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Date: NOV 1 2 2014
Symbol: ENV-DO-14-0345
LA-UR: 14-27469 , 14-28034
Locates Action No.: Not Applicable

Mr. John E. Kieling
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Dear Mr. Kieling:

Subject: Transmittal of Memorandum Associated with the Waste Characterization of Nitrate Salts at Technical Area 54

The purpose of this letter is to transmit information requested via phone conversation by New Mexico Environment Department (NMED) personnel. The Los Alamos National Security, LLC (LANS) and the U.S. Department of Energy (DOE), the Permittees, hereby submit the enclosed memorandum and its associated attachments regarding the applicability of Environmental Protection Agency (EPA) Hazardous Waste Numbers to nitrate salt wastes.

The memorandum is referenced in the *Second Addendum, Reporting Additional Instance of Noncompliance with Hazardous Waste Facility Permit and Generator Requirements, Los Alamos National Laboratory*; submitted to the NMED on October 21, 2014. The *Background Facts* section of the second addendum includes a description of the characterization efforts undertaken by the Los Alamos National Laboratory (LANL) acceptable knowledge (AK) team prior to the 2014 LANL Waste Re-characterization activities. The results of the LANL AK team efforts are summarized in the enclosed document. Enclosure 1 includes the 2012 memorandum titled, *Legacy TA-55 Nitrate Salt Wastes at TA-54 - Potential Applicability of RCRA D001/D002/D003 Waste Codes*, sent from the LANL waste management group to the LANL Transuranic Waste Program in February 2012.

If you have comments or questions regarding this submittal, please contact Mark P. Haagenstad at (505) 665-2014 or Gene E. Turner at (505) 667-5794.

Sincerely,

Alison M. Dorries
Division Leader
Environmental Protection Division
Los Alamos National Security LLC

Sincerely,

Gene E. Turner
Environmental Permitting Manager
Environmental Projects Office
Los Alamos Field Office
U.S. Department of Energy

AMD:GET:MPH:LVH/kt

Enclosures: (1) Legacy TA-55 Nitrate Salt Wastes at TA-54 - Potential Applicability of RCRA D001/D002/D003 Waste Codes

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ENCLOSURE 1

Legacy TA-55 Nitrate Salt Wastes at TA-54 - Potential Applicability of RCRA D001/D002/D003 Waste Codes

ENV-DO-14-0345

LA-UR-14-27469 and LA-UR-14-28034

Date: NOV 1 2 2014

Los Alamos
NATIONAL LABORATORY
EST. 1943

memorandum

Environmental Protection Division
Water Quality & RCRA Group (ENV-RCRA)

To/MS: Davis Christensen, ADEP-LTP-PTS, J910
From /MS: Mark Haagenstad, ENV-RCRA K404
Phone/Fax: 5-2014

Symbol: ENV-RCRA-12-0053
Date: February 29, 2012

SUBJECT: LEGACY TA-55 NITRATE SALT WASTES AT TA-54 – POTENTIAL APPLICABILITY OF RCRA D001/D002/D003 WASTE CODES

This memorandum was prepared in response to your request to provide ENV-RCRA's review of the Resource Conservation and Recovery Act (RCRA) characterization of approximately 200 drums of legacy TA-55 TRU wastes that were suspected of being unconsolidated nitrate salts. In 2011, ENV-RCRA was asked by ADPSM (the waste generating organization at TA-55) and ADEP-LTP-PTS to review new information on the drums, and recent chemical/physical studies of similar wastes at other DOE sites, in order to make a determination regarding their potential to exhibit the RCRA characteristics of ignitability (D001), corrosivity (D002), and/or reactivity (D003). The characterization of these drums is currently being reviewed by ADEP-LTP in preparation for their shipment to WIPP.

Investigation Approach

ENV-RCRA personnel worked in cooperation with ADEP-LTP-PTS and CCP, as follows:

- The team reviewed the current information in the LANL waste databases, and obtained and reviewed copies of the original data packages (as available) for the containers, including RSWDs, Discardable Solids Log sheets, and other data.
- The team reviewed the original LANL procedures and other pertinent Acceptable Knowledge (AK) source documents.
- The team interviewed several credible subject matter experts (SMEs) and technical personnel present at the point of generation.
- The team interviewed other LANL SMEs with expertise on the chemical and physical properties of concern with unconsolidated nitrate salts.
- Team members also held numerous meetings with CCP, CBFO representatives, and LANL counsel and managers.

The results of ENV-RCRA's analysis are presented below in this memo and its Attachments.

Conclusions and Recommendations

1. **Verifying the Containers:** The population of unconsolidated nitrate salts drums generated at TA-55 between 1978-1979 and late 1991 was approximately 200-250. ADEP-LTP is currently verifying the specific container ID numbers. As soon as that process is completed, LANL's database information should be promptly updated to properly identify the *confirmed* unconsolidated nitrate salts containers according to established ADEP-LTP protocols.

2. **D001 (Ignitability):** After a thorough review, ENV-RCRA has concluded with a high degree of confidence that these drums do not exhibit properties meeting the EPA ignitability definition.

3. **D003 (Reactivity):** After a thorough review, ENV-RCRA has concluded with a high degree of confidence that these drums do not exhibit properties meeting the EPA reactivity definition.

4. **D002 (Corrosivity):** It may be possible to encounter some unconsolidated nitrate salts drums that contain measurable free liquids. Prior to certification for WIPP disposition, all containers undergo a waste examination process. Any liquids identified in the unconsolidated nitrate salts drums should be managed as potentially RCRA corrosive (D002) waste (unless shown otherwise by pH testing) and remediated prior to shipment off-site. Drums containing free liquids will not be shipped to WIPP.

5. **Other RCRA Codes:** Regarding the RCRA toxicity characteristic codes and the F, K, P, or U-codes, ENV-RCRA confirmed the generator and CCP RCRA codes identified with these waste streams.

The details of our rationale are provided in the Attachments to this memo.

Waste Description
Evaporator salts and evaporator bottoms have been generated continuously from nitrate recovery operations at TA-55, PF-4 since the beginning of plutonium operations in 1979. This memo focuses only on ***'legacy TA-55 unconsolidated nitrate salts,'*** which are defined here as non-cemented waste evaporator salts and evaporator bottoms generated at TA-55 during the 1980s. When evaporator bottoms cooled to room temperature, they were filtered, and the nitrate solution would salt out. The salts were washed, vacuum dried (to reduce, but not eliminate, moisture content), double- (or triple-) bagged, and placed in lead- and polyethylene-lined 55-gal drums.

This is strictly a legacy waste. One hundred (100) percent of the nitrate salts generated from the evaporator process since late 1991 have been sent to cement fixation immediately upon generation, so ENV-RCRA believes that no unconsolidated nitrate salts were generated after 1991. These containers were generated in 1984-1985, prior to EPA's promulgation of RCRA definitions and regulations for mixed waste, and prior to LANL's initial mixed waste permit application submittal to NMED in early 1991. However, RCRA codes were not assigned to these containers until the early 1990s, based on the acceptable knowledge available at that time.

Additional Information
ENV-RCRA also prepared a draft *Generator Knowledge Supplemental Report* ("GK Report") on the legacy TA-55 unconsolidated nitrate salt wastes. It provides the detailed information ENV-RCRA compiled and reviewed in order to help ADEP more fully define and describe the legacy TA-55 unconsolidated nitrate salts waste.

The draft GK Report was formatted for consistency with the "REQUIRED WASTE STREAM INFORMATION" section in CCP's Acceptable Knowledge Summary Reports. The draft GK Report is available in our files, and can be finalized and distributed if needed in the future.

JC:PS:MH/lm

Attachments: a/s

Cy (w/att.,): K.W. Johns-Hughes, ADEP-LTP, J910
S. Clemmons, ADEP-LTP, J910
V. George, ADEP-REG-DO, M991
S. Ramsey, ADEP-LTP-PTS, J910
S. McMichael, LC-LESH, A187
D. Woitte, LC-LESH, A187
J. Carmichael, ENV-RCRA, E501
P. Schumann, ENV-RCRA, M704, (E-File)
ENV-RCRA File, M704

RCRA code	Discussion	Conclusion/ Recommendation
Ignitability	All parties agree that the legacy unconsolidated nitrate salt waste should only be assigned the EPA D001 (ignitability characteristic) code if the waste met the 40 CFR 261.21(a) ignitability definition. One MET-1 actinide chemist familiar with the salts' historical generation and management recently stated that, given the presence of at least the sodium and ammonium nitrates, unconsolidated nitrate salt drums might need to be conservatively labeled as potentially ignitable until evidence can be found indicating otherwise.	
	The legacy unconsolidated nitrate salt waste would meet the RCRA ignitability definition if a *representative sample of the waste* has <u>any of the following 4 properties</u>: -Per 40 CFR 261.21(a)(1), **it is a liquid** with a flash point less than 60 °C (140 °F). [NOTE: ENV-RCRA's AK review indicated that the unconsolidated salts of interest were packaged relatively dry, but probably still contained some small amount of liquid at the time of generation.]	• ENV-RCRA believes that a *representative sample of the waste* would not fail the free liquids test, and therefore each drum *in its entirety* should be characterized and managed as a solid-form waste. • Therefore, the 40 CFR 261.21(a)(1) definition would not apply. • However, ENV-RCRA recommends that all confirmed unconsolidated nitrate salts drums undergo verification that no liquids are present prior to shipment (according to routine LANL and CCP procedures).
	-Per 40 CFR 261.21(a)(2), if a *representative sample of the waste* is **not** a liquid **and** is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes **and**, when ignited, burns so vigorously and persistently that it creates a hazard. *[NOTE: EPA has clarified in guidance that **all these criteria must be met**; i.e., even if a sample burns so vigorously after ignition as to create a hazard, if it is difficult to ignite, it has not met the 40 CFR 261.21(a)(2)definition (per EPA FAXBACK 12089).]*	• ENV-RCRA found no evidence that, *as a nonliquid,* the unconsolidated nitrate salts spontaneously ignite at standard temperature and pressure through friction, absorption of moisture, or spontaneous chemical changes. • Likewise, ENV-RCRA found no evidence that, when ignited, unconsolidated nitrate salts would burn so vigorously and persistently as to create a hazard. • Therefore, the 40 CFR 261.21(a)(2) definition does not apply.
	-Per 40 CFR 261.21(a)(3), if a *representative sample of the waste* is an **ignitable compressed gas.**	The unconsolidated nitrate salts do not meet the definition of an ignitable compressed gas; therefore 40 CFR 261.21(a)(3) does not apply.
	-Per 40 CFR 261.21(a)(4), if a *representative sample of the waste* is an **oxidizer**. *An oxidizer for the purposes of 40 CFR 261.21(a) is a substance such as a chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter (see also 40 CFR 261.21(a), Note 4).* ENV-RCRA's AK review indicated that: • By the mid-1980s to early 1990s, the cover sheet of most TA-55 operating procedures (including this one) included a Hazards Summary table. MST-12 Procedure no. 485-REC-R00 included checked boxes for "pressure or vacuum; fire; explosives/pyrophoricity; flammable gas/liquid; thermal energy;" and "other" (which could potentially indicate the applicability of RCRA codes D001 or D003). • MST-12 Procedure no. 485-REC-R00 also required lid-deflection readings to be taken of the closed drums. • However, TA-55 waste technicians who packaged unconsolidated nitrate salt wastes in the 1980s	• There is no recent sampling or test data for the LANL unconsolidated nitrate salt drums to confirm whether or not they would now exhibit oxidizing behavior (or other aspects of the RCRA ignitability definition). • However, ENV- RCRA's AK review found no new information supporting the assignment of D001 to these drums now -- as they are presently stored at TA-54. • Since the containers are now in above-ground storage, as a best practice, they should be checked (on an ongoing basis) specifically for any external evidence of oxidizing behavior. • Likewise, any future drum handling or movement

RCRA code	Discussion	Conclusion/ Recommendation
	reported never observing any indications of oxidizing behavior (e.g., smoking, gas emission, fire) regarding the salts. • ENV-RCRA has found no evidence of any historical problems with these containers at any subsequent stages of the waste management process. • LANL transportation and explosives SMEs queried by ENV-RCRA did not see any reason to assign an ignitability code to these containers based on their past experience and their knowledge of the chemical and physical properties of the constituents. • There is no EPA-required oxidizer test applicable to the legacy unconsolidated nitrate salt waste (see detailed discussion on applicability of the RCRA oxidizer definition in Attachment 2). • As stated in SW-846, EPA relies entirely on a descriptive, prose oxidizer definition because available tests for measuring the variegated class of effects embraced by the definition suffer from a number of deficiencies. • The original waste description (in the RSWDs) made no reference to potential oxidizing behavior implying the RCRA characteristic. This has been corroborated by generator interviews.	should conservatively take into account the potential to exhibit oxidizing behavior. A more detailed discussion on the applicability of the RCRA oxidizer definition immediately follows this table (see Attachment 2).
Corrosivity	ENV-RCRA's AK review indicated that the unconsolidated salts of interest were packaged relatively dry, but probably still contained some small amount of liquid at the time of generation. Based on ENV-RCRA's AK review, any liquid encountered most likely would meet the RCRA corrosivity definition.	• The D002 code will not apply to the solid-form unconsolidated nitrate salts, by definition. However, it may be possible to encounter some unconsolidated nitrate salts drums that now contain measurable free liquids. • Any liquid encountered most likely would be a RCRA corrosive liquid (D002). This could be easily confirmed by a field pH test. • ENV-RCRA recommends that all confirmed unconsolidated salts drums undergo verification that no liquids are present prior to shipment (according to routine LANL and CCP procedures). • Sorption of any free liquid encountered will eliminate any concern that prohibited liquid—and D002 waste -- might inadvertently be sent to WIPP.
Reactivity	Based on the waste descriptions provided, ENV-RCRA considers it unlikely that the legacy TA-55 nitrate salt waste drums could exhibit any of the reactive waste properties, or meet any of the reactive waste form definitions listed in 40 CFR 261.23(a)(1) through (a)(8), for the following reasons: • The EPA reactivity definition was intended to identify wastes that, because of their extreme instability and tendency to react violently or explode, pose a problem at all stages of the waste management process. However, TA-55 waste technicians who packaged unconsolidated nitrate salt wastes in the 1980s reported never observing any indications of reactivity (e.g., smoking, gas emission, fire) regarding the salts. • ENV-RCRA has found no evidence of any historical problems with these containers at any subsequent stages of the waste management process. • LANL transportation and explosives SMEs queried by ENV-RCRA did not see any reason to assign a reactivity code to these containers based on their past experience and their knowledge of the chemical and physical properties of the constituents. • Further, there is no EPA-required reactivity test applicable to the legacy unconsolidated nitrate salt waste. As stated in SW-846, EPA relies entirely on a descriptive, prose definition of reactivity because available tests for measuring the variegated class of effects embraced by the reactivity definition suffer from a number of deficiencies.	• ENV-RCRA concurs with the generators and SMEs that there is no evidence that the D003 waste code should apply to this waste. • However, since the containers are now in above-ground storage, as a best practice, they should be checked (on an ongoing basis) specifically for any external evidence of reactive behavior. •

RCRA code	Discussion	Conclusion/ Recommendation
	• The original waste description (in the RSWDs) made no reference to potential reactivity implying the RCRA characteristic. This has been corroborated by generator interviews.	
Toxicity	In CCP's review of AK (as reported in CCP-AK-LANL-006, Rev. 10), they determined that the waste streams to which the nitrate salts drums are now assigned may be contaminated with toxicity characteristic compounds as defined in 40 CFR 261.24. Where a constituent was identified and there is no quantitative data available to demonstrate that the concentration of a constituent is below regulatory threshold levels, CCP conservatively applied that EPA toxicity characteristic code to the waste stream (therefore, CCP applies EPA codes D004 - D011, D018, D019, D021, D022, D035, D038, D039, and D040 to the TA55 wastes at the time they are prepared for final shipment to WIPP).	ENV-RCRA found no reason not to assign these D- codes to the nitrate salts drums when they are prepared for final shipment to WIPP by CCP..
F Listings	In CCP's review of AK relative to the chemicals used in TA-55 or present in its processes (as reported in CCP-AK-LANL-006, Rev. 10), they determined that solvent constituents could have contaminated some TRU drums in the waste streams to which the nitrate salts drums are now assigned. These may be F-listed hazardous wastes from non-specific sources (specifically F001, F002, and F005).	• ENV-RCRA found no new data supporting the assignment of F-codes to the nitrate salts drums now -- as they are presently stored at TA-54. • However, ENV-RCRA found no reason not to assign these F- codes to the nitrate salts drums when they are prepared for final shipment to WIPP by CCP.
K, P and U Listings	In CCP's review of AK (as reported in CCP-AK-LANL-006, Rev. 10), they determined that the waste streams to which the nitrate salts drums are now assigned do not contain and are not mixed with a discarded commercial chemical product, an off-specification commercial chemical product, or a container residue or spill residue thereof. The material in these waste streams would not be considered hazardous from specific sources, since they were not generated from any of the processes listed in 40 CFR 261.32.	ENV-RCRA concurs with CCP that there is no evidence that the nitrate salts drums contain a K-, P-, or U-listed waste.

ATTACHMENT 2

IGNITABILITY AND OXIDIZER POTENTIAL:
Legacy Unconsolidated Nitrate Salt Waste

A-2.1 Applicability of EPA ignitability test methods to the legacy unconsolidated nitrate salt waste.

It is not likely that any individual container of legacy unconsolidated nitrate salt waste would have enough free liquids present for the entire drum contents to be defined as a liquid waste; therefore, the waste could only be a D001 hazardous waste if it was an ignitable solid or an oxidizer. EPA does not require testing with the approved test methods (1030 or 1040) to determine if a solid-form waste passes or fails the characteristic of ignitability, even though 40 CFR 261.21(a)(4) states that "a representative sample of the waste" must exhibit one of the four ignitability properties. However, in guidance, EPA (2009)[3] stated that analytical results using the approved EPA methods **may not be used by themselves to classify a waste as a D001 hazardous waste**, nor can analytical results using Methods 1030 and 1040 be used by themselves to definitively classify a waste as non-hazardous. Rather, EPA stated, analytical results "*...provide relevant and useful information that may be applied to knowledge of a waste* in determining whether a waste meets the 40 CFR 261.21(a) criteria."

A-2.2 Applicability of the RCRA oxidizer definition to the legacy unconsolidated nitrate salt waste.

An oxidizer is defined in 40 CFR 261.21(a)(4) (as amended at 71 FR 40254, July 14, 2006) as "a substance such as a chlorate, permanganate, inorganic peroxide, **or a nitrate**, that yields oxygen readily to stimulate the combustion of organic matter". EPA's definition references the DOT definition (*40 CFR 261.21(a), Note 4, still references the old DOT oxidizer definition at 49 CFR 173.151. The current DOT oxidizer definition is found at 49 CFR 173.127(a) and 49 CFR 173.127(a)(1)*[4]).

In order for a waste to be classified under RCRA as an ignitable hazardous waste because it is an oxidizer, **it must meet the narrative regulatory definition** at 40 CFR 261.21(a)(4). As stated in SW-846 and the original May 19, 1980 RCRA rule [45 FR 33108], EPA's objective with the ignitability characteristic was to "identify wastes that either present fire hazards under routine storage, disposal, and transportation or are capable of severely exacerbating a fire once started." EPA has recommended in guidance that waste generators "use best engineering judgment" when deciding whether to apply the ignitability characteristic tests to solids (*see Footnote 5 and 68 FR 59940, October 20, 2003).* Note, however, that the DOT oxidizer definition does require testing[5].

- EPA Method 1040 for Oxidizing Solids is based on the United Nations (UN) Section 34 Test O.1 (*Test for Oxidizing Solids*) protocol. According to EPA, Method 1040 classifies a solid waste into one of four categories of oxidizers (the fourth being non-oxidizer). In the method, a waste sample is categorized by comparing the shortest mean burning time for either of the waste mixtures (1:1 and 4:1 waste/cellulose ratios) with the mean burning times exhibited by the standard reference substances. Any wastes that do not

ignite or burn within three minutes, or have burning times greater than the 3:7 potassium bromate standard, are not considered oxidizers under this test, and "may be assumed...not [to] exhibit the RCRA hazardous waste characteristic of ignitability pursuant to 40 CFR 261.21(a)(4) criteria."

A-2.3 Applicability of the 2010 INL study to LANL legacy unconsolidated nitrate salt waste.

Because of the potential oxidizing properties of nitrate salts when mixed with other materials, recent information raised a concern that legacy unconsolidated nitrate salt waste might meet the RCRA ignitability definition and thus not comply with the WIPP-WAC. This information came in part from a 2010 Idaho National Laboratory (INL) report[1] (obtained by David French, EES-12) on Rocky Flats (RFP) series 745 sludge wastes being retrieved from pits at INL (the RFP sludges contained evaporator bottoms with nitrate salts[2]).

The 2010 INL report specifically focused on the applicability of oxidizer tests to determine whether the RCRA oxidizer definition applied to targeted wastes being retrieved from pits at INL as part of their Accelerated Retrieval Project (ARP-II). The retrieved INL wastes may contain or be commingled with Rocky Flats series 745 sludge wastes. The INL report discussed two studies:

- 2003 burn-rate tests at INL performed on surrogates of several buried INL/RWMC waste types (i.e., soils, sludges and debris) commingled with Rocky Flats evaporator bottoms waste, in order to determine whether the presence of nitrate salts might cause any retrieved waste types to behave as an oxidizer (and thus be unacceptable to WIPP). The INL tests used a modified United Nations *Test for Oxidizing Solids* protocol.
- 2010 burn-rate tests at New Mexico Tech performed on two types of surrogates of the buried Rocky Flats salt wastes, in order to evaluate their behavior as an oxidizer (and thus be unacceptable to WIPP). The two waste surrogates tested were potassium nitrate combined with zeolite (an aluminosilicate mineral) and potassium nitrate combined with powdered grout. The tests used a modified EPA Method 1040.

Based on the surrogates' performance (i.e., the burn time at which a given sample was deemed an oxidizer) in the two studies, INL recommended that the salt content of excavated wastes should be maintained at less than 30% nitrate salts, in order to avoid labeling them as an oxidizer (and therefore avoid managing them as EPA ignitable waste or transporting them as DOT oxidizers). However, when considering whether and how the INL results and conclusions might apply to the legacy TA-55 nitrate salt waste, caution should be exercised for the following reasons:

1. The 2003 INL study tested three INL waste streams (inorganic or organic sludges, soil, and debris) that were potentially contaminated with nitrate salts, not on a waste stream of pure nitrate salts.
2. The 2003 burn-rate tests were performed on surrogates of the buried RWMC waste types, not on the wastes themselves.

3. Likewise, the 2010 burn-rate tests at New Mexico Tech were performed on surrogates of two waste types, not on the wastes themselves.
4. The 2003 burn-rate tests did not follow the correct analytical protocol for either the DOT/UN *Test for Oxidizing Solids* or EPA Method 1040 (they used an incorrectly prepared standard), and there is no indication that they requested approval from EPA to modify the method.
5. Likewise, the 2010 burn-rate tests did not follow the correct analytical protocol for either the DOT/UN *Test for Oxidizing Solids* or EPA Method 1040 (tests were performed only at a 1:1 waste surrogate/ cellulose ratio, and not at the 4:1 ratio), and there is no indication that they requested approval from EPA to modify the method.
6. The 2003 INL study (as reported in the 2010 INL report) was performed on samples of surrogate wastes only, and contained several errors including the composition of their reference standard. As a result, their final recommended threshold value of 30% nitrate content is an inferred value based on interpolation, not based on any values directly measured in the study.

A-2.4 ENV-RCRA Conclusions/Recommendations RE: Ignitability/ Oxidizing Potential

1. It has been suggested that LANL's unconsolidated nitrate salt waste, as-generated, *may* have the potential to behave as an oxidizer, suggesting that samples may have the *potential* to exhibit the EPA ignitability characteristic. However, LANL SMEs have never observed any indication that the nitrate salts exhibited any oxidizing behavior (e.g., smoking, gas emission, fire).
2. EPA's 2006 change in the 40 CFR 261.21 oxidizer definition [*and all supporting EPA guidance*] clarified that analytical results (using the approved EPA methods) may not be used by themselves to classify a waste as a D001 hazardous waste. Testing <u>may supplement</u> AK and other data in determining if a waste is a RCRA oxidizer (*note, however, that testing is required by DOT to determine whether DOT packaging and transportation requirements for solid oxidizers would apply).*
3. For the six reasons discussed under A-2.3 above, ENV-RCRA believes that the INL study conclusions are not directly applicable to LANL's unconsolidated nitrate salt waste Direct testing of the LANL waste would be necessary in order to make any comparisons between our pure-salts waste and INL's commingled waste.
4. The INL oxidizer test results would help support LANL's AK package if LANL was managing commingled nitrate-salt-containing waste similar to the INL/RFP waste stream. However, ENV-RCRA believes that only analytical results from testing samples of LANL nitrate salt waste would be directly applicable.

FOOTNOTES/ ENDNOTES

1 *Idaho Cleanup Project (ICP), 2010.* Allowable Nitrate Salt Concentration in ARP Waste. *ICP Engineering Design File no. EDF-8723, Revision 2, approved June 29, 2010.*

2 All RFP 74-Series sludge was placed inside double polyethylene bags within a 55-gal drum. The contents of RFP Series 745 sludge are described to be 60% sodium nitrate, 30% potassium nitrate, and 10% 'miscellaneous.' The miscellaneous mass consisted of organic wastes; used items such as rags, paper, and gloves; and organic compounds like alcohols, organic acids, and ethylene diamine tetraacetic acid (EDTA).

3 See EPA (2009), "Hazardous Waste Characterization; a User-Friendly Reference Document" *at http://www.epa.gov/osw/hazard/wastetypes/wasteid/char/hw-char.pdf, and references cited on pp. 11-18.*

4 The current DOT definition of oxidizer is at 49 CFR 173.127(a). It is a Division 5.1 material that may, generally by yielding oxygen, cause or enhance the combustion of other materials. Unlike the old DOT definition (which was purely qualitative), an oxidizing solid is now defined at 49 CFR 173.127(a)(1) as a solid material whose mean burning time is less than or equal to the burning time of a 3:7 potassium bromate/ cellulose mixture (when tested in accordance with the UN Manual of Tests and Criteria, Section 34, Test O.1).

ATTACHMENT 3

ENV-RCRA Generator Knowledge Supplemental Report for Legacy TA-55 Unconsolidated Nitrate Salt Waste

January 12, 2012
LA-UR-14-28034

ACRONYMS AND ABBREVIATIONS

AK	acceptable knowledge
AKIS	*Acceptable Knowledge Information Summary for LANL Transuranic Waste Streams*
Am	americium
CBFO	Carlsbad Field Office
CCP	Central Characterization Project
CFR	Code of Federal Regulations
CWDR	Chemical Waste Disposal Request
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
g	gram
GK	generator knowledge
HE	high explosive
HWN	(EPA) hazardous waste number
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security
lbs	pounds
m^3	cubic meters
M&O	Management and Operating
MT	material type
MOU	Memorandum of Understanding
nCi/g	nanoCuries per gram
NOx	nitrogen oxides
PCBs	polychlorinated biphenyls
PF	Plutonium Facility
ppm	parts per million
P/S codes	process/status codes

Pu	plutonium
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RSWD	Radioactive Solid Waste Disposal Request
RTR	real-time radiography
SME	subject matter expert
TA	technical area
TRU	transuranic
TSCA	Toxic Substances Control Act
U	uranium
UCNI	Unclassified Controlled Nuclear Information
µg	microgram
VE	visual examination
WCATS	Waste Characterization and Tracking System
WIPP	Waste Isolation Pilot Plant
WIPP WAC	*Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*
WIPP WAP	*Waste Isolation Pilot Plant Hazardous Waste Permit,* NM4890139088-TSDF, Attachment B, "Waste Analysis Plan"
WMC	waste matrix code
WMP	waste material parameter
WPF	Waste Profile Form

TA-55 PROCESS/STATUS (P/S) CODE INDEX

Note: This index indicates the main process report that covers each P/S code mentioned in this report.

P/S Code	P/S Name	Report*
EV, and others*	Evaporator**	*Process Acceptable Knowledge Report for Nitrate Operations at TA-55* *Generator Knowledge Report for Legacy TA-55 Unconsolidated Nitrate Salt Wastes at TA-54* (this report)

* Process Acceptable Knowledge or Generator Knowledge Reports
** NOTE: according to CCP-AK-LANL-006, Rev. 10, P/S codes were not used before 1987, and were not applied consistently until 1995. The following P/S codes were associated with nitrate operations: AL, AO, AP, AS, AT, ATL, BAC, BF, BL, BM, BU, CC, CD, CF, CH, COD, COL, CPOD, CR, DF, DP, DS, ED, ETD, EV, FA, FC, FX, GMS, HC, HCD, HD, HGMS, HP, HRA, IA, IS, LC, LG1, LG2, LR, MAG, MAS, MB, MELL, MF, ML, MPD, NC, NL, NR, OD, OH, OY, PA, PAF, PR, PS, PT, PTS, RB, RBJ, RC, RCM, RFX, RO, RR, SC, SP, SSD, SX, TDC, TSC, UPS, US, US2, VC, VP1, VP2, VP3, VUL, ZD

EXECUTIVE SUMMARY

This DRAFT Generator Knowledge Supplemental Report ("GK report") summarizes information about legacy TA-55 unconsolidated nitrate salt wastes currently stored at TA-54 gathered and reviewed by ENV-RCRA, in coordination with the Los Alamos National Laboratory (LANL) TRU waste management organization (ADEP-LTP). This information was requested by ADEP-LTP to define and describe the **'legacy TA-55 unconsolidated nitrate salts'** waste. It provides additional information to support the CCP *Acceptable Knowledge Summary Report for LANL TA-55 Mixed Transuranic Waste* (CCP-AK-LANL-006, Rev.10), to ensure that the unconsolidated nitrate salts wastes are properly characterized for shipment to WIPP.

This information is provided to better describe the waste and its packaging. It provides support and justification for the identification of the hazardous constituents (for the purpose of assigning hazardous waste numbers), the radiological properties of the waste, and the absence of items restricted from transportation in a TRUPACT-II and disposal at the Waste Isolation Pilot Plant (WIPP).
'Legacy TA-55 unconsolidated nitrate salts' are defined herein as <u>non-cemented</u> waste evaporator salts and evaporator bottoms that were generated at TA-55. The time frame of interest is from the onset of plutonium operations (1978-1979) to late 1991. ENV-RCRA believes that no unconsolidated nitrate salts have been generated since 1991. ADEP-LTP believes that there are currently approximately 240-250 55-gallon drums and 85-gal overpacks of this waste in storage at TA-54, Area G.
The waste is mixed transuranic waste of defense origin. Each container of unconsolidated nitrate salts contains plastic bags of non-cemented nitrate salts loaded directly into a 55-gallon drum, with one or more drum liners and layers of confinement.
Information on hazardous constituents was reviewed with the following results:

- F-listed (solvents/organics); None
- D001 (ignitability); None
- D002 (Corrosivity); None (unless liquids present)
- D003 (Reactivity); None
- P-listed, acute (commercial chemicals, off-spec); None
- U-listed, toxic (commercial chemicals, off-spec); None

- K-listed (specific sources); None
- Polychlorinated biphenyls; None
- Toxicity characteristic compounds: D007, D008, D009

The waste has been evaluated for WIPP-prohibited items with the following results:

- Compressed gases; None
- Free liquids; None
- Nonradionuclide pyrophorics; None
- Sealed containers >4 liters; None
- Explosives; None
- Beryllium; <1%

1.0 INTRODUCTION

This 'Generator Knowledge' supplemental report was prepared in response to ADEP's request for support regarding the subject issue. This information was requested by ADEP-LTP to define and describe the **'legacy TA-55 unconsolidated nitrate salts'** waste.

Its purposes are

- to provide ENV-RCRA's review of the Resource Conservation and Recovery Act Acceptable Knowledge documentation used to characterize a specific legacy TA-55 waste, unconsolidated nitrate salts, to enable their shipment to WIPP;
- to better describe the waste and its packaging; and
- to provide additional support and justification for the identification of the hazardous constituents (for the purpose of assigning hazardous waste numbers), the radiological properties of the waste, and the absence of items restricted from transportation in a TRUPACT-II and disposal at the Waste Isolation Pilot Plant (WIPP).

This additional information is intended to support the CCP *Acceptable Knowledge Summary Report for LANL TA-55 Mixed Transuranic Waste* (CCP-AK-LANL-006, Rev.10), in order to ensure that the unconsolidated nitrate salts wastes are properly characterized for shipment to WIPP. This report is intended to be used as a source document to better support the existing AK for this waste for purposes of TRU waste characterization, as described in "Waste Analysis Plan", Attachment B to the *Waste Isolation Pilot Plant Hazardous Waste Permit* (WIPP WAP) (2).

1.1 Problem Definition

In 2009, the Central Characterization Project (CCP) placed a hold on 48 drums from LANL legacy TA-55 waste streams (CCP Nonconformance Report (NCR) no. NCR-LANL-0509-09)[1]. New information on the drums provided by TA-55 (MET-1) subject matter experts (SMEs), together with recent chemical/physical studies of similar nitrate salts wastes at other DOE sites, raised questions about the accuracy of the original characterization. The issue is described in the original NCR as follows:

> "As a result of new AK information from the generator, i.e., TA55 Cement Fixation Group, forty-eight (48) drums that are currently on the AKTSS *[AK Tracking Spreadsheet]* have been identified as potentially, non-cemented Evaporator Salts, which would require these drums to be re-assigned to a separate waste stream. As of 06/22/2009, only one of these drums, i.e., drum no. S841320, has been through characterization, i.e., LA-RTR2-08-0192."

The approved-AK-waste-stream issue for the remaining 47 drums in the CCP-NCR is summarized in the following table.

TA-55 waste stream no.	COMMENTS
LA-MHD01.001	Any drums of unconsolidated nitrate salts containing inner steel cans (with >50% debris) would meet the stated definition of LA-MHD01.001.
LA-CIN01.001	Any drums containing cemented nitrate salts would meet the stated definition of LA-CIN01.001.
LA-MIN02-V.001	• Any drums containing sorbed liquids would meet the stated definition of LA-MIN02-V.001. They are not part of the unconsolidated nitrate salts waste stream to be defined herein. • Any drums containing unconsolidated, non-cemented nitrate salts would not meet the stated definition of LA-MIN02-V.001. They need to be reassigned to the appropriate waste stream.
LA-MIN04-S.001	None of the 47 drums of suspect unconsolidated nitrate salts in the NCR are currently assigned to this waste stream.

Consequently, the waste generating organizations (at TA-55) and waste management organizations (ADEP-LTP-PTS) asked ENV-RCRA to assist them in resolving the NCR issue for the remaining 47 drums, and review the current descriptions of LANL's four TA-55 waste streams as presented in CCP's AK-6 report, to determine what actions were needed to ensure that the unconsolidated nitrate salts were in the appropriate waste stream for purposes of WIPP characterization.

1.2 ENV-RCRA Conclusions/ Recommendations:

1. Among the total population of legacy TA-55 drums in current storage at TA-54, a subpopulation of approximately 240-250 potential candidates exists that are unconsolidated nitrate salts. They may currently be assigned to any of the four Waste Streams currently comprising CCP-AK-LANL-006. ADEP-LTP is currently in the process of confirming which specific containers on the candidate list are, in fact, unconsolidated nitrate salts, based in part on the information reviewed in this document.
2. No drums in current storage at TA-54 that are *confirmed* as containing unconsolidated, non-cemented nitrate salts should be assigned to two of the four Waste Streams currently comprising CCP-AK-LANL-006 (i.e., LA-CIN01.001 and LA-MIN02-V.001). As soon as possible after confirmation, all mis-assigned drums should be reassigned from their current waste stream designations to the appropriate waste stream, so they can be compliantly shipped to WIPP.
3. ENV-RCRA recommends that ADEP-LTP review the existing waste stream descriptions for LA-MHD01.001 (Heterogeneous Debris) and LA-MIN04-S.001 (Salts) in CCP-AK-LANL-006, Rev. 10, in order to ensure that they accurately and sufficiently describe and include the unconsolidated, non-cemented nitrate salts as written. This document is intended to supplement the existing backup documentation, and provide support for any revisions (*if any changes are determined to be necessary*).

1.3 Potential for Future Revision

This report focused on the 47 drums in the 2009 NCR. However, these 47 containers of unconsolidated nitrate salts represent only part of the total population of unconsolidated nitrate salts drums generated at TA-55 between 1978-1979 and late 1991 (believed to be approximately 240-250 total items). We believe our waste stream description in this report accurately represents the entire population of unconsolidated nitrate salts containers generated at TA-55 between 1978-1979 and late 1991. However, if requested,

ENV-RCRA will review whether this description of the unconsolidated nitrate salts is sufficient to describe the entire population, should any information be discovered suggesting a material difference in the total 1979-1991 drum population as compared to these 47 containers.

2.0 BACKGROUND

Evaporator salts and evaporator bottoms have been generated continuously from nitrate recovery operations at TA-55, PF-4 since the beginning of plutonium operations in 1979. Evaporators are used to re-concentrate plutonium, if possible, or to reduce the volume of liquid waste.

This report was prepared specifically to more fully describe one specific type of salt wastes - unconsolidated, non-cemented nitrate salts – which are currently assigned to several of the four Waste Streams currently comprising CCP-AK-LANL-006. '**Legacy TA-55 unconsolidated nitrate salts** are defined here as non-cemented waste evaporator salts and evaporator bottoms that were generated at TA-55. The time frame of interest is from the onset of plutonium operations (1978-1979) to late 1991. Since late 1991, 100% of the nitrate salts generated from the evaporator process were sent to cement fixation immediately upon generation. ENV-RCRA believes that no unconsolidated nitrate salts have been generated since 1991.

This report does not address chloride salts, or other types of salt wastes generated by other TA-55 processes. They represent different waste streams that are not part of this analysis (see CCP-AK-LANL-006, Rev. 10 for discussion of the other salt waste streams).

3.0 STUDY APPROACH

ENV-RCRA personnel, working together with LTP-PTS in coordination with CCP, reviewed available information, data packages, and procedures regarding these 47 containers, and conducted additional interviews of LANL SMEs. Information reviewed for this report came from a variety of sources including:

- Searches of the pertinent LANL databases (TA-55 database, TWSR, SWOON)
- The *Acceptable Knowledge Summary Report for LANL TA-55 Mixed Transuranic Waste* (CCP-AK-LANL-006, Rev. 10).
- The *Acceptable Knowledge Summary for LANL Transuranic Waste Streams* (AKIS) that includes information regarding TRU waste streams.
- Reevaluations of the original TA-55 processes that generated the waste.
- Reevaluations of the potential applicability of Resource Conservation and Recovery Act (RCRA) waste codes to the wastes.
- Reviews of documents related to the original TA-55 waste generation and TA-54 waste management activities.

Supplemental AK information describing this waste was also collected. The sources are referenced throughout this document and listed in Section 11.0. The types of supplemental information collected include:

- Standard operating procedures related to packaging of waste.

- Generator Documentation (i.e., the original data packages including RSWDs, Discardable Waste Log sheets, TWSRs, etc.) for each waste container
- MSDSs related to process chemicals identified
- Technical reports describing historical operations of TA-55, PF-4
- AK documents describing LANL TRU waste operations and management
- Interviews of subject matter experts, TA-55 personnel involved with the original waste generation, and TA-54 personnel involved with TRU waste management activities.

The records management staff responsible for TRU waste records at LANL maintain copies of the documents referenced in this report. Any Unclassified Controlled Nuclear Information (UCNI) contained in these records is not included in this report. Such records are identified as UCNI in the reference section of this report, if applicable (Section 9.0).

3.1 Database Searches

Initially, the review team was given a data dump from the CCP AK Tracking Spreadsheet (AKTSS). Some of the original difficulties in accurate characterization of the unconsolidated nitrate salts may have stemmed from inconsistencies in the data reported in different data fields. For example, the team observed two non-matching waste description fields for the same waste container (e.g., "LEACHED SOLIDS" and "HYDROCARBON OIL-LIQUID;" "SCRAP METAL" and "LEACHED SOLIDS"); unlikely waste-origin locations in PF-4 reported for "LEACHED SOLIDS" waste drums; unlikely RSWD "A-codes" reported for "LEACHED SOLIDS" waste drums; etc. The team quickly determined that multiple data fields will need to be cross-checked, and inconsistencies resolved, in order to accurately identify the sub-population of "LEACHED SOLIDS" or "NITRATE SALTS" waste drums that are, in fact, unconsolidated nitrate salts.

3.2 Trigger Points/ Selection Criteria

Based on these concerns, the LTP-PTS SME developed a series of "trigger points" or search criteria used in our database searches, as described below *[NOTE: this table has **not** undergone QA review by ADEP-LTP].*

TRIGGER POINT/ SEARCH CRITERION	Value	Comment
DATABASE FIELD		
Waste Description	LEACHED SOLIDS	may be nitrate salts (N-salts) (not 100% certainty). This was a 'catch-all' description for a number of different wastes (including nitrate salts, pyrochemical salts, chloride salts (Cl-salts)) (per SMEs interviewed)
	LEACHED PROCESS RESIDUES, LEACHED RESIDUE	may be N-salts (not 100% certainty)
	Other values	'COMBUSTIBLE' and 'NON_COMBUSTIBLE' are not reliable indicators; 'SCRAP METAL' needs to be checked; 'HYDROCARBON OIL' and 'OIL AND VERMICULITE' are almost certainly not N-salts.
WASTE_DESC	NITRATE SALTS	Likely to be N-salts (but not 100% reliable; must be verified using additional data fields)
	LEACHED PROCESS RESIDUES	may be N-salts (not 100% certainty)

Process/status (P/S) code	evaporator (EV)	P/S codes began use in 1981 (per SMEs interviewed)
	IXFS_RR/LR, IX_OX, or IXFS_F1/LR	Evaporator feed from process code IXFS_RR/LR, IX_OX, or IXFS_F1/LR solutions would have been unconsolidated nitrate salts
Date	1979-1991	Salts were 100% cemented after Sept 1991.
GROSS_WT	<500 lbs	Drums >500lbs are likely to be cemented wastes.
Origin/ room (in TA-55)		Likely to be N-salts
		drum loading room (not a unique identifier)
		Oil management room (not N-salts)
		Pyrochemical salts (not N-salts)
LA-WS	55-34	Definitely N-salts
	55-38	55-38 may be N-salts (not 100% certainty). 55-38 was a 'catch-all;' drums after 1985 are definitely cemented (not N-salts)
RSWD FIELD		
WASTE_CD (i.e., "A-code")	A25	may be N-salts (not 100% certainty). If A25 and 55-38, then Cl-salts.
	A26	may be N-salts (not 100%). If A26 and 55-38, then N-salts.
	A27	Definitely N-salts
Material Type (MT)		
		May be N-salts
Discardable Solids Log sheet (DSL) entry		DSL use began ca. 1987(JF)
Matrix	"nitrate salts"	Definitely N-salts
Room Box		N-salts
		May be N-salts
		Lean residue (from column – can contain N-salts) (per SMEs interviewed)
		Lean residue (from column – can contain N-salts) (per SMEs interviewed)
		Oxalate precipitation (can contain N-salts) (per SMEs interviewed)
Tamper Indicating device (TID) number		Presence of a TID number indicates cans (they were not used on bagged salts)
TRIGGER POINT/ SEARCH CRITERION	**Value**	**Comment**
DATABASE FIELD		
Waste Description	LEACHED SOLIDS	may be nitrate salts (N-salts) (not 100% certainty). This was a 'catch-all' description for a number of different wastes (including nitrate salts, pyrochemical salts, chloride salts (Cl-salts)) (per SMEs interviewed)
	LEACHED PROCESS RESIDUES, LEACHED RESIDUE	may be N-salts (not 100% certainty)
	Other values	'COMBUSTIBLE' and 'NON_COMBUSTIBLE' are not reliable indicators; 'SCRAP METAL' needs to be checked; 'HYDROCARBON OIL' and 'OIL AND VERMICULITE' are almost certainly not N-salts.
WASTE_DESC	NITRATE SALTS	Likely to be N-salts (but not 100% reliable; must be verified using additional data fields)
	LEACHED PROCESS RESIDUES	may be N-salts (not 100% certainty)

Process/status (P/S) code	evaporator (EV)	P/S codes began use in 1981 (per SMEs interviewed)
	IXFS_RR/LR, IX_OX, or IXFS_F1/LR	Evaporator feed from process code IXFS_RR/LR, IX_OX, or IXFS_F1/LR solutions would have been unconsolidated nitrate salts
Date	1979-1991	Salts were 100% cemented after Sept 1991.
GROSS_WT	<500 lbs	Drums >500lbs are likely to be cemented wastes.
LA-WS	55-34	Definitely N-salts
	55-38	55-38 may be N-salts (not 100% certainty). 55-38 was a 'catch-all;' drums after 1985 are definitely cemented (not N-salts)
RSWD FIELD		
WASTE_CD (i.e., "A-code")	A25	may be N-salts (not 100% certainty). If A25 and 55-38, then Cl-salts.
	A26	may be N-salts (not 100%). If A26 and 55-38, then N-salts.
	A27	Definitely N-salts
Discardable Solids Log sheet (DSL) entry		DSL use began ca. 1987(JF)
Matrix	"nitrate salts"	Definitely N-salts
Tamper Indicating device (TID) number		Presence of a TID number indicates cans (they were not used on bagged salts)

4.0 DESCRIPTION OF THE PROCESS WASTE

4.1 Facility and Mission

This waste was generated at LANL, located in Los Alamos County in north-central New Mexico, approximately 90 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe. The TA-55 Plutonium Facility (PF)-4 has extensive capabilities for the extraction and recovery of Pu from residues and scraps generated from operations at various LANL facilities and other DOE sites in the defense complex. TA-55 was the specific generator of this waste.

4.2 Activities that Generated the Waste

Today, evaporator salts and evaporator bottoms are generated as one of the major process steps in nitrate recovery operations at TA-55, PF-4. As discussed in CCP-AK-LANL-006, Rev. 10, Section 4.4.2, the overall goal of the TA-55 nitrate operations is to recover plutonium from scrap and residues for production of a purified plutonium oxide product, or for conversion into metal. The primary feed sources for the nitrate operations are plutonium residues from other recovery operations (e.g., chloride operations), metal preparation, metal fabrication, analytical laboratory operations, and residues from other DOE facilities. Evaporator operations (P/S code EV) constitute the 5th step of the six major process steps in nitrate recovery (Pretreatment, Dissolution, Purification and Oxide Conversion/Refinement, Americium Oxide Production, Evaporation, and Cement Fixation). These six process steps are described further in CCP-AK-LANL-006, Rev. 10 and other documents.

Evaporator salts (bottoms) above the discard limit are washed with water and retained. Salts below the discard limit are washed and sent to cement fixation. Evaporator liquids are either sent back to purification or sent to cement fixation, depending on their plutonium content. Spent acid waste low in heavy metals (e.g. chromium) is sent to the Radioactive Liquid Waste Treatment Facility. Heavy metals concentrated in the evaporator salts are treated by cement fixation.

Throughout most of the 1980s, two evaporators were in use. Most of the 47 containers were generated between 2/14/84 and 7/10/85. When the evaporator bottoms in the slab tank cooled to room temperature,

they were then filtered, and the nitrate solution would salt out. Depending on the feed type, the salts were then washed with either concentrated nitric acid or water, vacuum dried (to reduce, but not eliminate, moisture content), and double- (sometimes triple-) bagged, still slightly wet. The bags were placed in 1/16" lead-lined 55-gal drums with a 1/8" polyethylene liner.

4.3 Defense Determination

The WIPP-WAC (12) requires generator sites to use AK to determine if the TRU waste streams to be disposed of at WIPP meet the definition of TRU defense waste. Based on guidance from DOE, TRU waste is eligible for disposal at WIPP if it has been generated in whole or in part by one of the atomic energy defense activities listed in Section 2 of the *Nuclear Waste Policy Act of 1982*.

The waste stream of interest is a type of evaporator salts which, along with evaporator bottoms, are generated from nitrate recovery processes at TA-55, PF-4. Evaporators have been used continuously in these processes since the beginning of plutonium operations in 1979, in order to re-concentrate plutonium, if possible, or to reduce the volume of liquid waste. This work has been funded under defense-related projects in DOE's (and predecessor agencies') Defense Authorization budget requests since the beginning of TA-55 operations. Therefore, as confirmed in previous CCP documents, this waste stream is defense waste and is eligible for disposal at WIPP.

4.4 Waste Management

This waste stream is currently managed as legacy TRU waste under LANL's waste management program. In the present-day TA-55 waste certification process, assignment of a particular container to a waste stream is made on the basis of waste generator information compiled in the AKIS (for legacy waste) and in the TA-55 Waste Management System or the recently implemented institutional Waste Characterization and Tracking System (WCATS) database (for newly generated waste). Waste generator information is reviewed to identify the types and sources of waste items present in each drum, to evaluate the most appropriate waste summary group, waste matrix code (WMC), and potential for the presence of hazardous constituents. TA-55 wastes are assigned to waste streams based on the waste segregation schemes used by TA-55:

- By radioisotope content (e.g., Pu-238 or Pu-239 material type [MT])
- By material matrix (e.g., combustible, noncombustible, metal, glass, etc. waste types)
- By hazardous waste status (e.g., mixed, non-mixed, or special case waste streams)

LANL manages TRU waste in accordance with its Hazardous Waste Facility Permit (LANL Permit) and applicable LANL procedures and DOE/NNSA requirements. LANL generators follow the requirements of the *LANL Waste Acceptance Criteria* to package and label waste for storage at TA-54.

The 47 drums are currently stored at TA-54, Area G, and are currently characterized as follows:

Type	TRU or MTRU waste
Current EPA codes in database	D007 (2 drums), D008(14 drums), or none (*NOTE that 31 of 47 drums do not now carry RCRA codes*)
Waste Matrix Codes	S3110 (1); S3150 (15); S5400(31)
TRUCON	LA-224
Current waste stream nos.	LA-MIN02-V.001 (1); LA-CIN01.001 (15); LA-MHD01.001 (31)
Dates of generation	2/14/84 to 7/10/85
CCP AK report no.	CCP-AK-LANL-006, Rev. 10

Current drum type	55-gal. (18); 85-gal. (29)

4.5 Waste Physical Form and Content Description

In the mid-1980s, unconsolidated nitrate salts were generated in accordance with MST-12 Procedure no. 485-REC-R00, *Treatment of Evaporator "Bottoms"* (approved on 7/6/84; see summary in Attachment 1). In that procedure, when the bottoms in the slab tank cooled to room temperature, they were then filtered, and the nitrate solution would salt out. Depending on the feed type, the salts were then washed with either concentrated nitric acid or water, vacuum dried (to reduce, but not eliminate, moisture content), and double- (sometimes triple-) bagged, still slightly wet. The outer bag was horse-tail cut and taped from the bag-out process, and the bags were placed in 1/16" lead-lined 55-gal drums with a 1/8" polyethylene liner.

SMEs interviewed stated that the evaporator bottoms waste was fairly well characterized, containing sodium, magnesium, aluminum, ferric, ammonium, and calcium in a 3-9M HNO_3 solution. However, the concentrations of the solid salts are unknown, being affected by the differences in solubility of each salt when cooled vs. heated. Two types of salts were generated, as described in Attachment 1. One SME stated that TA-55 evaporator bottoms are very similar to Rocky Flats Plant (RFP) series 745 sludge wastes (which contained evaporator bottoms with nitrate salts.[2])

4.6 Waste Volume and Time Period of Generation

The time frame of interest is from the onset of plutonium operations (1978-1979) to late 1991. Since late 1991, 100% of the nitrate salts generated from the evaporator process were sent to cement fixation immediately upon generation. ENV-RCRA believes that no unconsolidated nitrate salts have been generated since 1991. The 47 drums in question were generated between 2/14/84 and 7/10/85. The total volume (population) of unconsolidated nitrate salts is still being determined.

4.7 Summary Category Group and Waste Matrix Code

The 47 containers in question currently carry the following designations. They are anticipated to change for the *confirmed* unconsolidated nitrate salts drums, as they are reassigned to different waste streams.

No. drums	TA-55 waste stream no.	Description	Summary Cat. Group	Waste matrix code
31	LA-MHD01.001	Heterogeneous debris	S5000, Debris waste	S5400, Heterogeneous debris waste
15	LA-CIN01.001	Cemented TRU waste	S3000, Homogeneous solids	S3150, Solidified inorganics
1	LA-MIN02-V.001	Absorbed liquid waste	S3000, Homogeneous solids	S3110, Solidified organics
0	LA-MIN04-S.001	Salt waste	S3000, Homogeneous solids	S3140, Salt waste

4.8 Waste Generation Process

According to generator SMEs interviewed, evaporator (EV) operations began in early 1979. However, during the 1980s, several different evaporators were used. Our focus will be restricted to evaporator wastes only (usually identified in TWSR and RSWD waste descriptions as "leached process residues," or"nitrate salts").

The 47 containers in question were generated between 2/14/84 and 7/10/85 – most of them under MST-12 Procedure no. 485-REC-R00, *Treatment of Evaporator "Bottoms"* (approved on 7/6/84). In that procedure, when the bottoms in the slab tank were allowed to cool to room temperature (~22° C) and then filtered through a 200-mesh stainless steel screen filter, the nitrate solution would salt out. Two types of nitrate salts were generated, depending on the nature of the feed, as summarized in Attachment 1.

4.9 Material Inputs to the Waste Generation Process and Physical Waste Form Identification

Only two (recent) sources of chemical analytical data have been found so far that can help provide clues to the chemical composition of the legacy drum salts as they were generated in the 1980s: chemical analyses of the current evaporator feed (see Attachment 3), and TCLP analyses of the salts (see discussion in Section 5.3).

According to generator SMEs interviewed, the chemical and radiological composition of the TA-55 nitrate salt wastes has remained relatively consistent since the beginning of PF-4 plutonium operations in 1979 (although from 1979 until the present day, certain specific details of the waste generation, matrix, and packaging processes have continued to change and evolve).

The MST procedure provided valuable clues to additional waste information which– if included in the data package for a given container –helped confirm/deny whether that drum in fact contains unconsolidated nitrate salts:

- Evaporator feed from process code IXFS_RR/LR, IX_OX, or IXFS_F1/LR solutions would have been unconsolidated nitrate salts
- Supernatant solutions with [redacted] or bottoms with uranium were transferred to the Cement Fixation process (and therefore would not have been unconsolidated nitrate salts).

4.9.1 Radionuclide Content Information

This waste is TRU waste, with a TRU concentration of >100 nanoCuries per gram (nCi/g).

5.0 ASSIGNMENT OF EPA HAZARDOUS WASTE NUMBERS

More details are provided in the ENV-RCRA memorandum, same subject.

5.1 F-Listings

Based on their review, CCP determined that the 4 TA-55 legacy waste streams may contain or be mixed with F001, F002, and F005 listed solvents that could potentially contaminate the waste. CCP did not find other applicable F-codes.

5.2 K, P and U Listings

CCP did not find that K, P and U Listings apply to the TA-55 waste streams.

5.3 Toxicity Characteristic Codes

5.3.1 D004-D006

CCP AK-6 Source Document no. M153 (the March 19, 1999 report entitled *Development of Control Charts for the Evaporator Bottoms Newly Generated Waste Stream from TA-55*) presented data for TCLP metal constituents in the TA-55 evaporator bottoms waste. The data suggest that As (D004), Ba (D005), and Cd (D006), although present in the TA-55 evaporator bottoms, have mean concentrations less than their respective TC regulatory threshold limits (RTLs), so D004, D005, and D006 should not be assigned to this waste.

5.3.2 D007, D008, D009

Available data suggest that this waste likely exhibits the toxicity characteristic for Cr, Pb, and Hg. Any drums *confirmed* as being unconsolidated, non-cemented nitrate salts waste should be checked for consistency of their RCRA identification.

5.3.3 D010, D011, D018, D019, D021, D022, D035, D038, D039, and D040

Available data suggest no basis for assigning the TC hazardous waste numbers D010, D011, D018, D019, D021, D022, D035, D038, D039, and D040 to this waste.

5.4 Beryllium Content

There is no evidence indicating the likelihood of Be occurring in this waste.

1.0 ABSENCE OF IGNITABLE, CORROSIVE, AND REACTIVE WASTES

According to the WIPP-WAP, "The prohibition of liquids and containerized gases prevents the shipment of corrosive, ignitable, and reactive wastes". Administrative controls on waste packaging are in place to ensure the absence of such items from the waste. More details are provided in the ENV-RCRA memorandum, same subject.

6.1 D001 - Ignitability

There have been no EPA ignitability or oxidizer tests performed on the legacy unconsolidated nitrate salt waste. However, based on ENV-RCRA's review of AK, we believe these drums are not likely to exhibit properties meeting the EPA reactivity definition. Thus, a 95% confidence level is assigned to this determination. More details are provided in the ENV-RCRA memorandum, same subject.

6.2 D002 - Corrosivity

The potential exists for small amounts of free liquid to be present in some containers due to dewatering of bagged salts over time. Any free liquid encountered in these drums should be managed as potentially RCRA corrosive (D002) waste (unless shown otherwise by pH testing) and remediated, since drums containing free liquids may not be shipped to WIPP.

6.3 D003 - Reactivity

Not applicable to these drums, based on ENV-RCRA's review of AK. There have been no EPA reactivity tests performed on this waste. More details are provided in the ENV-RCRA memorandum, same subject.

7.0 ABSENCE OF INCOMPATIBLE CHEMICALS

Administrative controls were in place at TA-55 during the 1980s to prohibit incompatible chemicals in the waste, and measures are taken to verify their absence, as confirmed by a review of waste generating procedures. In addition, all waste containers shipped from TA-55 to TA-54 for storage are evaluated for potentially incompatible chemicals in accordance with 49 CFR Subpart C – Segregation and separation chart of hazardous materials; Section 177.848, Segregation of hazardous materials, and were determined to be in compliance with this requirement.

8.0 ABSENCE OF COMPRESSED GASES, FREE LIQUIDS, NONRADIONUCLIDE PYROPOHORICS, SEALED CONTAINERS GREATER THAN FOUR LITERS IN VOLUME, >1% EXPLOSIVES, Explosives, >1% RADIONUCLIDE PYROPOHORICS, AND POLYCHLORINATED BIPHENYLS

The absence of prohibited items was determined by review of waste generating process documentation.

8.1 Compressed Gases

There are no compressed gases or pressurized vessels that may contain compressed gases in this waste, based on generator interviews, reviews of procedures, reviews of the original waste data packages, and knowledge of the waste generating process.

8.2 Free Liquids

The unconsolidated salts of interest were packaged relatively dry, but still contained some small amount of liquid. As stated above (Section 6.2), the potential exists for small amounts of free liquid to be present in some containers due to dewatering of bagged salts over time. Their absence will need to be confirmed by RTR and/or visual examination of a sample of the containers. This liquid most likely would be RCRA corrosive (D002). Liquids present in unacceptable amounts will be considered prohibited until the container is remediated to remove the liquids.

8.3 Nonradionuclide Pyrophorics

There are no known nonradioactive pyrophoric materials in this waste, based on a review of waste generating process documentation.

8.4 Sealed Containers Greater Than 4 Liters in Volume

There are no sealed containers greater than four liters in volume expected to be present in this waste.

8.5 Explosives

There are no explosives in this waste based on our review of waste documentation and knowledge of the waste generating process.

8.6 >1% Radionuclide Pyrophorics

There are no known radioactive pyrophoric materials in this waste, based on a review of waste generating process documentation.

8.7 Polychlorinated Biphenyls (PCBs)

There are no known PCBs in this waste, based on a review of waste generating process documentation.

9.0 WASTE PACKAGING

This waste is currently stored at TA-54 in DOT-approved containers. Before being sent off-site, it will be packaged per WIPP requirements. The following sections describe the packaging configuration of this waste.

9.1 Payload Containers

As currently stored at TA-54, this waste is packaged in DOT, Specification 7A, Type A containers (55-gallon drums) and/or 85-gallon overpack containers.

9.2 Layers of Confinement

As discussed above, some of the unconsolidated salts were vacuum dried (to reduce, but not eliminate, moisture content), and double- (sometimes triple-) bagged, still slightly wet. The outer bag was horse-tail cut and taped from the bag-out process, and the bags were placed in 1/16" lead-lined 55-gal drums with a 1/8" polyethylene liner.

Some SMEs stated that during a period later in the 1980s, some unconsolidated nitrate salts were placed into 1-gallon stainless steel slip cans without cement, and that the cans were then bagged and placed into 55-gal drums.

9.3 Filter Vents

When the containers were removed from TA-54 Pads 1, 2, and 4 during the 1990s TWISP project, they fitted with a WIPP-compliant filter vent.

9.4 Waste Identifiers

Each waste container (55-gallon drum) is identified with a unique numerical identifier at the time of packaging. Payload container identification and marking for the purpose of disposal at WIPP will be managed by CCP. Original and/or interim waste container identification numbers are correlated to final waste container identification numbers.

10.0 WASTE Container Specific Information

The waste container list is still being verified by ADEP-LTP at this time.

11.0 References

Waste Analysis at Facilities that Generate, Treat, Store and Dispose of Hazardous Waste, a Guidance Manual, OSWER 9938.4-03, U.S. Environmental Protection Agency, Washington D.C.

Waste Isolation Pilot Plant Hazardous Waste Permit, NM4890139088-TSDF, Attachment B, "Waste Analysis Plan", New Mexico Environment Department, Santa Fe, New Mexico.

Acceptable Knowledge Information Summary for LANL Transuranic Waste Streams (AK-00-019), Los Alamos National Laboratory, Los Alamos, New Mexico.

Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, DOE-WIPP-02-3122, Carlsbad Field Office, Carlsbad, New Mexico.

Nuclear Waste Policy Act of 1982, Public Law 97-425 and amendments, Section 2, "Definitions" (3).

LANL Waste Acceptance Criteria, PLAN-WASTEMGMT-002, R.4.1, Los Alamos National Laboratory, Los Alamos, New Mexico.

DOE Waste Treatability Group Guidance, DOE/LLW-217, Idaho National Environmental and Engineering Laboratory, Idaho Falls, Idaho, at http://www.osti.gov/bridge/servlets/purl/32780-hu1aQg/webviewable/

Title 40, Code of Federal Regulations, Part 261, *Identification and Listing of Hazardous Waste.*

TCLP Questions, U.S. Environmental Protection Agency, http://www.epa.gov/waste/hazard/testmethods/faq/faq_tclp.htm.

Contact-Handled Transuranic Waste Authorized Methods for Payload Control (CH-TRAMPAC), Washington TRU Solutions, LLC, Carlsbad, New Mexico.

CCP AK-6 Source Document no. M153, *Development of Control Charts for the Evaporator Bottoms Newly Generated Waste Stream from TA-5,* Benchmark Environmental Corporation (for LANL), March 19, 1999.

Email Communications and Interviews *[available in ENV-RCRA group files]*

FOOTNOTES/ ENDNOTES

1 *CCP NCR no. NCR-LANL-0509-09, June 23, 2009. The NCR stated that* "As (a) result of new AK information from the generator, i.e., TA55 Cement Fixation Group, forty-eight (48) drums that are currently on the AKTSS have been identified as potentially, non-cemented Evaporator Salts, which would require these drums to be re-assigned to a separate waste stream. As of 06/22/2009, only one of these drums, i. e. drum no. S841320, has been through characterization and discovered to be a chloride salt drum, i.e., LA-RTR2-08-0192."

2 *All RFP 74-Series sludge was placed inside double polyethylene bags within a 55-gal drum. The contents of RFP Series 745 sludge are described to be 60% sodium nitrate, 30% potassium nitrate, and 10% 'miscellaneous.' The miscellaneous mass consisted of organic wastes; used items such as rags, paper, and gloves; and organic compounds like alcohols, organic acids, and ethylene diamine tetraacetic acid (EDTA).*

APPENDIX 1

Synopsis of MST-12 Procedure no. 485-REC-R00, *"Treatment of Evaporator "Bottoms"*

APPENDIX 1

Synopsis of MST-12 Procedure no. 485-REC-R00, "*Treatment of Evaporator "Bottoms,"* approved on 7/6/84

(this was the procedure in effect at time of generation of most of the 47 drums).

1. Volume-Reduction Nitrate Salts

- Feed came from process code IXFS_RR/LR and IX_OX solutions containing no more than 50 g Pu per batch.
- Supernatant solution was transferred into the slab tank with filtering screen into 9-L bottles. Salts unfilterable through the screen were scooped directly into the filter boat for filtration after the supernatant solution was removed from the salts in the slab tank.
- Nitrate salts were then washed with bulk acid (washes were minimized -- not to exceed three).

> ***NOTE: the procedure warned that nitrate salts derived from oxalate filtrates should be washed only with water to prevent the acceleration of decomposition of any oxalic acid present in the salts, which could result in pressurization of the 55-gal drum once sealed.***

2. Routine Nitrate Salts

- Feed came from process code IXFS_F1/LR solutions containing no more than 50 g Pu per batch.
- Supernatant solution was transferred into the slab tank with filtering screen into 9-L bottles. Salts unfilterable through the screen were scooped directly into the filter boat for filtration after the supernatant solution was removed from the salts in the slab tank.
- Supernatant solution containing no salts or Pu was returned to the process stream for further volume reduction.
- Supernatant solution was transferred to the Cement Fixation process if foaming occurred; bottoms were syrupy and unfilterable; the solution contains [redacted]); bottoms contained uranium; or if 3-L of salts remained after filtration.

Both types of salts were then vacuum-dried for a minimum of 15 minutes. Vacuum-dried salts were then packaged in double plastic bags. Filteraid was added to absorb any moisture if salts were of gel-like consistency. Filled drums were then sealed, weighed, monitored, and a lid-deflection reading was taken. It was compared with another deflection reading taken at a later date.

APPENDIX 2

Detailed Waste Information

1. Location of Generation	During the 1980s, salts and bottoms were generated in PF-4, Room 434. These salts were managed/packaged in Room 432, the PF-4 waste management room.	Room number can be used as a tool to help identify unconsolidated nitrate salts drums in the database, but it is not a 100% reliable discriminator.
2. Waste Volumes and Time Periods of Generation	The waste type of interest, unconsolidated nitrate salts, was generated only during a finite period between approximately 1979 *(the beginning of PF-4 plutonium operations)* and late 1991. Since late 1991, 100% of the nitrate salt wastes generated at TA-55 have been sent to cement fixation upon generation. Evaporator salts continue to be generated at TA-55 today.	The total volume (population) of unconsolidated nitrate salts is still being determined. The 47 drums in question were generated between 2/14/84 and 7/10/85.
3. Cementation	Fifteen (15) of the 47 drums in question are currently listed in Waste Stream LA-CIN01.001 (Cemented wastes). Drums cemented using various cementation processes are not part of the unconsolidated nitrate salts waste as defined herein. Generally, cemented waste drums are listed in the TRU databases in the cemented waste stream, although some are listed in the debris waste stream when a sufficient percentage of debris (including steel inner cans) is present (*see* Waste Matrix Code, *below).* According to generator SMEs interviewed, cement fixation (CF) processes began very early in 1980 at TA-55. Throughout the 1980s, different CF processes were increasingly used to immobilize certain waste streams from the evaporator at the time of generation –including evaporator bottoms, certain salts and solutions, and nitrate salts. Initially, powdered cement was added to the plastic-bagged wet salts and mixed by hand-kneading the bag. Later, a power mixer was used to blend certain evaporator wastes with dry gypsum or Portland cement in a one-gallon steel can inside a glovebox. Later still, salts and cement were mixed together directly into a 55-gallon drum attached to the glovebox. These variations may have continued until September 1991, when the current computer-operated evaporator and cementation unit came on-line (per NMT-2 Safe Operating Procedure no. 485-REC-R01, *Computer Operated Nitric Acid Volume Reduction and Treatment of Evaporator Bottoms*). Since then, 100% of the nitrate-salt wastes have been cemented.	Our focus is on non-cemented wastes only. Containers of cemented salts do not meet our unconsolidated nitrate salts waste definition.

4. Documentation, Transportation and Storage (1)	During the 1980s, drums were transported to TA-54 for retrievable storage under a Radioactive Solid Waste Disposal Record (RSWD). SMEs interviewed stated that RSWDs for unconsolidated, non-cemented nitrate salts should only have used the RSWD code A-25 (*leached process residues*), A-26 (*evaporator bottoms [salts]*), or A-27 (*nitrate salts*).	RSWD codes A-25 (*leached process residues*), A-26 (*evaporator bottoms [salts]*), or A-27 (*nitrate salts*) can be used as a tool to help identify unconsolidated nitrate salts drums in the database, but they are not by themselves a 100% reliable discriminator.
5. Documentation, Transportation and Storage (2)	• ENV-RCRA believes the 47 drums under review were initially placed on Pads 1, 2, and/or 4. They were retrieved in the 1990s as part of the TWISP project, overpacked if necessary, and moved into their current storage configuration in the TA-54 domes. • They have undergone weekly (or more frequent) inspections ever since. • TA-54 personnel have never reported any problems or evidence of ignitable, corrosive, or reactive behavior in any of the 47 drums since they were moved to above-ground storage in approximately 1997, which supports the notion that the drums would not exhibit these RCRA characteristics.	• There is no recent sampling or test data for the LANL unconsolidated nitrate salt drums to confirm whether or not they would now exhibit oxidizing behavior (or other aspects of the RCRA ignitability definition). • However, ENV- RCRA's AK review found no new information supporting the assignment of D001 to these 47 drums now -- as they are presently stored at TA-54. • Since the containers are now in above-ground storage, as a best practice, they should be checked (on an ongoing basis) specifically for any external evidence of oxidizing behavior. • Likewise, any future drum handling or movement should take into account the potential to exhibit oxidizing behavior (it is not 100% ruled out). Detailed discussion of ignitability (D001) or reactivity (D003) potential is provided in a separate ENV-RCRA document.
6. Material Input Related to Physical Form (1)	The salts of interest are only the unconsolidated, non-cemented nitrate salts that were packaged wet into plastic bags inside 55-gallon drums.	Drums containing cemented salts do not meet our unconsolidated nitrate salts waste definition.
7. Material Input Related to Physical Form (2)	Throughout the 1980s, waste nitrate salts not returned to the processing stream were separated, washed, dried to a lower moisture content, double bagged, and then placed without cement into drums.	Unconsolidated salt wastes were being generated side-by-side with cemented wastes during the same time period. The two wastes were packaged into different drums.
8. Waste Matrix Code (1)	Thirty-one (31) of the 47 drums in question are currently listed in Waste Stream LA-MHD01.001 (Heterogeneous debris). As described above, for a time, some evaporator salts were cemented in small steel cans which were then stacked within a 55-gallon drum. The metal content due to the steel cans may cause the drum to meet the definition of Waste Stream LA-MHD01.001.	Drums containing inner steel cans are unlikely to be unconsolidated nitrate salts waste, as defined herein.
9. Waste Matrix Code (2)	Although thirty-one (31) of the 47 drums in question are currently listed in Waste Stream LA-MHD01.001 (Heterogeneous debris), all information reviewed indicates that only cemented salts would be found in small cans within a drum.	Drums of unconsolidated, non-cemented nitrate salts containing <50% debris are unlikely to meet the stated definition of Waste Stream LA-MHD01.001 and would need to be reassigned to an appropriate waste stream (currently there is none in AK-006).
10. Waste Matrix Code (3)	One (1) of the 47 drums in question is currently listed in Waste Stream LA-MIN02-V.001 (Absorbed liquid waste).	Drums that would meet the definition of waste stream LA-MIN02-V.001 (i.e., because they contain absorbed TRU liquids) likely would not contain unconsolidated nitrate salts.
11. Waste Material Parameters	1. Chemical analyses of the current evaporator feed provide clues to the chemical composition of the legacy drum salts. Totals analysis (see Attachment 3) show the presence of chromium potentially exceeding RCRA toxicity characteristic levels (i.e., D007) in the current evaporator feed. 2. The March 19, 1999 report entitled *Development of Control Charts for the Evaporator Bottoms Newly Generated Waste Stream from TA-55*	Drums confirmed to be unconsolidated, non-cemented nitrate salts waste should be checked for consistency of RCRA identification.

	(CCP AK-6 Source Document no. M153, TWCP Doc. no. TWCP-3568) presented data for TCLP metal constituents in TA-55 evaporator bottoms waste.	

APPENDIX 3

Totals analysis of current TA-55 evaporator feed solution (example)

Source: LANL C-AAC, 9/13/07

C-AAC Analytical Results Report

Report run on: September 13, 2007 9:42 AM

Report Number: 12845 Revision: 0 - SamID: 200172582 UserSamID: EVRFX061207B1

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COMPONENT	RESULT	UNITS
TOTAL BATCH VOLUME	25	L
PU	1.33	g/L
PU +/- RED	5	%
AM-241	1.28E-01	g/L
AM +/- RED	5	%
TOTAL PU IN BATCH	3.32E+01	g
TOTAL AM IN BATCH	3.19	g
SILVER	4.2	ug/mL
ALUMINUM	0590	ug/mL
ARSENIC	5.0	ug/mL
BORON	140	ug/mL
BARIUM	14	ug/mL
CALCIUM	159	ug/mL
CADMIUM	0.28	ug/mL
CHROMIUM	1210	ug/mL
IRON	3520	ug/mL
GALLIUM	364	ug/mL
POTASSIUM	682	ug/mL
LITHIUM	0.38	ug/mL
MAGNESIUM	99	ug/mL
SODIUM	359	ug/mL
NICKEL	731	ug/mL
LEAD	11	ug/mL
SELENIUM	11	ug/mL
SILICON	166	ug/mL
THORIUM	40	ug/mL
URANIUM	388	ug/mL
MERCURY	<0.05	ug/mL

*** This section contains sample results data in a format that can easily be copied into MS Excel.
When viewing this report, highlight the data in this section, then right-click and select "Open Table in Spreadsheet"
("Open Table in Spreadsheet" works with Adobe version 7 and later products. It may not work with earlier versions).