



Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

OCT 10 2003



Mr. Steve Zappe, WIPP Project Leader
Hazardous Waste Permits Program
Hazardous Waste Bureau
New Mexico Environment Department
2905 E. Rodeo Park Dr. Bldg. 1
Santa Fe, New Mexico 87505-6303

Subject: LANL Sealed Sources Permit Modification Request, WIPP Hazardous Waste
Facility Permit, EPA ID Number 4890139088

Dear Mr. Zappe:

In your letter dated September 30, 2003 you suggested additional data and information that New Mexico Environment Department (NMED) believes would supply needed information missing from our Permit Modification Request (PMR) for relief from headspace gas sampling and analysis requirements for Los Alamos National Laboratory (LANL) Sealed Sources. The suggestions made are the result of our discussions held on September 25, 2003 as referenced in your letter.

As I indicated in the response to your letter, the Department of Energy is hereby submitting the pertinent information which, we believe, will respond to your request for additional data. Once you have had time to review this information we would like to meet with you, if necessary, to answer any further question you may have.

The enclosure to this letter includes the following:

- A list of all changes in the revised PMR
- The revised preamble to the PMR
- A new Attachment (Attachment E) which describes the data collected on the drum randomly selected by the NMED (LA00000061414)

If you have any questions, please call me at (505) 234-7462.

Sincerely,

Harold Johnson for

H.L. (Jody) Plum
RCRA Compliance Manager

Enclosure



Mr. Steve Zappe

-2-

bcc: w/enclosure
P. Detwiler, DOE-HQ
I. Triay, CBFO
H. Johnson, CBFO
D. Bignell, WRES
B. Kehrman, WRES
CBFO M&RC

Attachment 1

Changes to the Sealed Sources PMR

The following changes have been made to the revised Sealed Sources PMR:

- The approximate number of containers in the sealed sources waste stream has been provided in the preamble.
- Additional information regarding the national security issues surrounding sealed sources and the difficulty in storing them at LANL has been discussed in the preamble.
- Various sections of the HWFP have been revised to reflect comments received by stakeholders. This includes Section B-3a(1)(iii) which has been revised to include the following “The integrity of each sealed source must be validated by documented contamination survey results to meet the requirements of 10 CFR 34.27, which must be assembled as part of the AK documentation”.
- Section B-3a(1)(iii) has further been revised to read: “Headspace gas sampling and analysis of a waste container **containing a pipe overpack** component belonging to the LANL sealed sources waste stream.....”
- Section B-3a(1)(iii) has further been revised to read: “All LANL sealed sources will be characterized as newly generated waste.”
- Section B-3a(1)(iii) has further been revised to read: “The VOC source term also must be re-evaluated if any significant (**e.g., change in material or change in manufacture**) is made to the packaging materials....”
- Section B-3a(1) has been revised to read “LANL waste containers that meet the conditions specified in Section B-3a(1)(iii) for sealed source containers are to be assigned VOC concentration values as directed in Section B-3a(1)(iii).”
- Attachment E has been added to the PMR which describes the AK available to verify that no hazardous waste constituents nor VOCs are present in the LANL sealed source waste stream.
- This Attachment also describes the defense determination and the transuranic nature of the sources selected for review by NMED.

Attachment E

Verification That Container LA00000061414 Has No Hazardous Constituents Nor Any Volatile Organic Compounds

On September 30, 2003 the Permittees received a letter from NMED regarding additional information requested by the agency for the permit modification entitled LANL Sealed Sources Wastes Streams Headspace Gas Sampling and Analysis Requirements.

The NMED requested a listing of all drums at LANL which currently contained sealed sources. From that list NMED indicated that they would randomly *"select at least one specific source/container from that list for which the required information would be provided in a revised PMR."*

NMED subsequently selected container LA00000061414.

The information requested by the NMED is as follows:

- Defense determination for individual sources
- Container packaging material examinations/considerations
- Transuranic status of sources
- Process information on how the sealed sources were generated, especially the contents of the sealed sources with respect to hazardous constituents
- Information pertaining to the outer casing not being of VOC bearing materials
- Estimated volume of the waste stream
- Technical difficulties associated with sampling sealed sources
- Clarify the national security issues of the PMR

It is the belief of the Permittees that bullets 1 through 5 are the crux of the issue however each of these requests have been addressed.

Container LA00000061414 is packaged with two sealed sources manufactured by the Monsanto Research Laboratory and have been identified with the serial numbers M364 and M561.

Both sources are plutonium 239/beryllium sources.

Appendix 1 of this Attachment is a letter from Ms. Jesse Hill Roberson, Assistant Secretary for Environmental Management to Dr. Ines Triay, Manager of the Carlsbad Field Office dated July 8, 2003. This letters states in part the following: *"The Pu-239 in these sources is weapons-grade plutonium manufactured at either the Savannah River Site or Hanford."* It further states *"The Pu-239 sources, as a group, are waste from defense activities as defined in the Nuclear Waste Policy Act..."* Therefore, the Pu-239 sources are defense related material and allowable for disposal at WIPP.

The container packaging material is described in detail in Attachment D entitled Headspace Gas Sampling and Analysis Evaluation for LANL Sealed Sources. Page 2 of 8 describes the drum

preparation and Table 1 lists the specific packaging materials.

In response to stakeholder comments which were submitted to the NMED on July 28, 2003 the Permittees responded to a comment regarding packaging (Comment 37).

Both Attachment D and Comment 37 are included as Appendix 2 of this Attachment

Since this is a Pu-239 source it definitely qualifies as transuranic and acceptable at the WIPP facility.

Appendix 3 of this Attachment is the Nuclear Materials Management and Safeguards System Report SS-1 indicating that sources M-364 and M-561 are Pu-239 sources manufactured by Monsanto.

Appendix 4 of this Attachment are shipping information for sources M-364 and M-561. Both documents indicate these are plutonium neutron sources. The container material is identified as tantalum and stainless steel and the method of sealing is "welded". Finally in the lower right hand area of the page the sources have been identified as "recanned". This means the sources were physically removed from their original canister and placed in a new canister as will be discussed later.

Appendix 5 of this Attachment is a report from the Monsanto Research Corporation entitled "Inspection and Recanning Program of PuBe Neutron Sources", dated January 7, 1964.

Page three of the Introduction describes the Monsanto fabrication process for these sealed sources including M-364 and M-561. The process involves placing the Pu pellet into a beryllium cup which was then placed in a tantalum case and sealed with a tantalum plug. This was sealed by tungsten-inert gas welding. The Pu and Be were then heated to about 2000 degrees centigrade and then allowed to cool. The potential for any hazardous constituent or volatile organic compound to be present in the tantalum sealed case is impossible.

This recanning process was required due to a single sealed source exploding. It was found that water had entered the source during leak testing which caused gas to be produced and the internal pressure rose to over 2000 psi which caused a failure of the canister. The leak test procedure has been revised and immersion in water or solvent is no longer performed.

It is impossible that any VOCs would remain after heating to 2000 degrees centigrade; no other materials other than Pu, Be, Ta, Ti and stainless steel are present in the sources (see page 3 of the report) and any contaminant in the source would create off-gassing and the source canister would be deformed from the internal pressure.

On page 11 of the report are the group serial numbers of the sources to be recanned and on page 14 of the report are the sources that were NOT recanned. Neither M-364 nor M-561 are on this list.

Included as Appendix 6 of this Attachment is the information on the reference standard and the

swipes from M-364 and M-561 which indicate the sources are not leaking and there is no potential of contamination.

Appendix 7 of this Attachment includes the VE report for container LA00000061414 which indicates the type of container configuration (page 1, item 2), that the outer casing is made of non-VOC bearing material (page 1, item 5), that the drums contains Pu239Be sources identified as M364 and M561 (page 2, item 1) and that the drums contains no prohibited items (page 3).

Included as Attachment 8 are all of the Monsanto procedures with respect to manufacturing sealed sources. This document may not be required for submittal with the PMR and is not included in this package.

The estimated quantity of containers within the sealed sources waste stream, the national security issues and the lack of storage for "attractive materials" has been addressed in the preamble to this PMR..

APPENDIX 1

DEFENSE DETERMINATION

Memorandum

DATE: July 8, 2003

REPLY TO
ATTN OF: EM-22 (Robert Campbell, 678-567-0336)

SUBJECT: Plutonium-239 Sealed Sources

TO: Dr. Inés Triay, Manager, Carlsbad Field Office

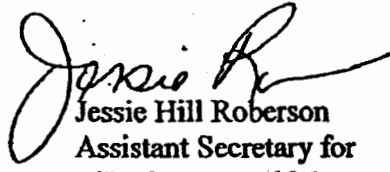
The Albuquerque Operations Office requested that the Office of Environmental Management (EM) review and make a determination regarding the eligibility for disposal at the Waste Isolation Pilot Plant (WIPP) of plutonium-239 (Pu-239) sources. The history of the production and use of these sources and other information has been reviewed by the Office of General Counsel (GC) pursuant to the guidance concerning atomic energy defense activities and the requirements of the Waste Isolation Pilot Plant Land Withdrawal Act. This review was undertaken in order to support the accelerated recovery of Pu-239 sources by the Off-Site Source Recovery Program at the Los Alamos National Laboratory.

This review revealed the following about these sealed sources:

- All Pu-239 sources were provided to lessees under loan-lease agreements. The Atomic Energy Commission and its successor, the Department of Energy (DOE), retained title to these sources, and the loan-lease agreements prohibited the user from altering the form of the material, specifically so this material could be recalled for use in weapons programs.
- Pu-239 has never been sold under the DOE's Isotope Sales Program.
- The Pu-239 in these sources is weapons-grade plutonium manufactured at either the Savannah River Site or Hanford. All of the Pu-239 was manufactured for weapons production.
- Of the 2,400 Pu-239 sources manufactured, about 1,320 were returned to the DOE and the plutonium was recovered and returned to plutonium stockpiles.
- The Pu-239 sources, as a group, are waste from defense activities as defined in the Nuclear Waste Policy Act (NWPA) because they were the result of defense nuclear materials production, defense nuclear waste and materials by-product management, and defense nuclear materials security and safeguards and security investigations.

The result of this review is that EM and GC have concluded plutonium-239 sealed sources meet the definition of defense waste as defined in the NWPA and described in the September 9, 1996, memorandum by Robert R. Nordhaus, *Interpretation of the Term 'Atomic Energy Defense Activities' As Used In the Waste Isolation Pilot Plant Land Withdrawal Act*. This determination is limited to Pu-239 sealed sources.

If you have any questions about this determination, please contact Ms. Patrice M. Bubar, Associate Deputy Assistant Secretary, Office of Integration and Dispost on at (202) 586-5151, or Mr. Paul Detwiler, Office of General Counsel at (202) 586-1371.



Jessie Hill Roberson
Assistant Secretary for
Environmental Management

cc: Jack Tillman, DOE-AL
Ralph Erickson, DOE-OLASO

APPENDIX 2

PACKAGING MATERIAL FOR SEALED SOURCES

**HEADSPACE GAS SAMPLING AND ANALYSIS EVALUATION
FOR LANL SEALED SOURCES
LAUR-03-0917**

**L. Leonard
Los Alamos National Laboratory**

INTRODUCTION

Since 1999, the Los Alamos National Laboratory (LANL), Off-Site Source Recovery (OSR) Project has been identifying and collecting radioactive sealed sources that are no longer needed. There is an existing backlog of sealed sources in known locations that are not secure. The OSR Project's mission is to secure and safely dispose of these sealed sources. The basis for this action is to eliminate the homeland security issues associated with this excess material while it remains unsecured. The vast majority of these sources contain transuranic (TRU) isotopes. Most of the TRU sealed sources are beyond the activity limits for acceptance at low-level waste disposal facilities. However, these sealed sources are candidates for disposal at the Waste Isolation Pilot Plant (WIPP). Many of these sources are the result of "atomic energy defense activity." Many more may be determined to meet this WIPP eligibility requirement at some time in the future.

In all cases, the excess unwanted TRU materials are considered to be of high attractiveness, which presents a homeland security risk if not appropriately secured and safeguarded. The Department of Energy (DOE) and the National Nuclear Security Administration have determined that the maximum level of risk reduction will occur only when the recovered sealed sources are dispositioned as TRU waste by permanent isolation. The objective, therefore, is to recover, package as waste, and transfer all eligible-sealed sources to WIPP as expeditiously as possible. To achieve this objective it is necessary to characterize the sealed source waste stream to WIPP requirements resulting in WIPP-certifiable waste.

Among other requirements, the characterization requirements of the Waste Analysis Plan (WAP) of the WIPP Hazardous Waste Facility Permit (HWFP; No. NM4890139088-TSDF) (Ref. 1) must be met in order to certify TRU waste for disposal at WIPP. Of particular interest for sealed sources is the WAP requirement for headspace gas sampling and analysis. The data quality objectives (DQOs) established by the WAP for headspace gas sampling and analysis are as follows:

- To confirm hazardous waste identification by acceptable knowledge (AK)
- To identify volatile organic compounds (VOCs) and quantify the concentrations of VOC constituents in the total waste inventory to ensure compliance with the performance standards of 20.4.1.500 NMAC (New Mexico Administrative Code; incorporating Title 40, Code of Federal Regulations, §264.601(c)) (Ref. 1).

Based on *Acceptable Knowledge Summary Report for Off-Site Source Recovery Sealed Sources* (OSR-MISC-03) (Ref. 2), the LANL sealed sources do not contain VOCs. However, packaging materials are a potential source for VOCs. The WAP does not require the assignment of hazardous waste codes for organic constituents associated with packaging materials. As such, no hazardous waste codes are assigned to the LANL sealed sources waste stream. Therefore, with respect to the first DQO, because AK assigns no hazardous waste codes and demonstrates that the sealed sources meet the stringent criteria for qualification as U.S. Department of Transportation (DOT) *special form* and comply

with the associated leak test requirement, headspace gas sampling and analysis confirmation is not necessary.

The objective of this report is to demonstrate that the second DQO can be fulfilled without headspace gas sampling and analysis of the waste containers comprising the LANL sealed sources waste stream. Because the TRU sealed sources do not contain VOCs, a headspace gas sample collected from a waste container packaged with the sealed sources would only represent the characterization of the packaging materials. The bounding quantification of potential VOCs from materials to be used for packaging the LANL sealed sources is the subject of this report.

PURPOSE

Headspace gas sampling and analysis was performed for the purpose of quantifying VOCs, hydrogen, and methane present in the headspace of waste containers packaging LANL sealed sources. The purpose of this report is as follows:

- To summarize the results obtained from the analysis of headspace gas samples collected from waste containers including only the materials used to package LANL sealed sources
- To present a justification for assigning VOC concentration values for each waste container of LANL sealed sources in lieu of performing headspace gas sampling and analysis
- To determine the VOC concentrations of the target analytes that will be used to satisfy the reporting requirement of the WIPP HWFP (Module II.C.3.i): "Any waste container that does not have VOC concentration values reported for the headspace is not acceptable at WIPP" (Ref. 1).

QUANTIFICATION OF POTENTIAL VOCs FROM PACKAGING MATERIALS

Drum Preparation

In accordance with *OSR Project Drum Test-VOC Evolutions From Packaging Material* (Ref. 3) the LANL OSR Project prepared ten (10) standard pipe overpack containers. As directed by the procedure, each drum was prepared with an identical configuration. These drums contained only the packaging materials that are used in OSR Project drums. No sealed sources were present in any of the drums.

Each empty standard pipe overpack container was initially inspected by performing the following steps:

- Open 55-gallon drum and inspect lid, locking ring, and gasket
- Remove rigid liner lid and fiberboard disk shim. Inspect rigid liner lid to ensure vent hole is open.
- Remove fiberboard packing top and fiberboard flange shims
- Loosen all bolts in pipe component cap and hoist lid vertically off of the pipe component
- Inspect pipe component O-ring for damage
- Verify serial numbers on pipe component lid matches pipe component body.

Each container was prepared for evaluation as follows:

- Place the poly shield insert into the payload cavity of the pipe component.
- The flanged lid of the pipe component was not installed to allow equilibration of VOCs throughout the pipe overpack container.

- Replace cane fiberboard flange shims, matching flange areas with cutouts in fiberboard
- Replace cane fiberboard packing top
- Install spacer(s) on top of cane fiberboard liner top
- Install rigid liner lid, verifying vent hole with a minimum 0.3 in. diameter
- Measure vertical distance between the bottom of the rigid liner lid and the upper surface of the top fiberboard shim. Verify distance is less than or equal to 0.5 in.
- Install drum lid (with filter previously installed) and closure ring, orient bolt closure ends downward and over the drum seam
- Ensure ring is properly seated on drum, thread drum closure bolt through the threaded drum closure ring lug and lightly tighten drum closure bolt. Torque to 40 ft-lb using calibrated torque wrench.
- Tighten lock nut against unthreaded drum closure ring lug
- Apply Tamper Indication Device (TID) to drum.

Table 1 presents the materials included in each standard pipe overpack container.

Table 1 Packaging Materials *

Packaging Components	Material of Construction	Weight (kg)
Poly Shield Insert	High density polyethylene	29.5
12" Pipe Component, without lid	Stainless Steel, 12-7/8 in. bolts	82.6
Dunnage	Cane Fiberboard	28.6
Rigid Liner and Liner Lid	High density polyethylene	7.7
DOT Type 7A 55 Gallon Drum, including lid and bolt ring	Steel	27.2
Drum gasket	Type I—tubular styrene-butadiene Type II—foam styrene-butadiene	
Drum Filter (NucFil-013)	Carbon composite 3.70E-6 mol/s/mol fraction	

*The packaging components used in this evaluation are compliant with the transportation specifications of the TRUPACT-II Authorized Methods for Payload Control (TRAMPAC), Revision 19a.

As required by *OSR Project Drum Test-VOC Evolutions From Packaging Material*, (Ref. 3) a LANL Record of Drum Closure was completed for each drum. Table 2 summarizes the information recorded on the LANL Record of Drum Closure Forms.

Table 2 Drum Information

Drum Serial #	Drum Vent Type	Drum Vent Serial #	TID #	Date Closed
DB4342	NucFil-013	RFP-6798	0000019	11/21/01
DB4340	NucFil-013	RFP-6782	0000063	11/21/01
DB4339	NucFil-013	RFP-6781	0000043	11/21/01
DB3724	NucFil-013	RFP-6779	0000037	11/21/01
DB4345	NucFil-013	RFP-6796	0000001	11/21/01
DB3725	NucFil-013	RFP-6784	0000024	11/21/01
DB3726	NucFil-013	RFP-6800	0000066	11/21/01
DB3723	NucFil-013	RFP-6795	0000071	11/21/01
DB3721	NucFil-013	RFP-6777	0000039	11/21/01
DB3720	NucFil-013	RFP-6778	0000202	11/21/01

The packaged drums were placed in a secure storage location at LANL.

Headspace Gas Sampling and Analysis

The drums were removed and transported to the LANL Headspace Gas sampling area. Sampling was conducted on September 9, 2002, in accordance with *Manual Headspace Gas Sampling for Analysis by INEEL* (TWCP-DTP-1.2-074) (Ref. 4). A 250-milliliter sample was collected in a SUMMA® canister from each drum and transported to the Idaho National Engineering and Environmental Laboratory (INEEL) for analysis for VOCs, hydrogen and methane with chain-of-custody (COC) forms. None of the samples were composited before analysis.

In accordance with *Manual Headspace Gas Sampling for Analysis by INEEL* (TWCP-DTP-1.2-074) (Ref. 4) a field blank, field duplicate, and field reference standard were collected during sampling and were included in the sampling batch sent to INEEL for analysis. The analysis was conducted in accordance with *Analysis of Gas Samples for VOCs by GC/MS* (ACMM-9930) (Ref. 5) and *Analysis of Gas Samples for VOCs by GC/FID* (ACMM-9910) (Ref. 6). The analytical batch data report (BDR) LA02-HGAS/IA-006 was subject to INEEL data generation verification and validation in accordance with *RWMC Data Generation Level Data Validation* (MCP-1850) (Ref. 7). The sampling BDR LA02-HGAS/IS-006 and the analytical BDR were validated and verified by LANL in accordance with *Project Level Data Validation and Verification* (TWCP-QP-1.1-010) (Ref. 8). The sampling and analytical quality control samples met acceptance criteria and the headspace gas sampling and analysis quality assurance objectives specified by the WAP were met.

Analytical Results

The analytical results for the headspace gas samples collected from the 10 standard pipe overpack containers are tabulated in Table 3. The program required quantitation limit (PRQL) for the alcohols and ketones is 100 parts per million by volume (ppmv) and 10 ppmv for the remaining VOCs. With the exception of three out of 32 analytes measured, the concentrations are reported at the method detection limit (MDL). For acetone, cyclohexane, and toluene, the results are just slightly above detectable. The analytical results identified no tentatively identified compounds (TICs) as determined in accordance with *Analysis of Gas Samples for VOCs by GC/MS* (ACMM-9930) (Ref. 5). As shown in Table 3, the results are clearly orders of magnitude below the PRQL for the regulated VOCs. The concentrations of regulated and flammable VOCs and hydrogen and methane are very small and, in most cases, not detectable. Therefore, VOC contributions from packaging materials are insignificant for the sealed sources waste stream.

Table 3 Analyte Concentrations Resulting from Packaging Materials

DRUM		DB4345	DB4340	DB3721	DB4339	DB3726	DB3723	DB3724	DB3725	DB3720	DB4342
Lab sample ID (INEEL)		022620 02	022620 05	022620 06	022620 07	022620 08	022620 09	022620 10	022620 11	022620 12	022620 13
Acetone	ppmv	1.1 J	1.5 J	1.7 J	1.2 J	1.2 J	1.5 J	1.7 J	0.80 J	1.6 J	0.86 J
Benzene	ppmv	0.055 U	0.056 U	0.055 U	0.054 U	0.056 U	0.054 U	0.056 U	0.057 U	0.055 U	0.058 U
Bromoform	ppmv	0.018 U	0.018 U	0.018 U	0.017 U	0.018 U	0.017 U	0.018 U	0.018 U	0.018 U	0.019 U
Butanol	ppmv	0.059 U	0.060 U	0.060 U	0.058 U	0.060 U	0.058 U	0.060 U	0.062 U	0.060 U	0.062 U
Carbon tetrachloride	ppmv	0.033 U	0.034 U	0.034 U	0.033 U	0.034 U	0.033 U	0.034 U	0.035 U	0.034 U	0.035 U
Chlorobenzene	ppmv	0.031 U	0.032 U	0.032 U	0.031 U	0.032 U	0.031 U	0.032 U	0.033 U	0.032 U	0.033 U
Chloroform	ppmv	0.030 U	0.031 U	0.031 U	0.030 U	0.031 U	0.030 U	0.031 U	0.032 U	0.031 U	0.032 U
Cyclohexane	ppmv	1.9 J	2.1 J	2.6 J	2.2 J	1.8 J	2.4 J	2.2 J	1.7 J	1.9 J	1.0 J
1,1-Dichloroethane	ppmv	0.047 U	0.048 U	0.048 U	0.047 U	0.048 U	0.047 U	0.048 U	0.049 U	0.048 U	0.050 U
1,2-Dichloroethane	ppmv	0.052 U	0.053 U	0.052 U	0.051 U	0.053 U	0.051 U	0.052 U	0.054 U	0.052 U	0.054 U
1,1-Dichloroethylene	ppmv	0.074 U	0.075 U	0.075 U	0.073 U	0.076 U	0.073 U	0.075 U	0.077 U	0.075 U	0.078 U
cis-1,2-Dichloroethylene	ppmv	0.038 U	0.039 U	0.039 U	0.038 U	0.039 U	0.038 U	0.039 U	0.040 U	0.039 U	0.040 U
trans-1,2-Dichloroethylene	ppmv	0.052 U	0.053 U	0.052 U	0.051 U	0.053 U	0.051 U	0.053 U	0.054 U	0.052 U	0.055 U
Ethyl benzene	ppmv	0.045 U	0.046 U	0.046 U	0.045 U	0.047 U	0.045 U	0.046 U	0.048 U	0.046 U	0.048 U
Ethyl ether	ppmv	0.079 U	0.080 U	0.080 U	0.078 U	0.081 U	0.078 U	0.080 U	0.083 U	0.080 U	0.083 U
Methyl ethyl ketone	ppmv	0.098 U	0.10 U	0.099 U	0.097 U	0.10 U	0.097 U	0.099 U	0.10 U	0.099 U	0.10 U
Methyl isobutyl ketone	ppmv	0.040 U	0.041 U	0.040 U	0.040 U	0.041 U	0.040 U	0.040 U	0.042 U	0.040 U	0.042 U
Methylene chloride	ppmv	0.082 U	0.084 U	0.083 U	0.081 U	0.084 U	0.081 U	0.083 U	0.086 U	0.083 U	0.087 U
1,1,2,2-Tetrachloroethane	ppmv	0.030 U	0.031 U	0.031 U	0.030 U	0.031 U	0.030 U	0.031 U	0.032 U	0.031 U	0.032 U
Tetrachloroethylene	ppmv	0.028 U	0.029 U	0.028 U	0.028 U	0.029 U	0.028 U	0.028 U	0.029 U	0.028 U	0.030 U
Toluene	ppmv	0.052 J	0.062 J	0.054 J	0.061 J	0.062 J	0.047 J	0.092 J	0.075 J	0.063 J	0.038 J
1,1,1-Trichloroethane	ppmv	0.032 U	0.033 U	0.032 U	0.032 U	0.033 U	0.032 U	0.033 U	0.034 U	0.032 U	0.034 U
Trichloroethylene	ppmv	0.028 U	0.029 U	0.029 U	0.028 U	0.029 U	0.028 U	0.029 U	0.030 U	0.029 U	0.030 U
1,1,2-Trichloro-1,2,2-trifluoroethane	ppmv	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U
1,3,5-Trimethylbenzene	ppmv	0.032 U	0.032 U	0.032 U	0.031 U	0.032 U	0.031 U	0.032 U	0.033 U	0.032 U	0.033 U
1,2,4-Trimethylbenzene	ppmv	0.036 U	0.036 U	0.036 U	0.035 U	0.036 U	0.035 U	0.036 U	0.037 U	0.036 U	0.038 U
p/m-Xylene	ppmv	0.045 U	0.046 U	0.046 U	0.045 U	0.047 U	0.045 U	0.046 U	0.048 U	0.046 U	0.048 U
o-Xylene	ppmv	0.033 U	0.034 U	0.034 U	0.033 U	0.034 U	0.033 U	0.034 U	0.035 U	0.034 U	0.035 U
Hydrogen	Vol%	0.011 U	0.012 U	0.012 U	0.011 U	0.012 U	0.011 U	0.012 U	0.012 U	0.012 U	0.012 U
Methane	Vol%	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Methanol	ppmv	2.6 U	2.7 U	2.7 U	2.5 U	2.7 U	2.6 U	2.7 U	2.7 U	2.6 U	2.8 U

POTENTIAL VOCs FROM RADIOLYSIS

Sealed radioactive sources, as packaged by the OSR Project, are not capable of significant hydrogen or VOC generation from radiolytic interaction. The AK documentation available demonstrates that sources meet DOT *special form*, and comply with the requirement for a leak test (Ref. 2). In addition, physical inspection during the visual examination assures that no VOC-bearing materials are associated with the TRU sealed source waste. Thus the *sealed* barrier prevents any possible interaction between alpha radiation and the compounds present in the packaging. By definition, no radiolytic gas generation is possible from the alpha and beta energy contained by the sealed sources.

The release of VOCs and hydrogen from the interactions of gamma radiation or neutron particles is zero or nearly zero as shown by the following analysis. Six hydrogen generation test vessels, or canisters, were loaded with a variety of materials, including the high density polyethylene used for packaging sealed sources, and were exposed to a neutron source loaded in each canister in the center of the material. The headspace gas in the canisters was sampled and subjected to gas chromatography measurements. With the exception of some residual hydrogen being released from packaging materials observed during curing, there was no hydrogen detected from radiolysis. The results from the tests are given in Table 4.

Table 4 Empirical Measurement Results of H₂ Released From Irradiated Packaging Materials

Canister #	Material	H ₂ Concentration After 114 Days	Effective "G" Value*
1	Concrete and Polybeads	<1.29 ppmv**	<0.012
2	High Density Polyethylene	<1.29 ppmv**	<0.045
3	Borated Polyethylene	<1.29 ppmv**	<0.017
4	Water-Extended Polyethylene	<1.29 ppmv** (H ₂ evolution from residual curing = 35 ppmv)	<0.026
5	Poly Cast	<1.29 ppmv** (H ₂ evolution from residual curing = 41 ppmv)	<0.024

* The units for the effective "G" value are molecules of H₂ released per 100 electron volts of energy absorbed.

** 1.29 ppm is the lower limit of detection for the gas chromatograph.

As shown in Table 4, the effective G values (gas generation release potential) measured in this test are insignificant for all tested materials. A low G value indicates low gas generation release and is associated with low hydrogen concentration also presented in Table 4. Low hydrogen generation has been correlated to low VOC generation. The G values for VOCs observed in previous studies (Ref. 9) were consistently more than a factor of 200 below those observed for hydrogen generation. Therefore, the generation of VOCs from non-alpha radiolysis is inconsequential for these packaging materials.

CONCLUSIONS

The analytical results listed in Table 3 for the packaging materials alone demonstrate that VOC, hydrogen, and methane concentrations are well below the PRQLs for those compounds. The headspace gas analysis taken from the combination of packaging materials and neutron sources provide confirmation that radiolytic generation of headspace gas from alpha, beta, gamma, and neutron emissions is inconsequential.

Therefore, the WAP DQO for identifying VOCs and quantifying the concentrations of VOC constituents can be fulfilled without headspace gas sampling and analysis of the waste containers comprising the LANL sealed source waste stream.

For the purpose of assigning headspace gas VOC concentration values to the OSR Project sealed source waste stream, UCL_{90} calculations were performed in accordance with *Calculation of UCL_{90} Values* (TWCP-DTP-1.2-006) (Ref. 10) using the results listed in Table 3. The resulting concentrations are presented in Table 5.

**Table 5 Proposed LANL Sealed Sources Waste Container
Headspace Gas VOC Concentration Values**

Compound	Concentration (ppmv)
Acetone	1.46
Benzene	0.03
Bromoform	0.01
Butanol	0.03
Carbon Tetrachloride	0.02
Chlorobenzene	0.02
Chloroform	0.02
Cyclohexane	2.17
1,1-Dichloroethane	0.02
1,2-Dichloroethane	0.03
1,1-Dichloroethylene	0.04
cis-1,2-Dichloroethylene	0.02
trans-1,2-Dichloroethylene	0.03
Ethyl Benzene	0.02
Ethyl Ether	0.04
Methanol	1.35
Methyl ethyl ketone	0.05
Methyl isobutyl ketone	0.02
Methylene Chloride	0.04
1,1,2,2-Tetrachloroethane	0.02
Tetrachloroethylene	0.01
Toluene	0.07
1,1,1-Trichloroethane	0.02
Trichloroethylene	0.02
1,1,2-Trichloro-1,2,2-trifluoroethane	0.01
1,3,5-Trimethylbenzene	0.02
1,2,4-Trimethylbenzene	0.02
p/m-Xylene	0.02
o-Xylene	0.02
Hydrogen	0.01 (vol %)
Methane	0.002 (vol %)

meet all of the characterization requirements of newly generated waste. This means that as they are packaged the AK is verified visually using the VE technique and no subsequent AK verification is required (i.e., subsequent radiography is not needed).

Comment 36: It is not clear how visual examination will determine that the outer casing is of non-VOC bearing material. (B-22). This should be made specific.

Response: The containers for sealed sources are metallic. As such they are not VOC bearing material.

Comment 37: The proposal states that a waste stream VOC source term for packaging is to be established based on sampling of five or more containers holding packaging materials “typical and representative” of such materials in the waste stream. (at B-4). It is not stated whether all sealed sources in the waste stream in question will be repackaged using substantially similar methods and materials, although that is the implication. This should be made explicit.

Response: All LANL OSR Program TRU sealed sources are packaged in a Pipe Overpack Component assembly payload container. Four variations currently approved and used are:

The standard 12" Pipe Component is used for sealed sources containing pure isotopes of Pu-239, Pu-238, or Am-241. These sources do not require shielding beyond that afforded by the steel in the 12" pipe.

The S-300 Container is a standard 12" Pipe Component with a polyethylene shield inside of the 12" pipe. This is used for neutron sources. Most typically Pu-239 Beryllium sources are packaged in this container and the total contents are usually limited to <10 Curies.

The S-100 Container is a 6" Pipe Component with a large Polyethylene shield surrounding the 6" Pipe and filling the space between the Pipe and the internal drum liner. This container is mainly used for the larger activity neutron sources like Am-241 Beryllium and Pu-238 Beryllium.

The S-200 Container is a Standard 12" Pipe Component which contains a lead shield for sealed sources which may emit gamma radiation and then is placed inside of cane fiberboard dunnage within the 12" pipe. Thus far this container has not been required for sealed source packaging.

These containers are described in LANL procedures and approved by NMED as part of the sealed sources program. These containers and packaging components are described in detail within Attachment D of the PMR.

Section B-3a(1)(iii) will have two changes added. These are:

Headspace gas sampling and analysis of a waste container containing a pipe overpack component belonging to the LANL sealed sources waste stream.....

• All LANL sealed sources will be characterized as newly generated waste.

APPENDIX 3

NUCLEAR MATERIALS MANAGEMENT AND SAFEGUARDS SYSTEM REPORT

MARTIN MARIETTA

NUCLEAR MATERIALS MANAGEMENT AND SAFEGUARDS SYSTEM

NMMSS Report SS-1

**Listing of Sealed Sources by Manufacturer
as of 12-31-85**

AS OF 12-31-85

FOUND LABORATORIES,
PLUTONIUM BERYLLIUM SEALED SOURCES

SERIAL #	RIS	NAME	ELEMENT WEIGHT	ISOTOPE WEIGHT	DATE OF MANUFACTURE	CONT TYPE IC	OC	POSSESSED BY	OWNERSHIP	STATUS
M350	ZCP	CALIFORNIA INSTITUTE OF TECHNOLOGY	15.9900	14.9900	062761	TA SS	A/S LIC	P/O		
M351	ZCP	CALIFORNIA INSTITUTE OF TECHNOLOGY	15.9200	14.9200	062761	TA SS	A/S LIC	P/O		
M352	ZCP	CALIFORNIA INSTITUTE OF TECHNOLOGY	16.0600	15.0600	062761	TA SS	A/S LIC	P/O		
M353	OZA	DUPONT DE NEMOURS & CO, AITKEN	15.8400	14.8300	093072		DOE CONT	DOE	OWNED	
M354	OZA	DUPONT DE NEMOURS & CO, AITKEN	15.9900	14.9700	093072		DOE CONT	DOE	OWNED	
M355	OZA	DUPONT DE NEMOURS & CO, AITKEN	15.9600	14.9400	093072		DOE CONT	DOE	OWNED	
M356	OZA	DUPONT DE NEMOURS & CO, AITKEN	15.9600	14.9400	093072		DOE CONT	DOE	OWNED	
M357	AUA	LOS ALAMOS NATIONAL LABORATORY	11.0000	29.0000	093072		DOE CONT	DOE	OWNED	
M358	CZA	ARGONNE NATIONAL LABORATORY, ILLINOIS	15.6900	14.5900	021962	TA SS	DOE CONT	DOE	OWNED	
M359	ZHC	GETTYSBURG COLLEGE	15.6400	14.5500	062961	TA TA	NRC LIC	P/O		
M360	AUA	LOS ALAMOS NATIONAL LABORATORY	79.9800	74.0000	081161		DOE CONT	DOE	OWNED	
M361	QZB	ARMY	2.0000	1.9000	080160	TA		GOVT	AGCY	
M362	AUA	LOS ALAMOS NATIONAL LABORATORY	79.9700	74.0000	031962	TA	DOE CONT	DOE	OWNED	
M363	ZMH	MANHATTAN COLLEGE, NUCLEAR REACTOR LAB	15.9600	14.8400	090161	TA	NRC LIC	DOE	LOAN	
M364	YNG	TRENTON STATE COLLEGE	31.6500	29.2000	112961	TA	NRC LIC	P/O		
M365	ZKL	KANSAS STATE UNIVERSITY	15.9900	14.8800	090561	TA	NRC LIC	P/O		
M366	ZKL	KANSAS STATE UNIVERSITY	16.0100	14.8900	090561	TA	NRC LIC	P/O		
M367	ZKL	KANSAS STATE UNIVERSITY	15.9800	14.8600	090561	TA	NRC LIC	P/O		
M368	ZKL	KANSAS STATE UNIVERSITY	15.8800	14.7600	090561	TA	NRC LIC	P/O		
M369	ZKL	KANSAS STATE UNIVERSITY	16.0900	14.9800	090561	TA	NRC LIC	P/O		
M370	ZTP	SAN DIEGO STATE UNIVERSITY	15.7800	14.6800	041662	TA	NRC LIC	DOE	LOAN	
M371	ZTP	SAN DIEGO STATE UNIVERSITY	15.9900	14.8900	041662	TA	NRC LIC	DOE	LOAN	
M372	ZLV	LOVELL TECHNOLOGICAL INSTITUTE	15.9500	14.8600	071251	TA	NRC LIC	P/O		
M373	ZLV	LOVELL TECHNOLOGICAL INSTITUTE	15.9800	14.8800	071251	TA	NRC LIC	P/O		
M374	ZLV	LOVELL TECHNOLOGICAL INSTITUTE	15.9900	14.9900	071261	TA	NRC LIC	P/O		
M375	ZLV	LOVELL TECHNOLOGICAL INSTITUTE	15.9900	14.9900	071261	TA	NRC LIC	P/O		
M376	ZLV	LOVELL TECHNOLOGICAL INSTITUTE	15.9900	14.9900	071261	TA	NRC LIC	P/O		
M377	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	15.8000	14.7000	071261	TA	DOE CONT	DOE	OWNED	
M378	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	15.6500	14.5600	071261	TA	DOE CONT	DOE	OWNED	
M379	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	15.7700	14.6700	071261	TA	DOE CONT	DOE	OWNED	
M380	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	16.0400	14.9300	071261	TA	DOE CONT	DOE	OWNED	
M381	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	16.1300	15.0100	071261	TA	DOE CONT	DOE	OWNED	
M382	AUA	LOS ALAMOS NATIONAL LABORATORY	15.9900	14.8700	112861	TA	DOE CONT	DOE	OWNED	
M383	AUA	LOS ALAMOS NATIONAL LABORATORY	79.9500	74.4000	112861	TA	DOE CONT	DOE	OWNED	
M384	ZSK	PRINCETON UNIV, OCCUPATIONAL HEALTH & SAFETY	1.0000	1.0000	093072		NRC LIC	P/O		
M385	ZPC	UNION CARBIDE CORP, ORNL, OAK RIDGE	80.0000	79.0000	101361	TA	DOE CONT	DOE	OWNED	
M386	ZPL	UNIVERSITY OF NEW MEXICO	15.9100	14.8000	101961	TA	NRC LIC	DOE	LOAN	
M387	ZPL	UNIVERSITY OF NEW MEXICO	15.9800	14.8600	101961	TA	NRC LIC	DOE	LOAN	
M388	ZPL	UNIVERSITY OF NEW MEXICO	15.9600	14.8500	101961	TA	NRC LIC	DOE	LOAN	
M389	ZPL	UNIVERSITY OF NEW MEXICO	15.9800	14.8600	101961	TA	NRC LIC	DOE	LOAN	
M390	ZPL	UNIVERSITY OF NEW MEXICO	15.9900	14.8700	101961	TA	NRC LIC	DOE	LOAN	
M391	HRA	ROCKWELL INTERNATIONAL CORP, HANFORD	15.9900	14.8700	080461	TA	DOE CONT	DOE	OWNED	

AS OF 12-31-89

HOONO LABORATORIES

PLUTONIUM BERYLLIUM SEALED SOURCES

SERIAL #	RIS	NAME	ELEMENT WEIGHT	ISOTOPE WEIGHT	DATE OF MANUFACTURE	CONT TYPE	POSSESSED BY	OWNERSHIP	STATUS
.....
M521	DZA	E I DUPONT DE NEMOURS & CO, AIKEN	31.2300	29.0000	101862	TA SS	DOE CONT	DOE OWNED	R
M522	DZA	E I DUPONT DE NEMOURS & CO, AIKEN	32.1800	30.0000	0711163	TA SS	DOE CONT	DOE OWNED	R
M523	DZA	E I DUPONT DE NEMOURS & CO, AIKEN	31.2900	29.2000	1011162	TA SS	DOE CONT	DOE OWNED	R
M524	DZA	E I DUPONT DE NEMOURS & CO, AIKEN	32.1700	30.0000	0711163	TA SS	DOE CONT	DOE OWNED	R
M525	FZC	UNION CARBIDE CORP, ORNL, OAK RIDGE	128.0000	119.0698	0922559	TA SS	DOE CONT	DOE OWNED	R
M526	VZO	E I DUPONT DE NEMOURS (SOLIOS) AGROD	6.0000	5.0000	0101159	TA SS	DOE CONT	DOE OWNED	R
M527	YCP	COLLEGE OF ST THOMAS	15.8200	14.7200	1011162	TA SS	NRC LIC	P/O	R
M528	AUA	LOS ALAMOS NATIONAL LABORATORY	79.0000	74.0000	0933072	TA SS	DOE CONT	DOE OWNED	R
M529	OZO	NAVY	79.5700	74.0000	0702259	TA SS	GOVT AGCY	P/O	R
M530	YHV	UNIVERSITY OF WISCONSIN, MILWAUKEE	47.9000	44.3600	0922261	TA SS	NRC LIC	P/O	R
M531	RCI	TAIWAN	79.5600	73.3900	0702259	TA SS	DOE CONT	P/O	R
M532	RCI	TAIWAN	79.8500	74.8900	0702259	TA SS	DOE CONT	P/O	R
M533	AUA	LOS ALAMOS NATIONAL LABORATORY	79.9200	74.3000	0801159	TA SS	DOE CONT	DOE OWNED	R
M534	AUA	LOS ALAMOS NATIONAL LABORATORY	80.0000	74.0000	0933072	TA SS	DOE CONT	DOE OWNED	R
M535	ZJP	ILLINOIS INSTITUTE OF TECHNOLOGY	15.8800	14.7800	0611961	TA SS	NRC LIC	P/O	R
M536	ZJP	ILLINOIS INSTITUTE OF TECHNOLOGY	15.9600	14.8000	0611961	TA SS	NRC LIC	P/O	R
M537	ALA	SANDIA NATIONAL LABS, ALBUQUERQUE	105.7500	100.0000	0922161	TA SS	DOE CONT	DOE OWNED	R
M538	KZA	GENERAL ELECTRIC COMPANY, KNOLLS LAB	159.9100	148.7600	0606662	TA SS	DOE CONT	DOE OWNED	R
M539	RSD	SWITZERLAND	79.9700	74.4000	0702259	TA SS	DOE CONT	P/O	R
M540	ZOK	SIEMENS GAMMASONICS, DES PLAINS, IL	79.7200	74.1570	0112263	TA SS	NRC LIC	P/O	R
M541	YBK	NAVAL UNDERSEA MEDICAL INST, GROTON	31.4900	29.0000	1122563	TA SS	NRC LIC	P/O	R
M542	YNO	NORTHERN STATES POWER CO, MONTICELLO	31.5600	29.3200	1217963	TA SS	NRC LIC	P/O	R
M543	ZRA	UNIVERSITY OF OKLAHOMA, NORMAN	15.0000	14.0000	1022268	TA SS	A/S LIC	P/O	R
M544	ZRA	UNIVERSITY OF OKLAHOMA, NORMAN	15.0700	14.0000	1022268	TA SS	A/S LIC	P/O	R
M545	ZRA	UNIVERSITY OF OKLAHOMA, NORMAN	15.9700	14.0000	1022268	TA SS	A/S LIC	P/O	R
M546	ZRA	UNIVERSITY OF OKLAHOMA, NORMAN	15.9900	14.0000	1022268	TA SS	A/S LIC	P/O	R
M547	ZRA	UNIVERSITY OF OKLAHOMA, NORMAN	15.9500	14.0000	1033368	TA SS	A/S LIC	P/O	R
M548	JSC	E G & G IDAHO-TRAIL, ARAPAHO, CO	79.6100	74.3000	0802559	TA SS	DOE CONT	DOE OWNED	R
M549	ZMK	MARQUETTE UNIVERSITY	15.9900	14.8800	0622861	TA SS	NRC LIC	DOE LOAN	R
M550	ZMK	MARQUETTE UNIVERSITY	15.9800	14.8600	0622861	TA SS	NRC LIC	DOE LOAN	R
M551	ZMK	MARQUETTE UNIVERSITY	15.9600	14.8400	0622861	TA SS	NRC LIC	DOE LOAN	R
M552	ZMK	MARQUETTE UNIVERSITY	15.0000	14.8800	0622861	TA SS	NRC LIC	DOE LOAN	R
M553	ZMK	MARQUETTE UNIVERSITY	15.9700	14.8500	0622861	TA SS	NRC LIC	DOE LOAN	R
M554	FZC	UNION CARBIDE CORP, ORNL, OAK RIDGE	0.4300	0.4000	1122563	TA SS	DOE CONT	DOE OWNED	R
M555	HXA	UNC NUCLEAR INDUSTRIES, RICHLAND	79.2300	74.0000	0203362	TA SS	DOE CONT	DOE OWNED	R
M556	LVB	LAWRENCE LIVERMORE NATIONAL LAB	79.6800	74.0000	0101159	TA SS	DOE CONT	DOE OWNED	R
M557	URA	ROCKWELL INTERNATIONAL CORP, HANFORD	90.0200	76.0000	0422559	TA SS	DOE CONT	DOE OWNED	R
M558	AUA	LOS ALAMOS NATIONAL LABORATORY	79.2300	74.0000	0933072	TA SS	DOE CONT	DOE OWNED	R
M559	AUA	LOS ALAMOS NATIONAL LABORATORY	79.8100	74.0000	0933072	TA SS	DOE CONT	DOE OWNED	R
M560	ZTH	RUTGERS UNIVERSITY, BUSH CAMPUS	79.6300	70.3300	0323651	TA SS	NRC LIC	P/O	R
M561	ZJH	UNIVERSITY OF HOUSTON	159.7700	149.0000	0711163	TA SS	A/S LIC	DOE LOAN	R
M562	ZVT	TEXAS A&M UNIVERSITY	159.6700	149.0000	0833061	TA SS	NRC LIC	DOE LOAN	R

APPENDIX 4
SHIPPING DOCUMENTS OF SOURCES M-364 AND M-561

SHIPPING DATA
PLUTONIUM NEUTRON SOURCE
MONSANTO CHEMICAL COMPANY

Work Order #6711-3
MOUND LABORATORY
MIAMISBURG, OHIO

TO: **Rutgers University**
Chemistry Area II
University Heights Campus
New Brunswick, New Jersey

Attn: Mr. Cunningham

May 23, 1961
DATE OF SHIPMENT & CALIBRATION
VIA Railway Express
YOUR P.O. No. 30398
LICENSE No. MM-314
SS ALLOTMENT QUOTA No. 7000/MM-314
WITHDRAWN FROM MM-3101

NEUTRON SOURCE No. N-361

1. TYPE OF SOURCE - **F₂₅₀**
 2. GRAMS OF BE - **20.50** *39.28*
 3. GRAMS OF PU - **77.94** *75.63*
 4. CONTAINER MATERIAL - **Tantalum and Stainless Steel**
 5. DIMENSIONS OF CONTAINER - INSIDE - **1.30" ID x 1.34" H**
OUTSIDE - **1.55" OD x 2.05" H** *int sw*
 6. METHOD OF SEALING - **WELDED**
 7. NEUTRON EMISSION - **8.81x10⁶** N/SEC
 8. TOLERANCE DISTANCE IN AIR FOR 8 HOURS - **45"** INCHES
(BASED ON **35** N/SEC/CM²)
- SHIPPING CONTAINER IS A PARAFFIN-FILLED **15** GALLON DRUM

SOURCE(S) IS IN A SLOT AT THE BOTTOM OF A PARAFFIN-FILLED TUBE WHICH MAY BE LIFTED AFTER REMOVING THE SEALED CLOSURE OF THE DRUM.

PRICE OF SOURCE

Received

PLUS COST OF SHIPPING CONTAINER

Do

TOTAL

Change

REMARKS:

CC:

A. E. Reed

THE TITLE TO THE PLUTONIUM USED IN THIS SOURCE
REMAINS WITH THE ATOMIC ENERGY COMMISSION.

CMR:lg

J. L. Richmond

GROUP LEADER, SOURCES

SHIPPING DATA
PLUTONIUM NEUTRON SOURCE
MONS. TO RESEARCH CORPORATION
MOUND LABORATORY
MIAMISBURG, OHIO

Work Order 36901-119
November 29, 1961

TO: Mr. Robert J. Kinsey
Central Foundry Division
General Motors Corporation
Denville, Illinois

DATE OF SHIPMENT & CALIBRATION

VIA REA

YOUR P.O. No. E-2014

LICENSE No. SM-277

SS ALLOTMENT QUOTA No. 7000/SM-240

WITHDRAWN FROM SM-3101

NEUTRON SOURCE No. M-364

1. TYPE OF SOURCE - PuBe
2. GRAMS OF BE - 13.88
3. GRAMS OF PU - 31.65
4. CONTAINER MATERIAL Tantalum and stainless steel
5. DIMENSIONS OF CONTAINER : INSIDE - 1.06" O. D. x 2.50" high
w/10-32 thread OUTSIDE -
6. METHOD OF SEALING - WELDED
7. NEUTRON EMISSION - 3.50×10^6 N/SEC
8. TOLERANCE DISTANCE IN AIR FOR 8 HOURS - 28 INCHES
(BASED ON 33 N/SEC/CM²)
- SHIPPING CONTAINER IS A PARAFFIN-FILLED 30 GALLON DRUM

SOURCE(S) IS IN A SLOT AT THE BOTTOM OF A PARAFFIN-FILLED TUBE WHICH MAY BE LIFTED AFTER REMOVING THE SEALED CLOSURE OF THE DRUM.

PRICE OF SOURCE

PLUS COST OF SHIPPING CONTAINER

TOTAL

Received -

No

Charge

REMARKS:

NON-PROJECT

CC:

Robert J. Kinsey

THE TITLE TO THE PLUTONIUM USED IN THIS SOURCE
REMAINS WITH THE ATOMIC ENERGY COMMISSION.

M. E. Merts

GROUP LEADER, SOURCES

APPENDIX 5

MONSANTO REPORT ON RECANNING SEALED SOURCES

MONSANTO RESEARCH CORPORATION

MOUND LABORATORY

MIAMISBURG, OHIO

U. S. GOVERNMENT CONTRACT NO. AT-33-1-GEN-53

AREA CODE 513
860-3311

November 25, 1963

Commander
New York Naval Shipyard
Naval Base
Brooklyn 1, New York

Dear Commander:

Return of PuBe Neutron Sources for Inspection and Recanning

The Recanning Program was initiated because of the discovery, in August 1960, of one source which had developed sufficient internal pressure to cause a visually detectable swelling of the outer stainless steel container. While the cause of the abnormality was determined and source fabrication procedures were immediately modified to prevent any possibility of pressure development in newly fabricated sources, there was some question as to the condition of the 740 sources previously fabricated and in the hands of users. A program of recall of all previously fabricated sources was therefore initiated. During the past three years, therefore, you have received several letters requesting return of your sources for inspection and recanning. The serial numbers of the sources you are now holding which have not been returned are listed as follows:

M-1

At the present stage of completion 650 of the 740 sources in question have been recanned. There has been no indication of internal pressure or potentially hazardous condition in any source, except for the single source which resulted in initiation of the program. Because of the favorable results the program is, therefore, being closed out effective January 1, 1964.

Commander, New York
Naval Shipyard

2

November 25, 1963

To permit orderly close-out of the program, shipment of sources to be recanned must be made to permit receipt at Mound Laboratory on or before December 15, 1963. We will not accept collect shipments after that date.

A dimensional check requirement will be placed on sources, formerly subject to recanning, which are not received prior to the cut-off date. This can be performed concurrently with the six-month alpha wipe test now required of licensees.

A comprehensive report of the investigation of the original abnormal source and of the results of the recanning program will be forwarded to all holders of PuBe sources in early 1964, together with instructions for performing the dimensional checks.

Thank you for your cooperation in this matter.

Very truly yours,

M. R. Hertz
Group Leader, Sources

MRH:lg

RECORDS SUBMITTAL

INSTRUCTIONS: This form is prepared by the record source when submitting individual records, batch data reports, or a records package to the RMDC Center. For records packages, a Table of Contents (TOC) must also be submitted. Each record submitted requires a complete form.

MANDATORY: ☒ To the best of my knowledge, the record(s) have no radioactive contamination.

Signature: [Signature]

RECORD TYPE:

☐ TWCP ☐ Facility (C-FM) ☐ E-ET Group (including Programmatic Facility)
☒ Other: OSR ☐ UCNI ☐ Proprietary

RECORD SOURCE:

Submittal Date: 01/29/2002 Z No.: 147549 Name/Org: Jerry McAlpin / E/EM/OSR
Originator: Jerry McAlpin Organization: E/EM/OSR

TYPE OF RECORD/ACTION TO BE TAKEN

☒ Individual Record ☐ Batch Data Report ☒ Records Package (+ TOC)
☐ New ☐ Revision* ☒ Addition* ☐ Supersedes*
*Record Barcode Number: TWCP - 05659 *Review Cycle (if applicable): ☐ Yes ☒ No ☐ NA

RECORD ID NUMBER: (e.g., memo symbol number, procedure (include revision), deficiency number, batch data report number, unique record identifier if applicable):

Record Date: 01/29/2002 Physical Page Count: 2 ☒ Single Sided ☐ Double Sided

Category Number: (from page two): 38

RECORD TITLE, SUBJECT, AND/OR KEYWORDS:

OSR - Manufacturers Data - Pkg-002
Monsanto- MLM-1188; Inspection and Recanning program of PuBe Neutron Sources; M.R. Hertz

RECORD CENTER USE ONLY

☒ Accepted Date: 2/8/02 ☐ Return Date: _____
Signature: [Signature] Resubmitted: _____
RIDs Type: NO

QC Date: _____ By: _____

(Subject to change prior to scheduled review cycle).

MLM-1188

TID-4500 (27th Ed.)

UC-23 Isotopes -
Industrial Technology

INSPECTION AND RECANNING PROGRAM OF PuBe NEUTRON SOURCES

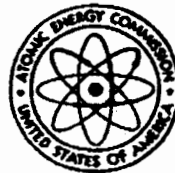
M. R. Hertz

Date: January 7, 1964

Issued: May 1, 1964

MONSANTO RESEARCH CORPORATION

A SUBSIDIARY OF MONSANTO COMPANY



M O U N D L A B O R A T O R Y

MIAMISBURG, OHIO

OPERATED FOR

UNITED STATES ATOMIC ENERGY COMMISSION

U.S. GOVERNMENT CONTRACT NO. AT-33-1-GEN-53

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INTRODUCTION

Prior to 1956 a number of PuBe sources were fabricated at Los Alamos Scientific Laboratory. The method, as described by Tate and Coffinberry¹, was not economically adaptable to the routine production fabrication of neutron sources. Stoichiometric amounts of plutonium and beryllium were placed into a beryllium oxide crucible which was then heated in a vacuum furnace to initiate the reaction to form the intermetallic compound, PuBe₁₃. The furnace heat, plus the exothermic heat of reaction, carried the temperature above the melting point of the alloy (1750°C), resulting in a cast slug of PuBe₁₃. The crucible was then broken from the slug and the PuBe₁₃ was encapsulated in double-sealed containers.

The fabrication method, developed at Mound Laboratory² and used until September, 1960, is illustrated in Figure 1. A weighed pellet of plutonium, (c), was placed in the beryllium cup, (a), which was in turn placed in the tantalum case (b). The tapered tantalum plug, (d), was driven in flush with the top of the case, which was then sealed by tungsten-inert gas welding.

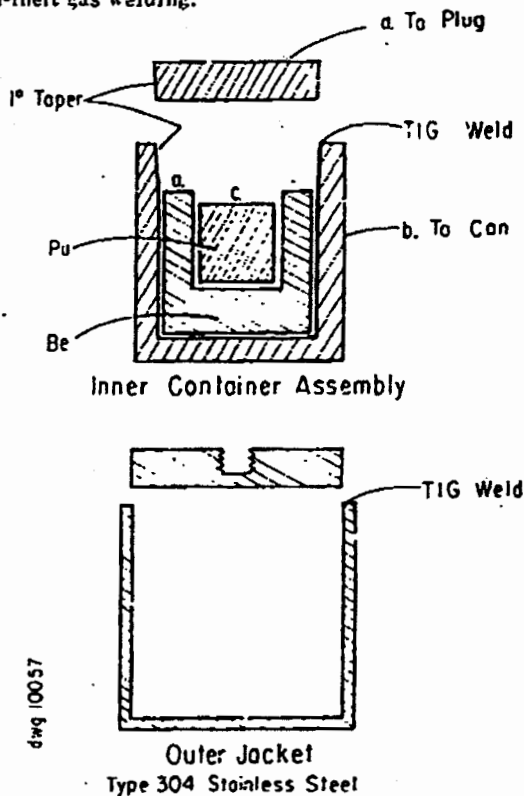


Figure 1 PuBe Source Assembly

The assembly was then placed on an alumina support in a Vicor vacuum chamber and heated in a 15KW electronic heater to initiate the reaction. Although plutonium melts below 650°C, the reaction did not start until the temperature approaches the melting point of beryllium, 1278°C. The heat of reaction carried the temperature to about 2000°C.

¹R. F. Tate and A. S. Coffinberry "Plutonium-Beryllium Neutron Sources, Their Fabrication and Neutron Yield". *Proceedings of Second United Nations International Conference on Peaceful Uses of Atomic Energy*, IV, 427 (1958).

²J. L. Richmond and C. E. Wells, US Patent 3,073,768 (January 15, 1963).

When the source was cool, it was removed from the chamber, and checked for wipeable contamination. Although the sources usually had a wipe count of less than 500 counts per minute (cpm), the inner containers were contaminated occasionally by their surroundings in the glove box during removal. In this case the sources were decontaminated using various techniques until a surface wipe count was less than 500 cpm. The source was then pressed into a 304 stainless steel outer jacket. The thick end plug, normally containing a 10-32 threaded hole for handling, was welded in place. After final neutron calibration the source was ready for use.

In August, 1960, as a result of an increase in internal pressure, a PuBe neutron source came apart violently as the outer case was being removed on a lathe. As a result of this incident, all users of Mound Laboratory sources which were fabricated prior to August 31, 1960, were requested to measure the dimensions of their sources to determine if any deformation of the container was evident. This request in October, 1960, was followed by a request in May, 1961, to return all of these neutron sources to Mound Laboratory for inspection, testing, and recanning.

This report describes the incident which resulted in the initiation of the Recanning Program, and the results of the investigation into the cause of the incident.

DESCRIPTION OF THE INCIDENT INVOLVING A SOURCE

Occasionally, sources were returned to Mound Laboratory by the users because of mechanical damage, usually to the handling threads. In these cases the outer jacket was removed in a lathe, and replaced with a new one. In August, 1960, two sources were returned from the same user; the first source was returned because of a damaged handling thread; and the second, Source No. M-218, was returned because the source could no longer be inserted in the 1.38-inch diameter hole in an oil well logging tool.

Laboratory personnel, intending to replace the jacket on the source with the damaged thread, mistakenly removed M-218 from the shipping container and, without close examination, placed it in the lathe chuck to remove the outer jacket. When the cut had been made more than four-fifths of the way through, the case ruptured with a sharp report.

The portion of the outer case outboard from the cut, including the heavy end cap, ricocheted from the lathe tail stock into the room. The remaining portion of the outer jacket was driven back through the chuck and partially into the hollow lathe spindle. The inner container weld was broken and both parts dropped to the lathe bed along with several grams of loose black powder from the interior of the source. The room was contaminated by flying powder. Figures 2 through 5 show the source parts after the incident.

PERSONNEL CONTAMINATION

The individual performing the operation suffered no physical damage but was contaminated externally and had apparently inhaled some of the contents of the source. Alpha wipe counts from the nostrils were more than 10^5 cpm. In the next few days alpha counts greater than 10^5 cpm were obtained from the feces. Counts decreased to background within two months. No count above background was obtained from the urine. The fact that urine counts did not appear and that feces counts rapidly returned to zero indicated that there was no permanent body burden and that all the inhaled plutonium was rapidly rejected from the lungs, passing out through the digestive tract. It also indicates that PuBe_{11} is biologically inert.

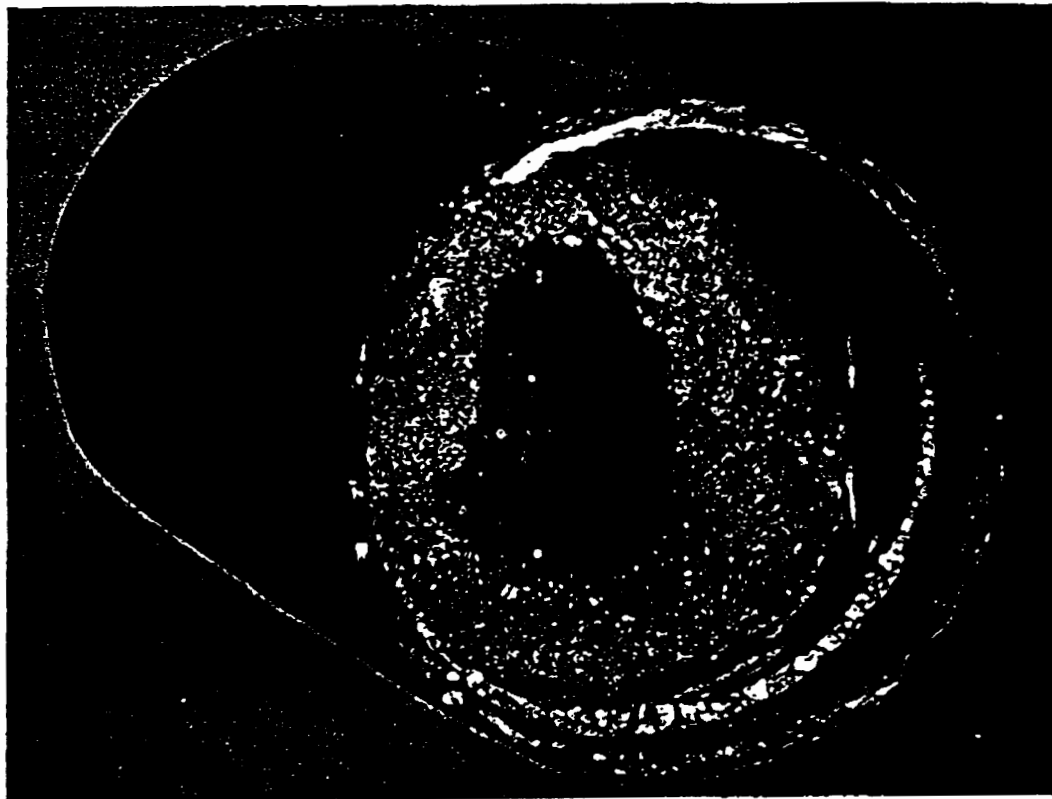


Figure 2 PuBe_{13} Alloy Remaining in the Tantalum Inner Container

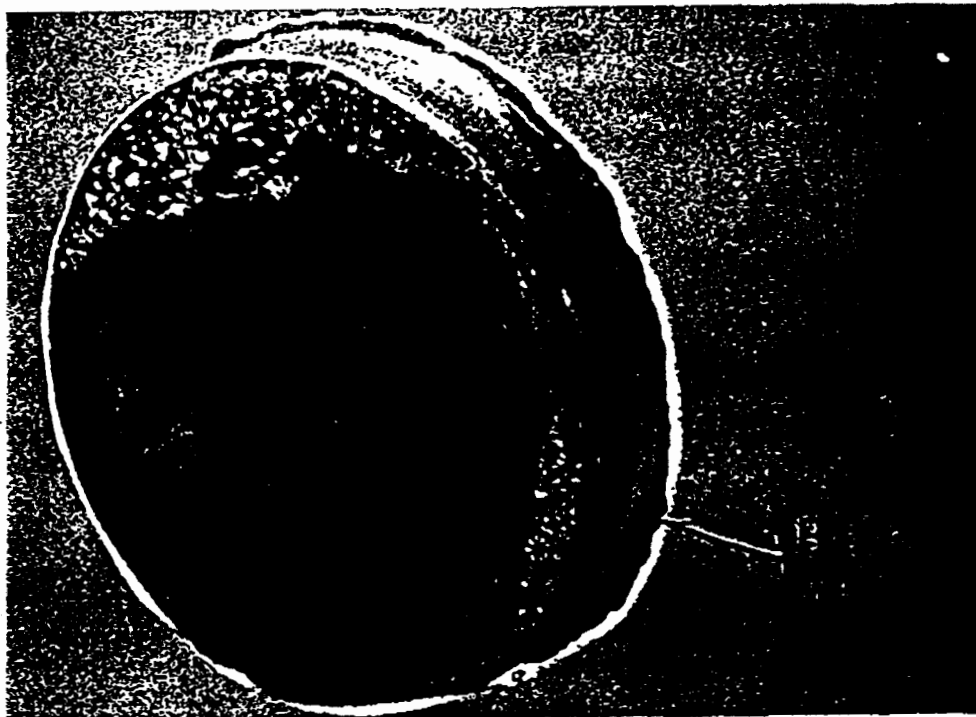


Figure 3 Tantalum Inner Container End Plug Showing Broken Weld

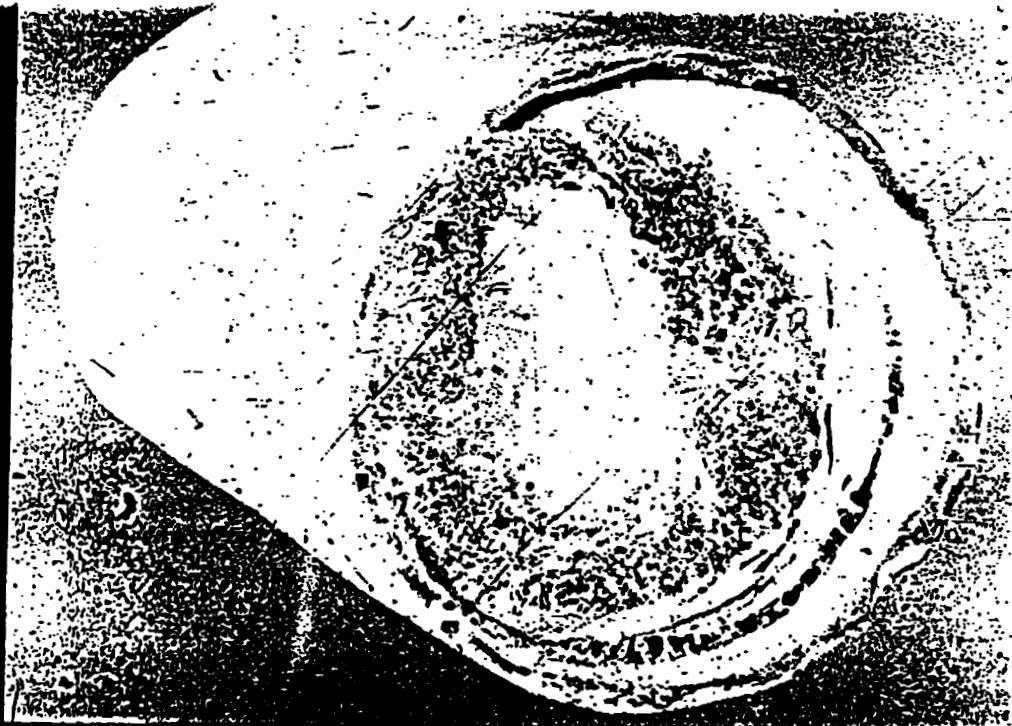


Figure 2 $PuSe_{11}$ Alloy Remaining in the Tantalum Inner Container



Broken
weld

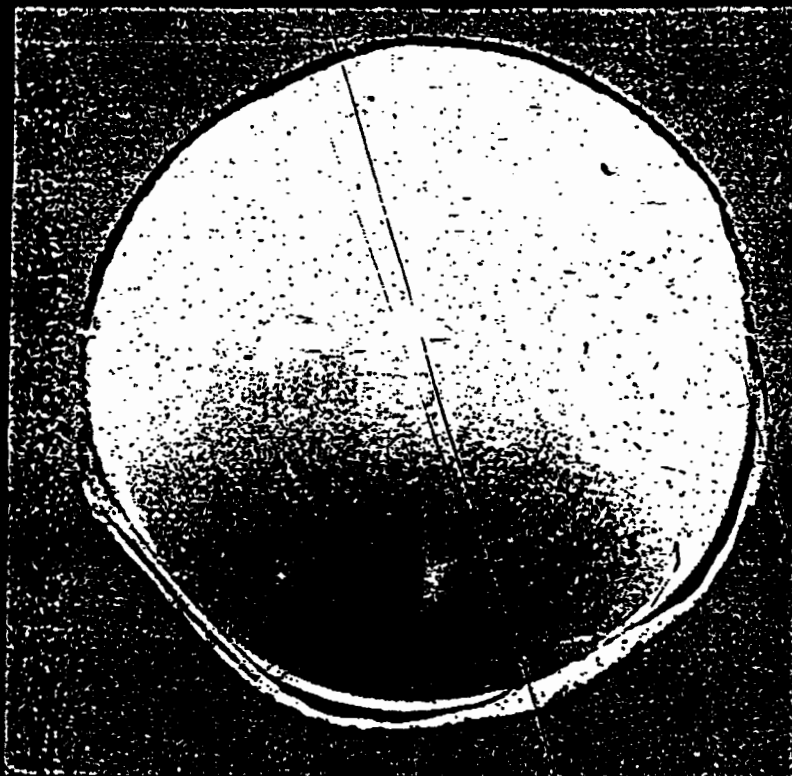


Figure 4 Stainless Steel Outer Container End Cap (interior).



1001
1002

CAUSE OF INTERNAL PRESSURE

Immediately after the incident all users of PuBe sources which were manufactured prior to August 31, 1960, were asked to measure the dimensions of their sources to determine whether or not other sources existed with internal pressure. Since the 304 stainless steel used in the outer containers has more than 40% elongation, swelling of a source would be indicated before rupture. The user of source No. M-218 reported that the source had swelled gradually over a period of several months. Replies to the questionnaire were obtained for about three-fourths of the outstanding sources with no dimensional changes reported. Since the swelling of Source M-218 had been gradual, the return of all sources on an emergency program was not requested.

A number of possible causes for the pressure increase were investigated, such as mechanical damage by the user, phase changes in the PuBe_{12} compound, plutonium decay, "trap door" leaks, inward diffusion of gas, and evolved hydrogen from corrosion. The details and results of the experiments to evaluate these mechanisms are presented in the appendix. The mechanism which probably caused the pressure increase is described below.

ENTRAPMENT OF FOREIGN MATTER DURING FABRICATION

The presence of gas-producing impurities in the inner container when originally welded is highly improbable, since it is difficult to conceive of any reaction taking place at low temperature which would not have been rapidly carried to completion at the 2000°C reaction temperature. If gas was produced, it would be immediately evident at 2000°C because of the negligible residual strength of the tantalum.

Although leak checks were not routinely made on the inner containers, they were assumed to be leak-free since the contamination was never higher than the levels which would have been expected from pick-up during removal from the glove box. Previous experience with several thousand polonium sources substantiated this assumption: nonremovable external contamination is a more sensitive leak test than the most sensitive range of a mass spectrometer helium leak tester. The contamination of the PuBe inner containers was routinely removed with an ultrasonic cleaner to a wipe count of less than 500 cpm.

To check the possibility of leaking inner containers, six sources, three recalled sources contemporary with M-218 and three new sources, were leak checked using a simple bubble technique. Each source was placed in a chamber which was pressurized with 200 psi helium for 15 minutes then immediately immersed in a side-lighted beaker of acetone. Three sources were found to be leaking at the weld. One of the new leaking sources was free of contamination after removal from the reaction chamber.

The results immediately suggested a mechanism for the pressurization of M-218. The source, assumed to be leaking, might have been removed from the reaction chamber before it had completely cooled, and placed in the cold tap water of the ultrasonic cleaner. Upon further cooling, the air in the head space would contract, resulting in the ingestion of water. Discussions with personnel later revealed that, on numerous occasions, sources had indeed been transferred to the cleaning bath while hot enough to sizzle.

If a leaking source at 100°C was placed in 25°C tap water, 20% of the free space in the source would be filled. If the source was at 300°C, 48% of the free space would be filled. Assuming all the water reacted with the source contents to form hydrogen, pressures of 3700 and 8800 psi could be generated in these two cases. It is assumed that the volume between the inner and outer containers is negligible.

An experiment was devised to test the mechanism. Source M-300, one of the original sources recalled from logging operations, was stripped of the outer container and leak checked. It was found to have an obvious leak. This source was heated to about 300°C and immersed in water. No water was drawn into the source, based on weights before and after the procedure. It was evident that the leak would have to be extremely large to allow water to enter in this manner.

The source was immersed in water in the helium leak test chamber which was then pressured with helium to 200 psi. Twelve grams of water were forced in, but in the next few minutes eight grams were forced out by the trapped gas in the source. This water was found to be uncontaminated. The source, with the four remaining grams of water in it, was canned in a standard outer container with a tubulation welded in the cap. This was connected to a gas measuring buret. Over a period of three months 3.5 cc of gas per day was evolved. Projected over a two-year period this would amount to 2600 cc. With a head space of 18.6 cc this gas evolution rate would produce a pressure of about 2050 psi. The outer case of M-218 had been cut more than four-fifths of the way through. Based on the 156,000 psi measured ultimate strength of the steel and one-fifth of the wall remaining, a pressure of 3700 psi would be required to produce endwise rupture.

Several additional variables are involved. Source M-218 may have ingested a larger amount of water; it would have been more uniformly distributed over the surface area of the contents due to the agitation over two years of shipping and handling; and it might have been stored at considerably higher temperatures.

Immediately after these experiments the source fabrication procedure was modified to include a helium leak check of the inner container after reaction, and the sources were not immersed in liquids during decontamination.

THE RECANNING PROGRAM

It was apparent that the sequence of events which probably produced the internal pressure in M-218 were not necessarily unique to this source. A total of 743 sources fabricated prior to the change in procedure was being used. Only three other sources, M-152, M-219 and M-300 had been recalled. The pressure was measured by placing the source in a closed chamber drill jig to which a pressure gage and gas sample bulb were attached, and drilling a small hole in the outer container end plug. These three sources did not have an internal pressure.

In view of the serious nature of a possible rupture in the field, the users of all sources fabricated prior to September 1, 1960 were requested to return their sources. Of the 743 sources, 668 sources were returned for recanning. The categories of users of the sources not returned are presented in Table 1.

The following operations were performed on the recalled sources.

1. A small hole was drilled through the center of one end of the outer container. This would furnish an indication of possible internal pressure, if it existed, and safely release it.
2. The outer container was machined off in a lathe.
3. The inner source container was helium leak checked. If a leak was found, the source was heated to drive out any possible trapped liquids.
4. If the inner container was leaking, it was rewelded and leak checked again.
5. The source was welded in a new outer container, leak checked, recalibrated and returned to the user. (See Appendix No. 3 for information on neutron recalibration).

Table 1

BREAKDOWN OF SOURCES, SUBJECT TO RECANNING, NOT RETURNED (By Users, To December 31, 1963)

Atomic Energy Commission Laboratories	18
Special U. S. Navy "Cable" Test Sources ^{1,2}	15
Other U. S. Government Agencies (Primarily Military)	8
Educational Institutions	7
Oil Well Logging Companies	13
Other Industrial Companies ³	2
Foreign Countries ²	12
TOTAL	75

¹These are special, heavy wall, inspected to Naval reactor specifications.

²No attempt was made to have these returned.

³One of these was exposed to 5×10^{11} n/cm²/sec thermal for several years. It will be replaced so that assessment of possible damage can be made.

GENERAL: Return of sources known to have been calibrated by the National Bureau of Standards was made optional pending outcome of the rest of the program.

The results of this program to date are given in Table 2. No additional sources with internal pressure were found; however, 142 sources were found with leaking inner containers.

Table 2

RESULTS OF PuBe NEUTRON SOURCE REGANNING PROGRAM

Serial No. Group	No. to Recan	Returned		Leaking Inner Container	
		No.	%	No.	%
1 - 100	81	77	95	13	16.9
101 - 200	96	94	98	26	27.0
201 - 300	98	91	93	23	25.0
201 - 400	87	80	92	17	21.3
401 - 500	98	93	94	23	24.7
501 - 600	96	83	87	20	24.2
601 - 700	81	54	67	5	9.3
701 - 800	91	82	88	12	14.6
801 - 840	15	14	93	2	14.3
TOTAL					
(1 - 840)	743	668	90	142*	21.2

*Of these, six sources were ruined during attempts to reweld inner containers and were replaced.

The probability of a source having an internal pressure in the group of sources not recanned was calculated as follows:

$$P = \frac{a}{a+b} = \frac{667}{667+1} = 0.9985$$

$$Q = 1-P = 0.00150$$

$$P_R = \frac{N!}{R!(N-R)!} (P^{N-R} Q^R)$$

- where
- P - Probability that the next source checked does not have internal pressure.
 - Q - Probability that the next source checked has internal pressure.
 - a - Number of sources checked and found to have no internal pressure (667 sources).
 - b - Number of sources checked and found to have internal pressure (one source).
 - N - Number of sources remaining to be checked (75 sources).
 - P_R - Probability that R more sources from the group of N sources remaining to be checked have internal pressure.

Of the 743 sources 668 were checked, and only one (M-218) was found to have internal pressures.

For $R=0$ (Probability that none of N remaining sources have internal pressure):

$$P_0 = (0.9985)^{75} = 0.894$$

The probability that one or more of the remaining 75 sources has internal pressure is 0.106.

The incidence of leaking inner containers was also examined by blocks of 100 serial numbers. Serial numbers generally correspond to the sequence of source fabrication and establish the approximate date of fabrication. There was no significant difference among the number of leaking inner containers in each block. Results of this tabulation are given in Table 2.

DISCUSSION

Since the dimensions of all other sources were reported to be within specifications, internal pressures which may exist are not sufficiently large to deform the outer container. The yield strength of the drawn seamless stainless steel tubing used for the outer container was measured at approximately two-thirds of the ultimate strength. There is, therefore, a probability of approximately 0.1 that a remaining source has developed internal pressure and may be stressed beyond the ASME pressure vessel code (working pressure = $1/5$ rupture pressure).

The only danger is that such a source, if it exists, might rupture if accidentally involved in a fire. A source with no internal pressure is not affected, except for minor surface oxidation, by the Standard Underwriters Laboratory One-Hour Test (1700°F for one hour). Its resistance to mechanical shock or crushing will not be appreciably affected. Puncture of a pressurized outer container will only release the pressure without danger of contamination.

The basic purpose of the recanning program was to eliminate the possibility of rupture of the outer container in the field. Such an occurrence would not be similar to the M-218 incident. A thin wall cylindrical container is twice as strong in longitudinal strength as in hoop strength. A hydrostatically tested dummy container failed by a lengthwise split on one side. Due to its ductility, stainless steel does not produce flying shrapnel when it ruptures. If the test container had been pressurized with gas instead of water, the only difference would have been that the edges at the rupture would have curled outward. The inner source would probably have been contained. Source M-218 failed endwise, resulting in a flying fragment only because the wall had been cut more than $4/5$ of the way through around the circumference, thus reducing the longitudinal strength considerably below the hoop strength.

If a source which was not cut on the circumference ruptures, it would split along its side; the inner container would be incarcerated and contamination would not spread. All standard sources have an outer container with a wall thickness of 0.030 inch. Less than five percent of the sources in the group being tested are of special construction with thicker walls.

The increase in hydrogen pressure in a source containing water is proportional to the surface area of the PuBe₁₂ alloy exposed to the water, rather than to the total amount of water contained.

Since all sources have approximately the same ratio of free volume to weight of alloy, the rate of pressure increase (in psi/year for a source containing water) is expected to be nearly the same for all sources.

The time after fabrication at which sources containing water would reach the yield point is inversely proportional to the source diameter and directly proportional to the wall thickness. If the data on the hydrogen evolution rate obtained by introducing water into only one source is valid for all sources, any source of standard wall thickness which contained water at fabrication should by this time show dimensional changes.

Of the nonstandard sources, the type with the thinnest walls have been calculated to fail at 18,500 psi internal pressure. If water completely filled the free space and reacted to form free hydrogen, the resultant pressure would be approximately 18,500 psi. The postulated mechanism by which water was introduced into M-218 would not be expected to fill more than one-third of the free space and result in much lower final gas pressure.

CONCLUSIONS AND RECOMMENDATIONS

The most probable cause for the development of internal pressure in PuBe Source M-218 was ingestion of water by the leaking inner container when the hot source was placed in a decontamination bath. Reaction of the water with the contents evolved hydrogen, and increased the internal pressure in both the inner and outer containers over a period of more than two years. Approximately 90% of the sources of similar fabrication were inspected, and no additional evidence of internal pressure was found.

It is significant that the individual performing the operation did not retain a permanent body burden, indicating that PuBe₂ is biologically inert.

Occurrence of internal pressure in any of the sources not inspected is unlikely. Fabrication methods have been revised to eliminate any possibility of internal pressure development in sources other than in the group discussed in this report. If internal pressure should develop in one of the not checked sources, it would be evident from visual inspection at least six months to one year before any danger of rupture.

It is recommended that all users of PuBe sources, listed by serial numbers in the Appendix, measure the source diameters at maximum intervals of six months. Methods of obtaining measurements with minimum exposure to source radiation are given in the Appendix. Any increase in diameter of more than 0.010 is of possible significance and should be reported to Neutron Source Group, Monsanto Research Corporation, Mound Laboratory, Miamisburg, Ohio - 45342.

APPENDIX

SOURCES NOT RETURNED FOR RECANNING (As Of January 1, 1964)

M-1	M-525	M-645*
M-11	M-526	M-646*
M-47	M-529	M-647*
M-75	M-531	M-648*
	M-532	M-651*
M-193	M-540	M-675
M-194	M-542	M-676
	M-558	M-677
M-203	M-559	M-678
M-205	M-560	M-679
M-206	M-570	M-692*
M-235	M-571	M-693*
M-236	M-581*	
M-238		M-719
M-256	M-602	M-730
	M-603	M-732
M-353	M-604	M-733
M-354	M-611	M-744
M-355	M-612	M-751
M-356	M-613	M-771
M-357	M-614	M-772
M-361	M-624	M-775
M-396	M-625	
	M-639*	M-805
M-445	M-640*	
M-446	M-641*	
M-448	M-642*	
M-457	M-643*	
M-465	M-644*	

*Navy Cable Test Sources

MEASUREMENT OF SOURCE DIMENSIONS

The only dimension of value in determining if a source is developing an internal pressure is the outside diameter.

To minimize personnel exposure, the source should be handled by a rod threaded into the hole in the source; 18-inch long laboratory tongs; or handling tools which allow equivalent body-source distance to be maintained. With a body-source distance in air of two feet, a 10-curie (160-gram Pu source can be handled for 30 minutes with an exposure of less than 25 milliroentgens. For smaller sources the exposure is correspondingly less. A measurement by either of the techniques described below should not expose personnel for more than 10 minutes.

Method A: Use of Standard Micrometer Caliper (see Figure 6)

The yoke of the caliper is held in a ring stand clamp which, in turn, is attached to a rod of suitable length.

Another rod is coupled to the micrometer barrel with a piece of rubber tubing. Readings can be obtained to 0.001-inch diameter by handling from the ends of the rods. Several readings should be obtained at different points on the source. Before actual source measurements are attempted, the method should be practiced using a non-radioactive test piece to gain confidence in the accuracy.

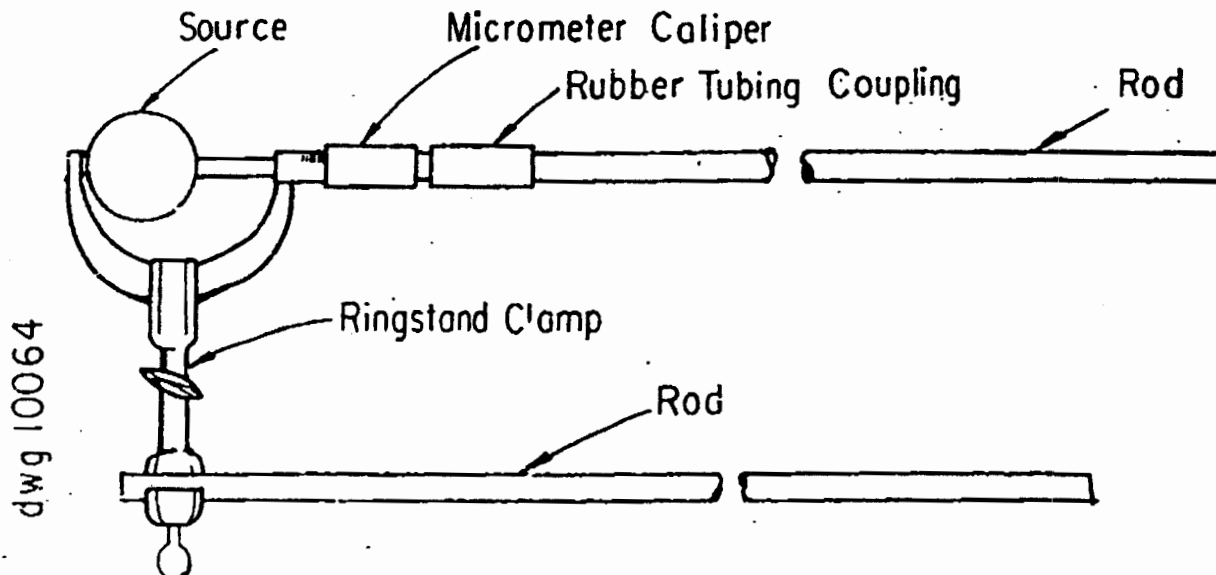


Figure 6 Micrometer Caliper with Extension Rods

Method B: Gage Ring (see Figure 7)

Due to the possibility of measurement errors, the gage ring should be made 0.010-inch larger than the largest diameter measured with a micrometer. Laboratory tongs may be used to drop the gage ring over the source or, if desired, a handling rod may be threaded or brazed to the ring.

Any increase in diameter of more than 0.010 is of possible significance and should be reported to Neutron Source Group, Monsanto Research Corporation, Mound Laboratory, Miamisburg, Ohio - 45342.

RECALIBRATION OF NEUTRON EMISSION

In addition to the testing and recanning discussed in the next section, the neutron emissions of all sources were determined after recanning. This was done using a "Precision Long Counter"³ and neutron source standards calibrated by the National Bureau of Standards. Data on anisotropy of neutron emission were also furnished.

³J. DePangher, "A Reproducible Precision Polyethylene Long Counter for Measuring Fast Neutron Flux", *Bull Am Phys Soc*, 6, 252 (1961).

⁴J. DePangher, "A Reproducible Precision Polyethylene Long Counter for Measuring Fast Neutron Flux", *AEC Report No. HW-70050*, pp 51-57 (1961).

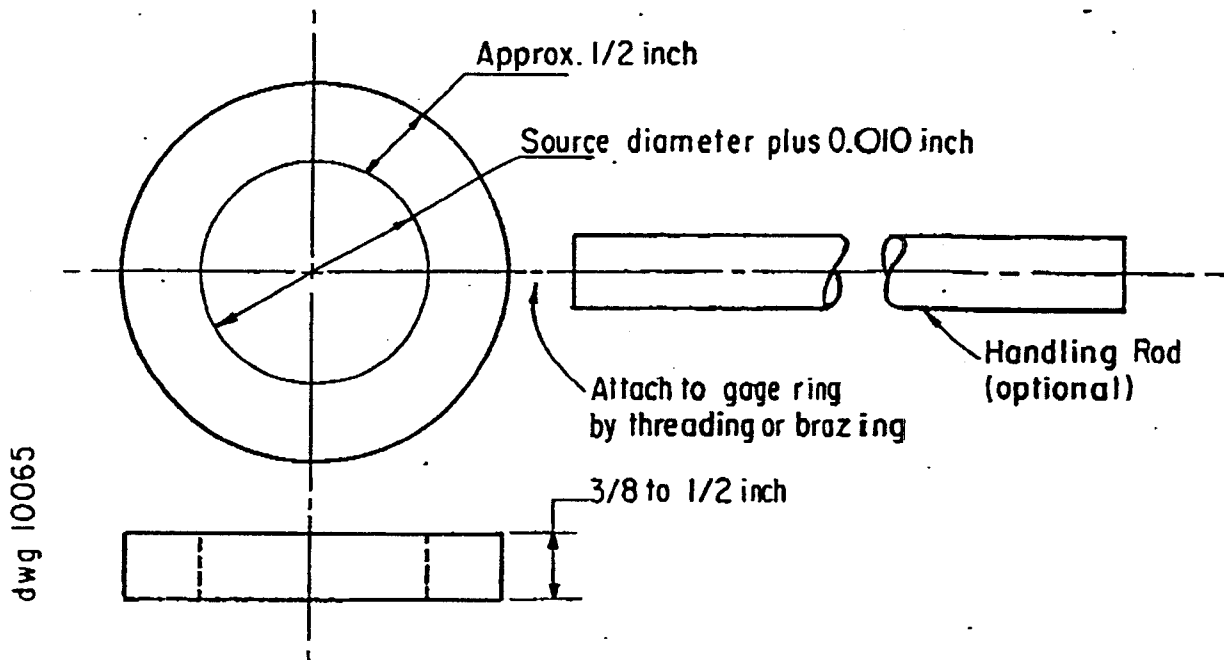


Figure 7 Ring Gage (Stainless Steel preferable)

Apparent changes in the values of total emission were from a combination of factors, including correction for anisotropy, better counting statistics, and the ingrowth of americium-241. Americium-241, an alpha emitter, is formed by the beta decay of 13.2 year plutonium-241 which is present in small amounts. The recanning process itself would not produce a detectable change in emission.

While neutron emission values are generally higher than those originally supplied, the change cannot be used to predict the emission growth due to americium-241 ingrowth. Isotopic analyses of the plutonium originally used are unavailable. An analysis is being made of the calibration data obtained during the Recanning Program and it may be possible, at sometime in the future, to furnish expected growth rates by blocks of serial numbers. This information will be furnished to source users when it becomes available.

EVALUATION OF PRESSURE INCREASES

A number of possible causes for the pressure increase were evaluated. The various possibilities and tests are discussed below:

Mechanical Damage Pressure on the end of the source might have occurred if an attempt had been made to place it in a logging tool designed for another type of source. This could account for the broken weld on the inner container. To store energy, the inner container would have to be stressed and held in a stressed condition by the outer container.

This does not account for the bulging sides of the outer container nor the large energy release at rupture. While the ultimate strengths of tantalum and 304 stainless steel are comparable, the tantalum is much softer. Compression forces as high as 20,000 pounds have been placed at the ends of the sources without causing damage.

Phase Change in the PuBe_{13} Compound Little is known of the metallurgy of this alloy. It is conceivable that changes might occur in the crystal structure of the PuBe_{13} , causing pressure on the tantalum container.

No endwise force would be expected as there was an 18.6 cc space above the PuBe_{13} . Also, the side walls of the stainless steel outer container had expanded to give at least 0.040-inch radial clearance between the inner and outer containers.

The hardness of PuBe_{13} exceeds Vickers 800. The slug is bonded to the tantalum by diffusion at the interface, and growth of the alloy to cause rupture is unlikely.

Helium Pressure Caused by Plutonium Decay One curie of plutonium-239 produces helium at the rate of 2.22×10^{12} atoms per minute; thus, 0.043 cc of helium per year is produced for each curie of plutonium. Since the free space is 18.6 cc, it would require 86 years to produce one atmosphere of pressure in the source. In addition, a major portion of the helium is trapped in the crystal lattice and does not cause gas pressure.

"Trap Door" Leak Although the possibility appears to be remote, leaks which allow the passage of gas in but not out have been reported.

In this case, the source was placed inside a sealed logging tool and not subjected to down-hole pressure. The source had been used on only 30-40 logging operations and not in any hole more than 5000 feet deep. This would indicate the maximum pressure to which it could have been subjected, even with a leaking logging tool, was about 3000 psi.

A dummy five-curie outer container was welded closed with a tubulation and subjected to a hydrostatic pressure test. Strain, as indicated by diameter change, was measured to 0.0001 inch by means of opposed dial indicators. The elastic limit was reached at 5200 psi internal pressure, corresponding to 108,000 psi tensile stress on the steel. Failure occurred at 7300 psi or 156,000 psi ultimate tensile stress. The stress-strain curve is presented in Figure 8. Even with a "trap door" leak, the outer container could not have been stressed beyond the elastic limit and this mechanism could not account for the swelling of the source.

Inward Diffusion of Gas This was proposed as a mechanism which might produce the same effect as the "trap door" leak, since downhole temperatures as well as pressures are considerable elevated. If the source was exposed to these conditions, gases might have diffused into the outer container and have been trapped as it was withdrawn from the hole. The only gas with an appreciable diffusion rate, however, is hydrogen. Free hydrogen is not normally a major constituent of oil well gases.

The diffusion rate of hydrogen through 304 stainless steel at one atmosphere and 300°C is approximately 5.5×10^{-4} cc (STP)/cm²/hr/mm thickness.⁵ Since recorded diffusion rates are variable from sample to sample of steel, the rate of hydrogen diffusion was measured for seamless drawn tubing used for the outer capsule. The apparatus is illustrated in Figure 9.

A five-curie source container, filled with a copper slug to reduce the volume, was welded to a heavy stainless steel plate. A concentric outer container was then welded to the same plate. One-eighth inch copper tubing was silver soldered into holes in the plate to furnish pressure connections to the two chambers. The inner chamber was connected to a pressure gage while the outer container was connected through a 500 psi regulator to a hydrogen cylinder. The unit was leak checked with a mass spectrometer helium leak tester and then placed in a furnace. Both chambers were maintained at 500°C and 450 psi hydrogen pressure for 24 hours to saturate the metal. The diffusion rates were then measured at 450 psi hydrogen pressure and

⁵P. S. Flint, "The Diffusion of Hydrogen Through Materials of Construction", KAPL 659, Knolls Atomic Power Laboratory, Schenectady, N. Y. (December 14, 1951).

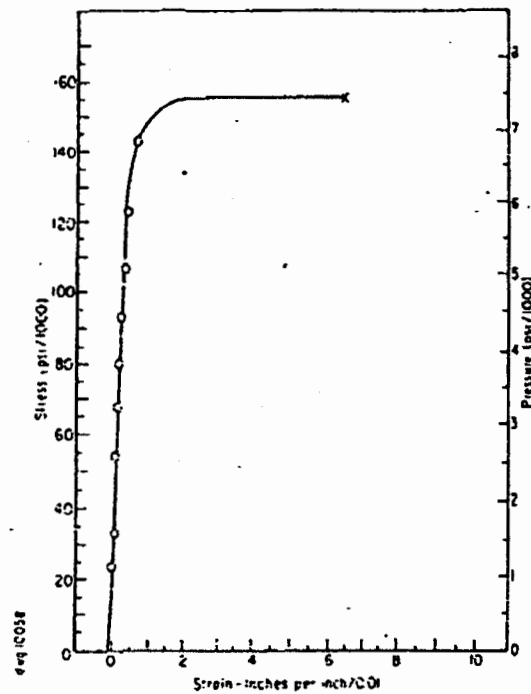


Figure 8 Pressure Test of 5C Stainless Outer Can

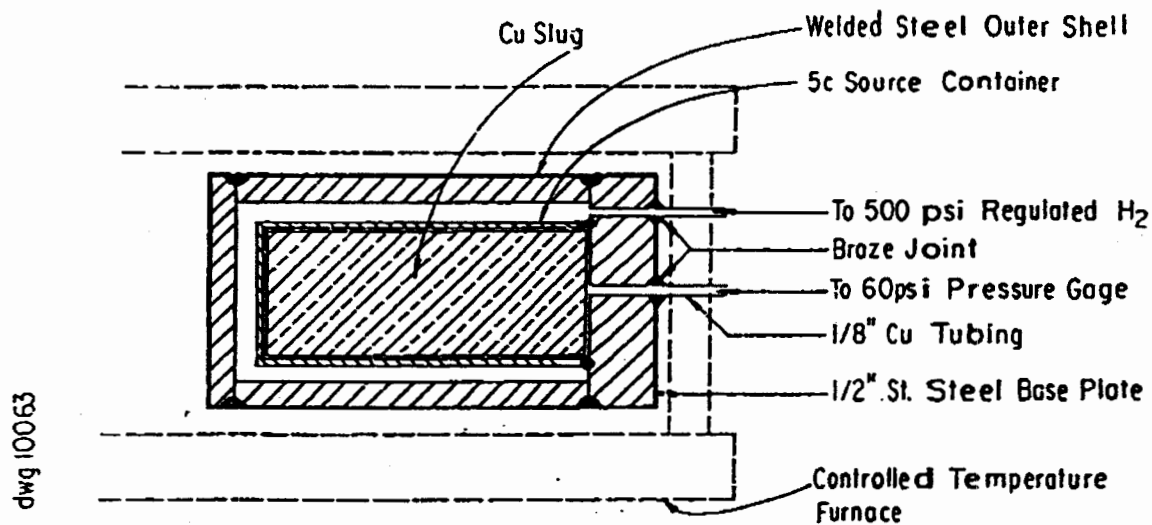


Figure 9 Hydrogen Diffusion Apparatus

500°, 400°, 300°, and 250°C. At 300°C the measured rate, calculated to one atmosphere, was 4.75×10^{-4} cm³/hr/mm thickness, which checked within five percent of the rates given in the literature. With this rate it would require 45 days at 5000 psi to raise the internal pressure one atmosphere. The rate was not measurable at 250°C.

This explanation does not seem plausible. The electronic circuitry in the logging tool would not operate above 200°C. Again the tool would have had to leak.

Hydrogen Pressurization Due to Corrosion or Electrolysis If hydrogen produced by acidic corrosion of steel is suppressed by the presence of hydrogen sulfide, the hydrogen is forced into the metal and will diffuse through. * Pressures in hollow rods have risen to 60 atmospheres in nine days. When carbon steel is used as a hollow cathode in electrolysis, pressure of 200 to 300 atmospheres have been measured.

The possibility of this occurring in the type 304 stainless steel container is considered highly improbable since the use of austenitic stainless steel is recommended where hydrogen cracking or blistering of other steels occurs. Stainless steel cathodes are used in commercial electrolytic hydrogen cells.

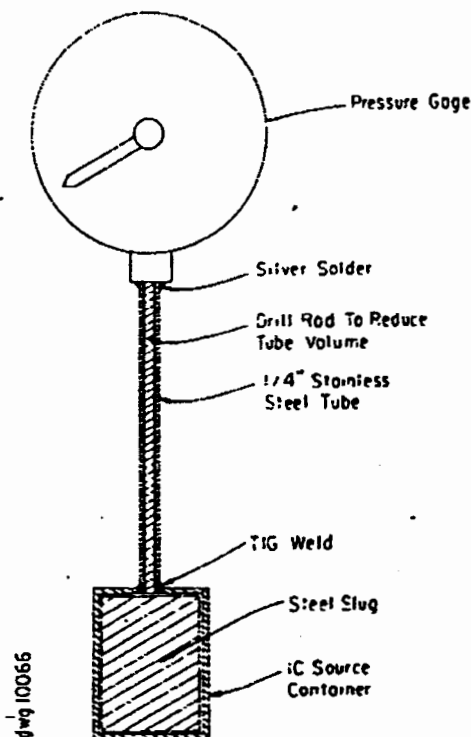


Figure 10 Hydrogen Corrosion Diffusion Apparatus

A test was set up to investigate this mechanism. The apparatus is shown in Figure 10. A one-curie size stainless steel outer container was welded closed with the inner volume filled with a steel slug. A 1/4-inch diameter stainless steel tube was welded in place and almost completely filled with a drill rod to reduce the volume. This was connected to a small pressure gage. The source container was immersed in dilute

*U. R. Evans "The Corrosion and Oxidation of Metals", St. Martins Press, Inc. New York (1960).

hydrochloric acid and operated as a cathode at one ampere for one week. This was then repeated with hydrogen sulfide continuously bubbled through the electrolyte, and finally repeated with an electrolyte composed of 10 percent sodium chloride slightly acidified with hydrochloric acid, saturated with hydrogen sulfide. The tests were run at 95°C.

While the surface of the capsule was noticeably corroded, the pressure did not increase in any of the tests. After the tests the tube was cut and both the gage and source portions were helium leak checked. No leaks were found.

APPENDIX 6
SWIPE DATA ON SOURCES

Pu-239 Standard
 Mass: 16.29596 g
 Source#: 493-19-1
 Ref Date: 5-15-95
 Amount: 5.09 uCi

M-561

PAGE: 1

ID: DAILY CHECK

8 AUG 2003 14:34

SER: 1 COMMENT: 20 ML STD
 RESET TIME: 1.00
 ATA CALC: DL DPM H# : YES SAMPLE REPEATS: 1 PRINTER : EDIT
 QUNT BLANK: YES ICH# : NO REPLICATES : 1 RS232 : OFF
 WD PHASE: NO ADC : YES CYCLE REPEATS: 1 DISK : OFF
 CINTILLATOR: LIQUID LUMEX: YES LOW SAMPLE REJ: 0
 CW LEVEL: NO HALF LIFE CORRECTION DATE: none

SCOTOP 1: 3H %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
 SCOTOP 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
 IDE OPEN WINDOW %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

ACKGROUND QUENCH CURVE: Off COLOR QUENCH CORRECTION: Off

Quench Limits Low: 3.753 High: 303.49

AM	POS	TIME	H#	ISO	CORRECTED	%ERROR	DPM	EFF-1	EFF-2	RATIO	LUMEX	ELAPSED
NO		MIN			CPM						%	TIME
1	3H	1.00	181.5	3H	198.00	14.21	803.57	18.60	0.97	2.602	0.01	1.45
	14C			14C	219.00	13.51	308.82	15.72	68.38			
	WIDE				11539.00	1.84						
Blank Average				DPM for	3H:		803.57	COEF. OF VAR:		0.000		
Blank Average				DPM for	14C:		308.82	COEF. OF VAR:		0.000		

239Pu DPM of std = 11,300

$$eff = \frac{obs - bkg}{known} = \frac{11,539 - 24}{11,300} = 1.02$$

8-7-03

M-561

PAGE: 1

ID: LSC LAB

8 AUG 2003 14:36

BER: 8 COMMENT:
 RESET TIME: 1.00
 DATA CALC: CPM H# : YES SAMPLE REPEATS: 1 PRINTER : STD
 COUNT BLANK: NO IC# : NO REPLICATES : 1 RS232 : OFF
 NO PHASE: NO AGC : NO CYCLE REPEATS: 1 DISK : OFF
 CINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
 DW LEVEL: NO HALF LIFE CORRECTION DATE: none

ISOTOPE 1: 3H %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0
 ISOTOPE 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
 IDE OPEN WINDOW %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

AM	POS	TIME	H#	3H		14C		WIDE		LUMEX	ELAPSED
NO		MIN		CPM	%ERROR	CPM	%ERROR	CPM	%ERROR	%	TIME
1	**1	1.00	13.5	12.00	57.74	6.00	81.45	24.00	40.82	2.98	1.52
2	**2	1.00	123.7	19.00	45.83	4.00	100.00	27.00	38.49	10.39	3.44

$$\text{Net cpm} = 27 - 24 = \frac{3 \text{cpm}}{1.02} = \boxed{3.0 \text{cpm}}$$

Pu-239 standard
 Mass: 16.29596 g
 Source #: 493-19-1
 Ref Date: 5-15-95
 Amount: 5.09 nCi

M-364

PAGE: 1

ID: DAILY CHECK

8 AUG 2003 14:28

SER: 1 COMMENT: 20 ML STD
 RESET TIME: 1.00
 DATA CALC: DL DPM H# : YES SAMPLE REPEATS: 1 PRINTER : EDIT
 COUNT BLANK: YES ICH : NO REPLICATES : 1 RS232 : OFF
 NO PHASE: NO AGC : YES CYCLE REPEATS : 1 DISK : OFF
 SCINTILLATOR: LIQUID LUMEX: YES LOW SAMPLE REJ: 0
 LOW LEVEL: NO HALF LIFE CORRECTION DATE: none

SOTOPE 1: 3H %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
 SOTOPE 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
 WIDE OPEN WINDOW %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

BACKGROUND QUENCH CURVE: Off COLOR QUENCH CORRECTION: Off

bench Limits Low: -3.793 High: 303.49

AM	POS	TIME	H#	ISO	CORRECTED	%ERROR	DPM	EFF-1	EFF-2	RATIO	LUMEX	ELAPSED
NO		MIN			CPM						%	TIME
01	**1	1.00	179.0	3H	234.00	13.07	991.42	19.09	0.97	3.514	0.01	1.46
				14C	203.00	14.04	282.12	15.84	68.56			
				WIDE	11725.00	1.85						

Blank Average DPM for 3H : 991.42 COEF. OF VAR: 0.000
 Blank Average DPM for 14C : 282.12 COEF. OF VAR: 0.000

²³⁹Pu DPM of STD = 11,300

$$eff = \frac{Obs - Bkg}{k_{std}} = \frac{11,725 - 30}{11,300} = 1.03$$

C Am den 2 Ci Pu Be SOURCE wipe
3-8-03

M-364

PAGE: 1

8 AUG 2003 14:30

LD=LSC LAB

SER: 8

COMMENT:

RESET TIME : 1.00
DATA CALC : CPM H# : YES SAMPLE REPEATS : 1 PRINTER : STD
COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : OFF
NO PHASE : NO ADC : NO CYCLE REPEATS : 1 DISK : OFF
CINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
LOW LEVEL : NO HALF LIFE CORRECTION DATE: none

ISOTOPE 1: 3H %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0
ISOTOPE 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
SIDE OPEN WINDOW %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

AM	POS	TIME	H#	3H		14C		WIDE		LUMEX	ELAPSED
				CPM	%ERROR	CPM	%ERROR	CPM	%ERROR		
1	**1	1.00	14.7	13.00	55.47	10.00	63.25	30.00	36.51	2.66	1.71
2	**2	1.00	113.0	11.00	60.30	11.00	60.30	34.00	34.30	5.83	3.53

$$Net\ CPM = 34 - 30 = 4\ CPM$$

$$\frac{4\ CPM}{1.03} = 4.0\ AM$$

HSR-1 SMEAR SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: 8-19-03 No. Of Samples: 15
 TA: 00 Bldg: N/A
 RCT: L. Mamanares Z Number: 109238
 RCT Signature: [Signature] MS: K988
 Phone/Fax: 5-4926

PURPOSE OF SURVEY

☐ Routine ☐ Pre-Job ☐ Post-Job ☐ Hot-Job
☐ Item Release ☐ Offsite Shipment ☐ Onsite Shipment
☒ Non-Routine / Other: OSR Rutgers University

ADDITIONAL INFORMATION

Occurrence No.: N/A
 Incident No.: N/A
 RWP No.: N/A

SAMPLE TRACKING NUMBER

HSR-1 SAMPLE TRACKING



INSTRUMENTATION

TYPE	HSE No.	CAL Due	% EFF	BKG
Alpha 543-10	13656	10/10/03	31.5	0
Beta 543-10	13656	10/10/03	35.2	233

TEST REVIEWER

[Signature]

Smear No.	Location	ALPHA	BETA	Smear No.	Location	ALPHA	BETA
1	Pre Job floor area	NDA	NDA	16			
2				17			
3				18			
4				19			
5				20			
6	Lucite source holder			21			
7	Source in SFC 11-1-0080			22			
8				23			
9	exterior SFC 11-1-0080			24			
10	Drum 61414 TOP			25			
11	side			26			
12	Bottom			27			
13	Post Job floor area			28			
14				29			
15				30			

*dpm/100 cm²

HPAL ANALYSIS REPORT FORM

FILE: 23019868

Comments: rutgers university

SAMPLE DESCRIPTION ANALYSIS REQUESTED
Berthold 780 at TA-50

RCT

Sample Date: 9/3/03 Nucon

Name: Leonard Manzanares 0

TA: 00

TA: 52

BLDG: N/A

Analyst: Trujillo Isaac

MS: K988

Sample ID #	Alpha Activity dpm	2*sigma dpm	Alpha MDA dpm	Beta Activity dpm	2*sigma dpm	Beta MDA dpm
1	NDA	NDA	5.0	NDA	NDA	7.7
2	NDA	NDA	5.1	NDA	NDA	7.4
3	NDA	NDA	6.3	NDA	NDA	7.0
4	NDA	NDA	5.0	NDA	NDA	7.5
5	NDA	NDA	6.3	NDA	NDA	9.5
6	NDA	NDA	5.9	NDA	NDA	8.3
7	NDA	NDA	5.0	NDA	NDA	7.0
8	NDA	NDA	4.9	NDA	NDA	7.7
9	NDA	NDA	5.5	NDA	NDA	7.7
10	NDA	NDA	6.6	NDA	NDA	9.0
11	NDA	NDA	5.0	NDA	NDA	7.7
12	NDA	NDA	5.1	NDA	NDA	7.4
13	NDA	NDA	6.3	NDA	NDA	7.0
14	NDA	NDA	5.0	NDA	NDA	7.5
15	NDA	NDA	6.3	NDA	NDA	9.5

Trujillo 109238

APPENDIX 7

VE REPORT

Container Packaging and VE Data Record

Page 1 of 3

Container Identifier		LA0000061414
Printed name of VE Packager		S. Leonard
Printed name of VE Recorder		J. A. Tompkins
Step	Requirement	Initials and Date of Recorder
1.	Procedure Used OSR-OP-120, R.7/IC2 Effective Date 03/05/03	<i>JE</i> 08/19/03
2.	Indicate the container configuration used (refer to OSR-OP-120, Attachment 2, for configuration types. Attachment 2 is included as part of the batch data report) (check one): <input checked="" type="checkbox"/> Standard Pipe Overpack (12" pipe component) POC Insert <input type="checkbox"/> None <input checked="" type="checkbox"/> Cane <input type="checkbox"/> Poly <input type="checkbox"/> Poly/Lead <input type="checkbox"/> S100 Overpack (6" pipe component) <input type="checkbox"/> S200-A Overpack (12" pipe component with lead/poly shielding) <input type="checkbox"/> S200-B Overpack (12" pipe component with lead/poly shielding)	<i>JE</i> 08/19/03
3.	Inspect and prepare the container by completing steps 1-5 of the <i>Container Loading and Closing Instructions</i> , Attachment 8. If container is found to be acceptable for use, then enter the Container ID at the top of all pages of this form.	<i>JE</i> 08/19/03
3a.	<ul style="list-style-type: none"> Filter model on drum lid: <u>NFT-019</u> Filter serial number on drum lid: <u>BD-76</u> Filter manufacture date: <u>02/03</u> 	<i>JE</i> 08/19/03
3b.	<ul style="list-style-type: none"> Filter model on POC: <u>UT9400</u> Filter serial number on POC: <u>025285</u> Filter manufacture date: <u>01/03</u> 	<i>JE</i> 08/19/03
4.	Check that OSROC has provided a list of the OSR sealed sources to be loaded into this container.	<i>JE</i> 08/19/03
5.	Complete step 6 of the <i>Container Loading and Closing Instructions</i> , Attachment 8. Verify the unique identifier, outer casing is made of non-VOC bearing material, and estimated weight of each sealed source on page 2 of this form as the sources are placed in the container.	<i>JE</i> 08/19/03
6.	Complete the checklist on page 3 of this form to verify the absence of indicators of prohibited items or conditions.	<i>JE</i> 08/19/03
7.	Verify, based on visual examination, that the contents of the container match the waste stream description and Summary Category Group.	<i>JE</i> 08/19/03
8.	Enter the Waste Matrix Code for the sealed sources, based on visual examination (typically S5100): <u>S5100</u>	<i>JE</i> 08/19/03
9.	Complete steps 7-13 of Attachment 8. Torque the POC bolts in accordance with steps 14-16 of <i>Container Loading and Closing Instructions</i> , Attachment 8 and record the following information. <ul style="list-style-type: none"> Closure bolts tightened to <u>65</u> ft-lbs Torque wrench ID # <u>027676</u> Calibration due date of torque wrench <u>06-08-04</u> 	<i>JE</i> 08/19/03
10.	Replace the packing materials in accordance with step 17 of the <i>Container Loading and Closing Instructions</i> , Attachment 8.	<i>JE</i> 08/19/03
11.	Close the container and torque ring bolt to 40 ft-lb (±4) in accordance with step 18 of the <i>Container Loading and Closing Instructions</i> , Attachment 8. Record the torque settings. <ul style="list-style-type: none"> Drum ring bolts tightened to <u>40</u> ft-lbs Torque wrench ID # <u>027676</u> Calibration due date of torque wrench <u>06-08-04</u> 	<i>JE</i> 08/19/03
Comments:		
NA		

Container Packaging and VE Data Record (continued)

Page 2 of 3

Container Identifier	LA00000061414
NOTE: Puncture protection (from heavy or sharp objects) for the container is ensured by the use of a pipe component for packing sealed sources.	

Record or verify the requested information for each OSR sealed source as it is loaded into the container.

Item #	OSR Sealed Source Description and Identifier	WMP*	Estimated Weight (indicate grams)	Verified item information during VE Enter Y (yes) or N (no)	Comments (if any)
1	Pu239Be SFC II-1-0080 containing M364 & M561	OM	7000	Y	NA
2	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA
5	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA
7	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA
9	NA	NA	NA	NA	NA
10	NA	NA	NA	NA	NA
11	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
13	NA	NA	NA	NA	NA
14	NA	NA	NA	NA	NA
15	NA	NA	NA	NA	NA
Total estimated weight (kg) for each WMP listed for above items			7.0 kg		
Total estimated weight (kg) for loaded container (using appropriate drum weight from OSR-OP-120, Attachment 2)			182.6 kg		

OSR-028.R.7

If the list of items is continued on additional pages, attach and number added pages (Page ____ of ____).

* WMP categories are listed in Attachment 1 of OSR-OP-120; WMP should be OM for OSR sealed sources. If a source is comprised of mixed WMPs, each WMP will be entered on a separate line.

† Conversion factors: 0.002205 pounds per gram; 453.59 grams per pound

Container Packaging and VE Data Record (continued)

Page 3 of 3

Container Identifier	
LA00000061414	
<p>NP There are no indicators for the presence of the prohibited item in this container.</p> <p>P An indicator for the possible presence of the prohibited item has been observed. (If any condition is noted as present (or possibly present), note details in the comments section at the end of this form.)</p>	
Enter P or NP	Prohibited Hazardous Items or Conditions
NP	Free liquids in an inner container or in the container
NP	* Incompatible waste (i.e., incompatible with WIPP backfill, seal and panel closure materials, shipping container materials, or other wastes as defined by TRUCON codes)
NP	* Polychlorinated Biphenyl (PCB) compounds
NP	* Explosive items
NP	* Ignitable items
NP	* Reactive items
NP	* Corrosive items
NP	* Hazardous waste not occurring as co-contaminates with TRU mixed wastes
NP	* Potentially pressurized containers (e.g., aerosol can, light bulb, gas cylinder)
NP	* Nonradionuclide pyrophorics greater than or equal to 1% by weight of the waste container.
NP	* Radioactive pyrophorics greater than or equal to 1% by weight of the waste container that have not been rendered nonreactive.
NP	* Chemical incompatibility
NP	* Sealed containers greater than 4 liters
Comments, including the identifiers of any relevant NCRs or PWRs:	
NA	
<p>I certify that I have visually examined each sealed source loaded into this container, and that the above information is correct. I also verify that no items other than those listed on this form have been placed into this container.</p> <p><u><i>Shirley J. Leonard</i></u> <u>8-19-03</u> Signature of VE Packager Date</p> <p>I certify that I examined and witnessed the loading of this container, and that the above information is correct.</p> <p><u><i>P. M. Jamison</i></u> <u>8-19-03</u> Signature of VE Recorder Date</p>	

APPENDIX 8

MONSANTO PROCEDURES

Appendix 8 is not included due to the voluminous nature of the document. If, after review of Appendices 1 through 7 you feel that this information is required a copy will be sent out immediately