the configuration implementation and/or revision stages, optimization studies may be necessary to efficiently accomplish the preferred configuration. The process for optimizing implementation is described in Section 2.3.2 of this document.

5.5.4 System Milestones

Major milestones and milestones for the program to comply with the preferred system configuration established through the Systems Engineering approach include:

1. Define and document the system configuration.
    - 1.1 Define the cylinder acceptance criteria and their relationship to industry standards.
    - 1.2 Fully define and authorize a safety basis.
    - 1.3 Define and document the remaining system configuration.
2. Determine compliance with defined configuration.
    - 2.1 Assess the cylinder inventory to acceptance criteria.
    - 2.2 Assess the storage facilities to acceptance criteria.
    - 2.3 Assess the system functional flow with functional requirements.

3. Comply with the preferred system configuration.
   3.1 Place all cylinders in acceptable storage facilities.
   3.2 Establish a coating on all cylinders.
   3.3 System performance assessments identify no critical non-compliances with preferred system configuration.

GLOSSARY

Activity–Organized, supervised actions or movements as distinct from mere existence or state (i.e., components). Activities are the lowest level of functional decomposition.

Allocation–A designation or apportionment of functions or requirements into subsystem levels. Allocation is performed to trace requirements and the division of the system down to the activity and component level.

Analysis of Options–Synthesized options to meeting a requirement. The synthesis is performed to evaluate and select a preferred option, method, and strategy for meeting a requirement. Tools used in the options analysis include trade studies, tests, demonstrations, feasibility studies, and cost–benefit analysis.

Baseline–The established expectations against which the performance (cost, schedule, status, and progression) of the system can be assessed. Baseline documentation consists of spending schedules; performance milestones; and configuration documentation, such as design drawings and work authorization processes.

Basis–Justification, including analyses and experience, for the arrangement of the system and performance specifications. Basis documentation includes but is not limited to physical and chemical properties of the components and analytical results from development studies, such as hazard assessments and risk analyses.

Change Control–A formal control of the system configuration alterations including the review, concurrence, approval, issuance, and distribution of baselines and other controlled documents.

Component–The lowest level constituent part of hardware, financial resources, organizations, humans, and software specified in dividing the system into manageable elements.

Configuration–The relative arrangement and condition of components and activities that comprise a stable system. This arrangement and condition describe the functional flow and physical characteristics of components and activities that combine to demonstrate technical and managerial adherence to system and technical requirements. The configuration is documented in the system baseline documents and system basis documents, which provide the form, fit, and function of components and activities.

Configuration Control–The controlling action of configuration management to develop and maintain a system configuration that adheres to the system and technical requirements.

Configuration Item–A component or activity necessary to operate the system safely.

Configuration Management–The identification of configuration items, the control of their developing and established baseline, and the assessment of operational and developmental status to baseline.

Control–The act of restraining or directing influence over activities usually accomplished by using mechanisms that guide or regulate the operation of machines, apparatus, or system.

Element–A distinct part of a composite device or program.

Evaluation Criteria–Factors to be considered in synthesizing, evaluating, testing, and selecting methods and strategies of accomplishment.

Function–A group of actions contributing to a larger action and purpose.

Functional Allocation–The act of apportioning the activities and components into functions for describing and managing the system flow.

Functional Analysis–The analysis of a defined function to determine all subfunctions necessary to accomplish the purpose of that function. Functional analysis also provides the means for identifying the requirements that the functional activities and components must satisfy to have an operable function. Functional analysis includes the identification of needed subfunction, component, and activity interfaces.

Manage–The act of exercising executive, administrative, and supervisory direction of actions for accomplishment of a purpose. Management are personnel responsible for overseeing the development and execution of the system such that it accomplishes the mission, and major objectives set forth in the program.

Performance–The execution of an action described in sufficient detail to determine if the action accomplished its intent.

Phase–A part of the life cycle of the system which typically describes the system in terms of the beginning to end (i.e., design, construction, start-up, operation, standby, decontamination, decommission). For the UF_6 cylinder system the life cycle is described in terms of design, construction, start-up, production, storage, material disposition, decontamination, and decommission. The current phase is primarily storage.

Program–A plan or system under which an action may be taken toward a goal. For the purposes of the SEMP the term *program* refers to the mission, major objectives, plans, and schedules to which the system is managed.

Requirement–Something essential to the existence or occurrence of something else; characteristics that identify the accomplishment levels needed to achieve specific objectives for a given set of conditions.

Requirements Analysis–The examination of specified characteristics identified as requirements for the system to determine the necessary activities and components to make the system operable.

Risk Management–An organized, analytical process to identify what can go wrong, to quantify and assess associated risks, and to implement/control the appropriate approach for preventing or handing each risk identified.

Safety Envelope–The system boundary conditions from which identified hazards and risks are analyzed to determine minimum controls for safe operation. The safety envelope is supported by a documented safety basis.

Segment–A separate piece of system defined to facilitate its management. Segments are defined in this program as operations, development, and administration.

Specification–A document that clearly and accurately describes essential technical information and verification procedures for items, materials, services, and activities. Specifications are used to support acquisitions and life cycle management. Contracts are a form of specifications identifying the who, what, where, when, how, and how much parameters for accomplishing work.

Standard–A definite rule or principle established by authority, custom, or general consent as a model or example to measure extent, value, or quality. Standards adopted by the program create a structure that integrates the system into external entities. Where pre-established standards are not applicable to the program, program-derived standards are developed.

Synthesis–A translation of requirements into possible integrated solutions (i.e., subsystems, actions, and components).

System–A regularly interacting or interdependent group of items forming a unified whole; a group of interacting bodies under the influence of related forces that perform vital functions. The system used to achieve the UF_6 Cylinder Program goals is defined as the containment of the UF_6 and associated support functions to maintain containment integrity. System is distinct from the program in that the system is the means for accomplishing the program tasks, objectives, and mission.

System Engineering–A comprehensive, iterative problem-solving method that is used to make the system accomplish the program goals. This method systematically identifies the program needs, establishes a system to accomplish these needs, and instills the controls for maintaining adherence to program objectives.

Verification–A completion step in the development and execution of actions to ensure progress is compliant with the intent and purpose of the planned task. The tasks performed to evaluate progress and effectiveness of products to measure specification compliance. For example, actions determined necessary to meet a specified requirement are verified completed to ensure the requirement is being meet.

Work Control Structure (WCS)–A composition of the work breakdown structure, specification tree, and performance tree used in the control of progress.

Work Breakdown Structure (WBS)–An organization of work tree composed of components (hardware, software, personnel, etc.) and activities (cylinder movement, inspection, painting, etc.) developed to divide work to manageable control points.

APPENDIX A
Sample Guidelines for Developing Roles and Responsibilities

This section establishes the guidelines for developing roles and responsibilities for the Business Management and Engineering functions within the program. This information is provided for example only.

BUSINESS MANAGEMENT

The primary responsibility of the Business Management organization is to support the UF_6 Cylinder Management program in the formulation, presentation, and execution of the uranium programs Baseline Program Plan and the annual budget request to Congress. This includes coordination of budget planning and execution with DOE Planning and Budget, Finance, and Construction Engineering organizations.

Business Management is also the integrating organization for the UF_6 Cylinder Management Program with other LMES and LMUS organizations such as Contracts (Interdivisional Operations Directives [IDODS] and LMUS Service Agreements), Central Accounting Services such as Cost Accounting Systems and the Payroll Accounting and Labor System (PALS), and Procurement.

The focal point for the Business Management interface is the Business Manager/Finance Officer(s) assigned to the UF_6 Cylinder Program. These individuals are usually physically co-located with the other members of the program team to facilitate day-to-day interaction and communication. Specifically, primary responsibilities of the Business Management interface include:

1. Establish and maintain a time-phased budget baseline at the cost account level against which financial performance can be measured. Budgets are established for all authorized work with separate identification of cost elements (labor, material, etc.).
2. Ensure that the commitment and expenditure of funds will not exceed authorized limits. Provide early warnings that funding limits are about to be exceeded.
3. Evaluate the impact of changes on planned funding limits and in turn on technical, cost, and schedule baselines and ensure that such impact is appropriately reflected in changes to the baselines.
4. Maintain the ability to reconcile between forecasts for funding requirements and estimates for costs to execute project work.
5. Ensure that program costs are recorded in a systematic timely and accurate manner.
6. Correct mischarges and other accounting errors in a timely manner.
7. Identify significant differences between planned and actual cost on a regular and frequent basis. Find the root cause of problem areas when there is some evidence of occurrence and develop a corrective action plan before problems escalate.
8. Communicate timely, accurate periodic progress reports in formats and reporting levels as stipulated and required by DOE and LMES management.
9. Perform special "what if" analyses as requested.

ENGINEERING SERVICES

Engineering Services (Engineering) is primarily responsible for successful implementation of hardware and capital improvement projects. Typically, a project consists of construction or modification of a facility, installation of large capacity equipment items, or implementation of service contracts. Once a project has been conceived by a customer organization, Engineering's role is to either perform or coordinate the various tasks necessary for project completion, authorization, design, procurement, construction, and testing. It is Engineering's responsibility to ensure that:

1. The customer's requirements are met;
2. The project is conducted in compliance with all laws and regulations concerning safety, the environment, security, labor relations, etc.;
3. The resulting facility or equipment is technically sound; and
4. The project is completed on time and within budget.

A project is complete when a new or modified facility or piece of equipment is turned over to the customer for operation.

Engineering is then the integrating organization with overall responsibility for successful project completion. Most tasks are performed by organizations within LMES. However, design is usually performed by an A-E firm and construction and construction management by MK-Ferguson (the construction manager for LMES). Industrial Safety, Security, Procurement, Environmental Compliance, Quality, Finance, and Facility Safety are typical LMES organizations involved in projects.

Work is accomplished by the project team headed by an Engineering project manager (PJ). Other team members consist of a representative from each organization involved, several representatives from MK-F, the A-E firm manager, the customer representative (usually a facility manager or project manager) and an engineer from each engineering discipline involved. One of the design engineers is designated as the principal engineer (PE) and is responsible for coordination of all technical aspects of the project.

Most interfaces occur within the context of the project team. Drawings, specifications, estimates, schedules, configuration management plans, procurement plans, permits, etc. are created with the consensus of pertinent team members. Consensus is realized by one or more iterations of document review and comments by team members. Where extensive or contradictory comments are submitted, comment resolution meetings are held. Most final documents require the approval of the PJ or principal engineer and the customer; some, the approval of upper level program management.

The PJ is responsible for the interface with the DOE engineering organization, and each team member including the customer representative is usually responsible for any interfaces with relevant DOE organizations and/or federal or state regulators. Thus, the project team is subject to direction from several organizations within DOE (and other regulatory groups as well) working through individual members.

Each of the five plants within LMES has a resident branch of Engineering Services, and central offices are located at K-25. The organizational boundaries between branches are minimal so that a PJ has a vast store of engineering resources and expertise at his disposal. It is not unusual for engineers assigned in the Oak Ridge area to serve as project team members at Portsmouth or Paducah.

APPENDIX B
Uranium Programs Baseline Program Plan
Change Control Procedures

Purpose

To establish guidelines and format for approving and communicating changes to the Baseline Program Plan so that all affected parties have the same understanding of the Baseline Program Plan at all times. The objective is to maintain the Baseline Program Plan so that it is consistent with the current Uranium Program mission and objectives, and to ensure that all levels are working together to accomplish these objectives.

Levels of Authority/Responsibility for Approving Baseline Change Proposals:

DOE-Headquarters
- All Changes to Major Milestones
- Level Two B&R Funding changes (i.e., CD1007) - ORO level only
- Level Three Budget Authority Funding changes greater than 10% - OR level only

DOE-Oak Ridge
- All Changes to Milestones
- All Level Three Budget Authority Funding changes (other than above)
- All Tasks Description changes

LMES
- All Changes to Markers
- All Budget Outlay B&R Funding changes within Budget Authority (B/A) Available

Explanation of Baseline Change Proposal Form:

Cover Sheet: Initiator completes the following fields:
- Date Initiated
- LMUS Service Agreement (MOU) Revision Required
- Type of Change Requested (Modification, Addition, Deletion)
- BCP Type (also complete & submit just the appropriate Form(s) as indicated on the Cover Sheet)
- Designation (Priority = A change proposal that corrects a potentially hazardous condition that may result in serious injury/death to personnel or damage to equipment)
- Point-of-Contact
- Description of Change
- Change Justification/Impact of Non-Approval

Completed Form(s) is(are) turned in to the Site Business Manager

- Review Form for accuracy and funding impact (B/A & B/O)
- Initiate Change process for LMUS Service Agreement (MOU) if applicable

Form submitted to Enrichment Facilities Support (EFS) Business Manager

- Log and assign BCP No.
- Determine Approval Level required
- Distribute form to appropriate Approving Official after review by lower level Approving Authority
    - Level 1 Program HQ: Director, Facility & Technology Management Division
    - Level 2 Field Office OR: Assistant Manager for Enrichment Facilities, OR
    - Level 3 Division Manager, Enrichment Facilities Support Division

Upon approval or disapproval, Approving Official returns Baseline Change Proposal request form to EFS Business Manager who then distributes copy to the Approving Officials of the other Two Levels for information purposes.

APPENDIX C
Cross Reference of Requirements

This appendix provides the cross-reference of requirements stated in the SRD published November 1995. Table 1 references the SRD-stated requirements to the revised technical requirements stated in this SEMP. Table 2 provides the same information but references the SEMP-stated technical requirements to the requirements stated in the SRD.

Table 1. UF_6 Cylinder Requirement Numbers Cross Reference, Old. vs. New
(November 1995 SRD-Stated Requirements
vs.
SEMP-Stated Technical Requirements)

OLD	NEW
5.1.1.2-1	1.1.2 a 1.1.3 b
5.1.1.2-2	1.1.2 b 1.1.3 c
5.1.1.2-3	1.1.2a 1.1.3 d
5.1.1.2-4	1.1.2a 1.1.3e
5.1.1.2-5	1.1.3 b 1.2.1 a
5.1.1.2-6	3.3.1a
5.1.2.2-1	1.1.3f
5.1.2.2-2	1.1.3b 4.1.1b
5.1.2.2-3	1.2.2a
5.1.2.2-4	1.1.3f
5.1.3.2-1	1.1.1b 1.2.1b 2.2.1h
5.1.3.2-2	1.1.1b
5.1.3.2-3	1.2.1c
5.1.3.2-4	1.2.1d
5.2.1.2-1	2.2.1e

NEW	OLD
5.2.1.2-2	2.1.1a 2.1.1b
5.2.1.2-3	2.1.1a
5.2.1.2-4	2.1.4a
5.2.1.2-5	2.1.4b
5.2.1.2-6	2.1.2a
5.2.1.2-7	2.1.3a 2.1.3b
5.2.1.2-8	2.1.4c
5.2.1.2-9	5.2.2c
5.2.1.2-10	5.2.2a
5.2.2.2-1	2.1.5a
5.2.2.2-2	2.1.5b
5.2.2.2-3	2.1.5c
5.2.3.2-1	2.2.1c
5.2.3.2-2	2.2.1c
5.2.3.2-3	2.2.1c
5.2.3.2-4	2.2.1d
5.2.3.2-5	2.2.1e
5.2.3.2-6	2.2.1f

NEW	OLD
5.2.3.2-7	2.2.2a 2.3.2a
5.2.3.2-8	2.1.1c
5.2.4.2-1	1.1.3b
5.2.4.2-2	1.2.1f
5.2.4.2-3	2.3.3b
5.2.4.2-4	2.3.3a
5.3.1.2-1	1.1.3b 3.1.2a 3.2.1e
5.3.1.2-2	1.1.3b 3.1.2b
5.3.1.2.3	3.1.2c
5.3.1.2-4	3.1.1a
5.3.2.2-1	1.1.3b 3.2.1a
5.3.2.2-2	3.2.1b
5.3.2.2-3	3.2.1c
5.3.2.2-4	3.2.1d
5.3.3.2-1	3.1.2d 3.2.1f 3.3.1b
5.4.1.2-1	4.1.2a

OLD	NEW
5.4.1.2-2	4.1.2b
5.4.1.2-3	4.1.2c
5.4.1.2-4	2.3.3b
5.4.1.2-5	4.1.2d
5.4.1.2-6	4.1.2a
5.4.1.2-7	4.1.2a 4.1.2d
5.4.2.2-1	4.1.3a
5.4.2.2-2	4.1.3b
5.4.2.2-3	4.1.2d
5.4.2.2-4	4.1.2e
5.4.2.2-5	1.2.2a 4.1.2e
5.4.2.2-6	4.1.2f
5.4.3.2-1	1.2.2 b
5.4.3.2-2	4.2.2b
5.4.3.2-3	4.2.2a
3.1	1.2.1g
3.2-1	5.2.2a
3.2-2	4.1.1a

Table 1. UF_6 Cylinder Requirement Numbers Cross Reference, Old. vs. New (cont.)
(November 1995 SRD-Stated Requirements
vs.
SEMP-Stated Technical Requirements)

OLD	NEW			
3.2-3	2.2.1a 5.2.2b			
3.3-8	2.2.1a			
4.3-1	1.1.3a 2.2.1b			
4.3-2	1.1.1a 1.1.1b 1.1.1c 1.2.1b 4.1.1b			

Table 2. UF_6 Cylinder Requirement Numbers Cross Reference, New vs. Old
(SEMP-Stated System and Technical Requirements
vs.
November 1995 SRD-Stated System Requirements)

NEW	OLD
1.1.1	4.3-2
	5.1.3.2-1
	-2
1.1.1a	4.3-2
1.1.1b	4.3-2
	5.1.3.2-1
	-2
1.1.1c	4.3-2
1.1.2	5.1.1.2-1
	-2
	-3
	-4
1.1.2a	5.1.1.2-1
	-3
	-4
1.1.2b	5.1.1.2-2
1.1.3	4.3-1
	5.1.1.2-1
	-2
	-3
	-4
	-5
	5.1.2.2-1
	-2
	-4
	5.2.4.2-1
	5.3.1.2-1
	-2
	5.3.2.2-1
1.1.3a	4.3-1
1.1.3b	5.1.1.2-1
	-5
	5.1.2.2-2
	5.2.4.2-1
	5.3.1.2-1
	-2
	5.3.2.2-1
1.1.3c	5.1.1.2-2
1.1.3d	5.1.1.2-3

NEW	OLD
1.1.3e	5.1.1.2-4
1.1.3f	5.1.2.2-1
	5.1.2.2-4
1.2.1	3.1
	4.3-1
	-2
	5.1.1.2-1
	-3
	-5
	5.1.2.2-4
	5.1.3.2-1
	-3
	-4
	5.2.1.2-1
	5.2.4.2-2
	5.3.1.2-1
	-4
1.2.1a	5.1.1.2-5
1.2.1b	4.3-2
	5.1.3.2-1
1.2.1c	5.1.3.2-3
1.2.1d	5.1.3.2-4
1.2.1e	5.2.1.2-1
1.2.1f	5.2.4.2-2
1.2.1g	3.1
1.2.2	5.1.1.2-3
	5.1.2.2-2
	-3
	5.3.1.2-4
	5.4.2.2-5
	5.4.3.2-1
1.2.2a	5.1.2.2-3
	5.4.2.2-5
1.2.2b	5.4.3.2-1

NEW	OLD
2.1.1	5.2.1.2-2
	-3
	-9
	5.2.3.2-8
2.1.1a	5.2.1.2-2
	-3
2.1.1b	5.2.1.2-2
2.1.1c	5.2.3.2-8
2.1.2	5.2.1.2-6
	-9
2.1.2a	5.2.1.2-6
2.1.3	5.2.1.2-7
	-9
2.1.3a	5.2.1.2-7
2.1.3b	5.2.1.2-7
2.1.4	5.2.1.2-2
	-4
	-5
	-8
2.1.4a	5.2.1.2-4
2.1.4b	5.2.1.2-5
2.1.4c	5.2.1.2-8
2.1.5	5.2.2.2-1
	-2
	-3
2.1.5a	5.2.2.2-1
2.1.5b	5.2.2.2-2
2.1.5c	5.2.2.2-3

NEW	OLD
2.2.1	3.2-3
	3.3-8
	4.3-1
	5.1.3.2-1
	5.2.3.2-1
	-2
	-3
	-4
	-5
	-6
2.2.1a	3.2-3
	3.3-8
2.2.1b	4.3-1
2.2.1c	5.2.3.2-1
	-2
	-3
2.2.1d	5.2.3.2-4
2.1.2e	5.2.3.2-5
2.1.2f	5.2.3.2-6
2.1.2g	
2.1.2h	5.1.3.2-1
2.2.2	5.2.3.2-7
2.2.2a	5.2.3.2-7
2.3.1	5.2.4.2-1
2.3.2	5.2.3.2-7
	5.2.4.2-2
2.3.2a	5.2.3.2-7
2.3.3	5.2.4.2-3
	-4
	5.4.1.2-4
2.3.3a	5.2.4.2-4
2.3.3b	5.2.4.2-3
	5.4.1.2-4
3.1.1	5.3.1.2-1
	-2
	-4

Table 2. UF_6 Cylinder Requirement Numbers Cross Reference, New vs. Old (cont.)
(SEMP-Stated System and Technical Requirements
vs.
November 1995 SRD-Stated System Requirements)

NEW	OLD
3.1.1a	5.3.1.2-4
3.1.2	5.3.1.2-1
	-2
	-3
	5.3.3.2-1
3.1.2a	5.3.1.2-1
3.1.2b	5.3.1.2-2
3.1.2c	5.3.1.2-3
3.1.2d	5.3.3.2-1
3.2.1	5.3.1.2-1
	5.3.2.2-1
	-2
	-3
	-4
	5.3.3.2-1
3.2.1a	5.3.2.2-1
3.2.1b	5.3.2.2-2
3.2.1c	5.3.2.2-3
3.2.1d	5.3.2.2-4
3.2.1e	5.3.1.2-1
3.2.1f	5.3.3.2-1
3.3.1	5.1.1.2-6
	5.3.3.2-1
3.3.1a	5.1.1.2-6
3.3.1b	5.3.3.2-1
4.1.1	3.2-2
	4.3-2
	5.1.2.2-2
	5.4.2.2-5
4.1.1a	3.2-2
4.1.1b	4.3-2
	5.1.2.2-2

NEW	OLD
4.1.2	5.1.3.2-1
	5.4.1.2-1
	-2
	-3
	-5
	-6
	-7
	5.4.2.2-1
	-3
	-4
	-5
	-6
4.1.2a	5.4.1.2-1
	-6
	-7
4.1.2b	5.4.1.2-2
4.1.2c	5.4.1.2-3
4.1.2d	5.4.1.2-5
	-7
	5.4.2.2-3
4.1.2e	5.4.2.2-4
	-5
4.1.2f	5.4.2.2-6
4.1.3	5.4.2.2-1
	-2
4.1.3a	5.4.2.2-1
4.1.3b	5.4.2.2-2
4.2.1	
4.2.2	5.2.1.2-9
	5.4.3.2-1
	-2
	-3
4.2.2a	5.4.3.2-3
4.2.2b	5.4.3.2-2
5.1.1	
5.1.2	

NEW	OLD
5.2.1	
5.2.2	3.2-1
	-2
	-3
	4.3-2
	5.2.1.2-4
	-9
	-10
5.2.2a	3.2-1
	5.2.1.2-10
5.2.2b	3.2-3
5.2.2c	5.2.1.2-9

APPENDIX D
Needed Actions

The results of the system requirements analysis are provided in the following tables. The product of the requirements analysis is a list of comprehensive actions necessary to meet the system and technical requirements. These tables trace the requirements and associated standards from the major objectives to required actions. The numbering system corresponding to this tracing provides unique numbers for each major objective, requirement category, system requirement, technical requirement, and action. The numbering system is defined as follows:

major objective	requirement category	system requirement	action	subactions	
X.	X.	X.	X.	X.	X.

Technical requirements subordinate to the system requirements are identified by the system requirement number followed by a unique alphanumeric identifier. Actions key to complying with the technical requirements are identified by technical requirements in [ ] following the action statement.

The tables also provide the following information:

- *Standards*–The standards identified are used to establish the degree and extent to which requirements and actions will be accomplished. In some circumstances, standards provide the methodology for how a requirement will be met.
- *Requirements Allocation*–After the requirement statements in ( ) are the operational functions for which the requirement is allocated.
- *Evaluation Criteria*–These criteria are used in evaluating more detailed actions to be developed by the program management. The criteria ensure that the actions to be further detailed meet the intent of the requirement. Many criteria were developed from the issues identified in the DNFSB "Tech 4" report, to ensure the program is responsive to DNFSB's concerns.
- *Action Allocation*–Each action has been allocated to either the EDP or the PMP for completion. This designation is shown in the last column of the tables.

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS
Requirement Category: 1.1 Define the Safety Envelope
Requirement: 1.1.1 The program technical configuration shall be defined and documented. DOE 5480.1B, 5480.10, 5480.19, 5480.20A, 5480.21, 5480.22, 5480.23, 5480.28, 5483.1A, 5633.3B, 5700.6C, 6430.1A; 10 CFR 835, 10 CFR 830.120; ORO-651; (F:All)

Evaluation Criteria:
1. Are all program functions identified and documented?
2. Do all components, activities, and subsystems have technical basis for their design and operation?
3. Do the design basic documents completely describe the physical configuration?
4. Is the technical configuration formally controlled to keep accurate and current?
5. Is the technical configuration integrated?
6. Are all operational states (start-up, including demonstration and validation, steady-state, off-normal, emergency, and standby) evaluated, defined, and documented?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet this requirement is not applicable.	NA	NA
2	Define baseline configuration.	All Number 2 actions.	P
2.1	Identify and document all flow-down from the program objectives to components, activities, and subsystems.	All Number 2 actions.	E
2.2	Identify and document all functions, subfunctions, and interfaces needed to meet objectives. (Develop functional flow diagrams and interface diagrams.) [1.1.1.a]	All Number 2 actions.	E
2.2.1	Integrate the purpose of cylinder inspection functions including code inspections, periodic visual inspections, handling, transport, maintenance, and contents transfer functional acceptance inspections.	3.2.1.2.2.1	E
2.2.2	Integrate the functional flow of cylinder inspections, degradation studies, degradation factor monitoring, and cylinder maintenance.		E
2.3	Document the technical basis for design of components, activities, and subsystems that comprise the technical configuration. Incorporate into the technical basis the anticipated operational states i.e., test/demonstration, start-up, steady-state, off-normal, emergency, and standby.	All Number 2 actions.	P
2.3.1	Resurrect/re-document the technical basis for components, activities, and subsystems. [1.1.1.b]	All Number 2 actions.	P
2.3.2	Revise specifications (drawings, etc.) to reflect current configuration of components. [1.1.1.b]	All Number 2 actions.	P
2.3.3	Document pertinent history of component use. [1.1.1.b]		P
2.3.4	Improve the database that provides cylinder location, condition, content, maintenance, and history necessary to manage actions and constraints related to maintaining cylinder integrity.		P

Actions		Related Actions	EDP/ PMP
2.4	Determine required baseline maintenance.	1.2.2.2.1, 2.1.1.3.4, 3.1.1.2,	P
2.4.1	Develop a baseline configuration management system. [1.1.1.b, 1.1.1.c]	3.1.1.2	P
2.4.2	Determine the intent and periodicity of configuration audits. [1.1.1.c]	3.1.1.2.3	P
2.5	Determine method to verify baseline meets requirement.		P
3	Implement baseline configuration.	1.1.3.3, 3.1.1.3, 3.1.1.3.1, 3.1.1.3.4	P
3.1	Implement configuration management system for system baseline. [1.1.1.c]	3.1.1.3, 3.1.2.3.3	P
3.2	Implement configuration audits.	3.1.1.3.5	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS
Requirement Category: 1.1 Define the Safety Envelope
Requirement: 1.1.2 Program hazards shall be identified and documented. DOE 5480.18A, 5480.19, 5480.20A, 5480.21, 5480.22, 5480.23, 5480.31, 5633.3B, 5700.6C, 6430.1A; 10 CFR 835, 10 CFR 830.120, 29 CFR 1910; ANSI N14.1; (F:All)

Evaluation Criteria:
1. Are the industrial, radiological, and chemical hazards identified for the public, workers, and the environment?
2. Are hazards defined sufficient to grade and identify required program emphasis areas?
3. Is the hazards analysis kept current?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet this requirement is not applicable.	NA	NA
2	Define the baseline configuration.	1.1.1.2	E
2.1	Identify the industrial, chemical, and radiological hazards within the program configuration (see requirement 1.1.1). [1.1.2.a]	1.1.1.2, 1.1.3.2.1, 2.3.2.2.1	E
2.2	Perform process hazards analysis (see requirement 1.1.1). [1.1.2.a]	1.1.1.2	E
2.3	Grade hazards to identify program emphasis areas for detailed analysis and development of controls. [1.1.2.a]	1.1.1.2	E
2.3.1	Record the hazard analyses in the safety envelope documentation. [1.1.2.a]		
2.4	Determine required baseline maintenance including methods for keeping the hazards analysis current. [1.1.2.b]	1.1.1.2	E
2.4.1	Determine the periodicity of hazards re-assessment of program operations/conditions. [1.1.2.b]	1.1.1.2	E
2.4.2	Identify controls for triggering hazards assessment for new/modified operations. [1.1.2.b]	1.1.1.2	E
2.5	Determine method to verify baseline meets requirement.		P
3	Implement baseline configuration.		P
3.1	Obtain authorization of the safety basis (SAR). [1.1.2.a]	1.1.3.2.3, 1.1.3.3.1	P
3.2	Periodically re-assess hazards. [1.1.2.b]		P
3.2.1	Assess hazards for new/modified operations. [1.1.2.b]	1.1.3.3.1	P
3.2.2	Obtain approval of changes in the safety basis.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS
Requirement Category: 1.1 Define the Safety Envelope
Requirement: 1.1.3 The program risk(s) and required controls shall be documented. DOE 440.1, 1540.2, 5400.5, 5480.3, 5480.1A, 5480.1B; 5480.3, 5480.7A, 5480.10, 5480.18A, 5480.19, 5480.20A, 5480.21, 5480.22, 5480.23, 5480.24, 5480.31, 5483.1A, 5633.3B, 5700.6C, 6430.1A; 10 CFR 830.120, 10 CFR 835, 29 CFR 1910, 29 CFR 1926, 40 CFR 302.4, App. B; ORO-651, ANSI N14.1; DOE-HDBK-1090-95, DOE-STD-1027, 3009, 3011-94; ASME Codes; (F:All)

Evaluation Criteria:
1. Are identified risks commensurate with those identified in a comparable private industrial operation?
2. Are program risk commensurate with other risks assumed by LMES and DOE?
3. Are required controls feasible?
4. Are risks sufficiently defined to identify where controls are needed and to what degree?
5. Is the risk analysis kept current?
6. Is ALARA used in identifying control?
7. Are risk controls identified for applicable operational states (start-up, steady state, off-normal, emergency, and standby)?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods includes the analysis of eliminating the risk(s) or controlling the risk(s).		E
2	Define baseline configuration.	1.1.1.2	E
2.1	Identify program risks relative to the configuration defined in requirement 1.1.1. Use identified standards for determining the relevance of program risks to other DOE and industry risks. [1.1.3.b]	1.1.1.2, 1.1.2.2.1, 1.2.1.3.1, 2.1.3.2.3, 2.1.4.2.3, 2.1.4.2.4, 2.2.2.2.3	E
2.1.1	Identify plausible accident scenarios given identified functional hazards. Plausible accident scenarios to be identified will include scenarios stemming from cylinder breaches into the ullage space and degraded cylinder conditions as possible initiators. [1.1.3.b]	1.1.1.2	E
2.1.2	Determine the probability of accidents scenarios occurring. [1.1.3.b]	1.1.1.2	E
2.2	Determine controls necessary to decrease the probability of occurrence for accidents with unacceptable consequences to a tolerable level (ALARA). Controls are determined for anticipated operational states. [1.1.3.a, 1.1.3.b, 1.1.3.f]	1.1.1.2, 1.2.1.2.1, 2.1.1.2, 3.1.2.2.1, 3.2.1.2.2	E
2.3	Complete the risk analysis and risk control sections of the SAR relative to the program. [1.1.3.b]	1.1.1.2, 1.1.2.3.1, 1.2.2.2.1	E
2.3.1	Document the risk management matrix.		P
2.4	Determine required baseline maintenance.	1.1.1.2, 1.2.1.2.3, 1.2.1.2.4	P
2.4.1	Identify intent and periodicity of risk re-assessments. [1.1.3.c, 1.1.3.d]	1.1.1.2	P
2.4.2	Identify controls for triggering risk assessments for new/modified operations. [1.1.3.c, 1.1.3.d, 1.1.3.e]	1.1.1.2, 3.1.1.3.5	P
2.5	Determine method to verify baseline meets requirement.		P

	Actions	Related Actions	EDP/ PMP
3	Implement baseline configuration. (see 1.1.1 configuration management)	1.1.1.3, 3.1.1.3	P
3.1	Obtain authorization of safety basis (Safety Analysis Report). [1.1.3.b]	1.1.2.3.1	P
3.2	Periodically re-assess risk within the program. [1.1.3.c, 1.1.3.d]		P
3.3	Assess risks of new/modified operations. [1.1.3.c, 1.1.3.d, 1.1.3.e]	1.1.2.3.2.1	P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS
Requirement Category: 1.2 Operate Within the Safety Envelope
Requirement: 1.2.1 Required risk controls shall be implemented. DOE 5480.1B, 5480.10, 5480.19, 5480.20A, 5480.21, 5480.23, 5480.24, 5483.1A, 5630.11A, 5633.3B, 5700.6C; 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:
1. In practice, do the risk controls actually decrease to a tolerable level the probability of an accident with unacceptable consequences occurring?
2. Are measures and controls in place to eliminate or mitigate identified risks?
3. Are risk controls integrated within the program and with site requirements?
4. Are affected personnel knowledgeable about risk controls?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods includes the analysis of engineered controls, administrative controls, and/or multiple controls for making risk(s) acceptable.		E
2	Define baseline configuration.	1.1.1.2	E
2.1	Develop all program risk controls in accordance with the system configuration (see requirement 1.1.1). Integrate the development of risk controls with site requirements.	1.1.1.2, 1.1.3.2.2, 2.3.2.2.2, 3.1.2.2.1	E
2.1.1	Verify the industrial hazard controls to be administered by the industrial hygiene program. [1.2.1.a]		P
2.1.2	Verify the inventory controls including movement and processing authorization to be administered by the NMC&A program. [1.2.1.b]		P
2.1.3	Verify criticality controls including mitigative alarms and inventory segregation to be administered by the Nuclear Criticality Safety program. [1.2.1.c]		P
2.1.4	Verify the safeguards and security controls including periodic patrols, physical boundaries, and facility lighting to be administered by the Safeguards and Security program.		P
2.1.5	Verify operational controls to prevent cylinder placement in ground contact beyond a specified duration. Specify duration. [1.2.1.e]		P
2.1.6	Verify in the authorization of cylinder repair/replacement through contracted services the validation of a safety envelope for specified operations. [1.2.1.f]		P
2.1.7	Verify integration of program hazards with site emergency preparedness.		P
2.2	Develop implementation means for all program risk controls.	1.1.1.2, 2.1.1.2.3	P
2.2.1	Develop a training for personnel on program risks and subsequent controls.	1.1.1.2, 2.2.2.4, 2.2.2.2.4	P
2.3	Determine required maintenance of risk controls.	1.1.1.2, 1.1.3.2.4	P

	Actions	Related Actions	EDP/ PMP
2.4	Determine method to verify baseline meets requirement.	1.1.3.2.4	P
2.4.1	Determine the effectiveness of controls for reducing, eliminating, and mitigating risks.		P
3	Implement baseline configuration.		P
3.1	Identify current risks that are above acceptable program risks.	1.1.3.2.1, 2.1.3.2.3, 2.1.4.2.2, 2.1.5.3.1, 2.3.3.2.4	E
3.2	Develop risk reduction actions.	2.3.3.2.3, 2.3.3.2.5, 2.3.3.2.6	E
3.3	Prioritize and implement risk reduction actions utilizing a risk reduction matrix for guidance. [1.2.1.g]	2.1.1.3.1, 2.1.2.3.1, 2.1.2.3.2, 2.1.3.3.1, 2.1.3.3.2, 2.1.4.3.1, 2.1.5.3.1, 2.3.3.2, 2.3.3.3.1	P
3.4	Implement controls. [1.2.1.a, 1.2.1.b, 1.2.1.c, 1.2.1.d, 1.2.1.e, 1.2.1.f]	2.1.1.3, 2.1.2.3, 2.1.3.3, 2.1.4.3, 2.1.5.3, 2.2.1.3, 2.2.2.3, 2.3.1.3, 2.3.2.3, 2.3.3.3, 3.1.1.3, 3.1.2.3, 3.2.1.3, 5.1.1.3, 5.1.2.3, 5.2.2.3, 2.2.2.3.2, 2.2.2.3.2.1	P
3.5	Train personnel.	2.2.2.3.1, 2.3.2.3.2, 3.2.1.3.2	P
3.6	Implement risk control maintenance.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS
Requirement Category: 1.2 Operate Within the Safety Envelope
Requirement: 1.2.2 Performance shall be monitored and evaluated to identify potential risks within the program. DOE 440.1, 4330.4A, 4330.4B, 5400.5, 5480.1B, 5480.10, 5480.19, 5480.20A, 5480.21, 5480.23, 5483.1A, 6430.1A; 10 CFR 830.120, 10 CFR 853; (F:All)

Evaluation Criteria:
1. Is technical and operational performance monitored for risks?
2. Are lessons learned outside the program being monitored and evaluated for improvements in the program?
3. Are occurrences investigated and subsequent recommendations implemented?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods is not applicable.	NA	NA
2	Define baseline configuration.		E
2.1	Identify risk monitoring and evaluation tools to be used in the program. These tools will include technical and operational performance monitoring, company, corporate and industry lessons learned sharing, and investigations of occurrences. [1.2.2.b]	1.1.1.2, 1.1.1.2.4, 1.1.3.2.3, 1.2.2.2.1, 2.1.2.2.4, 2.1.3.2.4, 2.1.4.2.5, 2.1.5.2.3, 2.1.5.2.4, 2.2.1.2.6, 2.2.2.2.4, 2.3.1.2.4, 2.3.3.2.4, 3.1.1.3.2, 3.1.1.3.3, 3.1.1.3.5, 3.1.2.2.3, 3.2.1.2.5, 3.3.1.2.2, 3.3.1.2.3, 4.1.1.2.2, 4.1.2.2.4, 4.1.3.2.4, 4.1.3.2.5, 4.2.1.2.4, 4.2.2.2.4, 5.1.1.2.5, 5.1.2.2.4, 5.2.2.2.4, 5.2.2.2.5	P
2.1.1	Establish a facility safety walk-through program with the intent of identifying risk initiators. [1.2.2.a]		P
2.1.2	Model corrosion to project cylinder integrity.		E
2.2	Define standards for when and how these risk monitoring and evaluation tools will be used.	1.1.1.2, 3.1.1.2.3, 3.1.2.2.3, 3.2.1.2.5, 3.3.1.2.2, 4.1.1.2.3, 4.1.2.2.4.1, 4.1.3.2.5, 4.2.2.2.6	E
2.3	Develop a risk monitoring subsystem as necessary to maintain compliance with requirements in Action 2.2 above.	1.1.1.2	E
2.4	Determine method to verify baseline meets requirement.	1.1.1.2	E
3	Implement baseline configuration.		P
3.1	Train personnel.	3.2.1.3.2, 3.3.1.3.3	P
3.2	Implement the risk monitoring subsystem.	2.1.1.3.4, 2.1.2.3.3, 2.1.3.3.3, 2.1.4.3.5, 2.1.5.3.3, 3.1.2.3.4, 3.2.1.3.5, 3.3.1.3.1, 4.1.1.3.1, 4.1.2.3.4,	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.1 Mitigate Deterioration of Cylinders
Requirement: 2.1.1 A barrier between the cylinder mild steel containment surfaces and wetness shall be maintained. DOE 4330.4B, 5480.19, 6430.1A; 10 CFR 830 120, 10 CFR 835; (F:S&M)

Evaluation Criteria:
1. Is the option selected responsive to current deterioration rates?
2. Does the option integrate with the existing program?
3. Can the option feasibly meet the requirement?
4. Are toughness, durability, repairability, and life expectancy criteria for selecting coatings?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2	Define baseline configuration.	1.1.3.2.2	E
2.1	Define performance objectives for coating (toughness, adhesion, porosity, repairability, life expectancy). [2.1.1.a, 2.1.1.c]	1.1.1.2	E
2.2	Select coating.	1.1.1.2	E
2.3	Develop coating method including surface preparation, coating application, and curing.	1.1.1.2, 1.2.1.2.2	E
2.4	Establish a coating work plan and schedule that prioritizes cylinders on the basis of condition.	1.1.1.2, 5.2.2.3.1	E
2.5	Test coating method.		E
2.6	Determine method to verify baseline meets requirement. [2.1.1.c]		E
2.7	Determine the coating inspection and maintenance intent, method and frequency.	1.1.1.2, 2.1.2.2.4, 2.1.3.2.4, 2.1.4.2.5, 4.1.2.2.4	E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Initiate immediate temporary actions to mitigate the deterioration from worst case corrosion rates (paint skirts). [2.1.1.a]	1.2.1.3.3	P
3.2	Coat all cylinders per work plan and schedule. [2.1.1a, 2.1.1.b]		P
3.3	Adjust physical array of cylinders as necessary to maintain coating.	2.1.4.3.4	P
3.4	Implement coating inspection and maintenance.	1.1.1.2.4, 1.2.2.3.2, 2.1.3.3.3, 2.1.4.3.3, 2.1.5.3.5, 4.1.2.3.4	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.1 Mitigate Deterioration of Cylinders
Requirement: 2.1.2 Water retention on cylinders caused by cylinder structural features shall be minimized. DOE 5480.19, 6430.1A, 10 CFR 835, 10 CFR 830.120, ORO-651; (F:S&M)

Evaluation Criteria:
1. Have all structural features been assessed to determine their capacity to retain water?
2. Have features that retain water been modified to allow drainage?
3. Have performance objectives and time of wetness criteria been defined such that they may be verified through inspection techniques?

	Actions	Related Actions	EDP/ PMP
1	Analyze options to reduce cylinder time of wetness caused by cylinder structural features.	2.2.1.1	E
2	Define the baseline configuration.		E
2.1	Define acceptable cylinder time of wetness in a manner such that it is technically meaningful and can be verified.	1.1.1.2.1	E
2.2	Identify all cylinder structural features that retain water beyond acceptable time of wetness.	1.1.1.2	E
2.2.1	Define performance objectives of the cylinder structural features relative to the surveillance and maintenance function.	1.1.1.2.1, 2.2.1.2.3	E
2.2.2	Integrate the structural feature performance for the surveillance and maintenance function with performance objectives for the other system functions.	1.1.1.2.2	E
2.3	Identify and evaluate modifications to cylinder structural features that retain water to allow drainage.	1.1.2.2.2	E
2.4	Develop a structural feature inspection and maintenance plan to maintain compliance with this requirement, and integrate the plan with the program.	1.2.2.2.1, 1.1.1.2.4, 2.1.1.2.7, 2.1.4.2.4, 2.1.5.2.5, 4.1.1.2.3, 4.1.2.2.4	E
2.5	Determine cylinder inspection/acceptance requirements for transitioning cylinders from one function to another if one cylinder acceptance criteria is not adopted for all functions.	1.1.1.2.2	E
2.6	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Implement immediate actions to reduce cylinder time of wetness (clear debris from skirts). [2.1.2.a]	1.2.1.3.3	P
3.2	Modify structural features to meet acceptable cylinder time of wetness. [2.1.2.a]	1.2.1.3.3	P
3.3	Perform inspection and maintenance of cylinder structural features. [2.1.2.a]	1.2.2.3.2, 2.1.1.3.4, 2.1.3.3.3, 2.1.4.3.5 , 4.1.1.3.1, 4.1.2.3.4	P
3.4	Implement baseline maintenance.		P
4	Verify compliance with this requirement.		P

Actions		Related Actions	EDP/ PMP
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.1 Mitigate Deterioration of Cylinders
Requirement: 2.1.3 Water retention on cylinders caused by cylinder support structures shall be minimized. DOE 5480.19, 6430.1A; ORO-651, 10 CFR 835, 10 CFR 830.120; (F:S&M)

Evaluation Criteria:
1. Have all support structural designs been assessed to determine their capacity to retain water?
2. Have features that retain water been modified to allow drainage?
3. Do cylinder support structure design criteria include the protection of cylinder coating?
4. Does the design of support structures integrate with other system performance objectives?

	Actions	Related Actions	EDP/ PMP
1	Analyze cylinder support structure options to minimize cylinder time of wetness and accomplish other system performance objectives.	2.2.1.1	E
2	Define baseline configuration.		E
2.1	Define performance objectives of cylinder support structures with respect to system functions including the interface with cylinder coatings, periodic inspections, and water drainage. [2.1.3.a, 2.1.3.b]	1.1.1.2.1, 2.2.1.2.3	E
2.2	Identify cylinder support structures that do not meet performance objectives.	1.2.1.3.1, 1.1.1.2	E
2.3	Identify and evaluate modifications to cylinder support structures to meet cylinder time of wetness performance objectives.	1.1.1.2, 1.1.3.2.1	E
2.3.1	Assess current designs to determine their capacity to drain water.		E
2.4	Determine inspection and maintenance methods to maintain compliance with this requirement.	1.1.1.2, 1.2.2.2.1, 2.1.1.2.7, 2.1.3.2.4, 2.1.5.2.5, 4.1.2.2.4	E
2.5	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Implement immediate actions to performance objectives. [2.1.3.a, 2.1.3.b]	1.2.1.3.3	P
3.2	Procure or modify support structures to meet acceptable cylinder time of wetness.	1.2.1.3.3	P
3.3	Perform inspection and maintenance of cylinder support structures to ensure meeting this requirement.	1.2.2.3.2, 2.1.1.3.4, 2.1.2.3.3, 2.1.4.3.5, 4.1.2.3.4	P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.1 Mitigate Deterioration of Cylinders
Requirement: 2.1.4 Water retention on and adjacent to storage facilities shall be minimized. DOE 5480.28, 6430.1A; 10 CFR 830.120, 10 CFR 835; ORO-651; (F:S&M)

Evaluation Criteria:
1. Have all storage facilities been assessed to determine their capacity to meet time of wetness performance objectives?
2. Have features that retain water been modified to allow drainage?
3. Is the storage facility designed to minimize water retention?
4. Are the performance objectives for the facility including expected life, factored into design and construction?
5. Is there maintenance on the drainage routes from the facilities to maintain drainage.
6. Have time-of-wetness performance objectives been defined using technical bases?
7. Have the facility performance objectives and inspection procedures been integrated within the cylinder program?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet this requirement is not applicable.	NA	NA
2	Define the baseline configuration.		E
2.1	Define, using technical basis, storage facility performance objectives including retention of moisture, operational use, and expected life. [2.1.4.a, 2.1.4.b]	1.1.2.1, 2.2.1.2.3	E
2.2	Identify storage facility features that retain water beyond acceptable time of wetness performance objectives.	1.1.1.2, 1.2.1.3.1	E
2.3	Identify and evaluate modifications to existing storage facilities and new storage facility designs so that performance objectives are met.	1.1.1.2, 1.1.3.2.1	E
2.3.1	Assess current storage facilities for deficiencies in meeting performance objectives.		E
2.3.2	Assess current facility design and construction methods to performance objectives.		P
2.4	Identify and evaluate modifications to the cylinder storage array to meet system performance objectives.	1.1.1.2, 1.1.3.2.1, 2.2.1.2.5.3	P
2.4.1	Integrate storage array design with system functions including anticipated surveillance and maintenance of cylinders. [2.1.4.c]		E
2.5	Determine inspection and maintenance of storage facilities to maintain compliance with this requirement.	1.1.1.2.4, 1.2.2.2.1, 2.1.1.2.7, 2.1.2.2.4, 2.1.3.2.4, 4.1.3.2.3	E
2.6	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Implement immediate actions to reduce cylinder time of wetness (remove from ground contact, improve drainage of existing yards).	1.2.1.3.3	P

Actions		Related Actions	EDP/ PMP
3.2	Determine demand for modifications and new facilities.		P
3.3	Build new or modify storage facilities to meet cylinder performance objectives. Utilize new/modified facilities. [2.1.4.b]		P
3.4	Adjust cylinder storage array. [2.1.4.c]	2.1.1.3.3	P
3.5	Perform inspection and maintenance of the storage facilities to ensure that this requirement is met.	1.2.2.3.2, 2.1.1.3.4, 2.1.2.3.3, 2.1.3.3.3, 4.1.3.3.1	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.1 Mitigate Deterioration of Cylinders
Requirement: 2.1.5 Cylinder valve and plug integrity shall be maintained to program standards. DOE 4330.4B; 10 CFR 830.120, 10 CFR 835; ORO-651; (F:S&M)

Evaluation Criteria:
1. Are criteria identified to allow existing valves to be operated when necessary?
2. Are failed valves and plugs detected and repaired/replaced?
3. Have cylinder valve and plug performance criteria been defined in accordance with applicable industry standards and codes?
4. Has cylinder valve and plug inspection and maintenance been integrated with other system activities?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2	Define the baseline configuration.		E
2.1	Identify performance objectives for cylinder valve and plugs for each system function under the anticipated operational states. Define performance in terms of industry standards to the extent possible.	1.1.1.2.1	E
2.2	Integrate these performance objectives with the required configuration of the valve and plug. (packing, port and packing nut condition, valve body, threads showing, stem seat, torque, thread to boss interface including the presence of tape).	1.1.1.2.2	E
2.3	Determine inspection/acceptance requirements for transitioning from one function to another if one valve and plug baseline configuration is not implemented. [2.1.5.a, 2.1.5.b]	1.1.1.2.2, 1.2.2.2.1, 4.1.1.2.2, 4.1.1.2.3	E
2.4	Develop a valve and plug management program to ensure that performance objectives are met. [2.1.5.a]	1.1.1.2.4, 1.2.2.2.1	E
2.4.1	Determine the necessary periodic surveillance and preventive maintenance of valves and plugs. [2.1.5.a, 2.1.5.b]		E
2.4.2	Determine methods and when valves and plugs should be repaired/replaced as corrective maintenance. [2.1.5.b]		E
2.4.3	Determine methods and frequencies for valve and plug surveillance and preventive maintenance. [2.1.5.a]		E
2.5	Determine method to verify baseline meets requirement.	1.1.1.2	E
3	Implement the baseline configuration.	1.2.1.3.4	P
3.1	Replace or repair of all missing or damaged cylinder valve or plug protective measures. (This is restricted to only those measures that were installed or recommended by the cylinder manufacturer.) [2.1.5.c]	1.2.1.3.3	P
3.2	Implement the valve and plug management program. [2.1.5.a]		P
3.3	Periodically inspect the cylinders to detect failed valves and plugs. [2.1.5.b]	1.2.2.3.2, 4.1.1.3.1	P
3.4	Repair/replace failed valves and plugs so that the performance criteria are met. [2.1.5.b]		P
4	Verify compliance with this requirement.		P

Actions		Related Actions	EDP/ PMP
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.2 Mitigate Damage to Cylinders
Requirement: 2.2.1 Cylinder containment integrity shall be maintained during handling, processing, and transport operations. DOE 5480.19, 6430.1A; 10 CFR 830.120, 29 CFR 1910; DOE-HDBK-1090-95; ORO-651; ASME B30.5, ASME B56.1, ASME B30.10, Chapter 10-2, ASME B30.20, 20-1.2.2; (F:HS, CT, OT)

Evaluation Criteria:
1. Does the baseline address the concern of handling, processing, and transporting corroded cylinders?
2. Do the handling, processing, and transporting operations damage the protective coating? If so, is there a program to mitigate such damage?
3. Have engineered controls been designed and implemented to prevent cylinder damage during handling, processing, and transporting operations?
4. Are redundent controls and constraints in place to identify, handle, process, and transport corroded cylinders?

	Actions	Related Actions	EDP/ PMP
1	Analyze options that would prevent cylinder damage (including new or modified equipment) during handling, processing, and transporting operations.	2.1.2.1, 2.1.3.1	E
2	Define the baseline configuration.		E
2.1	Identify equipment performance objectives relative to handling, processing, and transport operations. [2.2.1.e]	1.1.1.2.1	E
2.2	Identify methods and equipment to be used to handle, process, and transport cylinders and their contents.	1.1.1.2.2	E
2.3	Identify performance objectives for cylinders, support structures, and storage facilities relative to handling, processing, and transporting methods and equipment. [2.2.1.f]	1.1.1.2, 2.1.2.2.2.1, 2.1.3.2.1, 2.1.4.2.1	E
2.3.1	Define acceptable cylinder integrity, incorporating cylinder degradation concerns, for handling, processing, and transport.	4.1.2.2.2	E
2.4	Identify engineered control(s) for each function that are needed to prevent, reduce, and mitigate cylinder and coating damage.	1.1.1.2, 1.2.1.2.1	E
2.4.1	Integrate the protection of cylinder coatings into the saddle design. [2.2.1.f]		E
2.4.2	Inmcorporate into new handling equipment design additional engineered controls to prevent coating damage from the equipment and damage when placing cylinder on support structures. [2.2.1.d]		E
2.4.3	Evaluate engineered controls to mitigate damage to cylinders and coatings from the use of existing equipment. [2.2.1.e]		E
2.5	Identify operational control(s) for each function that are needed to prevent, reduce, and mitigate cylinder damage during test/demonstration, start-up, routine, emergency, off-normal, and standby states of operation.	1.1.1.2, 1.2.1.2.1, 2.2.2.2.2, 2.2.2.3.1	E
2.5.1	Define methods for handling, processing and transporting cylinders and corroded cylinders to meet system performance objectives. [2.2.1.a, 2.2.1.g]	1.1.1.2, 2.2.2.2.2	E
2.5.2	Establish movement and processing authorization requirements. [2.2.1.h]	1.1.1.2, 1.2.1.2.1, 3.1.2.2.1	E

Actions		Related Actions	EDP/ PMP
2.5.3	Determine handling route specifications. [2.2.1.c]	1.1.1.2, 2.1.4.2.4	E
2.5.4	Develop operational procedures for handling, processing, and transporting cylinders. Integrate hoisting and rigging handbook guidelines into cylinder movement procedures. [2.2.1.a]		P
2.5.5	Integrate degraded cylinder conditions into operational procedures. Utilize hoisting and rigging handbook guidelines where applicable. [2.2.1.g]		P
2.6	Identify necessary inspection and maintenance of equipment and operations to ensure compliance with this requirement and ensure non-conforming and non-compliant cylinders are managed safely. [2.2.1.b]	1.2.2.2.1	E
2.7	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Modify existing equipment to add additional engineered controls. [2.2.1.d]		P
3.2	Implement a safe move program. [2.2.1.c, 2.2.1.g]	1.2.1.3.4	P
3.2.1	Implement administrative controls. [2.2.1.c]	1.2.1.3.4	P
3.3	Perform the necessary inspection and maintenance on equipment and operations including the verfication actions to compensate for non-conforming and potentially non-compliant cylinders. [2.2.1.b]		P
3.4	Implement baseline maintenance.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.2 Mitigate Damage to Cylinders
Requirement: 2.2.2 Cylinder handling, processing, and transporting equipment operators shall be proficient. DOE 5480.19, 5480.20A; 10 CFT 830.120, ORO-651; (F:H&S, CT, OT)

Evaluation Criteria:

1. Are operator skill and training objectives and qualifications specified?
2. Do operators demonstrate skills necessary to perform their functions without damaging the cylinders, support structures, equipment, or storage facilities?
3. Is documentation of operator proficiency available?
4. Are knowledge and skill requirements systematically determined?

	Actions	Related Actions	EDP/ PMP
1	Analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2.	Define the baseline configuration.		E
2.1	Identify all handling, processing, and transporting equipment and the tasks to be performed.	1.1.1.2, 3.2.1.2.1	E
2.2	Perform a job task analysis for each operation.	1.1.1.2, 2.2.1.2.5, 2.2.1.2.5.1, 3.2.1.2.1	E
2.2.1	Define the training objectives and their relationship to operational procedures.		
2.3	Identify potential consequences associated with each operation.	1.1.1.2, 1.1.3.2.1, 3.2.1.2.1	E
2.3.1	Define the necessary operator proficiency in terms of identified standards.		P
2.4	Establish training program for cylinder handling, processing, and transporting equipment operators and support crews.	1.1.1.2, 1.2.1.2.2.1, 1.2.2.2.1, 2.3.2.2.2, 2.3.2.2.3, 3.2.1.2.2	E
2.4.1	Develop the training material.	3.2.1.2.3	
2.4.2	Develop procedures to maintain training and qualification documentation.	3.2.1.2.4, 3.2.1.2.5	
2.5	Determine operator and support crew evaluation and retraining methods and frequencies.	1.1.1.2.4, 3.2.1.2.6, 2.3.2.2.4	E
2.6	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Train the operators to the skill level as determined by the task to be performed.	1.2.1.3.5, 2.2.1.2.5, 3.2.1.3.2, 2.3.2.3.2	P
3.1.1	Evaluate student performance against objectives and recognized performance standards.	3.2.1.3.5	P
3.2	Perform evaluation and requalification according to the training program. [2.2.2.a]	3.2.1.3.4, 2.3.2.3.2	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.3 Manage Non-Compliant Cylinders
Requirement: 2.3.1 Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated service life and configuration. DOE 6430.1A; ANSI N14.1; ORO-651; (F:S&M,CT)

Evaluation Criteria:
1. Are replacement parts designed to industry standards and within the program safety envelope?
2. Does the procurement process utilize qualified vendors?
3. Do replacement parts specifications include service life and configuration?
4. Do the manufactured products meet the design criteria?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet this requirement is not applicable.	NA	NA
2	Define the baseline configuration.		E
2.1	Determine service life and other performance objectives of replacement parts.	1.1.1.2.1	E
2.2	Identify required spare parts inventory and procurement capacity and duration.	1.1.1.2, 5.2.2.2.2	E
2.3	Document design specifications for replacement parts that include materials, tolerances, and manufacturing procedures that are acceptable in meeting the expected service life, reliability, and performance objectives. Incorporate industry standards into design specifications.	1.1.1.2	E
2.4	Establish a procurement quality control program to ensure specifications are met.	1.1.1.2, 1.2.1.2.1, 1.2.2.2.1	E
2.5	Identify qualified vendors.	1.1.1.2, 1.2.1.2.1	E
2.6	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Obtain a spare parts inventory in accordance with projected demand.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.3 Manage Non-Compliant Cylinders
Requirement: 2.3.2 Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions. DOE 5480.19, 5480.21, 5480.23, 5481.1B, 5500.1B, 6430.1A; 10 CFR 830.120, 10 CFR 835; 49 CFR 117 thru 180; ORO-651; (F:S&M, CT)

Evaluation Criteria:
1. Are hazards associated with processing degraded cylinders identified?
2. Are these identified hazards included in personnel training and other command media (such as contracts with outside organizations)?
3. Have minimum experience and training requirements been established for working and performing emergency response in a potential UF_6 hazard?
4. Does a mechanism exist to update training and command media as additional cylinder characterization data is processed?

	Actions	Related Actions	EDP/ PMP
1	Analyze option to automate operations involving deteriorated cylinders.		E
2	Define baseline configuration.		E
2.1	Identify and document hazards of cylinders for identified conditions and the level of skill and knowledge necessary to perform tasks on or around those cylinders.	1.1.1.2, 1.1.2.3	E
2.2	Include cylinder conditions, associated hazards, and required experience and training as a part of project command media, including: training, procedures, contracts, etc.	1.1.1.2, 1.2.1.2.1, 2.2.2.2.4, 3.1.2.2.1	E
2.3	Integrate training and command media revisions with cylinder condition data processing. [2.3.2.a]	1.1.1.2.2, 2.2.2.2.4, 3.2.1.2.3, 3.2.1.2.6	P
2.4	Determine required retraining frequency. [2.3.2.a]	1.1.1.2.4, 2.3.2.2.5, 3.2.1.2.4	E
2.5	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Periodically update cylinder conditions and associated hazards.	4.1.2.3.4, 4.2.2.2.6, 4.2.2.3.2	P
3.2	Notify performing personnel of degraded cylinder hazards through training, procedures, contracts, and other command media. [2.3.2.a]	1.2.1.3.5, 2.2.2.3.1, 2.2.2.3.2, 3.1.2.2.2, 3.1.2.3.2, 3.2.1.3.2	P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.3 Manage Non-Compliant Cylinders
Requirement: 2.3.3 Non-compliant cylinders shall be repaired or replaced to meet program standards. DOE 5480.21, 5480.23, 5481.1B; 10 CFR 830-120, 10 CFR 835, 49 CFR 117 thru 180; ORO-651; ANSI N14.1; (F:S&M, CT)

Evaluation Criteria:
1. Is repair to cylinders conducted in accordance with maintaining cylinders as coded vessels?
2. Are cylinder program standards commensurate with recognized industrial standards?
3. Do the permanent repairs bring the cylinder into conformance with cylinder performance objectives?
4. Is the disposition of non-compliant cylinders a risk-based decision?

	Actions	Related Actions	EDP/ PMP
1.	Analyze alternatives to repairing/replacing breached, thinned, and other expected non-conforming cylinder conditions?		E
2.	Define baseline configuration.		E
2.1	Document program cylinder standards.	1.1.1.2	E
2.2	Develop immediate response methods for expected non-compliant cylinders.	1.1.1.2	E
2.3	Develop repair/replacement and disposition methods and procedures that are commensurate with cylinder program risks, standards, and where applicabe industry standards. [2.3.3.b]	1.1.1.2, 1.2.1.3.2, 3.1.2.2.1	E
2.4	Identify non-compliant cylinders.	1.1.1.2, 1.2.2.2.1, 1.2.1.3.1, 4.1.2.2.1, 4.1.2.2.4	P
2.5	Prioritize and schedule cylinders in need of repair/replacement according to risk.	1.2.1.3.2	E
2.6	Develop repair/replacement capabilities and capacities with projected demand. [2.3.3.a]	1.1.1.2, 1.2.1.3.2, 5.2.2.2.2	P
2.7	Determine method to verify baseline meets requirement.		E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Perform immediate actions on cylinders when found to be non-compliant.	1.2.1.3.3	P
3.2	Repair or replace cylinders based on risk-determined, prioritized schedule.	1.2.1.3.3	P
3.3	Implement baseline maintenance.	4.1.2.3.4	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO3: IMPROVE CONDUCT OF OPERATIONS
Requirement Category: 3.1 Improve Process Controls
Requirement: 3.1.1 The system configuration (physical components, functions, and documents) shall be controlled through a formal process.
DOE 1324.2A, 1324.4A, 1324.5B, 1360.2B, 5480.19, 5480.20A, 5480.23, 4330.4B, 5633.3B, 5700.6C, 6430.1; 10 CFR 830.120, 10 CFR 835; (F:All), 5.3.y

Evaluation Criteria:
1. Are design basis documents integrated with safety analysis?
2. Are changes to system components and process control documents controlled?
3. Are the necessary disciplines involved with reviewing and approving configuration changes?
4. Does a records management system exist?

	Actions	Related Actions	EDP/ PMP
1	Analyze the options for what level(s) of program management should control the system configuration.		P
2	Define baseline configuration. Note: The physical and functional baselines defined under requirement 1.1.1.	1.1.1.2	P
2.1	Develop a configuration change process that includes a review by qualified individuals of changes against the design basis and performance requirement documents. The change process is to include defined levels of authority and corresponding change categories. [3.1.1.a]	1.1.1.2.4	P
2.2	Develop a document control and records management process. [3.1.1.a]	1.1.1.2.4	P
2.3	Develop the intent and periodicity of configuration assessment process and documentation audits.	1.1.1.2.4.2, 1.2.2.2.2	P
3	Implement baseline configuration.	1.1.1.3, 1.1.3.3, 1.2.1.3.4	P
3.1	Implement the configuration change process. [3.1.1.a]	1.1.1.3.1	P
3.1.1	Identify configuration items for configuration control.		E
3.2	Review temporary modifications to facilities and equipment for potential unreviewed safety questions.	1.2.2.2.1	P
3.3	Review procedures and training to ensure that changes in operational activities do not create an unreviewed safety question.	1.2.1.3.4, 1.2.2.2.1, 3.1.2.3	P
3.4	Implement the document control and records management system.	1.1.1.3, 1.2.1.3.4	P
3.5	Conduct audits and independent assessments of configuration control, document control, and records management process.	1.1.1.3.2, 1.2.2.2.1, 1.1.3.2.4.2	P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO3: IMPROVE CONDUCT OF OPERATIONS
Requirement Category: 3.1 Improve Process Controls
Requirement: 3.1.2 Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process. DOE 1324.2A, 1324.4A, 1324.5B, 1360.2B, 4330.4B, 5480.19, 5480.20A, 5480.23, 5480.26, 5000.3B, 5633.3B, 5700.6C; 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:
1. Do the work controls provide the specifications for what resources are to be used, how the work is to be conducted, and the work performance?
2. Does the work authorization process clearly define the work to be performed, the priority for performing work, and the personnel responsible for performing work?
3. Do work control documents include standards for acceptable results?
4. Is work performed by qualified workers and in accordance with work controls?
5. Do procedures identify precautions and warnings to user?
6. Do procedures accomplish the performance requirements of the task?
7. Are work controls managed at an appropriate level?
8. Are only current documents used to control work?
9. Do work controls account for all operational states (start-up, including demonstration and validation, off-normal, emergency, and standby)?

	Actions	Related Actions	EDP/ PMP
1	Analysis the options for what level(s) of management should control and authorize work controls.		P
2	Define the baseline configuration. The physical, functional, and document baselines are defined under requirement 1.1.1 actions.	1.1.1.2	E
2.1	Identify the work controls to be used by the system and their intent including the specification of resources, responsibilites, work methods, work performance, and verification.	1.1.1.2, 1.1.3.2.2, 1.2.1.2.1, 2.2.1.2.5.2, 2.3.2.2.2, 2.3.3.2.3	E
2.2	Develop a process(es) for authorizing and implementing work controls including responsible personnel and positions. This process includes the work control structure.	1.1.1.2, 2.3.2.3.2	P
2.2.1	Develop a work control process description and implementing procedures including the integration of safety documentation, emergency response, lessons learned, and site specific requirements. [3.1.2.a, 3.1.2.c]	1.1.1.2	P
2.2.2	Develop a database to track work controls currently authorized.	1.1.1.2	P
2.2.3	Incorporate verification and validation steps in the authorization of work controls to ensure the control will accomplish the intent of the task(s).	1.1.1.2	P
2.3	Develop the intent and periodicity of reviews and audits of the work controls and work control authorization and implementation process(es). Intent is to include 3-site consistency and uniform risk management with the system. [3.1.2.b]	1.1.1.2.4, 1.2.2.2.1, 1.2.2.2.2	P
3	Implement baseline configuration.	1.2.1.3.4, 3.1.1.3.3	P
3.1	Train personnel on process controls.	3.2.1.3.2	P

Actions		Related Actions	EDP/ PMP
3.2	Implement work control process(es). [3.1.2.a]	1.2.1.3.4, 2.3.2.3.2	P
3.3	Manage system documents and records per the document control and records management process.	1.1.1.3.1	P
3.4	Review and audit work controls and authorization and implementation process(es). [3.1.2.b]	1.2.2.3.2	P
4	Verify compliance with this requirement.		P
4.1	Conduct independent performance based assessments. [3.1.2.d]		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO3: IMPROVE CONDUCT OF OPERATIONS
Requirement Category: 3.2 Improve Staffing and Training
Requirement: 3.2.1 Personnel shall be selected, trained, and developed through a structured process.
DOE 5480.18A, 5480.19, 5480.20A, 5480.21, 5480.23, 5481.1B, 5700.6C; 10 CFR 830.120, 10 CFR 835, 49 CFR 117 thru 180, 29 CFR 1910.120; (F:All)

Evaluation Criteria:

1. Are jobs analyzed to determine the complexity of the task, severity of the consequences if preformed incorrectly, and the human factors involved with accomplishing the intent of the task?
2. Is personnel selection based on required knowledge, skills, experience, and physical ability?
3. Are training, qualification, and certification requirements identified and determined based on the complexity of the task and potential consequences, the frequency with which it is performed, and the desired proficiency of the performing personnel?
4. Are the learning objectives developed from the analysis data?
5. Are the training media developed and delivered based on the learning objectives?
6. Are retraining frequencies determined by the program line and training organizations, considering the potential consequences of the task, the complexity of the task, and the frequency with which it is performed?
7. Are training records kept current and available to line supervisors to faciliate work authorization?
8. Is performance periodically monitored and assessed to determine that procedures are being followed, training is effective, and the intent of the operation is being fully met?
9. Is training development integrated with procedure development?
10. Are trainers qualifications identified?

	Actions	Related Actions	EDP/ PMP
1	Analyze the options for determining the integration of procedures with training and determine criteria for an integrated development based on tasks.		E
2	Define baseline configuration.		P
2.1	Develop a personnel selection and training management plan and implementing procedures based on the complexity of tasks, severity of consequences, and human factors. Training plan is to include qualification specifications of trainers and training of safety documentation. [3.2.1.a, 3.2.1.b]	1.1.1.2, 2.2.2.2.1, 2.2.2.2.2, 2.2.2.2.3	P
2.2	Determine the performance-based training, qualification, and certification specifications for performing personnel. [3.2.1.d]	1.1.1.2, 1.1.3.2.2, 2.2.2.2.4	P
2.2.1	Specify the degree of training (certification, qualification, etc.) for performing personnel (inspectors) who determine cylinder condition. The quality of which cylinder conditions are determined impacts the functional and inter-functional risks within the system.	1.1.1.2.2.2	P
2.2.2	Specify the degree of training (certification, qualification, etc.) for performing personnel (operators) who perform work (handle, transport, transfer contents, maintenance) on cylinders. The quality for which this work is performed can directly impact the immediate and long-term functional risks within the system.		P
2.3	Develop training documents (modules, etc.) to train performing personnel based on learning objectives. Modules are to include safety precautions, hazards, emergency response, lessons learned, and site specific requirements. [3.2.1.e]	1.1.1.2, 2.2.2.2.4.1, 2.3.2.2.3	P

Actions		Related Actions	EDP/ PMP
2.4	Develop systems to maintain baseline of trained personnel. Systems are to include training records retention and ready access to current training by authorizing and implementing personnel. [3.2.1.c]	1.1.1.2.4, 2.2.2.2.4.2, 2.3.2.2.4	P
2.5	Develop the intent and periodicity of audits, assessments, and reviews of the training program.	1.1.1.2.4, 1.2.2.2.1, 1.2.2.2.2, 2.2.2.2.4.2	P
2.6	Develop a training revision process to accomodate changes in tasks, and improvements to training. The process is to include line and training personnel to determine the extent and frequency of retraining.	1.1.1.2.4, 2.2.2.2.5, 2.3.2.2.3	P
2.6.1	Revise job hazard analyses as necessary.		P
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Select personnel per criteria in the management plan.		P
3.2	Perform required training, qualification, and certification. [3.2.1.a]	1.2.1.3.5, 1.2.2.3.1, 2.2.2.3.1, 2.3.2.3.2, 3.1.2.3.1	P
3.2.1	Train cylinder inspectors.		P
3.3	Develop and maintain a database to include the following: job and task analysis results, learning objectives, linking of test items, task-to-training data, instructor qualifications, training material identification data, training delivery data, employee training history, and training intervals. [3.2.1.c		P
3.4	Perform retraining as required by line management and training personnel. [3.2.1.b]	2.2.2.3.2	P
3.5	Conduct periodic reviews of selection and training process effectiveness. [3.2.1.f]	1.2.2.3.2, 2.2.2.3.1.1	P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO3: IMPROVE CONDUCT OF OPERATIONS
Requirement Category: 3.3 Monitor System Performance
Requirement: 3.3.1 System functions shall be monitored to reinforce expectations for work performance and facility condition. DOE 4330.4B, 5480.18A, 5480.19, 5480.20A, 5700.6C; 10 CFR 830.120; (F:All)

Evaluation Criteria:
1. Performance objectives are defined for the system functions.
2. An assessment process exists to evaluate system performance against the objectives.
3. A process exists to evaluate assessment results and improve system performance.
4. The line managers use the performance objectives for monitoring and improving work activities.
5. Performance indicators are used to keep program personnel and customers informed of progress toward meeting the performance objectives and the mission.

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet this requirement is not applicable.	NA	NA
2	Define baseline configuration.		P
2.1	Select and develop performance objectives for the system functions; consider customer expectations and long-range plans.	1.1.1.2.1	P
2.2	Develop an assessment process based on guidelines in Order 5480.19 to evaluate system performance against the objectives, to include observation of work in the field, review of other audits/assessments, operating experience, document reviews, interviews of key personnel, facility condition inspections. [3.3.1.a]	1.1.1.2, 1.2.2.2.1, 1.2.2.2.2	P
2.3	Develop line management process to evaluate assessment results and improve system performance. The process is to include the method for keeping program personnel and customers informed of the status of the system performance to performance objectives and program mission.	1.2.2.2.1	P
3	Implement baseline configuration.		P
3.1	Implement the structured process to monitor system functions per the performance objectives. This requires active participation in system functions at all levels. [3.3.1.b]	1.2.2.3.2	P
3.2	Evaluate assessment results to provide the basis for system improvements, to include the following: evaluate results, define issues, develop mitigating actions, prioritize actions and cost/benefit analysis of highest priority actions, develop and implement action plan.		P
3.3	Train line-management to use the assessment process for monitoring and improving work activities, including observation skills, performance objectives selection and use, evaluation process skills, and action plan development process.	1.2.2.3.1	P
3.4	Develop and use performance indicators for the system functions to demonstrate that performance objectives and mission are met to identify trends, and to identify areas requiring improvement. [3.3.1.b]		P
4	Verify compliance with requirement.		P
4.1	Conduct independent assessments of the evaluation process.		P

Actions		Related Actions	EDP/ PMP
5	Adjust baseline as necessary to meet the program requirement.		P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY
Requirement Category: 4.1 Monitor Containment Integrity
Requirement: 4.1.1 Exposure to the environment shall be monitored. DOE 5700.6C; 10 CFR 830.120, 10 CFR 835, ORO-651; (F:S&M)

Evaluation Criteria:
1. Have all pathways of exposure to the environment been identified?
2. Is the monitoring balanced with the potential impact on subsequent phases of the program?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2	Define baseline configuration.		E
2.1	Identify potential pathways of exposure to the environment due to failure of containment integrity.		P
2.2	Develop methods for identifying and quantifying releases to the environment and the effects of releases. The exent of these methods for determining releases is to be commensurate with decontamination and decommissioning of the system. [4.1.1.a, 4.1.1.b]	1.2.2.2.1, 2.1.5.2.3	E
2.3	Determine the required frequency for performing the monitoring methods, and for periodic assessments of methods and data. [4.1.1.b]	1.2.2.2.2, 2.1.2.2.4, 2.1.5.2.3	E
2.4	Determine a method to verify that all potential pathways of exposure to the environment are being monitored.		E
3	Implement baseline configuration.		P
3.1	Monitor cylinders and the environment for releases to the environment and the effects of such releases. [4.1.1.b]	1.2.2.3.2, 2.1.2.3.3, 2.1.5.3.3	P
3.2	Implement actions to maintain compliance with this requirement.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement		P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY
Requirement Category: 4.1 Monitor Containment Integrity
Requirement: 4.1.2 Cylinder condition shall be monitored. DOE 5480.23, 5480.28, 5633.3B, 5700.6C; 10 CFR 830, 10 CFR 830.120, 10 CFR 835, 49 CFR 173.420, DOE-HDBK-1090-95, ORO-651, ANSI N14.1, ASME Codes, EPA ACD; (F:All)

Evaluation Criteria:
1. Are the cylinder acceptance criteria defined?
2. Are cylinder acceptance criteria integrated with industry standards?
3. Is the inspection frequency technically based?
4. Is the integrity monitoring integrated with other risk control programs (Nuclear Material Control and Accountability and Health & Safety)?
5. Are the inspection methods integrated with the cylinder access (storage array) in order to determine cylinder condition?
6. Do inspections verify cylinder compliance with acceptance criteria?

	Actions	Related Actions	EDP/ PMP
1	Analyze the integration of cylinder storage array with periodic monitoring to determine system configuration options.		E
2	Define the baseline configuration.		E
2.1	Identify all cylinder monitoring performance objectives.	2.3.3.2.4	E
2.1.1	Perform laboratory studies and other anaylses to support the definition of cylinder integrity criteria.		E
2.1.2	Perform structural analysis in support of the developing functional acceptance criteria.		E
2.2	Define cylinder functional acceptance criteria based upon applicable industrial standards and cylinder performance objectives. [4.1.2.a, 4.1.2.b]	2.2.1.2.3.1	E
2.2.1	Develop code case(s) to demonstrate compliance with industry standards. [4.1.2.b, 4.1.2.c]		E
2.3	Identify factors that make cylinders non-conforming and identify constraints necessary to maintain compliance with the safety envelop (non-conformance may be based on non-certified volumes, exceedence of fill limits, etc.) [4.1.2.a]		E
2.4	Establish inspection/evaluation methods for determining the acceptability of cylinders relative functional criteria. [4.1.2.d]	1.2.2.2.1, 2.1.1.2.7, 2.1.2.2.4, 2.1.3.2.4, 2.3.3.2.4	E
2.4.1	Determine a technically acceptable risk-based periodicity to perform inspections and evaluations for determining the acceptability of cylinders' relative functional criteria. [4.1.2.e]	1.2.2.2.2	E
2.4.2	Specific the extent to which cylinder anomiallies identified during inspections will be documented. The extent of documentation includes the precision for which anomiallies will be measured and their location defined i.e., a dent on the right side of the cylinder versus a 1/2" deep, 3" circumfrencial dent located 5" from the valve side of the valve-end stiffener at the 3 o'clock position.		E
2.4.3	Develop the visual inspection/quantitative evaluation integration (the use of visual inspections to select cylinders and general surface areas for obtaining quantitative data to verify compliance with functional criteria).		E

Actions		Related Actions	EDP/ PMP
2.4.4	Define ultrasonic thickness techniques and their application i.e., how many points, and extent of area to measure thickness to verify compliance with functional criteria.		E
2.4.5	Integrate inspection/evaluation methods and resultant data with risk controls such as inventory accountability, cylinder maintenance, and contamination control.		P
2.4.6	Integrate the periodic inspection performance objectives with cylinder accessibility. [4.1.2.f]		E
2.4.7	Perform laboratory studies to support the cylinder functional acceptance criteria and the cylinder monitoring evaluation techniques.		E
2.5	Determine method to verify that the baseline configuration meets the requirement.		E
3	Implement baseline configuration.		P
3.1	Identify existing cylinder conditions.		P
3.1.1	Determine the baseline condition of each cylinder with respect to functional criteria to the extent visual inspections are applicable.		P
3.1.2	Statistically determine the baseline condition of cylinder populations by obtaining quantitative data.		P
3.2	Identify non-compliant and non-conforming cylinders.		P
3.3	Implement constraints for non-conforming cylinders.		P
3.4	Periodically monitor cylinder conditions. [4.1.2.e]	1.2.2.3.2, 2.1.1.3.4, 2.1.2.3.3, 2.1.3.3.3, 2.3.2.3.1, 2.3.3.3.3	P
3.5	Examine justification of inspection frequency and evaluate the need to adjust.		P
3.6	Conduct independent assessments of the evaluation of cylinder condition.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY
Requirement Category: 4.1 Monitor Containment Integrity
Requirement: 4.1.3 Factors that affect cylinder condition shall be monitored. DOE 5480.23, 5480.26, 5480.28, 6430.1A, 10 CFR 835, 10 CFR 830.120; DOE-HDBK-1090-95, ORO-651; (F:S&M)

Evaluation Criteria:
1. Has a structured approach to the comprehensive identification of degradation factors been used?
2. Is the monitoring method consistent with the applicable degradation factor?
3. Does the monitoring provide timely and reliable data that will be useful in forecasting cylinder conditions?

	Actions	Related Actions	EDP/ PMP
1.	Analyze optional storage configuration to reduce or eliminate degradation factors.		E
2.	Define baseline configuration.		E
2.1	Identify, and grade for severity, factors that could degrade cylinder integrity. [4.1.3.a]		E
2.2	Develop a database for tracking degradation factor monitoring data.		E
2.3	Develop methods to monitor the degradation factors for the collection of timely and reliable data that is useful in forecasting cylinder condition. Monitoring method is based on applicable degradation factor. [4.1.3.b]	2.1.4.2.5	E
2.4	Develop a monitoring plan, incorporating the methods and frequencies for performing those methods.	1.2.2.2.1	E
2.5	Determine the intent and frequency for audits, assessments, and reviews of degradation factor monitoring.	1.2.2.2.1, 1.2.2.2.2	E
2.6	Determine methods to verify the baseline meets the requirement.		E
3	Implement baseline configuration.		P
3.1	Monitor the cylinder degradation factors. [4.1.3.b]	2.1.4.3.5	P
3.2	Record the cylinder degradation factor information in the developed database.		P
3.3	Implement baseline maintenance.		P
3.3.1	Perform self-assessments and other quality control measures to ensure that the degradation factors are being monitored according to the developed plan.		P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY
Requirement Category: 4.2 Evaluate Containment Integrity
Requirement: 4.2.1 Cylinders shall be categorized to ensure risks are identified. (F:All)

Evaluation Criteria:
1. Are the categories clearly defined such that all cylinders are categorized?
2. Are the categories conclusive to effective decision making?
3. Do the categories provide for assessment of the overall risks within the program?
4. Are changes in category definitions conveyed to the trend analysis effort?
5. Have approved procedures been developed to guide the categorization process?
6. Is the categorization method consistent across all three sites?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods to meet the requirement is not applicable.	NA	NA
2	Define baseline configuration.		E
2.1	Review the cylinder functional criteria and degradation factors.		E
2.2	Define and describe categories in terms of cylinder functional criteria and/or factors that could adversely impact cylinder integrity.		E
2.3	Develop procedures for grouping cylinders and storage environments in the defined categories.		E
2.4	Develop a method for tracking cylinders and storage environments according to their categories.	1.2.2.2.1	E
2.5	Determine a method to verify the baseline configuration.		E
3	Implement baseline configuration.		P
3.1	Categorize the cylinders and storage environments.		P
3.2	Record the categorization information to allow tracking.		P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO5: ADMINISTER THE SYSTEM
Requirement Category: 5.1 Obtain Resources
Requirement: 5.1.1 Financial resources to sustain the system shall be obtained and utilized. 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:
1. Are financial requirements systemmatically developed?
2. Have financial requirements been identified?
3. Are financial resources available to accomplish critical tasks?
4. Are financial resources allocated to critical tasks?
5. Are costs controlled to progress?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2	Define baseline configuration.		P
2.1	Develop a standard, systemmatic method for estimating level of effort within the system to support standard cost estimates.		E
2.2	Identify the critical path of system activities (tasks).		E
2.3	Define budgeting cycle activities and schedules.		P
2.4	Develop a funds allocation and accounting system reflective of the WBS.		P
2.4.1	Obtain accurate accounting of costs (funds committed to-date) as needed at the single site and 3-site level to effectively control financial resources.		P
2.5	Define and develop financial management methods (review periods, reallocation processes, financial configuration control, etc.).	1.2.2.2.1	P
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Define task (WBS) elements with accounts.		P
3.2	Define budget requirements with identified activities (tasks).		P
3.3	Obtain budget authorization.		P
3.4	Gather accurate costs.		P
3.5	Control costs to the progress of activities (tasks).		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO5: ADMINISTER THE SYSTEM
Requirement Category: 5.1 Obtain Resources
Requirement: 5.1.2 Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured. DOE 5480.21; (F:All)

Evaluation Criteria:
1. Is the necessary expertise to accomplish activities identified?
2. Is the necessary expertise retained and used to accomplish tasks?
3. Are roles and responsibilities identified for ensuring activities, subsystems, and functions accomplish objectives?
4. Are organizational structures functional?

	Actions	Related Actions	EDP/ PMP
1	Analyze optional methods for obtaining intellectual resources (contract, subcontract, direct employment).		P
2	Define the baseline configuration.		P
2.1	Define how disciplines necessary to accomplish system activities and objectives are identified and secured, and allocated.		P
2.2	Establish a program organization reflective of the system functions, subsystems, and activities.		P
2.3	Define roles, responsibilities and qualifications reflective of the organizational structure.		P
2.4	Define the personnel performance monitoring system.	1.2.2.2.1	P
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Obtain and allocate intellectual resources necessary to operate the system and accomplish activities.		P
3.2	Monitor personnel performance.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO5: ADMINISTER THE SYSTEM
Requirement Category: 5.2 Integrate the System Operations
Requirement: 5.2.1 System and technical requirements shall be traceable from the program mission to implementing documentation. 10 CFR 830.120, ORO-651; (F:All)

Evaluation Criteria:
1. Are requirements identified?
2. Is there a structured approach to identifying, organizing, and maintaining system, subsystem, functional, component, and activity requirements.
3. Are requirements linked to the mission and implementing documents?
4. Are requirements used in determining system activities (tasks)?

	Actions	Related Actions	EDP/ PMP
1	An analysis of optional methods for meeting this requirement is not applicable.	NA	NA
2	Define baseline configuration.		P
2.1	Develop the requirement structure and traceability method(s).		P
2.2	Develop a method for controlling and maintaining requirements.		P
2.3	Develop a method for ensuring system tasks are based on requirements.		P
3	Implement baseline configuration.		P
3.1	Identify requirements.		P
3.2	Trace requirements to the mission and implementing documentation.		P
3.2.1	Reconcile requirements against the results of the necessary and sufficient closure process.		P
3.3	Utilize requirements in identifying and developing system activities (tasks).		P
4	Verify compliance with requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P

MO5: ADMINISTER THE SYSTEM
Requirement Category: 5.2 Integrate the System Operations
Requirement: 5.2.2 The system configuration shall be optimized in accordance with life-cycle projections. DOE 5480.1B, 5480.10, 5480.19, 5480.28, 5483.1A; 10 CFR 830.120, 10 CFR 835, 29 CFR 1910, 29 CFR 1926; (F:All)

Evaluation Criteria:
1. Is there a projected system life-cycle and phase duration?
2. Is the system configuration based on the projected life-cycle and duration?
3. Is the configuration assessed for efficiency, reliability, and maintainability through the projected life-cycle and duration?
4. Is there a mechanism for reoptimizing the configuration with revised life-cycle projections and new technologies?
5. Are subsystem, function, component, and activity interfaces identified and utilized in modifications to the system configuration?

	Actions	Related Actions	EDP/ PMP
1	Trade study alternatives/options of life-cycle projections.		E
2	Define baseline configuration.		P
2.1	Define the projected life-cycle including phase durations and operating parameters that impact current phase objectives and criteria. [5.2.2.a, 5.2.2.b]		P
2.2	Develop the system configuration and change control based on life-cycle and phase duration projections. [5.2.2.a]	2.3.1.2.2, 2.3.3.2.6	P
2.3	Identify the factors for triggering an assessment of the configuration, i.e., revisions to the life-cycle and duration projections, sub-standard performance, identification of new technologies. New technologies include methods for reducing cylinder corrosion. [5.2.2.c]		P
2.4	Develop methods/sub-systems for identifying when a configuration assessment is necessary.	1.2.2.2.1	P
2.5	Develop a method for identifying and controlling the interfaces between organizations, functions, subsystems, components and activities.	1.2.2.2.1	E
3	Implement baseline configuration.	1.2.1.3.4	P
3.1	Assess the configuration for efficiency, reliability, and maintainability. [5.2.2.a]	2.1.1.2.4	P
3.1.1	Determine the 3-site aspects of the system configuration. Specifically, determine whether the K-25 cylinder inventory should be relocated to Paducah and Portsmouth or should the long-term maintainability functions be implemented at K-25.		P
3.2	Implement methods for identifying when a configuration assessment is necessary.		P
3.3	Identify the interfaces within the system configuration.		E
3.4	Control the interfaces within the system.		P
4	Verify compliance with this requirement.		P
5	Adjust baseline as necessary to meet the program requirement.		P