Public & Regulatory Acceptance of Blending of Radioactive Waste vs Dilution - 11018

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ABSTRACT

On April 21, 2009, the Energy Facilities Contractors Group (EFCOG) Waste Management Working Group (WMWG) provided a recommendation to the Department of Energy's Environmental Management program (DOE-EM) concerning supplemental guidance on blending methodologies to use to classify waste forms to determine if the waste form meets the definition of Transuranic (TRU) Waste or can be classified as Low-Level Waste (LLW). The guidance provides specific examples and methods to allow DOE and its Contractors to properly classify waste forms while reducing the generation of TRU wastes. TRU wastes are much more expensive to characterize at the generator's facilities, ship, and then dispose at the Waste Isolation Pilot Plant (WIPP) than Low-Level Radioactive Waste's disposal. Also the reduction of handling and packaging of LLW is inherently less hazardous to the nuclear workforce. Therefore, it is important to perform the characterization properly, but in a manner that minimizes the generation of TRU wastes if at all possible. In fact, with the generation of additional volumes of radioactive wastes under the ARRA programs, this recommendation should improve the cost effective implementation of DOE requirements while remaining protective of human health and the environment.

This paper will describe how the message of appropriate, less expensive, less hazardous blending of radioactive waste is the "right" thing to do in many cases, but can be confused with inappropriate "dilution" that is frowned upon by regulators and stakeholders in the public. A proposal will be made in this paper on how to communicate this very complex and often confusing technical issue to regulatory bodies and interested stakeholders to gain understanding and approval of the concept. The results of application of the proposed communication method and attempt to change the regulatory requirements in this area will be discussed including efforts by DOE and the NRC on this very complex subject. The purpose of this paper is to attempt to clarify the issue and provide illustrative guidance.

INTRODUCTION AND BACKGROUND

The U.S. Department of Energy (DOE) is responsible for managing DOE's radioactive waste and providing radiological protection from DOE operations pursuant to its *Atomic Energy Act* (AEA) authority. It is DOE's responsibility to ensure that radioactive waste management practices are continually assessed and modified to include new requirements, lessons learned, and best management practices such that they provide for the protection of the public, workers, and the environment. DOE Order 435.1 *Radioactive Waste Management* and the associated Manual and Implementation Guide originated in 1999 and is the document that provides the DOE requirements for the management of radioactive wastes in the DOE complex. Implementers of DOE Order 435.1 are in general agreement that the Order and its associated documents are functional and continue to be protective of human health and the environment; however, radioactive waste could undoubtedly be managed more efficiently and cost effectively.

Since DOE Order 435.1 became effective, implementers of the Order have gained significant experience and insight in radioactive waste management practices and improvements. Some improvements are captured in standalone draft guides that are used in the field, but have not been formally adopted into the directives system. Other improvements have not been captured in documents and, therefore, are not committed to institutional memory. Implementers also confront issues that are not addressed in DOE Order 435.1 and its associated documents, as currently written, because they have arisen following the previous revision process. These constitute some of the most important issues across the DOE complex. Field sites are challenged with resolving these issues on an ad hoc basis, without the benefit of shared knowledge and lessons learned from similar experiences at other sites.

The objectives of the Order update project are to:

- Institutionalize current requirements pertaining to radioactive waste management;
- Reduce programmatic uncertainty by ensuring consistency across the complex;
- Increase efficiency and lower operational costs;
- Reduce redundancy in operational requirements;

- Improve accessibility to information; and,
- Increase safety and accountability at the field level.

As a part of this effort, the Energy Facilities Contractors Group (EFCOG) Waste Management Working Group has provided assistance, expertise, and leadership to the DOE Order 435.1 Update effort. The Energy Facility Contractors Group (EFCOG) Waste Management (WM) Working Group is chartered to leverage the expertise and experience of contractors to the U.S. Department of Energy (DOE), including the National Nuclear Security Administration (NNSA). The purpose of the WM Working Group is to seek out and promote the best practical technologies and disposal options for all waste streams generated at DOE facilities or that are destined to be dispositioned by DOE facilities (some best practices and technologies would be applicable to wastes destined for commercial facilities). The WM Working Group is focused on complex wide integration and technology transfer while supporting cost effective and efficient waste options. This is achieved in a way that maintains a priority on safety, environmental stewardship and security.

One of the major efforts undertaken by the EFCOG WM Working Group is to provide DOE with recommendations and expert assistance in assessment and rewrite of all of the DOE Order 435.1 requirements. Blending of radioactive waste is one of those efforts. EFCOG WM Working Group provided specific draft recommendations to the DOE Order Update team and continues to assist DOE in formulating the proper policies and requirements in this important area. .

In addition, the U. S. Nuclear Regulatory Commission (NRC) is in the process of developing an official policy on blending. To quote from the NRC website (http://www.nrc.gov/waste/llw-disposal/llw-pa.html): *"The NRC staff has accepted intentional mixing of radionuclides, in past cases, where similar waste streams from different sources have been mixed to meet a disposal facility's waste acceptance criteria. Although the staff has made statements that recommend constraints on blending, the staff has also noted that blending is not prohibited by the regulations. Moreover, the NRC's guidance notes that blending to reduce waste classification (determined according to 10 CFR Part 61) is appropriate under some circumstances."*

NRC staff recommendation SECY-10-0043, ***"BLENDING OF LOW-LEVEL RADIOACTIVE WASTE",*** April 10, 2010, promotes revising the NRC blending position to be risk-informed and performance-based. The principal performance measure would be whether a final blended waste form could be safely disposed of.

THE ISSUE: Blending of radioactive wastes should not only be formally recognized as an acceptable practice, it should be encouraged as a legitimate and practical solution to promote efficient use of available disposal capacity and to reduce risks of handing the wastes by workers.

Blending is the mixing of higher and lower concentrations into a final waste form. It is *not* the mixing of clean or untainted material with contaminated material for the sole purpose of lowering the waste classification. The practice of intentional mixing of radioactive wastes from different sources prior to disposal has been discouraged and viewed as a taboo ever since RCRA prohibitions were put in place to prevent waste managers from evading treatment of hazardous wastes. Over-interpretation of the restriction on intentional dilution of TRU waste solely for the purpose of changing its classification to LLW contributes to the practice of segregating waste during generation, accumulation, and aggregation.

Confusion results from imprecise guidance on determining the TRU concentration for overpacked containers. The TRU Chapter in the Guide states, "Even if a waste container fails and has to be overpacked, the mass of the failed container *does not need to be* included in the transuranic waste determination." (emphasis added). This is in stark contrast to the definition which was contained in DOE Order 5820.2A (the predecessor of DOE Order 435.1) and was omitted from DOE Order 435.1 without explanation:

> *"Waste Package. The waste, waste container, and any absorbent that are intended for disposal as a unit. In the case of surface contaminated, damaged, leaking, or breached waste packages, any overpack shall be considered the waste container, and the original container shall be considered part of the waste."*

The TRU determination does not consider the waste container nor any rigid liners because these comprise the packaging required to contain the waste for transport. However, if a waste container is overpacked it is not prudent to separate the waste contents from the original container just because it no longer serves its intended purpose. Therefore, the overpacked container and any liner(s) become part of the waste matrix and must be reported as waste being disposed and its mass included in the new TRU determination. This will result in some wastes which are on the margin of TRU classification becoming LLW after overpacking.

The classification of a waste as TRU vs. LLW does not signify differences in physical treatment to reduce the greater hazards presented by TRU wastes, the distinction affects the degree of isolation required in the final disposal. It is not DOE's intent to segregate and manage all transuranic isotopes in separate disposal facilities so it is unnecessary to segregate them as early as possible. It is human nature to segregate and organize things by similar properties but this orderly habit can be counter-productive in radioactive waste management.

> *Example: A researcher needs to dispose of numerous archived samples that were accumulated over several years. The transuranic concentration in some of the samples is known to be above the 100 nCi/g threshold. The researcher determines that blending all the samples together will result in a low level waste which is suitable for onsite disposal.*

While a homogeneous mixture may be the ideal situation when performing waste treatment or stabilization, complete homogenization for disposal is often impractical and would result in unnecessary handling and exposure. Safety requirements, technological limits, ALARA considerations, economic factors, and process limitations present constraints that often make complete homogenization impractical when dealing with radiological waste. A graded approach should be used when determining the extent of mixing needed when waste is blended for disposal. When performing treatment it may necessary to ensure the treatment agent interacts with the waste to the extent that the hazard being treated is mitigated by the treatment process whereas blending wastes during the packaging, accumulation, and/or aggregation stages it is generally unnecessary to produce a truly homogenous final waste form. The degree of waste homogenization required should support the goals of the performance requirements of the disposal facility.

> *Example: The SRS needed to dispose of an excess shielded cask that was used to ship fuel elements. SRS also needed to dispose of remote-handled irradiated targets and were not considered spent nuclear fuel. If packaged separately, some of the items would have been classified as remote-handled transuranic waste. The performance requirements of the intended disposal facility required the transuranic content in the final waste form be less than100 nCi/g. Compliance with this requirement was documented in an engineering analysis which demonstrated the final waste form was classified as low level waste when the waste items were blended with the excess cask.*

BENEFITS OF THE PROPOSAL TO ALLOW WASTE BLENDING

Because disposal capacity for higher activity low-level wastes and transuranic wastes are very limited, it is important that generation of these types of wastes requiring this high degree of isolation be minimized to the extent possible and this can be accomplished through engineered waste blending.

If modeling assumes homogeneous distribution of non-radioactive as well as radioactive components then our practices should strive to achieve those conditions as close as practical. Additionally, blending of wastes from different sources could improve the performance of disposal facilities by reducing high concentrations that could result in point-source concerns.

A guiding principal that has been proposed is that waste management practices should always consider waste blending at all stages of waste management to reduce the hazards of handling the waste during treatment, storage, characterization or preparation for disposal, and to reduce the hazard of the final disposed waste form

The objective of this principal is to promote blending as a cost effective method for disposing higher activity wastes within available disposal facilities in a way that will reduce risks of handing the wastes. In addition, combining high-activity wastes with a large volume low activity wastes prior to disposal will reduce jackpot concentrations and result in a more uniform distribution within the disposal facility. It should also be pointed out that a contaminated waste container should and can be used to efficiently combine wastes together and the resulting waste forms entire weight including the contaminated container would be used to determine its classification as TRU or LLW.

Benefaction of waste can occur by combining wastes with different physical, chemical, or radiological characteristics. Waste blending produces benefits such as dispersing high-activity waste in a larger matrix reducing container dose rates, minimizing inert void filler required to mitigate subsidence concerns, reduces high concentration “hot spots” in disposal facilities, reducing the amount of disposed wastes that require unique engineering controls needed for stabilization or other forms of isolation.

Performance of the blended wastes in the disposal facility must be determined by performance assessment to meet the performance objectives and measures required by DOE Order 435.1. Blended wastes are not always homogeneous mixtures with indistinguishable components. The degree of waste homogenization achieved through waste blending must satisfy the performance assessment requirements of the final disposal facility. Methods used for demonstrating compliance with the homogenization requirements that are derived from the performance assessment for specific low level wastes can be documented in the generator’s waste certification program.

> *Example: A facility needs to dispose of a contaminated pump removed from a tank waste system. Packaged separately, the pump would require disposal in high-integrity containers to meet disposal facility performance requirements. The facility determines that combining the waste pump with low-activity demolition waste in large disposal containers will result in a final waste form that will not require stabilization. Compliance with this requirement is documented in an engineering analysis which demonstrated the*

final waste form is classified as low-activity waste when the wastes are combined in the final waste form.

An additional guiding principal is to ensure that waste that has been subject to treatment, blending, repackaging, or overpacking is characterized to reflect the state of the waste at that point of the process. The objective of this principal is to ensure that wastes are properly characterized after physical changes are made during the waste management process. Treatment, blending, and changes to the waste packaging can alter the radiological characteristics of a waste and these changes must be considered when a waste is presented for disposal. Additional handling of the waste adds additional risks to the workers involved and to the environment should spills or releases occur. As such any additional handing of the waste should be avoided if possible.

Because disposal requirements are determined by the properties of the waste form being disposed, any changes made to the waste during the waste management process must be taken into consideration to ensure accurate waste classification.

Example: In addition to altering the physical properties to make a waste more amenable to handling and/or disposal, the addition of stabilization agents increases the overall mass of waste requiring disposal and may alter the disposal requirements.

A container is usually overpacked because some defect prevents the container from serving its intended purpose. The unacceptable container cannot be emptied and reused, nor can it be recycled as scrap metal so it must be disposed as radioactive waste. The process of overpacking a failed container results in the added mass of the original container and this change needs to be reflected in the disposal paperwork. Separating the waste from the original container is discouraged because it does not reduce the volume of waste requiring disposal but it does introduce additional cost and risk of additional handling the radioactive contents.

If a waste container needs to be overpacked or re-packaged because it no longer functions as an acceptable container it will become a waste. It is not necessary to empty the old container and discard it as a separate waste stream. For safety, technological, process, and ALARA reasons it is usually preferable to overpack an unacceptable container. If overpacked, the unacceptable container will become part of the waste matrix that requires treatment and/or disposal and its mass should be included in the transuranic waste determination.

> *Example: A facility which processes waste packages for shipment to WIPP receives a drum that fails to meet WIPP criteria so it must be packaged into a compliant container. The old drum is radioactively contaminated and cannot be reused or recycled for its steel content so the facility overpacks the waste package into a new container. Since the unacceptable container is now radioactive waste and is part of the waste matrix, the facility does a new transuranic waste determination which includes the mass of the unacceptable drum*

Waste Blending Guidance Applicable to All Waste Types

Blending is a beneficial and necessary part of optimizing waste management processes. Combining waste forms for safety, technological, ALARA , or processing reasons is a long standing and acceptable practice. As opposed to dilution of a radioactive waste with uncontaminated material solely for the purpose of changing its classification, blending can performed for a variety of reasons and may *result* in a change in the waste reclassification. The entire mass of the waste matrix/form requiring treatment/disposal after blending shall be used to calculate the TRU isotopic concentration. In some cases this may include the mass of the waste container.

The benefits of blending include reducing the variability in process inputs, providing a more consistent and stable feed which gives the operator greater process control. The results of waste blending should be known in advance to avoid unintended consequences such as creating larger quantities of transuranic or mixed waste.

> *Example: A treatment facility uses a thin-film drier to remove dissolved solids from radioactive effluents. A new waste stream received by the facility contains sufficient transuranic material that could result in treatment residues exceeding the 100 nCi/g*

limit. To avoid generating a transuranic waste the facility blends this influent with other compatible feeds and the treatment residues are managed as low level waste.

In the examples above blending is an efficient means to reduce the different types of waste that need to be managed.

Creating a homogeneous mixture is often the ideal situation when performing waste treatment or stabilization. Safety requirements, technological limits, ALARA considerations, and process limitations present constraints that often make homogenization impractical when dealing with radiological waste. A graded approach should be used when determining the extent of mixing needed when waste is blended. When performing treatment it may necessary to ensure the treatment agent interacts with the waste to the extent that the hazard being treated is mitigated by the treatment process. When blending wastes during the packaging process it is generally unnecessary to produce a homogenous final waste form. The degree of waste homogenization required should be sufficient to satisfy the performance requirements of the disposal facility and should be determined by the performance assessment required by DOE Order 435.1 to authorize disposal of the waste.

Example: A facility needs to prepare of a high-activity waste for disposal. The facility determines the contact-handled dose limits of the disposal facility can be achieved if the waste is blended with low-dose waste in a large steel box. In this case the degree of waste homogeneity is unimportant to the disposal facility; the performance measure that needs to be achieved by blending is the dose rate of the waste package. Compliance with the requirement is verified by measuring the external dose rate of the final waste form to be shipped.

WITHOUT PUBLIC PARTICIPATION A SOUND POLICY DEVELOPMENT FOR THE BLENDING WOULD NOT BE POSSIBLE

Community involvement in consideration of all of the DOE Order 435.1 requirements is planned and is strongly encouraged. The project plan for the Order Update requires public involvement and it is expected that all submitted comments will be reviewed and considered. Blending requirements and principals are expected to be one of several issues that will need well-considered public participation and education.

However, in order to come together with a sound policy on blending that DOE and NRC could agree, a vigorous Public Involvement program is needed to involve and educate the public, and to receive input from the public for all government agencies to consider. It is expected that the State Regulatory agencies and the U. S. Environmental Protection Agency (EPA) will also take an interest and be very active in this blending policy and regulation development process. It was clear through the involvement with the SRS Citizens Advisory Board (CAB), that the public will want to understand whether or not additional risk to workers of handling radioactive materials will occur if segregation (vs blending) was required that resulted in unnecessary handing of radioactive wastes. The CAB has also consistently expressed concern if negative environmental impact may result from blending as well. Therefore, the planning and execution of the public involvement is critical to success.

It is recommended that a series of public meetings began with the general public and the CAB to begin to educate them on the issues involved. These meetings may last several hours each and should include many visual aids in addition to descriptions of the fairly complex discussions of regulations, costs of operations, and technical concepts.

To begin discussions a grounding of the definitions and the problem was needed. The starting place for this type of understanding is as simple as, “What is blending and how is it applied at DOE waste management facilities?” The answer lies in a simple definition along with specific examples of how it works.

The public involvement program should also allow NRC, EPA, States, and DOE to give separate presentations that aired the differences of opinion and allowed the public participation during the resolution of the issues. This will become “real” public input when the CAB and other public provide formal Recommendations to the all parties based on a very good understanding of the regulatory, cost, and technical issues.

RESULTS AND CONCLUSIONS

Blending is a beneficial and necessary part of optimizing waste management processes. Combining waste forms for safety, technological, ALARA, or processing reasons is a long standing and acceptable practice. As opposed to dilution of a radioactive waste with uncontaminated material solely for the purpose of changing its classification, blending can performed for a variety of reasons and may *result* in a change in the waste reclassification. The entire mass of the waste matrix/form requiring treatment/disposal after blending shall be used to calculate the TRU isotopic concentration. In some cases this may include the mass of the waste container.

The benefits of blending include reducing the variability in process inputs, providing a more consistent and stable feed which gives the operator greater process control. The results of waste blending should be known in advance to avoid unintended consequences such as creating larger quantities of transuranic, higher activity low-level waste, or mixed waste. Additional handling of wastes by operators to segregate waste increases risks and should be avoided through blending.

A guiding principal that has been proposed is that waste management practices should always consider waste blending at all stages of waste management to reduce the hazards of handling the waste during treatment, storage, characterization or preparation for disposal, and to reduce the hazard of the final disposed waste form

A possible definition for dilution and for blending is proposed below. The intent of such a definition is to ensure that it is clear to the professional waste management community and to the public that dilution is not acceptable, but blending of wastes to reduce the hazards in handling the wastes is desired and should be required.

Dilution. Mixing contaminated waste with uncontaminated material solely for the purpose of reducing the waste classification of the resulting waste or even to release it into the general environment. Dilution increases the total quantity of contaminated waste that needs to be managed and is prohibited by the Department.

Blending. Combining materials with different radionuclide concentrations into a single tank or container to produce a mixture that is more amenable for storage, further treatment, and/or final disposal. Blending may include some forms of treatment and general waste packaging processes