Remediated and Unremediated Nitrate Salts - Lessons Learned

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Searching for lessons learned can turn up unexpected factoids….

Among the Savannah River Site construction workers were Eugene and Eulie David. The two skilled welders had been among the actors in the 1939 classic film “The Wizard of Oz” who played the part of Munchkins.

Overarching RNS/UNS Lessons Learned

Essential ingredients for success

- **Great leaders working as a team**
- **Building a strong safety culture in the workforce (pause if unsure)**
- **Strong technical basis for treatment**
- **Implementation through process engineering principles and formal change control**
- **Robust procedures, training, and qualification**
- **Strong use of Quality Control, and oversight (internal and Federal)**
- **Effective partnering among LANS, EM-LA, NA-LA, HQ, CBFO, and NMED**

Operational Leadership-setting the stage

- **Asking critical questions:**
  - RNS Waste Readiness process was preceded by significant inquiry into the chemistry underlying the LANL nitrate salt incident at the WIPP
  - Our robust studies established the basis for recognition that we have the knowledge, expertise, and facilities:
    - Understood the chemistry and variables involved in exothermic reactions
    - Incorporated strong technical knowledge in management team
    - Division Leader brought “fresh eyes” and additional operational expertise to the team
    - Team Leaders selected their core teams in treatment and facility operations
    - WCRRF FOD maintained significant involvement in waste processing operational learning
    - Waste processing operational procedure evolved with continuous learning from workers, observations, and field-evaluation
- **Emphasizing deliberate speed and a questioning attitude:**
  - Smooth is fast, fast is slow; operational paradox

Understanding critical steps (what has to go right)

- **Processing of RNS Waste involved identification of multiple controls for inclusion in operations:**
  - Technical aspects – manage temperature and pressure of the waste
  - Develop and Implement Facility Safety Basis controls
  - Develop and Implement RCRA controls and Hazardous Waste Permit Modification
  - Incorporate Criticality Safety controls
  - Developed an Engineered Process and Associated Tools
  - Others
- **Changing procedure development process enhanced critical communications, incorporation of worker input, and efficiency in process**
  - Eliminated serial nature of operational procedure review cycle
  - Empowered our competent operators in detailing procedural steps to optimize execution on the floor
  - Modified operating procedures based on learning in field

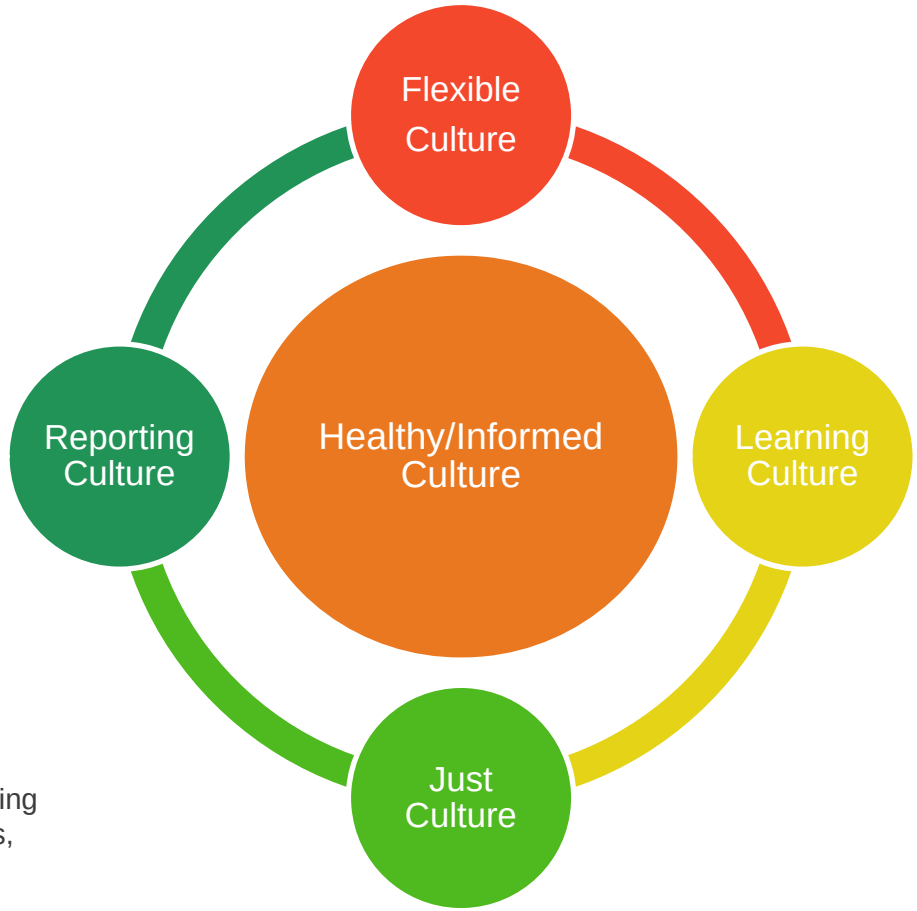
Flexible management of risk = agile learning

- **During Contractor and Federal Readiness Assessments**
  - WCRRF power outage (Automatic Transfer Switch issue)
    - Chance to conduct real corrective maintenance, led to clarification of craft training to vital safety systems
    - Provided Control Room with real abnormal event response situation. Persons maintained controlled exit, excellent RadTech surveying and segregation, and enabled team leaders to communicate ConOps expectations following exit
  - Waste team identification of damaged glovebox glove
    - Issue raised immediately and work paused
    - Condition corrected and waste processing evolution delayed but completed
  - Waste team identification of potentially cracked drum lift belly band
    - Same conditions inspected for months with a different outcome per a fresh look
    - Differing opinions among operators as to whether conditions were concerning
    - Employees trusted management enough to raise concern and management trusted employees enough to take action
  - Emergency exercise learning
    - Immediate identification of need to bolster emergency planning/practice
    - Immediate learning regarding hazards communication with responder organizations

Healthy culture seen in observations and interviews

- **Sustained line management involvement in field**
  - Engaged operational leadership observers
  - Line continuously coached and mentored - focus on what had to go right
- **Operational learning incorporated immediately**
  - Field procedures modified as knowledge changed
  - Field practice reinforced learning
- **Team interaction reflected cohesion, trust, and open communication**
  - Damaged glove reported immediately by newer team member
  - Interviews with teams demonstrated acceptance of differing opinions
  - Healthy team interaction to derive best practices for field execution observed
  - Direction taken from most qualified at the moment: (PIC identified effective means of coordinating activities and members responded. Team Lead informed team and support organization to maintain their location for accountability when personnel expressed desire to leave)
  - Team noted that others “had their back” via coaching and supporting right execution

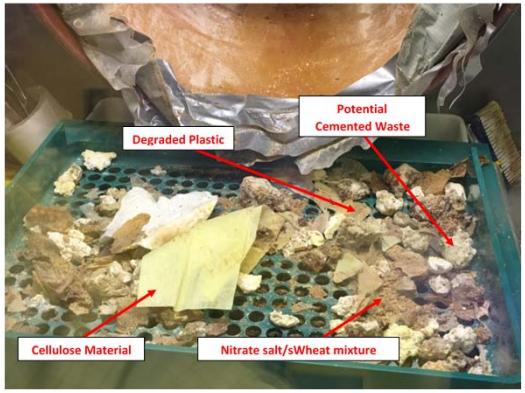
RNS- Human and Organizational Performance



Derived from James Reason- Managing the Risks of Organizational Accidents, Taylor and Francis

Treatment of Remediated Nitrate Salt (RNS) waste began at LANL on May 18, 2017

- **After receiving approval from EM-LA and DOE/EM-HQ and after processing two surrogate containers, LANS processed the first RNS drum.**
  - Contents were unexpected (e.g., contained possible cemented waste) but were processed successfully.
- **The 60 RNS drums were completed in November 2017; 27 UNS drums in March 2018.**
  - Each proved to be unique, and yet provided valuable lessons learned for subsequent drums.



Waste from the first LANL RNS drum.

Waste images from the sister container to 68660, 68685

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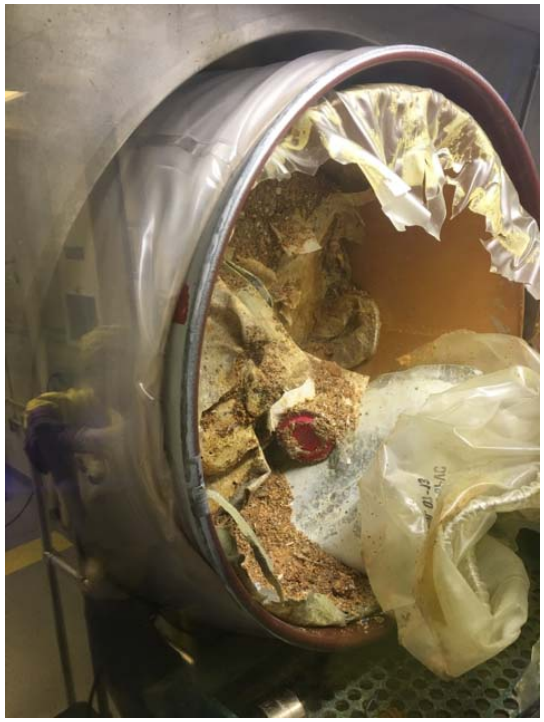


Unexpected items required analysis, processing method development

Images from 69490

Images from 69616

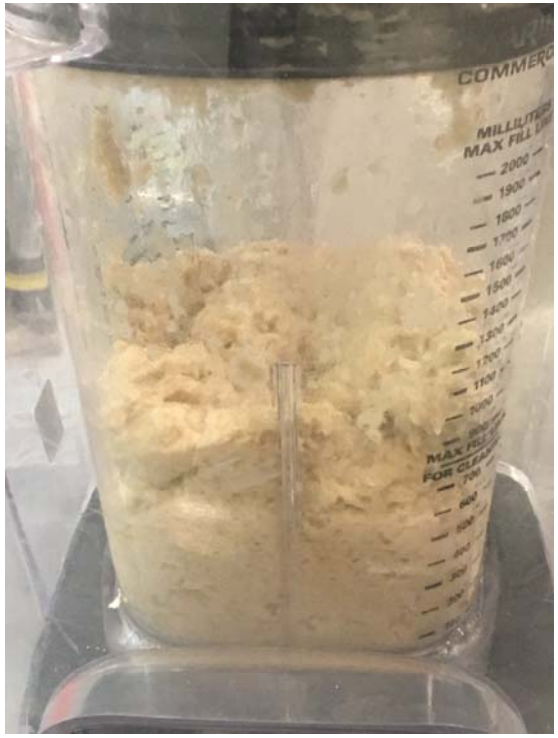
Initial Processing Lessons

- **RNS #1 (68553) – May 18-19, 2017 (Batches: 14, Daughters: 3)**
- **The first drum was chosen due to light RNS loading (limited number of batches required), to ensure one day completion**
- **Waste form was “chunkier” than expected, requiring additional time for processing. Requested permit mod for additional tools to use, from NMED.**
- **Post-treatment sampling was taken, with three samples gathered. Procedures required bagging out each sample individually, which took additional time to transition the crew to respiratory protection for each sample bag-out. We have since revised the procedure to allow all samples to be bagged out at the same time.**

Class 1* permit mod for use of additional size reduction tools was approved by NMED

Initial Processing Lessons

- **RNS #2 (92669) – May 22-26, 2017 (Batches: 55, Daughters: 5)**
  - **The second drum had more RNS, and unexpected conditions caused the drum to take the entire week for treatment.**
  - **Activities associated with treating RNS went well (actually outpacing our schedule assumptions), the handling and cleaning the debris waste was very time-consuming.**
  - **Operational pauses included:**
    - Pause for a batch of cellulosic rags that was too dry to blend properly (wastelock - required an urgent procedure revision and the introduction of a replacement blender)
    - unexpected masslinn in the parent waste (evaluated to require treatment rather than being debris waste)
    - zeolite bags that were missing the quality acceptance labeling.



Initial Processing Lessons

- **RNS #3 (68638) – May 30-31, 2017 (Batches: 6, Daughters: 3)**

This drum had relatively small quantities of RNS but contained considerable debris that extended the treatment into the morning of May 31, 2017.

- **RNS #4 (69280) - May 31-June 2, 2017 (Batches: 62, Daughters: 7)**

Two equipment issues were experienced: a broken weld on the tube that adds water to one of the mixing bowls (resulting in use of only one mixer to finish the drum), and a leaking fitting on the water line to the blender (requiring the introduction of a replacement water line).

- **RNS #5 (69445) – June 5-7, 2017 (Batches: 129, Daughters: 11)**

This was the first drum to employ extended-shift operations, as a result of effective crew rotations demonstrated during the treatment of the first 4 drums. This drum contained the most RNS to date (approximately 92 batches). The capacity of the RNS daughter drums was found to be less than estimated (24 batches rather than 30), requiring more daughter drums and the associated bag-on/bag-off operations under respiratory protection. Rotation of the drum allows additional batches to fit in the drums and has been implemented. (92 batches predicted; 130 processed)

Initial Processing Lessons

- **RNS #6 (69618) – June 8-9, 2017 (Batches: 123, Daughters: 9)**

This drum proceeded very smoothly until we reached the end of the container. The material had, until that point in time, been straightforward to process. Near the bottom of the drum, after pulling out the old poly liner lid, the material was found to be caked and/or doughy, making it difficult to run through the sieve. A review of the genealogy indicated that this was the first daughter and that the parent had three gallons of liquid. Operationally, one mixer system developed a leak, and we bagged in a new bowl and hose (not sure of the origin of the leak) since we have plenty of spares.

- **RNS #7 (69636) – June 12-13, 2017 (Batches: 59, Daughters: 5)**

This container went smoothly.

- **RNS #8 (68685) – June 13-16, 2017 (Batches: 120, Daughters: 11)**

This is the sister container to 68660 and requires both pre- and post- treatment sampling. Material at the top of the drum was dry, but as we approached the bottom it became sticky/gooey. This made it difficult to handle, as it stuck to the gloves etc. However, after drying, the gloves cleaned up pretty well. We also found two respirator cartridges, which were processed by removing the cellulosic material (rayon) and treating it with the WypAlls. After consultation with manufacturer, disposition of cartridge involved opening cartridge and treating filter material. During treatment, RNS shipment arrived – contamination discovered on 69076.

Initial Processing Lessons

- **RNS #9 (69641) – June 19-21, 2017 (Batches: 127, Daughters: 9)**

Processing was relatively smooth. Solidified RNS in lower portion of 69641 required significant manual size-reduction effort.

- **RNS #10 (69076) – June 21-28, 2017 (Batches: 196, Daughters: 14)**

Very full RNS drum, but morphology very similar to surrogate material.

Mid-morning on June 22, after 30 of 196 batches completed, operations were suspended due to ice on an HVAC coil. (Ice had also formed on the coil early on June 19). Upon evaluation due to the HVAC alarm, there was a CAM alarm that was determined to be false (radon). Maintenance diagnosed three Freon fittings that were leaking; the leaks were repaired on June 23.

- **RNS #11 (68631) – June 28-30, 2017 (Batches: 42, Daughters: 5)**

68631 contained two bags of what initially appeared to be simply sWheat (on in a "Green is Clean" bag). However, in discussions with the operators, it was noted that on occasion, liquid from salt containers would be poured into bags of sWheat, to sorb the liquid. Dose rates were consistent with this and the material was processed according to our normal protocols.

Initial Processing Lessons

- **RNS #12 (69616) – June 19-21, 2017 (Batches: 165, Daughters: 9)**

Similar to RNS #8 (68685), some layers of RNS material was relatively dry; other layers were wet and sticky, requiring significant work to clean the debris waste as part of our waste segregation requirements. It is noted that both 69616 and 68685 were drums with higher concentrations of headspace CO_2. It is thought that the chemical reactions generating the CO_2, with water as a reaction product, is the cause of the higher moisture content in these drums. A closed sharpie pen was found in the waste container (was wiped off and treated as debris after consultation with WIPP personnel).

RNS #13 (69615) – July 7-11, 2017 (Batches: 104, Daughters: 6)

Drum processed relatively quickly. The waste was relatively dry and easy to clean from debris and process with zeolite. It is noted that this drum had relatively low CO_2 concentrations in headspace gas. A process efficiency was implemented for this drum, involving introduction of zeolite into the glovebox via the RNS daughter port rather than the debris daughter port, which had required bagging off the debris drum when more zeolite was needed even if the debris drum was not full of waste. This improvement will save time and reduce the number of debris drums created during the RNS treatment campaign. Loose bungie cord was found; determined to have a nylon coating (not cellulosic)

Initial Processing Lessons

- **RNS #14 (68635) – July 11-12, 2017 (Batches: 100, Daughters: 5)**

Drum processed relatively quickly. The waste was relatively dry and easy to clean from debris and process with zeolite. It is noted that this drum had relatively low CO_2 concentrations in headspace gas.

- **RNS #15 (69490) – July 12 – 18, 2017 (Batches: 196, Daughters: 9)**

Very moist/sticky with a lot of debris that was challenging to brush/wipe off, and additional cellulosic rags to treat due to use of these rags to clean glovebox gloves and tools during the treatment process. Drum 69490 had exhibited the highest CO_2 concentrations of all the RNS drums. To date, we have processed four of the seven highest gas generators (69490, 69616, 69076, and 68685).

- **RNS #16 (69642) – July 18 – 19, 2017 (Batches: 69, Daughters: 4)**

Drum processed relatively quickly. The waste was relatively dry and easy to clean from debris and process with zeolite.

- **RNS #17 (94227) – July 20 – 20, 2017 (Batches: 44, Daughters: 4)**

On the afternoon of July 19, the inspection of the drum lift prior to bagging on 94227 identified a missing retainer clip on a hinge pin. The lift was deemed inoperable, the clip replaced, and a load-test was performed on June 19. The drum was processed relatively quickly (bagged on in the morning, completed in one day).

Miscellaneous Images; 30 gallon drum in drum (left), masslinn (right two)

UNS Campaign: Discovered Degraded Inner Drums

- **UNS Repackaging**
  - started on 11/28/17 after tooling development, successful MSA, CRA
  - Repackaging completed 1/4/18
- **UNS Treatment**
  - Started 12/15/17 after completing activities to prepare WCRRF for UNS
  - Completed UNS treatment on 3/14/2018
- **Many UNS drums contained significant free liquids**

Treatment Lessons Learned

- **Waste form can vary significantly – every container is unique**
  - Spread a wide net to ensure all RNS captured
  - Morphology is variable, and depends on moisture content, precise nature of initial waste, etc.
  - Debris is more difficult to process than anticipated
- **Operational lessons have led to processing changes**
  - WypAll processing
  - Size reduction tools
  - Spare components; size of glove box
- **Waste batch estimates are ~67% of actual (roughly)**

Depending on final remedy for containers at WCS, these lessons will provide helpful insight