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CHALLENGES IN CLASSIFYING LOW SPECIFIC ACTIVITY MATERIAL AND SURFACE CONTAMINATED OBJECTS

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ABSTRACT

Commercial low level radioactive waste (LLW) destined for near surface disposal in the United States (US) must be properly characterized using the given facility's waste acceptance criteria (WAC) which, at a minimum, for NRC licensed disposal facilities, must incorporate the US Nuclear Regulatory Commission (NRC) waste classification criteria [1], or Department of Energy (DOE) Order 435.1 when destined to a DOE LLW disposal facility [2].

The packaging and transportation of the LLW offsite is subject to the regulations of the US Department of Transportation (DOT) Hazardous Materials Regulations [3]. Challenges are faced by those responsible to characterize LLW for disposal and classify it again for transport – differing scopes in establishing the requirements; differences in terminology; similar terms with different meanings; different nuclide distribution allowances; differing activity limits, and others. The information necessary for LLW characterization may not be sufficient to properly determine DOT classifications. The complexities of the DOT Hazardous Materials Regulations are further increased by the challenges in categorizing LLW for packaging and transport as Low Specific Activity (LSA) material and Surface Contaminated Objects (SCO). A single system to characterize LLW for proper facility acceptance and disposal, and packaging and transport may be impractical – the criteria applied by each differ such that independent assessments must be completed against each specified requirement. Furthermore, LLW generation activities must be assessed separately and LLW characterization and classification methodologies prepared that adequately address chemical, radiological, and physical parameters of what may be expected.

The two areas of concern addressed in this paper are: (1) the necessity of classifying SCO; and (2) the differences between NRC waste characterization and DOT radioactive material classification criteria for LSA material and SCO.

Three assumptions have been incorporated into the preparation of this paper:

1. Commercial and some DOE-generated LLW will be transported offsite to a NRC licensed disposal facility.
2. Some DOE-generated LLW will be transported offsite to a DOE LLW disposal facility.
3. The methodologies applied for LLW characterization are shared regardless of its final destination (i.e., NRC or DOE disposal facility).

INTRODUCTION

The NRC requires that LLW destined for near surface disposal is classified to ensure it is suitable for such disposal. As such, criteria are established for both the disposal facility and LLW entering such facility. The NRC regulations, 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste" [4] establish the LLW classification system, a system based on the volume of the waste (Ci/m^3) or weight of the waste (nCi/g), as applicable. 10 CFR 61 presents three LLW Classes: Class A, Class B and Class C. Low level wastes deemed to exceed Class C (termed "greater than Class C" or GTCC) are not acceptable for near surface land disposal.

The NRC LLW Classes and their associated activity limits, and other facility controls, are established to limit potential exposure at 500 mrem/year whole body to an inadvertent intruder who takes up residence on a closed disposal site (closed for 100 or more years) where the waste which is assumed to be indistinguishable from soil, and as a result, is unaware of his/her interaction with previously disposed radioactive waste. NOTE: Activity limits for Class C wastes and primary gamma-emitting nuclides (Co-60, Nb-94 and Cs-137/Ba-137m) assume an undisturbed disposal period (i.e., before intrusion) of 500 years. This is achieved through the waste configuration, burial container requirements and other controls.

Unlike the NRC LLW disposal regulations which are based on known, generic waste types destined for disposal facilities in various locations, the DOE LLW program, excepted from 10 CFR 61, took a different approach to facility requirements and waste classification. For many years, the DOE has disposed of its LLW onsite, where available, in lands with past, present and future access restrictions. The DOE generated-LLW does not share the 'generic' nature of LLW generated in commercial facilities. The specialty of the DOE LLW coupled with onsite disposal affords DOE a more site-specific classification system taking into account both known environmental and waste characteristics. Like the NRC intruder-based scenario, the DOE LLW disposal requirements share similar criteria albeit more dose restrictive (DOE requirements in DOE Manual 435.1-1 [5] establish a 100 mrem/year limit for chronic exposures and 500 mrem limit for acute exposures).

In May 1983, not long after the regulations governing NRC licensing of near surface disposal facilities were amended [6], the NRC developed a Branch Technical Position (BTP) on LLW classification [7]. This BTP was expanded further in the 1995 BTP on Concentration Averaging and Encapsulation [8]. The BTP describes overall practices acceptable to the NRC which may be used to determine the appropriate LLW Class. Of particular importance are the procedures employed to determine the volumetric and mass concentrations of radioactivity in the LWW. Naturally, the BTP cannot provide guidance on all conceivable waste concentration averaging methods. Guidance is provided specifically for: (1) homogeneous wastes; (2) mixing of homogeneous wastes; (3) solidified and absorbed liquids; (4) mixing of activated materials or metals, or components incorporating radioactivity in their design; (5) contaminated materials; (6) mixing of cartridge filters; (7) waste in high-integrity containers (HIC); (8) encapsulation of solid material; (9) mixing of dissimilar waste streams (different waste types); and (10) alternative provisions.

Packaging and transportation of the LLW is another regulated area. Except for some DOE sites, LLW are seldom generated at the same location where they are disposed. Hence, packaging and transportation becomes a necessary activity. The regulations for the packaging and transportation of hazardous materials in commerce, including radioactive material, are the responsibility of the DOT [3]. Regarding radioactive materials, the DOT has historically adopted, with some amendments and domestic exceptions, the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material [9] (see Table 1).

Table 1. Docket History of US Adoption of IAEA Transport Regulations

IAEA Regulation	DOT Adoption[1]	Docket Information
1967 Safety Series 6	04 October 1968	33 FR 14918 (HM-2)
1973 Safety Series 6	10 March 1983	48 FR 10218 (HM-169)
1985 Revised Safety Series 6	28 September 1995	60 FR 50291 (HM-169A)
1996 TS-R-1 (ST-1 Revised)	26 January 2004	69 FR 3632 (HM-230)

[1] Historically, the US DOT adopts the IAEA transport regulations with consideration of domestic amendments.

Low-level waste that meets the Class 7 (radioactive) material defining criteria is regulated by DOT in transportation. Separate criteria are applied to two materials types: (1) uniform distribution throughout of the radionuclides; and (2) non-radioactive materials that are radioactively contaminated. Both material types must exceed specified limits and must also exceed a total consignment value to be regulated as radioactive material in transport (see Table 2).

Table 2 Application of the Definition of Class 7 (radioactive) Material for Transport

<table>
<tr><th>Material Type</th><th colspan="3">Must exceed both columns to be regulated in transport as Class 7 (radioactive) material</th></tr>
<tr><td>Activity Concentration (Homogeneous Matrix)</td><td>Nuclide Specific Values (Bq/g)</td><td rowspan="3">&</td><td rowspan="3">Nuclide Specific Consignment Values (Bq total)</td></tr>
<tr><td colspan="2">or</td></tr>
<tr><td>Contamination Level (Non-radioactive material)</td><td>Activity Limits specified in Definition of Contamination (Bq/cm2)</td></tr>
</table>

The Class 7 (radioactive) material transport regulations are derived from a very different model than that used by the NRC for a near surface disposal facility since transportation is a short-term event. In establishing the activity limits for Class 7 (radioactive) material, the IAEA modeled a credible transport accident scenario in which a person is exposed to a radioactive material that has been released from the package (i.e., a Type A package[1]). The person is deemed to be at a distance of 1 meter from the radioactive content for a 30 minute period. The activity of the radioactive material is limited so that the total dose to the nearest person does not exceed 5 Rem whole body. Exposure pathways include external photon and beta emission dose, internal dose via inhalation, skin contamination and ingestion doses, and submersion dose due to gaseous isotopes[2]. This dosimetric model is called the "Q System." [10]

CLASSIFICATION CRITERIA

The person who offers Class 7 (radioactive) material for transportation is responsible to ensure the material is properly classified, described, packaged, communicated, and in proper condition for transport as required in the Hazardous Materials Regulations (HMR). Five main categories are available for classification of LLW to meet the DOT HMR transport requirements: Excepted material, Type A, Type B, LSA material, and SCO. Of these, LSA material and SCO are most often associated with LLW from D&D operations because of the attractiveness granted through the use of less restrictive packagings.

Candidate SCO wastes consist of non-radioactive material that are radioactively contaminated (i.e., radioactivity distributed on the surfaces the object; however, not distributed throughout the material). Examples of candidate SCO include process equipment, tools, furnishings, cabinets, laboratory equipment, sheet metal, piping and plumbing, plastics (i.e., sheeting, tubing), light fixtures, gloveboxes and hoods, and building rubble. Unlike most other DOT classifications for Class 7 radioactive materials, calculating the contribution of each radionuclide to the overall activity does not apply to SCO determinations. Rather, each individual type of emitter is compared to its contamination limit. For example, if both beta/gamma emitters and high toxicity alpha emitters[3] are present, the SCO limits for both apply independently. Knowing what radionuclides are contaminating the item is important so that the appropriate limit can be applied. After identifying the radionuclides and verifying the applicable limits are individually met, the low-level waste may be identified as SCO.

Candidate LSA wastes consist of radioactive materials that are incorporated throughout a matrix. Examples of candidate LSA wastes include solutions, sludges, radionuclides chemically bound

[1] A Type A package is required to withstand, without loss or dispersal of content or significant increase in dose rate, normal conditions of transport. In a transportation accident, the Type A package may be damaged to the degree the radioactive content escapes the containment system. Loss of containment and shielding is accounted for in the IAEA TS-R-1 dosimetric model used to establish Type A activity limits.

[2] Other assumptions and special considerations were applied for alpha emitting special form, neutron emitters, Bremsstrahlung radiation, tritium and its compounds, radon and its progeny, and low specific activity material having unlimited Type A values.

[3] A high toxicity alpha emitter is an alpha emitter that is not specifically included in the definition of "low toxicity alpha emitter" (49 CFR 173.403; 10 CFR 71.4)

or absorbed into materials (i.e., swipe or rag, biological wastes), activated metals and materials, soil, and material specifically defined as LSA material (e.g., depleted uranium, nuclides with unlimited A_2 values). Most options for categorizing as LSA material is based on an allowed activity per gram derived from the A_2 value of the waste and demand some qualitative distribution of the radionuclides throughout the material (e.g., distributed throughout or essentially uniformly distributed).

In July 1998, the NRC Spent Fuel Project Office, in conjunction with the DOT Research and Special Programs Administration, published NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects" [11]. The primary purpose of this document is to assist shippers in classifying and preparing LSA material and SCO for transport. The document, beyond providing guidance in classification, also provides an acceptable means to allow the commingling of LSA material and SCO into a single package for transport.

In NUREG-1608, section 4.2.4, the NRC and DOT answers if compliance with the NRC 1995 BTP on Concentration Averaging and Encapsulation demonstrate that a mixture of candidate LSA material are distributed throughout or essentially uniformly distributed, as applicable.

> "Mixtures of LLW types or streams which meet the January 17, 1995, "Branch Technical Position of Concentration Averaging and Encapsulation," (NRC, 1995a) can be assumed to be either *distributed throughout* or *essentially uniformly distributed*, as applicable. This determination can be used in place of the determination described in Section 4.2.3 [IAEA's method], irrespective of the size of the container in which it is packaged for transport. Further, if averaging over the volume or mass of the waste is permitted by the concentration averaging Technical Position (TP) of disposal classification purposes, similar averaging over the mass of the waste is generally acceptable for LSA specific activity determination."

It would appear by reading the first few sentences of this section that any waste that has been characterized in accordance with the 10 CFR 61.55[4] and the BTP on Concentration Averaging and Encapsulation should be acceptable for LSA material specific activity determinations as well. This, however, is not the case. The remainder of NUREG-1604, 4.2.4 qualifies the initial statement.

> "However, materials which the TP recommends should be considered as discrete items for LLW classification should also be considered discrete items and be evaluated individually against the LSA definitions, as appropriate. Further it is assumed that nuclides important to transportation are distributed in the waste to the same degree as those important to waste classification. If it believed that this assumption does not hold, a more detailed analysis would be expected by the DOT and NRC.

[4] Waste Classification (NRC classification of LLW for near surface disposal)

> Note that the TP contains guidance for classification and averaging of some materials (i.e., contaminated materials, encapsulated materials, and sealed sources), that should not be applied for LSA material determinations.
>
> Specifically:
>
> - Nonradioactive, contaminated objects must be classed as SCO (see section 3).
> - Encapsulated wastes should not be averaged over the weight of the solidified mass for determination of the material's weighted specific activity (as is allowed for LLW classification).
> - Sealed sources cannot be considered LSA material unless the source itself meets the LSA definition (specific activity limit and distribution); although the TP allows averaging the sealed source activity over the entire waste form for LLW classification, this practice is not acceptable for LSA material determinations for transport."

In reality, many of the LLW types allowed by the NRC for volumetric- or weighted- averaging are not acceptable as LSA material. Wastes that contain candidate SCO must be assessed against the SCO criteria or be classified as Type A or >Type A for packaging and transport. The following discusses some of the differences between NRC waste characterization and DOT classification of LSA material and SCO.

Homogeneous. The IAEA and DOT recognize that most LSA materials will not be homogeneous[5]. However, some degree of homogeneity is an important factor in considering the probability of release and the consequences of potential dispersion in a transportation accident. Therefore, the IAEA and DOT have provided guidance that can be used to determine if a given material is homogeneous enough to be considered "distributed throughout" and available for LSA material determination[6].

The NRC's application of homogeneous as applied to waste is considerably different.

> "A homogenous waste type is one in which the radionuclide concentrations are likely to approach uniformity in the context of the intruder scenario used to establish the values included in Tables 1 and 2 of 10 CFR 61.55 (i.e., intruder interactions with the waste are assume to take place 100 years or more after disposal site closure)."

The NRC views homogeneous to be a condition that will be "arrived at" over a 100 year burial period. The IAEA and DOT view homogeneous as "real time" distribution reflected by the content of the package that is to be transported.

Volumetric Averaging. Most nuclides under 10 CFR 61.55 are limited based on an activity allowed in a given volume of waste (i.e., Ci/m^3). This information may be used for DOT classification to support a "distributed throughout" determination, and if enough information

[5] IAEA TS-G-1.1. Section 226.4; NUREG-1608, 4.2.2
[6] IAEA TS-G-1.1, Sections 226.14 – 226.17; NUREG-1608, Section 4.2.3

available given a specific matrix, provide an activity/mass determination. In general, however, volumetric averaging does not correspond to activity limits placed on materials under the DOT HMR.

Weighted-Averaging. Weighted-averaging is acceptable by the NRC for those waste where the activity is weight limited based on the weight of the matrix (i.e., nCi/g). As often allowed, given nuclide specific constraints, the entire weight of the matrix is considered in the NRC weighted-average nuclide concentration determination. For example, a component that has radioactive material incorporated into its design can take advantage of the entire weight of the "component" when determining activity/gram. The determination for LSA material (and likewise, the Class 7 defining criteria activity concentration for exempt material) is not allowed to take advantage of any non-radioactive portion of the matrix. Only the weight of those materials that are activated or that incorporate the radioactive material can be used to determine the activity per unit mass. The IAEA clarifies that this determination is even applied to compacted material.

> "Compaction of material should not change the classification of the material. To ensure this, the mass of any container compacted with the material should not be taken into account in determining the average specific activity of the compacted material."[7]

Solidified and Absorbed Liquids. The NRC limits volumetric- or weighted-average nuclide concentrations of absorbed liquids to the absorbed nuclide activity divided by the volume or mass of the liquid before absorption because absorption does not appreciably bind nuclides. DOT, however, does not consider long term disposal in their activity limits and classification structure. As long as the liquid is complete absorbed (i.e., no free liquid ever present in the packaging) and will remain so the entire time from initial packaging to its final consigned destination, the LSA material activity/gram can be based from the nuclide activity divided by the total absorbed mass.

Activated Materials or Metals. The NRC allows volumetric- or weighted-average nuclide concentrations for these wastes. The displaced volume or total weight of the activated material or metal is used in averaging. LSA material classification of activated materials or metals is based on the weighed-average nuclide concentration. For mixtures of activated materials or metals, it is acceptable to classify each piece, or classify the group based on the highest concentration of any one piece within the group. The NRC allows, with constraints, the averaging of the concentration of nuclides over the contents of the disposal container. This method is not acceptable for LSA material determination as it may allow one activated piece that exceeds LSA material activity limits to be "averaged" with pieces of very low activity.

Components Incorporating Radioactivity in Their Design. The NRC activity concentration averaging for these items is relatively the same as that for activated materials or metals. Volumetric averaging cannot include void space other than those within the envelope of the component itself. The NRC, however, will allow (with constraints) the entire content of the packaging to be used to determine the nuclide weighted-average. These averaging applications

[7] IAEA TS-G-1.1, Section 226.20

are completely foreign to LSA material classification, and as such, are not permitted. For classification as LSA material, the radioactive part of the component must: (1) be an activated material or metal, and (2) be a material that itself meets the definition of LSA-I, or meets the weighted concentration authorized for the specific LSA material group.

Contaminated Materials. The NRC allows either displaced volumetric- or weighted-averaging to be used to determine the class of waste for contaminated materials. Furthermore, the NRC permits (with constraints) averaging the concentration of the radionuclides over the contents in the disposal container, either volume or weight. This includes those items that may not even be radioactively contaminated as long as they are considered part of the "component". These methods to determine LLW activity concentrations are not appropriate for LSA material or SCO classifications under the HMR. To begin, contaminated materials are not candidate LSA material and must be considered for classification as SCO. Secondly, nuclide averaging over the entire surface area of the object(s) is not within the 300 cm^2 surface area averaging permitted by the DOT (unless the surface area of the object is <300 cm^2). Lastly, weighted-averaging for a contaminated item is only allowed by the DOT when: (1) the contaminated item itself is an activated material or metal; or (2) employing the alternate SCO-II determination method, Condition (3), as allowed in NUREG-1608, Section 3.3.1.

Cartridge Filters. The NRC allows volumetric- or weighted-average nuclide concentrations for cartridge filters and mixes of cartridge filters. The volume to use is the displaced volume of the filter (interstitial space within the filter may be included). For DOT classification purposes, most cartridge filters will have incorporated the radioactive material into or on the filter media (design dependent). Small cartridge filters (e.g., <280 cm^3) collected in waste drums may be considered dry active wastes and are LSA material like for classification purposes[8]. Larger filters are considered 'discrete items' by DOT, and as such, require independent classification[9]; averaging a group of filters is not acceptable unless the nuclide concentration is relatively uniform throughout the filter media. The classification of cartridge filters must be looked at case-by-case taking into account the type of filter, its design and material of construction, the process that generated the filter, and its size/volume.

Encapsulated Material. The NRC allows nuclide concentrations to be based on the overall volume (with constraints) of the solidified mass for encapsulated routine wastes such as filters, filter cartridges, and sealed sources. This is not authorized under the DOT classification of LSA material or SCO[10]. As stated in the IAEA TS-G-1.1, section 226.11:

> "A solid compact binding agent, such as concrete, bitumen, etc., which is mixed with the LSA material, is not considered to be an external shielding material. In this case, the binding agent may decrease the surface radiation level and may be taken into account in determining the average specific activity. However, if radioactive material is surrounded by external shielding material, which itself is

[8] NUREG-1608, Section 4.1.1
[9] NUREG-1608, Section 4.1.4
[10] NUREG-1608, Sections 5.1.3 and 6.2.3

> not radioactive … this external shielding material is not to be taken into account in determining the specific activity of the LSA material."

Discrete Items. In the first paragraph of 4.2.4, NUREG-1608 states:

> "…materials which the [NRC Branch Technical Position] recommends should be considered discrete items for LLW classification should also be considered discrete items and be evaluated individually against the LSA definitions, as appropriate."

This statement appears to conflict with what is stated in NUREG-1608, Section 4.1.4. To clarify, for the purposes of LSA material and SCO classification, a discrete item is:

- as presented in the BTP, an activated material or metal, a component incorporating radioactivity in its design, or a contaminated material, if: (1) the volume of the item is <280 cm^3 (0.00028 m^3); and (2) for primary gamma emitting nuclides (Co-60, Nb-94, Cs-137/Ba-137m) exceed the limits expressed in Table A of the BTP, or for other nuclides, exceed the limits expressed in Table B of the BTP.
- as presented in NUREG-1608, an object that exceeds 280 cm^3 (0.00028 m^3); any item smaller than this is considered a "small object".

In other words, for LSA material and SCO classification, any object that exceeds 280 cm^3 is considered 'discrete' and must be evaluated independently. Items that do not exceed 280 cm^3 are considered 'small objects'. However, if the 'small object' is considered to be a 'discrete' item by the NRC waste classification BTP, the item must be evaluated independently against the LSA/SCO criteria.

The DOT states in plain language that averaging of some materials for and LSA material determination is not acceptable:

> "Note that the [BTP] contains guidance for classification and averaging of some materials (i.e., contaminated materials, encapsulated materials, and sealed sources), that should not be applied for LSA material determinations."[11]

Mixing of Different Waste Types (Commingling). This matrix consists of two or more of the already discussed material/waste types, e.g., SCO (contaminated non-radioactive object) placed in a package or container commingled with LSA material (radioactivity incorporated in or throughout the material). In these cases, the NRC waste classification involving averaging the total activity over the total volume or weight of the waste in the packaging is allowed (with constraints such as only allowing volume averaging if the waste contains small concentrated sources (<3.7 MBq or 0.1 mCi)).

The DOT does not allow such classification. The consolidating of LSA material and SCO into a single packaging/container for shipment under the DOT HMR is allowed domestically only if classification of both the LSA material and SCO are performed independent of each other and prior to consolidation. The consolidation of these two waste type, each identified by their own proper shipping name (PSN) and United Nations Identification Number (UN Number), is

[11] NUREG-1608, Section 4.2.4

allowed in the HMR only as a "mixed content" package subject to 49 CFR 173.24a(c). Section 6.1.1 of NUREG-1608 provides for the consolidation of these two material types into one package without the need to meet the requirements of 49 CFR 173.24a(c) – this allowance, in essence, "acts like" a DOT Special Permit[12]. If each material type meets its respective classification criteria, the entire mix is allowed to be described using the PSN based on the LSA material group provided the total package activity does not exceed $1A_2$.

Any LSA/SCO consolidated package with a total package activity that exceeds $1A_2$ must be described using the PSN and UN Number of the material type (SCO or LSA material) contributing greatest to the A_2 fraction. It must be emphasized that a more rigorous classification requirement (e.g., quantitative and qualitative) is necessary when the total activity of the package exceeds $1A_2$. It is also important to recognize that the $1A_2$ activity level is applied to the package content and not individually to the LSA material or SCO. Therefore, as a condition of consolidating LSA material and SCO into a single package, if the total activity exceeds $1A_2$, a more rigorous characterization approach must be applied to both the LSA material and SCO.

CONCLUSION

Low-level waste destined for near-surface disposal must be classified and characterized as required by the NRC in 10 CFR 61. In 1983 and 1995, the NRC issued Branch Technical Positions that provided clarification and guidance for those responsible for such characterization. Some current management structures separate responsibilities for NRC LLW characterization and DOT radioactive materials classification, usually with DOT being at the latter end of the process. This separation provides an avenue for data that is acceptable for NRC LLW characterization to be used as the basis for the LSA material and SCO determinations, without consideration of the limiting parameters the DOT has placed on the use of such data. This is not to say that consideration of both requirements is unachievable. It does say, however, that a separate DOT classification must occur before or in conjunction with the NRC LLW characterization so wastes that required greater classification scrutiny are identified before they are containerized.

The effective date separating SCO classification from the definition of LSA material occurred in the U.S. over 14 years ago. LLW classification poses many challenges, especially when confronting large scale D&D projects. The technical challenges cannot, however, be allowed to excuse proper waste classification. It is inconsistent with the regulations and guidance provided from the NRC and DOT to ship, as LSA material, a mix of LSA-like waste in the same container as candidate SCO if independent classification of the candidate SCO has not occurred. Implementation of an SCO waste classification process is a significant and essential step if a shipper wants to successfully utilize both SCO and LSA material classifications.

The following is taken out of an abstract from "SCO Shipments from Rocky Flats-Experience and Current Practices" [12], a former 2001 Waste Management Conference paper.

[12] A Special Permit (49 CFR 107 Supbart B) is a document which authorizes a person to perform a function that is not currently authorized under the authority of the DOT hazardous materials regulations (49 CFR 100-185).

> "[Rocky Flats Environmental Technology Site] experience to-date using an SCO waste characterization method has shown significant time and cost savings, reduced errors, and enhanced employee safety. SCO waste is characterized prior to packaging, near the point of generation, by any of the site's 300 Radiological Control Technicians using inexpensive radiological control survey instruments… Further improvements in the SCO characterization and shipping process are focused on…additional statistical methods, so that the full extent of the SCO regulations can be used."

Each organization responsible for DOT classification must develop a technical basis for quantitative characterization of SCO and LSA material, and implement procedures and training. Candidate SCO should be identified apart from LSA-like waste before D&D activities commence. Statistical surveying and sampling of the projected wastes provide a means to calculate total activities of varying items destined for packaging. SCO determinations can then be made with confidence so that the eventual commingling of SCO and LSA materials will be in conformance with the regulations and guidance provided by the NRC and DOT.

REFERENCES

1. United States Code of Federal Regulations, Title 10, Part 61, Sections 55 and 56 (10 CFR 61.55 and 61.56).
2. Radioactive Waste Management, DOE Order 435.1, United Stated Department of Energy, Office of Environmental Management, July 9, 2001
3. Unites States Code of Federal Regulations, Title 49, Parts 100-180.
4. United States Code of Federal Regulations, Title 10, Part 61.
5. United States Federal Register, December 27, 1982, page 57446 (47 FR 57446)
6. Radioactive Waste Management Manual, Change 1, DOE M 435.1-1, United Stated Department of Energy, Office of Environmental Management, July 9, 1999, (Change 1 June 19, 2001)
7. Low-Level Waste Licensing Branch Technical Position on Radioactive Waste Classification, 1983a, U.S. Nuclear Regulatory Commission, May 11, 1983.
8. Branch Technical Position on Concentration Averaging and Encapsulation, NRC, 1995b, Nuclear Regulatory Commission, January 17, 1995.
9. Regulations for the Safe Transport of Radioactive Material, Safety Requirements No. TS-R-1, Vienna, Austria, May 2009, STI/PUB/1384, International Atomic Energy Agency (2009)
10. Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, Safety Guide No. TS-G-1.1 (Rev. 1), Vienna, Austria, August 2008, STI/PUB/1325, International Atomic Energy Agency (2008)
11. Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects, NUREG-1608 (NRC) and RAMREG-003 (DOT), July 1998

12. GARY BRACKEN and ROBERT L. MORRIS, “SCO Shipment from Rocky Flats-Experience and Current Practice”, WM’01 Conference, February 25-March 1, 2001, Tucson, AZ,