SANDIA REPORT

SAND2003-4082

Unlimited Release

Printed November 2003

Assessment of Packaging Needs for the National Nuclear Security Administration's Office of Defense Programs

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Prepared by
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Albuquerque, New Mexico 87185 and Livermore, California 94550

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Abstract

This report documents a study by Sandia's Systems Analysis Group to assess the status of, and need for, shipping containers to support the mission of National Nuclear Security Administration's Office of Defense Program. The focus of the study evolved into determining the status of existing packages relative to Federal Regulations for the Department of Transportation and Nuclear Regulatory Commission. Proposed regulatory changes will mandate the elimination or restricted use of many current DP packages. This study clarifies numerous misconceptions regarding these regulatory changes and status of packages relative to them. We have proposed guidelines for new package development based on the regulatory status of existing packages. Additionally, we have identified attributes that will make new packagings more amenable to accommodating new contents. This will allow the new packagings to better fill voids in container needs that are recognized but unable to be characterized at this time.

Acknowledgment

The authors would like to thank the many individuals who were interviewed and provided information for this assessment.

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Abbreviations & Acronyms

A ₁	Type A packaging activity limit for special form radioactive material	NNSA	National Nuclear Security Administration
A ₂	Type A packaging activity limit for normal form radioactive material	Np	Neptunium
AL	Albuquerque	NTP	National Transportation Program
AEC	Atomic Energy Commission	NTS	Nevada Test Site
ASME	American Society of Mechanical Engineers	NRC	Nuclear Regulatory Commission
Bq	Becquerel	NSE	National Security Exemption
CA	California	NWC	Nuclear Weapons Complex
CFR	Code of Federal Regulations	OST	Office of Secure Transportation
Ci	Curie	OTA	Offsite Transportation Authorization
CRT	Cargo-Restraint Transporter	OTC	Offsite Transportation Certificate
CV	Containment Vessel	PCD	Packaging Certification Division
DAF	Device Assembly Facility	psi	Pounds per square inch
DNFSB	Defense Nuclear Facilities Safety Board	Pu	Plutonium
DOE	U.S. Department of Energy	PX	Pantex Plant
DOT	U.S. Department of Transportation	RAM	Radioactive Material
DP	Defense Programs	RTG	Radioisotope Thermoelectric Generator
EM	Environmental Management	S	Small
H	High	SARP	Safety Analysis Report for Packaging
HAC	Hypothetical Accident Condition	SCE	Subcritical Experiment
HEU	Highly Enriched Uranium	SG	Safety Guide
HQ	Headquarters	SGT	Safeguards Transport
HSC	Horizontal Shipping Container	SNL	Sandia National Laboratories
IAEA	International Atomic Energy Agency	SNM	Special Nuclear Material
ICRP	International Commission on Radiological Protection	SRS	Savannah River Site
JTA	Joint Test Assembly	SST	Safe-Secure Trailer (or Transport)
KCP	Kansas City Plant	Sv	Sievert
LACEF	Los Alamos Critical Experiments Facility	S/Y	(Container) Shipments per Year
LANL	Los Alamos National Laboratory	TSRA	Transportation System Risk Assessment
LLNL	Lawrence Livermore National Laboratory	TSRP	Transportation Safety Review Panel
M	Medium	U	Uranium
N	No	WIPP	Waste Isolation Pilot Plant
NCT	Normal Conditions of Transport	WR	War Reserve
NM	New Mexico	Y	Yes
		Y-12	Oak Ridge Y-12 Plant
		Zr	Zirconium

Assessment of DP Packaging Needs

6M2R-055

Robert A. Watson
David H. Zeuch

February 2003

ES-2100

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03/08/15 Slide 1

- Information collection for this study was completed on February 11, 2003. The date on this briefing is to represent that time frame, as events in the container arena continue to unfold.
- The containers illustrated on this title slide represent extremes of the old and new in packaging technology:
 - 6M2R-055:
 - Specification package
 - Carbon steel drum – ring closure
 - Loose Celotex packing material
 - Specification vessel – not leak testable
 - ES-2100:
 - Performance package
 - Stainless steel drum – bolted closure
 - Encapsulated Kaolite packing material
 - ASME-certified containment vessel – leak testable

Note: Annotations are intended to elaborate on, rather than be a narrative of, the material presented in the slides.

Outline

Why We Are Doing This Study
Who We Talked To
Background & Regulatory Changes
Attributes of New & Existing DOE Packages
Assessment of DP Packaging Needs
Final Observations

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03/08/15 Slide 2

- This slide presents an outline for the complete briefing.

Why We Are Doing This Study

- Request from Paul Mann in May 2002.
- In response to:
 - Pending DP needs;
 - Alignment of DOT/NRC Regulations to IAEA Standards, including:
 - Revises activity limits (A_1 & A_2), removes Pu-238 from fissile material list,
 - Expands dynamic crush testing for fissile packages,
 - Eliminates double containment requirement for Pu,
 - Eliminates use of DOT “specification” (versus “performance”) packages.
- Study objectives:
 - Develop understanding of DP packaging issues & needs,
 - Explore ramifications of *pending* regulatory changes,
 - Assess proposals for six new DP packagings:

Necessary?

Sufficient?

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03/08/15 Slide 3

- Paul Mann, the DP Packaging Manager, requested assistance in assessing six new packaging designs proposed in a draft packaging plan (*Office of Defense Programs Packaging Inventory, Packaging Database, and Packaging Tracking System*, February 28, 2002). Some of the proposed new designs were purported to be needed due to pending DOT/NRC regulatory changes, some of which are summarized in this slide.
 - DOT regulations are detailed in 49CFR171-178, while NRC regulations are provided in 10CFR71. Though some overlap exists, the DOT regulations are primarily involved with the transportation of radioactive materials, while the NRC regulations focus on the packaging.
 - Proposed rule changes are contained in: U.S. Department of Transportation, Hazardous Materials Regulations; Compatibility with the Regulations of the International Atomic Energy Agency, and U.S. Nuclear Regulatory Commission, Compatibility With IAEA Transportation Safety Standards (TS-R-1) and Other Transportation Safety Amendments, both published in Federal Register, Vol. 67, No. 83, April 30, 2002. Current IAEA Standards are contained in: International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised), June 2000.
- Our charter was to assess these proposed designs in terms of DP's needs and the pending regulatory changes, recognizing that these changes are not finalized. The assessment was to include whether these six designs were necessary and sufficient to satisfy DP's needs.

Who We Talked To

Maximo Barela, Steve Bellamy, Glenn Binns, Tom Blanchat, Paul Blanton, Gerry Byington, Kevin Carbiener, John Clauss, Scott Couture, Matt Feldman, Pat Ferrell, Preston Foster, Charlie Gaynor, Monty Goins, Lee Griffith, Steve Hamp, Rick Haynes, Paul Hern, Steve Holder, Cliff Holman, Dean Jones, Lester Lee, Cindy Kajder, Bernadette Kirk, Ron Knief, Gary Lanthrum, Susan Longley, Paul Mann, Gerald May, Steve McClanahan, Steve Nunley, Brian Oden, Erich Opperman, Todd Owen, Dave Pace, Paul Parker, Cecil Parks, Tim Pflaum, Jeff Philbin, Jim Pierce, King Ragos, Gilbert Rosenberger, TJ Roseth, Eric Ryder, Tom Schara, Joe Schelling, Kathy Schwendenman, Norm Schwes, Harish Sharma, Scott Shiraga, Tim Stone, Warren Strong, Steve Thompson, Greg Tipton, Phillip Turner, Sharon Walker, Jim Walls, ...

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03/08/15 Slide 4

- During the course of our study, we talked to people from NNSA (AL & HQ), LANL, LLNL, SNL (CA & NM), Y-12, SRS, and beyond. These people included a variety of package designers, analysts, regulators, users, shippers, and managers.

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03/08/15 Slide 5

Regulatory Definitions

[per 49CFR173 Subpart I (DOT) & 10CFR71 (NRC)]

- **Packaging:** assembly of components necessary to enclose the radioactive contents completely, including:
 - **Containment System:** assembly of components of the packaging intended to retain the radioactive material during transport; and
 - **Overpack.**
- **Package:** the packaging with its radioactive contents.
- **A_1 / A_2 :** Maximum activity for special / normal form material permitted in Type A package:
 - $A_1 \geq A_2$ – specific regulations & qualification tests for special form;
 - Specific limits provided for large number of radionuclides, “ratio rule” for mixtures;
 - Multiples of activity limits used for other regulatory purposes (e.g., leakage, excepted package, and route control limits).

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03/08/15 Slide 6

- This slide provides some definitions from the DOT & NRC regulations:
 - The regulations provide specific definitions for the terms “packaging” and “package.” This briefing will also use the term “container” in a less specific manner.
 - Activity is the measure of radionuclide decay rate. Many of the operational limits defined in the regulations are stated in terms of activities.
 - The A_2 (and A_1) quantities are determined such that “an A_2 quantity of any radionuclide has the same potential for damaging the environment and human species as an A_2 quantity of any other radionuclide” (U.S. Nuclear Regulatory Commission, *Draft Regulatory Analysis of Major Revision of 10 CFR Part 71*, NUREG/CR-6713, March 2002).
 - Some examples of activity values are noted on the next slide.

More on Activities (Measure of Radionuclide Decay Rate)

- **Units: 1 Curie = 3.7×10^{10} becquerel (disintegrations/second).**
- **Activity limits for radionuclides are set to ensure safe, consistent human dose in the event of a hypothetical containment breach:**
 - Most proposed limits are within a factor of 3 of current limits;
 - A few radionuclides have increased A_1 values by 10-100X;
 - No A_1 or A_2 values are lower than 1/10th of previous values;
 - Specific differences between IAEA & proposed DOT/NRC limits exist.

	Current Values		Proposed Values		Current Values		Proposed Values	
	A_1 (TBq)	A_2 (TBq)	A_1 (TBq)	A_2 (TBq)	A_1 (g)	A_2 (g)	A_1 (g)	A_2 (g)
Pu-239	2	0.0002	10	0.001	870	0.087	4300	0.43
U-233	10	0.001	40	0.09	28,000	2.8	110,000	250
U-235*	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
H-3	40	40	40	40	0.11	0.11	0.11	0.11

* Type B packaging typically dictated by other radionuclides in mixture.

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03/08/15 Slide 7

- This slide elaborates on the calculation of activity limits and the effects of the revisions under consideration:
 - Revised (1996 IAEA Standards) radionuclide limits were derived from improved “Q system” dose calculations using latest International Commission on Radiological Protection (ICRP) coefficients and mostly unchanged, pragmatic, severe accident assumptions.
 - Effective dose of person exposed in the vicinity of a transport package following an accident should not exceed 50 mSv (5 rem). For calculational purposes the person is considered to be at a distance of 1 meter from the damaged package and to remain at this location for 30 minutes. The following doses are computed:
 - Q_A – external dose due to photons,
 - Q_B – external dose due to beta emitters,
 - Q_C – internal dose via inhalation,
 - Q_D – skin contamination and ingestion doses, and
 - Q_E – submersion dose due to gaseous isotopes.
- The A_1 value for special form materials is the lesser of the two values Q_A and Q_B , while the A_2 value for non-special form materials is the least of the A_1 and remaining Q values (International Atomic Energy Agency, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*, No. TS-G-1.1 (ST-2), June 2002).
- Also listed are current and proposed limits for isotopes of interest to DP (with specific activities used to convert activity limits to mass limits):
 - Compared to current values, the proposed activity limits are 5X higher for Pu-239, 4X/90X (A_1/A_2) higher for U-233, and unchanged for U-235 and tritium.
 - Note that there is no activity limit for pure U-235. However, U-235 is never pure, so the ratio rule must be applied to the impure mixture to determine the applicability of Type B packaging.

Packaging Types and Activities of Contents

Requirements

Containment						<i>Note: Type B categories are defined in NRC Reg. Guide 7.11 (i.e., not in 10CFR71).</i>
Subcriticality						
Shielding						
		<i>Type A</i>	<u>CAT III</u> Adequate margin of safety	<i>Type B</i> <u>CAT II</u> Large margin of safety	<u>CAT I</u> Very large margin of safety Controlled shipping routes	
	<i>Limited</i>					
	per 49CFR 173.425	A ₁ A ₂	30 A ₁ 30 A ₂	3000 A ₁ 3000 A ₂ 30,000 Ci (1110 TBq)		

Curies or Becquerel

Curies or Becquerel

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03/08/15 Slide 8

- This plot defines the different categories of Type B packages in terms of activities. It is important to understand that the different Type B categories are *not* defined in the Code of Federal Regulations. Rather, they are established in the NRC Regulatory Guides and carried through to the DOE Safety Guides.

(Note that the categories defined for packaging are different from those defined for safeguards. Safeguards categories are defined in terms of both the attractiveness level of the material or device and the mass of Pu/U-233 or U-235. See U.S. Department of Energy, *Manual for Control and Accountability of Nuclear Materials*, DOE M 474.1-1A, 11-22-00, for more information on safeguards categorizations.)

- Another observation from this plot is that activities should be viewed from a *logarithmic* scale perspective.

Recommended Design Criteria (ASME Code Sections per NRC Reg. Guides)

Source:
SG 100

	Package Contents		
	Category III	Category II	Category I
Containment Vessel	Section VIII Division 1	Section III Subsection ND	Section III Subsection NB
Subcriticality	Section III Subsection NG		
Shielding and other	Section VIII Division 1	or	Section III Subsection NF

- Category I transport packages equivalent to ASME Class 1 components; Category II transport packages equivalent to ASME Class 3 components.
- Normal Conditions of Transport (NCT) equivalent to ASME Service Level A; Hypothetical Accident Conditions (HAC) equivalent to ASME Service Level D.

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03/08/15 Slide 9

- This table contains the recommended design criteria for the different categories of Type B packages. It is important to note two items:
 - Once again, these design criteria are not legal requirements, but are established in the NRC Regulatory Guides and carried through to the DOE Safety Guides.
 - NRC allows for the use of other design criteria as long as they can be justified to be as conservative as the ASME Code.
- ASME Section III contains “Rules for Construction of Nuclear Facility Components;” Section VIII is for “Pressure Vessels.” Section III requirements are a more recent addition to the NRC recommended design criteria.
 - In the past, all containment vessels (CVs) were designed to Section VIII of the ASME Code. The FL and UC-609 are Category I/II packages with Section VIII CVs.
 - The current UC-609 SARP states “the containment vessel (is) fabricated in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 with additional requirements that make the *fabrication* equivalent to that required by Section III, Subsection NB of the code” (emphasis added). However, this does not mean that the UC-609 CV *design* satisfies Section III, Subsection NB requirements.
 - SRS reported that one of their CV designs, originally rated for 1100 psi using Section VIII, was nominally rated for 900 psi based on Section III criteria. While not definitive, this provides a useful comparison between the two sections.

Regulatory Tests for Hypothetical Accident Conditions

- **Sequential tests of single specimen in order:**
 - Free Drop (package from 30 feet onto rigid surface);
 - Crush (1100# plate from 30 feet onto package);
 - Exempted: - packages weighing more than 1100#, or
 - packages with specific gravity greater than 1, or
 - all (current) or *non-fissile (proposed)* contents under 1000 A₂;
 - Puncture (package from 40 inches onto 6"Ø bar);
 - Thermal (30-minute fuel/air fire or equivalent);
 - 3-Foot Immersion (only for fissile packages that utilize 10CFR71.55(c) leakage exception in criticality analysis).
- **50-Foot Immersion test of separate specimen.**
- **Crush test first introduced in 1996 NRC Regulations:**
 - IAEA Standards requires Free Drop or Crush (not *both* like 10CFR71);
 - *Proposed NRC regulatory changes (and current IAEA Standards) eliminate the activity exemption for fissile packages, as noted above.*

Tests
must be
oriented
to
maximize
damage.

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03/08/15 Slide 10

- This slide describes the Hypothetical Accident Conditions (HAC) tests required by 10CFR71.73:
 - The proposed change for the dynamic crush is highlighted in red, namely the elimination of the activity exemption for fissile packages. Eliminating this exemption will affect a significant percentage of existing DOE Type B packaging designs.
 - The order of tests is considered by the IAEA to correspond to the order of environmental threat to the packaging in a real transport accident; i.e., mechanical impacts followed by thermal exposure. The test sequence also ensures mechanical damage to the package prior to the imposition of the thermal test; thus, the package is most liable to sustain maximum thermal damage. NRC adds conservatism by requiring *both* Free Drop and Crush.
 - The 3-Foot Immersion test at the conclusion of the test sequence is optional, but particularly important for fissile material packages. If successfully passed, and in conjunction with (i) design features that prevent leakage from a single packaging error and (ii) pre-shipment measures that assure no containment system leakage, then exceptions are allowed to the requirement in 10CFR71.55 that worst-case criticality calculations assume water leakage into, or content leakage from, the containment system. As discussed later, utilizing this exception increases package flexibility and eliminates issues associated with criticality assessments. However, the applicant who requests the leakage exception also accepts responsibility for the shipments.

Double Containment Regulations for Plutonium

- **Instigated by AEC in 1974 (also requirement for solid form):**
 - In anticipation of widespread reprocessing of spent fuel – didn't happen;
 - Exemptions for reactor fuel, metal or metal alloy, and vitrified high-level waste;
 - Not required in IAEA Standards, and not required for any *other* radionuclide;
 - Small number of radionuclides have A_2 values less than or equal to Pu.
- **Petition by International Energy Consultants, Inc. in 1997:**
 - A_2 quantity of *any* radionuclide is supposed to have same consequence;
 - Argued that incongruence could lead to other challenges of regulations.
- **NRC proposed position:**
 - Remove double containment requirement for Pu;
 - Maintain requirement for solid form if >20 Ci;
 - Noted objections & possible consequences regarding WIPP shipments in TRUPACT-II (double containment) packagings.

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03/08/15 Slide 11

- This slide summarizes the history, and basis for change, of the requirement for double containment of plutonium:
 - Currently, 10CFR71.63 requires that quantities of plutonium in excess of 20 curies be shipped in solid form *and* in double containment. These regulations were instigated by the Atomic Energy Commission (AEC) in 1974, when widespread reprocessing of spent commercial reactor fuel and resulting shipments of liquid plutonium nitrate were anticipated. These assumptions were obviated in 1979, when the Carter administration decided against the reprocessing of spent civilian fuel.
 - Currently, five radionuclides have A_2 values less than, and eleven have values equal to, that for Pu-239. Thus, 16 radionuclides could be viewed as producing hazards equal to or greater than Pu-239, yet double containment is not required for them.
 - Commenters on this proposed change suggested that agreements and/or expectations existed for the use of TRUPACT-II, a double-containment package, for transuranic waste shipments to the Waste Isolation Pilot Plant (WIPP). However, the NRC found no conflicts between the proposed change and existing laws or agreements related to WIPP; double containment is not a special requirement for WIPP shipments.

(Information extracted from: U.S. Nuclear Regulatory Commission, *Compatibility With IAEA Transportation Safety Standards (TS-R-1) and Other Transportation Safety Amendments*, Federal Register, Vol. 67, No. 83, April 30, 2002.)

Proposed Transitional Arrangements for Existing Type B Packages

The proposed DOT/NRC regulations place the continued use of previously compliant packages into three categories:

- **Eliminated:** Certain specification packages and packages certified to pre-1983 regulations will be removed from service after a designated grace period;
- **Restricted (Grandfathered):** Packages certified to the current (1996) or previous (1983) versions of the regulations are allowed to remain in service *indefinitely*, but with restrictions including:
 - No fabrication of new packagings beyond a specified date,
 - Additional limitations on international shipments; and
- **Unrestricted:** The law allows recertification of an existing package to the proposed (~2003) regulations if it complies with the proposed regulations.

(Also, to be approved, modifications to the design and authorized contents of a previously approved package must satisfy the *proposed* regulations and must not be significant with respect to the design, operations, safety, or criticality of the package when subjected to the *proposed* NCT and HAC tests.)

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03/08/15 Slide 12

- The purpose of grandfathering is to minimize the costs and impacts of implementing changes in the regulations on existing packaging designs and packages. As regulations, these transitional arrangements provide the *legal* limitations for the use of existing packagings.
- There is significant confusion regarding the “Grandfathered” category. Numerous statements were made during interviews about what could and could not be done with packages that are unable to satisfy the proposed regulations. However, many of those statements are inconsistent with the regulations themselves. This slide summarizes what is actually contained in the proposed regulations. Much study effort was spent dispelling the inconsistencies in arriving at this summary.
- A particularly important point is that grandfathered packages can continue to be used *indefinitely*, that is, until they are specifically written *out* of law.
- Equally important, modifications can be made to the design and authorized contents of a previously approved Type B package:
 - The modifications must not be significant with respect to the design, operating characteristics, or safe performance of the containment system, and not be significant with respect to the prevention of criticality for fissile material packages, when the package is subjected to the *proposed* tests for Normal Conditions of Transport and Hypothetical Accident Conditions.
 - The modifications must satisfy the *proposed* requirements of 10CFR71.
 - This provision does *not* distinguish between restricted and unrestricted packages.
- Backup Slide 37 provides a tabulated summary of the current and proposed transitional arrangements.

DOE/NNSA is a Type B Packaging Regulator

- 49CFR173.7 allows DOE to make & certify its own packages to standards equivalent to 10CFR71, but also exempts DOE from DOT hazardous materials regulations for the purpose of national security.
- The NNSA Regulator provides two types of package approvals:
 - Offsite Transportation Certificates (OTCs), valid up to 5 years.
 - ✓ Package fully satisfies 10CFR71, as documented in a Safety Analysis Report for Packaging (SARP).
 - Offsite Transportation Authorizations (OTAs), used for a “specific package and loading configuration, designated routes and campaign duration.”
 - ✓ Package cannot fully satisfy 10CFR71, but a Transportation System Risk Assessment (TSRA) quantifies the risk.
- A National Security Exemption (NSE) is a signed transportation authorization that includes any requirements or restrictions deemed necessary by the Deputy Administrator for Defense Programs.

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03/08/15 Slide 13

- There are currently two regulatory groups in DOE, one under NNSA and the other under EM. The EM Regulator function may be eliminated. The NNSA Regulator (i.e., the Packaging Certification Division (PCD) of the NNSA Service Center) will continue to function as allowed by law.
- Offsite Transportation Certificates (OTCs) are the typical form of approval used by the NNSA Regulator for Type B packages. Offsite Transportation Authorizations (OTAs) are designed to deal with DP contents that are fundamentally unable to satisfy the federal regulations. OTAs are *not* intended to be used in cases where a certifiable package is attainable. There are exceptions to these general characterizations, e.g., the Horizontal Shipping Container (HSC).
- The National Security Exemption (NSE) is reportedly appropriate for limited, preferably one-time, possibly emergency shipments. Though used extensively, this terminology and acronym are not sanctioned in any regulation or order. Utilization of the NSE is rare, and because of this, the process for authorizing one is not well defined. (Since the NSE is by definition outside the regulatory bounds, the NNSA Regulator does not believe the NSE process is theirs to own.) EM recently withdrew an exemption it had authorized after it was publicized that the justification was to meet deadlines rather than national security interests.
- Backup Slides 38-42 provide an expanded discussion of these topics.

Observations on Regulations

- **There is a common belief that the regulations are stabilizing (i.e., the number of substantive regulatory changes is diminishing):**
 - Some anticipate even fewer exemptions to the crush test in the future;
 - DOT & NRC have not yet embraced IAEA Type C package requirements;
 - There are concerns about the revision period for IAEA Standards being shortened to two years, but the effects on transitional arrangements (in both the IAEA Standards and DOT/NRC CFRs) are undefined.
- **There is still much empiricism involved in establishing, and subjectivity involved in applying, the A_1 & A_2 limits.**
- **The existing double-containment exemption for solid-form Pu metal or alloy is already utilized in some DOE certifications.**

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03/08/15 Slide 14

- This slide, and the two slides following, contain observations regarding the regulations. These observations primarily result from the interviews conducted as part of this study:
 - The IAEA Type C package is for air transport of radioactive materials, the design requirements for which have not yet been adopted by DOT and NRC (ref., International Atomic Energy Agency, *Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised)*, No. TS-R-1 (ST-1, Revised), June 2000).
 - The technical basis for establishing the activity limits is as much an art as it is a science. This is reflected in the significant changes that have been made between regulatory revisions and the differences purposely allowed between the IAEA and NRC/DOT values. Applying (multiples of) these limits to establish Type B category boundaries and exemption limits involves additional subjectivity.
 - It is interesting to note that DOE has long utilized the double-containment exemption for metals and alloys expressed in 10CFR71.63(b), e.g., the FL pit container.

More Observations on Regulations

- **Grandfathering policy is not consistent across DOE:**
 - The NNSA Regulator has allowed the use of grandfathered packages:
 - The FL pit container is still in use, and can continue to be used indefinitely, though no more of these 1983-certification packagings can be fabricated;
 - However, the NNSA Regulator feels DOE should set an example by developing packages that satisfy the new regulations;
 - The NNSA Regulator also uses a stringent interpretation of 10CFR71 for modifications to the design or contents of previously approved packages.
 - Historically, the EM Regulator has avoided transitional arrangements and required packages to satisfy updated regulations for recertification.
 - The amount of tritium in the UC-609 will be reduced to $<1000A_2$ in the upcoming SARP revision to avoid the crush test requirement.
- **EM may cut its package certification program. Recertifications may be referred to the NRC, where the process for recertifying packages *originally* certified by EM is uncertain.**

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- The NNSA Regulator has allowed the use of grandfathered packages, but is actively discouraging it and advocating development of new packagings that satisfy the proposed regulations. The argument is: since the NRC is proposing that all fissile packages be crush tested, then all NNSA fissile packages should satisfy the crush requirement. However, the counter-argument is that the NRC does not view this proposed change as being significant enough for safety to preclude grandfathering those fissile packages that cannot withstand the crush test.
- There is confusion as to what constitutes “modifications” to authorized contents versus what constitutes “new” contents, particularly for grandfathered packages. Some view acceptable modifications as anything that poses “no additional risk” when compared to previously approved contents. However, the regulations detailed in Slide 12, and the NNSA Regulator, do not allow that interpretation.
- Historically, the EM Regulator has chosen to avoid transitional arrangements and required packages that come up for recertification to satisfy any regulatory updates. However, the EM regulator has also shown flexibility in addressing deflagration issues beyond the regulatory norm for the 9975 container.
- There is a concern among package designers and users regarding the process NRC will use to recertify packages with which it has no “history.” This concern is greatest for packages that are or will need to be grandfathered into the current or proposed regulations.

Final Observations on Regulations

- To take full advantage of the law when prioritizing the design and procurement of new packagings, it is essential to know the version of the regulations against which each existing package is certified and the expiration date of each certification.
 - Although currently grandfathered packages may be eliminated in future (beyond proposed) regulatory revisions, their continued use allows time to design and procure more urgently needed packages.
 - Until grandfathered packages are specifically written out of the law or safety issues arise, they can be used for their pre-grandfathered certified purposes indefinitely.
 - However, adding new contents to an existing packaging must satisfy the regulations currently in effect to be certifiable.
 - Unlike the EM Regulator, the NNSA Regulator does not use the NRC nomenclature to identify regulatory versions in the certificate number.

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- As long as there is no intent to violate the spirit of the law, there is nothing wrong with using the law to full advantage when prioritizing the design and procurement of new packagings. In order to do this, it is essential to know:
 - The version of the regulations against which each existing package is certified;
 - The expiration date of each certification (note that a packaging can have any number of certificates for different contents); and
 - Whether or not a package is: (i) currently grandfathered, or (ii) “grandfatherable” under the proposed regulations when its certification expires.
- Unlike the EM Regulator, the NNSA Regulator does not use the NRC system of suffixes that identify a package’s corresponding regulatory version. This would simplify tracking the relationship between packages and the regulations under which they were certified.

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Elements of New DOE Packaging Designs

- **Larger/stiffer overpacks with bolted (versus ring) closures:**
 - Driven by revised dynamic crush requirement;
 - Could affect integrity of payloads (which is beyond the scope of the CFRs).
- **Celotex use as filler material *strongly* discouraged:**
 - In spite of low up-front cost and long history of use;
 - Corrosion, vibration, and cleanliness issues result in increased O&M costs;
 - Questionable structural performance, particularly for dynamic crush;
 - Alternatives likely to be fully enclosed or encapsulated.
- **Single containment for plutonium.**
- **Maximize payload flexibility and SST/SGT efficiency:**
 - Default to ASME Section III, Subsection NB for containment systems;
 - Accommodate leakage exception allowed in 10CFR71.55(c) for criticality;
 - Minimize package weight and footprint.
- **Avoid addressing storage requirements for shipping containers.**

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- This slide summarizes our view of the physical attributes required in new packaging designs. It reflects: (i) perspectives of the DOE Regulators, (ii) changes in design required by the proposed regulations, and (iii) our own analysis.
 - Celotex is a sugarcane pulp fiberboard that can be laminated and machined easily to any shape needed for spacers. Other materials such as plywood and aluminum plates may be added for increased rigidity and load distribution. Celotex performs acceptably during the HAC thermal test (it smolders rather than burns), provided it is not exposed directly to flame. Corrosion issues, particularly for but not limited to beryllium, result from the trace presence of chloride as well as fluoride and sulfate anions. Handling and vibrations cause sloughing of exposed fibers that can contaminate the containment vessel, violate sealing surfaces, and ultimately lead to the need to replace the Celotex. Possible encapsulated alternatives include engineered foams (AT-400A), low-density concrete (ES-2100), and cork (SAFKEG).
 - Two somewhat conflicting requirements are payload flexibility and Safe-Secure Transport/Safeguards Transport (SST/SGT) efficiency. Because of the limited funding and interest for developing new packagings, every new packaging should be as flexible as possible in accommodating new contents. SST/SGT efficiency becomes more important as the number of shipments increase. A special-purpose packaging may be warranted when the design and procurement costs can be offset by transportation savings.
 - The combination of storage and shipping requirements was *one* of the root causes for the failure of the AT-400A program. If shipping packages are being considered for storage beyond their normal one-year maintenance cycle, issues such as O-ring degradation, pressure build-up, and corrosion must be addressed in greater detail.

Regulatory Attributes of Selected DOE Type B Containers

Container Designation	Contents	DOT/NRC Regs ~	ASME § III/NB CV?	Crush Required? *	Regulator	Earliest Certificate Expiration
6M2R-055	Pu/U Metal/Alloy, U Oxides/Compounds	Spec	N	NCR	Spec	NA
5X22°	U Metal/Alloy/Oxides/Compounds	96	Y	NCR	NRC	03/31/08
6M2R-110	U/Zr Oxides, Zr-Clad Fuel Rods	Spec	N	NCR	Spec	NA
DT-20	Weapon Components	83→96	N	NCR	NNSA	07/01/03+
DT-22	Weapon Components, U Parts, Pu-Bearing Items	83→96	N	NCR	NNSA	09/30/03+
	Pu/U Parts	83	N	NT	NNSA	09/30/03
DT-23	Weapon Components, U Parts	83→96	N	NCR	NNSA	12/01/03+
FL	Pits	83	N	NT	NNSA	04/01/07
ES-2100	HEU Metal/Broken Metal/(Oxide)"	96(→03)	Y	NCR	NNSA	06/30/05+
9975	Pu/U Metal/Oxides	96(→03)	Y	NR	EM	03/31/06
SAFKEG	Pu/U/Np Metal/Oxides, Am Oxide, RTGs, Etc.	96(→03)	Y	NR	NNSA	TBD
UC-609	Tritium (Gas, Tritiated Water, Metal Tritides)	83(→03)	N	NR	EM	02/28/04^
H-1616-1	Tritium Reservoirs, Hydride Transport Vessel	96(→03)	Y	NR	NNSA	05/31/07
H-1616-2	Tritium Reservoirs	96(→03)	Y	NR	NNSA	05/31/07

° = Commercial container. " = Activity to certify for oxide. ~ XX→YY = Original→Current; XX(→YY) = Original(→Projected).

* NT = Not Tested (required in current regs); NCR = Not Currently Required (required in proposed regs); NR = Not Required (in current or proposed regs). + = Multiple certifications exist for this container. ^ = Activity to extend certification to ~06/08.

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- This table contains regulatory attributes of the DOE Type B packages included in this study (as of April 15, 2003):
 - The primary focus was those DOE-designed packages having a projected use by DP.
 - The 5X22, a leak-testable 6M2R-055 uranium package, was not designed by DOE. However, it was included because of its significant current use by DOE and because it will not be eliminated by the proposed regulations.
 - It is recognized that DP utilizes a number of other commercial Type B packages that were not included in this study. The ramifications of the proposed regulatory changes on these packages are uncertain.
 - DP also has the Horizontal Shipping Container, which is a certified Type B package for shipping B83 assemblies and is authorized for shipping other weapon components. This is a unique package, and modifications to satisfy proposed regulatory changes are not necessary for the B83. Therefore, it has been excluded purposely from this list.
- The attributes on this and the following slide are given stoplight colors when possible. A greater number of red attributes for a container roughly translates to a higher need for replacement. Weighting the various attributes to establish an overall priority ranking was viewed as too subjective to be of benefit.
- As noted previously, understanding the regulatory status of existing DP packages involved much study effort. Conflicting opinions, even inside the NNSA Regulator, had to be reconciled. Packages designed to the current regulations and *expected* to be able to satisfy the proposed (2003) regulations are colored green in the "DOT/NRC Regs" column. Specification packages and already-grandfathered packages (including the DT-22 with some contents) are colored red in the "DOT/NRC Regs" column.

Physical Attributes of Selected DOE Containers

Container Designation "	Robust Overpack Closure?	No Celotex?	Single CV?	# Mfg'd/ In-Service	Max # per SST-2/SGT (Indiv/CRT)	Projected OST Use
6M2R-055	N	N	Y	Unknown	22/(40/32)*	H
5X22	N	N	Y	Unknown	22/32	H
6M2R-110	N	N	Y	Unknown	Unspecified	S
DT-20	Y	N	Y	201/182	10/NA	M
DT-22	Y	N	Y	437/264	22/24	H
DT-23	Y	N	Y	508/301	10/NA	M
FL	Y	N	Y	300/294	18/24	H
ES-2100	Y	Y	Y	100/100	22/20	H
9975	Y	N	N	?/~800	22/25	H
SAFKEG	Y	Y	N	36/0	22/(40/32)*	M
UC-609^	N	N	Y	?/23	18/20	M
H-1616-1	N	Y	Y	2088/2072	26/64	H
H-1616-2	N	Y	Y	212/208	26/64	M

* Designations color-coded to usable CV volume profiles; tritium package profiles are dashed.

^ Usable UC-609 CV volume inside honeycomb. * Different CRT capacities for SST-2 & SGT.

Usable CV Volume Profiles

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- This slide summarizes the physical attributes of the DOE Type B packages included in this study:
 - The first three attributes are stoplight-colored based on the elements of new DOE packaging designs detailed in Slide 18.
 - Column 6 contains useful information on the transportation efficiencies of the various packages when carried in either the SST-2 or SGT. Quantities that can be shipped when packed either individually or in Cargo-Restraint Transporters (CRTs) are given. These data are of particular use in prioritizing containers that may have similar missions, but which differ in efficiencies.
 - “Projected OST Use” is based primarily on Office of Secure Transportation (OST) scheduling information obtained from the National Transportation Program (NTP). It is intended to provide a relative measure of DOE usage in terms of container shipments per year (S/Y) averaged over approximately the next ten years:
 - 0: No Shipments Scheduled
 - S (Small): $S/Y \leq 10$;
 - M (Medium): $10 < S/Y \leq 100$;
 - H (High): $100 < S/Y$.

It is recognized that the OST scheduling information is focused on the short-term and that the fidelity diminishes rapidly beyond ~2-3 years.

Observations on Existing Containers

- **6M specification packages are workhorses for the Complex:**
 - **Inexpensive, efficient, leak-testable, U/Pu replacement is absolutely needed:**
 - Could obsolete double-containment packages (9975 & SAFKEG),
 - Need for longer (~85-110 gallon) and shielded versions recognized, but DP is not the main user for these;
 - **Many DOE offices have vested interest, but limited & uncoordinated effort:**
 - 5X22 & ES-2100 can address some interim needs for uranium,
 - Commercial industry will also need to address loss of specification packages, but DOE is a major user of the 6Ms;
 - *Immediate action may not be able to avert crisis.*
- **DT Packages:**
 - **Vulnerable to proposed crush regulations – grandfathering will be necessary, but *will preclude adding any new fissile contents*;**
 - **Section VIII CVs already complicate adding new Category I/II contents;**
 - **Already grandfathered (DT-22) & exempted (DT-22 & -23) applications.**

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- This slide, and the two slides following, provide observations on the existing suite of containers included in this study:
 - Two years after taking effect, the proposed regulations require the DOT 6M specification packages to be removed from service. Additionally, the NNSA Regulator has already recommended a phased removal of specification packages from OST service between April 30, 2001 and July 1, 2005 (G.V. Binns, *Phased Removal from Service of DOT Specification Packaging for the Shipment of Type B Quantities of Normal Form SNM*, DOE Memorandum, May 29, 2001). There is no doubt that a U/Pu-capable replacement is needed for DP, or that other DOE users have additional needs. Despite the clear importance of the 6M—and its imminent demise—there has been little coordinated progress to design, certify, and procure a replacement. With three years being the typical time frame to accomplish these tasks, *even immediate action may not be able to avert a crisis.*
 - No DT package is expected to be able to pass the crush test, but neither are these packages eliminated by the proposed regulatory changes. Thus, these packages will become grandfathered with the usual restrictions imposed by that designation (see Slides 12 and 37). In particular, no new fissile contents can be added because the proposed regulations require crush testing of all fissile packages. Additionally, some DT-22 contents are already and can remain grandfathered and, as will be discussed, some DT-22 contents have been exempted from the regulations. All DT packages have ASME Section VIII containment vessels which, by guidance but not law, restricts new contents to Category III and contributed to the exemption sought to add SKUA reactor fuel plates to the DT-23's contents.

More Observations on Existing Containers

- **FL pit package is already grandfathered:**
 - Could be obsoleted by regulatory changes *beyond* current proposals;
 - Thermal issues have significantly complicated operations;
 - AT-400A experience suggests difficult design effort for replacement.
- **ES-2100:**
 - Originally designed for NN mission that did not materialize;
 - Currently expanding NN mission scope and being tested for crush;
 - No projected use identified for DP.
- **9975/SAFKEG:**
 - Largely redundant scope, with EM as primary customer;
 - SAFKEG more efficient for shipping, but certification difficulties with (first) EM Regulator and (now) NNSA Regulator;
 - 9975 provides better shielding, but incorporates Celotex & is EM certified;
 - 6M Replacement may obsolete both.

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- The FL pit package was designed to the 1983 regulations and is already grandfathered. It is most susceptible to being eliminated by regulatory changes *beyond* those currently proposed. Moreover, thermal limits established for pits after the design of the FL have had significant repercussions on storage, handling, and shipping operations. This is just one element of the increased scrutiny placed on pits since the closure of Rocky Flats. Past experience with the AT-400A indicates that the design of a single packaging to carry a variety of pits will be a difficult and protracted process.
- The ES-2100 is a modern packaging that is attempting to be recertified to the proposed regulations (i.e., crush tested). However, it is currently a packaging without a projected DP mission.
- 9975 and SAFKEG have very similar missions, with EM as the primary customer. Thus, neither container is a high DP priority. Also, SAFKEG is yet to be certified despite *years* of effort to resolve issues. Both utilize double containments and are comparatively expensive containers; they may well be made obsolete by an inexpensive, Pu-capable 6M Replacement.

Final Observations on Existing Containers

- **UC-609:**
 - Older design, certified by possibly-to-be-disbanded EM Regulator;
 - In-process recertification buys time for securing replacement;
 - Replacement requires approximately the same usable CV volume (stop-gap PV for H-1616 is not sufficient for all anticipated needs).
- **H-1616s:**
 - Modern packaging design – overpack ring closure acceptable since crush is not and will not be required;
 - No issues identified for satisfying proposed regulation changes.

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- The UC-609 is a large-volume tritium container designed to the 1983 regulations. It is being recertified to transport up to 90 grams of tritium. By staying below 1000 A₂, the package will not be subject to the crush test even after the proposed regulations are adopted. Its recertification is nominally in-process by the possibly-to-be-disbanded EM Regulator, which buys time to design and certify the needed replacement. We were informed of continued missions for this container, viz., some outsized components and large volumes of tritium at low pressure. Certification of an H-1616 package with a small tritium pressure vessel was suggested as an alternative, but that does not meet the reported need for a large-volume CV.
- The H-1616 is also a tritium package, but it is designed for small tritium reservoirs and the Hydride Transport Vessel. It can transport up to 20 grams of tritium. The H-1616 is a modern package, and its tritium content is well below 1000 A₂. Thus, it too will avoid the crush test requirement and should be certifiable to the proposed regulations.

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Suggested Guidelines for New Packaging Development

- **Let transitional arrangements guide the prioritization of redesign efforts:**
 - Design replacements for DOT specification packages immediately;
 - Over the next decade, redesign all packages originally based on the 1983 NRC Regulations that have continuing workload, with priority to those that have already been grandfathered;
 - Migrate packages to the new regulations when possible (e.g., H1616s, crush-tested ES-2100).
- **Incorporate elements of new packaging designs.**
- **Specify contents in the broadest terms (e.g., 9975) to minimize the “new contents” issue.**
- **Accelerate development by decoupling design & certification from procurement.**

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- This slide presents a proposed set of guidelines to manage the development of new DP packagings:
 - The first bullet & sub-bullet set reiterate the importance of knowing the status of existing packages relative to the current and proposed regulations in order to prioritize new designs.
 - When we suggest incorporating elements of new packaging designs, we are referring to those outlined in Slide 18, specifically:
 - Crush-resistant overpacks with bolted closures and no Celotex;
 - ASME Section III, Subsection NB containment vessels accommodating the 10CFR71.55(c) leakage exception; and
 - Maximized payload flexibility and minimized package weight and footprint.
 - The last bullet provides some budgeting flexibility while allowing better utilization of packaging designers and regulators. Here, we are suggesting a continuous flow of new designs migrating from concept to certification. This approach: (i) keeps designers and regulators productively engaged, (ii) provides a range of new, certified designs to select from as old designs become eliminated or restricted by future regulatory revisions, and (iii) allows procurement in stages to smooth budgetary spikes.

Assessments of Six Proposed New Containers

- **SAFKEG:**
 - Fundamentally redundant, and obsoleted by proposed regulations;
 - Too much effort for too little DP payback (except for OST).
- **6M Replacement(s):**
 - No question on immediate need;
 - Commercial sources may provide partial, non-optimal solution;
 - High priority needed to secure new packagings in time to avert crisis;
 - DP needs to focus efforts on 30- to 55-gallon, Pu-capable, single-containment version.
- **Shielded Package:**
 - DP is a minor user for this package and should prioritize accordingly;
 - 9975 may be a viable alternative provided it continues to be recertified;
 - Incorporating as an option to the 6M Replacement is appealing.

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- Six new packaging designs were proposed in the draft packaging plan (*Office of Defense Programs Packaging Inventory, Packaging Database, and Packaging Tracking System*, February 28, 2002). Assessments of these proposals are now provided on this and the following slide, based on the information collected in this study:
 - SAFKEG has been in development and certification for over a decade, yet it is still uncertified and is principally an EM container with a similar mission to the 9975. Although OST finds the smaller footprint and weight of the SAFKEG attractive (as compared to the 9975), it is not a container with much projected DP usage.
 - The 6M Replacement, on the other hand, is needed without question. Though widely-used across the Complex, the effort among the various offices to replace the 6M has lacked urgency and coordination. Three conceptual designs have been put forward, but much of the work was done without explicit funding. Averting a crisis will be challenging even if funding was made available today. It is recognized that DP's needs do not encompass the needs of the entire Complex.
 - Evidence of a significant DP need for a shielded package has not been found. For such needs as DP may have in the near future, the EM-certified 9975 is a viable alternative provided it can continue to be recertified. This could be problematic because the 9975 contains Celotex, which is increasingly disdained by the NNSA Regulator. We have recommended a shielded version of the 6M Replacement as an alternative to an independent design.

More Assessments of Six Proposed New Containers

- **New Tritium Packaging:**
 - Concur with need for modernized UC-609 design for DP use;
 - Scheduling dictated by expiration of final (in-process) recertification by EM Regulator.
- **DPP-2 (Replacement for DT-22):**
 - Need driven by grandfathered/exempted applications (though crisis was exaggerated);
 - DT-22 can continue to be used for other high-use applications even when grandfathered into the proposed regulations.
- **DPP-1 (Replacement for FL package):**
 - Need driven by grandfathered status of FL;
 - Primarily for WR pits, but also proposed for large subcrits;
 - Must incorporate long design time to develop better understanding of thermal & structural requirements for pits;
 - Pursue synergisms with MD-1 (surplus pit container under development).

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- A new tritium packaging—actually a modernized version of the UC-609—is required based on the projected need to transport larger components and volumes of tritium. The UC-609 is certified by EM, whose Regulator may be disbanded. Current plans call for DP to fund the EM Regulator to perform one final recertification of the UC-609. If this transpires as expected, then scheduling of the UC-609 replacement can be based upon the UC-609’s future expiration date.
- The DPP-2—a replacement for the DT-22—has been driven by the need to transport small subcritical experiments (SCEs) to NTS, which reportedly was currently using an NSE that expires 9/30/2003. However, all small SCEs to date have been shipped under an OTC—no shipment has yet to use a contingency written into the NSE for SCEs exceeding the limits of the OTC. (The NSE was motivated by an entirely separate application.) It is not known if a small SCE will ever exceed the OTC limits. However, it would appear that at least part of the “crisis” was exaggerated and could be remedied simply by maintaining the OTC currently used for these shipments. When the proposed regulations take effect, this and other high-end uses of the DT-22 can be grandfathered indefinitely, as the crush requirement will preclude certification to the new regulations. However, grandfathering will buy time until the DPP-2 can be brought on line.
- The DPP-1 is intended to replace the grandfathered FL pit container, with which a number of operational complexities are associated. We concur that this container is needed, and further expect any container capable of carrying a variety of pits to require a protracted design time. This design effort should be started as soon as possible.

Assessments of Additional New Containers

- **Replacement for DT-20 & DT-23 (DPP-3?):**
 - Recognized long-term need to modernize because of grandfathering into the proposed regulations;
 - Y-12 (SARP owner for DT packages) believes consolidation achievable;
 - Merger creates no transportation penalty based on current attributes;
 - Modern package will be more amenable to new contents;
 - Consider adding large subcrit mission to allow reduced DPP-1 footprint.
- **Reactor fuel plate package:**
 - NNSA Regulator believes special-use package needed;
 - Multi-office involvement complicates ownership of issue;
 - Dedicated package for such a small number of shipments is hard to justify;
 - Current issues could be resolved using DPP-3 (Section III CV) with:
 - improved support of internal contents, and
 - utilization of leakage exception allowed in 10CFR71.55(c)
(as has been done for some contents in the DT-23).

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- Two additional packagings require assessments based on information gathered in this study:
 - Though not as critical as a replacement for the DT-22, a replacement for the DT-20 and DT-23 packages should be added to the schedule. Y-12 believes a single replacement for these two packages is feasible, as the two packagings share similar contents and common transportation characteristics (cf., Slide 19 and Slide 20/Column 6). For our purposes, the DT-20/DT-23 replacement has been named the DPP-3.
 - The NNSA Regulator is advocating the design of a reactor fuel plate package. We do not concur with this view. We are aware of the issues associated with the shipment of SKUA plates in the DT-23, but we do not believe those issues warrant a new special-use (and limited-use) packaging design:
 - There is only a handful of such reactors around the country, each of which operates with approximately two dozen fuel plates plus spares. In any given year, it is unlikely that even 50 packages would be shipped.
 - The reactor plates are a well-defined content that, with proper planning and execution, could easily be fit into the envelope of a DPP-3. The only *uncorrectable* deficiency of the DT-23/SKUA package was the incompatibility (by guidance, not law) of the DT-23's Section VIII containment vessel with the Category II SKUA plates.

Questions on Sufficiency

- **DNFSB Action:**

- Concern regarding timely disposition of inactive nuclear materials, primarily motivated by overcrowded vaults at physics labs;
- Initial DOE response noted a graded approach being used for characterization, generally:
 - Sufficient for storage,
 - Moderate for shipping, and
 - Low for disposition (dictated by acceptance criteria at receiver site),but the storage characterization was subsequently challenged by the DNFSB;
- DOE plan establishes a new inactive actinides working group;
- Impossible to assess packaging needs with current information, though DNFSB expects the issue to be addressed.

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- The second part of the study charter dealt with the sufficiency of the new packagings being considered. This and the following slide summarize three key issues that make the question of sufficiency impossible to answer at this time:

- In May 2002, the Defense Nuclear Facilities Safety Board (DNFSB) revisited an issue it has been monitoring since the Board first issued Recommendation 94-1, *Improved Schedule for Remediation in the Defense Nuclear Facilities Complex*, in May 1994:
 - New concerns were documented regarding inadequacies at DOE facilities to characterize, stabilize, and package inactive nuclear materials for safe interim and long-term storage and for ultimate disposition.
 - As part of its September 2002 response, DOE stated that its level of material characterization was generally: (i) sufficient for storage, (ii) moderate for shipping, and (iii) low for disposition. However, in acknowledging receipt of DOE's response in December 2002, the DNFSB questioned even the basic assertion that "characterization for storage warrants 'high' confidence."
 - It is also noteworthy that the Department's *Management of Nuclear Materials* (DOE Order 5660.1B, 5-26-94) does not address a graded approach for characterization.

Based on these DNFSB-related activities, we do not believe a full assessment of DP's future packaging needs is possible—one cannot specify packaging for uncharacterized materials with unknown destinations.

More Questions on Sufficiency

- **TA-18 Relocation:**
 - DOE decision to relocate TA-18 operations to NTS;
 - Primarily motivated by TA-18 security costs (~\$11.5M in FY99), coupled with \$40+M in planned security upgrades;
 - Currently in early planning stages:
 - What goes to NTS versus elsewhere hasn't been answered,
 - Suffers from same characterization shortcomings;
 - Possible packaging needs are recognized and being assessed.
- **Pending Regulatory Changes:**
 - DOE uses commercial packages for special-case shipments;
 - Commercial packages face the same obsolescence/limitation issues in terms of changing regulations as DOE packages;
 - Ramifications are another TBD.

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- Further complicating future packaging needs is DOE's recent decision to move the Los Alamos Critical Experiments Facility (LACEF) from TA-18 at LANL to the Device Assembly Facility (DAF) at NTS:
 - LACEF is dedicated primarily to "the design, construction, research, development, and application of critical experiments." Security for this facility has become prohibitively expensive (J.P. Kindinger, E. Mullen, and M. Moy, *DOE Critical Assembly Facilities Configuration Alternatives Evaluation, Volume I*, LA-UR-99-5810, November 4, 1999).
 - Two preliminary attempts have been made to identify materials that might be moved, along with the DOE and commercial containers that might be used for shipment (S.A. Thompson, *Survey of RAM and SNM located at TA-18 (Pajarito Site)*, DOE Memorandum, August 21, 2000, and N.S. Khalil, *Transportation Study - TA-18 to DAF Relocation*, DOE Memorandum, August 2, 2002). While there *appeared* to be packaging alternatives for most contents, some of those packagings may not be available by the time TA-18 is de-inventoried. Moreover, the two lists are disparate in many respects, and another effort is in progress to inventory the contents of TA-18. Finally, the same characterization issues noted in the DNFSB action may adversely affect packaging planning for the TA-18 closure.
 - Depending upon what "turns up" in the most recent effort to inventory TA-18, the TA-18 relocation project could be a driver for a "shielded package."
- Finally, DOE uses commercial packages for some shipments. These packages will be subject to the same inevitable effects of obsolescence and changing regulations as are the DOE/DP packages. Loss or limitations on the use of these packages could affect the issue of sufficiency, but we are not able to assess these future impacts.

Bottom Line on Sufficiency

- **There are possible voids in the current assessment of DP packaging needs.**
- **Information needed to identify these voids is not available at this time.**
- **Modern packagings will be more amenable to accommodating special-case contents.**

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- This summarizes the current situation regarding the question of sufficiency:
 - By “modern packagings,” we mean containers that incorporate the design features described in Slide 18.
 - Backup Slides 43-47 provide a suggested decision path for material shipments, applicable to both the DNFSB action and TA-18 relocation.

Outline

Why We Are Doing This Study
Who We Talked To
Background & Regulatory Changes
Attributes of New & Existing DOE Packages
Assessment of DP Packaging Needs
Final Observations

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Final Observations

- **Diffuse DP structure for packaging management, funding, and priorities is not currently positioned to avert crises:**
 - Obvious DT-22/DPP-2 problems repeatedly ignored for too long;
 - 6M Replacement funding/schedule path forward is not sufficient;
 - Too much priority on SAFKEG for too little DP return.
- **Numerous disconnects exist between DP packaging management, package certification, and transportation:**
 - DP packaging management & development was totally ignored for two years and continues to suffer from lack of attention & funding;
 - NNSA Regulator attempted to backfill management void to the detriment of their own responsibilities and autonomy;
 - PCD, OST, and NTP concerns need to be heeded;
 - Delineation of responsibilities further confused by NNSA reorganization.

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- This and the following slide provide final observations regarding the study:
 - We are not confident regarding the current management of DP packaging needs. Too many examples can be given to illustrate this concern, some of which are presented in the slide.
 - Moreover, numerous disconnects exist among DP packaging management, packaging certification, and transportation:
 - The DP Packaging Manager position went unfilled at DOE/ALO for two years (cf., D.E. Beck, *Integrated Container Program Plan and Data Base*, DOE Memorandum, February 8, 2000, and W.J. Arthur, *Albuquerque Operations Office Assignment of Packaging Manager for Defense Programs*, DOE Memorandum, January 11, 2002), then was re-assigned to Paul Mann four months later (ref., K.L. Boardman, *Albuquerque Operations Office Assignment of Packaging Manager for Defense Programs*, DOE Memorandum, May 13, 2002).
 - Examples of management-like actions by the NNSA Regulator include providing a radioactive and special nuclear material survey of TA-18 (including proposed shipping containers), chairing the specifications committee for the DPP packagings, proposing short-term mitigation strategies for the looming 6M crisis, and advocating a reactor fuel plate package.
 - The DP Packaging Manager currently resides in Office of Program Integration, NA-13, a new DP organization whose role and authority is still uncertain except for reportedly having no program management responsibilities. A Memorandum of Agreement to define the DP Packaging Manager's role has stalled amidst all of the organizational changes.

The Final Observation

- **Complex-wide integration of packaging and transportation needs is required for optimal solutions:**
 - **Commitments made in “Optimizing Transportation and Packaging Strategies”(June 2000 *Integrated Nuclear Materials Management Plan*) should be carried through;**
 - **Routine funding process for cross-cutting packaging needs should be established;**
 - **Relying on NRC as a Regulator may not be a good answer for the Complex.**

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- Even more fundamental is our concern for the lack of Complex-wide integration of packaging & transportation needs:
 - What is disturbing about this problem is that it has been recognized but is being ignored. DOE's June 2000 *Integrated Nuclear Materials Management Plan* demonstrates a clear understanding of the issues. Unfortunately, the multi-year agenda for the Nuclear Materials Council has since been suspended indefinitely, and a Department-wide Package Management and Planning Working Group promised in the plan has yet to be established.
 - Many DOE programs and sites will be able to use the same new packages, but developmental funding is being decided by a “who needs it first” philosophy. Package design, certification, and procurement are predictable needs that should be planned for and funded from across the Complex. Instead, only impending disaster prompts action.
 - Finally, using NRC as a Regulator for DOE packages has raised an assortment of concerns. Familiarity with DOE's business and contents is minimal, and their ability to deal with classified contents is unclear. The positive teaming that exists between the NNSA Regulator and SARP owners may not exist. Furthermore, 49CFR173.7 exempts DOE, but not NRC, from requirements “for the purpose of national security.” What is certain is that the NNSA Regulator currently does not have the resources to be the Regulator for the entire Complex.
- We conclude with the observation of one of the interviewees:
“Packaging is not rocket science; it should *never* be on the critical path.”

Backup Slides

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One More Recommendation

- **The NNSA Regulator needs to:**
 - **Formalize its grandfathering and “new contents” policy;**
 - **Clarify its policy regarding exceptions to regulations (i.e., the law) versus exceptions to regulatory guides;**
 - **Be explicit in the regulatory version utilized for each certification – consider adding an NRC-compatible suffix.**

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- Though not part of the study charter, we feel some improvements to the NNSA Regulator’s processes would be beneficial. Our suggestions are:
 - By formalizing their grandfathering and “new contents” (or modification to authorized contents) policies, the NNSA Regulator could save applicants time and effort. It is inefficient for an applicant to prepare a SARP or Addendum to add new contents to an existing package that the NNSA Regulator knows it will not approve. Since there is no legal definition of “new contents,” and because we have noted inconsistent interpretations of that terminology, we feel the Regulator needs to provide clear guidance. Formalizing these policies would be a useful addition to DOE Safety Guide 500, Rev. 3.
 - Primarily because of the legacy Section VIII containment vessels, we have seen repeated situations of a package being able to satisfy the law but not the associated guidance. This contributes to the confusion surrounding grandfathering and new contents, and should be clarified accordingly.
 - As we have demonstrated, understanding the version of the regulations under which a package has been approved is extremely beneficial. An NRC-styled suffix tied to the regulatory revision would be very helpful to achieve this goal and eliminate confusion for all OTCs.

Regulatory Transitional Arrangements (Grandfathering) for Existing Type B Packages

IAEA Standards	DOT/NRC Alignment	Designation*	Regulations: Current and Proposed
		DOT Specification (6M, 20WC, & 21WC)	C: Allowed per 49CFR173.416. P: Packaging fabrication prohibited after date of final rule. P: Packages prohibited 2 years after date of final rule.
Safety Series No. 6, 1967	1968	Types B & BF	C/P: Packaging fabrication completed by 8/31/86. C: International shipments subject to multilateral approval. P: International shipments prohibited. P: Packages prohibited 3 years after date of final rule. C/P: Can add -85/-96 suffix if design meets current/proposed regulations.
Safety Series No. 6, 1973 & 1973 (As Amended)	1983	Types B(U), B(M), B(U)F, & B(M)F	C/P: Packaging fabrication completed by 4/1/99. C/P: International shipments subject to multilateral approval. C/P: Can add -85/-96 suffix if design meets current/proposed regulations.
Safety Series No. 6, 1985 & 1985 (As Amended 1990)	1996	Types B(U)-85, B(M)-85, B(U)F-85, & B(M)F-85	C: No additional restrictions. P: Packaging fabrication completed by 12/31/06. P: International shipments subject to multilateral approval after 12/31/03. P: Can change suffix to -96 if design meets proposed regulations.
Safety Standards Series No. ST-1, 1996 Edition & No. TS-R-1 (ST-1, Revised), 1996 Edition (Revised)	In Process	Types B(U)-96, B(M)-96, B(U)F-96, & B(M)F-96	C: Not applicable. P: No additional restrictions.
Modifications to Design and Authorized Contents of Previously Approved Package			C/P: Modifications not significant to design, operation, or safety. C/P: Modifications to fissile package not significant to criticality. C/P: Modifications satisfy current/proposed regulations (e.g., A ₁ & A ₂ limits).

[^] Grandfathering minimizes the costs and impacts of implementing changes in the regulations on existing package designs and packagings.

* U/M = Denotes requirement for unilateral/multilateral approval international shipments (either can be used for domestic transportation);

F = Fissile material (Pu-238 - eliminated in proposed regulations, Pu-239, Pu-241, U-233, & U-235) packaging.

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- This table summarizes the current and proposed regulations regarding transitional arrangements for existing Type B packages:
 - The purpose of grandfathering is to minimize the costs and impacts of implementing changes in the regulations on existing packaging designs and packages. As regulations, these arrangements provide the *legal* limitations for the use of existing packagings.
 - These transitional arrangements are seen as the Rosetta stone for understanding package redesign needs. By associating package designs with the governing DOT/NRC Regulations (or IAEA Standards), the legal status and regulatory restrictions of the package can be understood readily from this table.
 - Note that there were two earlier versions of IAEA Safety Series Number 6, dated 1961 and 1964, that have no relevance to the current or proposed regulations.

DOE as a Type B Packaging Regulator (Expanded Version)

- 49CFR173.7(d) establishes DOE as a regulator.
 - “packagings made by or under the direction of the [DOE] may be used for the transportation of Class 7 materials when evaluated, approved and certified by the [DOE] against packaging standards equivalent to those specified by 10 CFR part 71.”
- However, 49CFR173.7(b) exempts DOE (& DoD) from DOT hazardous materials regulations “for the purpose of national security.”
 - Shipments must be “escorted by personnel specifically designated by or under the authority of those agencies.”
 - “A document certifying that the shipment is for the purpose of national security must be in the possession of the person in charge of providing security during transportation.”

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- This slide, and the four slides following, provide an expanded view of the regulations and processes used by NNSA in their role as a Type B Packaging Regulator:
 - 49CFR173.7(d) establishes that DOE can evaluate, approve and certify hazardous materials packages made by or under its own direction. However, the packages must be certified against standards equivalent to those specified by 10CFR71, i.e., the NRC’s regulations.
 - At the same time, 49CFR173.7(b) allows DOE and DoD to exempt themselves from requirements of the CFRs for shipment of hazardous materials “for the purpose of national security.” The National Security Exemption option is one that is seldom exercised, so DOE’s internal process for authorizing one is obscure. However, the requirements described in 49CFR173.7(b) are straightforward:

“Shipments of hazardous materials, made by or under the direction or supervision of the U.S. Department of Energy (DOE) or the Department of Defense (DOD), for the purpose of national security, and which are escorted by personnel specifically designated by or under the authority of those agencies, are not subject to the requirements of this subchapter. For transportation by a motor vehicle or a rail car, the escorts must be in a separate transport vehicle from the transport vehicle carrying the hazardous materials that are excepted by this paragraph. A document certifying that the shipment is for the purpose of national security must be in the possession of the person in charge of providing security during transportation.”

The “subchapter” here refers to Subchapter C - Hazardous Materials Regulations, which encompasses all of 49CFR parts 171-185.

NNSA Implementation of 49CFR173.7

- **Governing DOE Order 461.1 and implementing Safety Guide 500, Rev. 2 are both undergoing revisions.**
- **Current version of SG 500 (Rev. 2) is already out of date with respect to current version of Order 461.1.**
 - *E.g.*, no mention of exemptions in SG 500, Rev. 2, but brief and vague discussion in 461.1, §4, para. g and §5, para. a.
- **Some measure of consistency can be obtained only if the two revisions – DOE Order 461.1A and SG 500, Rev. 3 – are adopted simultaneously.**
- **Though not yet approved, the current processes appear predominantly to follow Order 461.1A and SG 500, Rev. 3.**
- **However, changes due to the NNSA reorganization have yet to be incorporated.**

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- DOE Order 461.1, *Packaging and Transfer or Transportation of Materials of National Security Interest*, is the current directive under which DP operates. Details of Order 461.1's implementation are laid out in DOE Safety Guide 500, Rev. 2 (August 1998). Both documents are undergoing revisions. However, Safety Guide 500, Rev. 2 is already out-of-date with respect to 461.1, so there are inconsistencies between the two nominally current documents. This is because Safety Guide 500, Rev. 2 implemented 461.1's predecessor, DOE Order 5610.12, which was superseded by 461.1 on 09/29/00.
- The two *draft* successors to 461.1 and SG 500, Rev. 2—Order 461.1A and SG 500, Rev. 3, respectively—are more internally consistent than their predecessor documents. However, creation of the NNSA and subsequent reorganizations therein have delayed review and adoption of these two documents to the point where they, too, are out-of-date on at least minor points.
- Nevertheless, the mode of operation appears predominantly to reflect the combined influences of Draft Order 461.1A and Draft SG 500, Rev. 3. That is, our discussions with NNSA Regulator staff indicate that the work processes by which containers are certified, and the responsibilities of the various personnel *prior* to the latest NNSA reorganization, are generally consistent to those outlined by the two draft directives. Those processes are outlined in the following three slides.

Certification or Exemption Processes: Offsite Transportation Certificate (OTC)

- If the package is not a certified Type B package, but the applicant believes that it could be certified:
 - a Safety Analysis Report for Packaging (SARP) is prepared and submitted to Packaging Certification Division;
 - the SARP demonstrates, via calculation and testing, that the package satisfies the law with respect to structural, thermal, containment, shielding, criticality and quality assurance requirements;
 - the SARP is reviewed by a Transportation Safety Review Panel (TSRP);
 - if/when the SARP is approved by the TSRP, that specific packaging and content can be granted an Offsite Transportation Certificate (OTC).
- The OTC is valid for one-time use, or up to 5 years.

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- This slide outlines the process by which a Type B package can be granted an Offsite Transportation Certificate (OTC). Additional details may be found in DOE Order 461.1 and DOE Safety Guide 500, Rev. 3, from which this outline was drawn:
 - It is useful to note here that the Safety Analysis Report for Packaging (SARP) that must be submitted to the NNSA Regulator for approval has an “owner,” i.e., the organization that prepares the document. It is the owner who will subsequently modify the SARP on behalf of an applicant if it is decided that new content can be added to the packaging.
 - The applicant must provide funding to the owner for the preparation/modification of the SARP.
 - The owner does not necessarily use the package.
 - Granting of an OTC indicates that the NNSA Regulator has determined that the package satisfies the letter of the law with respect to 10CFR71.

Certification or Exemption Processes: Offsite Transportation Authorization (OTA)

- If the package is not certified and cannot meet the letter of the requirements of 10CFR71 or 49CFR173:
 - a Transportation System Risk Assessment (TSRA) is prepared and submitted to the TSRP;
 - the TSRA differs from a SARP in that it includes a Probabilistic Risk Assessment that quantifies “public risk attributable to the proposed shipping campaign;”
 - if/when the TSRP approves the SARP and TSRA, the package may be granted an Offsite Transportation Authorization (OTA).
- An OTA authorizes a shipping campaign limited to a particular package and loading configuration, designated routes, and specific duration (not to exceed 5 years).

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- An Offsite Transportation Authorization (OTA) is granted if a package cannot meet the letter of the requirements of 10CFR71 or 49CFR173, but the “public risk attributable to the proposed shipping campaign” can be quantified by a probabilistic risk assessment included in a Transportation System Risk Assessment (TSRA) document.
- “Transportation authorization [is] based on the estimation of composite public risk and [is] decided on a case-by-case basis” (*DOE Safety Guide 500*, Rev. 3, Undated Draft).

Certification or Exemption Processes: National Security Exemption (NSE)

- **If the package is not certified and cannot be shown to meet the requirements of the CFRs, but must be shipped for reasons of national security, the applicant can apply to DOE/NNSA Deputy Administrator for Defense Programs**
 - **via their management chain *and***
 - **the Packaging Certification Division****for a National Security Exemption (NSE).**
- **A NSE appears simply to be a signed memorandum that can include any number of restrictions or limitations.**

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- This slide documents what (little) information is available regarding the NSE process. DOE Order 461.1 allows for an exemption provided it: (i) is not prohibited by law, and (ii) does not present an undue risk to public health and safety, the environment, or workers. Recall that (i) is accommodated via 10CFR173.7(b): “Shipments of hazardous materials, made by or under the direction or supervision of the U.S. Department of Energy (DOE) ... for the purpose of national security, ... are not subject to the requirements of this subchapter.”

Proposed Decision Path for Material Shipments (Characterize for Disposition)

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- This slide, and the four slides following, outline a process by which radioactive material (RAM) shipments might be made. It is intended to address the unknowns associated with the DNFSB action and TA-18 relocation. It views new packaging as a last resort after all other options have been exhausted. These other options include reprocessing the material into forms more amenable to shipment and disposition. For this study, “disposition” has a broader context than that used by the materials management community.

Proposed Decision Path for Material Shipments (Review Currently Certified Containers)

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Proposed Decision Path for Material Shipments (Explore Previously Certified Containers)

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Proposed Decision Path for Material Shipments (Explore Alternatives to New Package Design)

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Proposed Decision Path for Material Shipments (Design New Package Only If Necessary)

Full Decision Path for Material Shipments

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