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Department of Energy

Washington, DC 20585

November 30, 1995

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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 System Requirements Document" dated November 1995. This document represents the first 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 will be used in the decision-making process to determine the necessary cylinder management program activities. This document specifies the requirements for the program during its current storage phase and is the initial segment of the Depleted UF_6 Systems Engineering Approach that will demonstrate that the program complies with applicable standards.

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

95/5496

K/TSO-001, Rev. 1

LOCKHEED MARTIN

UF_6 Cylinder Program
System Requirements Document

November 1995

EM and Enrichment Facilities
Technical Support Organization

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

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K/TSO-001, Rev. 1

UF_6 Cylinder Program
System Requirements Document (SRD)

EM and Enrichment Facilities
Technical Support Organization

November 1995

Prepared by
Oak Ridge K-25 Site
Oak Ridge, Tennessee 37831-7603
operated by
Lockheed Martin Energy Systems, Inc.
for the
U. S. Department of Energy
under contract
No. DE-AC05-84OR21400

UF_6 Cylinder Program SRD
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EXECUTIVE SUMMARY

The Department of Energy manages an inventory of uranium hexafluoride through the Depleted Uranium Hexafluoride Cylinder Program; the program mission is continued safe storage of the uranium hexafluoride inventory until its ultimate disposition. Lockheed Martin Energy Systems, Inc., the managing contractor, is applying systems engineering principles to the cylinder program to strengthen and integrate program activities. This System Requirements Document is the first of four documents to be developed in the application of systems engineering principles to the program. It contains the requirements necessary to achieve the program mission and illustrates the rationale and intent of the requirements and the applicable standards.

This document will be used in the decision-making process to determine necessary program activities for compliance with the stated requirements. The decision-making process will be documented in the Systems Engineering Management Plan, the next in the series of documents associated with the application of systems engineering principles to the program. The requirements and rationale herein will be updated as the program generates new information and the standards governing the program change. Once the Systems Engineering Management Plan is completed, it will drive revisions to the System Requirements Document.

This System Requirements Document specifies the requirements for the program during the current, storage phase of the program, and it provides the initial segment of the flow-down process, to demonstrate that the program complies with applicable standards. The requirements apply to both technical and management aspects of the program. During development of the requirements, consideration was given to maintaining the flexibility in subsequent phases of the program, which include dispositioning of the depleted uranium hexafluoride and decommissioning the facilities and equipment.

The requirements were identified through the following steps as illustrated in Figure 1.

- **Conduct Situation Analysis**: Major objectives for the program were developed by articulating the current configuration of the program, reviewing the situation to determine focus areas that are necessary to meet the mission, and delineating and verifying baseline considerations and assumptions.
- **Define System Functions**: The program was defined in terms of components and activities for various operational states, (e.g., routine and off-normal), which are described in four system functions. These four system functions are: (1) surveillance and maintenance, including maintenance coating; (2) handling and stacking; (3) transfer of UF_6 contents; and (4) off-site transport. The key relationships between these functions were also specified.
- **Determine Requirements**: The system functions were compared to the major objectives to determine the technical and management requirements for successfully meeting the program mission. To complete this functional analysis, the standards (applicable Department Of Energy Orders, federal regulations, industry codes, etc.) that govern the requirements were identified. Deviations from applicable standards are fully addressed, to ensure safe operation. An iterative process of reviewing the requirements for applicable standards and reviewing potential standards for necessary requirements established the quality and comprehensiveness of the requirements identified herein.

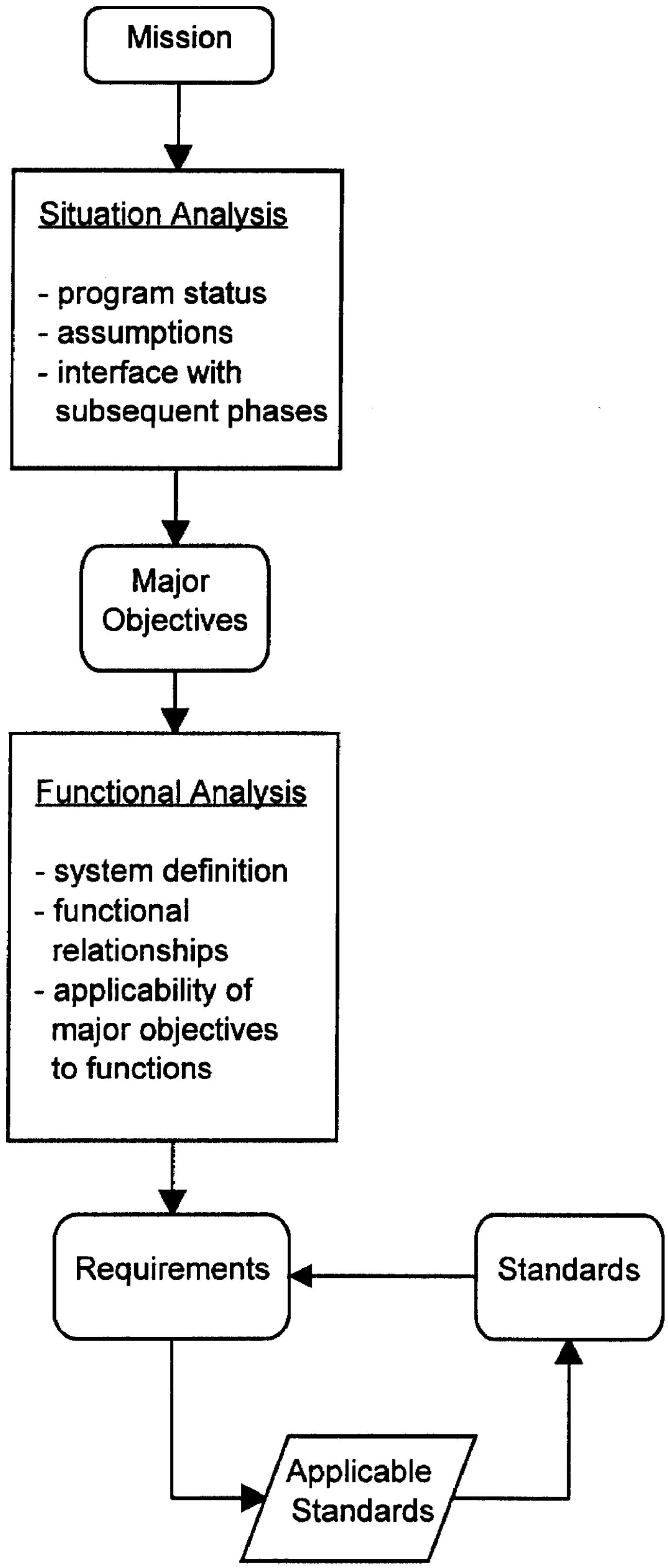


Figure 1. Requirements Development Process

1. SCOPE

The following section describes the application of systems engineering principles to the storage phase of the UF_6 Cylinder Program. In particular, this defines the development and application of systems requirements.

1.1 Purpose

This System Requirements Document (SRD) illustrates the process of determining the requirements for the uranium hexafluoride (UF_6) Cylinder Program during the storage phase. The requirements are in part defined in applicable legislation, regulations, orders, directives, codes, and standards. The SRD provides the initial segment of the flow-down process to ultimately demonstrate program compliance with applicable requirements. These requirements include technical and management aspects of the program. In cases where a requirement has no governing reference, the requirement is derived in support of the program mission. In the development of the storage phase requirements, consideration was given to maintaining the flexibility in subsequent phases of the program (dispositioning of uranium hexafluoride (UF_6) and decommissioning of existing facilities and equipment).

The requirements define the basis for actions necessary to achieve the program mission. Therefore, the SRD is integral to the configuration by which the program is controlled. Management to the SRD (flow-down to implementing activities) is accomplished through the Systems Engineering Management Plan (SEMP). The SEMP will incorporate a requirements analysis that provides the decision-making rationale for developing activities. Thus, these activities by derivation will demonstrate compliance with applicable codes and standards. This decision-making function will enable the integration of various aspects of the program and will define activities consistent with the program mission. The utility of the SEMP largely depends on the quality and thoroughness of this SRD. The activities are carried out through the overall Program Management Plan (PMP). Necessary development actions before implementation are managed through the Engineering Development Plan (EDP). Actions within the EDP and PMP generate new information, expertise, and experience. This information is iterative feedback into the SEMP integrated decision-making process for producing and improving requirements.

1.2 System Overview

1.2.1 Mission

The UF_6 Cylinder Program mission is to safely store the existing DOE-owned UF_6 inventory managed at the Oak Ridge K-25 Site, and the Paducah (PGDP) and Portsmouth (PORTS) Gaseous Diffusion Plants until ultimate disposition of the UF_6. The average ages of cylinders in storage at K-25, PGDP, and PORTS are 29, 21, and 20 years, respectively. Much of this UF_6 inventory has been stored for many years without adequate surveillance and maintenance of facilities sufficient to meet the current program mission; therefore, corrective actions are critical to the program.

The next phase of the program, dispositioning the UF_6 inventory, is under development. The final phase, decommissioning of the facilities, will be integrated into the decontamination and decommissioning (D&D) of the diffusion cascades at the aforementioned sites. The SRD does not encompass the requirements for these subsequent phases. However, the SRD does establish the interface between the storage phase and these subsequent phases, including the impact on requirements stated herein. These interfacing requirements establish continuity for the program.

1.2.2 Background

DOE has about 47,000 large-capacity cylinders containing about 555,000 metric tons of depleted uranium hexafluoride (DUF_6) in long-term storage. DUF_6 is generated during the operations of the gaseous diffusion process; withdrawn from the diffusion cascade as a gas; liquefied; drained into steel cylinders, where the material solidifies at subatmospheric pressure; and then stored outdoors in cylinder yards. Initially, DUF_6 was withdrawn into 2½-ton cylinders, but during the 1950s 10-ton cylinders were used. In 1958, use of 14-ton cylinders was initiated. Most (94%) of the DUF_6 storage cylinders have 5/16-inch-thick shells and are called "thin wall" cylinders; the rest have 5/8-inch-thick shells and are called "thick wall." The thin wall cylinders were designed as economical storage containers that meet the pressure and temperature conditions required during liquefaction.

After a significant inventory was produced, outdoor storage facilities evolved independently at the sites. Cylinder yards are constructed of either concrete or compacted gravel, and cylinders are stacked in two-tiered rows on wooden or concrete saddles. The handling equipment used to stack these cylinders in double-tiered rows has also evolved, from mobile cranes to specially designed tractors that grasp and lift the cylinders with hydraulically actuated tines.

Until 1990, surveillance consisted of an annual nuclear materials inventory of the cylinders. The K-25 cylinder yards were surveyed in May 1990 to provide input for planning long-term corrosion monitoring of cylinders. Cylinder valves with corrosion and evidence of potential valve leakage were discovered. A subsequent valve survey in June 1990 at PORTS revealed two cylinders with breached side walls. Investigation of these cylinder breaches determined that the causes were mechanical tears caused by impact from adjacent cylinder lifting lugs.[1] Subsequent inspections of stored DUF_6 cylinders revealed four breached cylinders at K-25. Two breaches were attributed to handling damage, and two were most likely initiated by external corrosion resulting from substandard storage conditions.[2] Another breached cylinder resulting from handling damage was discovered at PGDP.

The risk to personnel health and safety, and the potential environmental impact posed by these cylinder breaches and valve leaks, are low by nature of the system. The UF_6 inventory is stored as a solid. Reaction deposits formed when UF_6 is exposed to the atmosphere in the presence of the mild steel containers have a self-sealing nature. The uranium is depleted in the fissionable isotope of the UF_6 to the point that the hazard is mostly chemotoxic, not radiological. These factors contribute to the low risk incurred from these and potential additional failures. This low risk was confirmed by analysis of the air and soil samples collected near the breaches at PORTS and by subsequent weighing of the cylinders. Although the risk posed by these breaches is low, the existence of breached cylinders heightened the importance of a comprehensive, long-term, three-site cylinder management program.

In 1992 a cylinder integrity management plan was developed to address concerns within the storage yards and to establish the initial premise of the program today.[3] To establish more rigor within the program and further ensure that the inventory is stored safely, a systems engineering approach is being adopted. The quantity of DUF_6 primarily drives the scope of the program managed by DOE. However, the program also encompasses the DOE-owned natural assay and low-enriched (<5% ^{235}U) UF_6 inventories stored at these sites.

1.3 Organization and Description

1.3.1 Development

The storage phase is ongoing, and the development and implementation of systems engineering will run concurrent with the existing activities. Aspects of the current program will be evaluated from a systems engineering perspective and modified as the evaluation dictates.

The development of the SRD necessitated an analysis of the current program (system) functions and the current situation (configuration) of the program. This analysis is graphically depicted in Fig. 2. In preparation for functional analysis, the current configuration of the program was articulated in a situation analysis. Major objectives for the program were developed from the situation analysis in keeping with the program mission. In support of the major objectives, the program was bounded by delineating and verifying baseline considerations and assumptions. To initiate the functional analysis, the functions of the storage phase (surveillance and maintenance (S&M), handling and stacking, contents transfer, and off-site transport) were defined in terms of respective components and activities. These components and activities include hardware, personnel, command media or documentation, support functions, program activities, and interfaces with organizations regulating and performing the activities. The components and activities for each function were identified for relevant operational states including start-up, shutdown, routine, and off-normal. The interrelations among these functions were delineated, and the interface of the current phase of the program (storage) with subsequent phases was evaluated. This later evaluation was performed to ensure flexibility and success in the dispositioning and decommissioning phases of the program. To complete the functional analysis and determine the technical and management requirements for successfully executing the program mission, the defined system functions were evaluated in the context of the major objectives. In many cases requirements are grouped into categories facilitating the rationale and intent of the requirements. Where applicable DOE Orders, regulations, industry codes, and standards govern these requirements, they are referenced. Deviations from applicable standards are fully identified, to ensure safe operations.

This process reflects the adaptation of systems engineering into an existing program, where many activities within the program are defined and underway.

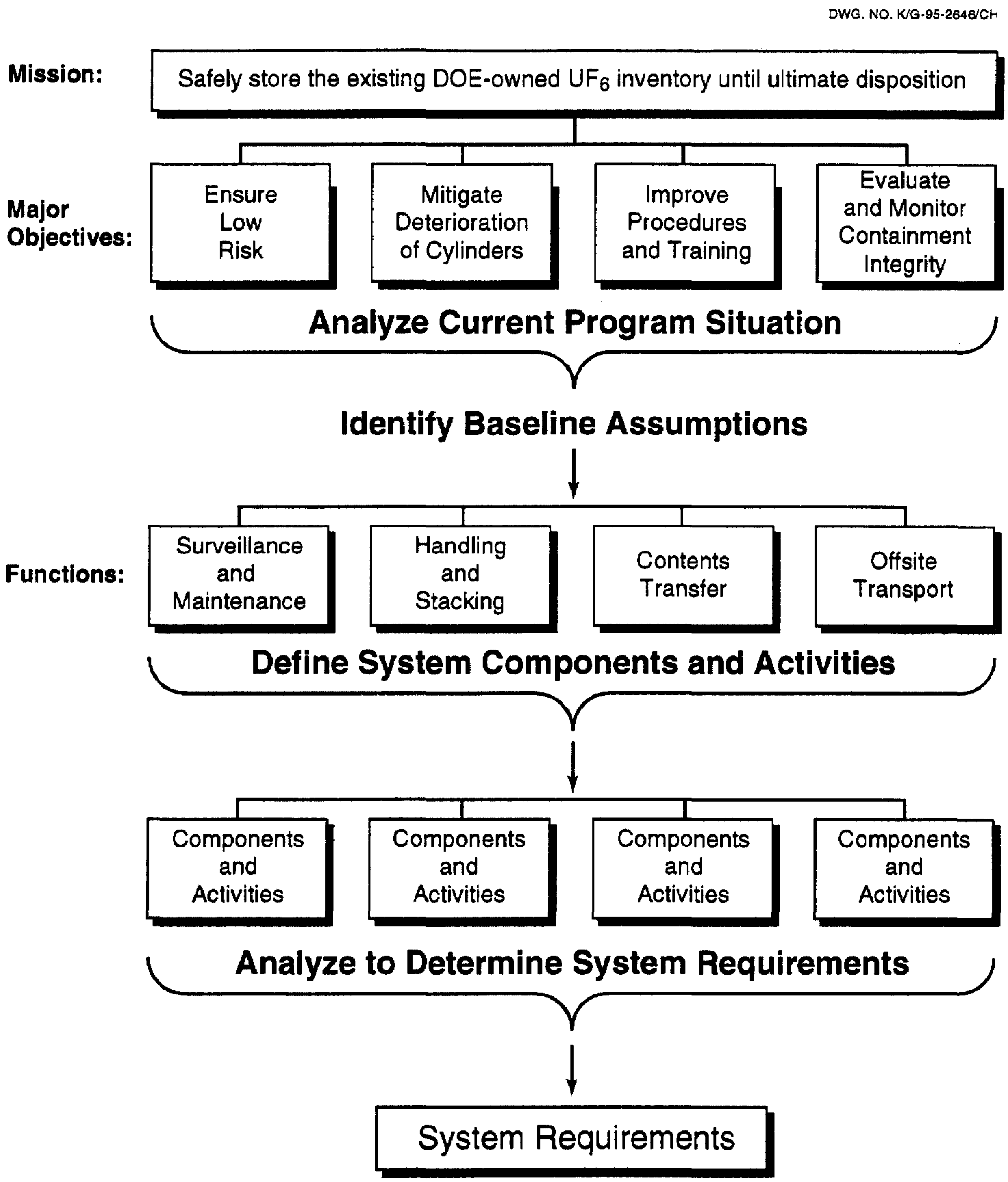


Figure 2. Development of System Requirements

1.3.2 Requirements Structure

The requirements are documented where specific rationale logically dictates the need for a requirement. The purpose for listing requirements immediately following the rationale is to clearly show the development and intent of each system requirement and facilitate its application in the SEMP. Applicable standards and governing documents for specified requirements are identified in [*brackets*] following each requirement. The [*brackets*] are the means for locating requirements in the body of this document. Where a requirement, as specified by [*brackets*], does not have an applicable standard or governing document, the standard is considered to be managed within the program. These standards are denoted in the text by [*Derived*]. Requirements identified in the Situation Analysis are repeated in the Functional Analysis.

2. APPLICABLE DOCUMENTS

As effected by Requirements Change Notice Number OR35 to Contract Number DE-AC05-84OR21400, dated October 1, 1995, DOE Environmental , Safety and Health (ES&H) directives were deleted and contract activities were subjected to alternative DOE approved ES&H requirements.

2.1 Governing References

Appendix A of this document lists the regulatory and guidance source documents currently comprising this contractual ES&H basis for requirements' identification. The list was generated from the Standards Management Information System data base and includes federal and state regulations, executive orders, DOE orders and standards. Standards and requirements are modified in a controlled manner under the contract's requirements change notice process. Events that may initiate a change to the contract requirements include modification, addition or deletion of federal and state regulations or DOE orders and standards. As systems engineering proceeds for the UF_6 cylinder program, appropriate requirements will continue to be incorporated into the program SARs and procedures.

2.2 Guidance Reference

Essential and fundamental features of Lockheed Martin Energy Systems (LMES), Inc. environmental and safety programs are identified and summarized in *Safety Management Program Support Nuclear and Hazardous Facilities*.[4] This report addresses requirement sources, scope, and/or gradation for the following programs:

Standards Management	Criticality Safety
Radiation Protection	General Environmental Protection
Industrial Hygiene	Radioactive and Hazardous Material Waste Management
Maintenance	Initial Testing and In-Service Surveillance
Conduct of Operations	Fire Protection
Training	Human Factors
Quality Assurance	Emergency Management
Configuration Management	Decontamination and Decommissioning
Occurrence Reporting	Safety Analysis Review and Unreviewed Safety Question Determination

Subsequent to development of system functional requirements in support of major objectives, specific source requirements pertinent to the UF_6 Cylinder Program were identified by subject matter experts. Refinement of this initial "mapping" of source requirements to systems requirements, definition of activities and subsequent verification of compliance and adherence to standards will continue throughout the UF_6 Cylinder Program Systems Engineering process. Results of initial "mapping" appear in Section 5, *Requirements to Achieve Major Objectives*. The source requirements identified in this manner are listed below:

1. 10 CFR 830.120, *Quality Assurance*
2. 10 CFR 835, *Occupational Radiation Protection*
3. 29 CFR 1910, *Occupational Safety and Health Standards*
4. 49 CFR 173.420, *Uranium Hexafluoride (Fissile and Low Specific Activity)*
5. DOE 4330.4B, *Maintenance Management Program Maintenance*
6. DOE 4700.1, *Project Management System*
7. DOE 5480.18A, *Accreditation of Performance-Based Training for Category A Reactors and Nuclear Facilities*
8. DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*
9. DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*
10. DOE 5480.23, *Nuclear Safety Analysis Reports*
11. DOE 5480.24, *Nuclear Criticality Safety*
12. DOE 5480.26, *Trending and Analysis of Operations Information Using Performance Indicators*
13. DOE 5480.28, *Natural Phenomena Hazard Mitigation*
14. DOE 5481.1B, *Safety Analysis and Review System*

15. DOE 5633.3B, *Control and Accountability of Nuclear Materials*
16. DOE 5700.6C, *Quality Assurance*
17. DOE 6430.1A, *General Design Criteria,* including all applicable regulatory requirements referenced in Section 0106 and all references standards and guides in Section 0109
18. DOE/ORO-651, Rev. 6, *Uranium Hexafluoride: A Manual of Good Handling Practices*
19. Amended Consent Decree, State of Ohio (DRAFT- under negotiation)
20. ANSI N14.1, *Uranium Hexafluoride - Packaging for Transportation*
21. ASME Boiler and Pressure Vessel Code
22. DOE-HDBK-1090-95, *DOE Handbook - Hoisting and Rigging*

3. SITUATION ANALYSIS

The following section provides the development of the program's major objectives rationale. The major objectives are established to focus the management of the program on key aspects necessary to meet the program mission. These objectives stem from an understanding of: (1) the current status of the program, (2) the interface of the storage phase (current phase) with subsequent phases (UF_6 disposition and decommissioning of the storage facilities), and (3) the bounding assumptions for the program. To complete the situation analysis, the major objectives are identified and defined for application in the functional analysis used to determine the necessary requirements of the system.

3.1 Program Status

The program status documents the current understanding of the condition of the program including known deficiencies and concerns, and actions taken to date to reduce the risks within the program. The actions stated in this section will be evaluated in the SEMP.

A number of general and specific system problems and deficiencies have been identified through self assessments and improvements in management practices. Conditions and factors that have contributed to the causes date back to when DOE and predecessor agencies began placing DUF_6 in storage. The fundamental cause is that a risk analysis for the UF_6 Cylinder Program has not been adequately documented. Additional contributing causes include the absence of a defined life-cycle cylinder maintenance program, lack of appropriate resource application at the onset of long-term storage, lack of adequate operational controls used to place cylinders in their current locations, inadequate integration of program operations, and absence of a well-defined mission leading to the ultimate disposition of DUF_6 stored in cylinders.

These past general program management deficiencies have resulted in the following conditions:

1. A number of cylinders were permitted to remain for extended periods in ground contact and in storage yards where drainage was not maintained. This condition, in conjunction with no maintenance of a protective coating, has resulted in accelerated corrosion of cylinder bodies and the through-wall corrosion (failure) of two cylinders. The mild steel composition of the cylinders corrodes at an accelerated rate under extended periods of wetness.

2. Before 1990, the program did not include a cylinder inspection program, which caused the cylinders and storage conditions to deteriorate without updated characterization. This lack of characterization resulted in the unmitigated continued storage of breached cylinders and cylinders with leaky valves, use of cylinders without nameplates, and the continued use of safety documentation that does not reflect current cylinder conditions.
3. Handling and stacking procedures and operations before 1990, resulting in the current storage configuration, are the cause of stacked cylinder arrays with insufficient spacing to facilitate inspection, configurations with less than desirable cylinder support, the impact failure of five cylinders, and other physical damage to the cylinders and protective coatings.

Many specific deficiencies have been identified concerning the long-term storage facilities and the cylinders. This section states the deficiencies identified to date and prioritizes them relative to risks. Further characterization and evaluation of risks will revise this prioritization. Prioritizing deficiencies will be used in the optimization of actions taken to reduce risks within the program. [*Derived*]

Table 1 categorizes identified deficiencies and potential deficiencies as: (A) Direct Container Integrity Concerns, (B) Storage Facility Concerns, (C) Uranium Control Issues, (D) UF_6 Transfer Issues, or (E) Other Issues. An estimated number of cylinders impacted by each deficiency is provided to illustrate the magnitude of these concerns. Efforts to correct many of these deficiencies have been expelled and are underway.

Categories A, B, and C (Direct Container Integrity Concerns, Storage Facility Concerns, and Uranium Control Issues) are given priority over categories D and E (UF_6 Transfer Issues, and Other Issues). Categories A, B, and C have a potential to result in an undesirable occurrence while these cylinders are being used as long-term storage vessels. A release of uranium could occur, or the handling of mistaken uranium assays could result (i.e., DU thought to be normal or enriched and vice versa). Within the three priority categories, highest priority is given to breached cylinders, substandard facilities, and non-DU material deficiencies (A1, B1, and C1, respectively). An occurrence from these deficiencies is considered the most serious. Category D, UF_6 Transfer Issues, applies to the removal of the UF_6 from the subject containers and is relative to the subsequent UF_6 dispositioning phase of the program. Category E, Other Issues, is relative to best management practices in keeping with the long-term, safe storage of UF_6. Categories D and E do not impose an immediate concern on the containment integrity of storage cylinders.

The highest priority, A1, is given to identifying and controlling breaches to minimize the release of uranium compounds and potential environmental insult or exposure. A lesser priority is given to repairing or replacing cylinders. Until final resolution can be accomplished, patched breaches are periodically inspected and provisions are made to prevent any spread of uranium contamination from the cylinder.

Breaches can occur by either of two mechanisms: impact or external corrosion. Other failure mechanisms, such as internal corrosion, have not proven to be realistic mechanisms within the scope of the storage program. However, further study may be warranted. Five breaches by impact from adjacent cylinders during stacking and two breaches by corrosion have been identified. The investigation into the exact circumstances causing the breaches has provided information crucial to the management of long-term storage cylinder integrity.

Corroded cylinders, Category A2, are a product of external accelerated corrosion due to the design of the cylinder or due to its physical placement, (e.g., a skirted cylinder or cylinders in ground contact). The estimated number of cylinders for Category A2 does not include cylinders with degraded or absent protective coatings that atmospheric corrosion has affected. The protective coating is applied to provide an initial protection against rusting and it degrades with the aging of the cylinder or deficient cylinder handling. In addition to the protective coating, the cylinder shell thickness is designed with a minimum of 50 mils of corrosion allowance. Atmospheric corrosion (less than 1 mil per year reduction in wall thickness) is visually identified by a uniform rust-coated surface without scale or pits. The rate of shell thickness reduction from accelerated corrosion can vary greatly from general atmospheric corrosion rates.

Continued use of corroded cylinders will be subject to the scrutiny of the storage vessel criteria and of possible corrective actions to be developed. The criteria will determine if a corroded cylinder is unsafe for continued use. If the cylinder requires a maintenance coating, the shell surface will be prepared and a rust-protective coating will be applied. These cylinders have been in storage the longest period of time without protective coatings and in areas not specifically designed for long-term storage. The oldest design models include the 10-ton Model T, the 14-ton Model O, and 2½-ton del 30A cylinders. If a cylinder is unsuited for continued storage, as determined by the storage vessel criteria, it will be placed in a queue for transfer of its contents to another cylinder via to-be-established defective cylinder feed procedures.

Without the application of a protective coating or a change in the corrosive environment, cylinders that exhibit heavy scaling rust or pitting-type corrosion will continue to corrode at an above-normal rate, and their life expectancy will be reduced considerably from the projections based on general atmospheric corrosion rates. Scaling rust and pitting corrosion are results of extended periods of wetness imposed on the cylinder shell. Once initiated, the pits and scale, without proper maintenance, will continue to facilitate water retention. Extended wetness can occur on cylinders that by design retain rainwater or on cylinders that are stored in ground contact or in poorly drained yards. Cylinders that by design retain rainwater are cylinders with skirts and cylinders with channel-type stiffening rings. Although drain holes can be provided where water would collect, proper drainage can be obstructed by rust and foreign material or improper cylinder stacking orientation. Maintenance to ensure these drain holes stay clear is necessary.

Table 1. Long-term Storage Inventory Potential Deficiencies		
	Potential Deficiency	**Estimated Number of Cylinders Affected**
A	**Direct Container Integrity Concerns**	
A1	Breached cylinders - cylinders with holes in the cylinder shell	7
A2	Corroded cylinders - cylinders with visible pitting and/or scaling rust	15,000
A3	Leaking valves - valves and plugs that have recurring contamination	10
B	**Storage Facility Concerns**	
B1	Substandard Facilities - sinking or poorly drained load-bearing surfaces	12,000
B2	Improper Support - upper tier cylinders supported by unsound points of contact	3,000
C	**Uranium Control Issues**	
C1	Non-Depleted Material - normal and enriched material located in DU storage facilities	8
C2	ID Plates - loose or detached identification plates	200
D	**UF_6 Transfer Issues**	
D1	Fill-Limit Consideration - cylinders without certified internal volumes or cylinders filled above the current maximum allowable limit established in ORO-651	15,000
D2	Substandard Valves - valves with missing or cracked parts, Teflon tape on threads, bent stem, and/or improper engagement	3,000
D3	Plug Replacing Valves - plugs in place of valves	1,000
D4	Physically Damaged Cylinders - cylinders that do not pass the inspection criteria established in ORO-651 for liquid transfer	1,000
D5	Cylinders Design hindrances- cylinders that will not fit into currently designed autoclaves	140
E	**Other Issues**	
E1	Inaccessible Cylinder - cylinders that cannot be accessed at both heads for a visual inspection	22,000
E2	Above Internal Vacuum - cylinders with internal pressure above the ideal vacuum conditions	1,000

Leaking valves and plugs, Category A3, have a potential to release small quantities of uranium. Leaks can to some extent be identified visually by recurring contamination. Leaks can be verified by an HF monitor and/or a radiation contamination survey. Monitoring of suspect leaks is more effective during the summer months, when leakage is most likely to occur. Leakage will be contained by tightening the valve/plug or by replacing the valve/plug. To date, valves verified as leaking have been mitigated.

Substandard facilities, Category B1, consist of yards that permit extended periods of wetness on cylinder surfaces due to poor drainage or settling to the extent that cylinders contact the ground. Cylinders on the bottom tier under these conditions corrode at the six o'clock position at an accelerated rate as discussed in Category A2. The corrective action is to remove these cylinders from substandard conditions as soon as technically feasible and either renovate the yard to meet current standards or no longer use the yard as a storage facility. PGDP yards C-745-F and C-745-G, which contain about 12,000 cylinders, have been identified as substandard storage facilities. Other yards within the three sites have been identified as having sporadic substandard conditions. In these cases, subjected cylinders will be removed and placed in proper storage yards.

Improper support, Category B2, consists of upper-tier cylinders that are not soundly supported by the bottom-tier cylinders because of improper placement (e.g., a narrow-stiffening-ring to narrow-stiffening-ring support or support from a lifting lug). These cylinders present a concern in the event of an earthquake, when an improperly supported cylinder could be dislodged and fall freely for a few inches to a new resting position. Structural analysis will determine if the subject cylinders will become breached from this free fall, and a safety evaluation will determine the impact from these possible breaches.

Non-depleted uranium, Category C1, is defined as cylinders that contain natural and enriched material are located in the DU storage facilities. Adequate uranium control is necessary to ensure that cylinders containing non-DU are not mistaken for cylinders containing DU and vice versa. All sites have a Nuclear Material Control and Accountability (NMC&A) organization that requires that the cylinder contents, including assay, are verified by records before the cylinder is serviced or shipped off site. The NMC&A uranium control requirements for keeping cylinders with different assays segregated will be followed. As an additional measure, subject cylinders that cannot be easily accessed for segregation have been identified.

Cylinders with loose, detached, or missing cylinder identification (ID) plates, Category C2, are another uranium control issue. Identification plates become loose or detached because of corrosion facilitated by moisture retention between the plate and the cylinder shell and by the dissimilar metals, stainless steel plate, and the mild steel shell. Loose and detached ID plates are occurring on the oldest cylinders in storage. American National Standards Institute (ANSI) guidelines require that the original fabrication documentation be in-hand before ID plates are reattached. If the documentation can be obtained, ID plates will be reattached; if not, tags will be fabricated and attached. As minimum requirements, the replacement tags will indicate they are replacements and will give the cylinder identification number. Authorization to reattach tags will be documented and signed by appropriate personnel. Documentation will remain in the cylinder history file as long as the cylinder is in service.

Table 1 lists five potential defiencies in Category D that are relative only to material transfer operations and not long-term storage. These five potential defiencies are: (1) fill-limit consideration, (2) physically damaged cylinders, (3) substandard valves, (4) plug replacing valve, and (5) non-certified volumes. Transfer Issues also include the potential presence of hydrocarbon oil in the cylinder. Some cylinders were filled before use of the improved vacuum pump design, which eliminated the source of the hydrocarbon oil. Hydrocarbons and UF_6 produce an exothermic reaction. Mitigation of these potential deficiencies will be addressed as necessary in the control of the UF_6 transfer operations.

Table 1 defines the two other potential defiencies relative to long-term storage. These are: relocating inaccessible cylinders so that a more thorough visual inspection can be conducted and establishing an internal vacuum to ensure the integrity of the UF_6 contents. These potential deficiencies will be addressed accordingly through a risk-benefit cost optimization.

3.2 Interface with Subsequent Phases

No significant design and configuration changes within the program that would incrementally impact the decommissioning of cylinders, storage facilities, and equipment are anticipated. Current plans require the reconstruction of substandard facilities, to mitigate unacceptable conditions. However, if regulation changes (external governing documents) or cylinder conditions necessitate a configuration change, the incremental impact on the decommissioning phase could be significant. Examples of this potential impact include: (1) the need for additional precautions to protect against environmental exposure and (2) more prescriptive cylinder access requirements. These examples could dictate a change in configuration such that indoor storage, single cylinder spacing, or mass cylinder replacements are considered. These options would impact the decommissioning phase with the consumption of additional real estate for storage, and the radioactive contamination of additional mild steel (i.e., the need for new cylinders). Impact on the subsequent dispositioning and decommissioning phases of the program will be considered when developing actions to accommodate regulation changes under the current storage phase. [*Derived*]

The greatest incremental impacts on the decommissioning phase from current operations include decontamination and environmental remediation. These aspects are closely related when considering the current program. Support organizations provide oversight for compliance with requirements for contamination control. Environmental remediation is impacted primarily by degree of containment integrity. Containment integrity is a major element within the storage phase, and the requirements for such are specified in Section 5.4. Environmental monitoring in the current phase will be assessed to ensure the establishment of additional actions, if any, beyond current activities that are necessary to maintain compliance with applicable orders and regulations. Additional activities will be established such that environmental monitoring actions within the storage phase are balanced with potential environmental remediation in the decommissioning phase. [*Derived*]

Operations within the current storage phase require a significant interface with the dispositioning phase currently under development. The condition of the cylinder will greatly influence the flexibility of the dispositioning phase (i.e., normal off-site transport and normal transfer of the contained UF_6). Deteriorated cylinders limit this flexibility. The cylinder contents also have some impact on the flexibility of the dispositioning phase. For example, the purity of the contents, the mass, and the internal pressure can impact the dispositioning operations. It is expected that the condition of a portion of the current cylinder inventory does not meet the minimum standards of Department of Transportation (DOT) and ANSI for off-site transport. However, the off-site transport of these cylinders for dispositioning is not a requirement at this time. As a contingency, engineering studies will evaluate the conditions of these cylinders and will propose solutions to the transportation and transfer operational constraints. In addition, the planning for UF_6 dispositioning is taking into consideration the condition of cylinders and necessary actions to accomplish disposition operations. [*Derived*]

3.3 Baseline Considerations and Assumptions

The following considerations and assumptions are provided to bound the scope of systems engineering. Many of these assumptions are current working assumptions that will be modified through improvements defined in the EDP. The current working assumptions are identified as such to integrate the systems engineering approach with the current program.

1. *Risks are managed within the current program.* This assumption permits the program to continue planned operations concurrent with the safety analysis upgrade as authorized under the current safety basis. Planned operations are necessary to correct substandard conditions. This assumption does not preclude the program from pursuing reduction of risks.

2. *Effective risk management for handling degraded cylinders will not appreciably impact planned costs and relocation timing.* This statement assumes the degraded cylinder handling risks are accounted for in recent procedure improvements. Storage vessel criteria under development will not necessitate additional controls that impact cost and timing of planned operations. This assumption is integrated into budget planning for cylinder handling operations.

3. *Current yard construction will result in storage surfaces with acceptable time of wetness.* This assumption permits the progression of yard construction while the definition of unacceptable/acceptable extended time of wetness is under development. Current design of yards derived from general outdoor construction standards is thought to be acceptable.

4. *Corrosion rates are variable and cylinder specific.* This statement is substantiated by the failure of two cylinders at the K-25 Site from external corrosion and the lack of thickness data obtained to date on other cylinders below 0.14 inches. This statement limits the usefulness of statistical wall thickness data when considering specific cylinders.

5. *Skirt corrosion necessitates priority corrective measures.* This assumption is based on limited thickness data collected, corrosion products collected from cylinder skirts, and subsequent projected rates of corrosion. This assumption substantiates the expedited implementation of cleaning and coating skirted regions prior to whole body painting.

6. *As more data are gathered through nondestructive analyses, structural analyses, visual inspections, valve monitoring, and experiences with failed cylinders, the majority of cylinders will be shown to comply with industry standards for storage; the condition of those cylinders that do not meet industry codes will be shown to present no imminent danger.* This assumption permits the near term storage of the DUF_6 in existing cylinders instead of the alternative configurations such as replacement of cylinders, restoration of cylinder thickness, or acceleration of the DUF_6 disposition phase.

7. *Cylinders to be replaced will be accommodated with existing transfer capabilities at PGDP and PORTS.* This assumes that only a small number of cylinders will need to be replaced. This statement is based on the continued working relationship with United States Enrichment Corporation (USEC) and the known number of cylinders to be replaced.

8. *Compliance with ANSI N14.1 is not necessary for continued safe storage of cylinders.* The impact of this assumption is minor within the current phase. However, the assumption limits the flexibility and economics of the subsequent phases because ANSI N14.1 is applicable for shipment of cylinders. The validation of this assumption requires the evaluation, determination, and approval of storage vessel criteria and viable means to transport cylinders subject to the standard or under a DOT exemption for foreseeable shipments. [Derived]

9. *Cylinder contents purity is reflective of the statistical sampling and analysis completed at the time of filling.* This assumption permits the planning and implementation of the dispositioning phase based on statistical purity information and is sufficient for continued storage.

10. *Cylinder contents reflect the NMC&A database records.* This assumption permits the shipment of cylinders in compliance with DOT requirements where a means to weigh cylinders for accountability is not available.

11. *The majority of X-745-C and K-1066-E yards are acceptable for continued use.* This assumption permits the continued planned use of these yards while storage criteria are under development.

12. *Cylinders with inaccessible plug ends do not require immediate priority action to verify containment integrity.* This assumption is substantiated by the verified conditions of accessible cylinders and by the verified conditions of the recently moved inaccessible cylinders.

13. *DOE will continue to regulate the inventory of DUF_6.* This assumption is based on the recent status of negotiations with the Ohio EPA on the regulatory jurisdiction of this inventory and enables DOE to continue to manage the inventory.

14. *DOT exemption for breached cylinder shipment will be approved.* This assumption limits the exploration and planning of alternative means to replace failed cylinders at K-25. The assumption also limits the pursuit of alternative cylinder containment methods for off-site transport.

15. *Funding will be obtained to complete necessary activities as planned.* This assumption limits the amount of contingency planning necessary to ensure the mission will be successfully accomplished.

16. *The dispositioning phase of the DUF_6 inventory will be initiated in FY 2020 and progress at a rate of 5000 cylinders/year.*[5] *The cylinders of lesser integrity will be dispositioned first.* This assumption is used in determining the extent of corrective actions necessary and the degree of periodic maintenance implemented. This assumption is under review and will be revised through the programmatic environmental impact statement (PEIS).

17. *The maintenance coating operation will result in cylinder coating life of 8 to 10 years.* This assumption is supported by the literature reviews, solicited vendor experience, and the value engineering study conducted by the program. This assumption will be used to size the coating capacity at each storage site and develop the surface preparation method.

18. *Requirements for the program that were not considered program specific are maintained and managed at the site level and are not contained in this SRD.* This statement relies on the support organizations at each site to oversee adherence to applicable requirements and standards.

19. *Risks within the program will be prioritized and actions to reduce these risks will be optimized as practical.* The statement enables the program to manage risks and risk reduction activities within the program.

3.4 Definition of Major Objectives

The major objectives of the storage program are promulgated from the situation analysis. The mission of the program is to safely store the existing DOE-owned UF_6 inventory until ultimate disposition. Current expectations are that the cylinders will continue to be used as storage vessels for the UF_6 material and the cylinders will remain in outdoor storage, until ultimate disposition. To achieve this mission in light of the current situation, four major program objectives have been formulated to assist in focusing and organizing various program activities. These major program objectives are:

1. Ensure risks to personnel, the public, and the environment are low.
2. Improve procedures and training.
3. Mitigate deterioration of cylinders.
4. Evaluate and monitor containment integrity of cylinders.

The objectives are intended to provide the framework for a risk management strategy for long-term storage of UF_6 in cylinders.

The following sections describe these major objectives and provide the rationale for their establishment.

3.4.1 Ensure Risks to Personnel, the Public, and the Environment are Low

This major objective ensures the program remains focused on a risk management strategy to identify risks, control them, and to further reduce them as feasible. Identified risks associated with the program include: (1) radiation exposure, (2) contact with surfaces contaminated with radioactive material, (3) exposure to toxic materials resulting from the release of UF_6 and/or reaction products, (4) standard industrial hazards, and (5) an environmental insult caused by the release of UF_6 and/or reaction products.

DUF_6 contained in cylinders presents a low radiation risk. Dose rates are estimated to be 2 mrem per hour at a distance of 1 foot from cylinders and 0.5 mrem per hour for persons performing general cylinder yard work. The remaining risks associated with the UF_6 Cylinder Program are related to the release of cylinder contents. Therefore, the primary focus of the program is to minimize risk by maintaining the containment integrity of the cylinders.

As stated in the mission, the program strives for safe operations. In order to prepare for, establish, and conduct operations the associated risks to personnel, the public and the environment must be articulated. These risks are a product of the hazards within the program and the probability they will materialize. After the hazards are identified and risks are evaluated, determining the initiating events and consequences, measures are established to lesson the likelihood of occurrence. In addition, mitigative measures are also pursued to minimize consequences. These defensive measures can be in the form of design, engineering, and/or administrative controls. A graded approach to implementing defensive measures is taken to combat the severity of the risk recognizing design and engineering controls can provide greater assurance for protecting against initiating events and consequences.

3.4.2 Mitigate Deterioration of Cylinders

This objective reflects the storage phase of the program and the primary risk associated with this phase. Because the primary event of concern is loss of containment, a major objective to mitigate deterioration and maintain or improve existing integrity is established. Consequences including criticality; personnel, the public, and the environmental exposure to UF_6 and reaction products; contamination; and exposure to elevated level of radiation all have the common failure of loss of containment. This objective also stems from the lack of maintenance of cylinders and storage facilities in past years. This condition presents an elevated systemic risk to the program. Mitigating deterioration of the cylinders, particularly during the storage phase of the program, provides the greatest flexibility in the subsequent dispositioning phase.

3.4.3 Improve Procedures and Training

Because the hazards within the storage phase are inherently low, the controls within the program to manage risks are primarily administrative controls. This objective addresses the quality assurance of these controls and their effectiveness in controlling activities that present risk.

3.4.4 Evaluate and Monitor Containment Integrity of Cylinders

This objective also focuses on the current phase of the program, storage of the UF_6 inventory. This objective defines and maintains a status of conditions and establishes the forecasting information to ensure success of the program mission. This is accomplished by monitoring and evaluating cylinder and storage conditions, in addition to monitoring factors that degrade conditions for the purposes of forecasting. The monitoring of degradation factors establishes a proactive approach to potential system problems with containment integrity.

4. FUNCTIONAL ANALYSIS

4.1 Functional Analysis Process

The functional analysis derives the requirements and applicable standards from the major objectives of the program (Fig. 2). In order to comprehensively determine the requirements for the program, it is necessary to first identify the system functional activities and components within the start-up, routine, shutdown, and off-normal states of operation for the fundamental system roles of surveillance and maintenance, handling and stacking, contents transfer, and off-site transport. The first task of the functional analysis was to define the system. A checklist method was used to define the system. This checklist method used key words to elicit the components and activities within the system at the various operational states. The key words used include: physical equipment, personnel, documents, support functions, and organization interfaces. The next task was to analyze the activities and associated components for each major objective to identify requirements necessary to meet the major objectives. Practicability dictated that the functional analysis process involve not only cylinder program management personnel and technical experts, but also subject matter experts from a broad range of other disciplines. Subject matter experts and their command media resources were relied upon to ascertain the applicability of orders, codes, and standards to the requirements. This methodology, which is depicted in Fig. 3, ensures that program requirements appropriately translate into compliance with existing applicable orders, codes, and standards, and that they ultimately support follow-down into procedures. During the functional analysis process, requirements were categorized to enable discrimination of the rationale and intent of the requirements.

4.2 System Definition

The system consists of solid UF_6, primarily depleted, contained in steel cylinders currently in storage yards and the associated management programs. The system encompasses elements such as the cylinders, storage yards, and handling equipment. The system also encompasses safety analyses, risk assessments, a cylinder identification database, inspection database, technical expertise, training requirements and modules, operating procedures, construction contracts, consultant support, expenditure control, documents, program management, and intra- and inter-plant transportation of cylinders.

The principle physical element of the system is the approximately 47,000 cylinders containing DUF_6. The cylinder population is generally characterized as follows.

1. About 86% are 14-ton cylinders, 9% are 10-ton, 4% are 2½-ton, and 1% are miscellaneous capacities.
2. The 10- and 14-ton cylinders are nominally 48 inches in diameter and range from 10 to 12 feet in length.
3. The 2½-ton cylinders are 30 inches in diameter, about 7 feet in length, have skirts, and have walls that are either ½ or 13/32 inches thick.
4. About 94% of the 10- and 14-ton cylinders are thin walled (5/16-inch wall thickness), and the rest of these cylinders are thick walled (5/8-inch wall thickness).
5. About 20% of the 10- and 14-ton cylinders have skirted ends, and the rest are without skirts.
6. Cylinders were procured on an "as needed" basis during five decades; consequently, vendors, designs, materials, etc., vary.
7. Distribution of the cylinders is as follows: 61% are stored at PGDP, 29% at PORTS, and 10% at the Oak Ridge K-25 Site.
8. The cylinders contain DUF_6 with a ^{235}U assay of less than 0.7%, enriched UF_6 less than 5% ^{235}U, and normal assay (0.71% ^{235}U) UF_6 .

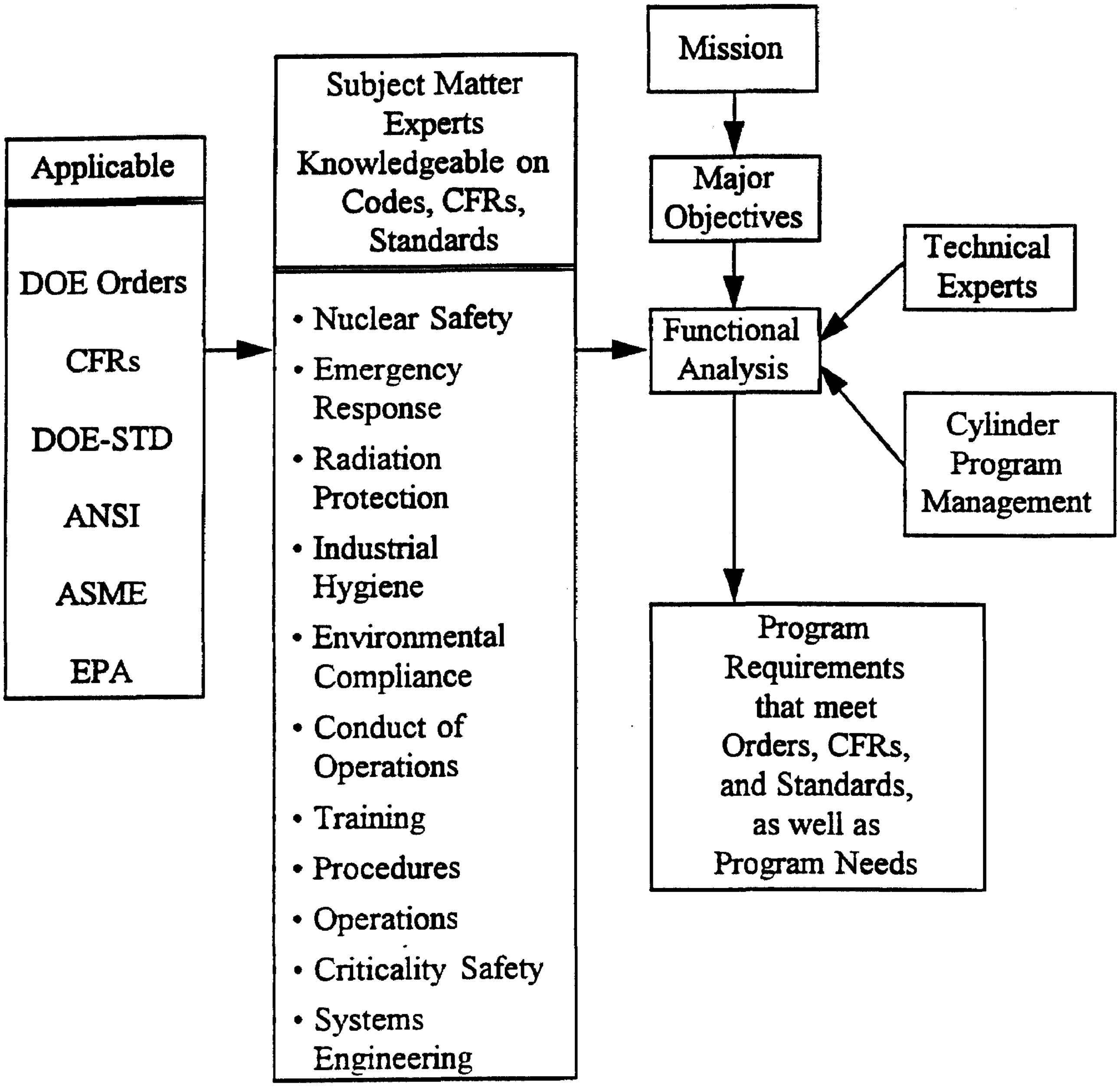


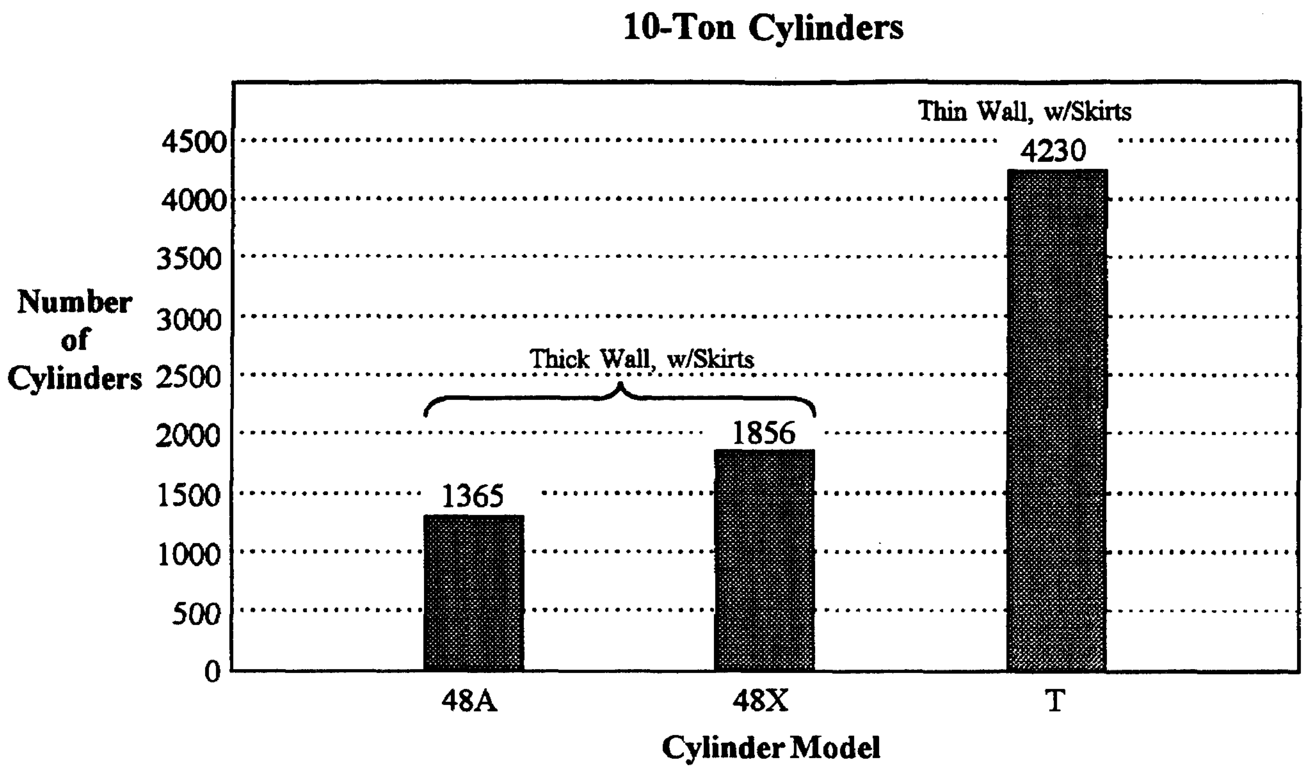
Figure 3. Relationship of Requirements to Orders, Codes, and Standards

Cylinder designs have evolved over the years. Design modifications vary from lifting lug shapes and stiffening ring designs to a change in the reference grade of steel. The cylinder model types and the number of each type that have been in service are shown in Fig. 4.

Manufacturing standards have also changed over the years. Current manufacturing guidelines are contained in ANSI 14.1 and are primarily directed at the original cylinder duty cycle.

Storage yards are another physical element of the system and are constructed of either concrete or compacted gravel. Cylinders are typically double stacked on cylinder yards in straight double rows, and there is a small aisle between some double rows. Some of these aisles are currently wide enough to allow personnel access, but most are not wide enough to allow passage of mobile equipment. In most cases, the cylinder heads face the aisles, to facilitate inspection and inventory control. The bottom cylinders are positioned primarily on wood saddles, and a limited number of concrete saddles are currently in use. The top cylinders are positioned on two bottom row cylinders. Empty cylinders or heel cylinders may be triple stacked in straight rows with a small aisle between each double row. Currently there are two yards at PORTS, ten at PGDP, and five at the K-25 Site. These yards cover a combined surface area of about 3.3 million square feet.

An additional physical element of the system is the cylinder handling equipment, which has also evolved over the years. Originally mobile cranes and removable bands were used to stack and unstack cylinders. Current handling equipment includes the cylinder stacker, which is used for stacking and unstacking as well as for transporting cylinders short distances. The "straddle carrier" is used for in-plant transport of cylinders. An additional device used for in-plant transport of cylinders is a specially designed trailer. Although there are slight variations in types of equipment items at the three sites, these are the principal pieces of hardware used to handle UF_6 cylinders.



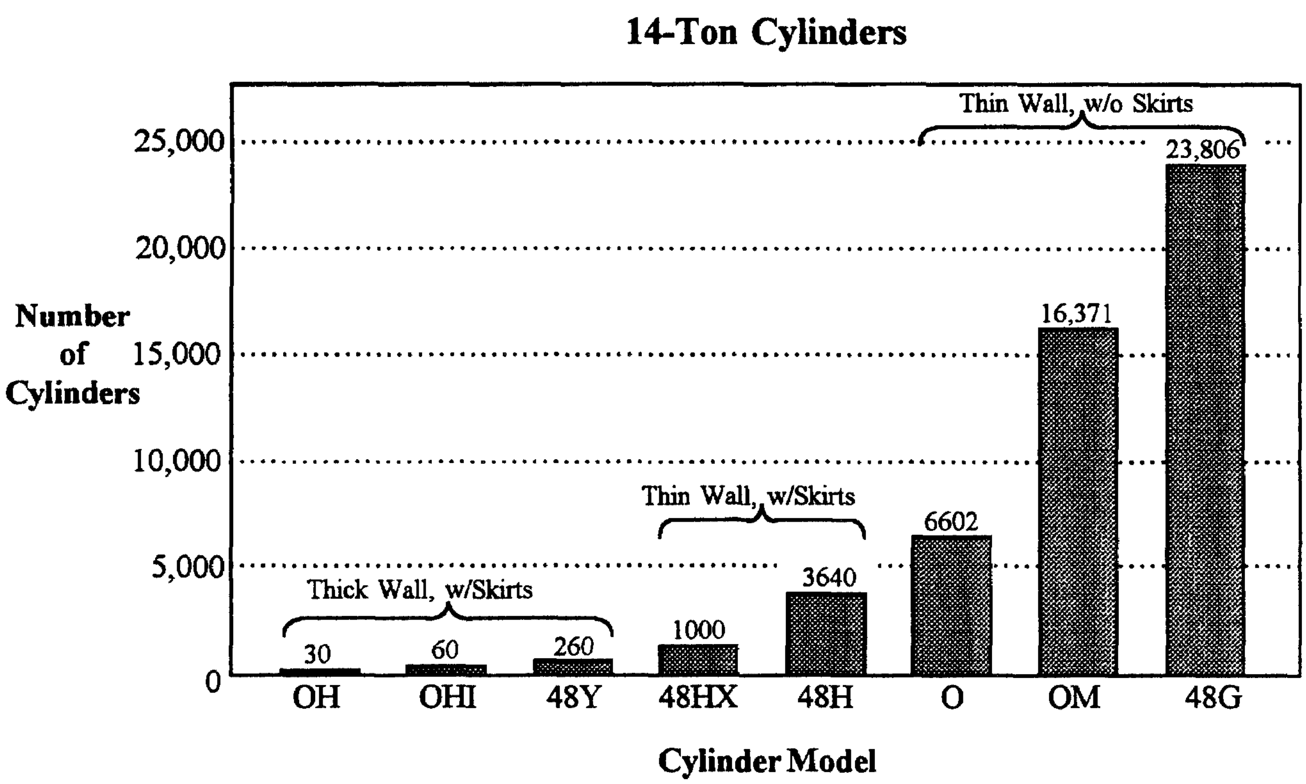


Figure 4. Number of Cylinders Containing DUF_6, by Model

4.2.1 System Functions

The four primary functions in the storage phase of the program are, as shown in Fig. 2. (1) surveillance and maintenance, (2) handling and stacking, (3) contents transfer, and (4) off-site transport of cylinders. Function 1, surveillance and maintenance, includes system activities to maintain cylinder and storage yard conditions. Function 2, handling and stacking, focuses on the on-site movement of cylinders and associated support activities. Function 3, contents transfer, addresses activities necessary to remove the cylinder contents. Function 4, off-site transport, includes the activities required to ship cylinders from the DOE facilities to other locations. Functions 1 and 2 are expected to include significant activity for the next 5 to 10 years as substandard conditions are mitigated (e.g., cylinder storage yard reconstruction and cylinder coating maintenance). After this corrective actions period, these two functions are expected to focus on surveillance and maintenance activities, including maintenance of cylinder coating. Functions 3 and 4 are expected to involve a minimal number of cylinders, but these functions are necessary to support the program mission of safe storage and to facilitate the development of the dispositioning phase of the program. The near-term level of activity within these two functions is dependent on the population of cylinders found to be unacceptable and repairable for continued storage. Another impact on the level of activity in Function 4 is the possibility of inventory consolidation from three sites to two or one.

Section 4.2.2 provides a detailed listing of components in each function. Section 4.2.3 provides a detailed listing of activities within each function.

4.2.2 System Components

The system components are categorized as physical equipment, personnel, support organizations, documentation, and organization interfaces and are shown in Lists 1 through 5. The physical equipment and personnel are further categorized by the system functions.

List 1. PHYSICAL EQUIPMENT

Surveillance and Maintenance Function

UF_6 (including depleted, enriched, and normal)

Cylinders (including nameplates, stiffening, rings, lifting lugs, and seam welds)

Cylinder valves and plugs

Storage facilities (including concrete and gravel yards, concrete saddles, yard lighting, alarms, run-off, catch basins, and fallouts)

Technical assessment equipment, i.e., ultrasonic thickness (UT) apparatus

Inspection, monitoring, and survey equipment

Cylinder coating facility/designated area

Cylinder surface preparation equipment

Blast media

Coating equipment

Coating (including paint, thinner, and cleaners)

Coating operation wastes

Yard boundary control signage

Personal protection equipment

Valve change out equipment

Decontamination equipment

Emergency patch equipment

Cylinder stand/turning fixture

Handling and Stacking Function

Straddle buggy

Crane (including associated hoisting & rigging (H&R) equipment)

Trailers and tractors (including trailer saddles)

Full cylinder handler/stacker

Empty cylinder handler

Forklift (including cylinder handling attachments)

Communication equipment (e.g., radios)

Equipment certification devices (load cells, etc.)

Check weight cylinders

Contents Transfer Function

(in addition to handling and stacking function and physical equipment)

Feed and withdrawal equipment (including associated safety systems)

New cylinders; new valves, and plug

Cylinder decontamination Facility

Decontamination wastes

Building crane (including associated H&R equipment)

Pigtails

Heat source

Off-Site Transport Function

(in addition to handling and stacking function and physical equipment)

Rail cars
Trailers and Tractors
Overpacks

Tie-down rigging
Valve covers

TIDs (tamper indicating devices)
HP survey equipment

List 2. PERSONNEL

Surveillance and Maintenance Function

Line management/supervisor	Finance officers	Nondestructive equipment certified personnel
Periodic cylinder inspections	Program management	System safety engineers
Envirn. monitoring technicians	Chemical operators	Emergency preparedness/response team
Health physics technicians	Material handlers	Procedure writer
Security force	Maintenance personnel	Training personnel
Decontamination operators	Metallurgists	Lab technicians
Health and safety representation	Industrial hygiene technicians	Construction contractors
NMC&A personnel	Painters	Engineering support personnel
Qualified ASME code inspectors	Quality assurance and evaluation personnel	Equipment testing/inspection personnel
		Records management personnel
		Computer support personnel

Handling and Stacking Function

(in addition to surveillance and maintenance function personnel)

Spotter	Equipment operator	Operator to set saddles
Cylinder inspector	Maintenance (laborers)	H&R crew
H&R representatives		

Contents Transfer Function

(in addition to handling and stacking function personnel)

Operator

Off-Site Transport Function
(in addition to handling and stacking function personnel)

H&R crew
Qualified inspector
Health physics technician
Transport driver
Transportation safety
DOT certified transportation "officer"

List 3. SUPPORT ORGANIZATIONS

Facility Safety
Emergency Preparedness
Finance
Uranium Material Handlers
NMC&A
Utilities
Industrial Hygiene (IH)
Health Physics (HP)
Nuclear Criticality Safety
Chemical Operations
Maintenance
Procurement
Operations
Security
Waste Management
Envirn. Monitoring
Compliance
Quality Assurance
Self Assessment
Engineering
Records Management
Computer Support
Technical Services
Equipment Test and Inspection
Analytical Services

List 4. DOCUMENTATION

Recommendation 95-1
Technical Report to 95-1
Management plans
Work Plans
Inspection reports
Technical reports
Technical logs
Self-assessment reports
Design Drawings (yards, saddles, fixtures, cylinders, etc.)
System Requirement Doc.
Sys. Engr. Mgmt Plan
Engr. Development Plan
Maintenance Records
Safety basis documentation
DOT exemptions
Job performance analysis
Bid specifications
Technical specifications
Program Mgmt. Plan
95-1 Implementation Plan
Shipping manifests and other DOT paperwork
HP/IH survey reports
Environmental Mgmt. Records
Procedures
Training modules
Materials & Transfer Records

List 5. ORGANIZATION INTERFACES

Contracted services
Local, state, federal agencies
DOE
Lockheed Martin Energy Systems
Lockheed Martin Utility Services
Regulators

4.2.3 System Activities

The activities specific to the program are shown in List 6. The activities are organized by function.

List 6. SYSTEM ACTIVITIES

Surveillance and Maintenance Function

Environmental monitoring
Security monitoring
Inventory accountability
Containment integrity monitoring
Technical studies/monitoring/analysis
Radiation/criticality and other hazard surveys
Worker training
Boundary/access control/posting/maintenance
Maintain emergency readiness/response/drills
Records management (UCLIM, NMC&A, procedures)
Program planning
Financial accounting
Thickness data acquisition
Inventory modeling
Analysis for safety document
Occurrence reporting
Self assessments/audits
Yard construction/reconstruction
Cylinder coating/surface preparation, etc.
Valve replacement and/or decon
Skirt cleaning/coating/drain hole drilling
Yard maintenance (sweeping, lighting, mowing)
Alarm maintenance
Cylinder patching/repair operations
Inventory accounting
Inspections (routine, coating quality evaluation)
Data entry
Design (yard, saddles, etc.)
Monitoring equipment maintenance/certification
Decontamination
Waste disposal
Coating touch-up
Valve/plug replacement
ID plate replacement
Cylinder coating maintenance

Handling and Stacking Function

(in addition to surveillance and maintenance functional activities)

Cylinder inspection
NMC&A verification and authorization
Equipment maintenance
Operator training
HP survey
Emergency response/readiness
Saddle placement/moving
Cylinder lifting, hauling, and stacking
Old saddle disposition
UT testing
H&R training

Contents Transfer Function

Authorization to transfer
Feed and withdrawal preparation
Cylinder inspection
Cylinder lifting and placement with building crane
Receiving cylinder preparation and connections
Cylinder connections, heating
Material control verification
Investigation activities
Transfer operation
Safety systems testing monitoring
HP monitoring
Cylinder weighing

Off-Site Transport Function

External inspection cylinder components and transport equipment
HP survey
Cylinder pressure check
NMC&A verification/authorization
Securing cylinder on transportation vehicle
Installation of TIDs and valve covers
Stenciling of "radioactive LSA" on cylinder body
Cylinder weight verification
H&R to transport vehicle
Transport authorization/documentation
DOT training
DOT inspection of transport vehicle

4.3 Functional Relationships

The relationships between the functions is a key aspect to having a program of safe storage. Examples include: (1) cylinders must be handled and restacked to mitigate substandard storage conditions and reduce surveillance and maintenance risks and (2) it will be necessary to transfer the contents of cylinders found to be non-compliant with storage vessel criteria and unrefurbishable to acceptable cylinders, also reducing surveillance and maintenance risks. Transfer of cylinder contents may involve off-site transport. Off-site transport may also be required to pilot or demonstrate the disposition of the DUF_6. Intra-site inventory consolidation, if found to optimize the program, would necessitate off-site transport of a large number of cylinders.

The primary interrelationship of these functions is the cylinder and an integrated set of acceptance criteria (storage vessel criteria) for cylinder condition that accommodates all functions. There are expected to be different criteria for each of the four system functions: surveillance and maintenance, handling and stacking, contents transfer, and off-site transport. Existing standards such as ANSI N14.1 and ORO-651 provide detailed criteria for specific functions, respectively off-site transport and liquefaction transfer of contents. ASME Boiler and Pressure Vessel code also provides design, construction, and maintenance standards for cylinders. A significant portion of the cylinder population does not meet the 1/4 inch minimum wall thickness for thin wall cylinders specified in these standards. The relationship between functional criteria will be addressed in the development of an integrated set of cylinder acceptance criteria (storage vessel criteria). These storage vessel criteria will enable the program to successfully meet its mission for the storage phase, will optimize the use of existing containers with respect to the overall program life cycle, and will optimize ultimate disposition flexibility.

Compliance with these storage vessel criteria will necessitate continued maintenance and verification. Cylinders that do not currently meet the storage vessel criteria, require other system functions to initiate precautionary measures, including additional inspections and possible operations. Examples of this scenario include:

- The mass limit on cylinder contents is not a limiting criterion for the surveillance and maintenance function and is not verified within this function; however, safety precautions within the transfer function require that the mass content be verified, because some cylinders are above weight limits for routine heating. Heating overfilled cylinders could result in hydrostatic rupture.
- An internal vacuum is not a limiting criterion for the cylinder handling and stacking function and is not verified within that function. However, off-site transport standards require that the cylinder contents be at or below atmospheric pressure. These criteria are verified within the transport function, and it may be necessary to reduce internal pressure before shipment.

The program will establish maintenance and verification activities within each function to compensate for cylinders that do not meet the storage vessel criteria. These activities will ensure the risks of processing cylinders from one function to another are sufficiently controlled. [*Derived*]

The capacity of a function is determined by the rate at which it can perform its intended actions. This rate is also interrelated to other functions. Examples include:

- The capacity to handle and restack cylinders from substandard storage conditions could impact the number of cylinders that meet storage vessel criteria in out-years and thus the number of cylinders requiring mitigative actions.
- The capacity to transfer the contents of unacceptable cylinders impacts the duration for which these cylinders have to remain in the surveillance and maintenance function. Risks with prolonged storage of unacceptable cylinders need to be balanced with the capacity to replace or repair these cylinders.

The program will ensure function capacity is made available commensurate with the impact on other functions. Other functional relationships include nuclear materials accountability control, contamination control, information from technical studies, and cylinder history records management. These relationships will be identified and appropriate controls verified and/or implemented to maintain continuity of the program. [*Derived*]

4.4 Functions Crosswalk with Major Objectives

Figure 5 provides an overview of the major objectives' applicability to the system functions. All major objectives are applicable to the entire system; however, this overview identifies the emphasis areas for each major objective. The overview provides the basis for the functional analysis used to determine program requirements.

As shown in Fig. 5, the major objective *Ensure risks are low* applies unilaterally across all system functions. A graded approach, depending on the potential consequences and frequency, is used to evaluate specific risks within each function. The greatest risks are within the cylinder contents transfer function where significant energy is introduced to the system.

Activities to support the major objective *Mitigate deterioration* are not unilaterally applied to all system functions. The greatest level of effort to mitigate deterioration is concentrated in the storage, and handling functions where cylinder operations are continuous. The primary actions associated with successfully meeting this objective include facility improvements, coating maintenance, and valve and plug maintenance. These actions do provide benefit to the transport and transfer functions by reducing risk and increasing program flexibility.

The *Improve procedures and training* major objective is similar to the first objective, *ensure risks are low*, and unilaterally applies to all system functions. Procedures and training are needed to support operations in all functions. The effectiveness of these administrative controls is a key element to successfully meeting the program mission.

Activities necessary to meet the major objective *Monitor/evaluate conditions* lie primarily in the surveillance and maintenance function of the system. However, the criteria for which these actions verify acceptable conditions consider all criteria within the system.

Major objective	System Function			
	surveillance and maintenance	handling and stacking	contents transfer	off-site transport
ensure risks are low	<-------unilateral application------->			
mitigate deterioration	<----emphasis area---->			
improve procedures and training	<-------unilateral application------->			
monitor/evaluate conditions	<emphasis area>			

Figure 5. Applicability of Major Objectives to System Functions

5. REQUIREMENTS TO ACHIEVE MAJOR OBJECTIVES

The system requirements within this document provide the framework for developing activities necessary to accomplish its mission. The systems engineering approach is being applied concurrently with an ongoing program, and many actions are in progress. The SEMP will establish the technical basis for program activities through an analysis of requirements contained herein and others as they are identified.

The requirements in the following section were developed through a functional analysis of the activities and components identified in the system description section. These activities were analyzed in the context of each major objective to determine what requirements needed to be established to accomplish the objective. To bound the development of requirements, only those standards that directly affect this program and its ability to meet its mission were considered.

Categories of requirements under each major objective have been established. These categories are shown in Fig. 6. These categories are not requirements of the program. They summarize the rationale for the requirements.

Requirements were reviewed to identify applicable standards and governing documents. These standards are identified in [*brackets*] following each requirement. Section 2 provides a listing of standards and governing documents for the program. Where a requirement does not have an applicable standard or governing document, the standard is considered to be derived within the program.

The following sections relate system requirements to the major objectives described in preceding sections of this document. The motivation for the development of these requirements within major objectives is to respond to the need expressed by the objective and, ultimately, to determine activities necessary to accomplish the objectives.

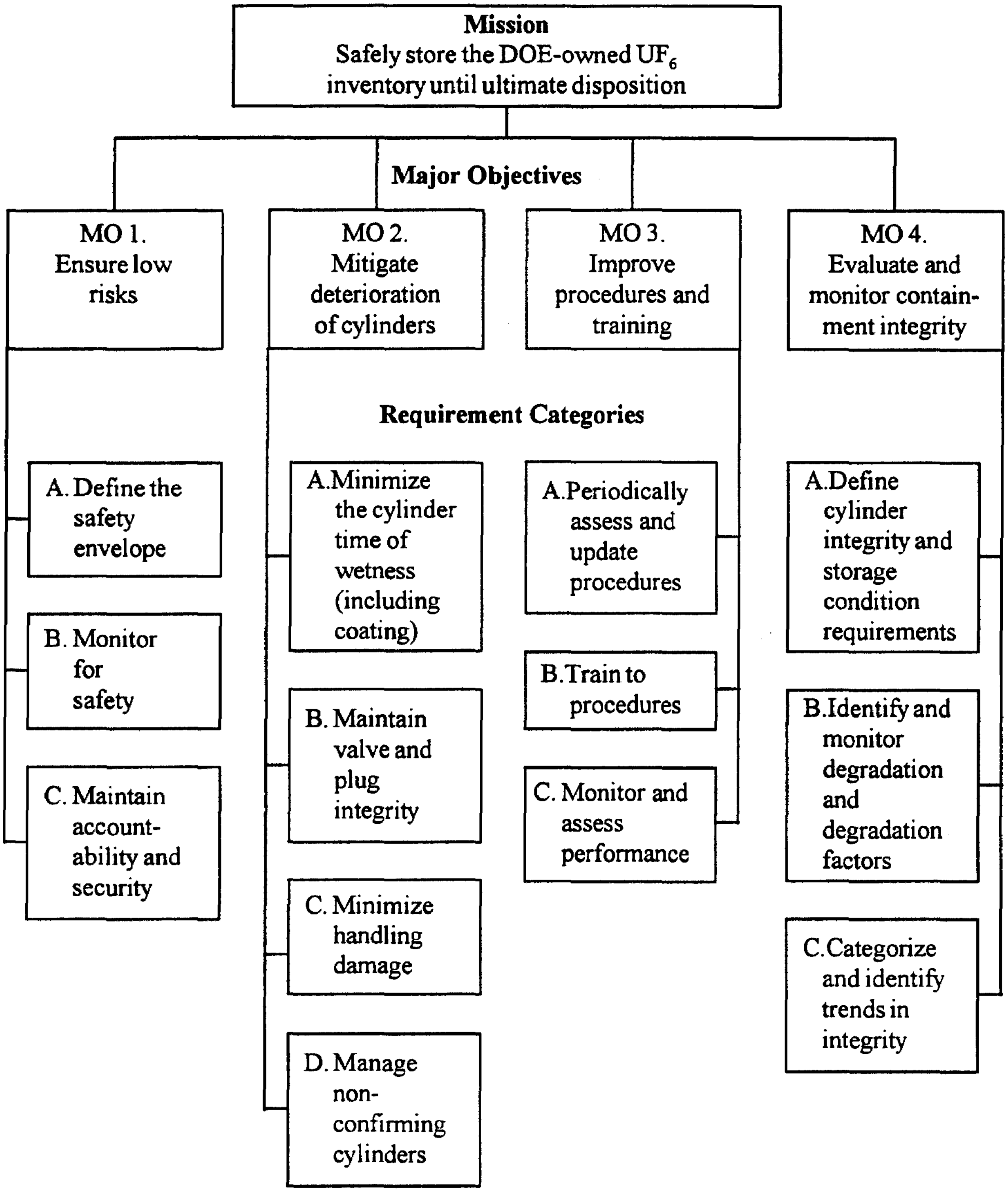


Figure 6. Categories of Requirements Associated with Major Objectives

5.1 Requirements to Ensure Low Risks

5.1.1 Define the Safety Envelope

Major Objective (MO) 1, Requirement Category A: Define the safety envelope for the handling and storage of UF_6 and consider it in all system requirements, procedures, and program elements, which will take into consideration all DOE orders and pertinent laws, including state and federal.

5.1.1.1 Description and Rationale

In order to ensure a safe storage program, the hazards associated with storage must be identified and evaluated for control. In addition, the minimal controls necessary to manage the risks within planned activities must be determined, to successfully maintain a safe program. These actions, identify and evaluate hazards and determine minimal controls, define the safety basis for the program. This safety basis is the bounds for safe operation of the necessary program activities. The ongoing activities and potential new activities within the program are then managed within the bounds defined by the safety basis. This requirement category defines and documents the hazards and their associated risks and consequences for clear dissemination to the workforce and control within the safety basis.

An integral function of the safety basis is to grade the hazards. This hazard grading facilitates clear delineation of which hazards pose the greatest risk and where multiple controls (defense-in-depth) are required and most beneficial. The grading also establishes the basis for prioritizing risk reduction actions.

5.1.1.2 Requirements and Intent

The following requirements ensure the safety aspects of the program are defined, documented, and maintained.

1. The hazards, risks, and minimum controls will be identified, evaluated, and documented in a complete safety analysis to define the program safety basis. [DOE 5480.23, 6430.1A, 5480.22, 5480.24, 5480.7A]
2. The authorized safety basis will be periodically reviewed and updated, to reflect a current safety analysis and definition of hazards and risks within the program. [DOE 5480.23, 6430.1A]
3. Appropriate evaluations of compliance with the safety envelope will be conducted when the authorized safety basis is in question due to changes in procedures, work scope, and/or storage configurations. [DOE 5480.21]
4. Appropriate reviews and assessments will be performed, to ensure the preparedness of new activities and facilities, and the restart of activities as appropriate. [DOE 5480.31]
5. An industrial hygiene program will identify and administer controls to ensure proper management of industrial hazards. [DOE 5480.1B, 5480.10, 5483.1A]

6. Conduct of Operation principles will 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]

5.1.2 Monitoring for Safety

MO 1, Requirement Category B: Monitor facilities and operations for safety.

5.1.2.1 Description and Rationale

Facilities and operations must be monitored to determine the presence of hazards and potential initiators. These hazards and initiators are identified in the safety analysis. This monitoring ensures compliance with the authorized safety basis and identifies necessary ameliorative actions to maintain compliance with the authorized safety basis.

5.1.2.2 Requirements and Intent

The following requirements are established to ensure facilities and operations are monitored for compliance with the authorized safety basis.

1. The concept of as low as reasonably achievable (ALARA) will be incorporated in the development and execution of system operations. ALARA will serve as a guide to the risk management and reduction efforts within the program. [10 CFR 835, DOE 5480.23, 5400.5, 5480.10, 5480.11, 6430.1A]
2. Facilities will be regularly surveyed for radiation and release of UF_6 and reaction products to evaluate program risks. [10 CFR 835, DOE 5480.23, 5400.5, 5480.10, 440.1]
3. Facility safety walk-throughs will be conducted regularly, to identify initiators and determine ameliorative actions. [DOE 5700.6C]
4. Any subsequently identified conditions out of compliance with the safety authorization will be ameliorated in a manner such that risks to personnel and environment are minimized. [10 CFR 830.120, 10 CFR 835, DOE 5700.6C, 5480.23]
5. Alternative methods for investigating risks, hazards, and initiators will be evaluated. [10 CFR 830.120]

5.1.3 Maintain Accountability and Security

MO 1, Requirement Category C: Maintain accountability and security of the inventory

5.1.3.1 Description and Rationale

The uranium in storage is considered a "source material" as defined by the Atomic Energy Act (AEA). This designation requires accountability and security of the inventory. In order to stay within the authorized safety basis, mass and assay must be maintained. Movement, including off-site transport of cylinders containing accountable inventory, is controlled through a NMC&A program. Security within the facilities is maintained with appropriate perimeter fencing, routine patrols, and storage yard lighting.

5.1.3.2 Requirements and Intent

1. Accountability of the inventory will be managed through a nuclear materials control and accountability program. This program will control through authorization the movement and processing of the inventory and will provide the assay and mass quantities necessary for controlling fissile material relative to criticality concerns. The program will also maintain information regarding the service history of cylinders. [10 CFR 835. DOE 5633.3B]
2. Management will ensure storage history for each cylinder is documented. [10 CFR 835, DOE 5633.3B]
3. Cylinders containing fissile material will be segregated from non-fissile inventories and spaced in accordance with nuclear criticality control guidelines [10 CFR 835, DOE 5480.24, 5633.3B]
4. The security of the UF_6 inventory will be maintained in accordance with a safeguards and security program. This program will specify and maintain the periodicity of routine patrols and physical boundaries. The program will also specify other security requirements including lighting, as determined necessary. [DOE 5633.3B]

5.2 Requirements to Mitigate Deterioration of Cylinders

5.2.1 Minimize Time-of-Wetness (TOW)

MO 2, Requirement Category A: Minimize the cylinder time of wetness through defense in depth

5.2.1.1 Description and Rationale

Currently, the UF_6 is stored outdoors, in mild steel containers that are fully exposed to atmospheric conditions. The atmospheric conditions at the present storage facilities maintain a corrosive environment for mild steel, with high relative humidity and an abundance of precipitation. This configuration requires the comprehensive management of mild steel exposure to wetness. Mild steel exposure to wetness has ramifications on the overall program mission that warrant significant defense in depth. The primary control for minimizing cylinder time of wetness is proper drainage of the storage facilities and from cylinder bodies. The second level of protection is adequate ventilation and separation from regions with continuous high humidity regions (i.e., proximity to the ground). The third level of defense is a protective coating to be maintained on cylinder bodies.

5.2.1.2 Requirements and Intent

1. Cylinders will be removed from storage in ground contact, and subsequent storage in ground contact will 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]
2. A cylinder maintenance coating program will be initiated. This program will begin with a pilot operation and will expand to all sites. The cylinder prioritization and rate at which initial coatings are applied will be determined based on the present condition of the cylinder and the forecasted deterioration of wall thickness. Cylinders will be selected for initial coating in groupings to facilitate operational logistics with yard refurbishment and coating operations. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]
3. Cylinder protective coatings will be maintained throughout the storage phase of this program to provide defense in depth from cylinder deterioration. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]
4. Storage facilities will be designed for the expected life of the storage phase of this program and for the expected operational activities during this phase to minimize future capital expenditures. [10 CFR 830.120, 10 CFR 835, DOE 6430.1A, DOE 5480.28]
5. Cylinders will be stored on load-bearing surfaces that, when in use, drain properly (as determined by the program) and rigidly support handling equipment during operations. (This requirement for all practical purposes eliminates asphalt and gravel storage yard designs) [10 CFR 830.120, 10 CFR 835]
6. Skirt region drainage will be promoted, to minimize corrosion. [10 CFR 830.120, 10 CFR 835, DOE 4330.4B]
7. By design, cylinder saddles will provide ventilation between the cylinder and the load-bearing surface and will facilitate proper drainage from the cylinder and storage facility in depth to minimizing time of wetness. [10 CFR 830.120, 10 CFR 835, DOE 5480.19]
8. Cylinders and supporting saddles will be configured on storage facilities such as to facilitate proper drainage. [10 CFR 830.120, 10 CFR 835]
9. As part of continuous improvement other methods for reducing time of wetness and cylinder degradation will be evaluated as identified (e.g., cathodic protection). [10 CFR 830.120, 10 CFR 835]
10. Impact on the subsequent program phases will be considered in changes to the system configuration. [*Derived*]

5.2.2 Maintain Valve and Plug Integrity

MO 2, Requirement Category B: Maintain valve and plug integrity commensurate with the program mission

5.2.2.1 Description and Rationale

Other potential initiators of loss containment involve the failure of valve and/or plug. Scenarios of valve/plug failure are specific to the function being imposed on the cylinder (surveillance and maintenance, handling and stacking, contents transfer, and off-site transport). However, generic scenarios involve the failure of the component and the release of UF_6 and reaction products as contamination or potential exposure for the worker and environment. An ingress of moisture to the ullage facilitates further degradation of the valve or plug. Substantial quantities of moisture in the cylinder can establish internal corrosion as a loss of a containment initiator. The interface of dissimilar metals (e.g., bronze alloy valve/plug connected to a mild steel container) can affect the integrity of the steel cylinder. The control of these initiators as determined by the program will be managed through a valve management program.

5.2.2.2 Requirements and Intent

1. A valve and plug integrity management program will 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, ORO-651, DOE 4330.4B]
2. Failed valves and plugs including intermittent leaking will be detected and corrected. Known and suspect sources of leaks and releases of UF_6 to the environment will be eliminated. [10 CFR 830.120, 10 CFR 835, ORO-651, DOE 4330.4B]
3. Valves with missing or damaged parts will be replaced or the parts replaced. The port cap and the bonnet packing nut provide a secondary level of containment that will be maintained during the storage phase of the program. [10 CFR 830.120, 10 CFR 835, ORO-651, DOE 4330.4B]

5.2.3 Minimize Handling Damage

MO 2, Requirement Category C: Minimize handling damage to the cylinders

5.2.3.1 Description and Rationale

Physical damage to the cylinder can affect the containment integrity in varying degrees. Specific types of damage can be unique concerns to various system functions. The loss of protective coating is a concern to the surveillance and maintenance function, and gouges and dents can be a concern to the surveillance and maintenance function and the contents transfer function. The risk of this damage occurring lies primarily in the handling and stacking function of the program. Much of the potential damage lies in the areas where saddles and handling equipment contact the cylinder. This anticipated contact is managed by the design of the saddles and equipment and by the design and maintenance of the coating. Other, undesirable contact is controlled by configuration design of the storage array and through administrative control in handling procedures. Administrative control is also used as mitigative measure to identify for corrective action any damage that does occur.

5.2.3.2 Requirements and Intent

To minimize damage to cylinders during the handling and stacking function, the following requirements have been established.

1. Cylinder handling and stacking configurations that minimize potential impacts between cylinders will be established and incorporated into procedures. [10 CFR 830.120, ORO-651]
2. Cylinder storage configuration and control that facilitate stacking and unstacking without cylinder damage will be established and incorporated into procedures. [10 CFR 830.120, ORO-651]
3. Only like cylinders will be stacked together, to the extent necessary, to minimize handling damage. [10 CFR 830.120, ORO-651]
4. Engineering controls to prevent cylinder damage during stacking operations will be evaluated. [29 CFR 1910, DOE-HDBK-1090-95]
5. The design of new handling equipment will consider additional controls to prevent coating damage on the body of the cylinder and cylinder damage by operator error when lowering cylinders for placement. Existing equipment modifications to reduce potential damage will be evaluated. [ORO-651]
6. Criteria for saddle design will include the protection of cylinder coating. [DOE 6430.1A]
7. Operators using cylinder handling equipment will be qualified to verify their proficiency in the use of such equipment and their understanding of risks and hazards of handling UF_6. [DOE 5480.20A]
8. Toughness, durability, and repair qualities will be criteria in the review and acceptance of coatings and replacement coatings. Increased toughness will minimize the damage caused by handling. [DOE 6430.1A]

5.2.4 Manage Non-Conforming Cylinders

MO 2 Category D: Replace or repair unacceptable cylinders.

5.2.4.1 Description and Rationale

As a result of past storage practices, some cylinders are expected not to meet the storage vessel criteria under development. See MO 4 for a discussion of the storage vessel criterion's development. Cylinders that don't meet these criteria will be replaced or repaired. However, these unacceptable cylinders are not expected to present an imminent danger to workers, the public, or the environment. The means for managing this population depends on the extent and nature of unacceptability and the size of the population. Currently, failed cylinders are few and the means to remove them from service is obtained from contracted services. DOE does not possess the ready capacity to replace or repair unacceptable cylinders. Method and capacity for managing unacceptable cylinders will be established in conjunction with determining the unacceptable population and the nature and extent of their deficiency.

The primary criterion for permanent repair of cylinders is compliance with ASME Boiler and Pressure vessel code. Based on discussions with private companies that have repaired boiler and pressure vessels, repairing corroded cylinders is a feasible alternative to cylinder replacement.

5.2.4.2 Requirements and Intent

1. New cylinders, valves, and plugs will be designed, procured, and manufactured in accordance with the anticipated service and configuration. [ORO-651, ANSI N14.1, DOE 6430.1A]
2. Replacement/Repair services contracted will be from organizations knowledgeable of the hazards of UF_6, and deteriorated cylinders. These organizations will operate within an established safety basis. [10 CFR 830.120, DOE 5480.23]
3. Permanent repair to cylinders will be conducted in accordance with maintaining cylinders as coded vessels. [ORO-651]
4. The functional capacity to safely manage non-conforming cylinders will be established in order to minimize the impact on the surveillance and maintenance function. [*Derived*]

5.3 Requirements to Improve Procedures and Training

5.3.1 Periodically Assess and Update Procedures

MO 3, Requirement Category A: Periodically review and update procedures, work plans, and training modules to incorporate lessons learned, requirement changes, safety bases, and engineering development while maintaining three-site consistency.

5.3.1.1 Description and Rationale

Administrative measures, procedures, are the primary controls of initiators within the program. Procedures are necessary to perform activities within all system functions (surveillance and maintenance, handling and stacking, contents transfer, and off-site transfer) The quality of these procedures reflects the program's ability to control risks. Procedure development must consider the intent of the activity, the impact if not accomplished, and the knowledge and skill of personnel performing the operation. The procedure also considers the effectiveness of the training.

This requirement category will rely on the program SEMP to identify new information that necessitates the review and update of applicable procedures. A procedures management organization conducts the procedure upgrade and involves all affected organizations. The key organization to be involved is the organization that generated the new information submitted to the decision-making process, documented in the SEMP. Key personnel include the user of the procedure and personnel who established the intent of the proceduralized operation.

Other documents (including training modules, work plans, and safety basis) may need to be updated as a result of the decision-making process, documented in the SEMP. Program management coordinates these updates with appropriate organizations such as training, facility safety, etc.

5.3.1.2 Requirements and Intent

1. Procedures, work plans, and training modules will incorporate all the pertinent information that flows down from the SEMP including (e.g., safety documentation; input from the stakeholders, emergency response; lessons learned; and the engineering development process). [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.20A, 5480.23, 5633.3B, 5700.6C]
2. Procedures will 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. Any site-specific documentation requirements will be identified and taken into consideration in the procedure process. [10 CFR 830.120, 10 CFR 835, DOE 5480.19, 5480.23, 5633.3B]
4. The SEMP decision making process will establish a mechanism to obtain, process, and document information relevant to the program. [10 CFR 830.120]

5.3.2 Train to Procedures

MO 3, Requirement Category B: Train personnel to current procedures, work plans, training modules, and safety envelope

5.3.2.1 Description and Rationale

In addition to quality procedures the program needs current and effective training to procedures for successful control of initiators and to accomplish the intent of operations. Performing personnel will have the capacity to understand the intent of the operation and the safety aspects and will be able to demonstrate proper use of procedures. Safety aspects of the operation flow down from the authorized safety basis. Performing personnel are to be generally knowledgeable of the program's authorized safety basis.

To accomplish this category of requirements, the training organization interfaces with the procedure development process to ensure training modules are current and effective. Personnel knowledgeable of specific procedures intent will periodically review training and the training modules, to ensure the intent is being presented accurately.

5.3.2.2 Requirements and Intent

1. Personnel will be trained to provide understanding of the safety documentation, which flows down to the procedure and field operations. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910, DOE 5480.19, 5480.20A, 5480.23, 5700.6C, 5480.18A]

2. Personnel will 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. A data base will be in place that cross-links training requirements (including training to procedures and training intervals) to training records. The data base will be used to maintain training current with procedure revisions. [10 CFR 835, DOE 5480.20A, 5480.23]
4. A performance-based methodology will be used for training. [10 CFR 830.120, DOE 5480.20A, 5480.18A, 5480.23]

5.3.3 Monitor and Assess Performance

MO 3, Requirement Category C: The performance of activities supporting the program will be periodically monitored and assessed to ensure procedures are being adhered to and the intent of the activities are being met.

5.3.3.1 Description and Rationale

The success of the program is supported by quality procedures and training to prepare performing personnel. To accomplish objectives, the actions taken by performing personnel have to complete the desired tasks, be performed in a safe manner, and achieve the intent of operation. Experience has shown actual performance can vary on an individual and crew basis and can evolve away from the intent of operation. This category of requirements ensures activities are performed such that the intent of the operation is accomplished.

5.3.3.2 Requirements and Intent

1. Performance will be periodically monitored and assessed, to determine that procedures are being followed, training is effective, and the intent of the operation is being fully met. [10 CFR 830.120, DOE 5700.6C]

5.4 Requirements to Evaluate and Monitor Containment Integrity

5.4.1 Define Cylinder Integrity and Storage Condition Requirements

MO 4, Requirement Category A: Define storage vessel criteria and storage conditions necessary for specific program activities

5.4.1.1 Description and Rationale

Cylinders are the integral component in the storage phase of the program. They are used to contain the UF_6 inventory and provide the primary barrier between the UF_6 and worker, public, and the environment. Actions performed on these cylinders are outlined in the system definition discussed in Section 4.2.3. In order to ensure this integral component performs as desired within each function and within subsequent phases of the program (disposition and decommissioning), functional criteria for cylinders are necessary. These functional criteria will establish the minimum integrity necessary to safely perform operations using routine controls.

The cylinders in service were designed to ASME pressure vessel standards. All, except a small population, were manufactured to ASME standards and are code stamped as such. Other standards related to the in-service use of UF_6 cylinders include ANSI and DOT standards for packaging and transport, and DOE ORO-651, *A Manual of Good Handling Practices for UF_6*. It is expected that, because of past storage practices, an undetermined number of cylinders does not comply with these standards. The primary cause of non-compliance is external corrosion resulting in cylinder wall thicknesses less than minimum standard thicknesses, and code stamped nameplates being displaced from cylinders. Data collected and preliminary analyses to date show these cylinders still have adequate structural integrity for continued storage of the DUF_6 in the yards. Additionally, preliminary analyses show that non-compliant cylinder conditions are also safe for other functional operations. Program objectives discussed in Section 3.4 provide the means to mitigate further deterioration of the cylinders and thus control the increase in the non-compliant population of cylinders.

It is the intent of the program to maintain compliance with industry standards applicable to UF_6 containers. This intent preserves the flexibility in the current storage phase and in the subsequent UF_6 dispositioning phase. However, substandard cylinders may be a candidate for near-term corrective action.

This category of requirements defines the standards by which non-compliant cylinders will be managed. An evaluation will be performed to determine minimum safe criteria for each system function. These minimum safe criteria in conjunction with an inspection and evaluation scheme enable the determination of the acceptability of individual cylinders and will provide the basis for an exception case to be presented to the standards organizations. The approved exception case will provide criteria for managing cylinders that do not meet current standards. Additional controls may be needed, to obtain an exception from the standards. Standards within the current phase and subsequent phases may dictate development of actions to upgrade the cylinders to standards.

Approved exceptions to standards, in conjunction with necessary additional controls, will be obtained before cylinders are processed through system functions governed by industry standards.

5.4.1.2 Requirements and Intent

The following program requirements are established to define storage vessel criteria.

1. Define the criteria to ensure safe operations within each system function. Actions necessary to verify cylinder compliance with criteria will also be established. [10 CFR 830.120, 10 CFR 835, ORO-651, DOE 5480.23]
2. Determine applicability of various industry standards, including ANSI 14.1 and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code to system functions. [10 CFR 830.120, 10 CFR 835, 49 CFR 173.420, ORO-651, DOE 5480.23]
3. Develop and obtain exceptions as necessary to maintain adherence with industry standards. [ASME Boiler and Pressure Vessel Code]
4. Establish methods, when necessary, for processing non-compliant cylinders in a safe manner. [10 CFR 830.120, 10 CFR 835, DOE 5481.1B, DOE 5480.23]
5. Establish inspection/evaluation methods for determining the acceptability of cylinders' relative functional criteria to enable the identification of unsafe cylinders. [ORO-651, ASME Boiler and Pressure Vessel Code]
6. Perform finite element analyses of loading conditions. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]
7. Perform laboratory studies and other analyses as necessary to support definition of criteria or to facilitate cylinder monitoring/evaluations. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]

5.4.2 Identify and Monitor Degradation and Degradation Factors

MO 4, Requirement Category B: Determine cylinder conditions and monitor relative to defined criteria.

5.4.2.1 Description and Rationale

To ensure a safe configuration, the cylinder conditions must be known and monitored for adherence to specified standards. The status of other components within the system must also be monitored appropriately. This category of requirements establishes the means for determining the condition of the cylinders and for monitoring the cylinders.

The requirements for determining and monitoring cylinder and storage facility conditions are derived from the program mission and objectives, and are intended to meet contractual obligations imposed on the operating contractor and commitments made to regulatory agencies. Activities to monitor the system configuration include radiological surveys, environmental monitoring, cylinder inspections, and monitoring of necessary degradation factors. These activities relate to monitoring for confirmation that the program is maintained within its authorized safety basis.

Three primary efforts accomplish this category of requirements: determine cylinder conditions based on functional criteria, monitor cylinders as necessary for compliance to criteria, and monitor factors effecting the degradation of cylinders.

5.4.2.2 Requirements and Intent

The following program requirements ensure cylinder conditions and acceptability are known.

1. Environmental and other factors affecting cylinder integrity will 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 will determine what factors need to be monitored for proactive management and preventive measures. The rigor of this comprehensive evaluation will be based on the degree of effect on the containment integrity. [DOE 6430.1A, DOE 5480.23, DOE 5480.28]
2. As technically determined, cylinder degradation factors will be monitored to collect forecasting and trending data. [10 CFR 830.120, DOE 5480.26]
3. A cylinder's fitness-for-storage relative to the storage functional criteria will be determined, to identify cylinders unsafe for continued storage. [10 CFR 830.120]
4. Cylinders will be inspected on a risk-based periodicity to detect loss of containment. At a minimum, cylinders of suspect integrity will be inspected annually, other cylinders will be inspected once every 3 years. The specific frequency is derived from the experience with breached cylinders identified within the program and the lack of uranium detectable material lost to the environment. The 3-year period establishes a more conservative requirement than specified in the earlier program documentation but has been dictated by the Ohio EPA. [ACD]
5. Cylinders and storage facilities will be inspected periodically as determined by the program, to ensure compliance with applicable cylinder functional criteria and conformance to the authorized safety basis. The extent of this monitoring will be balanced with the potential impact on subsequent phases of the program. [10 CFR 830.120, 10 CFR 835, ORO-651, DOE 5700.6C]
6. Cylinders will be properly spaced, to facilitate inspection. [10 CFR 835, 10 CFR 830.120, ORO-651]

5.4.3 Categorize and Identify Trends in Integrity

MO 4, Requirement Category C: Forecast cylinder conditions to establish preventive measures and accomplishment of the expected duration of the storage program.

5.4.3.1 Description and Rationale

The system includes about 50,000 cylinders in various physical conditions. This category of requirements ensures information generated by the program is consolidated and used to effectively guide program decisions.

5.4.3.2 Requirements and Intent

1. The program will establish performance indicators in critical areas, to determine the effectiveness of activities. [DOE 5480.26, 5700.6C, 4700.1]
2. Mechanisms to consolidate information for summary level decision-making determinations will be developed. [DOE 5480.26, 5700.6C, 4700.1]
3. Specific information as determined by the program will be tracked to project the current and future conditions of the system. [DOE 5480.26, 5700.6C, 4700.1]

6. NEXT STEPS

The requirements specified herein will be used as the basis for identifying necessary program activities or changes in activities necessary to accomplish the program mission. The stated intent and rationale for the requirements have been provided in sufficient detail to ensure the utility of this SRD in comprehensive development of program activities. Activities will be developed based on a requirements analysis conducted with participation from operating personnel and subject matter experts. These activities will be identified and developed through the decision-making process to be documented in the SEMP and carried out in the EDP and PMP. The SEMP is the next document to be developed in the overall effort to apply systems engineering principles to the ongoing UF_6 Cylinder Program. Specific actions that need further development will be addressed by the EDP. Actions that are currently sufficient or can be directly implemented will be managed through a work breakdown structure as part of the PMP.

LIST OF REFERENCES

1. POEF-2086, ORNL/TM-11988, *Investigation of Breached Depleted UF_6 Cylinders*, E. J. Barber, et al, September 1991.

2. K/ETO-155, ORNL/TM-12840, *Investigation of Breached Depleted UF_6 Cylinders at the K-25 Site*, E. J. Barber, October 1994.

3. K/ETO-114, *UF_6 Long-Term Storage Cylinder Integrity Management Plan*, M. S. Taylor, et al, September 1992.

4. ES/ESH-66, *Safety Management Programs Supporting Nuclear and Hazardous Facilities*, W. R. Williams, August 1995.

5. Letter to L. P. Duffy from P. G. Sewell, *Plans for Ultimate Disposition of Depleted Uranium,* dated February 20, 1992.

APPENDIX A

Regulatory and Guidance Source Documents

Comprising the LMES ES&H Basis

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
INPO 85-001	Performance Objectives and Criteria for Operating and Near Term Operating License Plans
INPO 85-015	Performance Objectives and Criteria for Construction Project Evaluations
INPO 87-030	Performance Objectives and Criteria for Corporate Evaluations
INPO 90-009	Guidelines for the Conduct of Design Engineering
NFPA 10	Portable Fire Extinguishers
NFPA 11	Low Expansion Foam and Combined Agent Systems
NFPA 11A	Medium- and High-Expansion Foam Systems
NFPA 11C	Mobile Foam Apparatus
NFPA 12	Carbon Dioxide Extinguishing Systems
NFPA 13	Installation of Sprinkler Systems
NFPA 14	Installation of Standpipe and Hose Systems
NFPA 15	Water Spray Fixed Systems for Fire Protection
NFPA 16	Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 18	Wetting Agents
NFPA 20	Standard for the Installation of Centrifugal Fire Pumps
NFPA 22	Water Tanks for Private Fire Protection
NFPA 24	Installation of Private Fire Service Mains and Their Appurtenances
NFPA 25	Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 31	Installation of Oil-Burning Equipment
NFPA 33	Spray Application Using Flammable and Combustible Materials
NFPA 34	Dipping and Coating Processes Using Flammable or Combustible Liquids
NFPA 37	Installation and Use of Stationary Combustion Engines and Gas Turbines

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
NFPA 40E	Storage of Pyroxylin Plastic
NFPA 43A	Storage of Liquid and Solid Oxidizers
NFPA 43B	Organic Peroxide Formulations, Storage of
NFPA 43C	Storage of Gaseous Oxidizing Materials
NFPA 43D	Storage of Pesticides in Portable Containers
NFPA 45	Fire Protection for Laboratories Using Chemicals
NFPA 50	Bulk Oxygen Systems at Consumer Sites
NFPA 50B	Liquefied Hydrogen Systems at Consumer Sites
NFPA 51	Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes
NFPA 51B	Fire Prevention in Use of Cutting and Welding Processes
NFPA 52	Compressed Natural Gas (CNG) Vehicular Fuel Systems
NFPA 54	National Fuel Gas Code
NFPA 55	Compressed and Liquefied Gases in Portable Cylinders
NFPA 58	Storage and Handling of Liquefied Petroleum Gases
NFPA 69	Explosion Prevention Systems
NFPA 50A	Gaseous Hydrogen Systems at Consumer Sites
NFPA 70	National Electrical Code
NFPA 70E	Electrical Safety Requirements for Employee Workplaces
NFPA 72	Installation, Maintenance and Use of Protective Signaling Systems
NFPA 75	Protection of Electronic Computer/Data Processing Equipment
NFPA 79	Industrial Machinery
NFPA 80	Fire Doors and Windows
NFPA 82	Incinerators, Waste and Linen Handling Systems and Equipment
NFPA 86	Ovens and Furnaces
NFPA 86C	Industrial Furnaces Using a Special Processing Atmosphere

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
NFPA 86D	Industrial Furnaces Using Vacuum as an Atmosphere
NFPA 88B	Repair Garages
NFPA 90A	Installation of Air Conditioning and Ventilating Systems Systems
NFPA 90B	Warm Air Heating and Air Conditioning Systems
NFPA 91	Exhaust Systems for Air Conveying of Materials
NFPA 96	Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment
NFPA 101	Code for Safety to Life from Fire in Buildings and Structures
NFPA 102	Assembly Seating, Tents, and Membrane Structures
NFPA 110	Emergency and Standby Power Systems
NFPA 111	Stored Electrical Energy Emergency and Standby Power Systems
NFPA 211	Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances
NFPA 214	Water Cooling Towers
NFPA 220	Types of Building Construction
NFPA 231	General Storage
NFPA 231C	Rack Storage of Materials
NFPA 232	Protection of Records
NFPA 241	Safeguarding Construction, Alteration, and Demolition Operations
NFPA 295	Wildfire Control
NFPA 306	Control of Gas Hazards on Vessels
NFPA 318	Protection of Cleanrooms
NFPA 321	Basic Classification of Flammable and Combustible Liquids
NFPA 327	Cleaning or Safeguarding Small Tanks and Containers
NFPA 385	Tank Vehicles for Flammable and Combustible Liquids
NFPA 386	Portable Shipping Tanks for Flammable and Combustible Liquids
NFPA 472	Professional Competence of Responders to Hazardous Materials Incidents

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
NFPA 473	Competencies for EMS Personnel Responding to Hazardous Materials Incidents
NFPA 480	Storage, Handling and Processing of Magnesium
NFPA 481	Production, Processing, Handling and Storage of Titanium
NFPA 482	Production, Processing, Handling and Storage of Zirconium
NFPA 490	Storage of Ammonium Nitrate
NFPA 495	Explosive Materials Code
NFPA 496	Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations
NFPA 505	Powered Industrial Trucks
NFPA 512	Truck Fire Protection
NFPA 600	Industrial Fire Brigades
NFPA 664	Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities
NFPA 703	Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials
NFPA 704	Identification of the Fire Hazards of Materials
NFPA 780	Lightning Protection Code
NFPA 1002	Fire Department Vehicle Driver/Operator Professional Qualifications
NFPA 1021	Fire Officer Professional Qualifications
NFPA 1001	Fire Fighter Professional Qualifications
NFPA 1033	Fire Investigator Professional Qualifications
NFPA 1041	Fire Service Instructor Professional Qualifications
NFPA 1031	Professional Qualifications for Fire Inspector
NFPA 1141	Planned Building Groups
NFPA 1221	Installation, Maintenance and Use of Public Fire Service Communication Systems
NFPA 1403	Live Fire Training Evolutions in Structures
NFPA 1404	Fire Department Self-Contained Breathing Apparatus Program
NFPA 1406	Outside Live Fire Training Evolutions

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
NFPA 1410	Training Standard on Initial Fire Attack
NFPA 1470	Search and Rescue Training for Structural Collapse Incidents
NFPA 1500	Fire Department Occupational Safety and Health
NFPA 1521	Fire Department Safety Officer
NFPA 1561	Fire Department Incident Management System
NFPA 1581	Fire Department Infection Control Program
NFPA 1582	Medical Requirements for Fire Fighters
NFPA 1901	Pumper Fire Apparatus
NFPA 1902	Initial Attack Fire Apparatus
NFPA 1903	Mobile Water Supply Fire Apparatus
NFPA 1904	Aerial Ladder and Elevating Platform Fire Apparatus
NFPA 1911	Service Tests of Pumps on Fire Department Apparatus
NFPA 1914	Testing Fire Department Aerial Devices
NFPA 1921	Fire Department Portable Pumping Units
NFPA 1931	Design of and Design Verification Tests for Fire Department Ground Ladders
NFPA 1932	Use, Maintenance, and Service Testing of Fire Department Ground Ladders
NFPA 1961	Fire Hose
NFPA 1962	Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles
NFPA 1963	Screw Threads and Gaskets for Fire Hose Connections
NFPA 1964	Spray Nozzles (Shutoff and Tip)
NFPA 1971	Protective Clothing for Structural Fire Fighting
NFPA 1972	Helmets for Structural Fire Fighting
NFPA 1973	Gloves for Structural Fire Fighting
NFPA 1974	Protective Footwear for Structural Fire Fighting
NFPA 1975	Station/Work Uniforms for Fire Fighters

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
NFPA 1981	Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters
NFPA 1982	Personal Alert Safety Systems (PASS) for Fire Fighters
NFPA 1983	Fire Service Life Safety Rope, Harness, and Hardware
NFPA 1991	Vapor-Protective Suits for Hazardous Chemical Emergencies
NFPA 1992	Liquid Splash-Protective Suits for Hazardous Chemical Emergencies
NFPA 1993	Support Function Protective Garments for Hazardous Chemical Operations
NFPA 1999	Protective Clothing for Medical Emergency Operations
NFPA 2001	Clean Agent Fire Extinguishing Systems
NFPA 8501	Single Burner Boiler Operation
NFPA 8503	Pulverized Fuel Systems
NIOSH PUB 86-115	CRITERIA FOR A RECOMMENDED STD. - OCCUP. EXPOSURE TO HOT ENVIRONMENTS
NQA-1	STANDARD QUALITY REQUIREMENT EVALUATION CRITERIA & SAFETY GUIDELINES
DOE-STD-1027-92	Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports
DOE-STD-1032-92	Guide to Good Practices for Operations Organization and Administration
DOE-STD-1073-93	Guide for Operational Configuration Management Programs
DOE/EM/RM/01EM-40MPR	EM-40 MANAGEMENT POLICIES AND REQUIREMENTS
DOE/EM/RM/02EM-40MP	EM-40 MANAGEMENT PLAN
DOE/EP-0108	Standard for Fire Protection of DOE Electronic Computer/Data Processing Systems
DOE/EV-0043	Standard on Fire Protection for Portable Structures
DOE/OR 1006	REQUIREMENTS FOR THE ACCOMPLISHMENT OF CONSTRUCTION PROJECTS UTILIZING A CONSTRUCTION MANAGEMENT CONTRACTOR QUALITY
10 CFR 60	ATOMIC ENERGY ACT 1994
10 CFR 71	Nuclear Regulatory Commission
10 CFR 820	Procedural Rules for DOE Nuclear Activities
10 CFR 830.120	Nuclear Safety Management (Quality Assurance Requirements)

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
10 CFR 835	Occupational Radiation Protection
10 CFR 1021	NEPA - Implementating Procedures and Guidelines - Final Rule
10 CFR 1022	Compliancy with Floodplain/Wetlands Environmental Review Requirements
18 CFR 1312	ARCHAEOLOGICAL RESOURCES PROTECTION ACT
29 CFR	Occupational Safety and Health Standards
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.95	Occupational Noise Exposure
29 CFR 1910.119	Process Safety Management of Highly Hazardous Chemicals
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1910.141	Sanitation
29 CFR 1910.146	Permit-Required Confined Spaces
29 CFR 1910.1001	Asbestos, Tremolite, Anthophyllite, and Actiorolite
29 CFR 1910.1030	Occupational Exposure To Bloodborne Pathegens
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.1450	Occupational Exposure To Hazardous Chemicals in Laboratories
29 CFR 1926	Occupational Safety and Health for Construction Work
29 CFR Subpart C	General Safety and Health Provisions
33 CFR 153	CLEAN WATER ACT
33 CFR 154	CLEAN WATER ACT
32 CFR 229	Archaeological Resources Protection Act
33 CFR 321	THE RIVER AND HARBOR ACT
33 CFR 322	CLEAN WATER ACT
33 CFR 323	Navigation and Navigable Waters
33 CFR 328	Definition of Water Regulations
33 CFR 329	Definition of Navigable Waters Regulations

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
33 CFR 330	CLEAN WATER ACT
36 CFR	Federal Records; General
36 CFR 60	National Register of Historic Places
36 CFR 63	NATIONAL HISTORIC PRESERVATION ACT
36 CFR 65	NATIONAL HISTORIC PRESERVATION ACT
36 CFR 68	NATIONAL HISTORIC PRESERVATION ACT
36 CFR 78	NATIONAL HISTORIC PRESERVATION ACT
36 CFR 296	ARCHAEOLOGICAL RESOURCES PROTECTION ACT
36 CFR 800	Parks, Forests, and Public Property
40 CFR 11	National Resource Damage Assessments
40 CFR 50	CLEAN AIR ACT
40 CFR 53	Ambient Air Monitoring
40 CFR 58	CLEAN AIR ACT
40 CFR 60	Clean Air Act (Standards of Performance for New Stationary Sources)
40 CFR 61	CLEAN AIR ACT
40 CFR 68	Chemical Accident Prevention
40 CFR 69	Special Exemptions
40 CFR 72	Permits Regulations
40 CFR 82	Stratospheric Ozone Protection
40 CFR 109	Oil Removal Contingency Plans
40 CFR 110	CLEAN WATER ACT
40 CFR 112	CLEAN WATER ACT
40 CFR 116	Designation of Hazardous Substances
40 CFR 122	CLEAN WATER ACT
40 CFR 130	Requirements for Water Quality Plan and Management

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
40 CFR 133	Regulation on Secondary Treatment
40 CFR 141	SAFE DRINKING WATER ACT
40 CFR 142	SAFE DRINKING WATER ACT
40 CFR 143	SAFE DRINKING WATER ACT
40 CFR 144	SAFE DRINKING WATER ACT
40 CFR 146	SAFE DRINKING WATER ACT
40 CFR 147	State Underground Injection Program
40 CFR 148	SAFE DRINKING WATER ACT
40 CFR 165	FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT
40 CFR 171	FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT
40 CFR 191	ATOMIC ENERGY ACT
40 CFR 230	CLEAN WATER ACT
40 CFR 231	Clean Water Act
40 CFR 232	Activities Exempt from Dredge and Fill Permit
40 CFR 241	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 243	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 245	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 246	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 260	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 261	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 262	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 263	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 264	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 265	RESOURCE CONSERVATION AND RECOVERY ACT
4O CFR 266	RESOURCE CONSERVATION AND RECOVERY ACT

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
40 CFR 266	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 267	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 268	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 270	RESOURCE CONSERVATION AND RECOVERY ACT
40 CFR 280	TECHNICAL STANDARDS & CORRECTING ACTION PROCEDURES FOR THE ANALYSIS OF POLLUTANTS
40 CFR 300	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, & LIABILITY ACT
40 CFR 302	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, & LIABILITY ACT
40 CFR 370	EMERGENCY PLANNING & COMMUNITY RIGHT-TO-KNOW ACT
40 CFR 372	EMERGENCY PLANNING & COMMUNITY RIGHT-TO-KNOW ACT
40 CFR 403	Clean Water Act (General Pretreatment Regulations for Existing and New Sources of Pollution)
40 CFR 761	TOXIC SUBSTANCES CONTROL ACT
40 CFR 1500	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1501	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1502	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1503	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1504	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1505	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1506	NATIONAL ENVORNMENTAL POLICY ACT
40 CFR 1507	NATIONAL ENVORNMENTAL POLICY ACT
41 CFR	Federal Information Resources Management Regulation
43 CFR 3	NATIONAL HISTORIC PRESERVATION ACT
43 CFR 7	ARCHAEOLOGICAL RESOURCES PROTECTION ACT
49 CFR	Federal Motor Carrier Safety Regulations
49 CFR 107	Hazardous Materials Regulations
49 CFR 171	HAZARDOUS MATERIALS TRANSPORTATION ACT

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
49 CFR 172	HAZARDOUS MATERIALS TRANSPORTATION ACT
49 CFR 173	HAZARDOUS MATERIALS TRANSPORTATION ACT
49 CFR 174	HAZARDOUS MATERIALS TRANSPORTATION ACT
49 CFR 177	HAZARDOUS MATERIALS TRANSPORTATION ACT
49 CFR 178	HAZARDOUS MATERIALS TRANSPORTATION ACT
49 CFR 180	HAZARDOUS MATERIALS TRANSPORTATION ACT
50 CFR 17	ENDANGERED SPECIES ACT
50 CFR 222	ENDANGERED SPECIES ACT
50 CFR 225	ENDANGERED SPECIES ACT
50 CFR 226	ENDANGERED SPECIES ACT
50 CFR 227	ENDANGERED SPECIES ACT
401 KAR 30	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 31	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 32	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 33	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 34	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 35	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 36	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 37	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 38	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 39	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 40	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 42	KENTUCKY UNDERGROUND STORAGE TANK ACT
401 KAR 47 & 48	KENTUCKY WASTE MANAGEMENT ACT
401 KAR 49	KENTUCKY WASTE MANAGEMENT ACT

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
401 KAR 5.010	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.005	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.015	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.026	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.029	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.031	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.045	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.050	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.055	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.060	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.065	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.070	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.075	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.080	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 5.090	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.020	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.030	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.040	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.050	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.060	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.070	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.100	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.150	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.200	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.250	KENTUCKY WATER POLLUTION CONTROL ACT

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
401 KAR 8.300	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.350	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.400	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.420	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.440	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.500	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.550	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 8.560	KENTUCKY WATER POLLUTION CONTROL ACT
401 KAR 50	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 51	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 53	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 55	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 57	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 59	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 61	KENTUCKY AIR POLLUTION CONTROL ACT
401 KAR 63	KENTUCKY AIR POLLUTION CONTROL ACT
5 USC	Freedom of Information Act
44 USC	Disposal of Records
CHAPTER 1200-1-7.01	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-7.02	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-7.03	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-7.04	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-7.07	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.01	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.02	TENNESSEE SOLID WASTE DISPOSAL ACT

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
CHAPTER 1200-1-11.03	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.04	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.05	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.06	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.07	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.08	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.09	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-11.10	TENNESSEE SOLID WASTE DISPOSAL ACT
CHAPTER 1200-1-13.01	TENNESSEE HAZARDOUS WASTE MANAGEMENT ACT
CHAPTER 1200-1-13.02	TENNESSEE HAZARDOUS WASTE MANAGEMENT ACT
CHAPTER 1200-1-13.04	TENNESSEE HAZARDOUS WASTE MANAGEMENT ACT
CHAPTER 1200-1-15.01	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.02	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.03	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.04	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.05	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.06	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.07	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.08	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.09	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.10	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-1-15.11	TENNESSEE PETROLEUM UNDERGROUND STORAGE TANK ACT
CHAPTER 1200-3-3	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-4	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-5	TENNESSEE AIR QUALITY ACT

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
CHAPTER 1200-3-7	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-8	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-9	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-10	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-11	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-12	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-14	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-15	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-16	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-18	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-20	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-24	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-3-26	TENNESSEE AIR QUALITY ACT
CHAPTER 1200-4-2	TENNESSEE WATER QUALITY CONTROL ACT
CHAPTER 1200-4-3	TENNESSEE WATER QUALITY CONTROL ACT
CHAPTER 1200-4-5	TENNESSEE WATER QUALITY CONTROL ACT
CHAPTER 1200-4-6	TENNESSEE WATER QUALITY CONTROL ACT
CHAPTER 1200-4-10	TENNESSEE WATER QUALITY CONTROL ACT
CHAPTER 1200-5-1	TENNESSEE DRINKING WATER ACT
EO 11990	Protection of Wetlands
EO 12088	Federal Compliance with Pollution Standards
EO 12777	Implementation of Section 311 of Clean Water Act
EO 12843	Procurement of Ozone Depleting Substance
EO 12856	Federal Compliance with Right-to-Know and Pollution Prevention Requirements
EO 12873	Federal Requisition, Recycling and Waste Prevention

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
EO 12898	Environmental Justice
EO 12915	Federal Implementation of the North American Agreement on Environmental Cooperation
EO 11514	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EO 11593	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EO 11988	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EXEC ORDER 11990	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EXEC ORDER 12088	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EO 12580	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EXEC ORDER 12777	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EO 12780	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EXEC ORDER 12843	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
EXEC ORDER 12856	FEDERAL AGENCY RECYCLING AND THE COUNCIL ON FEDERAL RECYCLING & PROCUREMENT & POLICY
Fed. Facility Agmt.	Federal Facility Agreement
FFCA/TCLP	Federal Facility Compliance Agreement/Toxicity Procedure Addressing Waste Characterization
OAC 1301:7-9	OHIO UNDERGROUND STORAGE TANK LAW
OAC 1501:15	OHIO WATER POLLUTION CONTROL ACT
OAC 3745-1	OHIO WATER POLLUTION CONTROL ACT
OAC 3745-3	OHIO WATER POLLUTION CONTROL ACT
OAC 3745-15	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-16	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-17	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-18	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-19	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-21	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-23	OHIO AIR POLLUTION CONTROL ACT

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
OAC 3745-25	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-27	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745:28-37	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-29	OHIO SOLID AND HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-30	OHIO SOLID AND HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-33	OHIO WATER POLLUTION CONTROL ACT
OAC 3745-34	OHIO SAFE DRINKING WATER ACT
OAC 3745-35	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-36	OHIO SOLID AND HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-45	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-49	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-50	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-51	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-52	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-53	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-54	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-55	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-56	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-57	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-58	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-59	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-65	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-66	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-67	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-68	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
OAC 3745-69	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3745-71	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-75	OHIO AIR POLLUTION CONTROL ACT
OAC 3745-81	OHIO SAFE DRINKING WATER ACT
OAC 3745-100	OHIO SOLID & HAZARDOUS WASTE DISPOSAL LAW
OAC 3750-1	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
OAC 3750-10	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
OAC 3750-15	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
OAC 3750-20	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
OAC 3750-25	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
OAC 3750-50	OHIO EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
Ohio AIP	State of Ohio Agreement in Principle
Ohio Regulation	Basic State Requirements Ohio Rules of Evidence
OR FFCA	Oak Ridge Facility Compliance Agreement
PGDP Admin. Order	Administrative Order by Consent for Paducah Gaseous Diffusion Plant
PGDP AIP	Agreement in Principle for Paducah Gaseous Diffusion Plant
PL101-508	POLLUTION PREVENTION ACT OF 1990
PL102-386	FEDERAL FACILITY COMPLIANCE ACT
PORTS Consent Decree	Portsmouth Consent Decree
PORTS Consent Order	Portsmouth Consent Order
Tenn Code	Basic State Requirements Tennessee Code Annotated
TITLE 68-211	TENNESSEE SANITARY LANDFILL AREAS ACT
TITLE 68-213	TENNESSEE SANITARY LANDFILL AREAS ACT
TN Oversight Agmt.	Tennessee Oversight Agreement (TOA)
TSCA FFCA	TSCA Federal Facilities Compliance Agreement for PCB Issues of Uranium Enrichment Facilities

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
U. S. DOE Memo	Management of Cultural Resources at DOE Facilities
1300.2A	DOE Technical Standards Program
1360.2B	Unclassified Computer Security Program
1540.2	Hazardous Material Packaging for Transport - Administrative Procedures
4330.4A	Maintenance Management Program
4330.4B	Maintenance Management Program
4700.1	Project Management System
5000.3B	Occurrence Reporting and Processing of Operations Information
5400.1	General Environmental Protection Program
5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements
5400.5	Radiation Protection of the Public and the Environment
5480.3	Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes
5480.4	Environmental Protection, Safety, and Health Protection Standards
5480.5	Safety of Nuclear Facilities
5480.6	Safety of DOE Owned Reactors
5480.7A	Fire Protection
5480.8A	Contractor Occupational Medical Program
5480.9	Construction Safety and Health Program
5480.10	Contractor Industrial Hygiene Program
5480.11	Radiation Protection for Occupational Workers
5480.13	Aviation Safety
5480.15	Department of Energy Laboratory Accreditation Program for Personnel Dosimetry
5480.16	Firearms Safety
5480.17	Site Safety Representatives
5480.18A	Accreditation of Performance-Based Training for Category A Reactors and Nuclear Facilities

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.20	PERSONNEL SELECTION, QUALIFICATION, TRAINING, AND STAFFING REQUIREMENTS AT DOE REACTOR AND NON-REACTOR NUCLEAR FACILITIES
5480.21	UNREVIEWED SAFETY QUESTIONS
5480.22	TECHNICAL SAFETY REQUIREMENTS
5480.23	NUCLEAR SAFETY ANALYSIS REPORTS
5480.24	NUCLEAR CRITICALITY SAFETY
5480.25	SAFETY OF ACCELERATOR FACILITIES
5480.26	TRENDING AND ANALYSIS OF OPERATIONS INFORMATION USING PERFORMANCE INDICATORS
5480.28	NATURAL PHENOMENA HAZARDS MITIGATION
5480.29	Employee Concerns Management System
5480.30	General Design Criteria for Nuclear Reactors
5481.1B	Safety Analysis and Review System
5482.1B	Environment, Safety, and Health Appraisal Program
5483.1A	Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5500.1B	Emergency Management
5500.2B	EMERGENCY CATEGORIES, CLASSES, AND NOTIFICATION AND REPORTING REQUIREMENTS
5500.3A	Planning and Preparedness for Operational Emergencies
5500.4A	PUBLIC AFFAIRS POLICY AND PLANNING REQUIREMENTS FOR EMERGENCIES
5500.7B	Emergency Operating Records Protection Program
5500.10	EMERGENCY READINESS ASSURANCE PROGRAM
5632.11	Physical Protection of Unclassified, Irradiated Reactor Fuel In Transit
5633.3A	Control and Accountability of Nuclear Material
5633.4	Nuclear Transactions: Documentation and Reporting

Regulatory & Guidance Source Documents
Comprising the LMES ES & H Basis

Document Number	Document Title
5633.5	Nuclear Materials Reporting and Data Submission Procedures
5634.1B	Facility Approval, Security Surveys, and Nuclear Materials Surveys
5700.6C	QUALITY ASSURANCE
5820.2A	Radioactive Waste Management
6430.1A	General Design Criteria
N5480.5	IMPOSITION OF PROPOSED NUCLEAR SAFETY REQUIREMENTS
N5480.6	USDOE Radiological Control Manual
DE-AC05-84OR21400	Energy Systems/DOE Contract
Pres. Memo	Presidents Memorandum on Environment, Quality and Water Resource
AL 5610.01	PACKAGING & TRANS. OF NUCLEAR EXPLOSIVES, NUCLEAR COMPONENTS, & SPECIAL ASSEMBLIES
1240.2B	UNCLASSIFIED VISITS AND ASSIGNMENTS BY FOREIGN NATIONALS
1324.2A	Records Disposition
1324.4A	Micrographics Management
1324.5A	Records Management Program
1324.6	AUTOMATED OFFICE ELECTRONIC RECORDKEEPING
1324.8	RIGHTS AND INTERESTS RECORDS PROTECTION PROGRAM
1450.4	Consensual Listening-In To or Recording Telephone/Radio Conversations
1540.1A	Material Transportation and Traffic Management
1540.4	Physical Protection of Unclassified, Irradiated Reactor Fuel In Transit
1700.1	Freedom of Information
4010.1A	Value Engineering
5300.2D	Telecommunications: Emission Security (TEMPEST)
5300.4C	Telecommunications: Protected Distribution System
5480.31	Startup and Restart of Nuclear Facilities
5530.1A	Response to Accidents and Significant Incidents Involving Nuclear Weapons

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
5530.2	NUCLEAR EMERGENCY SEARCH TEAM
5530.3	RADIOLOGICAL ASSISTANCE PROGRAM
5610.1	Packaging and Transportation of Nuclear Explosives, Nuclear Components, and Special Assemblies
5610.10	NUCLEAR EXPLOSIVE AND WEAPON SAFETY PROGRAM
5610.11	NUCLEAR EXPLOSIVE SAFETY
5631.4A	Control of Classified Visits
5630.11A	Safeguards and Security Program
5630.12A	Safeguards and Security Inspection and Assessment Program
5630.14A	Safeguards and Security Program Planning
5630.15	SAFEGUARDS AND SECURITY TRAINING PROGRAM
5630.16A	Safeguards and Security Acceptance and Validation Test Program
5630.17	SAFEGUARDS AND SECURITY (S&S) STANDARDIZATION PROGRAM
5631.1B	SECURITY EDUCATION BRIEFING AND AWARENESS PROGRAM
5631.2C	PERSONNEL SECURITY
5631.6A	PERSONNEL SECURITY ASSURANCE PROGRAM
5631.2B	Personnel Security Program
5632.1B	Protection Program Operations
5632.2A	Physical Protection of Special Nuclear Material and Vital Equipment
5632.5	Physical Protection of Classified Matter
5632.6	Physical Protection of DOE Property and Unclassified Facilities
5632.7	Protective Forces
5632.8	Protection Program Operations - Systems Performance Tests
5632.9A	ISSUANCE AND CONTROL OF SECURITY BADGES, CREDENTIALS, AND SHIELDS
5634.3	Foreign Ownership, Control, or Influence Program
5635.1A	Control of Classified Documents and Information

Regulatory & Guidance Source Documents Comprising the LMES ES & H Basis

Document Number	Document Title
5635.3	Hand-Carrying Classified Matter on Air Carriers
5635.4	Protection of Unclassified Controlled Nuclear Information
5636.1A	PROHIBITION ON WIRETAPPING AND EAVESDROPPING
5639.1	INFORMATION SECURITY PROGRAM
5639.3	VIOLATION OF LAWS, LOSSES, AND INCIDENTS OF SECURITY CONCERNS
5639.5	TECHNICAL SURVEILLANCE COUNTERMEASURES PROGRAM
5639.6	Classified Computer Security Program
5639.7	OPERATIONS SECURITY PROGRAM
5650.2B	IDENTIFICATION OF CLASSIFIED INFORMATION
5650.3A	IDENTIFICATION OF UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION
N4700.5	Project Management System
N5630.3A	Protection of Department Facilities Against Radiological and Toxicology Sabotage
ORIG 1321.1B	OAK RIDGE DIRECTIVES SYSTEM, OR DIRECTIVES MANUAL
ORIG N 1300.X1	OAK RIDGE OPERATIONS STANDARDS/REQUIREMENTS PROGRAM
SEN-22-90	DOE POLICY ON SIGNATURES OF RCRA PERMIT APPLICATIONS
SEN-29-91	PERFORMANCE INDICATORS AND TRENDING PROGRAM FOR DOE OPERATIONS
SEN-35-91	NUCLEAR SAFETY POLICY
SEN-37-92	WASTE MINIMIZATION CROSSCUT PLAN IMPLEMENTATION