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Author(s): Salzman, Sonja L.
Ballesteros Rodriguez, Sonia
Lopez, Lorraine Bonds

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Dissolving Uranium Oxide with Ammonium Bifluoride

In the field of nuclear forensics, one of the biggest challenges is to dissolve post-detonation debris for analysis. Debris generated after a nuclear detonation is a glassy material that is difficult to dissolve with chemicals. Traditionally, concentrated nitric acid, hydrofluoric acid, or sulfuric acid are employed during the dissolution. These acids, due to their corrosive nature, are not suitable for in-field/on-site sample preparations.

Uranium oxides are commonly present in nuclear fuel processing plants and nuclear research facilities. In uranium oxides, the level of uranium isotope enrichment is a sensitive indicator for nuclear nonproliferation and is monitored closely by the International Atomic Energy Agency (IAEA) to ensure there is no misuse of nuclear material or technology for nuclear weapons. During an IAEA on-site inspection at a facility, environmental surface swipe samples are collected and transported to the IAEA headquarters or network of analytical laboratories for further processing. Uranium oxide particles collected on the swipe medium are typically dissolved with inorganic acids and are then analyzed for uranium isotopic compositions.

To improve the responsiveness of on-site inspections, in-field detection techniques have been recently explored. However, in-field analysis is bottlenecked by time-consuming and hazardous dissolution procedures, as corrosive inorganic acids must be used. Corrosive chemicals are difficult to use in the field due to personnel safety considerations, and the transportation of such chemicals is highly regulated. It was therefore necessary to develop fast uranium oxide dissolution methods using less hazardous chemicals in support of the rapid in-field detection of anomalies in declared nuclear processes.

Chemists at LANL have discovered that a chemical called ammonium bifluoride (ABF, NH_4HF_2) can be used for dissolution of uranium oxide particles and potentially larger debris fragments as well. ABF is the active ingredient in car wheel cleaner and can be obtained from ordinary hardware stores. ABF is much less dangerous to handle than concentrated mineral acids, particularly in a field setting where conditions cannot easily be controlled. Use of ABF improves procedural safety by decreasing the utilization of concentrated, hazardous mineral acid. ABF digestion is faster than using concentrated mineral acids, which is very important when performing field analysis. Identification and quantification of trace metals provide valuable nuclear forensic signatures in the uranium oxide particles and post-detonation debris.

Reuse Optimization at LANL

LANL has a long history of reusing as many items as possible within its campus. By reusing items instead of purchasing new ones, LANL saves money and the employees also save time since new items do not have to be delivered. In many cases, one person's unwanted item is another person's treasured acquisition.

In the past several years, LANL has instituted housekeeping events that encourage employees to clean out their spaces. The events are staged at a few technical areas each time so that the salvage and reuse operations are not overwhelmed all at once with material. When employees move within the campus, reused packing boxes are also supplied and then collected afterwards for further reuse. LANL is committed to reusing as many items as possible so as to remain both fiscally and environmentally responsible. In 2016, over a million dollars worth of material was reused, including over half a million dollars of furniture. The programs that make this possible are summarized below.

LANL Internal Reuse

LANL operates an excess property operation that makes various types of property (shop/lab equipment, office supplies, and furniture) available for reuse by laboratory workers. The excess operation holds the property for internal reuse for approximately one month. In addition to the property reuse activities conducted by the Excess Operation and as a result of the Laboratory being spread-out over approximately 38 square miles, LANL has developed additional on-line internal reuse programs.

The LANL Swap Shop is an online tool that was developed to facilitate the reuse of excess barcoded property items. Items with barcodes are tracked in LANL's Sunflower property system and includes shop/lab equipment, cameras, copiers, printers, or other electronic property. LANL employees are encouraged to visit the Swap Shop website to search for such items prior to purchasing new ones.

The LANL eStockroom is another online tool that was developed to facilitate the reuse of non-barcoded property, which is typically printer cartridges, computer monitors, and other office equipment and supplies. LANL employees can post items themselves to the website and then arrange the transfer of the item to the LANL employee who wants the item. This self-directed listing feature requires minimal effort of the website.

A large category of reused material at LANL is comprised of furniture. Every year, a considerable amount of furniture is reused within the LANL campus. Some of the furniture for reuse goes through the LANL salvage system, but a separate process has also been created solely for office space furniture. When a group moves to a new building, a LANL property manager works with them in advance to collect old furniture that is still usable, and supplies them with used furniture that may be more suitable for their new space. Additionally, furniture for reuse in the warehouse is given to other LANL employees for use in their work spaces.

LANL Reuse from External Sources

In addition to reuse of property from internal sources, LANL property management works with laboratory workers to determine if the property need can be obtained from another federal agency. External property can be obtained either through one of the Federal excess property advertising sites or directly from another site based on internal business relationships. The requesting organization is only required to pay the cost of transportation which can optimize savings for any project or program.

Making LANL Excess Property Available for Reuse by Others

So as to promote corporate social responsibility, if LANL's excess property is not reused internally items are made available to other federal agencies, post-secondary schools, and the general public. However, prior to any property being released from the Laboratory it is checked to ensure that it is safe, environmentally friendly and that that all memory has been removed.

In support of LANL's cyber security policies, computers older than 4 years are not advertised for internal or external reuse but are recycled through a certified electronics recycler. Computers newer than four years that are not reused internally are donated to various federally approved non-profits and state agencies, as well as post-secondary schools through various websites and programs.

Lastly, if no one claims LANL's excess property, it is sent to an auction house to be sold. In the past, LANL held monthly public sales for unwanted items, but that practice was discontinued a few years ago in favor of the more streamlined process of sending all unwanted items to the auction house. After commission is paid to the auction house, LANL receives the proceeds from the sales which are used to off-set the costs of the excess operation.

In addition to its current excess property reuse initiatives, LANL is taking corporate social responsibility a step further by working with NNSA to pilot a program that would provide excess office furniture and supplies to approximately 34 school districts and 15 tribes located in northern New Mexico. A team has been established to ensure the program is fair and equitable, while minimizing the distribution to LANL's other operations. LANL's goal is to have the pilot in place before mid-2017.

Setting Site Specific Release Criteria for Volumetrically-Contaminated Materials

A great deal of metal and concrete has accumulated, or will be accumulated, at LANL. For example, an initial inventory places the amount of potentially recyclable metal at LANSCE at over 1400 tons, with a market value of over $2.1 million. Concrete has also accumulated as old buildings are demolished in conjunction with LANL's footprint reduction and/or land transfer initiatives.

Some of this material is clean, while some material contains residual surface and/or volumetric radioactivity. Possible disposition pathways for these materials are:

1) recycle based on indistinguishability from background status [clean materials only];

2) recycle based on measured radionuclide concentrations and risk analysis [radionuclide-bearing materials];

3) burial at a waste disposal site [radionuclide-bearing materials]. The disposition pathway is a significant financial issue for LANL. For example, the difference between potential disposal costs and recycle revenues for all metals and concrete at LANL could be more than six million dollars. Complex-wide, potential disposal costs vs. recycling revenues could exceed 60 million dollars.

The DOE allows the release of materials from radiological control via pre-approved surface-radioactivity criteria. However, there are no pre-approved release criteria for volumetric radioactivity in materials. ANSI standard 13.12-2013 provides release criteria for items bearing volumetric radioactivity, but this standard has not yet been approved by the DOE.

LANL scientists worked to develop site-specific release criteria for materials bearing volumetric radionuclides for the recycle disposition pathway. The Residual Radioactive (RESRAD), RESRAD-build, and RESRAD-recycle computer codes were used to calculate the risk to people exposed to the radionuclide-bearing recycled materials at each step of the recycling process, and this risk will drive release criteria. The proposed release criteria can be used to request release approval from DOE when accumulated material that meets the proper criteria is available.

Climate Research Symposium and Climate Adaptation Roundtables

Organizer: Lorrie Bonds Lopez, Environmental Communications and Outreach

Sponsors: Earth and Environmental Sciences Division, Jim Bossert, Division Leader and Environmental Compliance and Protection Division, John Bretzke, Division Leader

Tuesday: Land Use and Forest Management Day

Symposium Speakers

- Critical Watersheds; Dr. Richard Middleton, Senior Scientist, Los Alamos National Laboratory
- Accelerating global forest mortality, Dr. Nate McDowell, Senior Scientist, McDowell Lab, Los Alamos National Laboratory
- The past, present and future told in tree rings, Dr. Ellis Margolis, Professor, University of Arizona, Laboratory of Tree Ring Research
- Ongoing and expected landscape changes in northern New Mexico, Dr. Priya Shahani, Regional Analyst, United States Forest Service
- Fire impacts and modeling in the Jemez Mountains, Dr. Rod Linn, Senior Scientist, Los Alamos National Laboratory

Round Table Participants: Symposium speakers above and

- Jason Lott, Superintendent of Bandelier National Monument, National Park Service
- Jorge Silva-Banuelos, Superintendent of Valles Caldera National Preserve, National Park Service
- Jeremy Sweat, Sustainability Officer, Bandelier National Monument, National Park Service
- Jeanne Fair, Epidemiologist, Los Alamos National Laboratory
- Monica Witt, Sustainability Officer, Los Alamos National Laboratory
- Sonia Rodriguez, Sustainability, Office Los Alamos National Laboratory
- Leslie Hansen, Forest Manager, Los Alamos National Laboratory
- Terry Foecke, Pollution Prevention, Los Alamos National Laboratory
- Kent Reid, New Mexico Highlands University
- Blanca Céspedes, New Mexico Highlands University
- Will Donahue, Intern, Chama Peak Alliance
- Shawn Chato, Office of Environmental Management, Santa Clara Pueblo
- Eric Peterson, Open Space Coordinator, Los Alamos County

Wednesday: Weather, Climate, Storms and Water Supply Day

Symposium Speakers

- Climate change, forest disturbances and water management impacts on the San Juan / Chama river system, Dr. Katrina Bennett, Principal Investigator, Los Alamos National Laboratory
- Basins of the Rio Grande water management & operations, Dr. Dagmar Llewellyn, Chief Scientist, Bureau of Reclamation
- Hydroclimatic Forecasting in the Upper Rio Grande Basin, Dr. David Gutzler, Professor, University of New Mexico,
- Multidecadal Oscillations, El Niño and La Niña effect in NNM, Dr. Manvendra Dubey, Senior Scientist, Los Alamos National Laboratory
- Planning for future flood risk, Dr. Ariane Pinson, Climate science specialist, Army Corps of Engineers
- Climate measurements at LANL: Are we measuring climate change? Jean Dewart, Professor Emeritus, Los Alamos National Laboratory

Round Table Participants: Symposium speakers above and

- Sonia Rodriguez Ballesteros, Sustainability, Office Los Alamos National Laboratory
- James Alarid, Deputy Utilities Manager, Los Alamos County
- Chuck Hayes, New Mexico Game & Fish
- Jorge Silva-Banuelos, Superintendent of Valles Caldera National Preserve, National Park Service
- Phoebe Suina, Owner, High Water Mark
- Ginny Seamster, New Mexico Game & Fish
- Perry Vigil, City of Española
- Dagmar Llewlyn, Bureau of Reclamation
- Terrell Lemke, Manager for Storm Water Program, Los Alamos National Laboratory
- Jerome Martinez, Department of Cultural and Environmental Preservation, Pueblo de Santa Ildefonso

Why?

To bring together researchers of climate change with high desert land use and water supply managers from Northern New Mexico to share research, practices, decision criteria and insights, mingling what scientist know from climate change research with how leaders make land and water use decisions in northern New Mexico.

Who? Participants included land use managers; water supply decision makers; climate, water, forest and weather scientists from four counties, four cities, and six pueblos. In addition to the 12 scientists who spoke from Los Alamos National Laboratory, the Army Corps of Engineers, the University of Arizona, New Mexico Highlands University and the University of New Mexico; land and water managers from Los Alamos County, Santa Fe City and County, Taos County, Rio Arriba County, Española, Pueblo de San Ildefonso, Santa Clara Pueblo, Jemez Pueblo, Ohkay Owingeh, Pueblo of Pojoaque, and Pueblo of Cochiti also attended. Each day, over 75 other attendees listened, interacted, and contributed to the discussions.

When? Tuesday, November 15 and Wednesday, November 16, 2016 from 8:00 a.m. to 4:00 p.m. in Pojoaque, New Mexico.

What happened? Over 75 people attended each of the two days, listening, interacting, and contributing to the discussion. The talks informed participants of the depth and breadth of the Laboratory's research into the causes of climate change, the impacts of that change on Northern New Mexico, and hinted at ways to make the landscape more resilient to changes that effect safe lifestyles, future water supplies and robust watersheds. Land use managers got to meet and mingle with these scientists and in the afternoons, discussed actions they have each had to take to manage a resilient landscape and to ensure safe and sufficient water supplies for drinking, agricultural, power and recreational use for their constituents.

Participants had extremely positive feedback and reactions to the event. Comments and discussion overheard include:

- We should do this every year.
- I had no idea that the Laboratory was studying these things.
- This is an important conversation and body of knowledge. We should all keep it up.
- It's nice to know we're all working on the same things.

Production of Environmentally-Friendly Energetic Materials

Trinitrotoluene (TNT) is a common material used as a bomb fill due to its ability to melt at temperatures below the boiling point of water. The process to make TNT produces a significant amount of toxic waste and wastewater. TNT is also a skin irritant and toxic to humans. The use of TNT and another explosive called RDX has had profound ramifications to the environment at points of production and on test ranges across the US.

Mitigation of waste water from TNT processing is an expense that LANL high explosive machining has been burdened with ever since the beginning of the Manhattan Project. Currently LANL needs to treat hundreds of gallons of waste water contaminated with high explosives each year, but this process could be eliminated by using the new type of explosives. The mitigation issue is amplified at institutions like the Radford Army Ammunition Plant, where up to 50 tons of TNT per day may be processed. Both TNT itself and photo-degradation products, such as trinitrobenzene, are potent lipid-soluble carcinogens. RDX is a contaminant that can enter the ground water, so it is environmentally problematic for that reason. Over 16 million pounds of RDX are produced every year in the US.

The technology that LANL developed involves new, environmentally-friendly energetic materials to replace TNT and RDX that exist in numerous melt-castable explosive applications currently deployed by the Department of Defense. The technology employs a common fertilizer material with environmentally-benign heterocyclic compounds to produce useful melt-castable explosives as replacements for TNT-based explosives.

The new, environmentally-friendly melt-castable explosives have similar performance properties to TNT-based materials and are non-toxic. By switching to such materials, manufacturers and high explosive machining processes could avoid the waste water treatment costs associated with processing TNT-based explosives. Soil contamination from TNT-based explosives can also be avoided at firing sites. LANL is collaborating with the Army at Picatinny Arsenal to transition the new technologies to the Department of Defense.

Smart Labs at LANL

The University of California, Irvine, developed a laboratory energy efficiency program and is partnering with research institutions globally to reduce energy consumption in laboratories. In 2008, UC Irvine facilities/energy engineers recognized that laboratories possess the potential to be far more efficient without compromising occupant safety. This was defined as the Smart Lab concept.

The Smart Lab concept includes an integrated set of laboratory design criteria and performance standards that can improve and augment safety protocols and designs and at the same time, reduce building energy consumption and offer continuous commissioning.

A High Performance "Smart Lab" should be:

- Effective:
    - Support research and development
    - Flexible to change
- Safe:
    - Protect people from exposure
    - Compliance with standards
- Efficient:
    - Minimum energy consumption
    - Minimum operating costs
- Sustainable:
    - Minimum Carbon footprint
    - Maintainable with Long Lifecycle
    - Return of Investment

Because laboratory spaces consume so much energy, the potential for energy and dollar savings through energy-efficiency improvements and energy conservation is impressive. Studies have shown that implementing the seven elements or energy initiatives that define a Smart Lab can result in savings as high as 50% for these kind of spaces.

There are seven key elements that define a Smart Lab:

1. Installation of DDC systems
2. Real time demand-based ventilation controls air changes per hour (ACH) based on occupancy and measured air quality with a Centralized Demand Controlled Ventilation (CDCV) system.
3. More Efficient Lighting
4. Optimization (reduction) of the exhaust fan discharge velocity:
5. Pressure drop optimization
6. Fume hood flow optimization: apply AIHA/ANSIZ9.5 Standard to analyze if fume hood standby ventilation can be reduced:

7. Final Commissioning and Continuous Commissioning with automated cross platform fault detection like SkySpark software.

The first stage for LANL was to develop the Smarts Lab Core Team. This team should have technical and leadership skills and develop a scalable strategy. It should adopt a common challenging goal and understand the potential of “smart” labs to get the organizational culture ready. These are the relationships and roles of the team:

- There should be a synergy between facilities management (FOD/Owner) and ES&H group.
- ES&H along with the Field Engineering group should ensure that projects are checked for code compliance and that they do not decrease safety.
- The Project Manager should track documentation, incentives, funding etc.
- Construction and Cx team should report on project status and alerts to delays or problems.
- The Energy Manager should organize the team, set the agenda and coordinate Project Manager’s projects with utilities and sustainability group, operations and security.
- Engineering and BAS teams should check for technical opportunities and develop the technical steps to achieve the project goal.
- Procurement should report on coordination with budget office.
- Consultants can assist with the first steps of the project: Laboratory Risk Analysis and Laboratory Ventilation Program.
- The team should meet biweekly to track the status of the project.

Figure 1. LANL Smart Lab Core Team

The second stage was developing a RELSA or Rapid Energy Laboratory Risk Assessment. The purposes of a RELSA were:

- Select and Prioritize best buildings
- Analyze the Size and Space allocation
- Analyze the Energy Use and Operation costs
- Analyze the state of the systems
- Calculate the energy reduction potential
- Classify the best building/buildings according to the best ECMs
- Calculate the potential energy reduction for the chosen buildings
- Calculate the project costs and payback

Eight facilities were selected at LANL to be assessed. The RELSA was performed in all the eight buildings and allowed the selection of the "best" buildings in terms of potential energy savings for the next step: Demand Ventilation Assessment-DVA or Project Plan.

The DVA is the third stage of the process and constitutes the last step of Phase 1. The DVA consist on a Laboratory Ventilation Risk Assessment (LVRA) and Ventilation Effectiveness Evaluation, Laboratory Environment (LETs) tests, HVAC System Operating Mode Tests

(SOMTs) and Compilation and Analysis of Data. The DVA final deliverable is the project scope of work and the feasibility analysis for each of the buildings.

LANL started the DVA process at the beginning of FY17 in five facilities and is planning to select another set of five buildings to be assessed between the end of FY17 and FY18 and start with the Phase 2 of the program.

Phase 2 includes project funding and optimization process, including the review of engineering standards and specifications.

The last phase of the program will be Phase 3 and will consist on the performance management phase. It is the phase where we will achieve a safe, efficient and sustainable laboratory facility.

SMART LABS PROGRAM GENERAL SCHEDULE					
PHASE 1			PHASE 2		PHASE 3
Stage 1	Stage 2	Stage 2	Stage 1	Stage 2	Performance Management
Team	RELSA	DVA	Funding	Optimization Project	

Figure 2. Smart Labs Program Roadmap