5
SEP 15 1994

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 608631

2. To: (Receiving Organization) Cesium Return Program	3. From: (Originating Organization) Cesium Return Program	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Cesium Return Program	6. Cog. Engr.: P. T. Saueressig	7. Purchase Order No.: N/A
8. Originator Remarks: Transmittal and release of the supporting document which compiles the documentation necessary for cesium capsules to be shipped as special form radioactive material.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks: Comments have been incorporated.		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 12 September, 1994

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-CSD-004	-	0	Criteria for cesium capsules to be shipped as special form radioactive material.	N/A	1,2	1	1

16. KEY											
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)					
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)				1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged					
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)						(G)	(H)		
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1,2	1	Cog. Eng. (P.T. Saueressig)	<i>Paul T. Saueressig</i>	9/13/94	S6-65						
1,2	1	Cog. Mgr. (E.D. Robbins)	<i>E.D. Robbins</i>	9-13-94	S6-65						
		QA	N/A								
		Safety	N/A								
		Env.	N/A								
3		Central Files		L8-04							
3		OSTI (2)		L8-07							

18. Signature of EDT Originator <i>[Signature]</i> 9-13-94	19. Authorized Representative for Receiving Organization <i>[Signature]</i> 9-13-94	20. Cognizant Manager <i>[Signature]</i> 9-13-94	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-CSD-004, REV 0

Document Title: CRITERIA FOR CESIUM CAPSULES TO BE SHIPPED AS
SPECIAL FORM RADIOACTIVE MATERIAL

Release Date: 9/15/94

* * * * *

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

Kara Broz

(Signature)

9/15/94

(Date)

SUPPORTING DOCUMENT

1. Total Pages 42

2. Title Criteria for cesium capsules to be shipped as special form radioactive material.	3. Number WHC-SD-WM-CSD-004	4. Rev No. 0
5. Key Words Cesium chloride capsule, Waste Encapsulation and Storage Facility (WESF), Beneficial Uses Shipping System (BUSS) Cask, and special form. <i>AMB 9/</i>	6. Author Name: J. E. Lundeen <i>James E. Lundeen</i> 9-13-94 signature Organization/Charge Code 16800/KB51B	
7. Abstract <p style="text-align: center;">APPROVED FOR PUBLIC RELEASE</p> <p>The purpose of this report is to compile all the documentation which defines the criteria for Waste Encapsulation and Storage Facility (WESF) cesium capsules at the IOTEC facility and Applied Radiant Energy Corporation (ARECO) to be shipped as special form radioactive material in the Beneficial Uses Shipping System (BUSS) Cask.</p> <p>The capsules were originally approved as special form in 1975, but in 1988 the integrity of the capsules came into question. WHC developed the Pre-shipment Acceptance Test Criteria for capsules to meet in order to be shipped as special form material. The Department of Energy approved the criteria and directed WHC to ship the capsules at IOTEC and ARECO meeting this criteria to WHC as special form material.</p>		
8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed.	10. RELEASE STAMP OFFICIAL RELEASE BY WHC DATE SEP 15 1994 <i>sta. 4</i>	
9. Impact Level N/A		
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1.0 Introduction

The purpose of this report is to compile all the documentation which defines the criteria for Waste Encapsulation and Storage Facility (WESF) cesium capsules at the IOTTECH facility and Applied Radiant Energy Corporation (ARECO) to be shipped as Special Form Radioactive Material in the Beneficial Uses Shipping System (BUSS) Cask.

2.0 Discussion

The cesium capsule design was first tested in 1975 per U.S. Energy Research and Development Administration (ERDA) special form requirements. Because of this testing, the cesium capsules were qualified as special form radioactive material. This is documented by a letter by P. G. Rhoades dated October 23, 1975, which is enclosed in Appendix A.

Some of these capsules were leased to commercial irradiators to be used for beneficial purposes. In June, 1988, a leak was discovered in one of the cesium capsules at Radiation Sterilizers Incorporated (RSI) facility in Decatur, Georgia. Because of the leak, DOE ordered that all cesium capsules be returned to WESF. An assessment of the cesium capsule design was performed along with additional testing of the cesium capsule to support designation as special form material. The cesium capsule design met all current regulatory test requirements for special form radioactive material. The capsules leased to RSI were returned by the RSI 1500 cask, but the cask has since been decertified by the Nuclear Regulatory Commission (NRC) due to quality assurance record deficiencies.

The remaining capsules will be returned to WESF in the BUSS Cask. The BUSS cask Certificate of Compliance (CoC) requires that the contents of the BUSS cask meet special form criteria; they must either satisfy the requirements set forth in the 10 CFR 71.75 and 71.77 or pass a set of examinations and tests pre-approved by the DOE within 12 months preceding shipment. A copy of the BUSS cask CoC is enclosed in Appendix B. The Preshipment Test Acceptance Criteria was developed by Westinghouse Hanford Company (WHC) to provide a set of tests and examinations to ensure that the cesium capsules continue to meet special form criteria. The Preshipment Test Acceptance Criteria consists of the following:

- Capsules must have less than 300 thermal cycles.
- There must be no indication of cesium leakage, based on storage pool water analysis.
- Capsules must pass a visual inspection, verifying that welds are intact and there are no significant (1/16") gouges or marks.
- Capsules must pass a clunk test.
- Capsules must pass a ring gauge test.

The Preshipment Test Acceptance Criteria, which define the special form criteria, are documented by a letter by D. M. Bogen, dated November 2, 1993, which is included in Appendix C.

DOE determined that cesium capsules meeting the Preshipment Test Acceptance Criteria can be shipped as special form material in the BUSS cask. This is documented by a letter by J. R. Hunter dated November 3, 1993, which is included in Appendix C. DOE directed WHC to ship IOTECH capsules that meet the above criteria as special form material. This is documented by a letter by J. R. Hunter dated May 11, 1994, which is also included in Appendix C. The capsules that pass the criteria will be shipped as special form material using the BUSS cask. Those capsules that do not pass the criteria will be shipped as normal form material in an appropriate container.

3.0 Summary

The cesium capsules were originally tested and passed as special form material in 1975. However, in 1988, when a leak was discovered in a cesium capsule at RSI, additional testing was performed on the cesium capsule design. It was determined that the cesium capsule design meets special form requirements. In order to pass the capsules as special form material to ship in the BUSS cask, WHC drafted the the Preshipment Test Acceptance Criteria. The DOE found the criteria sufficient to allow the cesium capsules, contingent on passing the criteria, to remain special form radioactive material and directed WHC to ship the IOTECH capsules back to WESF. The cesium capsules that pass the criteria will be returned to WESF as special form material in the BUSS cask. Those capsules that do not pass the criteria will be classified as normal form material and will be returned in an appropriate container.

WHC-SD-WM-CSD-004 Rev 0

Appendix A: Letter by P. G. Rhoades, 1975

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

RICHLAND OPERATIONS OFFICE
P. O. BOX 550
RICHLAND, WASHINGTON 99352

OCT 23 1975

N.12 (IF)

Letter No. 6612
Action: RCR
Reply Due: N/A
Info: GEB

RRJackson
LMK
CWM
GCO
RGO
MFR
HPS
TES
GTS
JHW
GOW
ATW
RAZ
DEB
LIB
GB
HEC
EFC
FRD
KLEnglehardt
RCForsman
JF
JEHammond
DAH
LCH
C. File

Atlantic Richfield Hanford Company
ATTN: Mr. G. T. Stocking, President
Richland, Washington

Gentlemen:

SHIPMENT OF ~~REDACTED~~ CHLORIDE CAPSULES IN THE NRBK-43 CASK

The RL Safety Staff have reviewed your October 14, 1975 request to approve the WESF Cesium Chloride Capsules in the NRBK-43 Cask [USA/5814-3/BLF (ERDA-NR)]. Based upon the results of capsule testing described in ARH-CD-440, "Cesium Chloride Capsule Testing for Special Form Qualification" dated August 29, 1975, RL concurs with ARHCO's determination that the capsules meet special form requirements.

Accordingly, the WESF Cesium Chloride Capsule is approved for use as an inner container in the NRBK-43 Cask.

Very truly yours,

P. G. Rhoades
P. G. Rhoades, Acting Director
Safety Division

SAF:DWT

cc: E. F. Curren, ARHCO

WHC-SD-WM-CSD-004 Rev 0

Appendix B: BUSS Cask CoC

United States Government

Department of Energy

memorandum

DATE: MAY 02 1994

REPLY TO
ATTN OF: Transportation & Packaging Safety Div.:Wangler:3-5078

SUBJECT: REVISION 1, CERTIFICATE OF COMPLIANCE USA/9511/B(U) (DOE),
DOCKET 93-33-9511

TO: R. Chitwood, NE-46

This memorandum notifies you that Revision 1 of Certificate of Compliance USA/9511/B(U) (DOE) has been issued. Attached is a copy of Revision 1, its Approval Record, and the Safety Evaluation Report that documents EH-332's confirmatory analysis. Changes to the Certificate are marked by vertical bars in the left margin. If you have any questions, please call me at 301-903-5078 or Bob Towell at 301-601-9006.

Michael E. Wangler
Director
Transportation and Packaging
Safety Division, EH-332

Attachments

cc w/atts:
L. Harmon, EM-32
J. Keenan, EM-322
L. Romine, RL
D. Robbins, WHC
G. Popper, ANL

United States Government

Department of Energy

memorandum

DATE: MAY 02 1994

REPLY TO
ATTN OF: Transportation & Packaging Safety Div.:Wangler:3-5078

SUBJECT: REVISION 1, CERTIFICATE OF COMPLIANCE USA/9511/B(U) (DOE),
DOCKET 93-33-9511

TO: Distribution Lists C and D

This memorandum notifies you that Revision 1 of Certificate of Compliance USA/9511/B(U) (DOE) has been issued. Attached is a copy of Revision 1 and its Approval Record. Changes to the Certificate are marked by vertical bars in the left margin. If you have any questions, please call me at 301-903-5078 or Bob Towell at 301-601-9006.

Michael E. Wangler
Director
Transportation and Packaging
Safety Division, EH-332

Attachments

U.S. DEPARTMENT OF ENERGY
CERTIFICATE OF COMPLIANCE
For Radioactive Materials Packages

OMB Approval
No. 1910-2000

1a. Certificate Number 9511	1b. Revision No. 1	1c. Package Identification No. USA/9511/B(U) (DOE)	1d. Page No. 1	1e. Total No. Pages. 6
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2. PREAMBLE

- 2a. This certificate is issued under the authority of 49CFR Part 173.7 (d).
- 2b. The packaging and contents described in item 5 below, meets the safety standards set forth in subpart E, "Package Approval Standards" and subpart F, "Package and Special Form Tests" Title 10, Code of Federal Regulations, Part 71.
- 2c. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. This certificate is issued on the basis of a safety analysis report of the package design or application —

(1) Prepared by (Name and address): U.S. Department of Energy Albuquerque Operations Office P.O. Box 5400 Albuquerque, New Mexico 87185	(2) Title and Identification of report or application: Beneficial Uses Shipping System (BUSS) Cask, Safety Analysis Report for Packaging Volumes I and II, SAND 83-0698 (TTC-0430), Revision 4, Sandia National Laboratories	(3) Date: May 1993
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4. CONDITIONS

This certificate is conditional upon the fulfilling of the applicable Operational and Quality Assurance requirements of 49CFR parts 100-199 and 10CFR Part 71, and the conditions specified in item 5 below.

5. Description of Packaging and Authorized Contents, Model Number, Fissile Class, Other Conditions, and References:

(a) Packaging

(1) Model No.: BUSS (R-1)

Appendix B

Page 3

WHC-SD-WM-CSD-004 Rev 0

(2) Description

The major components of the packaging include the cask body and lid, basket, impact limiters, personnel barrier, and skid.

The cask body is a cylindrical forging with outer dimensions of 137.8 cm (54.25 inches) diameter and 124.5 cm (49 inches) high. The cavity is 51.4 cm (20.25 inches) in diameter and 58.4 cm (23 inches) high.

On the outside surface of the cask body, eleven, 10.2-cm (4-inch) high integral, non-welded fins are situated symmetrically around the circumference of the cask for heat removal.

The cask lid is a single 32.6-cm (12.84-inch) thick forging and is bolted to the cask body using 12 corrosion-resistant steel 1.5-inch diameter bolts through a 9.7-cm (3.8-inch) thick lid flange.

6a. Date of Issuance: APR 22 1994	6b. Expiration Date: February 28, 1996
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FOR THE U.S. DEPARTMENT OF ENERGY

7a. Address (of DOE Issuing Office)

U.S. Department of Energy
Transportation and Packaging Safety Div.
Office of Environment, Safety and Health
Washington, DC 20585

7b. Signature, Name, and Title (of DOE Approving Official)

Michael E. Wangler

Michael E. Wangler, Director
Transportation and Packaging
Safety Division, EH-332

The lid seal is provided by a combination elastomeric-metallic seal. The metallic seal is responsible for providing the necessary leak tightness while the elastomeric seal, which is located outboard to the metallic seal, provides an annular test volume that enables leak testing of the metallic seal.

Two covered ports on the side of the cask body, equipped with testable seals, are provided for filling the cask cavity with helium before transport, filling the cavity with water before unloading contents, and draining entrapped water after unloading or loading contents. A permanent repair plug was threaded and seal-welded into the cask body at the upper port to correct a fabrication machining error that damaged the sealing surface. This plug forms a new surface for the upper drain plug seal. A removable bore plug was also added to the upper port to reduce the unexpected radiation streaming.

The three cask seals (lid and two ports) retain helium coolant under normal conditions of transport. Containment of helium is not required under hypothetical accident conditions. The special form capsules provide the containment boundary for the radioactive material.

One of four solid stainless steel baskets is used for transport depending upon the thermal power level of the cesium or strontium special form capsules. Each basket is equipped with extensions to protect the special form capsules and a handling fixture.

The impact limiters are 215.1 cm (84.7 inches) in diameter and 99.1 cm (39.0 inches) high fabricated from 0.30- to 0.64-cm (0.12- to 0.25-inch) thick stainless steel sheets and filled with foam. The limiters are held to the cask with four turnbuckles. In addition, a loose-fitting tape joint retains each impact limiter on the cask body under accident conditions.

The tiedown and lift features on the cask body include two trunnions and two lifting lugs that are bolted to the cask body.

The cask mounts to a handling skid which in turn mounts to the vehicle. On the handling skid, the cask is covered by a personnel barrier of aluminum channels and expanded metal sheets. The personnel barrier, along with the impact limiters, defines the accessible surface of the package. The overall dimensions of the package, without the personnel barrier and handling skid but including the impact limiters, are 215.1 cm (84.7 inches) in diameter by 271.8 cm (107 inches) in length.

The weight of the BUSS cask as presented for transport is approximately 15,286 kilograms (33,700 pounds). The weights of its several components are: cask body, 9299 kilograms (20,500 pounds); lid, 680 kilograms (1,500 pounds); basket, 726 kilograms (1,600 pounds); impact limiters, 1361 kilograms (3,000 pounds) each; personnel barrier, 136 kilograms (300 pounds); skid, 1542 kilograms (3,400 pounds); and contents, 181 kilograms (400 pounds) maximum.

(3) Drawings

- (i) The packaging design is defined by Sandia National Laboratories drawing number S54774, Revision C, Cask in Cradle, and its attendant drawings plus drawing number S52614, Revision D, Personnel Barrier-Lower, S52615, Revision D, Personnel Barrier-Upper, and attendant referenced drawings with revision dates of February 28, 1994 or earlier.
- (ii) The cesium chloride encapsulation is defined by Vitro Drawing Numbers H-2-66760, all Revisions for which Special Form tests have been documented; and H-2-66761, all Revisions for which Special Form tests have been documented.

The strontium fluoride encapsulation is defined by Vitro Drawing Numbers H-2-66759, all Revisions for which Special Form tests have been documented; and H-2-66758, all Revisions for which Special Form tests have been documented.

(b) Contents

(1) Type and Form of Material

Capsules of melt-cast cesium chloride or press-filled strontium fluoride that have been qualified by testing or examination to satisfy the requirements of Special Form as set forth in 10 CFR 71.75 and 71.77 within the 12 months preceding shipment. Examinations and tests different from those authorized in 10 CFR 71.75 and 71.77 must be approved in advance by the DOE Headquarters Certifying Official.

(2) Maximum Quantity of Material per Package.

Capsules loaded into one of four solid stainless baskets as follows:

BASKET	TYPE CAPSULE	CAPSULE THERMAL POWER (W)	CASK THERMAL POWER (kW)	MAXIMUM TOTAL CASK ACTIVITY (MILLIONS OF CURIES)
16 HOLE	CsCl	250	4.0	0.85
12 HOLE	CsCl	333	4.0	0.85
6 HOLE	SrF ₂	650	3.9	0.65
4 HOLE	SrF ₂	850	3.4	0.56

(c) Fissile Class: None (No fissile material)

(d) Conditions Applicable to Both CsCl and SrF₂ Special Form Capsules

- (1) The shipper shall certify that capsules are loaded into the correct basket.
- (2) The package authorized by this Certificate must be transported on a conveyance assigned for the exclusive use of this package.

(e) Special Condition Applicable to CsCl Special Form Capsules

The shipper shall ensure that the transit and wait period from assembly to disassembly of the package shall not exceed 30 days.

8. In addition to the requirements of Subpart G of 10 CFR Part 71:

- (a) The BUSS (R-1) cask shall be prepared for shipment and operated in accordance with the requirements of Chapter 7, Operating Procedures, in the Safety Analysis Report for Packaging referenced in item 3.(2) of this Certificate.
- (b) The BUSS (R-1) cask shall satisfy the requirements of Chapter 8, Acceptance Tests and Maintenance Program, in the Safety Analysis Report for Packaging referenced in item 3.(2) of this Certificate.

Department of Energy
Washington, DC 20585

PACKAGING CERTIFICATION APPROVAL RECORD

Certificate of Compliance USA/9511/B(U) (DOE), Revision 1
BUSS (R-1) Cask, Docket 93-33-9511

Revision 1 of this Certificate is issued to:

1. correct errors in the weight of the skid and contents,
2. add a bore plug to reduce the unexpected radiation streaming from the upper port,
3. reveal a welded permanent repair plug in the cask body at the upper port that corrects a fabrication machining error,
4. present a redesign of the transportation skid and personnel barrier so the personnel barrier is attached to the skid rather than the trailer bed, and
5. change the seal leakage test method from rate-of-rise to mass-spectrometer (helium leak test).

The changes with Revision 1 are marked by vertical bars in the left margin.

Based on the statements and representations in the Reference and the conditions listed in the Certificate, the EH-332 staff has concluded via independent confirmatory analyses contained in the Safety Evaluation Report (Docket 93-33-9511) that the BUSS (R-1) cask design meets the requirements of DOE Orders 1540.2 and 5480.3, 10 CFR Part 71 and 49 CFR Part 173.

Michael E. Wangler
Director
Transportation and Packaging
Safety Division, EH-332

Date: APR 22 1994

Reference:

SAND 83-0698 (TTC-0430), Beneficial Uses Shipping System (BUSS) Cask Safety Analysis Report for Packaging (SARP), Revision 4, May 1993.

Department of Energy
Washington, DC 20585

SAFETY EVALUATION REPORT
BUSS (R-1) CASK
DOCKET 93-33-9511

SUMMARY

By application dated October 29, 1993, as revised, the United States Department of Energy (DOE) Albuquerque Operations Office requested a revised DOE Certificate of Compliance (CoC) for the BUSS (R-1) cask design. The DOE is the owner of the packaging design.

Based on the statements and representation made in the Safety Analysis Report for Packaging (SARP), Revision 4 (Reference 1), and the conditions listed below, the staff of the Transportation and Packaging Safety Division, EH-332, has concluded that the BUSS (R-1) cask design meets the requirements of DOE Orders 1540.2 and 5480.3, 10 CFR Part 71, and 49 CFR Part 173.

REFERENCES

1. Beneficial Uses Shipping System Cask, BUSS, Safety Analysis Report for Packaging (SARP), Volumes I and II, Report SAND 83-0698 (TTC-0430), Revision 4, May 1993, Sandia National Laboratories, Albuquerque, NM 87185.

DRAWINGS

The packaging is constructed in accordance with Sandia National Laboratories Drawing Numbers S54774, Rev. C, Cask in Cradle, S52614, Rev. D, Personnel Barrier-Lower, S52615, Rev. D, Personnel Barrier-Upper, and attendant referenced drawings with revision dates of February 28, 1994 or earlier.

The general information and drawings presented in the reference were reviewed by the staff and found acceptable. The BUSS (R-1) cask packaging is adequately described by the Sandia National Laboratories drawings. The drawings provide information pertaining to materials of construction, component dimensions and tolerances, and the location and size of all weld joints. The drawings identify the weld joints to be nondestructively examined and the code or standard for the examination procedure.

1. General

The BUSS cask contents are Category I quantity as defined in DOE/DP-0049, "Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings" and Nuclear Regulatory Commission (NRC) Regulatory Guide 7.11. The BUSS (R-1) cask does not, as designed, provide a containment boundary but only provides a confinement boundary for Special Form capsules. Since the only welds to the cask do not directly relate to providing adequate shielding, they are not subject to ASME Code rules for fabrication.

The BUSS Model R-1 cask is a Type B packaging for shipping highway route controlled quantities of nonfissile, radioactive Special Form strontium-90 fluoride and cesium-137 chloride, double-wall (Type 316L stainless steel, Hasteloy C and Type 316L stainless steel, Type 316L stainless steel) capsules. The total gross weight of the fully loaded package is 15,286 kg (33,700 lb). The cask is shipped exclusive use.

This SER only assesses the changes to the BUSS Model R-1 cask design and performance based on the statements and representations made in Revision 4 of the SARP. Based on the statements and representations made in the revised SARP, the staff has concluded that the changed BUSS cask Shipping Package design meets the requirements of DOE Orders 1540.2 and 5480.3, 10 CFR Part 71, and 49 CFR Part 173.

1.1 Description

The changes in Revision 4 of the SARP to the package design include an increased package gross weight, a welded permanent repair plug in the cask body at the upper port, a removable bore plug in the upper port, a redesign of the personnel barrier, larger handle hole diameters for the baskets, and a changed bolt insert material for the baskets.

The package weight was increased by 363 kg (800 lb) from 14,923 kg (32,900 lb) to 15,286 kg (33,700 lb). This weight change is due to a 318 kg (700 lb) weight increase in the transportation skid and a 45 kg (100 lb) increase in the weight of the contents. The transportation skid weight increase was due to changes to accommodate the new personnel barrier design. The contents weight increase is a result of obtaining more accurate data on the filling of the capsules.

A permanent repair plug was threaded and seal-welded into the cask body at the upper port to correct a machining error that damaged the sealing surface. This plug forms a new surface for the drain plug seal. A removable bore plug was also added to the upper port. The personnel barrier was redesigned to attach to the transportation skid rather than to the trailer bed. The new personnel barrier fits between the impact limiters and is designed with a fixed lower portion and a removable upper portion. The handle holes in the baskets were increased in diameter to allow a greater clearance as the cask heats up. The basket handle bolt inserts were changed to a material with improved elevated-temperature mechanical properties. All of the changes to the packaging were incorporated in the drawings and are discussed in the SARP.

1.2 Contents and Fissile Class

The cask carries Special Form capsules containing up to 6.5×10^5 Ci of strontium-90 fluoride or 8.5×10^5 Ci cesium-137 chloride. These materials are not fissile so no fissile class is assigned. The contents in Revision 4 of the SARP remain the same as Revision 3.

2. Structural Evaluation

2.1 Structural Design

The significant changes in Revision 4 of the SARP that affect the structural design or performance of the BUSS (R-1) cask consist of three items. (1) The BUSS cask support system has been redesigned to accommodate the direct attachment of the personnel barrier to the support skid rather than to the transport truck trailer bed. This change is depicted in Drawing Number S52606, Rev. C, provided with Revision 4 of the SARP. (2) The weight of the entire package has increased from 14,923 kg (32,900 lb) to 15,286 kg (33,700 lb). This 363 kg (800 lb), 2.4%, change consists of a 45 kg (100 lb) increase in the contents weight, previously reported as a maximum of 136 kg (300 lb) and now reported as 181 kg (400 lb), and a 318 kg (700 lb) increase in the skid structure that the cask is mounted on during shipment. Revision 4 of the SARP explains the weight increases and discusses the expected consequences on the analysis results covered in Chapter 2 of the SARP. (3) A "plug bar" is inserted into the BUSS cask body in an opening machined into the upper drain port. The purpose of this plug bar is to repair a machining error. The plug is held in place through a 5-12UN-3A thread with 271 to 339 N-m (200 to 250 ft-lb) of torque. In addition, a seal weld keeps the attachment from loosening up. The "plug bar" repair has been reviewed by the staff and found to be acceptable.

The other changes introduced in Revision 4 of the SARP are the addition of a bore plug to the upper (front) drain port and a redesign of the personnel barrier. The addition of the bore plug has little structural significance because the plug is trapped in place by other components. The impact forces that could be produced by an unattached plug are discussed in Section 2.7 of this report. The personnel barrier provides a shield against hand access to the cask body but has no structural significance.

The design criteria, presented in Section 2.1.2 of Revision 4 of the SARP are the same as in Revision 3. The analytical presentations in Chapter 2 of the SARP are based on the original 14,923 kg (32,900 lb) design weight. The consequence of the increase to 15,290 kg (33,700 lb) is addressed at the conclusion of Chapter 2 as is the increase in the contents weight, from 136 to 181 kg (300 to 400 lb). The weight of the personnel barrier design shown in Revision 4 remains the same as the weight of the design shown in Revision 3.

2.2 Weights and Centers of Gravity

The correct weights and location of the center of gravity are not given in this section of the SARP. The staff has calculated that the location of the

center of gravity will be lower relative to the horizontal axis by about 2.5 cm (1 in) in 100 cm (40 in) which is not significant.

2.3 Mechanical Properties of Materials

Revision 4 of the SARP incorporates several material designation changes using nomenclature introduced since the original SARP was written. These changes have been reviewed by the staff and are acceptable. The physical materials and the material requirements have not changed.

2.4 General Standards for All Packages

The requirements of 10 CFR 71.43 are met for any changes in Revision 4 of the SARP in the same manner as Revision 3.

2.5 Lifting and Tiedown Standards

The lifting and tiedown calculations are affected by the change in package weight in a purely linear manner since stresses are required to remain elastic. Thus the 2.4% increase in package weight results in a 2.4% increase in stresses. In every component of the lifting and tiedown analysis, provided in the Appendix 2A of the SARP, a margin of more than 15% was shown to be available. Therefore, the increase in package weight is easily accommodated. The lowest available margin, about 16%, was for the stress in the trunnion fillet, with the cask subjected to forces equal to the package weight multiplied by the load factors specified in 10 CFR 71.45(b)(1), applied to the center of gravity of the package.

The tiedown design has not been changed in any manner that is significant to the calculation of stresses due to the tiedown loadings. Transverse dimensions of the skid have been increased to accommodate attachment of the personnel barrier. However, the dimensions of the crushable box supporting the cask, which is the significant component with respect to the behavior of the tiedown system, have not been changed.

2.6 Normal Conditions of Transport

For the normal conditions of transport, the forces associated with the drop tests and deformations associated with the temperature gradients do not change significantly as a result of the changes given in Revision 4 of the SARP. Margins of 100% or more are available to withstand the loads that would vary with the package weight. With these margins, the 2.4% change is not significant. Temperature gradient deformations remain unchanged and would be of concern only in evaluating containment boundary integrity which is not a requirement for the confinement boundary of the BUSS package.

2.7 Hypothetical Accident Conditions

With one exception, the 2.4% increase in package weight does not change any of the conclusions reached in Revision 3 of the SARP for the hypothetical accident 9 m (30 ft) drop conditions. The margins calculated in Revision 3 of the SARP exceed 2.4% and accommodate the package weight increase for all drop

orientations. The exception is that, in the case of a side drop orientation, the crushing depth predicted in the SARP is 28.4 cm (11.2 in) (see Appendix 2D.4). This crushing depth occurs when the lowest foam density and highest ambient temperature foam mechanical properties are used in the calculations. The available crushing depth for a side drop, before the flat end of the lifting trunnion makes contact with the unyielding surface, is 28.7 cm (11.3 in). The 0.25 cm (0.1 in) margin theoretically available is not sufficient to accommodate a 2.4% package weight increase and still prevent impact to the trunnion. However, for the 363 kg (800 lb) increase in weight, the potential energy change for a 9 m (30 ft) drop is 33,000 N-m (24,000 ft-lb). Compare this energy change to the impact energy for a drop to a puncture bar from a 1 m (3.33 ft) height with direct impact of the bar by the 14,970 kg (33,000 lb) cask, which is 149,000 N-m (110,000 ft-lb). The entire energy that remains to be dissipated at the instant of contact of the trunnion with the rigid surface, is still only 22% of the total energy associated with the drop to a puncture bar. The drop to a puncture bar was found to be acceptable in the calculations performed in Revision 3 of the SARP.

Other components that need to be considered with respect to the 9 m (30 ft) drop are the capsules and the bore plug. SARP Revision 4 does not update the calculations for the loadings on the capsules. However, the increased loadings on the capsules due to the 33% increase in reported capsule weight are acceptable since the calculations presented in the SARP in Appendix 2F, using the originally reported capsule weights, predict margins that are typically a factor of about ten and, with a reduction of 33%, these margins would still be about seven.

SARP Revision 4 discusses the impact of the added bore plug on the drain plug and other components holding the bore plug in place. Maximum impact loads would develop on the plug's restraining components during a side drop. The stresses developed in the restraining components with the mass of the bore plug included are only a few percent of allowable stresses and are therefore acceptable.

For the regulatory 1 m (40 in) drop to a puncture bar, the only significant change in Revision 4 of the SARP is the increase in total package weight. The analysis presented in Appendix 2E and summarized in Section 2.7.2 of the SARP shows no significant problems associated with the drop on a puncture bar. The associated margins are large enough to remain unaffected by the 2.4% weight increase. The drop to a puncture bar would only be significant for the maintenance of containment boundary seals which is not a requirement for Revision 4 of the SARP.

The other hypothetical accident test conditions, namely thermal and immersion, are not affected by the changes introduced in Revision 4 of the SARP.

3. Thermal Evaluation

In Revision 4 of the SARP, a redesigned personnel barrier will provide a minimum distance of 17 cm (6.5 in) between the cask body and accessible

SER, Docket 93-33-9511, page 6

package surface. Even though this distance is less than the original spacing, the separation is large in comparison to a thin thermal boundary layer of the order of 1 cm (0.5 in) at the cask surface. Therefore the accessible surface temperature will still remain close to that of the environment temperature. The package will therefore comply with the allowable temperature of 82°C (180°F) specified in 10 CFR 71.43(g) for an exclusive use shipment.

Revision 4 of the SARP also eliminates the need for the cask surface temperature monitoring to assure thermal loading would be less than the 4.0 kW certified. The deletion of this procedure is acceptable since the administrative and procedural requirements in Chapter 7, Section 7.1, assure the thermal decay power will not exceed 4.0 kW. In addition, the staff has calculated the thermal loading for the maximum radioactive loading of 6.5×10^5 Ci of strontium-90 fluoride to be 3.6 kW and for 8.5×10^5 Ci of cesium-137 chloride to be 3.0 kW, which is below the maximum 4.0 kW thermal decay power allowed.

3.1 Methods of Analysis and Confirmation

The methods of analysis and confirmation have not been changed in Revision 4 of the SARP.

3.2 Normal and Hypothetical Accident Conditions

The peak temperatures allowed for normal conditions are based on the cask cavity being filled with helium for heat transfer enhancement. The SARP specifies that the cavity be filled with helium before each shipment. Inadvertent loss of the helium will not jeopardize capsule integrity if the transit and wait period does not exceed 30 days. More than 30 days without helium fill may cause excessive internal corrosion of the cesium chloride capsule cladding due to increased temperatures. For the hypothetical accident conditions, the peak temperatures allowed are based on the cask cavity being filled with air because the packaging is not required to remain helium leaktight under accident conditions. The lid bolts, bolt inserts, and threads in the cask body can relax during the hypothetical accident fire since no credit is taken for lid seal performance under hypothetical accident conditions and containment is provided by the Special Form capsules. These conditions have not changed in Revision 4 of the SARP.

3.3 Cavity Internal Pressures

Peak cask cavity internal pressures have not been changed in Revision 4 of the SARP.

4. Containment Evaluation

4.1 Methods of Analysis and Confirmation

The confirmatory review covered the adequacy of the source description; the adequacy of the containment boundary description, specifically the corrosion

performance of the Special Form capsule materials and welds; and any supportive information or documentation provided in Revision 4 of the SARP.

The contents are Special Form radioactive cesium chloride or strontium fluoride mixtures that are contained in double walled, all welded capsules. After fabrication, the inner capsules were tested to ensure leak tightness in accordance with ANSI N14.5 or better. The outer capsule closure welds were inspected ultrasonically to ensure weld penetration of at least 55%. The Special Form capsules provide the containment for this package.

4.2 Normal and Hypothetical Accident Conditions

Revision 4 of the SARP has been reviewed to determine that the containment performance of the package complies with requirements of 10 CFR 71.51 under both normal and hypothetical accident conditions of transport. The BUSS cask only provides a confinement boundary for the helium fill gas while the Special Form capsules provide the actual containment. The confinement boundary was modified in Revision 4 of the SARP through the addition of a repair plug welded to the cask body at the upper vent port. The repair was judged adequate by the staff for the confinement of helium.

To determine that the Special Form capsules provide adequate containment, the thermal and stress conditions experienced by the Special Form materials in the packaging must be less severe than the Special Form test conditions of 10 CFR 71.77. The BUSS packaging provides this needed protection except that the capsules, during normal conditions of transport, will be held at an elevated temperature for a much longer time than the 10 minute Special Form elevated temperature test duration but at only 437°C (819°F) instead of the 800°C (1475°F) Special Form test condition. The exposure to temperatures less than 800°C (1475°F) may cause some corrosion of the cesium chloride capsule inner wall. The amount of corrosion, however, is found to be acceptable, being only 0.005 cm (0.002 in) in a 0.24 cm (0.095 in) thick wall for the 30 day transit and wait period allowed.

In addition to the containment provided by the Special Form capsules, the packaging must also confine helium for heat transfer enhancement. Confirmatory analyses of helium leakage have verified that the helium seal design and seal assembly and leakage testing procedures are adequate for confining helium during the maximum allowable 30 day transit and wait period.

5. Shielding Evaluation

5.1 Methods of Analysis and Confirmation

Neither the contents nor the methods of analysis and confirmation have been changed in Revision 4 of the SARP.

5.2 Normal and Hypothetical Accident Conditions

Therefore dose rates under normal conditions of transport and under hypothetical accident conditions shall continue to meet the regulatory requirements.

6. Criticality Evaluation

Since the allowable contents are non-fissile materials, criticality is not a concern.

7. Operating Procedures Evaluation

The changed requirement in the Cask Loading Procedure of Revision 4 of the SARP that the cask cavity be evacuated to 667 Pa (5 torr) for the purpose of verifying the absence of water is acceptable. 667 Pa (5 torr) is much less than the 1.230 kPa (9 torr) for the vapor pressure of water at 10°C (50.0°F), which is the minimum ambient cask cavity temperature allowed during loading.

The operating procedure requirements presented in the SARP will result in the safe operation of the BUSS cask when the requirements are incorporated into the user specific procedures. Procedures are included which assure that the thermal and radioactive loading of the cask will not exceed design limits, and multiple opportunities are present to detect contents overloads. Appropriate radiological protection is assured through the use of timely radiation surveys during both loading and unloading operations.

Review of the physical condition of the packaging and its critical seal surfaces is required prior to each usage. Post-loading leak tests will assure the integrity of the seals prior to shipment. Closure of the cask lid is done in a straightforward manner as is the assembly of the impact limiters onto the cask body and the loading of the assembled cask onto the shipping cradle and is considered acceptable.

8. Acceptance Tests and Maintenance Program Evaluation

Revision 4 of the SARP has changed the Cask Assembly Verification Leakage Test Procedure requirement from a pressure rise test to a mass spectrometer leak test with adequate sensitivity for the lid, and both upper and lower port covers. The requirement that a mass spectrometer leakage test be performed is much more sensitive than the original pressure rise test and this change is therefore found acceptable. The method of connection of the leakage test equipment has also been reviewed and found acceptable.

Fabrication of the parts of the BUSS cask to the required criteria is assured by the application of numerous inspection tests and material verifications. Forging integrity is verified through magnetic and liquid penetrant inspection as well as radiographic and/or ultrasonic techniques. Dimensional checks are indicated in a standard, approved manner. Fabrication of the foam-filled

impact limiters is verified by weight/volume measurements before and after filling and by testing of a box sample of the foam batch.

To verify the structural design criteria, a hydrostatic pressure test is required before first use that verifies a 150% pressure capability of the cask body and lid. In addition, helium leak tests are required both prior to first use and periodically thereafter.

Shielding integrity is verified before first use by loading the actual payload and making radiation measurements at the surface and at 2 m (6.5 ft). Thermal testing before first use is also required and is performed with the actual payload, verifying surface temperatures within design predictions. Should shielding or thermal tests exceed the acceptance levels, the acceptable loading will be reduced to levels that will result in proper thermal and radiological criteria.

As a final assurance of confinement integrity, a torque test is required for the lid closure bolts. This test verifies that the preload on the lid closure bolts at the specified torque is correct and assures bolt loadings no greater than those specified in the SARP.

After each use, inspection for "wear and tear" and the usual cleaning of components is performed. Regular maintenance requires the BUSS cask lid and port seals to be replaced after each shipment. A periodic test and inspection schedule is provided to assure that the cask body, impact limiters, trunnions, and other components meet original requirements over the life of the packaging.

9. Quality Assurance Evaluation

The Quality Assurance (QA) Plan requirements presented in the SARP have been reviewed and found to meet the requirements of 10 CFR 71, Subpart H. The QA plan requirements provide sufficient control over all items and quality-affecting activities that are important-to-safety as applied to the design, fabrication, assembly, testing, operations, and maintenance activities of the BUSS cask. The BUSS QA Plan requirements are based on a graded approach for QA requirements as described in 10 CFR 71.101. The graded approach in the QA Plan includes for each item and quality-affecting activity an important-to-safety list (Q-list) that is based on the design function of the item relative to the safety and performance requirements for the complete shipping cask. The Q-list is based on three QA levels with associated definitions for each. The QA level of each important-to-safety item is based on the following criteria and the necessary level of QA requirements is invoked for each item. In addition, the QA Plan requires the user to invoke the same level of QA requirements for any maintenance or repair as the original shipping cask had invoked.

Revision 4 of the SARP has changed the Q-list to represent the as-built configuration. The revised Q-list has been reviewed and found to be acceptable.

1. QA Level 1 (Critical)

Critical Level 1 items are structures, components, and systems whose failure or malfunction could directly result in an unacceptable condition of shielding.

2. QA Level 2 (Major)

Major Level 2 items are structures, components, and systems whose failure or malfunction could indirectly result in an unacceptable condition of shielding. An unsafe condition of shielding could result only if the failure or malfunction of a QA Level 2 item occurred in conjunction with the failure or malfunction of other items in the same QA level.

3. QA Level 3 (Minor)

Minor Level 3 items are structures, components, and systems whose failure or malfunction would not reduce the packaging effectiveness and would not result in an unacceptable condition of shielding regardless of other failures or malfunctions of items in the same QA level.

After determining the applicable QA level for each important-to-safety item, the appropriate level of QA effort for the design, fabrication, assembly, testing, acceptance, operations, and maintenance activities was determined from the 18 QA elements identified in 10 CFR 71, Subpart H and ASME NQA-1 and applied appropriately. The 18 elements identified in the SARP are organization; quality assurance program; design control; procurement document control; instructions, procedures, and drawings; document control; control of purchased material, parts, and components; identification and control of materials, parts and components; control of special processes; inspection control; test control; control of measuring and test equipment; control of handling, shipping, and storage; control of inspection, test and operating status; control of nonconforming materials, parts, or components; corrective action; QA records; and QA audits.

Michael E. Wangler
Director
Transportation and Packaging
Safety Division, EH-332

Date: APR 22 1994

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Appendix C: Preshipment Test Acceptance Criteria Qualification Letters

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J. E. Mecca, RL

9359358

Subject: CESIUM CAPSULE SPECIAL FORM RADIOACTIVE MATERIAL DESIGNATION

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November 02, 1993

9359358

Mr. J. E. Mecca, Director
Operations and Transition Division
U.S. Department of Energy
Richland Operations Office
Richland, Washington 99352

Dear Mr. Mecca:

**BASIS FOR CONTINUING DESIGNATION OF CESIUM CAPSULES AS SPECIAL FORM
RADIOACTIVE MATERIAL, PER 49 CFR 173 REGULATORY REQUIREMENTS**

This letter provides justification for continuing the designation of the cesium capsules located at the IOTech facility in Northglenn, Colorado, and at the Applied Radiant Energy Corporation (ARECO) facility in Lynchburg, Virginia, as special form radioactive material, per 49 CFR 173 Regulatory Requirements.

INTRODUCTION

Between 1974 and 1984, 1577 cesium capsules were fabricated at the Waste Encapsulation Storage Facility (WESF). Some cesium capsules were distributed to commercial irradiators to be used for beneficial purposes. The cesium capsule design was tested in 1975 per existing regulatory requirements for special form radioactive material to allow shipping the cesium capsules to the commercial irradiators.

In June 1988, a leak was discovered at the Radiation Sterilizers, Inc. (RSI) facility in Decatur, Georgia. Because of the leak, concern arose over the ability of the cesium capsules to meet current regulatory requirements for special form radioactive material. In 1988 the cesium capsule design was subjected to additional testing and evaluation to support the designation as special form radioactive material. These additional tests and evaluations led to the conclusion that the cesium capsule mechanical design did meet the current special form radioactive material regulatory requirements.

The ability of cesium capsules, used in commercial irradiator environments, to maintain the status of special form radioactive material, was questioned. However, no regulatory basis for the question existed since there were no maintenance requirements for special form radioactive material.

The following sections provide the technical basis, both regulatory and nonregulatory, for continuing the designation of cesium capsules as special form. A description of the cesium capsule environments at RSI, IOTech and ARECO are provided for comparison. An acceptance criteria for shipping the cesium capsules is provided.

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REGULATORY BASIS FOR DESIGNATION AS SPECIAL FORM RADIOACTIVE MATERIAL

The cesium capsule design was assessed per the current regulatory requirements in 49 CFR 173¹. The assessment compared the applicable special form radioactive material requirements for the cesium capsules to historical documentation from special form radioactive material tests performed. The assessment further provided a technical evaluation to conclude that the cesium capsules met existing regulatory requirements for special form radioactive material.

The cesium capsule design was first tested in 1975 per U.S. Energy Research and Development Administration (ERDA) Appendix 0529, Part 1, A.15.b, requirements for special form radioactive material². Because of this testing, the cesium capsules were qualified by ERDA as special form radioactive material³. In recent communications regarding the classification of cesium capsules as special form radioactive material, EH-33.2 agreed that the cesium capsules met the requirements for special form radioactive material at the time of manufacture⁴.

In 1988, after a cesium capsule was found leaking in the RSI-Decatur facility, issues focused on whether the earlier designation as special form radioactive material could be retained for the cesium capsules. An assessment of the cesium capsule design was performed along with additional testing of the cesium capsule to support designation as special form radioactive material⁵. The cesium capsule design met all current regulatory test requirements for special form radioactive material.

The failed cesium capsule (1502) at RSI-Decatur was located and noted to be bulged and unable to produce the "clunk" sound. This indicated the inner capsule was unable to move freely in the outer capsule. As part of the effort to return the cesium capsules from RSI-Decatur and Westerville, the cesium capsules were required to undergo additional evaluations and testing

¹ Report, "Technical Assessment of WESF Cesium Capsule Special Form Issue," WHC-SD-WM-TA-033, February 1992.

² Report, "Cesium Chloride Capsule Testing for Special Form Qualification," ARH-CD-440 August 1975.

³ Letter, P.G. Rhoades, ERDA to G.T. Stocking, ARCHO, "Shipment of Cesium Chloride Capsules in the NRBK-43 Cask, October 1975.

⁴ Memorandum, M.E. Wangler to L.W. Smith, "Response to Special Form Issue," April 10, 1992.

⁵ Report, "Interim Report: Resolution of Special Form Issues Associated with Cesium Chloride Capsules Manufactured at WESF," WHC-SD-WM-DIC-004, January 1989.

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prior to transport in the RSI 1500 shipping container⁶. All of the cesium capsules were subjected to two methods of testing for capsule bulging. One method to evaluate for gross bulging is to pass the 2.625 in. nominal OD capsules through ring gauges of 2.75 in. ID and 2.875 in. ID.

The second test method, the clunk test, permits determination of whether the inner capsule is free to slide within the outer capsule. The clunk test is performed by rapidly accelerating a vertically oriented capsule upward under water and quickly stopping while listening for a "clunk" sound. The clunk is heard when the inner capsule, after sliding within the outer capsule, stops as it hits the top and bottom ends of the outer capsule. Gamma scanning of the failed cesium capsule and other bulged cesium capsules validated the clunk test and demonstrated that the bulging associated with the failed cesium capsule was due to salt swelling in the lower one-third of the capsules⁷. The salt swelled in the inner capsule causing the inner capsule to press against the outer capsule. This prevented movement of the inner capsule.

Cesium capsules that passed the clunk test were determined to not have had sufficient inner capsule swelling to prevent the inner capsule from sliding within the outer capsule. Subsequent engineering studies performed to evaluate the cause of the cesium capsule failure at RSI-Decatur have led to the conclusion that cesium capsules meeting visual, dimensional (ring gauge), and clunk tests will provide acceptable outer capsule containment for shipment as special form radioactive material and meet the applicable transportation regulations⁸.

NONREGULATORY BASIS FOR DESIGNATION AS SPECIAL FORM RADIOACTIVE MATERIAL

Following the cesium capsule failure at the RSI-Decatur facility, WHC and PNL evaluations of the cesium capsules revealed bulging of several cesium capsules, one of which was the leaking RSI-Decatur cesium capsule (1502). It was determined that the bulging was caused by compaction of the salt within the lower one third of the inner capsule, which continued until the outer capsule started to bulge. It was not known then that salt compaction caused cesium capsule 1502 to leak cesium and several conditions were postulated which could account for the failure of the cesium capsule containment. The postulated conditions are:

⁶ Nuclear Regulatory Certificate of Compliance, USA/5939/B()F, Rev. 19.

⁷ Report "Interim Report: Cesium Capsule Bulging Phenomena," WHC-SD-WM-TI-405, September 1989.

⁸ Report, "Reclassification of Cesium Capsules," WHC-SD-WM-TI-409, Rev. 0, January 1990.

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- * Double salt pour
- * Salt overfill
- * Cesium capsule corrosion
- * Cesium capsule weld overlay

Double Salt Pour

Double pouring of salt was identified early as one processing variable during fabrication which possibly influenced cesium capsule bulging. When the supply of salt was insufficient to fill a cesium capsule to within 75% of the height of the inner capsule, a second quantity of salt was poured to fill the capsule. Gardner⁹ identified only one of the 12 bulged cesium capsules from RSI-Decatur as a double pour (1502). Hence, it was concluded that double pouring was not a cause for cesium capsule bulging. This conclusion is based on the fact that only one of the 12 bulged cesium capsules was a double pour. This conclusion is further substantiated by the fact that the salt in the bulged cesium capsules was noted by gamma scanning to have compacted in the lower third of the cesium capsule. This compaction phenomenon further reduced the salt height.

Salt Overfill

A second condition that would possibly lead to cesium capsule bulging is overfilling with cesium salt. This overfill condition would be identified by a cesium capsule having a salt weight in excess of that which would fill the minimum available volume of the inner capsule when heated to 800°C. Since only one of the 12 bulged cesium capsules from RSI-Decatur was identified as being overweight (capsule 1368) with a salt weight of 2.895 kg, this condition appears to not be a cause for capsule bulging⁹. Furthermore, two of the bulging cesium capsules, 1504 (salt weight of 2.311 kg) and 913 (salt weight of 2.225 kg), are substantially lower than the 2.767 kg limiting fill mass for designation as an overweight cesium capsule¹⁰.

Cesium Capsule Corrosion

Cesium capsule failure from corrosion did not appear to be a factor in the cesium capsule leak¹¹ at RSI-Decatur. In fact,

⁹ Report, "Interim Report: Cesium Capsule Bulging Phenomena," SD-WM-TI-405," September 1989.

¹⁰ Report "Cesium Chloride Compatibility Testing Program Annual Report - Fiscal Year 1982," PNL-4556, UC-70, December 1982.

¹¹ Unusual Occurrence Report, UOR RL-WHC-BPLANT-1993-0002, "Failure of Capsule to Pass Inner Capsule Movement Test", January 26, 1993.

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photomicrographs of sections of the failed cesium capsule (1502), showed the wall thickness did not change significantly.

Cesium capsule corrosion had been a concern even before the capsules were provided to commercial irradiators. A Hanford program underway since 1982 evaluated the compatibility of WESF cesium chloride with 316L stainless steel under thermal conditions¹². After eight years of storage pool conditions, very little corrosive attack was observed on the inner capsule wall.

Because of concern over the effect of RSI service on cesium capsule integrity, capsule 1526 was removed from the RSI-Westerville facility for metallographic examination after 15 months and 3327 cycles of service¹³. The depth of attack on the capsule wall, being less than a 0.001 in, indicates that no additional corrosion had taken place since the time of cesium capsule fabrication.

Cesium Capsule Weld Overlay

In addition to cesium capsule bulging, there was one cesium capsule that had an outer capsule weld failure. This failure is described below.

Weld-overlaying of faulty welds on outer capsule end cap was one manufacturing method of repairing inadequate welds during the assembly of the inner capsules into the outer capsule. If an inadequate weld was detected, the weld was repaired by re-welding over the defective weld section. Cesium capsule 1592, returned from RSI-Westerville to WESF, was identified as one such cesium capsule¹⁴.

During periodic clunk testing at WESF following the return of cesium capsule 1592, this capsule failed testing. The cesium capsule was then isolated in a hot cell and examined, whereupon steam was observed egressing from the capsule at the upper weld. Once all of the steam was allowed to escape, the capsule passed the clunk test. Contamination smears around the small hole and review of storage pool water analyses demonstrated that cesium did not escape from the cesium capsule. Considering the solubility of cesium chloride and the sensitivity of the analyses, both smear and water chemistry, it is reasonable to conclude the inner capsule maintained containment.

¹² Report, "Cesium Chloride Compatibility Testing Program Annual Report-Fiscal Year 1984", PNL-5341, January 1985.

¹³ Report, "Characterization of a WESF Cesium Capsule After Fifteen Months Service in a Dry Operation/Wet Storage Commercial Irradiator, PNL-6621, August 1988.

¹⁴ Report "Interim Report: Resolution of Special Form Issues Associated with Cesium Chloride Capsules Manufactured at WESF," WHC-SD-DIC-004, January 1989.

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As weld overlaying of a faulty weld on an outer capsule lid may possibly lead to a leaking outer capsule, the fabrication records of the cesium capsules at the IOTEC and ARECO facilities will be investigated. Those cesium capsules having weld overlay will be shipped in a normal form type B container.

Preliminary Results from Destructive Analysis (1502)

Considerable efforts have been made by Pacific Northwest Labs to investigate the cause of the leak at RSI-Decatur. Although the final report has not been issued, the following is a summary of the findings.

The leak was determined to be due to salt swelling in the lower third of the capsule to the point of rupturing the bottom end cap off the inner encapsulation and swelling the inner capsule wall to the point of impingement on, and swelling of the outer encapsulation. The exact phenomenon causing the salt swelling is not known. Salt swelling is believed to be due to thermal cycling of the cesium capsules in and out of the storage pool water, allowing the cesium capsules to experience elevated temperatures (such that they cycle through the recrystallization temperature with an increase in salt density). Salt swelling in the cesium capsules, prior to the point of outer capsule rupture, can be determined by clunk testing as noted above.

CESIUM CAPSULE FAMILIES

The service conditions of the cesium capsules at the commercial irradiator facilities could be a significant factor related to capsule integrity. The storage conditions of the cesium capsules remaining at ARECO and IOTEC are presented below along with the storage conditions of the RSI-Decatur facility where the capsule failure occurred¹⁵. The cesium capsules at the RSI facilities were subjected to relatively harsher conditions compared to the conditions existing at ARECO and IOTEC. As such, the integrity and condition of the cesium capsules remaining at IOTEC and ARECO are anticipated to remain intact.

IOTEC Cesium Capsule Family

Cesium capsules were shipped to the IOTEC facility beginning in February, 1985, and used in air irradiation operation with water storage. This facility was licensed by the state of Colorado, which is an NRC-Agreement state. A total of 309 cesium capsules exist at IOTEC.

Since the beginning of operation at this facility, the cesium capsules were air-to-water, thermal cycled less than 300 times. The racks during irradiation maintained the cesium capsules in a horizontal array with sufficient distance between capsules to allow adequate air

¹⁵ Report, "Cesium Capsule Family Characteristics", WHC-SD-WM-ES-214, May 1992.

Mr. J. E. Mecca
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flow between all capsules. The air temperature was maintained at approximately 35°C during cesium capsule operation and was continuously monitored for contamination. The water environment was maintained at approximately 25°C and cesium activity monitored to $<1 \times 10^{-12}$ Ci/l.

A leak that exceeds the regulatory limit would be readily detectable during routine analysis of the ^{137}Cs levels in the pool water, which provides ^{137}Cs sensitivity to less than 1.0×10^{-12} Ci/l. A leak of 1.0×10^{-12} Ci/l would be representative of 10^{-8} grams of cesium in the IOTech storage pool (30,000 gallons).

On May 31, 1991, IOTech ceased operation and the cesium capsules have been continuously stored underwater. The cesium capsules have never been clunk tested.

ARECO Cesium Capsule Family

Cesium capsules were shipped to ARECO, an Nuclear Regulatory Commission (NRC)-licensed facility, beginning in November, 1986. A total of 25 cesium capsules exist at ARECO.

Since commencement of operation at this facility, the cesium capsules have never been thermally cycled. The cesium capsules are both stored and used in water. Therefore, the cesium capsules have not been exposed to thermal cycles except for the initial storage pool loading. The storage pools and racks maintain the cesium capsules in a horizontal array. The water temperature is maintained at approximately 33°C, cesium activity monitored to $<1 \times 10^{-12}$ Ci/l, and conductivity monitored to below 10 micromhos/cc. The storage pool water is continuously monitored by a sipper system placed on each individual cesium capsule. The air temperature is maintained at approximately 27°C and continuously monitored for contamination. The cesium capsules at ARECO have been successfully clunk tested annually since 1990.

RSI Cesium Capsule Family

Cesium capsules were shipped to the RSI facilities beginning in July 1985. The cesium capsules were used in air irradiation operations and stored in water. A total of 431 cesium capsules existed at both RSI facilities.

In the 26 months of operation at the RSI-Decatur facility, each cesium capsule had been exposed to over 7300 thermal cycles¹⁶. The irradiation racks maintained the cesium capsules in a vertical array (three capsules high) with very little or no distance between the capsules to maintain effective air flow during the irradiation process. The water storage environment was not maintained by any

¹⁶ Report, "Type B Investigation Interim Report of the DOE Type B Investigation Group," ORO, 1990.

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surveillance program, and there was no monitoring program for temperature, isotope activity, or water conductivity. The air temperature was not maintained at a known value nor monitored for contamination. As a method for improving ventilation to lower the ambient temperature during operation, HEPA filters were removed and replaced with roughing filters. Therefore, no filtration between sources and environment was present.

CESIUM CAPSULE FAMILY ENVIRONMENTS

The environments were significantly different for each cesium capsule family. The RSI cesium capsule storage and irradiation environments provided several possible factors leading to the capsule failure and for not detecting the leak for at least a month. The RSI cesium capsule environments were harsher than the IOTEC and ARECO facility environments because of the number of thermal cycles, available air cooling during irradiation, handling, and storage of the capsules. RSI had numerous process upsets that resulted in the majority of the cycles.

PRESHIPMENT ASSESSMENT OF CESIUM CAPSULE SUITABILITY FOR TRANSPORT

Prior to loading a cesium capsule for shipment, the cesium capsule will be subjected to a series of examinations and tests. Each cesium capsule will be demonstrated to be acceptable for transport as special form radioactive material. The following information along with the preshipment testing will provide the basis for the assessment.

1. The cesium capsule initially met the requirements for special form radioactive material when fabricated.
2. The nature and configuration of the cesium capsule has not changed from the time of fabrication.
3. Continual surveillances of the pool cell water chemistry at the IOTEC and ARECO facilities indicate that the cesium capsule containment remains intact.

PRESHIPMENT TEST ACCEPTANCE CRITERIA

The acceptance criteria for transporting the cesium capsules are as follows:

1. Confirm the past history of the cesium capsule. Only those cesium capsules thermally cycled less than 300 times will be allowed transport as special form radioactive material.

NOTE: The cesium capsules at Decatur exceeded 300 thermal cycles by a factor of 26.

2. Review historical data and perform additional storage pool water analysis prior to shipment. Verify there has been no indication of a cesium capsule leak based on storage pool water analysis.

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NOTE: A leak that exceeds the regulatory limit would be readily detectable during routine analysis of the ^{137}Cs levels in the pool water, which provides ^{137}Cs sensitivity to less than 1.0×10^{-12} Ci/l. A leak of 1.0×10^{-12} Ci/l would be representative of 10^{-8} grams of cesium in the IOTech storage pool (30,000 gallons).

3. Verify cesium capsule configuration and appearance. All cesium capsules with fabrication records indicating weld overlaying will not be shipped as special form radioactive material. The cesium capsule was classified as special form radioactive material when manufactured. The current physical condition of the cesium capsule is evidence of a good containment barrier.

- a) Visual Exam - pass if all welds are intact and there are no significant (1/16 in.) gouges or marks on the cesium capsule or welds.
- b) Clunk Test - pass if the test operator and Quality Control representative both agree that the inner capsule slid within the outer capsule.

Note: The cesium test was validated during the Radiation Sterilizers, Inc., capsule receipt inspection using a gamma scan system. The NRC approved the amendment to the Model 1500 Certificate of Compliance (Reference 6), and referenced the clunk test as a preshipment requirement for assessing containment performance of cesium capsules (Reference 9).

- c) Ring Gauge Test - pass if the small ring gauge (2.75 in.) can be passed over the complete length of the cesium capsule.

SUMMARY

The above discussions provide the regulatory basis for supporting the continuing designation of the cesium capsules as special form radioactive material per 49 CFR 173 regulatory requirements. Also, the additional technical justification (nonregulatory basis) was presented to support the understanding that the IOTech and ARECO cesium capsule configuration will remain intact provided the cesium capsules adequately pass visual, ring gauge, and clunk testing. All cesium capsules subjected to weld overlaying will not be designated as special form radioactive material for transport.

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We believe this letter provides justification for continuing the designation as special form radioactive material designation, per 49 Code of Federal Regulations 173 Regulatory Requirements, of the cesium capsules located at the IOTech facility in Northglenn, Colorado, and at the ARECO facility in Lynchburg, Virginia. We anticipate shipping these cesium capsules back to WESF as special form radioactive material.

Very truly yours,

D. M. Bogen, Manager
B Plant
Facility Operations

sms

DOE-HQ - L. G. Blalock
J. O. Boda
R. B. Chitwood
J. J. Keenan

RL - S. K. Moy
R. O. Puthoff
L. D. Romine

MACTEC - R. D. Filbert

United States Government

Department of Energy

memorandum

Richland Operations Office

DATE: NOV - 3 1993
REPLY TO:
ATTN OF: OTD:LDR
SUBJECT: CESIUM CAPSULE SHIPMENT FROM IOTECH

93-BPL-001

TO: Lawrence H. Harmon, Acting Director
Office of Waste Operations, EM-32

RL is currently preparing to retrieve 309 radioactive cesium (Cs^{137}) capsules located at the IOTECH facility in Northglenn, Colorado, and 25 capsules from the Applied Radiant Energy Corporation (ARECO) facility in Lynchburg, Virginia. These capsules were manufactured at the Waste Encapsulation Storage Facility (WESF) and leased to IOTECH and ARECO for use as an irradiation source. A similar capsule leased to Radiation Sterilizers, Inc. (RSI) and located in Decatur, Georgia developed a leak prompting the DOE to initiate the return of all leased capsules. The capsules leased to RSI have been returned, but the RSI 1500 casks used for this purpose have been decertified by the NRC due to quality assurance record deficiencies.

Because of the decertification of the RSI 1500 casks, the capsules at IOTECH and ARECO are to be returned to the WESF using the Beneficial Use Shipping System (BUSS cask). The BUSS cask Certificate of Compliance (CoC) requires that the cesium capsules have been demonstrated to meet the requirements of Special Form Radioactive Material per 49 CFR 173 within twelve months prior to shipment. Accordingly, RL has worked with EM-322, EM-561, EH-33.2, and the Westinghouse Hanford Company (WHC) to ensure cesium capsules identified for shipment continue to meet the special form radioactive material designation. The Enclosure documents and presents the basis for continuing the designation of special form radioactive material.

The Richland Operations Office (RL) as the shipper-of-record for the return of the WESF capsules, has determined that cesium capsules meeting the "Preshipment Test Acceptance Criteria" as stated in the Enclosure can be shipped as special form. Any capsule not meeting this criteria will be shipped as normal form in an appropriate shipping system. As currently scheduled, RL will begin shipping cesium capsules by mid-February 1994.

Lawrence H. Harmon

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NOV. - 3 1993

If you have any questions, please contact me at 509-376-7434 or Larry Romine of my staff at 509-376-4747.

ORIGINAL SIGNED BY

John R. Hunter, Assistant Manager
Office of Waste Management

Enclosure

cc: J. O. Boda, EM-322
M. E. Wangler, EH-33.2
L. Blalock, EM-561

bcc: BPL Off File
BPL Rdg File
OTD Rdg File
AMW Rdg File
S. Moy, SWT
L. Romine, OTD
R. Filbert, MacTec
E. Robbins, WHC
J. Greg Field, WHC

Appendix C
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OFFICE >	OTD	WMD <i>gmy</i>	WMD <i>gmy</i>	WMD <i>gmy</i>	OTD <i>gmy</i>	AMW <i>gmy</i> ✓
SURNAME>	ROMINE <i>LDZ</i>	MOY <i>gmy</i>	GUERCIJA <i>LDZ</i>	HENNIG	MECCA <i>gmy</i>	HUNTER <i>gmy</i>
DATE >	11-3-93	11-3-93	11/3/93	11/3/93		11/3/93

(Please Return To Arlene Hanson, 6-7275, M0277/A108)

DOCUMENT No. 31502

Department of Energy

Richland Operations Office
P.O. Box 550
Richland, Washington 99352

MAY 11 1994

President
Westinghouse Hanford Company
Richland, Washington

94-BPP0-27

Dear Sir:

DIRECTION TO SHIP CESIUM CAPSULES

- Reference: 1. WHC letter, D. M. Bogen to J. E. Mecca, "Basis for Continuing Designation of Cesium Capsules as Special Form Radioactive Material, per 49 CFR 173 Regulatory Requirements," dated November 2, 1993.
2. Memorandum, J. R. Hunter to L. H. Harmon, "Cesium Capsule Shipment From IOTEC," dated November 3, 1993.

Activities have been underway at the Waste Encapsulation and Storage Facility (WESF) to return 309 radioactive cesium (Cs^{137}) capsules located at the IOTEC facility in Northglenn, Colorado, and the Applied Radiant Energy Corporation (ARECO) in Lynchburg, Virginia. These capsules, manufactured at WESF, were leased for use as an irradiation source.

The capsules at IOTEC and ARECO are to be returned to WESF in the Beneficial Uses Shipping System (BUSS) cask. The enclosed BUSS Cask Certificate of Compliance (CoC) requires that the cesium capsules have been demonstrated to meet the requirements of Special Form Radioactive Material per 10 CFR Part 71 and 49 CFR Part 173 within the twelve months prior to shipment. Reference 1 provided the necessary documentation to support the designation of the cesium capsules located at IOTEC and ARECO as special form, radioactive material for shipment purposes.

Reference 2 provided the documentation and notification to DOE-HQ that RL, as the shipper-of-record for the return of the capsules, has determined that cesium capsules meeting the Preshipment Test Acceptance Criteria (Reference 1) can be shipped as special form. Any capsules not meeting this criteria will be shipped as normal form in an appropriate shipping system.

WHC

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MAY 11 1994

WHC is therefore requested to ship as special form material, those capsules meeting the criteria.

If you have any questions, please feel free to contact me at (509) 376-7434 or L. D. Romine of my staff at (509) 376-4747.

Sincerely,

J. R. Hunter, Assistant Manager
for Waste Management

NMD:LDR

Enclosure

cc: J. J. Keenan, EM-36
D. M. Bogen, WHC
E. D. Robbins, WHC