95-0004998

The Secretary of Energy
Washington, DC 20585

October 16, 1995

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

Dear Mr. Conway:

This letter forwards the Department's implementation plan for addressing the issues raised in the Defense Nuclear Facilities Safety Board's Recommendation 95-1.

The implementation plan presents an aggressive program of corrective actions. The Department is proceeding on all activities identified in my June 29, 1995, acceptance letter. We expect that there will be further cylinder management program improvements as the commitments in the implementation plan are completed.

The implementation plan was prepared by Mr. Ray A. Hunter, Deputy Director of the Office of Nuclear Energy, Science and Technology, in coordination with other senior Department managers. This plan was developed in liaison with Defense Nuclear Facilities Safety Board staff. We appreciate your staff's dedication and support of the development of this plan.

Sincerely,

Hazel R. O'Leary

Enclosure

95/4998

Department of Energy
Implementation Plan

for

Defense Nuclear Facilities Safety Board
Recommendation 95-1

Improved Safety of Cylinders Containing Depleted Uranium

October 16, 1995

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I. EXECUTIVE SUMMARY

On June 29, 1995, the Department of Energy (the Department) accepted Recommendation 95-1 from the Defense Nuclear Facilities Safety Board (the Board). The recommendation addresses protection against potential dispersal of large quantities of uranium to the environment from the depleted uranium hexafluoride (UF_6) inventory in long-term storage. The material is stored at Portsmouth, Ohio, Paducah, Kentucky, and Oak Ridge, Tennessee. This Implementation Plan describes the process for carrying out and completing the tasks associated with the recommendation. This plan describes the Department's understanding of the underlying goals and issues identified by Recommendation 95-1 and provides the Department's proposed course of action to implement the recommendation.

As stated in its letter accepting Recommendation 95-1, the Department is focusing on five areas to implement the recommendation. Activities are underway on all five areas. Improvements and/or modifications will be made to these activities as a result of a systems engineering approach that will be used to respond to the recommendation. The five focus areas and status follow:

1. Relocate cylinders from ground contact and keep all cylinders from further ground contact.

    - All K-25 cylinders, and almost 3,300 cylinders at Paducah, have been removed from ground contact; none has shown evidence of a breach. A new concrete storage yard of improved design is complete at Paducah.

2. Relocate all cylinders into an adequate inspection configuration.

    - Approximately 1,600 cylinders have been relocated and restacked into a configuration adequate for visual inspections at Paducah. Relocating and restacking will continue as new yard construction is completed. A new concrete storage yard of improved design, to address inspection configuration, is complete at Portsmouth.

3. Repaint cylinders as needed to avoid excessive corrosion.

    - Painting of accessible, skirted cylinder ends has begun.

    - A pilot program to paint entire cylinder bodies will begin during the Summer of 1996 at Paducah. Painting at all three sites is expected to begin in the Spring of 1997.

4. Update handling and inspection procedures and site-specific Safety Analysis Reports.

   - The handling and inspection procedure has been revised to improve the safe handling of degraded cylinders, and personnel are being trained to apply the revised procedures.

   - The Department is now reviewing a Basis for Interim Operation for the cylinder yards at each of the three sites. These Bases for Interim Operations will be incorporated in the site-specific Safety Analysis Reports in accordance with Department Order 5480.23. The Safety Analysis Reports are to be approved by the Department in the Spring of 1997.

5. Complete an ongoing study that will include an analysis of alternative chemical forms for the material.

   The revised Safety Analysis Reports will document the safety basis of long term storage of depleted UF_6. The Department will use the Safety Analysis Reports to determine if the risks of continued storage are acceptable.

Since Recommendation 95-1 was issued, the Department has recognized the benefits of including risk management in a comprehensive, systematic approach to cylinder maintenance. To implement this approach, the Department has begun: (1) an early program to renew the protective coatings on cylinders, (2) to explore the possibility of additional measures to protect cylinders from damaging effects of exposure to the elements, as well as any additional handling that may be necessary, and (3) to institute a study to determine whether a more suitable chemical form for long-term storage of the depleted UF_6 should be selected. The Department has initiated a systems engineering approach to accomplish these tasks and to ensure the inventory continues to be managed safely. This approach facilitates the management of the depleted UF_6 cylinder inventory by improving the protection of workers, the public, and environment from exposures to depleted UF_6.

The systems engineering approach focuses on understanding and managing risks. After the risks are defined, the system requirements are identified and documented in a Systems Requirements Document. Program actions necessary to meet these requirements are developed through a requirements analysis documented in the System Engineering Management Plan. These program actions are then implemented, by work breakdown structure, through the depleted UF_6 Cylinder Program Management Plan which would be updated annually. Actions defined by the System Engineering Management Plan that require technical development before implementation are managed through an Engineering Development Plan.

This Implementation Plan describes the Department's planned activities to satisfy Recommendation 95-1 through a systems engineering approach to depleted UF_6 cylinder management. The Department uses the System Engineering Management Plan to identify how the Program Management Plan should be modified to address Subrecommendation 1. In addition to today's program activities (e.g., paint accessible, skirted cylinder heads and coating several hundred cylinders as a pilot effort), Subrecommendation 1 regarding coating renewal will be more comprehensively defined by the System Engineering Management Plan. Subrecommendation 2, on the effects of weather and handling, will be addressed by the Engineering Development Plan. The Engineering Development Plan has not been developed, but the handling procedures have been revised to take into account additional handling of degraded cylinders. Subrecommendation 3 on whether to seek alternate forms for storage, will be addressed as part of the Engineering Development Plan. Site Safety Analysis Reports are being developed and will enable the Department to determine whether the risks of continued storage as depleted UF_6 are acceptable. The Office of Nuclear Energy, Science, and Technology, through the Oak Ridge Operations Office and its Management and Operating Contractor, Lockheed Martin Energy Systems, is responsible for meeting the commitments in this Implementation Plan.

II. BACKGROUND

On May 5, 1995, the Defense Nuclear Facility Safety Board (the Board) issued Recommendation 95-1, dealing with the improved safety of cylinders containing depleted uranium hexafluoride. The Secretary of Energy accepted the recommendation on June 29, 1995.

The Department of Energy (the Department) is storing about 560,000 metric tons of depleted UF_6 in solid form in approximately 47,000 steel cylinders. The cylinders are located at the three gaseous diffusion plants at Portsmouth, Ohio, Paducah, Kentucky, and Oak Ridge, Tennessee. The oldest cylinders have been in service for as long as 40 years. The cylinders are stored outdoors in parallel aisles, typically stacked two layers high. To protect against the dispersal of large amounts of depleted UF_6 to the soil and groundwater in years to come, the Board recommends that the Department take actions to accomplish the following:

Subrecommendation 1:	Start an early program to renew the protective coating of cylinders containing the tails from the historic production of enriched uranium.
Subrecommendation 2:	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.
Subrecommendation 3:	Institute a study to determine whether a more suitable chemical form should be selected for long-term storage of the depleted uranium.

The Department initiated a program in 1992 to ensure the safety of the long-term storage of depleted UF_6. The Department's response to the Board recommendation is to improve the cylinder maintenance program through a systems engineering approach to risk management. These improvements will be developed concurrently with program activities underway and instituted with revised program direction. Ongoing activities include removing cylinders from substandard storage (complete at K-25 and Portsmouth; and in process at Paducah), preparing for an early start on a cylinder maintenance coating program (several hundred cylinders will be coated at Paducah during the summer of 1996), and painting accessible, skirted cylinder ends. Ultrasonic wall thickness measurements continue to be taken to improve estimates of current and future cylinder integrity.

III. UNDERLYING CAUSES

The Department assessed the issues associated with Recommendation 95-1 in terms of the program's current status and the history of the cylinders' storage. The Department determined that the root cause of the problems with the program is the lack of defined risks for degraded cylinders. Contributing causes include the absence of a defined life-cycle maintenance program, inadequate resources that have since been improved, inadequate operational controls used to place cylinders in their current locations, incomplete integration of program operations, and the absence of a well-defined mission. The need to incorporate risk management in a comprehensive, systematic approach to cylinder maintenance is the lesson the Department has learned that is being addressed by this Implementation Plan.

IV. PROGRAM MISSION, OBJECTIVES, AND ASSUMPTIONS

Managing risks involves identifying hazards, determining event initiators and consequences, determining the probability of occurrence, and developing and implementing preventive measures. As part of the safety approach, program management develops and implements actions to mitigate the consequences in case an incident occurs. Safety analysis, which includes the Basis for Interim Operations, as required by Department orders, is the primary means for evaluating hazards and risks. Preventive and mitigative measures are responsive to the risks and hazards identified through this process, and are incorporated through design, administrative, and engineered controls.

To integrate risk management in the program, the Department performs the following mission:

Safely store the depleted UF_6 inventory until ultimate disposition of the material.

In support of this mission, five preliminary major objectives have been established to assure accomplishment of the mission.

1. Ensure risks to personnel and environment are low.
2. Evaluate and monitor containment integrity of cylinders.
3. Mitigate deterioration rates for cylinders.
4. Improve procedures and training.
5. Improve and maintain storage conditions.

As part of the systems engineering approach, baseline assumptions have been identified. Such assumptions are necessary to continue program activities during the next twelve months while completing the Systems Requirements Document, the Systems Engineering Management Plan, the Engineering Development Plan, the Depleted UF_6 Cylinder Program Management Plan, and the Safety Analysis Reports. These assumptions are:

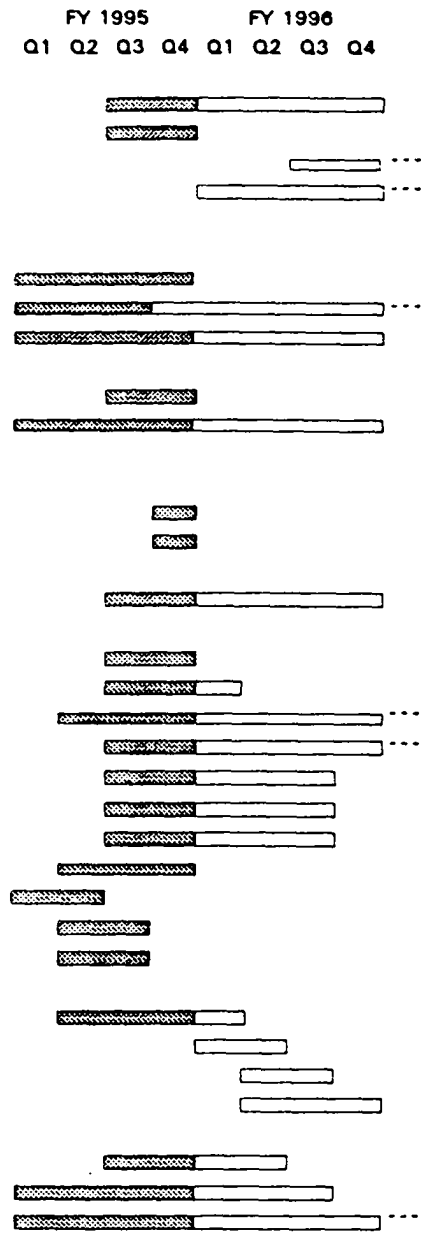
- The Department will continue to regulate the inventory of depleted UF_6.
- Multiple cylinder handling will be necessary as the program upgrades storage conditions for cylinder relocation, renewal of cylinder coatings, and storage yard renovations. Engineering and administrative controls will be maintained to minimize the risks from the increased cylinder handling.
- The majority of cylinders will meet industry standards.
- Funding will be obtained to complete necessary activities.

V. COMPLETED AND NEAR-TERM ACTIONS

The Department has implemented substantive actions to enhance the cylinder maintenance program. These actions will continue to be refined through a rigorous systems engineering approach. Table 1 shows the status of these actions, which have been grouped as they apply to the subparts of Recommendation 95-1. The unshaded bars indicate work planned in the future (e.g., Item 3) or work still in progress (e.g., Item 1). The shaded bars indicate work completed (e.g., Item 2). These actions and schedule will constitute the management plan until the Depleted UF_6 Cylinder Program Management Plan is completed in July 1996.

The sections that follow Table 1 address the means by which the Department intends to resolve the issues raised in the Recommendation. There are five sections arranged to correspond to the three subrecommendations.

Table 1 Completed and Near Term Actions



Subrecommendation 1

1. Paint skirted cylinder heads
2. Value engineering study for coating entire cylinder [1]
3. Pilot coating of entire cylinder at Paducah
4. Planning for routine coating at all sites

Subrecommendation 2

5. Clean debris from skirt ends/drain leaks (full cylinder)
   - K-25 Site
   - Paducah
   - Portsmouth
6. Remove full DU cylinders from ground contact
   - K-25 Site
   - Paducah
   - Portsmouth (have none in ground contact)
7. Replace confirmed leaking valves
   - K-25 Site (seven)
   - Paducah (one)
   - Portsmouth (none)
8. Cathodic protection field experiment at Paducah [2]
9. Construct new storage yards
   - Paducah (C-745-S)
   - Portsmouth (X-745-E)
10. Improve handling/inspection procedure to ensure cylinder integrity [3]
11. Determine percentage of cylinder population that meets industry standards 4,5
12. Design/test fixture to drill drain holes in skirts to mitigate accelerated corrosion
13. Design/evaluate saddle to prevent line contact in double stacking type 30A cylinders
14. Design/evaluate device to prevent lifting lug impacts during stacking
15. Identify primary mechanism of accelerated corrosion on cylinders
16. Develop corrosion rate model to statistically predict worst-case wall thinning 6
17. Analyze effects of water entering small hole in ullage of cylinder [7]
18. Revise DU Management Plan
19. Institute Systems Engineering approach
    - Develop Systems Requirements
    - Develop Systems Engineering Management Plan
    - Develop Engineering Development Plan
    - Update Cylinder Program Management Plan

Subrecommendation 3

20. Complete Draft Basis of Interim Operations at all sites
21. Complete Safety Analysis Reports
22. Complete Programmatic Environmental Impact Statement

[1] Value Engineering Study Report: UF6 Cylinder Refurbishment Process
Prepared by: Mashon & Hanger Engineering, Inc. 8/29/95

[2] "Draft Plan/Procedure for Cathodic Protection Field Experiment for UF6 Cylinder Bottoms in Heavy Ground Contact" 5/12/95

[3] DOE 48 Inch Diameter UF6 Cylinder Handling and Inspection, ERWM/EF-p2400, Rev. 0, 7/31/95

[4] "Code Calculations and Interpretations for the DUF6 Storage Cylinders Meeting in Lexington, Kentucky on July 26, 1995" 7/31/9
M. L. Lykins to T. M Marshall & V. S. Newman, POEF-38-343-95-50

[5] "General Storage and Handling Standard Development Work", 9/14/95, M. L. Lykins & V. S. Newman to D. L. Mason, POEF-38-3

[6] ORNL/TM-13012 Prediction of External Corrosion for UF6 Cylinders: Results of an Imperical Method, B. F. Lyon, June 1

[7] K/ETO-160 "Speculative Issues in the Breaching ofThin Wall Storage Cylinders for UF6", Dr. John Barber to D. L. Mason, April 3,

VI. SAFETY ISSUE RESOLUTION

The depleted UF_6 risk management program will be executed through five commitments. The first four commitments incorporate risk management in the program by means of systems engineering. The commitments are to develop and provide: (1) a Systems Requirements Document, (2) a Systems Engineering Management Plan, (3) an Engineering Development Plan, and (4) a revised Depleted UF_6 Cylinder Program Management Plan. These documents, and how they address the subrecommendations within Recommendation 95-1, are described in the following sections. The process for developing these deliverables, as well as the development of the program, is illustrated in Figure 1, and is described in the corresponding commitment sections below. The fifth commitment, a cylinder safety analysis that will be the basis for the Department's determination of the acceptability of the risk of continued storage of depleted UF_6, will be an activity in the Engineering Development Plan and documented in the site Safety Analysis Reports.

A. Systems Requirements Document

The systems requirements are the technical and management specifications for accomplishing the program mission. In addition, the Systems Requirements Document will address applicable Department orders and industry standards (such as American Society for Mechanical Engineers Boiler and Pressure Vessel Code, Section 8, Division I, and American National Standards Institute 14.1, Packaging of Uranium Hexafluoride for Transport). The Systems Requirements Document will address the Board recommendations to protect cylinders from exposure to the elements, to renew and maintain the cylinder's protective coating, and to develop an understanding of the factors affecting cylinder containment integrity.

1. *Discussion*

A first step in development of the Systems Requirements Document is the delineation and verification of baseline assumptions on which to base actions necessary to meet the mission and major objectives. As additional information is gathered, new assumptions may be defined and previous assumptions may be revised or eliminated. The baseline assumptions, mission statement, and major objectives, in effect, serve as the bounds for the program.

A system engineering functional analysis will be performed to establish requirements for the program and will be the basis for identifying the systems engineering, program management, and engineering development actions (see Figure 1). These requirements ensure that the program mission is adequately described and systematically accomplished. The requirements are documented in the Systems Requirements Document for the

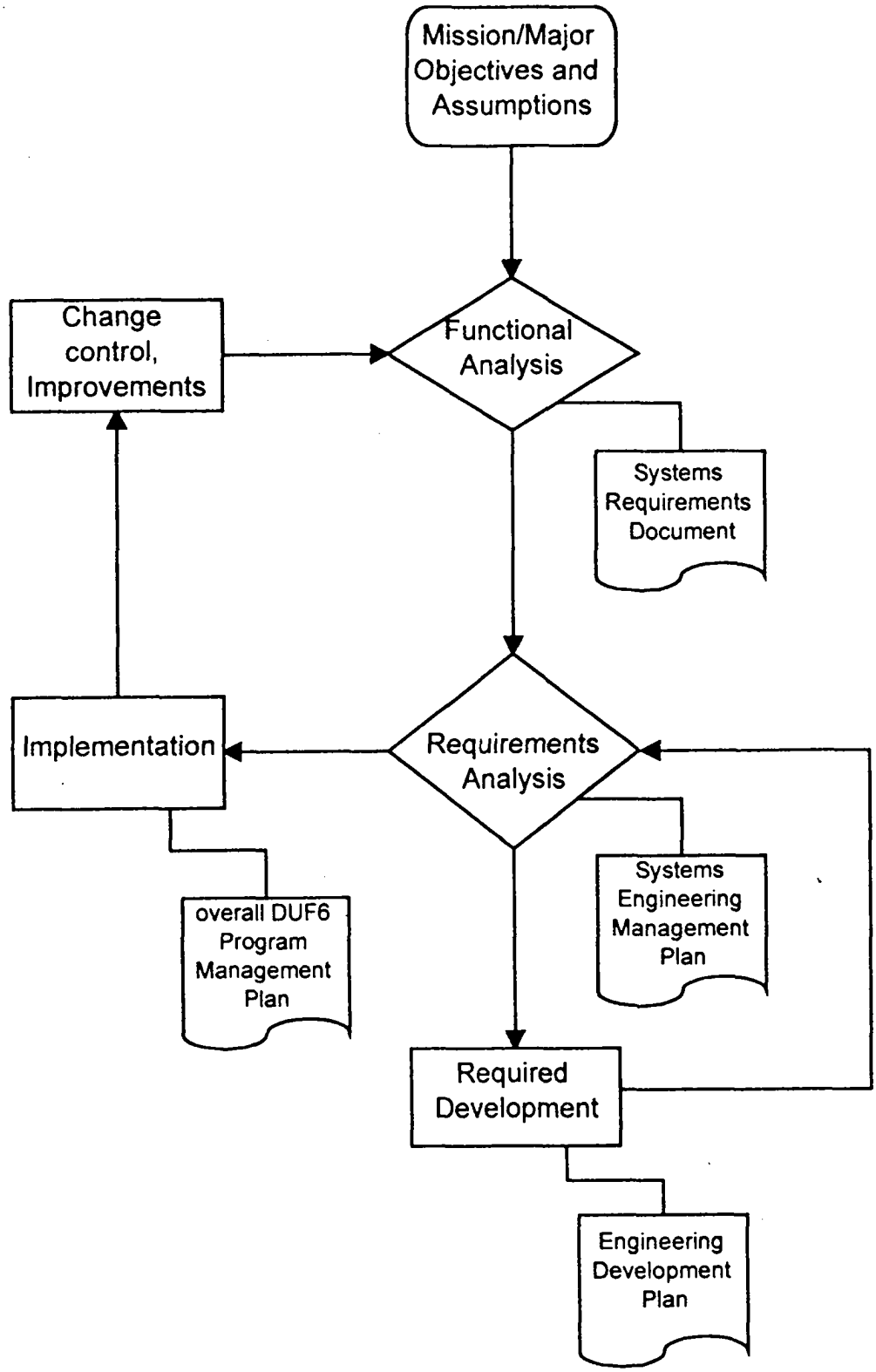


Figure 1. DUF6 Cylinder Program Development

program. Each requirement within the Systems Requirements Document is clearly defined, the functional analysis that derived the requirement is referenced, and the requirements will be linked to the major objectives. As part of specifying program requirements, any deviations from applicable government and industry codes and standards will be shown in the Systems Requirements Document.

2. *Commitment*

Commitment 1:	Develop the system requirements for the depleted UF_6 cylinder program
Deliverable:	Systems Requirements Document
Responsibility:	Lockheed Martin Energy Systems
Date:	November 30, 1995

B. Systems Engineering Management Plan

The requirements analysis (see Figure 1) develops the integrated decision-making process for establishing the actions required to meet the pre-established requirements. This process and subsequent decisions are documented in the Systems Engineering Management Plan. The Systems Engineering Management Plan will document the technical rationale for the actions, their schedule or sequencing, and verification requirements. Aspects of the technical report (Defense Nuclear Facilities Safety Board "Tech 4") will be considered for inclusion in the requirements analysis, and when included, documented in the Systems Engineering Management Plan.

1. *Discussion*

Once the requirements are established and documented in the Systems Requirements Document, the integrated decision-making process is used to establish how the requirements will be met by the program. The decision-making process integrates the hazard and risk knowledge of all activities associated with depleted UF_6 management, with the cylinder condition information, and the operational activities and constraints. This process and associated Department decisions are documented in the Systems Engineering Management Plan. The Systems Engineering Management Plan explains how the actions established address the specific requirements within the Systems Requirements Document. Two categories of actions will stem from the Systems Engineering Management Plan: (1) actions that can be incorporated directly into the program operations and (2) actions that need some technical development before actions are incorporated into program operations. Actions that need further development are detailed in the Engineering Development Plan. Actions implemented directly are managed through the work breakdown structure as part of the Depleted UF_6 Cylinder Program Management Plan.

2. *Commitment*

Commitment 2:	Develop the actions necessary to meet the systems requirements
Deliverable:	Systems Engineering Management Plan
Responsibility:	Lockheed Martin Energy Systems
Date:	March 31, 1996

C. Engineering Development Plan

As developed during the Systems Engineering Management Plan analysis, some actions may require technical development before being implemented in the field. The Engineering Development Plan will be the primary response to implementation of the second sub-recommendation. Actions anticipated to be within the Engineering Development Plan relative to the second subrecommendation include those such as cylinder surface preparation decisions and demonstrations. Development activities include the exploration of additional engineering controls for the cylinder handling and stacking operations and comprehensive corrosion studies, as necessary. The Engineering Development Plan will describe the significant activities of the site Safety Analysis Reports that will be done in response to the third subrecommendation. Aspects of the Board's "Tech 4" Report will be considered for inclusion, and when included, documented in the Engineering Development Plan.

1. *Discussion*

Development requirements are driven by the actions in the Systems Engineering Management Plan described in Section VI.B. The requirements analysis is done to determine actions needed to fulfill the requirements within the Systems Requirements Document and to identify actions needing technical development before deployment. The Engineering Development Plan documents engineering and technical tasks and schedules required to develop actions for field deployment. The development of these actions may significantly modify the Systems Engineering Management Plan action. Thus, the results of the required development are subjected to requirements analysis for final evaluation and assurance that expectations for the subject action are met.

The Engineering Development Plan is a sub-plan to the Depleted UF_6 Cylinder Program Management Plan and focuses on the costs and schedules for the development of actions before they are deployed in the field. While many Systems Engineering Management Plan actions may need development before being fully implemented, most of the tasks documented in the Engineering Development Plan will be resolved expeditiously for early

deployment. Some actions requiring development have been identified already (e.g., actions 7, 8, 12, 13 and 14 of Table 1).

2. ***Commitment***

Commitment 3:	Identify the required development tasks, with subsequent completion schedules
Deliverable:	Engineering Development Plan
Responsibility:	Lockheed Martin Energy Systems
Date:	June 1, 1996

D. Depleted UF_6 Cylinder Program Management Plan

The Depleted UF_6 Cylinder Program Management Plan is the controlling document for managing and implementing program operations (see Figure 1). The plan shows the links between the mission statement and specific actions within the program. The plan will demonstrate how the Department is addressing the concerns that prompted the issuance of Recommendation 95-1.

1. ***Discussion***

The Depleted UF_6 Cylinder Program Management Plan documents implementation of the coordinated three-site program, and the roles and responsibilities within the Department and Lockheed Martin Energy Systems for technical management, integration, and resources. The Plan documents the integration and logic of the Systems Requirements Document, the Systems Engineering Management Plan, and the Engineering Development Plan.

Any development required derives from the actions documented in the Systems Engineering Management Plan described in Section VI.B. As the requirements analysis determines actions needed in the Systems Requirements Document (and whether those actions need technical development before deployment), the "required development" function (see Figure 1) is given those actions to develop. The Engineering Development Plan documents engineering and technical tasks and subsequent schedules necessary to develop actions for field deployment. The maturation of Systems Engineering Management Plan actions within the required development function may significantly modify the Systems Engineering Management Plan. Lastly, the output from the required development function is submitted to requirements analysis for final evaluation and assurance that the subject action will satisfy the requirement.

The program management plan provides the work breakdown structure, establishes schedules and costs, and is used to control the program. To facilitate this control-and-monitoring aspect of the program, the management plan includes milestones and measures for performance, such as the schedule for painting the entire cylinder inventory (as modified by any lessons learned from the planned Paducah pilot cylinder painting project). Also, the program management plan would provide the mechanism for relating the engineering development activities with the actions implemented in the program operations.

2. ***Commitment***

Commitment 4:	Define the plan for managing cylinders
Deliverable:	Depleted UF_6 Cylinder Program Management Plan
Responsibility:	Lockheed Martin Energy Systems
Date:	July 31, 1996

E. Depleted UF_6 Cylinder Safety Analysis

The current safety bases for cylinder operations at the three sites are documented in the existing site Safety Analysis Reports and the Justification(s) for Continued Operation at Portsmouth and Paducah. A project to update the safety basis is underway. Bases for Interim Operations for cylinder management have been prepared and, when approved, will be incorporated into the Safety Analysis Reports being prepared for the three sites. When completed, these Safety Analysis Reports form the revised basis for the Depleted UF_6 Cylinder Program Management Plan.

The Board recommended that the Department should initiate a study "to determine whether a more suitable chemical form should be selected for long-term storage of the depleted uranium." The site Safety Analysis Reports applicable to the storage of depleted UF_6 will establish the technical basis for safely storing the depleted UF_6. The Department issuance of Safety Evaluation Reports approving the Safety Analysis Reports, within the context of its safety requirements, would be equivalent to a conclusion that the safety of cylinder management is acceptable for as long as the safety bases remain unchanged.

A letter that transmits the Safety Analysis Reports to the Board will state the Department's position on the adequacy or inadequacy of the safety basis for continued cylinder storage, and the actions necessary to maintain this safety basis. Should the Department conclude that the safety basis is inadequate, remedial measures will be taken to achieve an adequate safety basis. Such remedial measures could include conversion to alternative chemical forms.

1. ***Discussion***

The Department will develop Safety Analysis Reports for each of the three sites, to the requirements of The Department Order 5480.23. Starting with the already developed Basis for Interim Operations, additional analyses will be completed. These additional analyses will include further refinement of accident analysis, including more detailed consequence estimates, more detail on applicable operational controls and safety management programs, and greater consideration of site characteristics. The site Safety Analysis Reports will serve as the technical basis for the cylinder storage and maintenance. The Department will evaluate the Safety Analysis Reports in the Safety Evaluation Reports. The Safety Evaluation Reports will contain the Department's assessment of the adequacy or inadequacy of the safety basis for continued cylinder storage, and the need for any remedial measures, such as any potential need to convert the material to alternate forms.

2. ***Commitment***

Commitment 5:	An analysis showing the technical safety basis for the storage of depleted UF_6
Deliverable:	Draft Safety Analysis Reports
Responsibility:	Lockheed Martin Energy Systems
Date:	September 30, 1996
Deliverable:	Approved Safety Analysis Reports
Responsibility:	The Department of Energy, Office of Nuclear Energy, Science and Technology
Date:	March 30, 1997
Deliverable:	Final Safety Evaluation Reports with letter stating the Department's position on the adequacy of the cylinder safety basis
Responsibility:	The Department of Energy, Office of Nuclear Energy, Science and Technology
Date:	March 30, 1997

The following section addresses adminstrative matters associated with the process to carry out the commitments.

VII. ORGANIZATION AND MANAGEMENT

A. Configuration Management/Change Control

The configuration management/change control implemented by the Depleted UF_6 Cylinder Program will handle implementation course corrections and process changes. Flexibility is needed to address changes in commitments, actions, or completion dates because of additional information, project refinement, or changes in the Department's baseline commitment dates. The original dates for commitments may need to be modified in response to changes in out-year funding or mission. Any anticipation of significant changes in deliverable due dates will be promptly brought to the attention of the Board prior to the passing of the completion date.

B. Quality Assurance

The cylinder program operates under the Department's 5700.6C Quality Assurance requirements, and a site quality assurance specialist is designated functional responsibility for each cylinder project.

C. Reporting Requirements

The Depleted UF_6 Cylinder Program Management Plan will be updated annually. Recommendation 95-1 will be considered complete when the deliverables under the five categories are provided to, and accepted by, the Board.