Department of Energy
Washington, DC 20585

January 6, 2020

The Honorable Bruce Hamilton
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Chairman Hamilton:

In response to the April 11, 2018, over-pressurized transuranic (TRU) waste drum event at the Accelerated Retrieval Project (ARP) V facility in Idaho, the Department of Energy (DOE and/or the Department) conducted an investigation and subsequently directed all radioactive waste generator sites to review their waste inventories and processes for similar situations. The Office of Environmental Management (EM) issued a Safety Alert on May 28, 2019, directing its sites to respond to seven specific required actions and additionally provided seven recommended actions. Similarly, a Department-wide Operating Experience Level 2 (OE 2) document was issued in September 2019, covering all DOE and National Nuclear Security Administration (NNSA) sites. The OE 2 contained similar (but not identical) required actions and recommendations. In a letter dated October 18, 2019, you requested the answer to questions related to this topic as well as supporting data and analysis. This letter addresses your request, providing responses to your specific questions, based upon information in the Safety Alert and OE 2 responses for EM and NNSA sites, which account for the vast majority of radioactive waste generated and stored across the DOE complex.

The Department received responses covering twelve EM sites and six NNSA sites. The scope and detail of the responses varied based upon a number of factors including whether waste processing was currently occurring, availability and understanding of waste characterization documentation, and facility-specific safety analysis issues that affect how sites evaluated waste streams. The responses in some cases require further evaluation or supplemental information before the full answer to the Safety Alert and OE 2 questions will be available. DOE has initiated follow up inquiries to further refine the responses.

There are fundamental differences between the EM and NNSA radioactive waste storage, processing and disposal programs. NNSA does not store legacy waste and existing wastes stored are considered newly generated. The vast majority of NNSA waste is well characterized, with some low level waste (LLW) being partially characterized, and has associated process knowledge information. This information, along with data gathered to meet the established waste acceptance criteria for disposition pathways, allows database searches of waste constituents for NNSA waste and gives assurances of acceptable waste performance. In contrast, other than some waste from EM operating facilities, the vast majority of EM waste is legacy waste from operations up to 70 years ago. The completeness and reliability of information available for this waste varies. EM has programs in place to evaluate the available information,

conduct characterization activities and define a path forward for storage, processing (if necessary) and disposal.

The information in the responses to the Safety Alert and OE 2 to date support several broad conclusions:

- DOE has not identified any specific defense nuclear site, facility or issue that poses an imminent hazard to the public or our workers.
- We have found that, in general, flammable gas analysis is not conducted routinely to support waste processing or storage.
  - Most sites sample or assess waste at the point of generation. Some sites conducting packaging carry out processes and procedures to screen waste with conditions that have or could generate flammable gas. Given this, the need to conduct flammable gas analysis is limited to drums for which there is an indication that there are characteristics that would be of concern.
  - In some cases, sites address potential hazards (and reduce the need for testing) by installing vents to release gases and purge container headspace.
  - Sites that more regularly test for flammable gases generally do so based on requirements derived directly from shipping restrictions or waste acceptance criteria for disposal sites. For example, all transuranic (TRU) waste containers sent to Waste Isolation Pilot Plant (WIPP) for disposal are required to have flammable gas analysis prior to the certification of TRU waste to be transported and disposed at WIPP. The applicable limits are the lower explosive limit (LEL) or below.

The response to your specific questions are contained in the enclosure. There is additional information following the responses to your three questions regarding other wastes that were identified as otherwise hazardous e.g., reactive, pyrophoric, etc. This information came to light from review of the Safety Alert responses. In addition to the specific questions raised by the Defense Nuclear Facilities Safety Board, the Department is also examining how flammability risks are analyzed in documented safety analyses for relevant facilities and situations. Furthermore, as mentioned previously, in some cases hazard characterization of legacy waste, under the responsibility of EM, is based upon information that may be incomplete or uncertain. We are assessing how sites evaluate and accommodate waste streams with uncertain characteristics or components and to identify issues and associated actions that may be warranted to appropriately manage the uncertainties and associated risks.

Sincerely,

James J. McConnell
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Infrastructure, and Operations
National Nuclear Security Administration

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Enclosure

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Enclosure

Response to Defense Nuclear Facilities Safety Board Questions Regarding ARP V Safety Alert and Operating Experience Level 2

The following represents our response to your specific questions based on the information contained in responses to the Safety Alert and OE 2. We expect that the specific numbers and level of detail in the answers could change as we collect further information from our field sites and contractors regarding site practices, especially regarding legacy waste streams.

Question
Has the Department conducted an assessment to determine if defense nuclear facilities, beyond those at Idaho National Laboratory, have above-ground drums that have not had their flammable gas concentrations measured?

Response
As mentioned in our letter, EM and NNSA approaches and processes for radioactive waste storage, treatment and disposal vary based upon the origin of the waste and completeness of records.

NNSA TRU waste is well characterized and all LLW is partially to fully characterized. All TRU waste has flammable gas analysis prior to WIPP certification, as required. In addition, Los Alamos National Laboratory (LANL) (Triad National Security, LLC) has resampled 600 TRU waste containers; a little over half had detectable levels of hydrogen and methane but all 600 were well within WIPP acceptable limits. LANL is also embarking on an effort to regularly disposition LLW stores over time via their Difficult Waste Strategy (LA-CP-20563). The objectives of this strategy are effective pre-planning, waste avoidance and minimization, more efficient waste disposal, and other important objectives. In addition, Lawrence Livermore National Laboratory (LLNL) has sampled 1515 TRU waste containers and all were below the Central Characterization Project (CCP) notification requirement level (i.e., the lower explosive limit) for hydrogen and methane. Of these 1515 containers, 10 exceeded 500 parts per million (ppm) flammable gases but all 10 meet the TRU Waste Authorized Methods for Payload Control (TRAMPAC) requirements for shipping. Sandia National Laboratory (SNL) does not have LLW or mixed waste that has the potential to generate flammable gases. All waste is inspected upon receipt at SNL. Mixed waste stores are surveyed weekly and all other waste is inspected monthly. SNL also does not regularly generate TRU waste; most generation is from the identification of excess sealed and non-sealed sources. The Auxiliary Hot Cell Facility (AHCF) in TA-V stores remote-handled (RH) TRU waste (monitored weekly) that is awaiting shipment to WIPP. This waste stream does not have constituents that will generate gas. The RH TRU has been packaged, is vented, and characterized under a program certified by the CCP and has an approved enhanced Acceptable Knowledge Summary Report, an approved Chemical Compatibility Evaluation and an exemption from the Basis of Knowledge (for oxidizers) requirement. WIPP has determined that this waste does not require flammable gas testing. All other NNSA sites do not have above ground stores of TRU waste.

Initial responses from EM sites indicate that, except for TRU waste, flammable gas sampling and analysis is not routinely collected as part of the processing and storage operations. As noted above, most sites assess waste at the point of generation or packaging and carry out processing and procedures to screen waste with conditions that have or could generate flammable gas. Sites typically review waste characterization documentation to evaluate the potential to contain a number of constituents that may result in their inability to be processed and certified for disposal. The documentation is evaluated against site specific criteria for flammable gas concentration requirements. In some cases, but not frequently, this requires sampling for flammable gas concentrations. For example, at the Richland site, before low level waste and mixed low level waste are accepted into the waste storage facilities, the generator must comply with a local instruction (PRC-PRO-WM-40523 "Solid Waste Operations Complex Waste Acceptance Program") that places thresholds on heat and gas generation. However, this does not result in the testing of all or most of the waste sent for storage before disposal. The exception is TRU, for which specific requirements apply regarding flammable gas sampling as a prerequisite for certification and transportation to WIPP for disposal.

As mentioned previously, in some cases, hazard characterization of legacy waste, under the responsibility of EM, is based upon information that may be uncertain or may not be complete. We are working to further evaluate this legacy characterization information and explore what issues and actions may be warranted. The waste under the responsibility of NNSA is considered newly generated and typically is well characterized utilizing much more recent information.

Question
Has the Department identified any vented drums, beyond those at Idaho National Laboratory, that were sampled and found to have flammable or near-flammable conditions?

Response
The Department has identified vented drums and potentially non-vented waste streams with flammable or near flammable conditions. As described in response to the first question, sampling of drums is conducted at sites most often to meet shipping or waste disposal requirements, but otherwise potential flammable gases are managed from the point of generation or packaging by screening such waste for segregation, venting or treatment to eliminate characteristics or manage risks.

The table below summarizes drums identified by sites that may have flammable or near-flammable conditions:

Vented Drums & Non-Vented Waste Streams That May Have Flammable or Near Flammable Conditions

Site	Facility/Contractor	Number of Drums	Note Reference
Richland	Central Waste Complex	28	1
EM-Oak Ridge	UCOR	4	2
EMLA	Pit 9	(Waste Stream)	3
EMLA	Trenches A-D	(Waste Stream)	4
NA-LL		~30	5

EM Sites without Flammable or Near Flammable Conditions in Waste Drums

SRS	SPRU
ORP	MOAB
WIPP	EM-LA
EM-NV	West Valley

Notes:

1. These 28 drums are stored at the Central Waste Complex. Eleven of these drums, were found to have flammable constituents and a further 17 are known to have constituents with the potential to generate flammable gas, e.g., sealed can of liquid that may have the potential to generate flammable fumes if the liquid were to leak outside its container. A further 16 drums are stored with these 28 drums using the same controls due to corrosion potential. No current flammability issues exist for any of these 44 drums.. The drums were placed into segregated storage in National Fire Protection Association code 30 storage cabinets. Of the 44 drums stored in this manner, 43 are TRU and 1 is MLLW. There are controls in place regarding these drums.
2. These 4 drums exhibited high hydrogen (>3.2% hydrogen by volume) and remain in the ORO UCOR inventory. All four have been vented, purged, and sampled to ensure they no longer contain high hydrogen concentrations. In the past, other drums were sampled and found to have hydrogen concentrations above 3.2%, and these drums were subsequently vented and purged. However, all except these 4 drums have been shipped and are no longer in UCOR storage. These drums are stored in TRU drum storage buildings, 2 in Building 7572 and 2 in Building 7574. There are controls in place regarding these drums.
3. These wastes have not yet been exhumed but have less available information so have the potential to have characteristics that could generate flammable conditions. There are unvented drums in Pit 9 that share characteristics with drums that have been retrieved that generated flammable gasses.
4. These wastes have not yet been exhumed but have less available information so have the potential to have characteristics that could generate flammable conditions. There are unvented drums in Trenches A-D that share characteristics with drums that have been retrieved that generated flammable gasses.
5. All LLW; low potential for adverse reactions; Above ground storage; managed within a 5-year plan for disposal, stored under controlled conditions with weekly visual inspections.

Question
Has the Department identified other defense nuclear facilities, beyond those at the Idaho National Laboratory, that have or could have solid nuclear waste that include metal carbides?

Response
The Department has identified other defense nuclear facilities that have or could have solid nuclear waste that include metal carbides.

Drums and Waste Streams that Have or Could Have Solid Nuclear Waste that Include Metal Carbides

Site	Facility/Contractor	Number of Drums	Note Reference
SRS	Solid Waste Mgmt. Facility	1	1
Richland	Central Waste Complex	830	2
Oak Ridge	Transuranic Waste Processing Center	3	3
Oak Ridge	UCOR	Trench 13 (potential)	4
PPPO	Fluor BWXT Portsmouth	3	5

Sites Without Metal Carbides in Solid Nuclear Wastes

ORP	EM-NV	EMLA	MOAB	Oak Ridge (Isotek)
NNSA Sites	SPRU	WIPP	West Valley	

Notes:

1. This drum includes a saw blade with tungsten carbide teeth. This situation does not match the general conditions described in the ARP V Safety Alert, but it does match the specific text of your question.
2. These drums were identified from the Solid Waste Information and Tracking System (SWITS) database. They have mostly (2 remain in the burial grounds) been retrieved and are stored in the CWC. The documentation for these drums shows they are the result of operations utilizing predominantly calcium carbide. The only carbides identified as potentially present in waste stored at RL are calcium carbide, silicon carbide and boron carbide. These drums are included because the calcium carbide is itself reactive and the potential for some small amounts of metal carbides cannot be excluded.
3. There remain 3 original legacy drums containing uranium and plutonium metal carbide. Previous similar drums were repacked and showed the material to be stable. They were repacked into vented drums without other pyrophoric material.
4. The waste remaining in Trench 13 was generated by research and development work at ORNL Building 4508 in support of fuel fabrication process experiments for the High Temperature Gas-Cooled Reactor Program. Other work in the Metals and Ceramic Lab at building 4508 was listed as being performed in support of the Molten Salt Reactor Experiment. This R&D resulted in simulated fuel pellets, with some being converted to uranium carbide. Witness interviews regarding Bldg 4508 operations indicated that the simulated fuel may have come from a whole spectrum of cases. Therefore, the potential for metal carbides in Trench 13 exists.
5. Currently, the only planned use of metal carbides will be the addition of boron carbide into three of the 392 Lot 11A2b Low Enriched Uranium metal drums that exceed the Table E-3 fissile gram limitations of the NNSSWAC. To meet Table E-5 of the NNSSWAC, a minimum of 9 kg of boron must be added to mitigate criticality safety

restrictions for burial. Boron carbide was selected to satisfy the minimum boron mass, without exceeding the 9979-package maximum payload specification.

Additional Information on Other Hazardous Wastes

The EM Safety Alert questions were slightly different than the specific DNFSB questions. The question below requested sites to provide data on potential waste streams that had not yet been exhumed and data on other potentially reactive drums

> "Identify the source (generation location and process) and estimated inventory of stored waste drums ***(including potential waste streams yet to be recovered or excavated)*** with uncertain characteristics or inadequate process documentation to determine potential for flammable ***or other reactive conditions***."

Information regarding pyrophoric and other reactive wastes was included from some of the sites. The information provided below came to light during our review of the Safety Alert responses or subsequent discussions or emails. Although not necessarily a comprehensive list, we recognize your potential interest in these wastes. At Portsmouth, Paducah and Oak Ridge there are burial sites that have wastes that are known or suspected to contain pyrophoric and/or flammable gas generating wastes. Should these burial grounds be exhumed, they have the potential to generate large volumes of pyrophoric and/or flammable gas generating waste. The Paducah burial ground is mentioned below as an example and includes specific information provided by the contractor. The Oak Ridge and Portsmouth burial grounds are not included.

Site	Facility/Contractor	Number of Drums	Note Reference
EM-Oak Ridge	UCOR	18	1
EM-Oak Ridge	Transuranic Waste Processing Center	12	2
PPPO	Paducah C749		3
EMLA	N3B	548	4

Notes:

1. These 18 drums do not exhibit flammable gas concerns but there is information available indicating they are likely to be pyrophoric. The waste is stored in buildings 7572 and 7574 (9 each).
2. These 12 containers are considered potentially pyrophoric due to either known or uncertain characteristics. They consist of 8 drums of potentially pyrophoric metals generated from ORNL Defense Programs R&D; 1 drum that potentially contains a lithium hydride container generated from New Brunswick Laboratory Defense Programs R&D; and 3 casks expected to contain high activity radioactive materials generated from Knolls Atomic Power Laboratory Defense Programs R&D with uncertain radiological characteristics or indeterminate potential for flammable or other reactive conditions. There are controls in place for this waste.
3. Uranium Burial Ground (C749). Not yet exhumed, but potentially pyrophoric.

Approximately 270 tons (245,000 kg) of uranium; 59,000 gallons (223,000 liters) of oils; and 450 gallons (1,700 liters) of trichloroethene (TCE) were buried in the C749 Uranium Burial Ground. Most of the uranium wastes consisted of pyrophoric uranium metal in the form of machine shop turnings, shavings, and sawdust. Pyrophoric uranium metal usually was placed in 20, 30, or 55gallon drums, and petroleum based, or synthetic oils were used to stabilize the metal. Some of these oils may have included polychlorinated biphenyl (PCB)-contaminated oils. Anecdotal reports have been made of fires in the burial ground as a result of oxidation of pyrophoric uranium shavings. Although these fires may have resulted in potential volume reduction, no subsidence was observed. Other forms of uranium, including oxides of uranium, uranyl fluoride solutions, uranium-zirconium alloy, slag, and uranium tetrafluoride were buried in smaller quantities. Should the C749 burial ground be exhumed, a large potentially pyrophoric waste stream may be generated.

4. EMLA does have 548 drums above ground that are vented and had in the past released flammable gasses but are not now venting flammable gasses at any level of concern. These drums are labeled as having either D001 Ignitable or D003 Reactive.