LA-13475

Recovery of ^{241}Am/Be Neutron Sources Wooster, Ohio

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J. Andrew Tompkins
David Wannigman
Vance Hatler

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

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Abstract

In August 1997, the Nuclear Regulatory Commission (NRC) submitted to the U.S. Department of Energy (DOE) a partial list of licensed radioactive sealed sources to be recovered under a pilot project initiating Radioactive Source Recovery Program (RSRP) operations. The first of the pilot project recoveries was scheduled for September 1997 at Eastern Well Surveys in Wooster, Ohio, a company with five unwanted sealed sources on the NRC list. The sources were neutron emitters, each containing ^{241}Am/Be with activities ranging from 2.49 to 3.0 Ci. A prior radiological survey had established that one of these sources, a Gulf Nuclear Model 71-1 containing 3 Ci of ^{241}Am, was contaminated with ^{241}Am and might be leaking. The other four sources were obsolete and could no longer be used by Eastern Well Surveys for their intended application in well-logging applications due to NRC decertification of these sources. All of the sources exceeded the limits established for Class C waste under 10 CFR 61.55 and, as a result, are the ultimate responsibility of the DOE under the provisions of PL 99-240. This report describes the cooperative effort between the DOE and NRC to recover the sources and transport them to Los Alamos National Laboratory (LANL) for deactivation under the RSRP. This operation alleviated any potential risk to the public health and safety from the site which might result from the leaking neutron sources or the potential mismanagement of unwanted sources. The on-site recovery occurred on September 23, 1997, and was performed by personnel from LANL and its contractor and was observed by staff from the Region III office of the NRC. All aspects of the recovery were successfully accomplished, and the sources were received at LANL on September 29, 1997. Experience gained during this operation will be used to formulate operational policies and procedures which will contribute to the eventual routine recovery operations of a full-scale RSRP.

1.0 INTRODUCTION

This report covers activities related to a U.S. Department of Energy (DOE) retrieval program for unwanted sealed sources conducted as part of the Radioactive Source Recovery Program (RSRP) pilot project operations at Los Alamos National Laboratory (LANL). The purpose of the RSRP pilot project is to test the systems and procedures which are being developed in order to implement a fully operational program in 1999. The objectives are to initiate operations in the field and experiment with methods and procedures which will minimize the expense, expedite the process, and meet all applicable Nuclear Regulatory Commission (NRC) and U.S. Department of Transportation (DOT) shipping regulations required for an off-site operation. The RSRP has begun with provisions for neutron-emitting sealed sources to be sent to LANL for deactivation. During 1997, the NRC developed a list of 40 high priority neutron sources that were to be recovered by LANL. In August a partial list of these sources was provided and operational planning began. This report covers activities related to the recovery of the first five sources on the NRC priority list from Eastern Well Surveys in Wooster, Ohio.

2.0 BACKGROUND

Eastern Well Surveys, Inc., is a commercial firm engaged in the well logging business and an NRC licensee in possession of ten radioactive, neutron-emitting sealed sources. The company has downsized over the last decade, as have many other exploratory firms related to the petroleum industry. Subsequently, five of their neutron-emitting sources became unusable. Four sources were decertified for well logging use by the NRC and one source is suspected of leaking. These five sources became an unwanted liability to the company. However, since no radioactive waste disposal options exist for sources of this type, the company has been forced to store and maintain them without economic benefit. Under the cooperative agreement between DOE and NRC to have DOE accept this type of unwanted device, the NRC designated all five unusable sources at Eastern Well Surveys as part of the group of 40 sources to be recovered under the RSRP pilot project. On September 3, 1997, the DOE EM-36 Director provided guidance to LANL on the purpose of the pilot project. A copy of this letter is provided as Attachment A.

Figure 1. Eastern Well Surveys site.

3.0 SITE DESCRIPTION

The Eastern Well Surveys facility is located at 3305 Old Airport Road in Wooster, Ohio. The facility is a steel shell on a pad building about 150 ft by 50 ft (Figure 1). About two

thirds of the building consists of garage bays for the large wire line trucks used for well logging. An in-floor radioactive material storage pit is located in one corner of the building. Four of the five sealed sources to be recovered were stored in this pit (Figure 2). The fifth sealed source was stored in one of the Type A shipping containers used by the well logging industry to transport neutron sources to the job site. The fifth source was the suspected leaker and can be seen in Figure 3 in its Type A shipping container wrapped in a plastic bag, placed among a number of other Type A shipping containers. In addition to the sources being recovered, a few other radioactive sources which were still in use by Eastern Well Surveys were stored in the pit. This made positive identification of sources removed from the pit necessary.

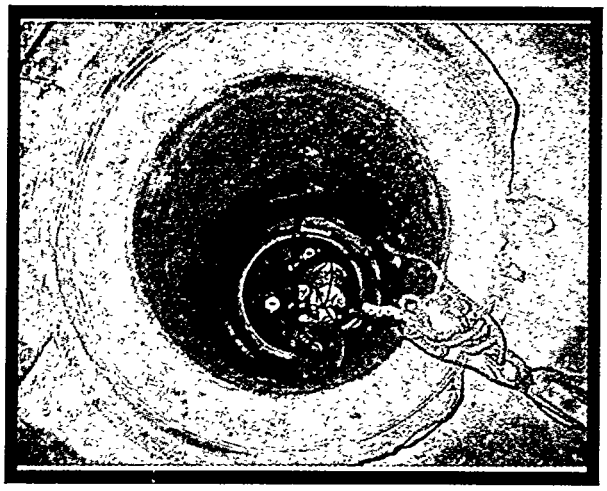


Figure 2. Eastern Well Surveys radioactive materials storage pit.

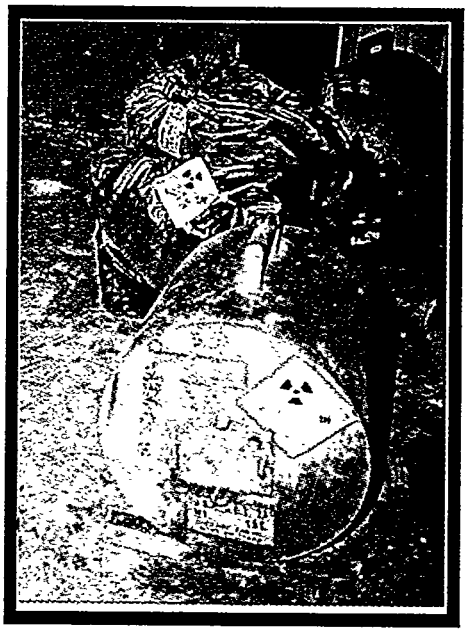


Figure 3. Type A shipping container and suspect source.

4.0 OPERATIONAL PLANNING

4.1 Regulation: The sources to be recovered were held under an NRC nuclear materials possession license administered by NRC Region III. The interest of the NRC region was to remove unwanted, obsolete, and potentially leaking sources from a storage-only situation. The interest of NRC HQ Sealed Source Branch was to initiate routine operations of the RSRP in cooperation with the DOE. However, before operations were initiated, the NRC HQ Transportation Branch raised questions concerning the fact that the Region III licensee did not have an approved QA plan (10CFR71 Subpart H) to permit shipping of the sources in a Type B container.

LANL had prepared and submitted a position paper on the QA issue to DOE HQ, and subsequent discussions between DOE and NRC HQ personnel had taken place. However, no final resolution had been identified by the time of the scheduled field recoveries. To avoid a

jurisdictional conflict between the federal agencies, LANL agreed to accept title of the sources at the licensee's facility. This made LANL the owner prior to shipping and eliminated the need for a QA approval by NRC since LANL/DOE-owned material is not subject to NRC regulation. It is clear, however, that such regulatory conflicts need to be addressed in a way that will enhance the ease and efficiency of source recoveries in the future.

4.2 Health and Safety Operations: At the outset it was known that this recovery would require handling of a source with alpha contamination that was suspected to be leaking ^{241}Am. A meeting was held at LANL on September 17 to discuss procedural issues for radiation control and environmental safety and health coverage of the operation at the Wooster site. The following conclusions were reached:

- The operation would be under the direction of Andy Tompkins, representing the DOE subcontractor, using their Health and Safety Plan. The on-site team would also include representatives from ESH-1 (Health Physics Operation) who would observe the operation and would intercede with the operations only if they identified an activity that could potentially have unwanted health and safety implications or was inconsistent with normal LANL radiation control policy and/or procedures.

- ESH-1 would supply all of the instrumentation and dosimetry to be used on the recovery operation and would compile the personnel exposure results.

- ESH-1 would observe the operation and make ES&H procedural recommendations for incorporation into future recovery operations.

4.3 Processing Personnel: Two staff members from the source processing group (NMT-2) from LANL TA-55 PF-4, Vance Hatler and Tony Guillen, were assigned to the operation.

4.4 Transportation: Since a highly neutron-shielded 6M Type B shipping container was not fully tested to permit use, five separate 6M shipping containers were pre-shipped to Wooster to accommodate one source per container. An NMT-4 representative, Leonard Trujillo, was part of the recovery team to handle the shipping process.

5.0 SOURCE DESCRIPTION

The ^{241}Am/Be sources being recovered were about 30 years old and had been manufactured by three different vendors, Monsanto Research Corporation (MRC), Parkwell Laboratory (PL), and Gulf Nuclear (GN). All of these firms are no longer in business. The model, serial numbers, and activities of the sources are provided in Table 1.

Table 1. Sources for Recovery			
Manufacturer	**Serial No.**	**^{241}Am (g)**	**Activity (Ci)**
MRC	MRC-1125	1	3.0
MRC	MRC-1118	1	2.77
MRC	MRC-1498	1	2.55
PL	PL AmBe 106	1	2.49
GN	71-1-453B	1	3.0

Each source contains approximately 3 Ci of ^{241}Am oxide powder mixed with beryllium metal powder packed into a thin wall stainless steel capsule which, in turn, is contained in an additional external stainless steel metal capsule. A drawing of the Gulf Nuclear Model 71-1 capsule is provided in Attachment B as an example. Smear count results from a leak test in 1996 indicated that the single GN Model 71-1 source was contaminated and presumed to be leaking. The leak test indicated 32,000 dpm of activity on the 71-1. With an NRC limit of 0.005 μCi, which is equivalent to 11,000 dpm, the source was nearly three times the limit, and obviously contaminated.

6.0 HAZARD DESCRIPTION

Prior to the mobilization of the recovery operation, the owner had placed the four obsolete sources in nylon source holders as shown in Figure 4, which were then placed in a cylindrical container made of a capped 2 in. pipe imbedded in the center of a 10 in. by 10 in. metal, paraffin-filled container. This container was stored in the radiation pit at the facility. Prior to the arrival of the LANL team, the four uncontaminated sources had been removed from their source holders and shielded container. These four sources were found secure and upright in sockets at the bottom of the storage pit with threaded ends exposed to simplify removal from the pit.

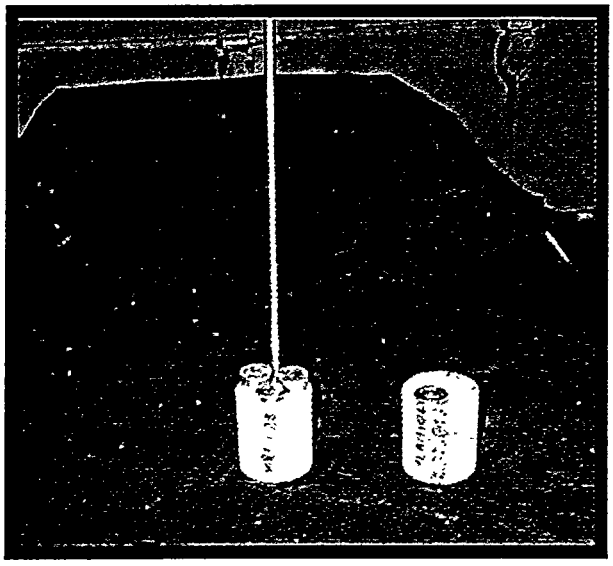


Figure 4. Nylon source holders containing the intact sources.

The suspect leaking source was inside a pressure vessel whose exterior was free of contamination. This pressure vessel was locked in a boron hydride crystal-filled DOT-7A specification shipping container.

Smears of the facility taken by Eastern Well Surveys prior to the arrival of the recovery team indicated that floors and sources were free of transferable contamination. Since the leaking source was contained and the facility was not contaminated, there was no reason to expect airborne activity and therefore no respirator usage was considered. Gloves and shoe covers were used in the event of undetected floor contamination. Tyvek coveralls were worn only to protect personal clothing against oil and dirt in the high bays of the facility.

All personnel on the recovery team were issued whole body thermoluminescent detectors (TLDs) and Aloka direct reading neutron dosimeters. Beta-gamma pocket dosimeters were issued to the source handlers. In addition, the source handlers were issued extremity TLDs. The primary source handler wore a finger ring on each hand, and the secondary source handler wore a finger ring on his primary hand. Previous experience with neutron sources indicated that as long as the sources were handled one at a time for brief periods (1-2 minutes) radiation exposures could be expected to be less than 1 mrem per source handled.

The following radiological survey equipment was used on site for this operation:

- Eberline ESP-1 with: AC3 probe (zinc sulfide scintillometer) for alpha measurements
  HP260 pancake GM probe for beta and gamma field measurements
  HP210T for on-site beta and gamma smear analysis
- Ludlum PNR4 Rem ball neutron detector for neutrons
- PIC 6 pressurized ion chamber for gamma for measuring Transport Index (TI)

7.0 RETRIEVAL ACTIVITIES

A series of photographs depicting the building and work activities are provided in Figures 5 through 10.

The DOE subcontractor and LANL representatives traveled to Wooster, Ohio on September 22, 1997, and met with the owner of Eastern Well Surveys, Mr. William L. Musselman, and a representative of NRC Region III prior to the start of recovery activities. A letter outlining LANL terms and conditions for the job was presented to Mr. Musselman. This information was discussed and then accepted and signed for by Mr. Mussleman. All personnel had previously read the Health and Safety Plan for this job site and had signed the compliance agreement. A copy of the H&S Plan is provided as Attachment C. A pre-job planning session ensued, using the LANL Preliminary Hazard Analysis (PHA) form to address physical hazards present in the work environment and the LANL Activity Hazard Analysis form to plan the sequence of job steps. Copies of these documents are provided as Attachment D. Five 6M shipping drums were already on site, having arrived from LANL the previous day, and were available for use.

7.1 Pre-job Activities: The following activities were performed in preparation for the actual recovery of the sources.

- Personnel were issued dosimeters.
- The radiological instruments were unpacked, turned on, given a battery test, and checked for functionality.
- A radiological control area was established. A white soapstone line was drawn on the concrete floor contiguous with the storage pit, the storage container for the leaking source, and the vise for holding the 2R container.
- Source-handling tools were brought into the controlled area.
- A pre-job alpha survey was conducted immediately adjacent to the storage pit. The results were NDA (no detectable activity).
- Pre-job swipes were taken of the floor in the work area and monitored for gross contamination. The floor area immediately next to the top of the pit and the Type A container could not be surveyed because the alpha scintillation monitor responds to neutron fields.
- A sheet of polyethylene (approximately 5 ft x 8 ft) was laid down in the controlled area in case of a release of contamination.
- The shipping drums were positioned about 10 ft away from the controlled area. Drum lids were removed. Each 2R was opened and the poly inserts were extracted and opened to prepare for source insertion. The first poly insert to be used was placed in the controlled area, with the remainder placed at the edge of the controlled area to afford quick access.
- The three source-handling personnel each donned gloves, shoe covers, and Tyvek suits. The Tyvek suits were worn only to protect personal clothing from dirt and oil on the floor, not as personal protective equipment (PPE), since none of the pre-job surveys indicated elevated levels of contamination.
- The pit was unlocked and the cover swung aside.
- Swipes were taken inside the pit and monitored. The results were NDA.
- Radiation field readings at the top of the pit were taken with neutron and gamma instruments. Results indicated 100 mrem neutron and 150 mrem gamma. The gamma field was increased by the presence of a cesium well logging source in the storage pit.

7.2 Job Activities/Results: Work began on the four sources which were not suspected of having surface contamination.

- A 5 ft long tool with a male 5/16-18 screw threaded on the end, which engaged the threads in the source holder, was used to retrieve the sources from the bottom of the storage pit. Once the source holder was attached to the tool, the source was lifted out of the pit and laid on the polyethylene sheet.
- A contact neutron dose rate measurement was made. Results indicated 150 mrem/hr at 4 in., which is at contact with the REM ball. Identification numbers were checked,

and a swipe of the source holder surface was taken. All of this activity took place in about 30 - 45 seconds.

- Once the source had been identified and swiped, it was placed in the poly insert using either the source handling tool or a set of tongs. The poly insert lid was inserted and the restraining screw attached. The neutron dose rate measurement was 150 mrem/hr, which was a 40% reduction.
- The poly insert was then placed inside the 2R. The 2R cap, which had previously been coated with sealing compound, was then screwed into place and torqued to the required 65 ft-lbs.
- The sealed 2R was then removed from the controlled area and inserted into a drum. The Celotex™ insulation was repositioned, the drum lid with gasket put in place, and the drum sealing ring mounted and restrained. The restraining bolt was torqued to the required 75 ft-lbs. All packaging was accomplished following a packaging Q/A procedure used by LANL in the Pu-239/Be acceptance program. A copy of this procedure is attached as Attachment E.
- An empty 2R was then brought into the controlled area for the next source.
- This activity was repeated three more times until the four sources had been removed from the pit and were packaged in the drums.
- After work on the fourth source was completed, all source handlers checked their self-reading neutron pocket dosimeters. The highest reading was 1 mrem. All remaining dosimeters read less than 1 mrem and were recorded as zeros.

Attention now turned to addressing the source that had previously shown contamination.

- The fifth source was contained in a Type A shipping container which was wrapped in plastic and had been placed on the floor adjacent to the pit. The plastic was removed and the exterior of the container was swiped and monitored. No contamination above background levels was found using the zinc sulfide scintillometer. Prior to the arrival of the team, Mr. Mussleman had decontaminated the exterior of the "leaking" source's bull plug to ensure minimal potential spread of contamination in the facility. A decision had already been made by the recovery team that this source would be shipped without removing the bull plug to minimize the potential spread of contamination.
- The container was unlocked and the shield plug removed. The shield plug and the inside of the shield were swiped and monitored, with no indication of elevated alpha contamination. Neutron fields around this Type A container did not interfere with alpha survey measurements.
- The attempted use of a tool, provided by Mr. Mussleman, to restrain and unscrew the source from its position in the shipping container was unsuccessful. To reduce the potential for further dose to the workers in the removal process, the shipping container was simply inverted and the source was dumped out. The serial number was checked and a radiation measurement made. The source holder was swiped and the swipe monitored. Since there was no indication of alpha contamination, the

source holder was inserted into the poly insert. The poly lid was returned to the poly insert and restrained. If the source holder had shown external contamination, it would have been bagged prior to insertion into the poly insert.

- The sealed poly insert was placed in the 2R and the prepared cap was screwed and torqued to the required specification. The 2R was moved to the final empty drum and set in place. The Celotex™ insulation was repositioned, the drum lid with gasket was put in place, and the drum sealing ring was mounted and restrained. The restraining bolt was torqued to the required 75 ft-lbs (see Q/A procedure in Attachment E).
- After the last source was sealed in its drum, all self reading neutron and beta-gamma pocket dosimeters were inspected. Total personnel neutron doses ranged from 1 to 3 mrem. The total neutron dose for swiping, identification, and packaging in the 2Rs was 1 mrem or less. An additional dose did result from working with the shipping drums.
- Personnel monitored their hands and feet for contamination. None was detected.

7.3 Post-job Activities and Transportation:

- The polyethylene sheeting was rolled up and the job area swiped.
- Personnel removed protective clothing.
- The paperwork for shipping the drums to LANL was completed and the labels were applied. Surface radiation fields were measured and Transportation Indies (TI's) were calculated and assigned to each drum. The results are shown in Table 2.
- Tamper-indicating devices (TIDs) were applied to each drum.
- The pickup time for the road freight handler was advanced from 4:00 pm to 1:30 pm.
- The road freight driver looked over each drum, examined the paperwork, and was offered placards. The drums were loaded onto the truck, which departed at about 2:00 pm.
- The shipment was received at LANL on Monday, September 29, 1997.

Table 2. Shipping Container Dose Rate Readings					
Drum S/N	**23**	**24**	**25**	**26**	**27**
Source S/N	71-1-453B	PL AmBe 106	MRC-1125	MRC-1498	MRC-1118
Source Activity (Ci)	3.0	2.49	3.0	2.55	2.77
Beta/Gamma					
Contact (mR/hr)	4.0	5.0	6.0	4.5	6.0
One Meter (mR/hr)	<1.0	<1.0	<1.0	<1.0	<1.0
Neutron					
Contact (mrem/hr)	40	35	35	40	35
One Meter (mrem/hr)	3.5	4.0	4.5	4.5	3.5
Total Gamma/ Neutron (mrem/hr)	<4.5	<5.0	<5.5	<5.5	<4.5
TI (selected)	3.5	4.0	4.5	4.5	3.5

8.0 DOSIMETRY RESULTS

Personnel dose for this operation was strictly limited to individuals performing the actual handling of the sealed sources. Personnel doses were recorded at about 1-2 mrem whole body for the five individuals packaging these sources. The collective dose for the team on this recovery action was less than 10 person mrem. The main source handler, who was wearing an extremity dosimeter on each hand, received a 10 mrem deep gamma dose on one extremity. No shallow skin dose or neutron dose was received by this individual. Dosimetry results for all other participants were negative for shallow skin dose, deep gamma dose, and neutron dose.

This work was performed without a formal procedure or the availability of specialized tools and other engineering controls. Future work should use a procedure developed from the experience of this recovery action to delineate all operations where potential exposures might occur. ALARA practices can then be incorporated. An established procedure in conjunction with some minor tooling and engineering controls could further reduce radiation doses to the individuals involved.

For external exposure to gamma and neutron radiation fields, personnel dose is not a limiting factor for these typical (3 Ci) neutron sources. An estimate of total whole body neutron dose for an individual is approximately 2 mrem or less per source handled for the entire recovery and packaging operation. Consequently, a person could handle up to 1,000 typical sources per year and still only be at the administrative dose limit of 2,000 mrem/yr. The potential for internal exposure from leaking neutron sources needs to be recognized and accounted for by training field personnel to monitor contamination levels on sources and in the work area. Pre-job monitoring and set limits on the maximum levels of loose contamination to be handled in the field will prevent internal depositions of activity. The fact that owners of sealed sources are accountable to NRC regional offices insures that some level of leak testing will be provided prior to arrival of Laboratory personnel on site.

9.0 LESSONS LEARNED

9.1 Personnel Requirements: The number of personnel required to perform the recovery operation will vary depending on the hazards and/or risks presented by the sources to be packaged. After the sources were packaged in the drums, it took more than two hours to finish the paperwork for five drums. Minimizing the number of drums in each shipment will greatly reduce the time required to complete the necessary paperwork.

In general, it may be said that when dealing with leaking or potentially leaking sources, where a reasonable chance exists for the spread of removable contamination, it is advisable to use at least two operational team members (per the "buddy system" recommended for all hazardous materials operations). For such recovery operations, the recovery team, in total, must have the following qualifications:

- trained and qualified to handle nuclear material,
- trained and qualified to operate radiological monitoring equipment, and
- trained and qualified to perform radiological materials packaging and shipping operations on behalf of the Los Alamos National Laboratory.

9.2 Personnel Equipment: Personnel should pack a "Recovery Kit" which includes the following items:

Tyvek coveralls,
Tyvek booties,
moist towelettes,
rope (approximately 50 feet),
disposable plastic tarp, and
basic first aid kit.

Some of the items on this list may be available at a licensed operating facility, but in many cases, the facility may be either in a location where items such as running water and utilities

are not available or the facility may have declared bankruptcy. It is the responsibility of the recovery personnel to assure that necessary personnel equipment and tools be available at the site or be brought to the site. Personnel protective gear (i.e., Tyvek suits and nitrile gloves) should always be worn, not to eliminate potential contamination of personal clothing but to control the dirt and grease from the wireline truck service bays. The service bay worked in had been cleaned, and it still was not like the work areas at the Laboratory for cleanliness. The used PPE were left at Eastern Well Surveys for disposal. Even if the PPE had been contaminated, they would have been left with the NRC licensee for appropriate disposal, since programmatic policy does not allow the sending of any unnecessary low level waste (LLW) to LANL. There is a clear need for a checklist so that sequencing of all activities required for the recoveries are appropriate to protect health and safety.

9.3 Official Representation: The participation of the NRC regional office insures the cooperation of the licensee. Formal communication with NRC to tell them the status of sources removed from their licensees is a necessity. It was only by happenstance that an NRC representative was able to be on site and observe our work for this recovery.

9.4 Tools: The suite of tools for packaging and handling Am/Be sources should include

pressure vessel handling tools (example drawings provided as Attachment F),
torque wrench,
2R wrench,
sealing compound, and
swipe holding tool.

9.5 Dose Assessment: Personnel whole body and extremity doses during the source retrieval from Wooster, Ohio, are reported in Section 8.0. These doses are extremely low and should not pose an impediment to similar source retrievals in the future. Additional measures are recommended below to reduce these doses even further.

This work was performed without a formal procedure or the availability of specialized tools and other engineering controls. Future work should use a procedure developed from the experience of this recovery action to delineate the steps that should be followed to ensure doses are maintained as low as reasonably achievable (ALARA).

A simpler and quicker method for securing the lid on the poly insert should be developed. Currently, a restraining screw is used to tighten the lid in place before the poly insert is placed into the 2R container. This requires the source handler to remain in close proximity to the source for an additional 15-20 seconds. Some kind of simple latching mechanism for the poly insert lid could reduce this exposure time to 1-2 seconds.

When performing a source packaging operation with three or more sources, it quickly becomes cumbersome to move the sources from the working area to the cold area because of

radiological monitoring requirement. Moving the packaged neutron sources away from the working area is important to minimize exposure to personnel.

During the last phases of this source retrieval, the source handler had some difficulty removing the source from the 71-1 storage container (i.e., the "pig"). Prior to trying to access a source from a unique or unfamiliar storage configuration, a mockup and dry run should be performed. The time involved in accessing this source could have been reduced by at least an order of magnitude had the source handler had previous experience with this particular storage arrangement.

9.6 Transportation: Transportation is a major issue for getting excess neutron sources into LANL. Improperly shipped material generates DOE incidents, which DOE must respond to. The current DOT policy of requiring a special form certificate in hand inhibits many Type A shipments. As the RSRP was originally implemented, all shipments were Type B since neither LANL nor the owners had special form certificates. The use of a Type B container, such as a 6M drum, while expedient, is expensive. The drums are typically 30 or 50 gallon containers. Type B shipments under NRC auspices require a QA program for use of the container.

An alternative to Type B shipments is to find some of the special form certificates for neutron sources and subsequently ship the sources in a Type A package, which is lighter, cheaper, and does not require a QA program. In fact, the small size of the package lends itself to express air shipments which reduce the transit time and risk to sources shipped to the Laboratory. Efforts to obtain special form certificates require the specific manufacturer and model numbers for a neutron source. The recently upgraded database on the U.S. neutron sources requiring disposal will provide information on the most frequently listed sources. DOT has promised some support in finding special form certificates. Calculational efforts to make a special form determination and even a limited program of testing existing sources may be necessary to allow the program to use this cost effective form of shipping.

Another source transportation issue is the use of a consolidation vendor to batch shipments of multiple sources to LANL. Qualified vendors would arrange transportation of neutron sources from an approved list to their facility. Upon arrival, sources would be identified, leak tested, stripped of their pressure vessel/source holder, and stored for a consolidated shipment to LANL. Cost reductions will result from reduction in the number of receiving charges from BUS to actually process incoming shipments, fewer transportation shipping incidents, and better allocation of facility resources as receiving work is focused into a narrow, well-defined time frame. The view of cost minimization should not only examine approximate costs for the few shipments currently contemplated but should also recognize that thousands of sources need to be collected and that meager resources to fulfill this program must insure that a safe, regulatory compliant methodology is used.

9.7. Costs: The expense of a five-man crew must be carefully examined. The number of sources that can be collected by laboratory personnel on an annual basis is directly proportional to the expense of sending out a team. The cost for this team was the number of travel and work days (3) x the daily labor rate + the travel expense. If labor rates are $20 to $30/hr (unloaded), then daily rates were $500 - $750. A three-day trip would cost $1500 - $2250 for labor, plus approximately $1,000 for travel, giving a grand total of $2,500 to $3,250 per person. Five people on-site results in a programmatic expense of $12,500 to $16,250. This is the estimated expense for five individuals on a single trip to package and ship five sources individually in Type B containers. The skills required to perform the necessary on-site functions are as follows:

work area setup,
identification and swiping,
packaging,
paperwork,
labeling,
shipping,
measurement of TI's, and
ES&H (distribution of dosimeters, return of same to Laboratory, use of portable survey equipment).

10.0 SUMMARY

This recovery operation clearly demonstrated that successful and cooperative efforts by DOE, NRC, and LANL personnel can be performed under the RSRP. In this case, the team demonstrated its ability to recover and ship the five sealed sources from Eastern Well Surveys.

Procedures were developed for future use and questions raised about on-site limiting conditions of operation, training, and staffing that will require further research. This operation served as another practical learning exercise to help develop methods to cost effectively manage source recovery operations as the RSRP mission becomes better defined.

As the first recovery under the RSRP pilot project, an effort was made to establish dialog with all groups at LANL involved in transferring ownership, packaging, shipping, receiving, storing, and processing these sources. Particular attention was paid to the ES&H issues associated with the potential for personnel radiation exposures and other hazards which can be encountered during off-site operations. The ES&H and transportation issues dictated that subject matter and expertise from the responsible organizations required to make up the recovery team for this first field operation of the pilot. Together the team provided the additional perspective necessary to establish procedures for future operations. A representative from NRC Region III was present and provided useful perspective and commentary.

Figure 5. Checking serial number of source.

Figure 6. Using tongs to manipulate source.

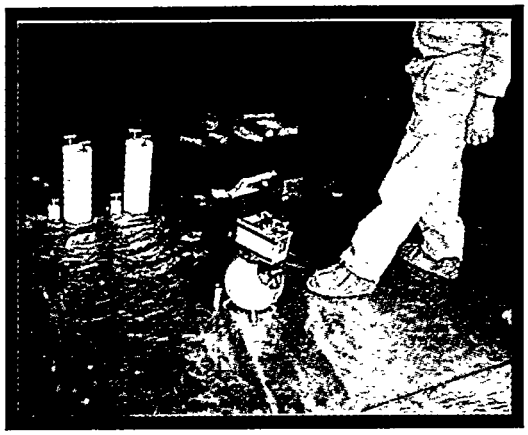


Figure 7. Obtaining a contact neutron dose rate measurement.

Figure 8. Swiping the source for removable contamination.

Figure 9. Inserting source into poly insert using tongs.

Figure 10. Sealing poly insert prior to placing into 2R.

Department of Energy
Germantown, MD 20874-1290
September 3, 1997

Mark Dinehart, Project Leader
Radioactive Source Recovery Program
Los Alamos National Laboratory
NMT-6, MS E511
Los Alamos, New Mexico 87545

Dear Mr. Dinehart,

I am writing to provide guidance and tasking to the Radioactive Source Recovery Program (RSRP) in accordance with our Fiscal Year 1997 program guidance of November 29, 1996. The first task in that guidance was to receive up to 40 neutron sources. The U.S. Nuclear Regulatory Commission (NRC) has provided us with the list of high priority sources which my office requested. I am forwarding that list and requesting that the RSRP begin the recovery of those sources as a pilot project supporting the development of the full program.

The purpose of the pilot project is to test out the systems and procedures you have developed in order to implement a fully operational program. Therefore, in taking the necessary actions to bring these sources to the Los Alamos National Laboratory (LANL), the goal is to keep costs down and have the owners of the sources or the appropriate state agencies perform and pay for as many functions as possible, such as packaging, shipping, and meeting regulatory requirements. In situations where you believe valuable information or experience can be gained which is beneficial to the program, you can deviate from this goal, but please coordinate these actions with Robert Campbell of my staff.

Since this program has evolved to the point of pilot testing, it is important that all communications with regulatory agencies such as the NRC be coordinated directly between you, the project manager, and Robert Campbell of my staff. All necessary communications and inquiries with the NRC should be discussed with my staff and in general, my staff will forward those items to the NRC or determine that those inquiries can be forwarded directly by you as the project manager. Furthermore, each source owner and state regulatory agency must be notified explicitly that this is a pilot program and that the Department of Energy is not yet prepared to accept sources on a routine basis. The particular source owners on the attached list were provided by the NRC and were chosen due to their unique individual circumstances by the NRC to participate in this pilot program. Source owners, regulatory agencies, and other state agencies shall be informed that the actions performed by LANL, the costs, and other actions associated with the pilot program are not necessarily representative of the full program, and that there will very likely be fees charged when the program is fully operational.

It should be noted that the NRC informed us that this was a partial list, and that they will be forwarding an additional list, up to 40 sources. I will forward that list when it arrives. You are requested to begin work on the pilot project as soon as possible. Given the approach of the end of the fiscal year, you are authorized to carry over into Fiscal Year 1998 any necessary funds to continue this action to completion. Please forward to us any inquiries which are received as a result of this pilot project, and keep us informed of the status on a routine basis. If you have any questions, please contact Robert Campbell, the RSRP Program Manager, at (301) 903-7127.

Joseph F. Daly, Jr. for

James A. Turi, Director
Office of Western Operations
Office of Waste Management
Environmental Management

Attachment

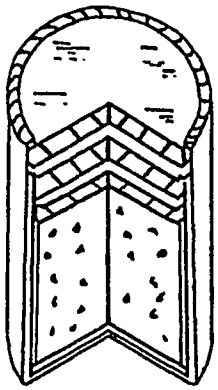
cc:
J. Grimm, DOE-AL
R. Erickson, LANL

Attachment

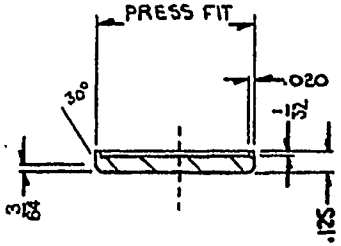
List of sources provided by the U.S. Nuclear Regulatory Commission, August 25, 1997
Sources listed in order of priority by the NRC.

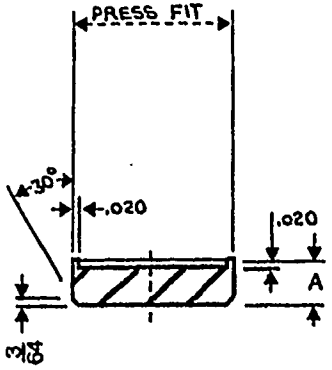
Licensee Name	Licensee Contact	Regional Contact	Source Description
Eastern Well Surveys	W. L. Musselman (216) 264-6560	John Madera (630) 829-9834	5 AmBe sources. 2.5-3.0 Ci each. One leaker.
WeGo Perforators, Inc.	Marshall Brackin (405) 332-1346	Christi Hernandez (817) 860-8217	1 AmBe, Monsanto model MRC-N-SS-W-AmBe, 3.0 Ci
Frontier Logging Corp.	Francis Weedon (405) 787-3952	Christi Hernandez (817) 860-8217	2 AmBe, Gamma Industries model NB(HP), 1.0 and 1.5 Ci.
Petro Data Inc.	Harold Haught (918) 885-4962	Christi Hernandez (817) 860-8217	2 AmBe, Gulf Nuclear, 4.6 Ci. Model 71-1.
Precision Logging and Perforating	Jeffery Spess (918) 358-5831	Christi Hernandez (817) 860-8217	2 AmBe, 5.0 Ci model 71-1 and 4.6 Ci NSSI model AN-HP
Perforating Services	Charles Franklin (307) 682-6719	Christi Hernandez (817) 860-8217	1 AmBe, 5.0 Ci Gammatron model AN-HP
Applied Health Physics	Todd Mobley (412) 835-9555	Frank Costello (610) 337-5275	1 AmBe, 80 mCi, Nuclear Chicago model 6806
State of Oklahoma	Louis (Gene) Smith (405) 271-1902	Christi Hernandez (817) 860-8217	3 AmBe sources, 1.2 Ci and 3.1 Ci.
Ohio State University	Robert Peterson, Jr. (614) 292-1284	John Madera (630) 829-9834	1 AmBe, 500 mCi, Monsanto model MRC-AmBe-519

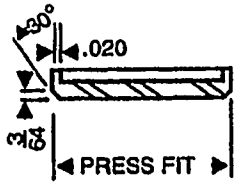
Gulf Nuclear Model 71-1 Capsule



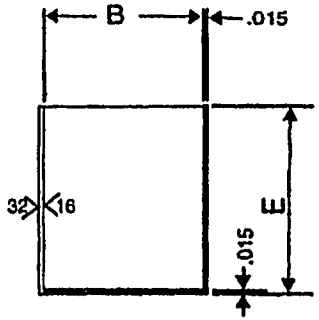
ASSEMBLY



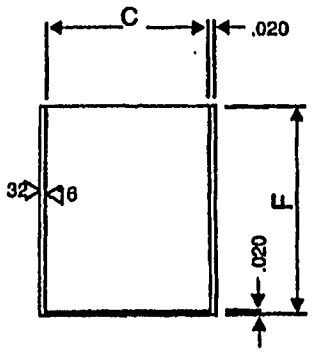




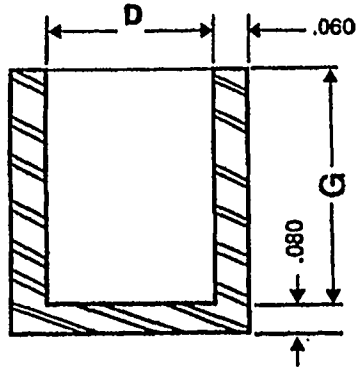
DIM.	A	B	C	D	E	F	G
1 CURIE	.200	.625	.658	.714	.825	1.226	1.561
2 CURIE	.200	.802	.857	.812	1.022	1.307	1.542
3 CURIE	.150	1.015	1.060	1.115	.862	1.252	1.442



SOURCE CAN
MAT'L 347 SST
1 - REQ'D



INNER CONTAINER
MAT'L 347 SST
1 - REQ'D



OUTER CONTAINER
MAT'L 347 SST
1 - REQ'D

Am - Be Source Containers

Attachment B

HEALTH AND SAFETY PLAN
for the
Eastern Well Surveys, Inc. Site
in
Wooster, Ohio

1.0 INTRODUCTION

This Health and Safety Plan (hereinafter called the PLAN) describes the program to be implemented by the and Los Alamos National Laboratory (LANL) team, (hereinafter called the Team) when performing the handling and packaging for shipment of five well logging americium-241/beryllium (Am/Be) neutron sources containing approximately 3 curies of americium-241. One of the sources is believed to be leaking. All are currently located in a storage facility at the Eastern Well Surveys, Inc. Site, 3300 Old Airport Road, Wooster, Ohio.

Safeguarding the health and safety of the Team and other personnel incidental to this recovery is a key part of this project and is the focus of the Health and Safety Plan. All work will be conducted in accordance with applicable federal, state and local regulations regarding radioactive material, those of OSHA concerning occupational safety and EPA regulations concerning the environment.

This PLAN identifies procedures to be followed to minimize the potential for personnel exposure to radioactive materials known to be or suspected of being present at the site. All Team members and subcontractors who perform field work during the project will be required to read this PLAN, and acknowledge receipt and understanding of this PLAN by signing Attachment C and submitting it to the , Project Manager before performing any field activities.

2.0 KEY PERSONNEL

The Project Manager, Andy Tompkins, has the primary responsibility for all on-site activities associated with the work to be done at the site. Although safety and health is the responsibility of all personnel working at the Site, primary responsibility for the Safety and Health program is assigned to the Safety and Health Officer (SHO).

2.1 Safety and Health Officer (SHO)

The Safety and Health Officer (SHO) is Andy Tompkins, and his telephone number is (770) 517-4320. The SHO has overall responsibility for the implementation of this PLAN and the approval of any changes, modifications and/or additions to it. He has authority to:

- Upgrade Protection levels as required.
- Suspend work due to Safety and Health Program violations, health related incidents and other increased risk situations.

- Remove personnel from the work site if their actions endanger the health and safety of other field personnel.
- Authorize team members to enter the site based on medical and training requirements.

The SHO's responsibilities are:

- Implement the Site Safety and Health Plan.
- Conduct Site inspections to monitor compliance with the approved Plan.
- Provide or coordinate training sessions as site conditions require.
- Coordinate the Medical Monitoring Program.
- Verify respirator training if required.
- Coordinate the acquisition, calibration, and maintenance of air monitoring equipment, respirators and other safety equipment where required.
- Direct on-site health and safety activities.
- Report safety-related incidents or accidents to the Project Manager and fill out Lost Time Incident forms as required.
- Perform, or oversee performance of all air monitoring activity.
- Perform radiation measurements on the work site and monitor personnel to assure personal safety and to maintain exposures ALARA.
- Maintain, or oversee maintenance of on-site Health and Safety equipment.

2.2 Nuclear Regulatory Commission

The NRC Project Coordinator is John Madera from NRC Region III and his telephone number is (630) 829-9834. NRC Headquarters Project Coordinator will be Doug Broaddus and his phone number is (301) 415-5847.

2.3 U.S. Department of Energy

The DOE Program Manager authorizing this action is Robert Campbell, EM-36. His telephone number is (301) 903-7127.

2.4 Los Alamos National Laboratory

The LANL Project Manager is Mark Dinehart, NMT-6. His telephone number is (505) 667-2335.

2.3 Medical Contacts

Use **911** for all emergencies, i.e. fire, police or ambulance.

When contacting the Emergency Ambulance Service inform the dispatcher as to the specific hazard to insure that if the injured person is contaminated, he will not be rejected.

The local hospital is Wooster Community Hospital telephone # (330) 263-8100

3.0 SITE DESCRIPTION AND HISTORY

This is a commercial site where the licensee is in the possession of various radioactive sealed source materials used in the well logging industry. Five of these sources are the subject of this recovery effort. The sources are Americium-241/Beryllium sources with activities ranging from 2.49 to 3.0 Curies. One of the sources, a Gulf Nuclear Serial #71-1-453B is believed to be leaking. The source is thought to be contained in an uncontaminated pressure vessel. The remaining four sources are obsolete and are on the NRC's "Not Approved for Use" list. They include one source manufactured by General Nuclear, Inc. and three manufactured by Monsanto Research. As part of the Radioactive Source Recovery Program pilot at Los Alamos National Laboratory (LANL), all five sources will be retrieved from the site and transferred to LANL for deactivation. A copy of a letter explaining the pilot program is attached to this PLAN. Eastern Well Surveys, Inc. has provided information concerning the sources, along with photographs of the storage containers. These photographs will be discussed at the site briefing conducted by the SHO prior to entering the work site.

4.0 HAZARD DESCRIPTION

The combination of Americium and beryllium produces a neutron emission as the primary hazard and a secondary gamma emission from americium decay. Attached is a graph showing the safety curve for potential exposure hazards of a 2.7 Ci. Am-241/Be source. Under normal circumstances, a sealed source of this type would present only a neutron and photon exposure potential. The leaking source is contained inside a pressure vessel with a threaded seal. The licensee has reported that the pressure vessel has been cleaned and that no removable contamination is present. This leaking source will not be removed from the pressure vessel during the recovery operation. For this job, the maximum allowable dose to individual personnel designated as source handlers is 25 mrem. Should any one individual exceed this limit as indicated by personal dosimetry, all work will be stopped and a reassessment of personnel doses necessary for job completion will be made.

The Team has been informed by William Musselman, the President of Eastern Well Surveys, that there is no smearable contamination at the site. As a result, the only protective equipment necessary will be gloves and shoe covers.

5.0 FIELD ACTIVITIES

Activities associated with this project include:

1) One engineer and six LANL personnel will travel to Wooster, Ohio on September 22, 1997 for recovery operations to be completed on September 23.

2) The leaking source (in its pressure vessel) will be removed from its storage container by Andy Tompkins under LANL observation.

3) A visual inspection of the pressure vessel containing the source will be performed to insure it is intact. The pressure vessel will be surveyed with hand held radiation monitoring equipment to determine whether there is any surface contamination.

4) The leaking source, in its pressure vessel and each of the other four sources will be inserted into separate polyethylene shielding containers and each transferred to a separate 2R container. Each of the five 2R containers will be sealed and a 6M shipping package assembled per standard QA procedures developed by LANL for Am/Be neutron source shipments in 6M Type B shipping containers.

5) The sealing rings will be placed on the 6M drums and the retaining bolts will be torqued to specifications.

6) Appropriate shipping labels will be applied to the packages and LANL personnel will perform external radiation measurements to determine the proper TI to be assigned to the shipping labels.

7) Surface smears of the package will be taken and analyzed on site to assure that the level of removable contamination is below applicable limits for transport.

8) Shipping and transfer of ownership papers will be prepared to the satisfaction of the LANL/ Field Operations Team on site. The papers will be signed by a LANL NMT-4 representative.

5.1 Limited Hazardous Material Contact Activities

Based on information provided by the licensee and discussions with the licensee in preparation for this operations, it is anticipated that there is only a limited potential for physical contact with nonradioactive hazardous materials.

6.0 PERSONNEL PROTECTIVE EQUIPMENT

It is important that personnel protective equipment is appropriate to protect against the potential or known hazards at the Site. Protective equipment has been selected based on the types and concentrations of substances at the Site and the possibilities for and the routes of personnel exposure. The following levels of protection are required for the following activity groups.

Activity	**Protective Equipment**
Visual inspection	Gloves, shoe covers
Smearing	Gloves, shoe covers

Packaging sources	Gloves, shoe covers
Handling damaged sources*	Gloves, shoe covers, Tyvek suits

*Not anticipated. The Team has been informed by the licensee that there is no smearable contamination present. As a result, the only protective equipment necessary will be gloves and shoe covers. Procedures outlined in the Emergency Response Plan will be followed if necessary.

7.0 SITE CONTROL

7.1 Site Access

Access to the Site will be provided and controlled by the licensee. Contaminated areas are not anticipated, however Team personnel will be restricted to entry and only those site locations necessary to perform the described recovery operation

8.0 MEDICAL MONITORING PROGRAM

The SHO has responsibility to coordinate the medical monitoring program for radiation control. LANL has the responsibility for providing the radiation control instrumentation and personal dosimetry. Instrumentation for alpha, beta, gamma and neutron radiation field measurement and personal dosimetry will be provided as follows:

Rem ball
ion chamber
zinc sulfide alpha scintillation counter
job specific TLD's (personal and extremity)
direct reading neutron and beta/gamma dosimeters
control TLD's as necessary

Team personnel handling the sources will be wearing two extremity rings, one on each hand and two dosimeters which are set up for beta, gamma and neutron monitoring.

9.0 TRAINING REQUIREMENTS

9.1 Basic Training

The Team leader has a minimum of six years experience in the operation and handling of radioactive materials. He has also completed a 40-hour hazardous waste site training program as required under 29 CFR 1910.120 and Radiological Emergency Response Operations training under FEMA. He has been certified by the National Registry of Radiation Protection Technologies (NRRTP).

9.2 Site Specific Training

The Team leader has completed LANL's RAD Worker II safety training that emphasizes the prevention of exposure to radiation contamination and protective equipment used for this purpose. All other Team members directly handling source material must also have completed Rad Worker II safety training.

10.0 EMERGENCY RESPONSE PLAN

There is no emergency condition identified in connection with this operation. The only potential incidents would be derived by

1) site conditions being drastically different from those reported, and
2) mishandling the presumed leaking source in its pressure vessel such that removable contamination was spread to other parts of the building or personnel on site.

Should either of these situations occur, consultation will be made with NRC and LANL ES&H personnel to determine the appropriate course of action. Work will be stopped until this plan is formulated.

Appropriate notification of a contamination incident shall go to the individuals listed below:

Nuclear Regulatory Commission
John Madera (630) 829-9834

Nuclear Regulatory Commission Headquarters
Doug Broaddus (301) 415-5847

DOE Headquarters Project Manager
Robert Campbell, EM-36 (301) 903-7127

Los Alamos National Laboratory
Mark Dinehart (505) 665-2335

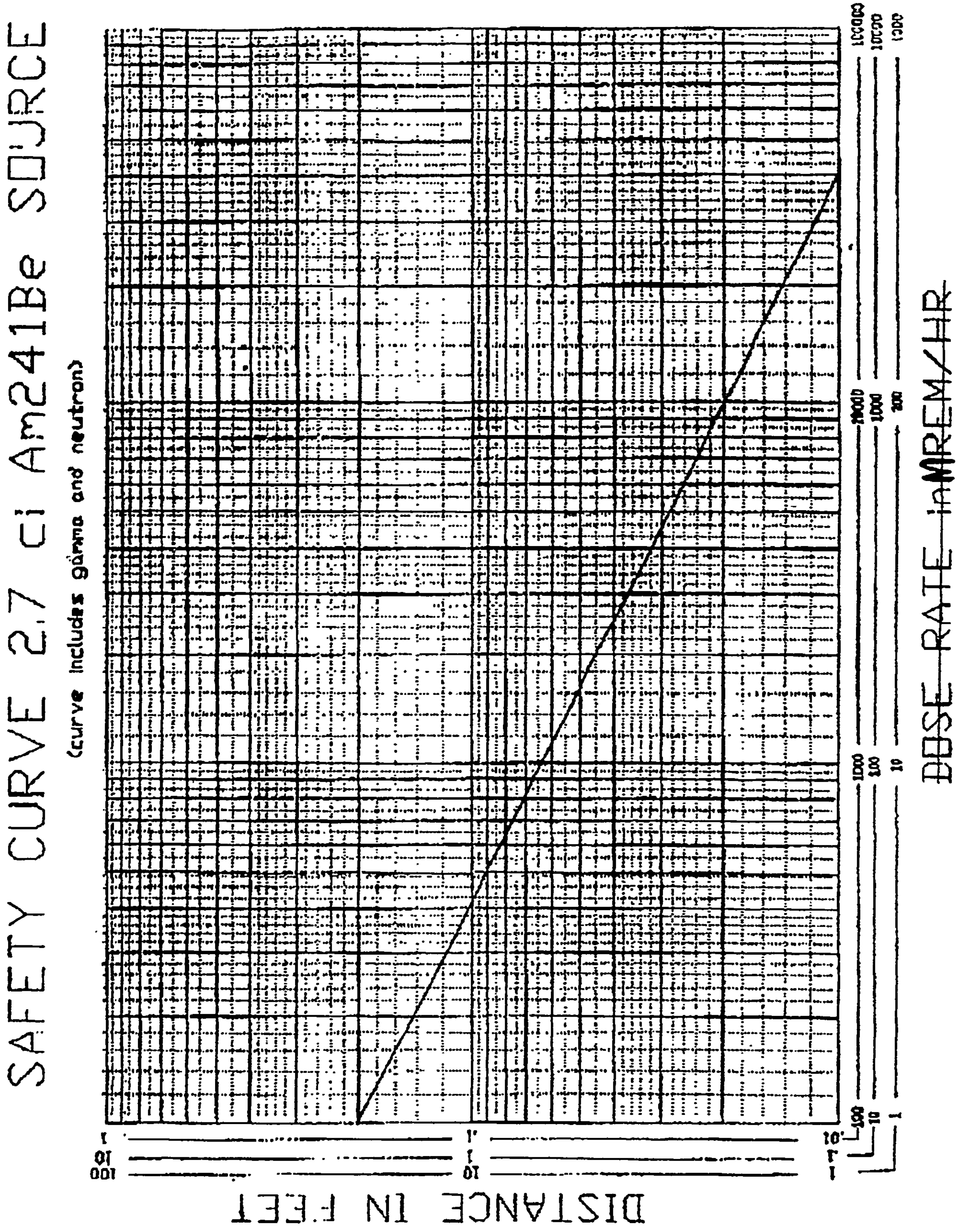

SAFETY CURVE 2.7 Ci Am241Be SOURCE
(curve includes gamma and neutron)
DOSE RATE in MREM/HR
DISTANCE IN FEET

Figure 13

COMPLIANCE AGREEMENT

Safety and Health Plan Compliance Agreement
Eastern Well Surveys, Inc. Site in Wooster, Ohio

I have read the Safety and Health Plan for the Eastern Well Surveys, Inc. Site Project. I understand the PLAN and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in this PLAN.

Signed:

Printed Name	Signature	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

LANL PRELIMINARY HAZARD ANALYSIS (PHA)

JOB TITLE: Eastern Well Surveys DATE(S) JOB WILL BE CONDUCTED: 9-23-97

JOB LOCATION: TA- Off-site BUILDING- _____ ROOM- _____ OTHER- _____

EMPLOYEE(S) OR CONTRACTOR PERFORMING WORK: J.A. Tompkins & Vance Hatley

SUPERVISOR RESPONSIBLE FOR ES&H: Tompkins

Required PPE: Hard Hat__Safety Shoes__Safety Glasses/Goggles__Ear Plugs__Respirator__Anti-C.__Fall Protection__High Voltage Gloves__

			IF YES, LIST HAZARD CONTROLS
1. General Housekeeping Required?	YES__ NO__ N/A✓		oil on clothing only work
2. Are Emergency Procedures established?	YES✓ NO__ N/A__		
3. Will spark/flame producing devices be used?	YES__ NO✓ N/A__	(permit required)	
4. Will Confined Space Entry be required?	YES__ NO✓ N/A__	(permit may be required)	
5. Is a hazardous atmosphere possible?	YES__ NO✓ N/A__		
6. Is an oxygen deficient atmosphere possible?	YES__ NO✓ N/A__		
7. Will chemicals be used? (list)	YES__ NO✓ N/A__		
8. Is Asbestos present at the site?	YES__ NO✓ N/A__		
9. Will excavation work be required?	YES__ NO✓ N/A__	(permit required)	
10. Will the excavation be over 4 feet in depth?	YES__ NO✓ N/A__		
11. Will walls, ceilings or floors be penetrated?	YES__ NO✓ N/A__		
12. Will work above 6 feet be required?	YES__ NO✓ N/A__		
13. Will ladders be used?	YES__ NO✓ N/A__		
14. Will scaffolds be used	YES__ NO✓ N/A__		
15. Will work platforms or man lifts be used?	YES__ NO✓ N/A__		
16. Will roof work be required	YES__ NO✓ N/A__		
17. Will a Crane be used?	YES__ NO✓ N/A__		
18. Will a Forklift be used?	YES__ NO✓ N/A__		
19. Will Lockout / Tagout be required?	YES__ NO✓ N/A__		
20. Will energized electrical work be required?	YES__ NO✓ N/A__	(permit required)	
21. Will electrical hand tools be used?	YES__ NO✓ N/A__		
22. Will pneumatic power tools be used?	YES__ NO✓ N/A__		
23. Is work on Steam/Condensate Systems required?	YES__ NO✓ N/A__		
24. Is work on Natural Gas/High Pressure Gas Systems required?	YES__ NO✓ N/A__		
25. Will explosives be used or present?	YES✓ NO__ N/A__		
26. Will biohazards be used or present?	YES__ NO__ N/A✓		
27. Will machine tools be used?	YES__ NO✓ N/A__		
28. Will manual lifting be required?	YES✓ NO__ N/A__		
29. Will vehicle or pedestrian traffic be disrupted?	YES__ NO✓ N/A__		
30. Will barricades/access control be required?	YES✓ NO__ N/A__		
31. Will the work use lasers or take place in a laser area?	YES__ NO✓ N/A__		
32. Is the project located in a SWMU?	YES__ NO✓ N/A__		
33. Will work take place in a Radiation or Contamination Area?	YES✓ NO__ N/A__	(permit required)	No, offsite, you bet!
34. Have workers received Rad Worker Training?	YES✓ NO__ N/A__		
35 Will the Contractor be on site over 30 days?	YES__ NO✓ N/A__		
36. Have employees received LANL GET Training?	YES✓ NO__ N/A__		
37. OTHER HAZARDS: (list)	NA		

Completed by: J.A. Tompkins Title: Health Physicist Date: 9-23-97

Approved by: _____ Title: _____ Date: _____

Is an AHA Required for this job? YES__ NO✓ Initial JAT (ADDITIONAL COMMENTS ON BACK)

ACTIVITY HAZARD ANALYSIS (AHA)

Sequence of Job Steps	Potential Hazard	Recommended Action or Procedure
Establish Control Zone		
Assess Contamination in Zone		Swipes, Survey verify/ cross counts
Protection, Dosimeters		
Prepare ------ 2R		
Remove from Pit Location		Swipes, T.I.D.s, check Poly, I.D. verify ID
Load 2 Poly		Surface tools
Load 2R		
Placed 2R on Dunnage		
TIDs, Labels, Paperwork		
		End of 1st Cycle verify self-dosimetry
Repeat cycle		

Q/A Packaging Procedures for Pu-239/Be Acceptance Program

OPERATING PROCEDURE - DOT 6M SHIPPING CONTAINER ^{239}PuBe NEUTRON SOURCES

49 CFR § 173.417

DOT Specification 6M metal packaging. Authorized only for solid radioactive materials that will not decompose at temperatures up to 121°C(250°F). Radioactive decay heat output may not exceed 10 watts. Radioactive materials in other than special form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R containment vessel.

INTRODUCTION TO THE DOT 6M OPERATING PROCEDURES:

The operating procedures for the DOT 6M container consist of several elements: **1)** container inspection, **2)** preparation of material for loading, **3)** loading of the DOT 2R, and **4)** final assembly.

Within the Department of Energy (DOE) complex there are written procedures and instructions used to ensure DOT 6M packaging compliance. Each facility has developed procedures, checklists and instructions that reflect proper packaging for the type of radioactive materials being offered for shipment. These detailed procedures, checklist, and instructions establish a solid foundation upon which radioactive materials shipments can be made in compliance with DOT regulations.

1.0 SCOPE/PURPOSE

To establish procedures for packaging DOT 6M shipping containers for transfer. Operating procedures are established to assist facilities outside the Los Alamos National Laboratory complex in the packaging of ^{239}PuBe Neutron Sources in the DOT 6M shipping container for transfer to Los Alamos. **You must initial and date after each procedure is performed.**

2.0 PROCEDURE

2.1 INSPECTION PRIOR TO USE

All packages must be inspected prior to each use per 49 CFR § 173.475. The following should be checked before use of the DOT 6M:

Drum Markings

1. Welded metal plate has: "Fissile Radioactive Material N.O.S., UN2918, DOT 6M, Type B, Max. Gross wt. 480 lbs.

Drum Physical Characteristics

1. Drum: Rust Free

2. Surface: No dents greater than 1/2" with no resulting cracks or holes.

3. 5/8" Closure Bolt: No visual damage and a hole for the "Tamper Indicating Device" (TID).

4. Locking Ring: With forged lugs one of which is threaded, threads functional, no visual damage.

5. Head Gasket: No dents greater than 1/2" and no damage resulting in cracks or holes.

6. Vents: Four min. of 1/2" diam. with tape or plastic plugs.

7. Closure Ring: Must maintain contact with lid & drum.

Celotex Rings

These celotex rings must be assembled in the order they were disassembled, pay close attention when you remove them from the DOT 6M (see Figure 1).

1. No visual damage or degradation

30 Gal. 6M Celotex Ring Assembly

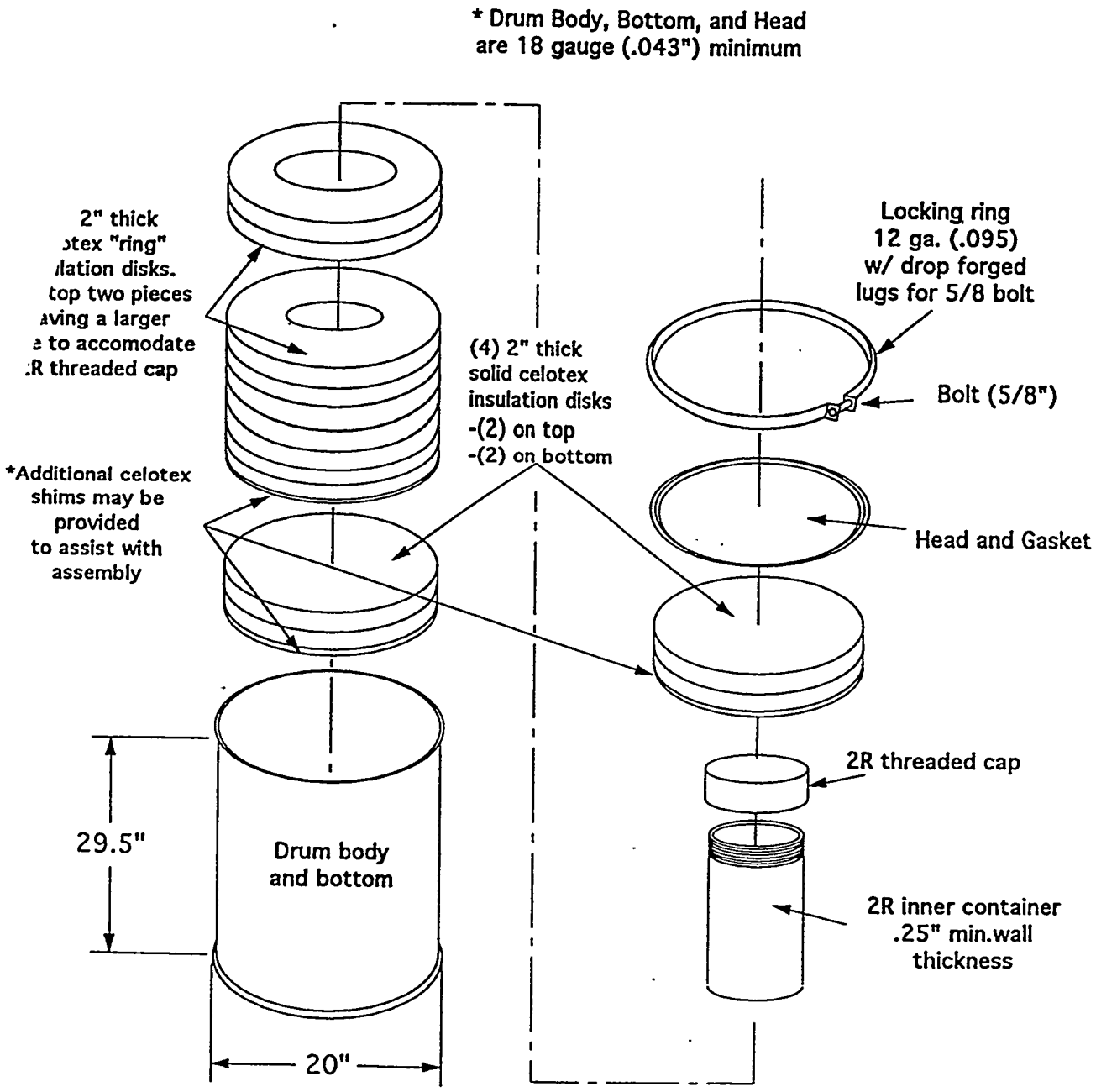


Figure 1

2R Inner Container

1. Marking 1/2" min. and permanent "Radioactive Material 2R.

2. Cap closures engage 5 threads (min.)

Initial and date that the above was performed _____

2.2 PREPARATION OF MATERIALS FOR LOADING INTO THE DOT 2R VESSEL

Radioactive materials placed inside the DOT 2R vessel shall be in special form or sealed in one or more metal cans or polyethylene bottles. The radioactive materials must not decompose at temperatures up to 250^{0} F.

The composition of the radioactive materials must be such that there will be no significant chemical or galvanic reaction among any of the materials in the package.

Fissile materials are defined in Title 49, Part 173.403 (j) as plutonium^{238}, plutonium^{239}, plutonium^{241}, uranium^{233} and uranium^{235}. Under DOT regulations the above radionuclides are treated as essentially radioactive materials. This fissile Class I package is limited to 0.9 kilograms of plutonium. The maximum ratio of hydrogen to fissile material must not exceed three, including all of the sources of hydrogen within the DOT Specification 2R containment vessel.

Initial and date that the above was performed _____

2.3 LOADING OF ^{239}PuBe NEUTRON SOURCES INTO POLYETHYLENE HOLDER

A specially designed polyethylene holder has been designed and fabricated for insertion into the 2R inner container. The neutron sources must be placed inside the polyethylene holder with the retaining pin inserted through both the body of the poly holder and the poly cap.

Initial and date that the above was performed _____

2.4 LOADING OF THE 2R VESSEL

Once loading of the polyethylene shield has been accomplished, the entire assembly must be placed inside the DOT 2R inner vessel. The threads on the pipe body and the cap should be coated with C5A pressure lubricant, and the cap screwed onto the pipe body to 100 ft-lbs. torque.

Initial and date that the above was performed _____

2.5 FINAL ASSEMBLY OF THE DOT 6M PACKAGE

The final assembly of the DOT 6M consists of a number of verification steps to ensure total compliance with Title 49 regulations. Shown below is a checklist that will assist in complying with the above mentioned regulation.

2.5.1 Verify that the radioactive material complies with the requirements specified for the DOT 6M.

2.5.2 ^{239}PuBe Neutron Source has been placed inside the Polyethylene holder and retaining pin is in place prior to placing assembly inside 2R.

2.5.3 Verify the 2R threads have been luted (C5A pressure lubricant) prior to replacing the cap on the 2R. Luting compound on pipe threads shall be non-harding and capable of withstanding up to 300°F without loss of efficiency.

2.5.4 Torque the cap to 100 ft-lbs.

2.5.5 Place the 2R into slot allocated within the celotex rings, and cover with the remaining celotex rings.

2.5.6 Check that the drum lid gasket is in place and in good condition.

2.5.7 Secure the drum lid to the drum with the closure ring. Ensure that the closure ring bolt is turned down against the drum.

2.5.8 Secure the closure ring with the bolt and secure with the locking nut.

2.5.9 Apply tamper indicating device (TID).

Initial and date that the above was performed _____

DOT 6M PACKAGING CHECK-LIST

You and a second person must assure that the above procedures have been followed. You and the second person must complete, sign and date the DOT 6M Check-List (page 7) before the shipment leaves your site.

You must keep this check-list in your records for three years.

DOT 6M PACKAGING CHECK LIST

Did you inspect the DOT 6M prior to use? (section 2.1) _____

Did you properly load your source(s) in the polyethylene holder? (section 2.2 & 2.3) _____

Did you properly load the 2R vessel? (section 2.4) _____

Did you properly assemble the DOT 6M package? (section 2.5)

2.5.1 Radioactive material complies with DOT 6M requirements? _____

2.5.2 Source(s) are in polyethylene holder and retaining pin is in place prior to placing holder inside the 2R? _____

2.5.3 Have you luted the threads of the 2R? _____

2.5.4 Have you torqued the cap of the 2R to 100 ft-lbs.? _____

2.5.5 Have you replace the 2R in the celotex rings? _____

2.5.6 Have you checked the drum lid gasket? _____

2.5.7 Have you secured the drum lid with the closure ring, and is the bolt turned down? _____

2.5.8 Have you secured the closure ring with the bolt & nut? _____

2.5.9 Have you applied you tamper indicating device? _____

Name of Site: _____
Print or Type

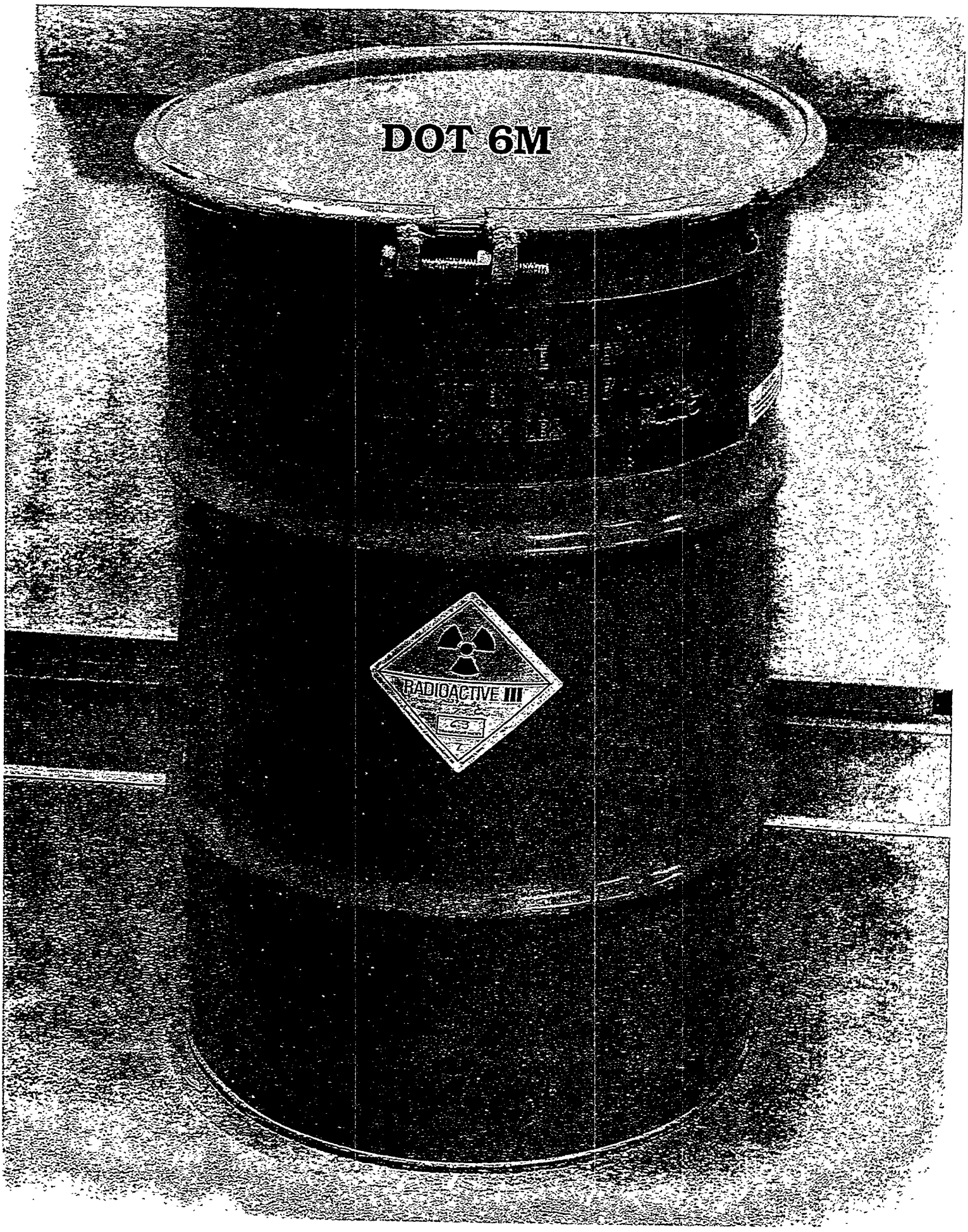
Name of Site Representative: _____
Print or Type

Signature of Site Representative: _____

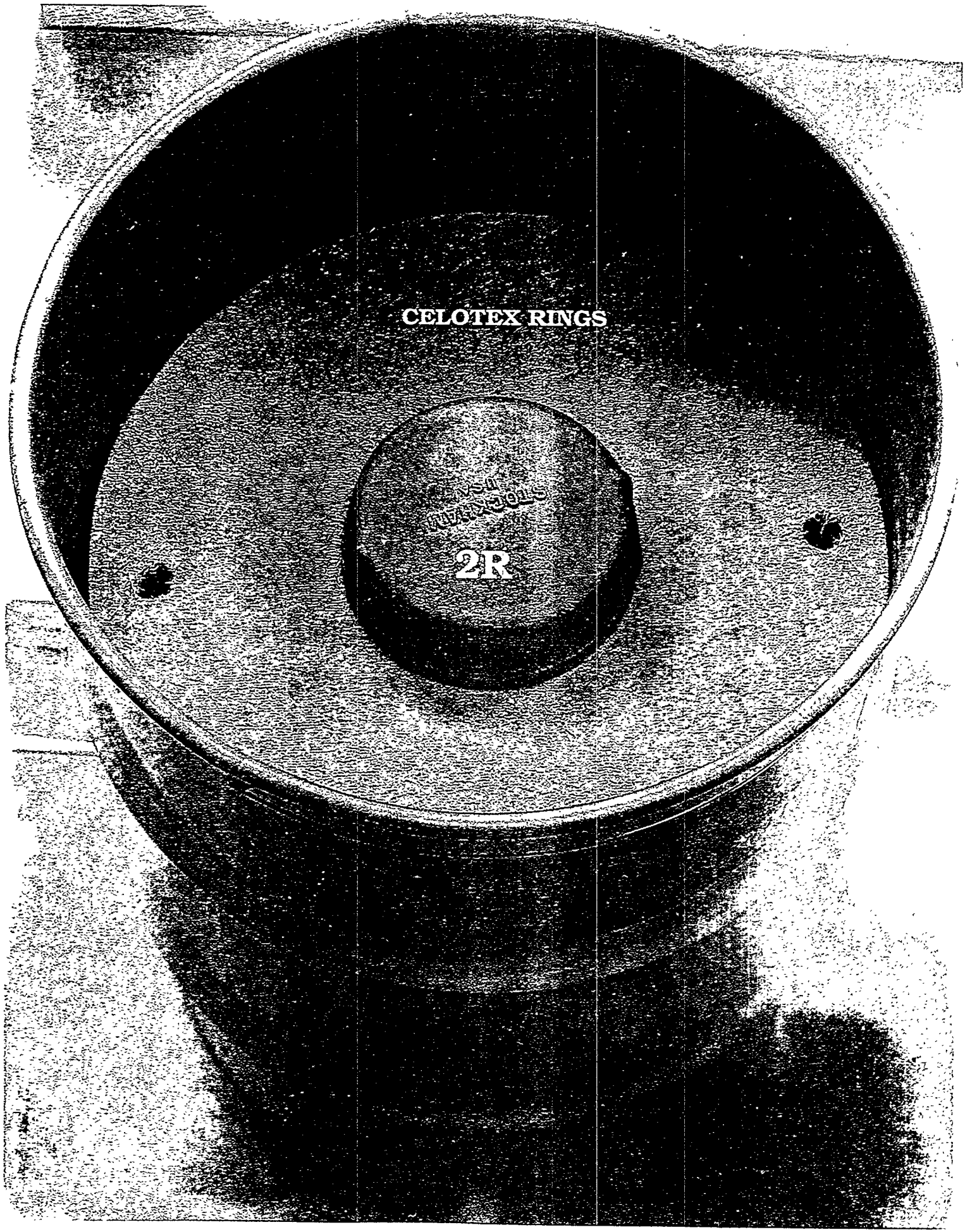
Name of Second Reviewer: _____
Print or Type

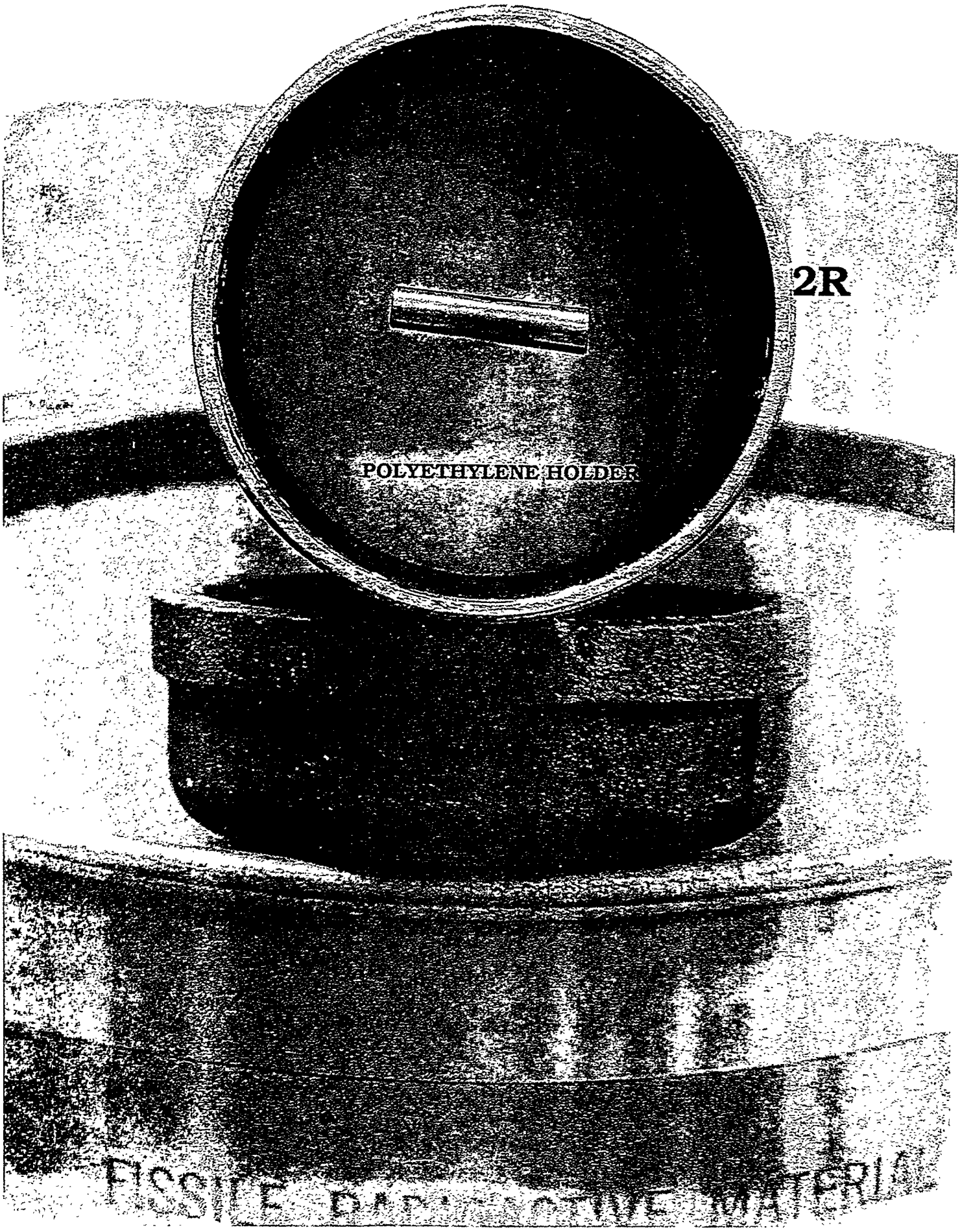
Signature of Second Reviewer: _____

Date: _____


DOT 6M
RADIOACTIVE III


DOT 6M
2R
CELOTEX RINGS
LID
POLYETHYLENE HOLDER
CLOSURE RING


CELOTEX RINGS
2R


2R
POLYETHYLENE HOLDER
FISSILE RADIOACTIVE MATERIAL

APPLICABLE SECTIONS OF 49 CFR

SUBPART A - General § 172.1. Purpose, Scope, and Applicability. Lists and classifies hazardous material, prescribes requirements for shipping papers, package marking, labeling, and transport vehicle placarding.

SUBPART B - Table of Hazardous Materials & Special Provisions § 172.101. The Hazardous Materials Table designates the materials as hazardous for the purpose of transportation.

SUBPART C - Shipping Papers § 172.200. Description of hazardous materials required. Each person who offers a hazardous material for transportation shall describe the hazardous material on the shipping paper.

SUBPART D - Marking § 172.300. Each person who offers a hazardous material for transportation shall mark each package, freight container, and transport vehicle.

SUBPART E - Labeling § 172.400. Each person who offers for transportation or transports a hazardous material shall label the package or containment device with labels specified for the material.

SUBPART F - Placarding § 172.500. Each person who offers for transportation or transports any hazardous material shall comply with the applicable placarding requirements.

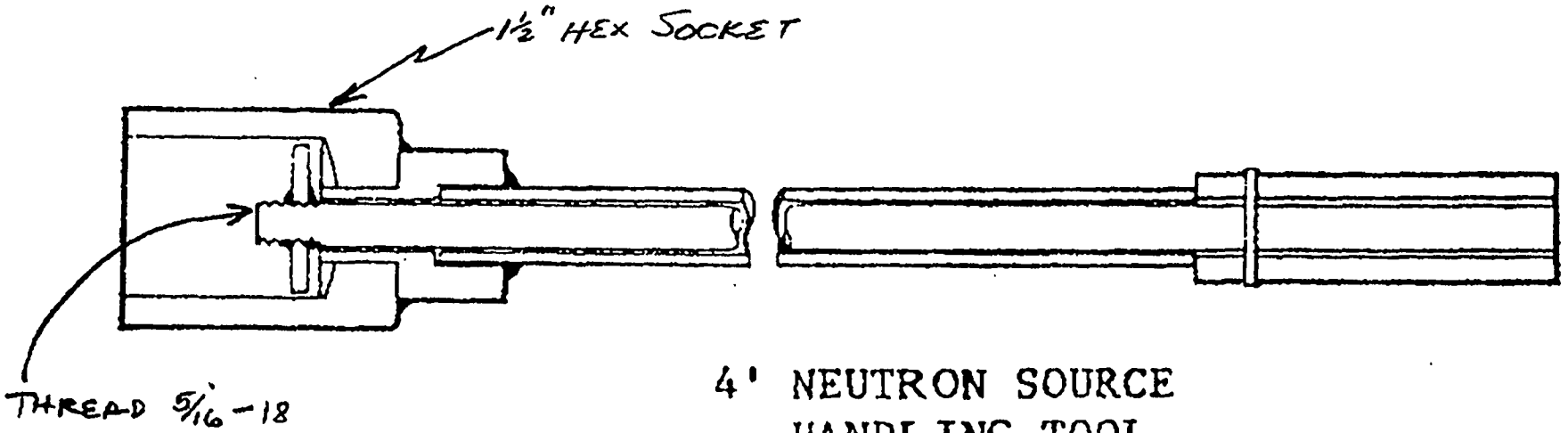
SUBPART H - Training § 172.700. Each person shall be provided general awareness familiarization training and shall be able to recognize and identify hazardous materials.

SUBPART I - Radioactive Materials § 173.401. Sets forth the requirements for the transportation of radioactive materials by carriers and shippers.

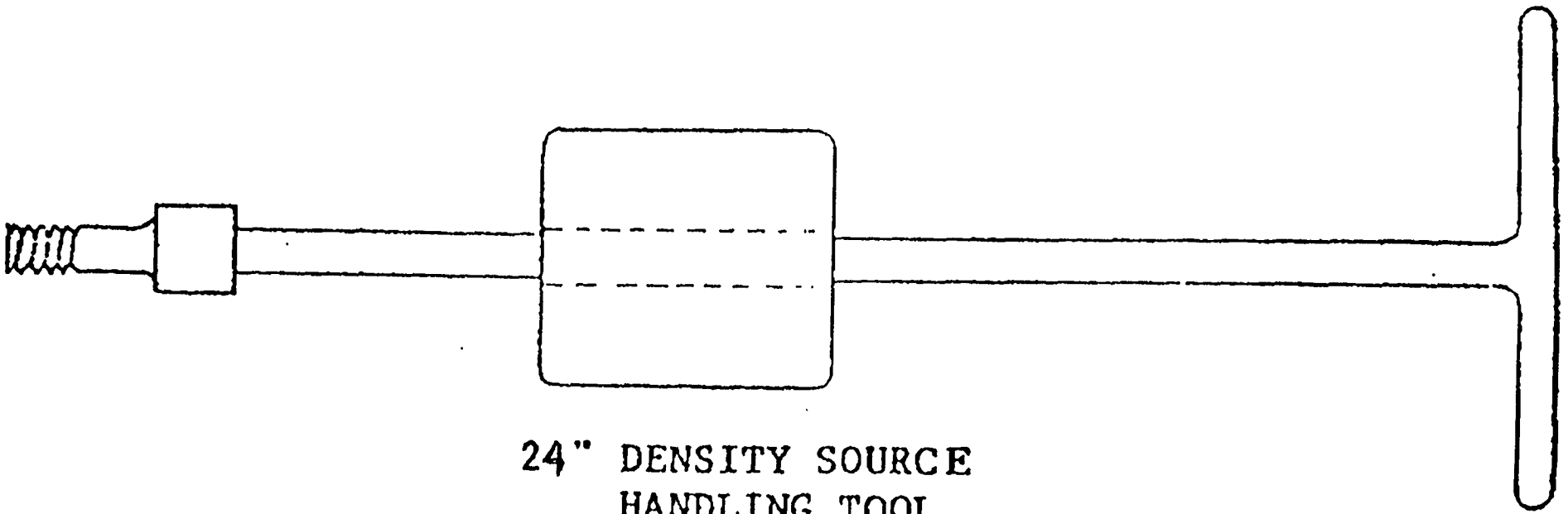
APPENDIX TO § 172.101 - List of Hazardous Substances and Reportable Quantities (Table 2 Radionuclides) 172.101. The letters "RQ" should be entered on the shipping paper for each hazardous substance.

SPECIFICATION 6M; METAL PACKAGING §178.354. Each package must meet the applicable requirement set forth in CFR 49.

Source Handling Tools



4' NEUTRON SOURCE
HANDLING TOOL



24" DENSITY SOURCE
HANDLING TOOL

Attachment F