

Attachment 3

LANL-Carlsbad Office Difficult Waste Team (DWT)

Amount of Zeolite Required to Meet the Constraints Established by the EMRTC
Report RF 10-13: Application to LANL Evaporator Nitrate Salts, May 8, 2012

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Purpose:

The following document was developed in support of the Los Alamos National Laboratory Transuranic Program (LTP) by the LANL-Carlsbad Office, Difficult Waste Team. The document is divided into five sections, with the section on conclusions provided first, followed by background, assumptions, discussion, and recommendation.

Conclusions:

1. Nitrate salts not yet remediated having no free liquid should be mixed with at least 1.2 volumes of Kitty Litter/Zeolite clay per volume of nitrate salts. For operational efficiency at WCRRF (rule-of-thumb) for every gallon of nitrate salt present the addition of two (2) gallons of zeolite/kitty litter may be added to help ensure the final mixture meets or exceeds EMRTC testing constraints.
 2. Nitrate salts not yet remediated but having free liquids should be mixed with at least 1.2 volumes of Kitty Litter/Zeolite clay per composite volume of nitrate salt and liquid.¹ Ensure that no free liquid remains. For operational efficiency at WCRRF (rule-of-thumb) for every gallon of nitrate salt present the addition of two (2) gallons of zeolite/kitty litter may be added to help ensure the final mixture meets or exceeds EMRTC testing constraints.
 3. Nitrate Salts previously remediated with Waste Lock 770® should be mixed with at least 1.2 volumes of Kitty Litter/Zeolite clay per composite volume of nitrate salt, absorbed liquid and Waste Lock 770®. For operational efficiency at WCRRF (rule-of-thumb) for every gallon of nitrate salt present the addition of two (2) gallons of zeolite/kitty litter may be added to help ensure the final mixture meets or exceeds EMRTC testing constraints.
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Background:

Nitrates salts from evaporator operations at TA55 were packaged (up to around 1991) primarily in plastic bags and ranged in moisture content up to saturation (generator knowledge states the salts were “cursorily drained of liquid”).² Visual review by WCRRF operators of nitrate salts brought to WCRRF for remediation showed that almost all of

¹ When free liquids are readily apparent, the use of a “fired zeolite clay” product may be more efficient in holding free liquids than non-fired (e.g., ordinary kitty litter). The following are examples only of some fired zeolites and no endorsement is made for any of the examples given: Oil-Dry QuickSorb1™, ZeoFill™, or Zeolit™.

² Email Gerald W. Veazey to Randy Fitzgerald, August 9, 2011, subject: “RE: Information on 47 Drums of Suspect Nitrate Evaporator Salts (from TA-55)”.

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evaporator salt drums had free liquids (as much as 12 gallons) or the salt itself appeared quite wet. As a result, the LANL TRU Program (LTP) added Waste Lock 770³® as an absorbent to the free liquids and wet salt. In some cases several 50-pound bags of Waste Lock 770® were used to absorb the volume of free liquid present in a drum.⁴ Neither the volume nor weight of Waste Lock 770® added to drums or POCs was recorded for the remedial nitrate salt actions taken at WCRRF.

Nitrate salts brought into WCRRF for remediation were not weighed nor were their volumes estimated. Salts that did not have free liquids were not mixed with Waste Lock 770®. A surface dose rate was taken directly on these nitrate salts and if the reading was >180 mrem/hr the salts were packaged into a 12" Pipe Overpack Container (POC). Nitrate salts having free liquids with surface dose rates > 180 mrem/hr were packaged into 12" POCs with Waste Lock 770®.

Currently, there are four (4) basic categories of evaporator nitrate salts identified by LTP in Solution Package - SP 72:

1. Non-remediated salts without free liquids, that may or may not have lead shielding
2. Non-remediated salts with free liquids, that may or may not have lead shielding
3. Salts repackaged into drums or POCs that did not have free liquids (no Waste Lock 770® added)
4. Remediated salts repackaged into drums or POCs that did have free liquids (Waste Lock 770® has been added)

The Energetic Materials Research and Testing Center (EMRTC)⁵ operating in conjunction with LANL-Carlsbad Office and Washington TRU Solutions previously tested the most oxidizing mixture of sodium and potassium nitrate salts mixed with zeolite or grout. The results of EMRTC⁶ testing established the concentration at which the most reactive mixture of sodium and potassium nitrate becomes a non-oxidizer when mixed with either zeolite or grout. The results apply to LANL non-cemented nitrate salts. Accordingly, the application of the constraints established by EMRTC to the LANL evaporator nitrate salts, with certain bounding assumptions, provides sufficient information for the WIPP to affirm

³ http://www.m2polymer.com/html/waste_lock_770.html. "[A] solid, granular superabsorbent polymer [that is] cross-linked polyacrylate material [that] swells and absorbs many times its weight in aqueous solutions...suited for the absorption and solidification of low level radioactive waste (LLRW)." Waste Lock 770® has a bulk density of 5.4 – 6.0 lbs/gal., for use in solutions with pH>4 (pH adjustment is recommended for pH4 or less).

⁴ Oral communication with Energy Solutions WCRRF operations manager regarding the amount of Waste Lock 770® needed to absorb free liquids in some of the evaporator nitrate salts drums remediated at WCRRF.

⁵ EMRTC is an approved examining agency (DOT/UN Testing and Classifications) for explosives and other hazardous materials.

⁶ Graham Walsh, Research Scientist, Energetic Materials Research and Testing Center, New Mexico Institute for Mining and Technology, Socorro, New Mexico (Certified DOT Testing Laboratory), "Results of Oxidizing Solids Testing, EMRTC Report RF 10-13" prepared for Washington TRU Solutions, LLC, March 12, 2010.

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that the LANL nitrate salts, when mixed with zeolite/kitty litter, will be considered a non-oxidizing solid.

Assumptions:

1. Bulk density of KNO_3 is approximately 0.8 g/cc and the crystal density about 2 g/cc; accordingly, the assumed density for the nitrate salt is 1 g/cc.⁷
 2. Bulk density of kitty litter is about 0.4 g/cc to 0.5 g/cc.⁸ Kitty litter is assumed to be ½ the bulk density of the nitrate salt.
 3. Nitrate salts were loaded into POCs if the surface dose rate of the bare salt was >180 mrem/hr.
 4. Density of the Waste Lock 770® plus water is assumed to be 1 g/cc (Waste Lock 770® is around 0.71 g/cc but the addition of water increases the density closer to 1)⁹
 5. Cellulose used in the testing is more readily oxidized than Waste Lock 770®
 6. The nitrate salts themselves cannot be readily removed from the salt/Waste Lock mixture
 7. Weighing the mass of previously remediated nitrate salts in the WCRRF glovebox is impractical but the volume of the remediated salts can be estimated visually or by simple measurement (measurement of depth). Therefore, at least 10% excess of zeolite will be added to account for measurement error of the volume.
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Discussion:

The bounding ratios for zeolite from the EMRTC report are:

- 50 wt.% cellulose
- 33 wt.% of nitrate salts
- 18 wt.% of zeolite/kitty litter

Using the assumptions stated above these values correspond to the following bounding volume ratios:

For nitrate salts not mixed with Waste Lock 770®:

- 48 vol.% of nitrate salts
- 52 vol% of zeolite/kitty litter

⁷ See Merck http://www.merckmillipore.com/is-bin/INTERSHOP.enfinity/WFS/Merck-International-Site/en_US/-/USD/ViewPDFPrint.pdf?RenderPageType=ProductDetail&CatalogCategoryID=&ProductUUID=vdab.s1OzvUAAAEWevAW4z8b&PortalCatalogUUID=6dCb.s1Lbk0AAAf9cfVhTl, crystal density is listed at 2.109 in the Chemical Rubber Handbook for potassium nitrate.

⁸ <http://www.alibaba.com/showroom/cat-litter-bulk.html>

⁹ See footnote 2. The density of Waste Lock 770® is around 0.71 g/cc but the absorption of water increase the final density closer to 1 g/cc.

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Therefore, for every liter of nitrate salt present at least 1.2 liters of zeolite/kitty litter must be added. For operational efficiency at WCRRF (rule-of-thumb) for every gallon of nitrate salt present the addition of two (2) gallons of zeolite/kitty litter may be added to help ensure the final mixture meets or exceeds EMRTC testing constraints

For nitrate salts mixed with Waste Lock 770® there is a certain ratio of Waste Lock 770® to nitrate where less zeolite than the pure nitrate case would be necessary to result in a non-oxidizing mixture. However the ratio of Waste Lock 770® to nitrate is not known so no credit can be taken for the dilution of nitrate. Therefore, for every liter of composite nitrate salt, absorbed liquid and Waste Lock 770® present at least 1.2 liters of zeolite/kitty litter must be added. For operational efficiency at WCRRF (rule-of-thumb) for every gallon of nitrate salt present the addition of two (2) gallons of zeolite/kitty litter may be added to help ensure the final mixture meets or exceeds EMRTC testing constraints.

Recommendation:

Actual tests at WCRRF have demonstrated a 10X reduction in dose when the salts are loaded into 55-gallon drums; therefore, some of the salts previously packaged into POCs at WCRRF were done under an overly conservative constraint and could be re-packaged into 55-gallon drums and still meet the <200 mrem/hr surface dose rate on the outside of the 55-gallon drum.