

Position Paper on the Proper Characterization and Disposal of Sealed Radioactive Sources

Revision 2, October 1997

Revised by:
DOE/NV Radioactive Waste Acceptance Program
and
The NTSWAC Working Group

EXECUTIVE SUMMARY

The “Position Paper on the Proper Characterization and Disposal of Sealed Radioactive Sources” was originally developed by the NVO-325 Work Group, Sealed Source Waste Characterization Subgroup. The NVO-325 Workgroup, now called the NTSWAC Working Group, is comprised of representatives from DOE sites approved to ship waste to the NTS and representatives from DOE/NV's Radioactive Waste Acceptance Program. The NTSWAC Working Group is chartered to assist the generators and NTS in the future through the resolution of issues common to the sites, and through the promotion of more consistent and streamlined documentation packages for common waste streams.

The Sealed Source Waste Characterization Workgroup developed the subject paper to provide for the resolution of issues concerning the disposal of sealed radioactive sources at the NTS under the “Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements”, NVO-325, Revision 1. The subject paper was presented to DOE/NV Waste Management personnel and Revision 1, dated June 1996, was adopted by DOE/NV.

Subsequent to the adoption of the paper, NVO-325 was revised to the NTSWAC. This revision included substantial changes to the criteria including the introduction of waste profiles. These changes to the NTS criteria in the NTSWAC prompted the need to revise the subject paper in order to provide for consistency between its content and the requirements found in the newly revised NTSWAC. It was determined that document control was most easily facilitated by making the document a DOE/NV document. As such, this document has been revised by Radioactive Waste Acceptance Personnel at the direction of DOE/NV with input and concurrence from the NTSWAC Working Group.

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Introduction

Sealed radioactive sources are common throughout the DOE complex where they are used for a variety of purposes, most often for the testing and calibration of radiation detection instrumentation. The proper characterization and disposal of these items has been recognized as an item that should be standardized among sites designated to ship radioactive waste to the Nevada Test Site (NTS) for disposal. This need for standardized methodology has been reinforced by several characterization issues regarding sealed sources that have been raised during site audits by DOE/NV Radioactive Waste Acceptance Program (RWAP). The purpose of this position paper is to present a common basis for the proper characterization and disposal of sealed radioactive sources that will be utilized by generators disposing of waste at the NTS. This position paper was developed by the Sealed Source Characterization Working Group which was comprised of representatives from sites approved to ship radioactive waste to the NTS with technical support from DOE/NV's Radioactive Waste Acceptance Program (RWAP) representatives.

Definition of Sealed Radioactive Source

For the purpose of this position paper, a sealed radioactive source is defined as "radioactive material that is contained in a sealed capsule, sealed between layers of non-radioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to the use of the source" (Implementing Guide for Occupational Radiation Protection (G-N5400.9/M1) Sealed Radioactive Source Accountability and Control).

Recycling and Reuse

Prior to disposing of a sealed source as radioactive waste, it is strongly recommended that the generator contact the original manufacture of the source to determine if the source can be returned for re-use or if the source can be recycled. Once it has been determined that the source must be disposed of, it should be characterized as described in Appendix A.

Regulatory Status

The regulatory status of the radioactive component of sealed sources must be established before a meaningful discussion on the proper dispositioning of these materials can take place. The Resource Conservation and Recovery Act, Section 1004 (27) specifically excludes any source, special nuclear or byproduct material as defined by the Atomic Energy Act (AEA), 42 U.S.C. Sections 2011-2296 (1988), from the definition of solid waste. Since "hazardous waste" is a subset of "solid waste," source, special nuclear and byproduct material are exempt from the

definition of hazardous waste and thus from RCRA regulation. "Byproduct material" is defined as: (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. 42 U.S.C.A. Section 2014 (e).

The DOE issued a final rule interpreting the AEA definition of "byproduct material" to include "only" the actual radionuclides dispersed or suspended in the waste stream. Since only the radionuclides are exempt from RCRA regulation, if the radionuclides are dissolved, contained or suspended in a nonradioactive medium which is a RCRA hazardous waste, the nonradioactive hazardous component of the waste is subject to regulation. 52 Federal Register 15,937 (May 1, 1987) (codified at 10 CFR Part 962). A "radionuclide" is a type of atom which spontaneously undergoes radioactive decay. 54 Fed. Reg. 51,654 (December 15, 1989). In addition, RCRA Section 1006 (a) states that where incompatibility exists in the regulation of mixed waste, the AEA regulations take precedence.

Issue 1: Classification of Specific Radionuclides as AEA II(e)(1) Byproduct Materials

The issue to be resolved is the classification of specific sealed source nuclides which are isotopes of RCRA characteristic metals. Radionuclides classified as source, special nuclear, or byproduct materials under the AEA are specifically excluded from regulation as hazardous waste. There are eight RCRA metals which may potentially cause a waste to fail the Toxicity Characteristic and hence cause the waste stream to be regulated as hazardous waste. These eight metals are: arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se), and silver (Ag). When radionuclides of any of these metals are classified as AEA 11(e)(1) byproduct materials, they are excluded from regulation as hazardous waste. This represents the purest application of the exclusion under which RCRA defers regulation to the AEA as amended.

It is impossible to determine by direct examination or testing whether a particular nuclide originated from a nuclear reactor or from a charged particle accelerator. In practice, however, it is fairly easy to determine the probable source by accessing a reference which identifies the viable routes of production. It turns out that there are only a few cases when a nuclide may be produced by both a reactor and accelerator production route. Table 1, provides the basis for classification for the eight metals of concern.

Table 1¹

Metal of Concern	Predominant Sealed Source Isotope	Production Route	t-1/2 ³	AEA byproduct or NOARM
arsenic (As) ⁴	N/A	N/A	short	N/A
barium (Ba)	Ba-133	reactor	10.7 yr	AEA
cadmium (Cd)	Cd-109	reactor or accelerator ⁵	453 d	AEA
chromium (Cr)	Cr-51	reactor	27.7 d	AEA
lead (Pb)	Pb-210	Naturally Occurring	22.3 yr	NOARM
mercury (Hg)	Hg-203	reactor	46.8 d	AEA
selenium (Se)	Se-75	reactor	118.5 d	AEA
silver (Ag)	Ag-110m	reactor	252 d	AEA

¹ phone call with Gary Strathearn, Isotope Products Laboratories, CA

² Table of Isotopes, cite.

³ Nuclear and Radiochemistry, 3rd Ed., G. Friedlander, et. al., John Wiley & Sons, 1981.

⁴ arsenic not commonly used in sealed sources

⁵ both reactor and accelerator routes are feasible

As can be seen from Table 1, nearly all of the metals of concern are produced from reactors placing them in the AEA 11(e)(1) byproduct material definition. Arsenic does not have any isotopes with sufficiently long half life to be used in sealed sources. Cadmium-109 can be produced from both a reactor and an accelerator production route. It is common practice in industry to consider Cd-109 a byproduct material. In fact, the NRC requires that a licensee manage Cd-109 as byproduct material if it cannot positively demonstrate that it is solely derived from an accelerator. NRC maintains this rebuttable presumption because otherwise, if Cd-109 falls outside the scope of byproduct material, NRC has diminished power to regulate the material. Finally, lead-210 is an Naturally Occurring Radioactive Material (NORM).

With the exception of Pb-210, all of the metals found in Table 1 which would otherwise be regulated by RCRA may be classified as AEA 11(e)(1) byproduct materials exempted from regulation under RCRA and acceptable for management at the Nevada Test Site. As there can be no clearer application of the intent of Congress under the statutory exemption for AEA regulated source, special nuclear, or byproduct materials, DOE Nevada should concur with the position that the byproduct radionuclides identified in Table 1 are acceptable for disposal at the NTS. In regards to Pb-210, a component of U-238 decay chain, the Working Group recommends that it be managed in the same manner as AEA defined byproduct material. This position is further discussed in Issues two and seven.

Issue 2: Naturally Occurring or Accelerator-Produced Radioactive Material (NOARM)

Radionuclides contained in sealed sources may be classified as source, special nuclear, or byproduct materials under the AEA, or they may fall outside the scope of the AEA and be defined as naturally occurring or accelerator-produced radioactive material (NOARM). DOE Order 5820.2A defines NOARM as any radioactive material that can be considered naturally occurring and is not source, special nuclear, or byproduct material *or* any radioactive material that is produced in a charged particle accelerator. The vast majority of radionuclides contained in sealed sources are either source or special nuclear material or were produced in a nuclear reactor and thus fall under the AEA 11(e)(1) classification of byproduct material. However, certain sealed source radionuclides may only be produced, or are more efficiently produced, from a charged particle accelerator.

This portion of the position paper resolves the issue related to sealed source radionuclides and NOARM materials. The issue is whether NOARM radionuclides contained in sealed sources qualify as "small amounts" acceptable for management at the NTS under DOE Order 5820.2A.

DOE Order 5820.2A specifies that, generally, NOARM material is to be managed in accordance with 40 CFR 192 residual radioactive material guidelines, but that small amounts of NOARM may be managed as LLRW. This provision ensures that DOE low level waste disposal capacity is not consumed by large quantities of low activity NOARM wastes. The exception provides a mechanism for proper management of waste streams such as sealed sources which are much smaller in quantity and generally higher in activity than ordinary NOARM and hence warrant management as low level radioactive waste.

The working group estimates the total quantity of sealed sources currently in inventory would be 500 cubic feet if prepared for final disposal. Based on an average NTS disposal volume of 500,000 cubic feet per year this represents 0.1 %, assuming that all the sealed sources were disposed in the same year. The prevalent route of production for sealed source material is from a nuclear reactor; hence, NOARM sources would only comprise a fraction of this total quantity. Clearly, NOARM sources associated with sealed sources waste streams destined for management at the NTS would be considered a small amount in accordance with DOE Order 5820.2A. The Nevada Operations Office is vested with authority to concur with the determination that sealed sources constitute a small amount and are not precluded from management at the NTS solely because they contain NOARM.

Issue 3: Calculation of Radionuclide Concentration for Sealed Sources

Since many waste classification issues are determined by the concentration of radioactive material in the waste matrix, it is important to have a consistent approach when determining the concentration. Classification is based on the concentration of radionuclides in a waste (Title 10 CFR Part 61.55) and their availability to be a potential hazard. Concentration is expressed in activity per volume (Curies per cubic meter) except for some transuranic radionuclides that are alpha emitters in which concentration is expressed in activity per mass (nanoCuries per gram).

The source mass or volume includes the integral components of the source. An “integral component” is any component of a sealed source that cannot easily be mechanically removed and would compromise the integrity of the source if removed. Extrinsic materials such as packaging, encapsulants, or other diluents are not considered to be integral components. An exception to using the volume or mass of a source for determining the radionuclide concentration would be a situation in which a particular waste type is stabilized within a waste container using a solidification media or where the waste is encapsulated. “Issue 10” provides guidance on encapsulation requirements.

The *Branch Technical Position on Concentration Averaging and Encapsulation* (Nuclear Regulatory Commission, NRC, 1995) and the *Branch Technical Position on Waste Classifications* (NRC, 1983) specify that the activity of small concentrated sources, such as small check sources (< 3.7 MBq (100 uCi)), may be generally averaged over the waste volume when mixed with contaminated trash waste streams. Care needs to be taken to differentiate between the volume of the waste form and the volume of the waste container if the latter is significantly larger (e.g., greater than 10%). For sources that are 3.7 MBq (100 uCi) or greater, the volume or mass used in determining the radionuclide concentration is that of the source. The work group feels that the above approach utilizing the 100 uCi threshold should be adopted for all sealed sources except those containing transuranic nuclides at concentrations greater than 100 nCi/g. Thereby, sources < 3.7 MBq (100 uCi) could be disposed with other wastes and the activity averaged over the entire waste volume. Sources \geq 3.7MBq (100 uCi) would have to be profiled as a separate waste stream and the volume or mass of the source itself would be used in determining the radionuclide concentration. However, sealed sources that must be profiled as a separate waste stream (\geq 3.7MBq (100 uCi)) can be co-packaged with other waste streams provided radionuclide reporting and other NTSWAC requirements are met. All sources containing transuranic nuclides must be evaluated against the NTSWAC TRU criteria individually, considering only the mass of the source itself and any component integral to the source.

Issue 4: Characterization Data

Section 4.0, “Waste Characterization” of the NTSWAC, specifies the following: “Generators must prepare and submit a Waste Profile (WP) for each waste stream (Appendix B) which provides DOE/NV with a summary of waste characterization information. Generators shall provide waste characterization documentation that supports the WP (see Appendix E for examples) to DOE/NV for review during facility evaluations or upon DOE/NV request.” Appendix E of the NTSWAC, “Waste Characterization,” provides examples of waste characterization documentation. To help the acceptance process, a guidance document for the characterization of sealed radioactive sources is provided in Appendix A of this document to assist NTS generators in the preparation of characterization data packages.

The Guidance is an outline of the information required by NTS to accept sealed radioactive sources for disposal, and includes: waste identification, source category, physical characteristics, classification, packaging, certification, and approvals. Solid radioactive sources that do not meet the definition of a sealed source are specifically excluded from the guidance, since characterization and approval requirements may vary substantially between individual solid sources.

Development of the guidance document is intended to benefit the NTS generators by providing a pre-approved list of characterization information required for sealed radioactive sources. The guidance will benefit NTS by promoting consistent formatting of data packages and providing consistent data and supporting documentation. Consequently, the RWAP review and approval process will be more streamlined and efficient. Because most sealed sources are well documented the working group feels that the majority of the sealed sources will be able to be characterized by process knowledge.

The success and the applicability of the generic guidance document, as demonstrated by sealed-source data packages, will continue to be extended to other waste streams common to NTS generators in hopes of expediting document preparation for the generators and streamlining the approval process for the NTS.

Issue 5: Packaging Requirements

Compliance with the NTSWAC, packaging requirements found in Section 3.2, "Waste Package Criteria" will ensure the acceptance of approved sealed sources at the NTS. As currently provided in, the NTSWAC, deviations from the standard packaging will require prior approval from DOE/NV and the waste disposal organization. Any special packaging should be specified on the Waste Profile for approval.

Special packaging considerations may be needed to stabilize sealed sources in the container to prevent shifting in transport which could affect compliance with DOT requirements for radiation levels at the package surface. The external dose rate at the surface of the container is the primary concern in determining whether these packaging considerations must be applied.

Sealed sources with high external dose rates should be packaged in an inert material (e.g., diatomaceous earth, concrete, vermiculite). This packing material should maintain the position of the source in the container during transport and provide adequate shielding to maintain the external dose rate within acceptable limits.

Packaging guidelines are included in the generic application package (Appendix A).

Issue 6: Non-waste Lead Shielding

Certain sealed sources contain lead components as either external or integral shielding. It is EPA's position in guidance to all NRC Licensees that containers or container liners which are still serving their intended use, for shielding in low-level waste disposal operations, are not considered waste and, thus, are not subject to the hazardous waste rules. See EPA Guidance on the "Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste" and "Answers to Anticipated Questions," OSWER Directive 9432.00-2, October 4, 1989. NRC regulations define "Disposal Container" as a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility. The Commercial sector, governed by NRC regulations, permits disposal of lead shielding in Low-Level Waste Disposal facilities as long as the shielding came with the sealed source, was necessitated for ALARA

worker protection reasons, and is not radioactively contaminated.

In many cases where shielding is integral in the construction of the sealed source, separating that shielding from the source could increase the potential for worker exposure. In a similar nature removal of sealed sources from external shielding may also increase exposure rates to workers. Such action would violate the ALARA principle stated in 10 CFR 834 and 835. Therefore, it is our position, consistent with EPA, NRC, and the commercial sector, that lead shielding which is integral or external to the construction of a sealed source and is being used to reduce radiation exposure would meet the certification requirements for LLW.

Issue 7: Decay Products

Some radioactive sources contain radioactive constituents that in their stable elemental form would be considered to be hazardous under RCRA. The sources for consideration in this discussion include Byproduct Material and NOARM constituents.

In 1954, passage of the Atomic Energy Act (AEA) as amended established the regulatory program for radioactive materials (including waste) resulting from the production of nuclear weapons, the research and development of military application of atomic energy, and the safeguarding of nuclear materials and information. Included in the statute was the definition of "byproduct" material which consist of radioactive material or waste generated as a direct result of any of the above applications. In 1976, the Resource Conservation and Recovery Act (RCRA) was passed, thus establishing a framework for the regulation of hazardous waste. Included as part of the RCRA statute was the stipulation that "byproduct" material was specifically exempt from regulation. As a result of these two statutes, concerns were raised regarding the applicability of RCRA to radioactive waste. In 1986 waste containing both radioactive and hazardous constituents was determined to be "mixed" waste and subject to regulation under both the AEA and RCRA. In 1987 a final interpretive rule was issued by the Department of Energy stating that RCRA applied to the hazardous, non-radioactive portion of a mixed waste.

Based on the evolution of regulatory guidance regarding the applicability of RCRA to radioactive materials and the basis that DOE Radioactive Sources are comprised primarily of byproduct materials, it follows that the radioactive decay product generated from the decay of an exempt isotope into another radioactive isotope would also be exempt from regulation under RCRA.

Issue # 2 (Naturally Occurring or Accelerator-Produced Radioactive Material) requests that sealed source NOARM be managed as LLW and disposed at the NTS due to its small amount. If this request is accepted, then the decay products of these isotopes also need to be considered. The regulations are silent regarding the applicability of RCRA to the decay products of NOARM. Therefore the working group recommends that DOE/NV adopt a policy that since NOARM decay products follow the same radioactive decay process that the byproduct isotopes follow they should be subject to the same regulatory interpretation.

It is, therefore, the position of the Sealed Source Characterization Working Group that exempt original radioactive constituents and associated radioactive decay products contained in

Radioactive Sealed Sources are all byproduct material, and as such, they are excluded from regulation under RCRA for any hazardous characteristics that they may contain.

Issue 8: Adhesives and Binders

Many sealed sources utilize an adhesive or binder to affix the radioactive material to a backing of some kind. These adhesives have fully reacted or cured and are not considered to exhibit hazardous waste characteristics. The State of California has issued interpretive guidance to waste generators stating that hardened, cured, or polymerized resins do not exhibit the characteristics of a hazardous waste. The working group feels that this guidance is applicable to adhesives or binders that may be present in a sealed source.

Issue 9: Undocumented Sealed Sources

A portion of the sealed sources offered for disposal will have insufficient documentation to be characterized by process knowledge alone for disposal. Additional characterization beyond process knowledge will be required before these sources will be considered adequately characterized for disposal purposes. The working group feels that commonly available nondestructive evaluation and nondestructive assay techniques in combination with available process knowledge should be acceptable for characterizing the majority of the sources that fall into this category. Generators will be responsible for both nuclide identification and quantification in compliance with NTSWAC requirements.

Issue 10: Sealed Source Encapsulation

The working group believes that significant advantages could be obtained by offering encapsulation as an option in the disposal of certain sealed sources based on an assessment of cost effectiveness. Such benefits could include the following:

- ! Encapsulation may reduce the migration and/or intruder exposure potential for radionuclides and, therefore, may allow higher package activity limits.
- ! Encapsulation may also allow the use of less precise but more cost effective characterization techniques. However, characterization must be at the individual sealed-source level.
- ! Encapsulation would provide for greater confinement of leaking sealed sources.

The working group feels that Appendix C of the NRC *Branch Technical Position on Concentration Averaging and Encapsulation* (NRC, 1995) should be adopted as the criteria for encapsulation. The NRC specifies that the amount of credit allowed for encapsulation is limited so that extreme measures cannot be taken solely for the purposes of dilution. Bounding conditions are as follows:

1. A minimum solidified volume or mass that precludes significant movement of the waste without the assistance of mechanical equipment.
2. A maximum solidified volume or mass for encapsulation of a single discrete source should be 0.2 m³ or 500 Kg (55-gallon drum).
3. A maximum amount of gamma-emitting radioactivity or radioactive material generally acceptable for encapsulation is that which, if credit is taken for a 500 year decay period, would result in a dose rate of less than 0.2 uSv/hr (0.02 mrem/hr) on the surface of the encapsulating media. The maximum Cs-137/Ba-137m gamma-emitting source generally acceptable for encapsulation in a single disposal container is 1.1 TBq (30 Ci).
4. A maximum amount of any radionuclide that should be encapsulated in a single disposal container intended for shallow land disposal is that which, when averaged over the waste and the encapsulating media, does not exceed the maximum concentration limits for Class C waste, as defined in Table 1 and 2 of 10 CFR 61.55.
5. In all cases when a discrete source of radioactive solid waste is encapsulated, written procedures should be established to ensure that the radiation source(s) is reasonably centered within the encapsulating medium.

This guidance should not be applied to sources containing alpha emitting transuranic nuclides with half-lives greater than 20 years. These transuranic sources should be evaluated against the NTSWAC TRU waste criteria individually, considering only the mass of the source itself (no packaging, extrinsic shielding or other waste-diluting materials).

Encapsulated waste must be recognizable after the institutional control period of the disposal site so that inadvertent intrusion would be unlikely. This is accomplished by the waste maintaining its structural integrity under the expected disposal conditions. The NRC *Technical Position on Waste Form* provides guidance in using cementitious materials to solidify and stabilize LLW (NRC, 1991).

Part Two: Background Information

The following information presents supporting data that was obtained by the working group in developing the issues and resolutions presented in this paper.

Current DOE Practices for Sealed Sources

Within the Department of Energy complex, the methods for disposing of sealed sources are fairly consistent among the designated disposal sites. With the exception of those sealed sources containing transuranium isotopes that meet the definition of transuranic waste, sealed sources are disposed of as low level radioactive waste (LLRW).

In general, all Waste Acceptance Criteria (WAC) for DOE LLRW disposal facilities require generators to identify the components within a waste stream and the components contained in each waste container. There are some cases where the LLRW WAC contain requirements specific to sealed sources, such as for leak testing, packaging, considerations for leaking sources that are > 5 Ci of radioisotopes with half-lives greater than five years, and documentation that the sources are not suitable for reuse, recycling, or return to the manufacturer.

In general, from a disposal standpoint, waste streams containing sealed sources that meet the designated disposal site's established Waste Acceptance Criteria (WAC) for LLRW, are managed as LLRW components and not a distinct waste form requiring segregation and/or special handling.

Commercial Disposal Practices for Sealed Sources

The work group contacted a commercial LLW disposal site to gain an understanding of current commercial approaches to managing sealed sources for disposal as LLW. The basic premise was that a commercial site, receiving and managing sealed sources on a regular basis, would have addressed and resolved many of the technical and regulatory issues associated with sealed sources. While these approaches would not be dispositive on sealed source management within the DOE environment, they would lend valuable insights that could support the development of workable solutions for sealed source management at the NTS. Personnel working at the Barnwell Site, located in South Carolina and managed by ChemNuclear, were the primary source of information collected.

LLW disposal at the Barnwell facility is governed by Nuclear Regulatory Commission (NRC) regulations promulgated at 10 CFR 61. These regulations define the NRC licensing requirements for land disposal of LLW. This forms the basis for the specific requirements for operation of the Barnwell facility which are incorporated into the NRC license and, ultimately, the Waste Acceptance Criteria (WAC) for the facility. Certain aspects of operations are subject to oversight by the South Carolina Department of Health and Environmental Conservation (DHEC).

Some of the general disposal facility requirements that pertain to sealed source disposal at

Barnwell include:

- License limits for individual packages in regard to curie content and dose readings
- 10 CFR 61 defines isotopes and activities for class C material
- Barnwell can accept greater-than-class-C waste with DHEC permission
- Sealed sources often classify as greater-than-class-C
- Waste classification is based on activity averaged over source itself
- Materials of construction (casing, back plates and integral shielding) are included in mass
- Sealed sources must be encased in 4 inches of cement, all the way around
- Requirements for encapsulation are driven by intruder scenarios in the performance assessment
- Encapsulating cement must be rated at 2500 psi
- All sealed sources require pre-approval on source size and encapsulation methodology
- Lead shielding (e.g., source pig) may be acceptable based on an ALARA justification
- DHEC allows lead shielding if shielding is not contaminated and came with the source

Currently, ChemNuclear is amending its NRC license to provide a list of approvable sources (radionuclides, curie contents, and encapsulants) to relieve the burden of having to complete a specific review of each set of sealed sources offered for disposal. This list of approvable sources will define the types of sealed sources which may be accepted for disposal without need for specific detailed review. Sealed sources which do not fit the approvable sources list may still be acceptable for disposal but will require a case-by-case review by ChemNuclear and DHEC. For example, greater-than-class-C sources will still require a case-by-case review.

Sealed sources may include source, special nuclear, or by-product material. For reference, a list of by-product radionuclides regulated by the NRC under authority derived from the Atomic Energy Act (AEA) may be found listed in 10 CFR Part 30. Sealed sources which are classified as transuranic waste (with TRU nuclides greater than 100 nCi/g) are not acceptable for disposal at Barnwell. In making the determination of whether or not individual sources are TRU waste, the mass of the source and its integral components (e.g., including backplate, casing, and integral shielding) are included in the computation. Extrinsic materials, such as packaging, encapsulants of other waste diluents may not be included in the calculation. TRU nuclide concentrations are averaged over the mass of the entire sealed source.

Waste generators are required to submit an information package which provides the basis for characterizing the sealed source as non-hazardous, low level waste (i.e., not regulated by RCRA). In making this determination, the generator has to take into account all materials of construction of the sealed source. DHEC is particularly sensitive to the inclusion of radioactively *contaminated* lead with sealed sources. For lead to be acceptable, it must be part of the integral or approved shielding and must not be radioactively contaminated. There are no specific prohibitions on materials of construction and no specific concerns regarding the inclusion of stainless steel in sealed sources. Waste characterization, however, must be provided by the generator for each set of sealed sources offered for disposal.

Generic Waste Characterization Package

Development of a generic characterization package (Appendix A) for sealed source waste streams is intended to benefit all Nevada Test Site (NTS) generators. The benefit will be realized through a format that will provide consistent data and streamline the DOE/NV Radioactive Waste Acceptance Program Team (RWAP) review/approval efforts. A generic format providing consistent data and supporting documentation can be reviewed and approved with less effort than independently developed facility specific packages.

Conclusion

Central to acceptance of this document is the discussion of the applicability of the Atomic Energy Act and the byproduct rule to certain sealed source isotopes. The working group strongly feels that a consistent management strategy must be developed and that the practical difference between NOARM and byproduct material is non-existent. It is clear that it was the intent of the Congress that radioactive materials would be managed under the Atomic Energy Act which at the time of its issuance was the most comprehensive regulatory system in the world. The working group believes that NOARM isotopes given their small volume should be managed in a manner which is consistent with the Atomic Energy Act.

Another important issue raised in the paper is the management of lead in the disposal of sealed sources. The working group maintains that when lead is used for its shielding properties it should not be considered a waste and thus should not be excluded from disposal at the NTS. The working group realizes that the disposal of lead should be limited to those cases where the shielding is protecting workers from unnecessary exposure to ionizing radiation. This is in complete agreement with EPA and NRC guidance.

The issues presented in this position paper represent those areas considered by the work group participants to be key to allowing for the safe and cost effective disposal of sealed sources. The standardized information presented in this document will provide DOE/NV with opportunity to resolve these issues on a complex wide basis instead of on a generator by generator basis. This will result in substantial cost saving to both DOE/NV and the waste generator community.

Appendix A

Generic Waste Profile Guidance for Sealed Radioactive Sources

Introduction

This Guidance is provided to assist NTS generators in the development of waste characterization documentation for sealed radioactive sources. The guidance conforms to requirements of the NTSWAC, and is developed in compliance with applicable DOE Orders and Federal regulations. The information provided herein is written with the assumption that the regulatory positions put forth in the main body of this document will be approved. If modifications to the proposed regulatory positions are required, this guidance may need to be revised accordingly.

This document is intended to benefit NTS generators by pre-approving the information required for characterization documentation pertaining to sealed radioactive sources. The benefit to NTS will be realized through the development of consistent characterization data packages by generators. This will streamline the RWAP review/approval process by providing a consistent format, and documentation that can be reviewed quickly and efficiently. Each generator is urged to use the guidance as an outline of requirements for the characterization, documentation, and packaging of sealed radioactive sources offered for disposal at NTS.

Scope

The NTSWAC requires that adequate levels of documentation be maintained for each waste stream offered for disposal. This guidance is an outline of the characterization information required by NTS to accept sealed radioactive sources for disposal, including: waste identification, source category, physical characteristics, classification, packaging, and approvals. Solid radioactive sources are specifically excluded since characterization and approval requirements may vary substantially between individual solid sources.

Section 1: Waste Stream Identification and Tracking

Sealed sources that have an activity of 3.7 MBq (100 uCi) or greater shall be offered for disposal as an individual waste stream and shall not be included as a sub-stream of another waste stream. For these sealed sources, the radionuclide concentration should be calculated over the volume or mass of the particular source. The characterization documentation should include reference to the appropriate waste stream number. Each individual source must be identified in such a manner that characterization data is traceable to the individual source. The generator must provide adequate documentation so that sources can be tracked to the containers in which they are to be shipped.

Sealed sources that are less than 3.7 MBq (100 uCi) can be mixed with other waste streams such as contaminated trash. The total volume of the waste can be used for waste classification and for determination of the radionuclide concentration. Characterization on an individual source basis is

not required as long as the characterization method used is adequate to ensure compliance with Section 3.3, "Radionuclide Reporting," of the NTSWAC.

All sealed sources containing transuranic nuclides must be evaluated against the NTSWAC TRU waste criteria individually.

Section 2: Categorization of "Radioactive Sources"

Numerous generator sites have various types of radioactive sources that require disposition. The majority of these sources require disposition because they are leaking, or of unknown makeup and origin, or are excess materials no longer needed for DOE operations, or are otherwise unuseable. The range of these types of sources vary across the sites from certified sealed sources to sources manufactured onsite. For this reason, it is necessary for generators to categorize unwanted sources into one of the following groups:

1. Sealed Sources: Sources where the radioactive material is contained in a sealed capsule, sealed between layers of non radioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to the use of the source. (Implementing Guide for Occupational Radiation Exposure (G-N5400.9/M1 Sealed Radioactive Source Accountability and Control)).
 - a. Documented Sources: Sources meeting the above definition with appropriate documentation that objectively demonstrates the characteristics of the source. The minimum documentation for this category will be at least one of the following: certificate of traceability, manufacturer documentation, permanent markings on source, or non-destructive assay data. Inventory tracking documentation can also be used as long as there is traceability between the documentation and the associated sources and the activities have been verified;
 - b. Undocumented Sources: Sources meeting the above definition but lack appropriate documentation necessary to objectively demonstrate the characteristics of the source. This category of sources will require additional efforts in identifying isotopes and determining associated activities;
 - c. Leaking sources: Sources meeting the above definition for sealed source, except the confining barrier no longer prevents dispersion of the radioactive material. This category of sealed sources may include leaking sources that have appropriate documentation (documented) and those that lack appropriate documentation (undocumented). Leaking sources are categorized separately because they may require stabilization and/or other additional handling and packaging approaches.
2. Solid Radioactive Sources: This category will include those sources not meeting the definition for a sealed source as mentioned above, such as infinite plane sources and other miscellaneous radioactive sources. This type of source may require extensive

characterization and is not specifically addressed by this position paper.

Section 3: Physical Characteristics/General Information

Each source offered for disposal shall be identified as to its physical characteristics. At a minimum, these shall include the following. When the information is unavailable, it shall be so stated.

- ! General description of source
- ! Date of manufacture
- ! Name of manufacturer
- ! Method of sealing the radioactive material; i.e., is the radioactive material electro-deposited onto a backing material, or is it encapsulated in Lucite?
- ! Approximate dimensions of the source
- ! Type of shielding (if any)
- ! Composition of source, including backing material
- ! Weight of the source: Only the mass of the source itself should be provided, including any materials that are integral to the sealed source. Shielding that is constructed of an integral manufactured component of the sealed source may be included in the calculation.
- ! Other Information (any information that may aid in the characterization of the source)

The characterization documentation should also state what the basis was for deriving the above information. For example, was the source visually inspected, or was the information obtained from manufacturer specifications?

Section 4: Radioactive Constituent Identification

Each sealed source identified for disposal shall have a thorough characterization of the reportable radionuclides as specified in the NTSWAC, Section 3.3, "Radionuclide Reporting." It is recommended that this information be presented in tabular form listing the reportable radionuclides with their associated activities and the total activity of the source. On the Waste Profile, the activity concentration is calculated as follows:

- ! For non-transuranic sealed sources (those less than 100 nCi/g) that have an activity less than 3.7 MBq (100 uCi), the activity can be averaged over the waste volume.
- ! For sealed sources that have an activity of 3.7 MBq (100 uCi) or greater, the activity shall be divided over the mass or volume of the sealed source.

Also, it is required that each sealed source having an activity of 3.7 MBq (100 uCi) or greater have its mass or volume determined. Only the mass or the volume of the sealed source itself should be provided, including any materials integral to the sealed source. Shielding which is

constructed as an integral, manufactured component of the sealed source may be included in the mass calculation.

The technical basis for the activity, volume, and mass determinations are required. Methods that are considered appropriate for activity determination include the manufacturer data provided with the source and/or non-destructive assay of the source. All supporting documentation shall be provided for the radioactive constituent identification information. When other methods of constituent identification are utilized, supporting documentation of the adequacy of the characterization is required.

Section 5: Radioactive Material Classification

Each source shall be identified as to its radiological classification for disposal at NTS. The three classifications that are to be considered are as follows:

- ! Low-Level Radioactive Waste (LLW)
- ! Greater than Class C LLW
- ! Transuranic Waste

Supporting documentation for the radioactive material classification shall be provided by the generator. Calculations used to arrive at the waste classification of the source shall be provided and shall be based on the information provided in the Radioactive Constituent Identification section.

Section 6: Packaging of Sealed Radioactive Sources for Disposal

Proposed methods for packaging of sealed radioactive sources for disposal are required. A brief explanation on the method of preparing the individual sources and how they are packaged for final disposal should be provided.

When the requirements of the disposal site or the characteristics of the source deem it necessary, stabilization may be required. When sources require stabilization, the following information shall be provided:

- ! Stabilization Materials: A description of the material used for the stabilization.
- ! Mass of Stabilization Materials: The approximate mass of the stabilization material and the mass of the final stabilized source.
- ! Size of the Stabilized Source: Identify the size and dimensions of the stabilized source; e.g., stabilized in 10 gallon bucket - 10 inches in diameter by 12 inches in height.

Section 7: Review and Approval

Each radioactive source characterization package shall be reviewed for the technical adequacy of characterization and completeness of information by technically qualified personnel. The review

shall be documented and included or referenced within the characterization package.

Signature approval shall be provided by the author(s), the technical reviewer(s), and the appropriate level of management.

Signature Page

This revised information is presented to DOE/NV for the use in maintaining a uniform policy on the disposal of radioactive sealed sources. The following RWAP and NTSWAC Working Group signatures represent participation and concurrence in the revision.

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