Department of Energy
Washington, DC 20585

March 9, 2007

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004-2901

Dear Mr. Chairman:

The Department of Energy's (DOE) Implementation Plan (IP) for Recommendation 2005-1, *Nuclear Material Packing,* commits the Department to developing requirements for nuclear material packaging for the safe storage of nuclear materials outside of engineered contamination barriers. The Office of Health, Safety and Security (HSS), with the support of a complex-wide working group, has developed these packaging requirements and included them in a draft *Nuclear Material Packaging Manual.* This draft Manual has been submitted to the Department's Office of Management for distribution through the Directives System for complex-wide review and comment. The draft Manual will be available for a 60-day comment period.

In addition, as committed to in the IP, on March 9, 2007, HSS issued a request for the Office of Environmental Management, the Office of Nuclear Energy, the Office of Science and the National Nuclear Security Administration to provide, within 120 days, a schedule and funding plan for implementing the Manual requirements at their sites with defense nuclear facilities (enclosed). Included with the request were the draft Manual and a risk ranking methodology for the sites' use in evaluating their repackaging needs and priorities. These two documents resolve the open items identified in our July 27, 2006, letter to you on this subject. HSS will establish a complex-wide schedule based upon the site-specific schedules received and provide that schedule to the Board as committed to in the IP.

Please contact me at (301) 903-3777 or Dr. James O'Brien, of my staff, at (301) 903-1408 if you have questions or comments.

Sincerely,

Glenn S. Podonsky
Chief Health, Safety and Security Officer
Office of Health, Safety and Security

Enclosure

Department of Energy
Washington, DC 20585

March 9, 2007

MEMORANDUM FOR DENNIS R. SPURGEON
ACTING UNDER SECRETARY OF ENERGY

RAYMOND L. ORBACH
UNDER SECRETARY FOR SCIENCE

THOMAS P. D'AGOSTINO
ACTING ADMINISTRATOR OF THE NATIONAL
NUCLEAR SECURITY ADMINISTRATION

FROM: GLENN S. PODONSKY
CHIEF HEALTH, SAFETY AND SECURITY OFFICER
OFFICE OF HEALTH, SAFETY AND SECURITY

SUBJECT: Defense Nuclear Facilities Safety Board Recommendation 2005-1

On August 17, 2005, Secretary Bodman approved the Department of Energy's (DOE) Implementation Plan (IP) to address the safety issues raised by the Defense Nuclear Facilities Safety Board (DNFSB) in Recommendation 2005-1, *Nuclear Material Packaging* (attachment 1). The IP committed the Department to developing requirements for packaging of nuclear materials for safe storage outside of engineered contamination barriers. The Office of Health, Safety and Security (HSS), with the support of a complex-wide working group and a separate technical review board, has developed these packaging requirements and included them in a draft M441.1-1, *Nuclear Material Packaging Manual,* which has been submitted to the Office of Management for distribution through the Directives System (RevCom) for complex-wide review as committed to in the IP.

Pursuant to the commitments made in the IP, we are asking you to direct the appropriate sites under your purview (see attachment 2) to take the following actions:

- Evaluate stored nuclear materials to establish the actions necessary for implementing the DOE manual.
- Prepare site implementation plans to identify which packaging must be replaced or qualified.
- Include a prioritization assessment in these plans to determine an appropriate order in which to repackage materials.
- Develop a schedule and funding plan to meet identified repackaging needs.

Please submit this site-specific information to HSS within 120 days of the issuance of this memorandum. HSS will consolidate this information into a complex-wide schedule to be submitted to the DNFSB as committed to in the IP. The attached risk ranking methodology (attachment 3) should be utilized by your sites to support the development of their schedules. Additional details on the expectations for the site implementation plans from the IP are attached (attachment 4).

Based on these submittals, HSS has committed to develop a complex-wide repackaging schedule within 180 days of the issuance of this memorandum. In developing the IP, the Department recognized that these schedules and plans would be established based upon a draft Manual that would be undergoing review and comment; however, DOE committed to this approach to expedite planning for implementing the Manual once it is finalized. Through extensive input from the complex-wide working group and technical review board, HSS believes that the Manual review and comment process and schedule development can be undertaken at the same time.

Please provide your sites' schedules and funding plans for implementing the new Manual requirements to Dr. James O'Brien, Acting Director, Office of Nuclear Safety and Environmental Assistance, at James.O'Brien@hq.doe.gov. Dr. O'Brien can also be reached at 301-903-1408.

Attachments

cc: James A. Rispoli, Assistant Secretary for Environmental Management, EM-1
Richard H. Lagdon, Jr., Chief of Nuclear Safety, US
James J. McConnell, Chief of Defense Nuclear Safety, NA-1
M. Patrice Wagner, Manager, Sandia Site Office
Daniel E. Glenn, Acting Manager, Los Alamos Site Office
Steve Erhart, Acting Manager, Pantex Site Office
Theodore D. Sherry, Manager, NNSA Y-12 Site Office
Jeffery M. Allison, Manager, Savannah River Operations Office
Elizabeth D. Sellers, Manager, Idaho Operations Office
Richard B. Provencher, Asst Mgr, Environmental Mgt – Idaho Cleanup Project
Camille Yuan-Soo Hoo, Manager, Livermore Site Office
Keith A. Klein, Manager, Richland Operations Office
Shirley J. Olinger, Acting Manager, Office of River Protection
Gerald L.Talbot, Jr., Manager, Nevada Site Office
Gerald G. Boyd, Manager, Oak Ridge Office

The Secretary of Energy
Washington, DC 20585

August 17, 2005

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, D.C. 20004 - 2901

Dear Mr. Chairman:

We are pleased to forward the enclosed Implementation Plan (Plan) for the Defense Nuclear Facilities Safety Board's (Board) Recommendation 2005-1, *Nuclear Material Packaging.* This Plan provides the Department's approach to ensure safe storage and handling of nuclear material at our sites.

We appreciate the support provided by the Board and its staff during the development of this Plan. We will keep you informed of our progress in completing the Plan.
I have assigned Mr. Richard M. Stark as the responsible manager for ensuring the Plan's successful completion. You may contact Mr. Stark at (301) 903-4407 to answer any questions that might arise regarding details of the Plan.

Sincerely,

Samuel W. Bodman

Enclosure

cc:
M. Whitaker, DR-1
J. Shaw, EH-1

U. S. Department of Energy

Implementation Plan
To Improve Nuclear Material Packaging

(In response to Defense Nuclear Facilities Safety Board Recommendation 2005-1)

Washington, D.C. 20585

August 2005

Executive Summary

On March 10, 2005, the Defense Nuclear Facilities Safety Board (Board), unanimously approved Recommendation 2005-1, *Nuclear Material Packaging*. This recommendation addresses issuance of a requirement that nuclear material packaging meet technically justified criteria for safe storage and handling outside of engineered contamination barriers.

This Implementation Plan (IP) describes how DOE will:

- Specify the nuclear materials to which new requirements will apply. This includes conducting a survey of the sites currently storing nuclear materials.

- Develop the technical criteria and requirements that must be satisfied to ensure safe storage and handling of these materials, including the requirements for surveillance of packaged materials when appropriate.

- Develop a prioritization methodology for implementing the above criteria and requirements based on the hazards and risks posed by the existing packaging configurations and conditions.

On May 6, 2005, the Secretary accepted Recommendation 2005-1, *Nuclear Material Packaging*. The Assistant Secretary for Environment, Safety and Health, Mr. John Spitaleri Shaw (EH-1), is cognizant Secretarial officer. Mr. Richard M. Stark is the responsible manager.

Table of Contents

1.0 BACKGROUND

On March 10, 2005, the Defense Nuclear Facilities Safety Board (DNFSB, or Board) issued a recommendation to the Secretary of Energy identifying issues for the Department of Energy (DOE, or Department) concerning interim packaging and storage of nuclear materials. The DNFSB recommendation acknowledged that the Department has made progress in the stabilization and storage of its excess nuclear materials. However, the DNFSB states that storage requirements for other categories of nuclear materials are not as well defined and controlled. Specifically, there is no explicit Department-wide interim storage requirement to ensure the safe packaging of nuclear materials.

The DNFSB recommendation cites two Department recent events pointing out the need for formal Department action. One event resulted in workers receiving significant inhalation doses during routine inspection activities requiring a Type B Accident Investigation. The other event involved the accidental drop of a package containing salt-bearing plutonium oxide.

Past experience in nuclear material handling and storage at Department facilities has demonstrated the risk to nuclear material handlers due to package breaching.

Nuclear material packaging provides the primary containment boundary to protect facility workers during storage and handling activities. The Board believes the development of technically justified criteria for packaging systems for nuclear materials is necessary on a Department-wide level. Therefore, the Board recommended that the Department:

1. Issue a requirement that nuclear material packaging meet technically justified criteria for safe storage and handling. Packaging should, in general, provide a robust barrier between facility workers and the stored nuclear materials once they are removed from an approved engineered contamination barrier. It may be appropriate to include this requirement in an updated nuclear materials management Order.

2. Identify which nuclear materials should be included in the scope of the above requirement and then determine the technically justified packaging criteria needed to ensure the safe storage and handling of those materials. The scope need not include waste materials, fully encapsulated forms, or de minimis quantities such as analytical laboratory samples. The criteria should account for the nuclear material form and properties, expected future use, and duration of storage. It may be appropriate for this information to be included in a packaging Manual.

   The ISSC[1] may provide the beginning of a sound technical foundation for developing such criteria. Although some modifications may be necessary to make

[1] Interim Safe Storage Criteria were the subject of Deputy Secretary Curtis memorandum of January 25, 1996 titled "Criteria for Interim Safe Storage of Plutonium – Bearing Solid Materials"

the ISSC more applicable to short-term storage, the Board believes the basic ISSC principles – for example, the requirement for a minimum of two contamination boundaries for high-hazard materials such a plutonium, assurance that leak-tightness is maintained for materials requiring a sealed environment, ability of the containers to withstand maximum expected internal pressures, and protection against common insults such as drops – should be maintained. The criteria should also include provisions for surveillance programs to verify that the container and any limited-life components are performing in a manner consistent with the duration of storage.

3. Prioritize implementation of the improved nuclear material packaging requirement consistent with the hazards of the different material types and the risk posed by the existing package configurations and conditions.

2.0 UNDERLYING CAUSES

The end of the Cold War, and downsizing of the nuclear weapons production complex, changed the dynamics of nuclear materials management. Certain materials that once were considered valuable assets soon became liabilities. With little need to process those materials for recovery, processing capabilities have been lost, or have not been fully funded. As a result, some of these materials have been in storage for years, or even decades.

Because of the variability of nuclear materials inventories, processes, and equipment among sites, interim packaging has been determined by the individual site. Some sites have adopted site-specific best practices based on complex-wide experience, while other sites have adopted storage containers that meet some, or all, of the performance-based functional requirements of the Interim Safe Storage Criteria.

The long times and the various environments experienced in storage combined with material characteristics have led some packages to deteriorate from the effects of corrosion, radiation, pressure buildups and handling. The packages that are used for storage were not expected to continue to function for decades. Handling necessitated by Materials Control and Accountability (MC&A) surveillance requirements and deteriorating packages over long periods have increased the risk to workers.

3.0 BASELINE ASSUMPTIONS

The Department has developed implementation plans and taken actions to improve the storage of nuclear materials in response to previous DNFSB Recommendations 94-1, 97-1 and 2000-1. In general, the materials addressed in those implementation plans will not be addressed in this implementation plan.

The Department makes the following baseline assumptions regarding successful fulfillment of the 2005-1 Implementation Plan.

- Initial funding will be accommodated from existing budgets. The Department will vigorously pursue necessary funding for steady-state activities.

- This plan describes Department actions for nuclear facilities. For the purposes of interacting with the Board on this implementation plan, however, the deliverables are limited to those facilities within the Board's scope (i.e., defense nuclear facilities). The Department will consider the level of risk involved in prioritizing implementation.

- This plan deals with materials that are stored outside of an approved engineered contamination confinement barrier, such as a glovebox or packages meeting DOE-STD-3013 and/or DOE-STD-3028.

- This plan deals with solid and liquid nuclear materials in interim storage. Interim storage will be defined as a part of the requirements document to be issued in accordance with Section 5 of this IP.

- In the context of this plan, the criteria developed for packaging nuclear materials will be applicable only to onsite storage of nuclear materials. These packaging criteria are not intended to be applied to offsite transportation of nuclear materials, nor are they intended to conflict with or supersede accepted packaging criteria established in other applicable Department directives such as DOE-STD-3013-2004.

- In the context of this plan, the requirements for nuclear materials storage are limited to ensuring the storage container is compatible with the range of anticipated storage environments.

- Ongoing repackaging activities will continue at DOE sites. All sites will conform to the 2005-1 packaging requirements when the 2005-1 requirements are approved.

4.0 SUMMARY OF COMPLETED AND NEAR-TERM ACTIONS

The Department has established a dedicated team representing all Department organizations with nuclear materials to develop this implementation plan addressing nuclear material packaging and interim storage.

To date the team has met weekly to gather data, discuss the issues and to develop the implementation plan. On April 25, 2005 EH-1 formally requested that each Department line, field and site organization designate a point of contact and to develop a list of nuclear materials that exist at each site. The team will review the survey data and determine the remaining items to be surveyed. The team expects that the final survey request will be issued in September 2005.

The team will reconcile and integrate all existing DOE directives and guidance as a part of the new requirements development activity. 10 CFR 835, DOE Orders 420 and 5660.1B and associated guidance will be included in this activity.

In October and November the team will concurrently be (1) receiving survey data (2) finalizing the risk prioritization methodology (3) determining the document(s) needed to institutionalize the new packaging and storage criteria and the associated guidance being developed and (4) developing the technical requirements. The risk prioritization methodology will be issued in March 2006.

DOE will develop a risk-based methodology for prioritizing packaged nuclear materials so that the highest risk packages are addressed and repackaged or qualified preferentially. The methodology will likely include input parameters such as airborne release fractions, respirable fractions, reactivity factors, container type, the date that the materials were packaged, and package integrity considerations. The application of this methodology will allow DOE to focus resources on the highest risk materials and packages and will accelerate the reduction in risk to nuclear material handlers.

The initial draft of the new packaging and storage criteria, including specifically the nuclear material to which it will apply will be available in March 2006 after DOE completes a review by a technical review board. The team will brief the DNFSB in March and will solicit the DNFSB comments on the draft. The new nuclear materials packaging and storage criteria document will be issued using the Departments Directive Systems in June 2006, after which the affected sites will be required to develop their implementation plans.

Some Department sites have developed repackaging plans for stored nuclear materials that may ultimately meet all or part of the new packaging and storage criteria being developed in response to this implementation plan. These site actions will continue, consistent with the sites risk reduction programs until the new packaging and storage criteria are issued, and the sites have issued their respective implementation plans for complying with the new criteria. However, once the Department requirement document(s) is institutionalized all sites will adhere to the new 2005-1 requirement(s).

5.0 SAFETY ISSUE RESOLUTION

To fully address the concerns of the DNFSB, the Department will evaluate current nuclear materials and packaging configurations and their potential safety risk at the designated Department sites and then will complete the following activities.

- Specify the nuclear materials to which new criteria will apply. This effort will include conducting a survey of the sites currently storing nuclear materials.

- Specify threshold quantity levels for nuclear materials to which criteria will apply.

- Develop the technical criteria that must be satisfied to ensure safe storage and handling of these materials, including the requirements for surveillance of packaged materials commensurate with the safety risk. The requirements will be technically reviewed by a technical review board.

- Develop a prioritization methodology for implementing the above criteria based on the hazards and risks posed by the existing nuclear material. This methodology will be technically reviewed by a technical review board.

- Develop site specific implementation plans to address the new requirements. (The DOE 2005-1 responsible manager will then prepare and publish a DOE wide summary of the integrated site plans for all DNFSB reporting sites.)

- Implement the site plans.

- Institutionalize nuclear material packaging and by issuing a formal document that integrates existing requirements and incorporates new requirements in accordance with the Department Directives System. Note: No approved Directives for packaging are affected by this plan.

This section is organized around the following three main areas:

1. Improved Nuclear Material Packaging Requirements
2. Identifying Affected Nuclear Materials
3. Implementing Improved Nuclear Material Packaging Requirements

Within each of the above main areas, supporting discussion addresses specific issues, bases for the issues, resolution approaches, and commitments/deliverables/milestones to resolve the issues.

5.1 Issuing Improved Nuclear Material Packaging Requirements

Issue Description

Department-wide criteria need to be established for nuclear materials packaging and storage in order to provide adequate protection. The criteria that will be established in response to this implementation plan will provide a uniform, Department-wide set of criteria for developing adequate technical basis for packaging and storage of nuclear materials.

Board Recommendation

Issue a requirement that nuclear material packaging meet technically justified criteria for safe storage and handling. Packaging should, in general, provide a robust barrier between facility workers and the stored nuclear materials once they are removed from an approved engineered contamination barrier. It may be appropriate to include this requirement in an updated nuclear materials management Order.

The ISSC may provide the beginning of a sound technical foundation for developing such criteria. Although some modifications may be necessary to make the ISSC more applicable to short-term storage, the Board believes the basic ISSC principles? for example, the requirement for a minimum of two contamination boundaries for high-hazard materials such as plutonium, assurance that leak-tightness is maintained for materials requiring a sealed environment, ability of the containers to withstand maximum expected internal pressures, and protection against common insults such as drops? should be maintained. The criteria should also include provisions for surveillance programs to verify that the container and any limited-life components are performing in a manner consistent with the duration of storage.

Resolution Approach

The Department will use the results of the 2005-1 material survey and the information gained from its actions taken in response to Board Recommendations 94-1, 97-1 and 2000-1 to develop a robust set of packaging and storage criteria that address the material types, forms, and hazards for materials in interim storage at Department sites.

Isotopic threshold levels will be used to determine applicability of the new criteria. Specific exclusions, such as sealed sources, laboratory samples, spent nuclear fuel in otherwise approved packages or storage facilities, and waste materials will be specifically excluded in the scope section of the criteria document. Rather than establish one or two types of storage containers to be used by all sites for all material types, forms and hazards, the Department will identify the criteria that must be satisfied in order to establish an adequate technical basis for the storage of any nuclear material. This will allow each site to determine whether it is more feasible/economical to qualify containers previously or currently in use, or qualify a new container for its specific materials and conditions.

The criteria needed to establish an adequate surveillance program will also be included.

The new packaging and storage criteria document will consider the requirements previously identified in other directives, such as, 10 CFR 835 DOE Orders 420 and 5660.1B, in the ISSC, and be consistent with DOE-STD-3009-94 Change Notice 2 and the ISMS graded approach.

The packaging, storage and surveillance criteria for Recommendation 2005-1 will be proposed by a technical Working Group (WG). The WG will consist of Department and contractor technical representatives in the Department complex (see Appendix G). The proposed criteria will be reviewed by a technical review board. The technical review board individuals will consist of qualified individuals who are not involved in the working group. See the technical review board charter in Appendix H.

Deliverables/Milestones

This subsection includes the milestones and deliverables for sections 5.1 and 5.2.

Deliverable: Identify additional questions/data site survey. DOE will survey current packaging types, container types, and packaging configurations. The packaging approval status and surveillance conditions requirements will also be solicited in this survey. A formal data request will be issued to DOE sites.

Date: September 30, 2005

Milestone: Establish technical review board

Date: September 30, 2005

Milestone: Resolve document type and existing directives integration for new packaging and storage criteria. Provide the resolution to the special technical review board for their review.

Date: November 30, 2005

Milestone: Technical review board to conduct review of document type and existing directives and provide comments to DOE 2005-1 responsible manager.

Date: December 15, 2005

Milestone: DOE working group to provide technical review board comment resolution for document type and directives integrations to DOE 2005-1 responsible manager.

Date: January 15, 2006

Deliverable: Provide letter identifying document resolution to DNFSB staff.

Date: January 30, 2006

Milestone: Provide first draft of packaging and storage criteria document to technical review board for review and comment.

Date: January 31, 2006

Milestone: Technical review board to conduct review of draft packaging and storage document and provide comments to DOE 2005-1 responsible manager.

Date: February 20, 2006

Milestone: DOE working group to provide technical review board comment resolution for packaging and storage document to DOE 2005-1 responsible manager.

Date: March 10, 2006

Deliverable: Provide first draft of packaging and storage criteria document to Board staff for review and comment.

Date: March 31, 2006

Milestone: Forward packaging and storage criteria document for final technical board review.

Date: April 30, 2006

Milestone: Technical review board to conduct review of final packaging and storage document and provide comments to DOE 2005-1 responsible manager.

Date: May 20, 2006

Milestone: DOE working group to provide technical review board comment resolution on final packaging document to DOE 2005-1 responsible manager.

Date: June 10, 2006

Deliverable: Submit packaging (and/or rulemaking) storage criteria document(s) into Department Directives Systems for DOE wide review and approval.

Date: June 30, 2006

Deliverable: Issue packaging and storage criteria directive intent in letter to all sites.

Date: June 30, 2006

5.2 Identifying Affected Nuclear Materials

Issue Description

Several actions have already been implemented to stabilize and improve the storage of nuclear materials in response to Recommendations 94-1, 97-1 and 2000-1. In addition, some other materials, such as sealed sources, laboratory samples, spent nuclear fuel, and wastes are not intended to be included in the scope of this implementation plan. The materials to which the new packaging and storage criteria will apply need to be identified.

Board Recommendation

Identify which nuclear materials should be included in the scope of the above requirement and then determine the technically justified packaging criteria needed to ensure the safe storage and handling of those materials. The scope need not include waste materials, fully encapsulated forms, or de minimis quantities such as analytical laboratory samples. The criteria should account for the nuclear material form and properties, expected future use, and duration of storage. It may be appropriate for this information to be included in a packaging Manual.

Resolution Approach

The Department will conduct a survey of nuclear materials that are currently being used or stored throughout the Department complex. The Department will determine which materials can be excluded from the new packaging requirements and will establish the threshold at which each isotope becomes subject to the new requirements.

Deliverables/Milestones

See Section 5.1.

5.3 Implementing Improved Nuclear Material Packaging Requirements

Issue Description

After the new packaging and storage criteria document(s) is(are) issued each affected Department site office will evaluate their stored materials and establish a resource loaded schedule and funding plan for implementing the document. These activities will include identifying materials whose packaging must either be qualified or replaced, deciding whether to qualify current packaging or replace it with already qualified packaging, conducting a packaging prioritization assessment to determine the correct order in which to repackage materials, as applicable, and establish and implement a surveillance plan consistent with the technical basis for each packaging scheme employed. Based on the Department nuclear material risk profile, the Department will ensure that the highest priority items, as determined by the complex-wide risk ranking methodology will be qualified or repackaged first at all sites.

Board Recommendation

Prioritize implementation of the improved nuclear material packaging requirement consistent with the hazards of the different material types and the risk posed by the existing package configurations and conditions.

Resolution Approach

The Department will establish a risk ranking nuclear materials packaging methodology which each site will use to develop a site specific implementation plan based on the requirements of the approved interim storage order/standard/manual. The site implementation plan will include a risk based priority system that is consistent with the hazards of the materials/packages being stored. The site's implementation plan shall include the following information:

1. Identify the material type(s) in storage
2. Identify the material matrix
3. Describe current packaging configuration(s) for each material type(s) and maxtrix(es)
4. Risk ranking of current nuclear materials in storage
5. Number of containers in storage by material type(s) and packaging configuration(s)
6. Schedule, with milestones, for the repackaging of materials into packages that meet the new requirements.
7. Schedule for development and implementation of surveillance for materials packaged to the new requirements.

Deliverables/Milestones

Milestone: Provide draft of repackaging risk prioritization methodology to the technical review board for review and comment.

Date: November 30, 2005

Milestone: Technical review board to conduct review of repackaging risk prioritization methodology and provide comments to DOE-2005-1 responsible manager.

Date: December 20, 2005

Milestone:	DOE working group to provide technical review board comment resolution to DOE-2005-1 responsible manager.
Date:	January 15, 2006
Deliverable:	Provide draft of repackaging risk prioritization methodology to Board staff for review and comment.
Date:	January 31, 2006
Deliverable:	Issue repackaging risk prioritization methodology.
Date:	March 30, 2006
Deliverable to DOE HQ:	Resource loaded schedules and funding plans for implementing new packaging and storage criteria document for Sandia National Laboratory, Los Alamos National Laboratory, Pantex, Y-12, Savannah River Site, Idaho Cleanup Project, Lawrence Livermore National Laboratory, Hanford Site, Idaho National Laboratory, Oak Ridge National Laboratory, Nevada Test Site.
Date:	120 days after new packaging and storage criteria document(s) intent letter is issued
Deliverable:	DOE 2005-1 responsible manager issues a DOE wide schedule for 2005-1 implementation.
Date:	180 days after new packaging and storage document(s) intent letter issued.

6.0 ORGANIZATION AND MANAGEMENT

On May 6, 2005, the Secretary accepted Recommendation 2005-1, *Nuclear Material Packaging.* The Assistant Secretary for Environment, Safety and Health, Mr. John Spitaleri Shaw, is the cognizant Secretarial officer. Mr. Richard M. Stark, is the responsible manager.

The deliverables identified in Section 5.0 of this IP will be tracked to completion using the Department's Safety Issues Management System (SIMS) in accordance with DOE M 140.1-1B. SIMS commitments are reviewed monthly. Monthly status reports are distributed to the Secretarial officers and to designated site personnel. In addition, the responsible manager, or his designee, will conduct periodic status review meetings to ensure that activities are progressing on schedule and problems are identified early and resolved promptly.

Because Recommendation 2005-1 impacts several programs and sites, a multidiscipline team was formed to prepare this IP. Since implementing this IP will also require support from multiple programs and sites, the affected Secretarial officers, office Managers and site Managers were requested by a letter from the Assistant Secretary for Environment, Safety and Health to designate a knowledgeable point of

contact (POC) from their respective organizations to support both the preparation and implementation phases of this IP. The POCs have been selected. Each POC is responsible for maintaining awareness of the 2005-1 activities to be/being performed by his/her organization, and for promptly notifying both the 2005-1 responsible manager and his/her management if problems arise.

New materials packaging document(s) will be prepared in response to Recommendation 2005-1. The document(s) will be processed using the Department's Directives Systems in accordance with DOE O 251.1A.

After the new materials packaging document(s) is issued, each affected site Manager will prepare a resource loaded schedule and a funding plan for implementing the document. The work required to satisfy the commitments contained in this IP will be considered to be complete when the affected office Managers and site Managers have issued their schedules and funding plans. Each site will then be responsible for tracking its own scheduled activities.

The packaging, storage and surveillance criteria for Recommendation 2005-1 will be proposed by a Technical Working Group (WG). The WG composition will consist of Department and contractor technical representatives in the DOE complex (see Appendix G). The product of the WG will be peer reviewed by a technical review board and approved by the Department Directives System.

6.1 Change Control

Complex, long-range plans require sufficient flexibility to accommodate changes in commitments, actions, or completion dates that may be necessary due to additional information, improvements, or changes in baseline assumptions. The Department's policy is to (1) provide prior, written notification to the Board on the status of any implementation plan deliverable that will not be completed by the planned deliverable date, (2) have the Secretary approve all revisions to the scope and schedule of plan deliverables, and (3) clearly identify and describe the revisions and basis for the revisions. Fundamental changes to the plan's strategy, scope, or deliverable schedule will be provided to the Board through formal revision and re-issuance of the implementation plan. Other changes to the scope or schedule of planned deliverables will be formally submitted in appropriate correspondence approved by the Secretary, along with the basis for the changes and appropriate corrective actions.

6.2 Reporting

To ensure that the various Departmental implementing elements and the Board remain informed of the status of plan implementation, the Department's policy is to provide periodic progress reports until implementation plan commitments are completed. For this plan, the Department will provide as necessary, briefings to the Board and/or its staff. After the site schedules are developed, the Department will provide the DNFSB with quarterly reports on the status of the site repackaging plans.

Appendix A & B – Acronyms, Abbreviations & Glossary

ALARA – As Low As Reasonably Achievable

CFR – Code of Federal Regulations

DNFSB – Defense Nuclear Facilities Safety Board

DOE – Department of Energy

DOT – Department of Transportation

DSA – Documented Safety Analysis

IAWG – Inactive Actinide Working Group

IP – Implementation Plan

ISMS – Integrated Safety Management Systems

ISSC – Interim Safe Storage Criteria

LANL – Los Alamos National Laboratory

LLNL – Lawrence Livermore National Laboratory

MC&A – Materials Control and Accountability

NE – DOE Nuclear Energy, Science and Technology

NNSA – National Nuclear Security Administration

POC – Point of Contact

SNL – Sandia National Laboratory

SIMS – DOE's Safety Issue Management System

SRS – Savannah River Site

STD – Standard

U.S.C. – United States Code

WG – Working Group

Appendix C – References

DOE Rule 10 CFR 835, Occupational Radiation Protection

DOE Orders 251.1A, Directives System; 420.1A, Facility Safety; 5660.1B, Management of Nuclear Materials

DOE Standards 3009-94, Preparation Guide for DOE Nuclear Facility Documented Safety Analysis; 3013-2004, Stabilization, Packaging and Storage of Plutonium Bearing Materials; 3028-2000 Criteria for Packaging & Storing U_{233} Bearing Materials

DNFSB Recommendations 94-1, Remediation of Nuclear Materials; 97-1, Safe Storage of Uranium 233; 2000-1, Prioritization for Stabilizing Nuclear Materials

Appendix D – Summary of Commitments

No.	Commitment	Affected Facility	Deliverable	Due Date	Responsibility
5.1-1	Deliverable - Identify additional packaging questions/data requests to be included in survey.	N/A	Letter	9-30-05	R. Stark
5.1-2	Deliverable – Document resolution type for new packaging and storage criteria.	N/A	Letter	1-30-06	R. Stark
5.1-3	Deliverable – Provide first draft of packaging and storage criteria document to Board staff for review and comment	N/A	Document for review	03-31-06	R. Stark
5.1-4	Deliverable – Submit packaging and storage criteria document to DOE Directives System.	N/A	Document submitted via Department's Directive System	6-30-06	R. Stark
5.1.5	Deliverable – Issue packaging and storage criteria directive letter to sites	N/A	Letter	6-30-06	R. Stark
5.3-1	Deliverable – Provide draft of repackaging risk prioritization methodology to the Board staff for review and comment	N/A	Document for review	1-31-06	R. Stark
5.3-2	Deliverable – Issue repackaging risk prioritization methodology	N/A	Letter signed by EH-1	03-30-06	R. Stark
5.3-3	Deliverable to DOE HQ– Resource loaded schedule and funding plan	SNL	Schedule and funding plan	120 days after directive letter issued *	Sandia Site Office Manager
5.3-4	Deliverable to DOE HQ – Resource loaded schedule and funding plan	LANL	Schedule and funding plan	120 days after directive letter issued *	Los Alamos Site Office Manager
5.3-5	Deliverable to DOE HQ – Resource loaded schedule and funding plan	Pantex	Schedule and funding plan	120 days after directive letter issued *	Pantex Site Office Manager

No.	Commitment	Affected Facility	Deliverable	Due Date	Responsibility
5.3-6	Deliverable to DOE HQ – Resource loaded schedule and funding plan	Y-12	Schedule and funding plan	120 days after directive letter issued	Y-12 Site Office Manager
5.3-7	Deliverable – Resource loaded schedule and funding plan	SRS	Schedule and funding plan	120 days after directive letter issued *	SRS Site Office Manager
5.3-8	Deliverable – Resource loaded schedule and funding plan	Idaho Cleanup Project	Schedule and funding plan	120 days after directive letter issued *	Idaho Site Office Manager
5.3-8	Deliverable – Resource loaded schedule and funding plan	LLNL	Schedule and funding plan	120 days after directive letter issued *	Lawrence Livermore Site Office Manager
5.3-9	Deliverable – Resource loaded schedule and funding plan	Hanford	Schedule and funding plan	120 days after directive letter issued *	Richland Site Office Manager
5.3-10	Deliverable – Resource loaded schedule and funding plan	Nevada	Schedule and funding plan	120 days after directive letter issued *	Nevada Site Office Manager
5.3-11	Deliverable – Resource loaded schedule and funding plan	Idaho	Schedule and funding plan	120 days after directive letter issued *	Idaho Site Office Manager
5.3-12	Deliverable – Resource loaded schedule and funding plan	Oak Ridge	Schedule and funding plan	120 days after directive letter issued *	Oak Ridge Site Office Manager
5.3-13	Deliverable – DOE HQ issues DOE wide summary of 2005-1 implementation schedules		DOE wide schedule	180 days after directive letter issued *	R. Stark

***** The new nuclear materials packaging and storage criteria document will be submitted to the Departments Directive Systems in June 2006, after which the affected sites will be required to develop their implementation plans subject to any changes resulting from the RevCom process. (See Commitment 5.1-4)

Appendix E - Board Recommendation 2005-1

[DNFSB LETTERHEAD]

March 10, 2005

The Honorable Samuel W. Bodman
Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Bodman:

On March 10, 2005, the Defense Nuclear Facilities Safety Board (Board), in accordance with 42 U.S.C. § 2286a(a)(5), unanimously approved Recommendation 2005-1, *Nuclear Material Packaging,* which is enclosed for your consideration. This recommendation addresses issuance of a requirement that nuclear material packaging meet technically justified criteria for safe storage and handling outside of engineered contamination barriers.

After your receipt of this recommendation and as required by 42 U.S.C. § 2286d(a), the Board will promptly make it available to the public. The Board believes that the recommendation contains no information that is classified or otherwise restricted. To the extent this recommendation does not include information restricted by the Department of Energy (DOE) under the Atomic Energy Act of 1954, 42 U.S.C. §§ 2161-68, as amended, please arrange to have it promptly placed on file in your regional public reading rooms. The Board will also publish this recommendation in the *Federal Register*. The Board will evaluate DOE's response to this recommendation in accordance with Board Policy Statement 1, *Criteria for Judging the Adequacy of DOE Responses and Implementation Plans for Board Recommendations.*

Sincerely,

John T. Conway
Chairman

Enclosure

c: Mr. Mark B. Whitaker, Jr.

RECOMMENDATION 2005-1 TO THE SECRETARY OF ENERGY Pursuant to 42 U.S.C. § 2286a(a)(5), Atomic Energy Act of 1954, As Amended

Dated: March 10, 2005

Background

In Recommendation 94-1, *Improved Schedule for Remediation in the Defense Nuclear Facilities Complex,* the Defense Nuclear Facilities Safety Board (Board) urged the Department of Energy (DOE) to improve the packaging and storage conditions of its large inventory of nuclear materials once used for weapons manufacture. In particular, the Board recommended that DOE place plutonium metals and oxides in storage configurations meeting DOE's standard for long-term storage (DOE-STD-3013-2004, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials).* Some sites applied Recommendation 94-1 to excess materials only. The Board has continued to evaluate whether other categories of nuclear materials are stored in a safe manner.

DOE has made progress in the stabilization and storage of its excess nuclear materials.

The storage requirements for other categories of nuclear materials, however, are not as well defined and controlled. Specifically, DOE Order 5660.1B, *Management of Nuclear Materials,* does not address safe storage requirements. Other than two narrowly focused standards? DOE-STD-3013-2004 and DOE-STD-3028-2000, *Criteria for Packaging and Storing Uranium-233-Bearing Materials?* there are no explicit DOE-wide requirement to ensure the safe storage of nuclear materials. Currently, the technical adequacy of packaging-the combination of containers and other components providing a contamination barrier-for nuclear materials, including liquids, is dependent on the safety bases of individual facilities. Typically, facilities have credited engineered features, such as the confinement structure and ventilation system, for protecting offsite individuals and collocated workers. For facility workers, however, the controls are generally administrative, such as continuous air monitors, personal protective equipment, periodic contamination surveys, and other aspects of the radiological control program, in conjunction with proper evacuation training. In accordance with DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis* (DOE-STD-3009-94, Change Notice 02), accidents that pose the risk of significant radiological exposure to workers, such as a breached nuclear material storage package, should be prevented or mitigated using safety-significant controls. The preferred hierarchy of controls favors engineered, preventive features over administrative controls.

Establishing packaging requirements for nuclear materials within the DOE complex requires consideration of a diverse population of material types for storage for uncertain periods of time. From a safety standpoint, nuclear material packaging must protect against a number of challenges that could breach the container and release radioactive material. Many of the materials of concern generate gases that result in container pressurization and may be pyrophoric or highly reactive. The container design must take into account corrosion, oxidative expansion of stored metal, effects of radiolysis, diurnal pumping and damage due to impacts from drops and tooling during handling. The Board's recent review of nuclear material packaging at Lawrence Livermore National Laboratory (LLNL) revealed that

many of these insults had not been fully considered when packaging choices were made for nuclear materials not covered by Recommendation 94-1. In fact, many of these current packaging configurations are similar to the inadequate configurations addressed in Recommendation 94-1, and are documented as being susceptible to eventual failure in the report of the Recommendation 94-1 Materials Identification and Surveillance Working Group, entitled *Summary of Plutonium Oxide and Metal Storage Package Failures* (LA-UR-99-2896).

In general, the hazards posed by nuclear materials covered under DOE's Implementation Plan for Recommendation 94-1 are the same as those for nuclear materials not considered excess. When nonexcess materials are removed from glovebox confinement for interim storage, relocation to another work station, assay, or other purposes, the packages are susceptible to the same types of failures as those addressed in Recommendation 94-1. The longer the materials are stored, the greater are the chances that the packaging will fail, especially if the packaging has not been designed appropriately for the actual duration of storage. The Board found that approximately 15 percent of the nonexcess items at LLNL's Plutonium Facility are stored in packaging more than 5 years old. Some of the older items, previously declared excess, remain in their existing packaging while awaiting stabilization and packaging under DOE-STD-3013-2004. This situation emphasizes the need to establish a technical basis for packaging, such as designating the time period for which a particular container is confirmed to perform its function adequately, in conjunction with tracking the age of containers in use.

Two recent events serve as further reminders of the importance of using packaging that is properly designed for its function:

- An August 5, 2003, event at Los Alamos National Laboratory's (LANL) Plutonium Facility resulted in multiple workers receiving plutonium-238 uptakes as a result of the degradation of a package stored longer than planned. This event is documented in a DOE Type B investigation report (HQ-EH-2004-1). The release of material and the resulting contamination and worker uptakes were due, in large part, to the inadequate packaging of plutonium being stored and handled outside of a glovebox.

- An October 6, 2004, incident at LLNL involved the accidental drop of a package containing salt-bearing plutonium oxide. This event is documented in an Occurrence Reporting and Processing System report (OAK--LLNL-LLNL-2004-0046). Although no plutonium was released, this event highlights the need to specify robust packaging requirements for materials handled outside of a glovebox.

State of Nuclear Material Packaging

DOE-STD-3013-2004 sets forth requirements for a robust storage configuration for long-term storage of plutonium-bearing materials. The requirements ensure containment through a combination of material form, packaging design, and surveillance of containers. However, the robust, welded configurations in the standard may not be desirable when a short storage period is anticipated pending use of the material.

There are no equivalent requirements for interim storage. As part of its response to Recommendation 94-1, DOE finalized guidance for the storage of plutonium-bearing materials not packaged for long-term storage under DOE-STD-3013. This guidance, identified in a January 25, 1996, memorandum from

Deputy Secretary of Energy Curtis entitled *Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials,* provides a technically justified approach to safe packaging and storage of plutonium-bearing materials for a period of up to 20 years. Although these Interim Safe Storage Criteria (ISSC) were not intended to apply to materials in working inventory, much of the guidance remains germane to storage of all nuclear materials outside of approved engineered contamination barriers (e.g., gloveboxes or certified shipping containers).

The ISSC were only implemented for selected excess materials and were never formally issued as part of the DOE Directives System. In practice, the sites use a wide variety of packages, many of which do not meet the ISSC. According to the lessons learned from the DOE Type B investigation of the worker uptakes at LANL, packages containing radioactive material should be assumed unsafe until proven otherwise or the materials are repackaged to current standards. Yet sites continue to rely on container types that have been used historically, but have no technically justified safety or design basis. These container types are generally forms of packaging typically used in non-nuclear applications (e.g., paint cans, food pack cans). Thus, they are not designed to protect against the hazards of the nuclear materials they contain for the duration of storage.
Several commonly used containers and their potential inadequacies are briefly summarized in an attachment to this Recommendation. Many other containers are in use for specialized applications.

Remaining Problems

In response to the Board's May 20, 2002, correspondence on safety of nuclear materials storage, the National Nuclear Security Administration (NNSA) established the Inactive Actinide Working Group (IAWG), with the goal of developing a comprehensive approach to the characterization, packaging, and storage of a subset of nuclear materials. As presented in a February 7, 2003, letter from NNSA to the Board, the IAWG was to meet this goal through the development of three strategies for the following: acceptance and retention of nuclear materials, material characterization and storage adequacy, and disposition. The Board has been observing the IAWG's efforts and has made three observations.

First, a key product of the IAWG effort will be the strategy for material characterization and storage adequacy. Based on discussions with IAWG participants, the delivery of this strategy has been delayed, in large part because of disagreements among member sites on the requirements necessary for justifying adequate storage. The Board believes these requirements should provide for sufficient characterization based on an appropriate combination of analysis and process knowledge to determine the appropriate packaging. Characterization information should also be used to develop a surveillance program prioritized according to expected material and container risk (including, for example, material type, material form, and the age and type of container).

Second, in a June 2000 report entitled *A Strategic Approach to Integrating the Long-Term Management of Nuclear Materials,* DOE recognized the need to update the existing DOE Order on nuclear materials management. In particular, this report urged improvements to the nuclear materials management process. However, neither the current Order nor the report explicitly considers storage safety. The Board believes that DOE should require a technical basis for nuclear material packaging and storage safety. Efforts to meet this requirement should take advantage of the knowledge about storage adequacy being developed by the IAWG, as well as existing guidance, such as the ISSC.

Third, the IAWG strategy does not include other program offices in the defense nuclear complex, such as the Nuclear Energy, Science, and Technology (DOE-NE) facilities involved in defense nuclear activities. Currently, materials and activities in transition between the facilities of different program offices have the potential to be overlooked. For example, operators at the Savannah River Site have begun converting the neptunium-237 solutions covered under Recommendation 94-1 to oxide and placing the oxide in packaging intended for 1 year of storage at that site prior to offsite shipping. The long-term storage of large quantities of neptunium oxide has not been performed previously in the complex, and the technical basis for ensuring the safety of such storage is incomplete. Nonetheless, these materials will be transferred to DOE-NE for use, where they may continue to be stored in their existing packaging for a period of up to 20 years. In addition, the Board has learned that DOE-NE intends to assume more direct control of activities involving plutonium-238, which have to date been performed at NNSA sites.

The significant radiological hazards associated with this material necessitate appropriate storage containers for the expected storage period. The Board believes the requirement for a technical basis for nuclear material packaging and storage should encompass all program offices in the defense nuclear complex. DOE may wish to consider implementing this requirement for all program offices, including those outside of the defense nuclear complex.

The Board is encouraged by other efforts currently under way to improve nuclear material packaging. As a result of discussions between the Board's staff and LLNL, the Livermore Site Office, in a December 3, 2004, letter, directed LLNL to develop a technical basis for the adequacy of storage packages as part of a Special Nuclear Materials Storage Plan covering "all packaging activities". LLNL replied in a letter of January 31, 2005, outlining the required activities, milestones, and funding to develop and implement an approved packaging and storage program. Implementation of the plan is contingent upon the availability of key personnel and funding. Likewise, the proposed Documented Safety Analysis (DSA) for the LANL Plutonium Facility requires the use of a proposed facility packaging standard and designates material containers as a safety-related component. However, the new DSA has been awaiting NNSA approval. In general, these efforts represent an improvement, but they do not represent a comprehensive DOE-wide effort, and significant differences remain in the quality of the efforts at individual facilities.

Recommendation

Nuclear material packaging provides the primary containment boundary to protect facility workers during storage and handling activities. The Board believes the development of technically justified criteria for packaging systems for nuclear materials is necessary on a DOE-wide level. Therefore, the Board recommends that DOE:

1 Issue a requirement that nuclear material packaging meet technically justified criteria for safe storage and handling. Packaging should, in general, provide a robust barrier between facility workers and the stored nuclear materials once they are removed from an approved engineered contamination barrier. It may be appropriate to include this requirement in an updated nuclear materials management Order.

2 Identify which nuclear materials should be included in the scope of the above requirement and then determine the technically justified packaging criteria needed to ensure the safe storage and

handling of those materials. The scope need not include waste materials, fully encapsulated forms, or de minimus quantities such as analytical laboratory samples. The criteria should account for the nuclear material form and properties, expected future use, and duration of storage. It may be appropriate for this information to be included in a packaging Manual.

The ISSC may provide the beginning of a sound technical foundation for developing such criteria. Although some modifications may be necessary to make the ISSC more applicable to short-term storage, the Board believes the basic ISSC principles? for example, the requirement for a minimum of two contamination boundaries for high-hazard materials such as plutonium, assurance that leak-tightness is maintained for materials requiring a sealed environment, ability of the containers to withstand maximum expected internal pressures, and protection against common insults such as drops? should be maintained. The criteria should also include provisions for surveillance programs to verify that the container and any limited-life components are performing in a manner consistent with the duration of storage.

3 Prioritize implementation of the improved nuclear material packaging requirement consistent with the hazards of the different material types and the risk posed by the existing package configurations and conditions.

John T. Conway, Chairman

Attachment

ATTACHMENT [to Board Recommendation]

Selection of Commonly Used Nuclear Material Packaging

Food-Pack Cans

Food-pack cans are thin-walled tinned carbon steel containers used in the food industry. No additional manufacturing or structural requirements have been specified for application with nuclear materials. These cans typically rely on a double-crimped metal-to-metal closure with a thin layer of sealing compound to provide leak-tightness. Historically, many sites have reported failures of food-pack cans. Lawrence Livermore National Laboratory (LLNL) has reported anecdotal evidence suggesting that none of its food-pack cans have failed to the point of detectable contamination outside the container (UCRL-ID-11733). However, this same report states further that some degree of oxidation was observed in all of the examined food-pack cans containing plutonium metal, suggesting the lack of an airtight seal. Leakage of oxygen through nonairtight food-pack cans has been responsible for a number of container failures reported at other sites, due to oxidative expansion of plutonium metals (LA-UR-99-2896).

Improvements have been made to the technology, including better sealing equipment, as discussed in a May 1984 report entitled *The Effectiveness of Corrective Actions Taken to Preclude Events Involving Tin Cans and Plutonium* (RHO-HS-SA-59 P). Some evidence suggests, however, that these containers still may not be adequate for prolonged storage of nuclear materials. Approximately half of the sampled lot of food-pack cans sealed 10 to 14 years earlier at the Hanford Plutonium Finishing Plant using the improved methodology failed leak testing, and nearly all showed further indications of a potential lack of seal (LA-UR-99-3053).

Additional testing performed at Pacific Northwest National Laboratory confirmed that the performance of food-pack cans is highly dependent on the quality of the seal (PNL-5591). During these tests, 33 industry-standard food-pack cans were sealed according to federal specifications. The testing revealed leak rates ranging from less than 10^{-5} cubic centimeters per second (cc/sec) to more than 2 cc/sec. These findings should receive due consideration when food-pack cans are used for storage applications in which a hermetic seal is required. LLNL continues to use food-pack cans as inner and outer containers for the storage of plutonium metal and oxide, and other sites may be storing nuclear materials previously packaged in food-pack cans.

Paint Cans

Paint cans are thin-walled cans with a press-fit lid that are commonly used to store paint. They have been used as both inner and outer containers for the storage of some nuclear materials, including plutonium metal. The press-fit lid is typically placed by hand using a mallet, which results in a questionable seal lacking any evidence of quality control. According to a January 16, 1987, LLNL site report entitled *Incident Analysis/Plutonium Burn in Storage Can,* oxidation was found to be common for plutonium metal stored in paint cans (memorandum from R. H. Condit to K. Ernst). The report goes on to calculate that a 4 micron gap integrated across the seal area would be

sufficient to permit complete oxidation of 100 grams of plutonium metal in 1 year. A leak of this size can reasonably be assumed to be present in the press-fit closure; therefore, the adequacy of these cans for nuclear material storage applications requiring a seal cannot be ensured. Although LLNL reports that ingress of air is expected because the lid and rim of the can are not designed to be airtight (UCRL-ID-117333), paint cans remain approved for use for certain applications at the laboratory. Other sites may also be storing nuclear materials that were previously packaged in paint cans.

Taped Slip-Lid Cans

Slip-lid cans are thin-walled cans with a loose-fitting cover that is often taped. While convenient and inexpensive, the use of these containers has resulted in several breached storage packages, including the plutonium-238 package that led to the Type B event at Los Alamos National Laboratory (LANL). Many nuclear material packages consisting of nested taped slip-lid cans remain at the Department of Energy's defense nuclear facilities. By design, these cans were never intended to serve a containment function. Furthermore, except for tape, a mechanical closure is absent, resulting in a container that may not be able to provide even gross retention of the materials within. The effectiveness of tape in performing this sealing function over time and under high radiation conditions is poorly understood. For this reason, the Interim Safe Storage Criteria (ISSC) specifically prohibits crediting slip-lid cans as one of the two required contamination barriers. Yet several sites continue to use this type of packaging. For nonmetallic plutonium, including items containing plutonium-238, LANL plans to rely on stainless steel taped slip-lid cans only as an inner container; currently, however, a large number of items remain at the laboratory in nested slip-lid cans. Moreover, several varieties of slip-lid cans continue to be approved for use as inner and outer storage containers for certain materials at LLNL.

Hagan Can

LANL's Comprehensive Nuclear Material Packaging and Stabilization Plan approves the use of a standard container known as the Hagan can, a robust, screw-top container with an O-ring seal and filtered vent. The Hagan can generally meet the expectations of the ISSC and has undergone testing to certify its performance (Wickland and Mataya, PATRAM 98, 1998). However, drop testing was performed at a height lower than the expected maximum storage height; therefore, additional analysis or testing is required. Under the proposed Documented Safety Analysis for LANL's Plutonium Facility, the Hagan can is classified as a safety-significant engineered feature. The Hagan can appear to be an appropriate outer package for nuclear material storage, although, as recognized by LANL, the service life of the Viton (an organic fluorocarbon compound) O-ring requires verification through a surveillance program. Currently, Hagan cans are widely used only at LANL; however, their use may be under consideration at other sites.

Conflat Can

A can fabricated with a Varian-type Conflat flange results in a hermetically sealed, robust container that can be used to store plutonium metal. A copper gasket on a bolted flange closure is designed to maintain a long-term hermetic seal against oxidation of plutonium metal. This closure type has been standard in the high-vacuum industry for many years and has been certified to maintain a leak-tight seal under various temperature and pressure conditions. The Conflat can is identified in LANL's

Comprehensive Nuclear Material Packaging and Stabilization Plan as the inner container for the storage of plutonium metal. The use of Conflat cans for storage of other nuclear materials requiring a sealed environment may also be appropriate. Conflat cans have been used periodically at some sites for special storage applications, but their use is not widespread or uniform.

Metal Drums

Several sites commonly use U. S. Department of Transportation (DOT) Type A containers and similar types of metal drums for overpacking of packages of nuclear materials for onsite transportation and storage. These containers have been certified as Type A radioactive material packages per DOT specifications. For transportation purposes, this certification usually is limited to a single year. The use of these containers for interim storage beyond the certification period appears appropriate, but consideration should be given to periodic inspection and replacement for limited-life components, such as lid gaskets. The *Criteria for the Safe Storage of Enriched Uranium at the Y-12 Plant* (Y/ES-015/R2) allow interim storage of enriched uranium materials for a period of up to 10 years in DOT Type A or Type B containers.

Y-12 Prolonged Storage Container

The Y-12 Y/ES-015/R2 criteria specify the use of stainless steel cans similar to food-pack cans for prolonged low-maintenance storage for up to 50 years. While the reliance on a single robust barrier for the storage of enriched uranium may be appropriate, it is unclear whether the requirement to maintain mechanical and seal integrity during normal handling includes protection against drops. In addition, a lid sealant compound is specified in the appendix to Y/ES-015/R2, but no discussion of its longevity is provided. While fewer radiological hazards and less chemical reactivity are associated with enriched uranium than with plutonium and some other nuclear materials, further testing of these containers would better demonstrate their reliability for long-term storage. Currently, the Y-12 container specification is planned for use only at the Y-12 National Security Complex.

Plastic Bags and Bottles

Historically, plastic bags have been relied upon to provide contamination control for a limited period. Bag materials, which include polyethylene, polyvinyl chloride, and related polymers, play an important role in the overall packaging system. Their principal use is for contamination control during the "bagout" operation, when the nuclear material container is removed from the glovebox. Unfortunately, some types of bags have proven to be detrimental to the integrity of packages left in storage for prolonged periods of time. For example, the radiation-induced degradation of polyvinyl chloride bag material led to the production of hydrochloric acid, which in turn contributed to the corrosion and eventual failure of containers that occurred during the Type B event at LANL. The choice of material also impacts the generation of radiolytic gas and effectively defines the service life of a package when the outer container is not leak-tight. In repackaging campaigns at LLNL, as well as at other sites, such as Hanford, bags commonly have been found to be in a discolored or otherwise degraded state (UCRL-ID-117333 and WHC-SD-TRP-067). While plastic bags have been in use for a long time, little quantitative information exists on the effects of time, temperature, and radiation field exposure on

maintenance of an effective contamination barrier. It is recognized that plastic bags may be necessary for Contamination control, but they should not be relied upon as a long-term contamination barrier.

In some cases, plastic bottles (e.g., safe bottles) have been used for the storage of solutions containing nuclear materials, especially enriched uranium, outside of processing equipment. While bottles are constructed of thicker plastics than are bags, they undergo the same chemical and radiolytic degradation with time and must be compatible with the chemical properties of the contained liquids. Furthermore, whereas bags provide only contamination control, bottles are relied upon to provide a complete contamination barrier, including structural integrity. Any reliance on plastic bags or plastic bottles for extended periods of time should be informed by the available knowledge of polymer degradation, in combination with information gleaned from surveillance programs.

Appendix F - Secretary's Response Letter to Board Recommendation 2005-1

[DOE LETTERHEAD]

May 6, 2005

The Honorable A. J. Eggenberger
Acting Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, DC 20004-2901

Dear Dr. Eggenberger:

The Department of Energy acknowledges receipt of the Defense Nuclear Facilities Safety Board's Recommendation 2005-1, *Nuclear Material Packaging*, issued on March 10, 2005.

In response to Recommendations 94-1, 97-1, and 2000-1, the Department has made significant progress towards stabilizing and safely storing its nuclear materials, primarily plutonium metal and oxide materials and Uranium-233. For example, all of the commitments included in the Implementation Plan for Recommendation 97-1, *Safe Storage of Uraniun-233*, and over two-thirds of the commitments in the Implementation Plan for Recommendation 2000-1, *Stabilization and Storage of Nuclear Materials*, have been completed. Your Recommendation 2005-1 addresses storage requirements for other categories of nuclear materials that are beyond the scope of the Implementation Plans for Recommendations 94-1, 97-1, and 2000-1.

The Department accepts Recommendation 2005-1, and will develop an Implementation Plan to identify and issue additional nuclear material packaging and storage requirements. The Plan will address the following activities:

- Specify the nuclear materials to which new requirements will apply. This effort will include conducting a survey of the sites currently storing nuclear materials.

- Develop the technical criteria and requirements that must be satisfied to ensure safe storage and handling of these materials, including the requirements for surveillance of packaged materials when appropriate.

- Develop a prioritized plan for implementing the above criteria and requirements based on the hazards and risks posed by the existing packaging configurations and conditions.

I have assigned Mr. Richard Stark, Director, Office of Facilities Operations Support, as the Department's responsible manager for developing the Implementation Plan. He can be reached on (301) 903-4407.

Samuel W. Bodman

Appendix G – Charter for DNFSB Recommendation 2005-1 Working Group

OBJECTIVE

To define the charter and scope and to initiate a DNFSB Recommendation 2005-1 Working Group (WG) that proposes Technical and Safety Criteria for interim storage of nuclear materials, to be appropriately implemented by Department sites, which are consistent with said Recommendation.

BACKGROUND

The Department has nuclear materials stored in a variety of packages outside an engineered contamination confinement barrier. In response to DNFSB Recommendation 94-1 the then Deputy Secretary Curtis on 1/26/96, issued a memorandum titled "*Criteria for Interim Safety Storage of Plutonium – Bearing Solid Materials*". The Curtis memorandum proposed a number of criteria for interim storage.

Since 1996 Recommendation 94-1 and its successor 2000-1 have led to the stabilization, packaging and long term storage of excess plutonium-bearing materials according to DOE-STD-3013-2004. This standard was developed by a Working Group of Technical Experts drawn from all sites that stored excess plutonium-bearing materials. The model of technical experts developing implementing, and maintaining a DOE standard has been successful and will be followed in developing response to DNFSB 2005-1.

SCOPE

The WG is responsible to develop a Technical Safety Criteria and guidance for interim storage of nuclear materials. The composition of the WG will consist of a Department of Energy (DOE) designated chair and technical representatives from sites in the Department complex determined to have materials destined for interim storage that meet the criteria set out in 2005-1.

The criteria document inclusive of associated package surveillance criteria will be approved by the Department Directives Systems and implemented by designated Program Officers respective sites. Furthermore the WG will be responsible for assisting sites in implementing the Requirements document, when requested, and act as a technical resource for any site exclusion proposals for nuclear materials.

WORKING GROUP RESPONSIBILITIES

- Develop an Action Plan consistent with the 2005-1 IP and obtain approval from the 2005-1 Responsible Manager.
- Develop proposed set of criteria and associated technical bases for interim storage of nuclear materials consistent with 2005-1.
- Develop proposed criteria and guidelines for surveillance of interim stored packages.

- Develop comment resolution to address technical review board comments and deliver comment resolution responses to the DOE 2005-1 responsible manager for disposition.
- Review packaging technical reports and proposals from Department sites.
- Conduct frequent telecoms and meetings where appropriate to review ongoing progress.
- Provide assistance to Department sites in meeting interim storage requirements, when requested.
- Review site exclusion proposals for nuclear materials that may not fall under the Requirements of 2005-1.

Appendix H – Charter for Technical Review Board

A technical review board reporting to the DOE 2005-1 responsible manager will be instituted to provide a disciplined peer review of the 2005-1 products. The DOE 2005-1 responsible manager will select 3-5 technical professionals with strong backgrounds in packaging and storage of nuclear materials, radiation protection and ALARA. These individuals will have no involvement with the 2005-1 working group and their activities but will peer review the products of the 2005-1 working group.

The individuals will be a combination of DOE Federal Employees and contractors. The technical review board will conduct their review on a schedule that is described in the 2005-1 Implementation Plan. The technical review board will provide documented review comments and assessments to the DOE 2005-1 responsible manager for disposition by the DOE 2005-1 responsible manager. In the event that there is a minority opinion in the review board that will also be transmitted with the record.

Appendix I – Chronology

September 2005

— Material packaging survey request issued, September 30, 2005.
— Technical review board established, September 30, 2005

November 2005

— Draft repackaging prioritization methodology sent to technical review board, November 30, 2005.
— Requirements document resolution sent to technical review board, November 30, 2005.

December 2005

— Technical review board comments or directives integration to DOE-2005-1 responsible manager December 15, 2005.
— Technical review board comments on risk prioritization methodology sent to DOE-2005-1 responsible manager December 20, 2005.

January 2006

— Technical review board comments resolved on Directives integration and risk prioritization.
— Draft repackaging prioritization methodology sent to DNFSB, January 31, 2006.
— Requirements resolution sent to DNFSB, January 30, 2006.
— Draft repackaging criteria sent to technical review board, January 31, 2006.

February 2006

— Technical review board comments on draft packaging and storage requirements to DOE-2005-1 responsible manager, February 20, 2006.

March 2006

— Technical review board comments resolved on draft packaging, March 10, 2006.
— Issue repackaging prioritization methodology, March 30, 2006.
— Draft packaging criteria sent to DNFSB staff for review, March 31, 2006.

April 2006

— Final packaging criteria sent to technical review board, April 30, 2006.

May 2006

— Technical review board comments on final packaging criteria to DOE-2005-1 responsible manager, May 20, 2006.

June 2006

— Technical review board comments resolved on final packaging, June 10, 2006.
— Submit packaging requirements to DOE Directives process, June 30, 2006.
— Issue directive intent letter to all sites, June 30, 2006.

120 Days after directives intent letter issued

— Site wide schedules sent to 2005-1 responsible manager

180 Days after directives intent letter issued

— DOE wide schedule sent to DNFSB (status updated quarterly thereafter)

ATTACHMENT 2
APPLICABLE SITES

National Nuclear Security Administration

- Sandia National Laboratory
- Los Alamos National Laboratory
- Pantex
- Y-12
- Lawrence Livermore National Laboratory
- Nevada Test Site

Office of Environmental Management (EM)

- Hanford Site
- Oak Ridge National Laboratory (areas under the responsibility of EM)
- Savannah River Site
- Idaho Cleanup Project
- East Tennessee Technology Park

Office of Nuclear Energy

- Idaho National Laboratory

Office of Science (SC)

- Oak Ridge National Laboratory (areas under the responsibility of SC)

ATTACHMENT 3

METHODOLOGY FOR DETERMINING REPACKAGING NEEDS AND PRIORITIZATION OF REPACKING NUCLEAR MATERIALS

Revision 1

February 2007

U.S. Department of Energy
Office of Health, Safety and Security
Office of Nuclear Safety and Environment

Methodology for Determining Repackaging Needs and Prioritization of Repackaging Nuclear Materials

Abstract

Safe handling and storage of nuclear material at Department of Energy (DOE) facilities relies on the use of adequate containers to prevent worker contamination and uptake of radioactive material. DOE is establishing requirements in DOE Manual (DOE M) 441.1-1, "*Nuclear Material Packaging Manual,*" for packaging of nuclear materials other than those stored in engineered containment barriers or packaged pursuant to DOE Standard (DOE-STD)-3013-2004, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*; DOE-STD-3028, *Criteria For Packaging and Storing Uranium-233-Bearing Materials*; and DOE Handbook (DOE-HDBK)-1129, *Tritium Handling and Safe Storage.* This report describes a methodology to assist managers in prioritizing their current inventory of nuclear material (deemed to need repackaging) based upon relative worker risk.

Under this methodology, the relative risks are qualitatively determined based upon a combination of factors including the potential magnitude of consequence of package failure (based upon amount and type of nuclear material in the package), the chemical and physical attributes of the nuclear material (e.g., chemical corrosion characteristics), the container attributes (e.g., corrosion resistance and venting capability), and age of the container.

The methodology provides a formula by which a relative numerical score can be calculated for a container and stored material (or class of containers and stored materials) that accounts for these risk factors. Based upon the score, the container and stored material is grouped into one of four risk categories (Very High, High, Medium, and Low).

This prioritization methodology is a generic tool that management at all DOE sites can use to establish the priority for repackaging of nuclear material. This tool can be applied to individual packages or applied to groups of packages that have similar characteristics.

1. Introduction

Several incidents have occurred within the DOE/National Nuclear Security Administration (NNSA) complex that have resulted in personnel contaminations and/or exposures due to container failures. The container failures were caused by container degradation over time or by handling mishaps. Numerous types of materials and container configurations exist within the complex. The combinations of material and container configurations were in general adequate for the originally anticipated period of storage or for a particular use, but were not specifically engineered for the storage conditions and may no longer be adequate because of prolonged storage caused by changes in mission.

This document outlines the methodology for use by managers to determine the nuclear material packages that need to be repackaged and to prioritize repackaging needs at sites across the DOE complex. Additionally, this document meets a Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2005-1 commitment to develop a prioritization methodology for implementing the repackaging criteria based on the hazards and risks posed by the existing nuclear material inventory. The qualitative methodology uses the relevant physical, reactive, and radiological properties of the stored material as well as their interactions with the containment barriers as a basis to identify and prioritize repackaging needs. Its methodology is generic and covers a wide range of packaging systems, materials, forms, and hazards. It provides a means to focus on the most hazardous items first based on an objective measure of relative risk to the facility workers.

2. Scope

This qualitative prioritization methodology is intended to be applied to those nuclear materials that are subject to the requirements of the nuclear material manual (DOE M 441.1-1), i.e., nuclear materials (stored outside of an approved engineered contamination barrier) whose composition and quantity pose the potential for a 5 Rem committed effective dose equivalent. Refer to DOE M 441.1-1 for the criteria for applicable nuclear material and a list of material that are excluded from the DOE M 441.1-1 requirements.

3. Approach

The qualitative prioritization methodology provides a means of estimating the relative risk of stored nuclear material due to the potential consequences of a nuclear material container breach that results in a release of the material and the probability of such a release occurring. The potential receptors of concern are the facility workers who may be impacted by such a release. With this prioritization methodology, sites can focus resources on corrective actions, such as repackaging of the material, to reduce or minimize the potential risks posed by the containers. This methodology can be applied to individual packages or applied to groups of packages that have similar characteristics.

The methodology takes into account the following factors:

Consequence Factor:
The Consequence Factor is determined by the potential exposure to an individual if the stored material was released during normal handing or through a drop of the container. Four broad categories are utilized.

Group 1: $< 20xA_2$
Group 2: $20xA_2$ to $200xA_2$
Group 3: $200xA_2$ to $10{,}000xA_2$
Group 4: $> 10{,}000xA_2$

The A_2 quantity for radioisotopes (given in Curie [Ci]) as specified in 49 Code of Federal Regulations (CFR) 173.435, *Table of A1 and A2 Values for Radionuclides*, are determined from a calculation of the amount of packaged material which results in a 5 rem dose if 10^{-3} of the material becomes airborne as a result of the storage, handling or accident and 10^{-3} of the airborne material is subsequently inhaled and incorporated into a person located in the vicinity of the material. This calculation is based upon an analysis by the International Atomic Energy Agency (Safety Guide No. TS-G-1.1 [ST-2], Appendix I, "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Materials"). Table 1 shows A_2 values and specific activities for the most commonly stored isotopes at DOE. The A_2 value for mixtures can be determined as described in 49 CFR 173.433, *Requirements for determining basic radionuclide values, and for the listing of radionuclides on shipping papers and labels.*

Note, it is not expected that in any accident the total quantity of material in a package is released, and, therefore, assuming a total quantity release will overestimate the potential health risk. However, this is a convenient method for putting the health risk in perspective and is effective in separating out the highest risk materials. From these values, the quantity in grams of an isotope fitting in each of these groups can be determined. For example 300 grams of U-233, 8 grams of Pu-239 or 30 milligrams of Pu-238 would be in Group 1; 1000 grams of Pu-239 or 5 grams of Pu-238 would be in Group 3.

Frequency of Failure Factor: There are a number of ways for a package to fail and there are a number of ways the package can be designed not to fail. This factor is determined by developing a series of sub-factors that look at each of the failure mechanisms and comparing it to how resistant the container is to that failure mechanism. The sub-factors for each mechanism are then summed up. An age value is also included to account for the aging of the packages. This is used as a multiplier in the Frequency factor. The characteristics looked at are:

Material Physical and Chemical Hazards Factor: This factor accounts for the existence and degree of physical and chemical hazards that the contained material may have on the container that could cause failure of the container. The following broad categories are considered.

- Energetic Reactions with air: Pyrophoricity, Explosion Sensitivity or Flammability

- Pressurization: Gas Generating, Oxidative Expansion, and/or Moisture Content
- Corrosion: Corrosivity, Solutions, and/or Incompatible Materials
- Radiation Field and Heat Generation

Table 1
A_2 and Specific Activity Values

Isotopes	A_2 (Ci)	Specific Activity (Ci/g)	Isotopes	A_2 (Ci)	Specific Activity (Ci/g)
U-232	$2.7x10^{-2}$	$2.2x10^{1}$	Th-228	$2.7x10^{-2}$	$8.2x10^{2}$
U-233	$1.6x10^{-1}$	$9.7x10^{-3}$	Th-229	$1.4x10^{-2}$	$2.1x10^{-1}$
U-234	$1.6x10^{-1}$	$6.2x10^{-3}$	Th-232*	Unlimited	$1.1x10^{-7}$
U-235* [a]	Unlimited	$2.2x10^{-6}$	Np-237	$5.4x10^{-2}$	$7.1x10^{-4}$
U-235 enriched < 20%	Unlimited	$2.2x10^{-6}$	Am-241	$2.7x10^{-2}$	3.4
U-235 enriched > 20%	**	$2.2x10^{-6}$	Am-243	$2.7x10^{-2}$	$2x10^{-1}$
U-236	$1.6x10^{-1}$	$6.5x10^{-5}$	Bk-249	8.1	$1.6x10^{3}$
U-238*	Unlimited	$3.4x10^{-7}$	Cm-244	$5.4x10^{-2}$	$8.1x10^{1}$
Pu-238	$2.7x10^{-2}$	$1.7x10^{1}$	Cm-246	$2.7x10^{-2}$	$3.1x10^{-1}$
Pu-239	$2.7x10^{-2}$	$6.2x10^{-2}$	Cf-252	$8.1x10^{-2}$	$5.4x10^{2}$
Pu-240	$2.7x10^{-2}$	$2.3x10^{-1}$			
Pu-241	1.6	$1x10^{2}$			
Pu-242	$2.7x10^{-2}$	$3.9x10^{-3}$			

*The quantities for U-235, U-238, and Th-232 require an intake of more than 10 mg to result in the given threshold dose. Standards established by the IAEA assume an individual will inhale no more than 10 mg. For uranium isotopes, non-radiological effects, such as chemical toxicity, may be limiting and require evaluation per 10 CFR 851 and DOE O 440.1A.
**Gram values are based on 49 CFR 173.435 dated October, 2006. Isotopic mixtures vary and shall be calculated. Refer to 49 CFR 173.433.
[a] These isotopes have A_2 values that considered the contributions from progeny with less than 10 day half-life.

Container Characteristics Factor: This factor accounts for the container properties that serve to mitigate the potential impact of physical and chemical hazards. The following broad categories are considered:

- Prevention of reaction with air: Sealing Mechanism
- Resistance to pressurization: Venting and/or Expansion Mechanism
- Resistance to Corrosion: Resistance to packaged material, reaction by-products, gases, corrosion, etc.
- Resistance to Radiation Field

and Heat Generation: Materials of package construction including organic package materials, such as plastic bags, can seals, o-rings, etc.

- Ability to maintain integrity upon drop

Container age: The age of the container is considered using four general time frames:

- 0 to 5 years
- 5 to 10 years
- 10 to 20 years
- Greater than 20 years

Final Risk Ranking
A matrix is utilized that scores a material and container for each of these factors and multiplies or adds the scores to provide a qualitative prioritization. It is utilized to indicate a relative prioritization for repackaging. The resulting score is put into the following broad categories:

- Very High
- High
- Moderate
- Low

Judgment will have to be made as to the relative priority within a risk ranking category or at the boundaries between categories. In addition, surveillance data that indicates potential concern with a stored material/class of containers should be considered in establishing repackaging priorities. If there is an indication of potential problems with a stored materials/class of containers, appropriate action should be taken to ensure protection of workers including adjusting the priority for repackaging as needed.

4. Prioritization Procedure

The following is a step-by-step procedure for establishing a qualitative numerical score for the repackaging prioritization. This methodology can be applied to individual packages or applied to groups of packages that have similar characteristics.

Step 1: Determine Health Risk Category

The score for the health risk category is determined as follows. Calculate the typical content in the package(s) and determine what factor of the A_2 value it is. Use the following table to determine the Consequence Factor:

	Score
Group 1: $< 20 \times A_2$	1
Group 2: $20 \times A_2$ to $200 \times A_2$	2

Group 3: $200xA_2$ to $10,000xA_2$	10
Group 4: $> 10,000xA_2$	20

For example 300 grams of U-233, 8 grams of Pu-239 or 30 mgrams of Pu-238 would be in Group 1; 1000 grams of Pu-239 or 5 grams of Pu-238 would be in Group 3.

Step 2: Determine Material Physical and Chemical Hazards

Based upon available data or process knowledge of the stored nuclear material, determine whether the material is:

Category M1[1]:	Reactive with air: Pyrophoricity, Explosion Sensitive or Flammable
Category M2:	Pressure Generating: Gas Generating, Oxidative Expansion, and/or has Moisture
Category M3:	Corrosive: Corrosivity, Solutions, and/or has Incompatible Materials

In each of these categories, score the material as follows[2]:

No potential:	0
Low potential:	2
High potential:	5

In the Radiation Decay/Heat Generation category and Radiation Field (M4), score the material as follows:

Low Heat/Radiation Field Generation (Specific Activity $< 1x10^{-1}$ Ci/g):	1
Mid Heat/Radiation Field Generation (Specific Activity between $1x10^{-1}$ and 1 Ci/g):	2
High Heat/Radiation Field Generation (Specific Activity $> 1x10^{1}$ Ci/g) :	5

Step 3:Determine the Container Characteristics:

These container characteristics scores will be multiplied with the score for corresponding Material Hazards scores except for the last category, i.e., ability to maintain integrity upon drop (See Table 2). For example the Hazard Category M1 score will be multiplied with the Container Category C1 score. Therefore, the score for the container category score is based upon how poorly it acts to mitigate the corresponding hazard category.

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[1] The symbol M1 is used to denote "material hazard" category 1. The symbols C1, C2 etc are used to denote Container Characteristics categories.

[2] If material characteristics are not know then a medium value should be chosen unless some process specific knowledge indicates that a higher value is warranted.

The higher the number the worse the system performs. The following are qualitative guidelines for scoring each of the following container categories

Category C1: Reaction with air: Sealing Mechanism
Category C2: Pressure Generation: Venting and/or Expansion Mechanism
Category C3: Corrosion Resistance: Resistance to reaction by-products, gases, container corrosion, etc.
Category C4: Resistance to Heat and Radiation Field:

Good resistance to corresponding physical or chemical hazard: 1
Fair resistance to corresponding physical or chemical hazard: 3
Poor resistance to corresponding physical or chemical hazard: 5

For category C5 (Ability to resist drops), the following guidelines apply:

High probability of maintenance of complete integrity upon drop: 1
Medium probability of maintenance of complete integrity upon drop 3
Low probability of maintenance of integrity upon drop: 5

The group that any given container or class of container falls in should be based upon testing results and/or engineering judgment. The following are recommendations for characterizing commonly used containers:

Hagan:	High Probability
Food Pack Cans:	Medium Probability
Slip lid and Paint Cans:	Low Probability

Site-specific considerations as to the robustness and integrity of containers should be accounted for.

Table 2
Correlation Between Material Categories and Container Categories

Material Physical or Chemical Property	**Corresponding Container Characteristic potentially mitigating the property**
Category M1: Pyrophoricity, Explosion Sensitive or Flammable	Category C1: Sealing Mechanism
Category M2: Gas Generating, Oxidative Expansion, and/or has Moisture	Category C2: Venting and/or Expansion Mechanism
Category M3: Corrosivity, Solutions, and/or has Incompatible Materials	Category C3: Resistance to reaction by-products, gases, corrosion, etc.
Category M4: Radiation Heat Generation	Category C4: Materials of Construction (resistance to heat/radiation damage)
	Category C5: Ability to maintain integrity upon container drop

Step 4: Determine the time the material has been stored in the container. Score the container age as follows:

0 to 5 years:	1
5 to 10 years:	2
10 to 20 years:	5
Greater than 20 years	10

Step 5: Determine the total score for the combination of the Health Hazard, Material Hazard, Container Characteristics, and time the material has been stored in the container as follows:

Total Score = [Health Hazard]*[Sum of (Material Hazard {M1-4})*(Container Characteristics {C1-4})]*[Container Integrity {C5}]*[Age]

The following is an example for 2000 grams of wet pure plutonium oxide in a slip lip container that is 6 years old:

Health Hazard (> 1000 A2 Ci):	20
M1 (Pyrophoricity etc):	0
M2 (Pressure Generating, etc):	5
M3 (Corrosive etc):	2
M4 (Heat Generation):	2
C1 (Sealing):	3
C2 (venting)	1
C3 (Corrosion resistance)	1
C4 (Heat/Rad damage resistance)	1
C5 (integrity upon drop)	5
Age (6 years):	2

Total Score = 20*(0*3 + 5*1 + 2*1 + 2*1)*5*2 = 1800

The qualitative score is put into one of the following broad categories.

Very High	(>10000)
High	(1000-10000)
Moderate	(100-1000)
Low	(<100)

These relative scores (and category of priorities) are a tool for prioritizing the schedule for performing the repackaging of the nuclear materials.

Table 3 provides the matrix illustration for performing this calculation.

Step 6: Evaluate whether there are special conditions that warrant changing the prioritization category (based upon engineering judgment). The basis for any changes should be documented.

Table 3
Summary of Prioritization Data

Health Hazard		Material Hazard and Container Mitigation				Age	
Container Contents	Score	Material Characteristic	Score	Container Mitigation Characteristic	Score	Age (yrs)	Score
$< 20xA_2$	1	M1: Pyrophoricity, Explosion Sensitive or Flammable	0, 2, or 5	C1: Sealing Mechanism	1, 3, or 5	0-<5	1
$20xA_2$ to $200xA_2$	2	M2: Gas Generating, Oxidative Expansion, and/or Moisture Content	0, 2, or 5	C2: Venting and/or Expansion Mechanism	1, 3, or 5	5-<10	2
$200xA_2$ to $10,000xA_2$	10	M3: Corrosivity, Solutions, and/or Incompatible Materials	0, 2, or 5	C3: Resistance to reaction by-products, gases, corrosion, etc.	1, 3, or 5	10-<20	5
$> 10,000xA_2$	20	M4: Radiation Decay Heat Generation	1, 2, or 5	C4: Materials of Construction	1, 3, or 5	>20	10
				C5: Drop Vulnerability	1, 3, or 5		

Attachment 1 provides typical values for material types and container types utilized at DOE. These values were determined by a working group that tested implementation of this prioritization methodology.

5. References:

5.1 DOE M 441.1-1, Nuclear Material Packaging Manual, Draft.

5.2 Safety Guide No. TS-G-1.1 (ST-2), Appendix I, "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Materials", 2002.

5.3 DOE-STD-3013-2004, Stabilization, Packaging, and Storage of Plutonium Bearing Materials, April 2004.

5.4 DOE-STD-3028-2000, Criteria for Packaging and Storing Uranium-233-Bearing Materials, July 2000.

5.5 DOE HDBK-1129-1999, Tritium Handling and Safe Storage, March 1999.

5.6 49 CFR 173, Shippers-General requirements for Shipping and Packaging, October 1, 2006.

5.7 10 CFR 851, Worker Safety and Health Program, February 9, 2006.

5.8 DOE O 440.1A, Worker Protection Management For Doe Federal And Contractor Employees, 03/27/1998

ATTACMENT 1

TYPICAL VALUES

Material Properties

	Uranium Metal	Uranium Powder	High Surface Area Pu Metal	Low Surface Area Pu Metal	Un-stabilized Pure Pu Oxide	Un-Stabilized Impure Pu Oxide from pyrochemical processing	Stabilized Pu Oxide and Residues
M1: (Pyrophoricity etc):	1	0	5	0	0	0	0
M2: (Pressure Generating, etc)	1	0	3	3	2	4	1
M3: (Corrosive etc):	0	0	0	0	0	4	1
M4: (Heat/Radiation Field Generation)	1	1	1	1	1	1	1

Container Properties

	Slip Lid Cans	Paint Cans	Food Pack Cans	Hagan
C1 (Sealing)	5	4	2	1
C2 (venting)	5	4	2	1
C3 (Corrosion resistance)	2	2	2	2
C4 (Heat/Radiation damage resistance)	3	1	1	2
C5 (integrity upon drop)	5	4	3	1

ATTACHMENT 4
EXERPT FROM RECOMMENDATION 2005-1 IP

5.3 Implementing Improved Nuclear Material Packaging Requirements

Issue Description
After the new packaging and storage criteria document(s) is(are) issued, each affected Department site office will evaluate their stored materials and establish a resource loaded schedule and funding plan for implementing the document. These activities will include identifying materials whose packaging must either be qualified or replaced, deciding whether to qualify current packaging or replace it with already qualified packaging, conducting a packaging prioritization assessment to determine the correct order in which to repackage materials, as applicable, and establish and implement a surveillance plan consistent with the technical basis for each packaging scheme employed. Based on the Department nuclear material risk profile, the Department will ensure that the highest priority items, as determined by the complex-wide risk ranking methodology, will be qualified or repackaged first at all sites.

Board Recommendation
Prioritize implementation of the improved nuclear material packaging requirement consistent with the hazards of the different material types and the risk posed by the existing package configurations and conditions.

Resolution Approach
The Department will establish a risk ranking nuclear materials packaging methodology which each site will use to develop a site specific implementation plan based on the requirements of the approved interim storage order/standard/manual. The site implementation plan will include a risk based priority system that is consistent with the hazards of the materials/packages being stored. The site's implementation plan shall include the following information:

1. Identify the material type(s) in storage
2. Identify the material matrix
3. Describe current packaging configuration(s) for each material type(s) and maxtrix(es)
4. Risk ranking of current nuclear materials in storage
5. Number of containers in storage by material type(s) and packaging configuration(s)
6. Schedule, with milestones, for the repackaging of materials into packages that meet the new requirements
7. Schedule for development and implementation of surveillance for materials packaged to the new requirements

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Clarifications to Implementation Plan: (1) "resource-loaded schedule" is a schedule that includes the identification of manpower needs to perform the activity, (2) "material matrix" is the physical form of the material and (3) schedule should have containers prioritized by container and material type rather than by individual container as appropriate.