Turning the Surface Contamination Object Decontamination Process (SCO) into a Production Operation for the Remediation of the Transuranic (TRU) Waste as Part of the Los Alamos National Laboratory (LANL) 3,706 m^3 Campaign – 14115

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ABSTRACT

The Department of Energy National Nuclear Security Administration (DOE-NNSA), LANL and Energy*Solutions* (ES), subcontractor to LANL, are currently remediating and repackaging for disposal, legacy TRU waste that is stored aboveground as part of an accelerated waste removal effort. This includes remediating and disposing of 3,706 m^3 of TRU waste (55-gallon drums and oversized boxes). DOE-NNSA and LANL have committed to the New Mexico Environment Department (NMED) to complete this project by June 30, 2014.

Efficiencies were gained from using the SCO method versus sorting, segregating, size-reduction, and repackaging (SSSR) and during the process, LANL has matured the existing SCO processes into an integrated production operation using temporary facilities and on-hand resources to process a highly variable feedstock. Valuable lessons were learned regarding the decision process for determining the most efficient use of SCO processes versus SSSR remediation of containers.

The standard SSSR method includes size-reduction of LANL's non-uniform TRU waste boxes and their contents (including metallic waste), as well as packaging into standard waste boxes (SWBs) intended to be shipped as TRU waste to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, for final disposal. This process, although effective, proved time consuming and presented an inherent safety risk to workers. In an effort to address this risk, LANL discovered that by using decontamination products to chemically remove radioactive surface contamination, SCO method presented the potential opportunity to reduce radiation exposure to workers, achieve efficiencies in downstream disposition costs, and reduce industrial and ergonomic injuries risks associated with SSSR.

INTRODUCTION

The Las Conchas Fire which occurred near Los Alamos, New Mexico, burned more than 150,000 acres around LANL during June and July 2011 and came within 3.5 miles of LANL's waste management facility. As a result, New Mexico Governor Susana Martinez requested that the DOE-NNSA accelerate the removal of abovegrade TRU waste stored at LANL. DOE-NNSA and NMED developed a Framework Agreement that LANL would remediate and dispose of 3,706 m^3 of combustible and dispersible TRU waste stored aboveground by June 30, 2014[1], shown in Fig. 1. Though a combination of efforts designed to target efficiencies and implement new processing techniques, LANL has seen significant improvements in the amount of TRU waste processing. This is reflected in the below graph where a steady decrease in waste volumes is seen.

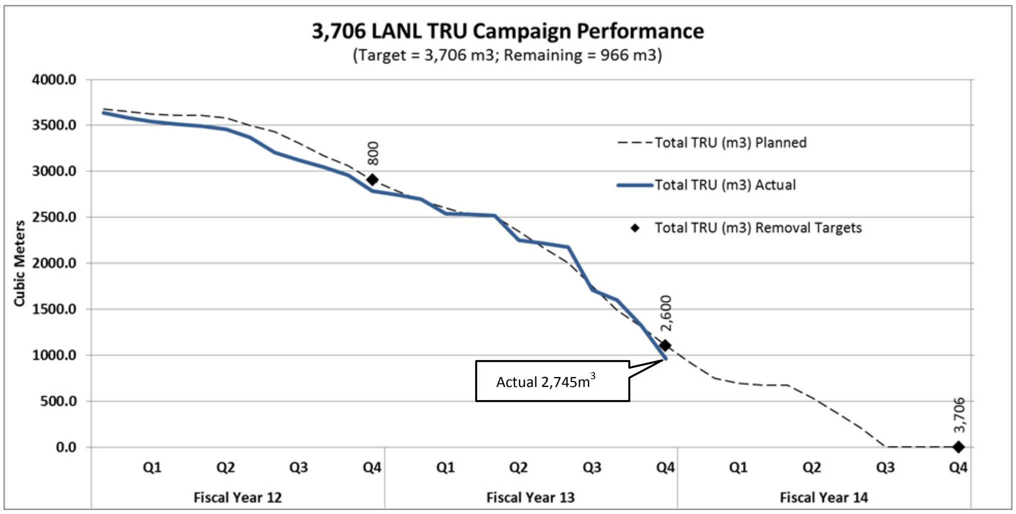

Fig. 1 LANL 3706 m^3 Governor's goal

Waste Configuration

Fig. 2 shows the distribution of the 3,706 m^3 population of waste to be remediated. The "Boxes" (76%) include large plywood, metal and fiberglass reinforced plywood boxes (FRPs), corrugated metal boxes (CMBs), SWBs, and the remainder of the volume (24%) is in 55-gallon drums. To meet the goal, a 125% increase in throughput had to be achieved from fiscal year (FY) 2012 to FY2013, and a simulation-based risk-management model to predict volume removal was developed. The model identified the ability to optimize the relationship between volume reduction and remediation time for each oversized waste container as critical. Maximizing volume reduction was also important to managing constraints on downstream transportation, characterization, and shipping resources.

The 2,801 m^3 of oversized containers consists of various items such as pipes, tunnels, pencil tanks, furnaces, glove boxes, and miscellaneous debris and range in size from 3 to 65 m^3. The approximately 90 FRPs (approximately 1,221 m^3) each contained glove boxes to be remediated. The majority of the containers had issues requiring them to be remediated or repackaged before they could be characterized for shipment to WIPP. Some issues included prohibited items such as free liquids, aerosol cans, and sealed containers greater than 4 liters in size; unvented containers; containers exceeding activity or fissile-gram equivalent (FGE) limits at WIPP; and containers that did not qualify for WIPP disposal [1]. Once the TRU waste container has been remediated and repackaged, they are required to go through WIPP characterization and certification by the Central Characterization Project (CCP) at LANL [1].

At this time, only 55-gallon drums (volume capacity of 0.208 m^3) and SWBs (volume capacity of 1.9 m^3) can be characterized at LANL and shipped to WIPP for disposal, so any TRU waste in other size containers has to be repackaged into one of the approved container types.

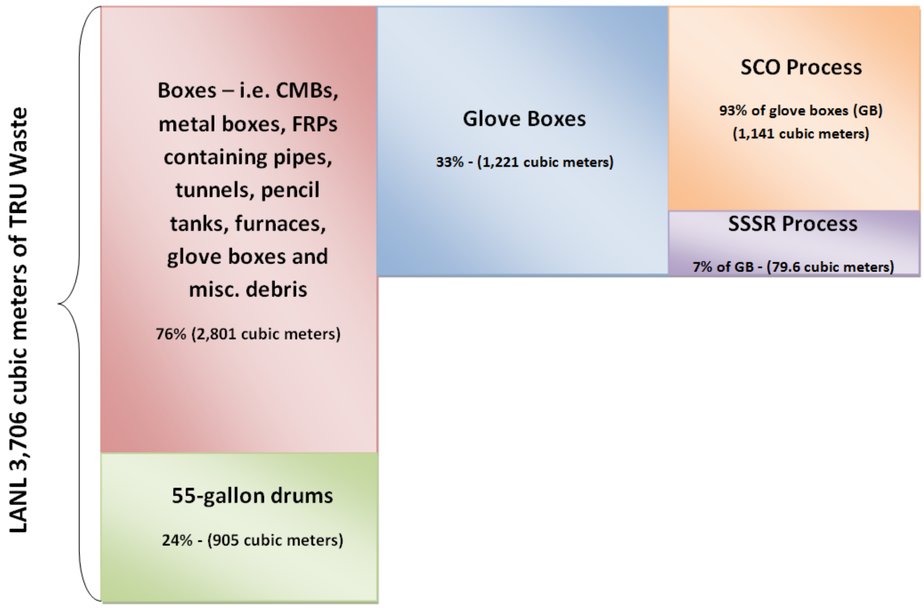

Fig. 2 Breakdown of parent waste to be remediated

Remediation Processes

The processes used to remediate/repackage the containers included SSSR and SCO processes. The SSSR process involves size-reducing the containers to fit into SWBs for TRU waste disposal. SSSR was used to remediate/repackage pencil tanks, miscellaneous debris, pipes, and tunnels. This process is time-consuming and has a higher safety risk to operators due to the use of power tools used to cut up the waste and sharps encountered in the waste stream.

LANL's constraint with the SSSR process is the temporary nature of the remediation facilities, coupled with limited funding that prevents the purchase, installation, and use of industrial remote-handled cutting equipment found at other DOE waste remediation sites. Hand-operated tools significantly inhibit the remediation rate and present a significant risk to operators of direct radiological uptake if an accident was to occur.

The large waste containers and more complex waste (mostly glove boxes) presented a challenge to the project. It was not feasible to size-reduce these items given the limitations of the size-reduction equipment and time constraints of the project. Alternative processes were researched by a joint LANL and ES team, and it was decided that the SCO process provided a better approach for these types of containers by not requiring size-reduction and by allowing for the decontamination of the radioactive particles from the glove boxes so that the containers could be disposed of in their original form as low-level waste (LLW) or mixed low level waste (MLLW).

The focus of the project was the remediation of the oversized containers, and during its execution, efficiencies were gained from using the SCO method over SSSR, and as a result operations at LANL improved the existing SCO processes into an integrated production operation during FY2013.

METHODS

The flow of the remediation of parent waste containers through the LANL remediaton process is shown in Fig. 3. During SSSR, the primary daughter container is shipped as TRU waste, and as a result of SCO process, the primary daughter container meets requirements to ship as LLW or MLLW.

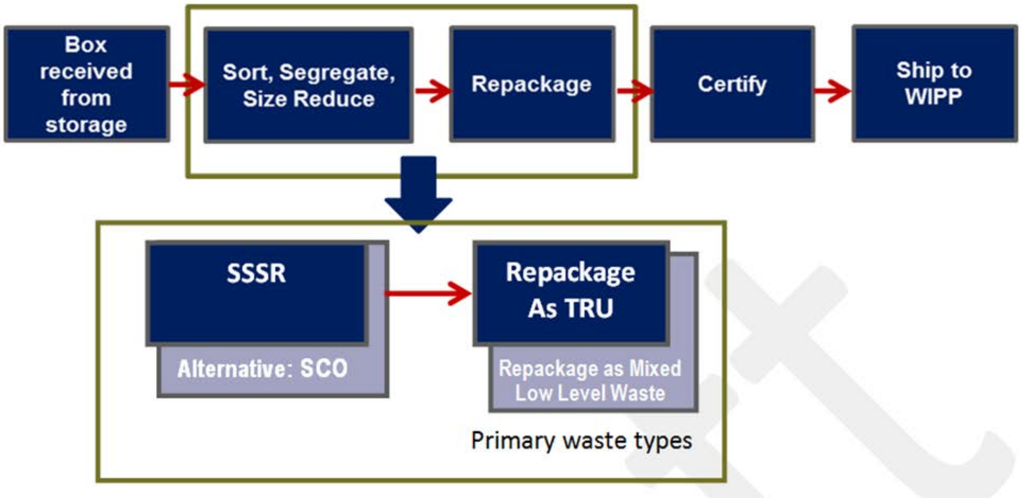

Fig. 3 High-level TRU waste SSSR/SCO process flow

The box line remediation process starts by introducing the parent container into the contamination area (CA), and the outer box is unsheathed to allow the insertion of ventilation to control the airborne radioactivity. The box is then cut back further to reveal the contents (Fig. 4). The operations team reviews the item to be remediated, and using available historical information (use, type of contamination, and weight of the waste items) confirms the path forward for remediation.

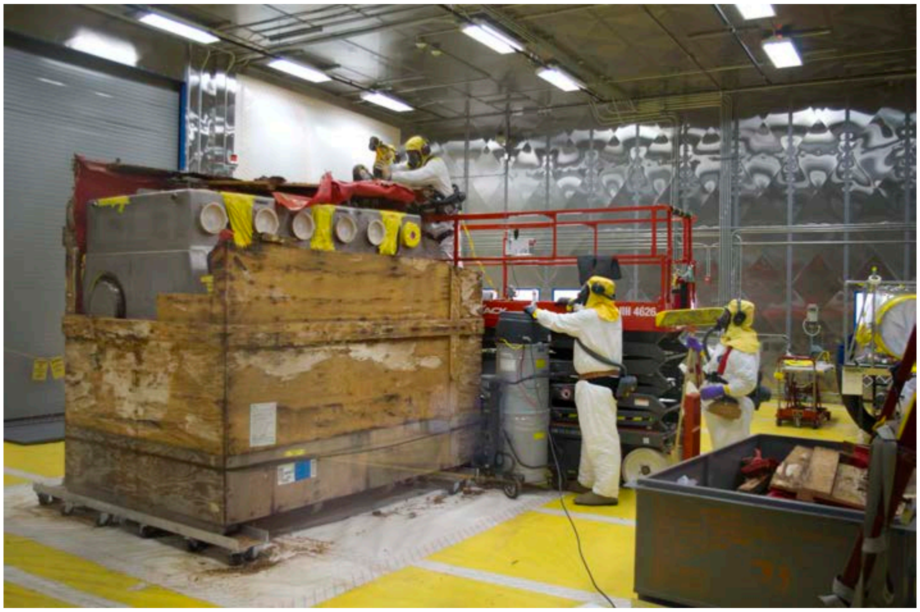

Fig. 4 Inserting ventilation on unsheathed waste item

SSSR Process

If the item is to take the path of SSSR, a detailed cut plan will be developed. It will take into consideration the type of contaminant, the dimensions of the item, the contents, any cut limiting factors, such as windows, ports and filters, and the mobility of the item (i.e., whether it is bolted or welded together). Once the cut plan has been developed and all the prohibited items are removed, the size-reduction process begins. During size-reduction, operators use hand tools such as Sawzalls, band saws, and nibblers to physically cut the waste using contamination control methods into pieces small enough to fit into a SWB (the WIPP-approved daughter container). The outer box material also has to be cut up and disposed of as LLW; depending on the size of the material, this process can take a significant amount of time to remediate. Once the daughter container is sealed and free from contamination, the container is removed from the CA and is transported to the certification process. It passes through High Energy Real Time Radiography for examination for prohibited items, and then typically undergoes a 12-day wait to allow for headspace equilibration, followed by testing of the headspace for flammable volatile organic compounds and hydrogen; and through High Energy Neutron Counter. Once the daughter container has passed the WIPP waste acceptance criteria (WAC), the container is certified and scheduled for shipment to the WIPP facility. The characterization/shipping time for TRU daughter containers can take up to 60 days.

SCO Process

If operations decide to remediate the waste using the SCO process, ventilation is applied to the waste item, and new gloves are installed in the glove ports to allow the safe removal of prohibited items and the application of the decontamination agent (Fig. 5). The process to decontaminate the item begins with a radiological control technician developing a radiological sampling plan that through its statistical robustness will provide confidence that the decontaminated item will meet the final shipping criteria. Operations then decide on the decontamination agent, or combination thereof, based on the characteristics of the waste. Many factors influence this decision, including the type of contaminant, level of decontamination required to meet shipping requirements, the condition of the surface of the object, accessibility of internal surfaces, and others discussed in more detail below. The decontamination process includes applying the agent and scrubbing the surface, followed by a wait time for it to take effect. The next step is to apply a neutralization agent that has to be absorbed as it comes off the waste item (the agent is disposed of as TRU waste). The item undergoes a final radiological survey, and if it passes the SCO shipping criteria and the LLW criteria, the item is wrapped. Once wrapped, it leaves the CA and is loaded into its final shipping container for transfer to an approved MLLW facility for final disposal. The characterization/shipping time for LLW daughter containers can take up to 20 days.

Fig. 5 Operators using SCO process

SCO is defined as a solid object that itself is not radioactive but that has fixed and/or removable radioactive contamination distributed on any of its surfaces. As part of the 3,706 m^3 campaign, LANL used the SCO process that uses decontamination agents to reduce contamination levels to achieve SCO-II criteria and the WAC of the disposal facility. Some advantages of using the SCO process included the ability to use IP-2 packaging (LLW) instead of Type B packaging (TRU) to transport the waste to the disposal facility and the ability to dispose of the waste in LLW Class C landfills (less than 3700 Bq/g) instead of the WIPP facility.

LANL made a determination that the SCO-II Department of Transportation shipping limits would be used. Shipping waste using the SCO-II limits (less stringent) required shipping in an IP-2 container not required for the SCO-I limits (more stringent).

The target isotopes to be decontaminated included those associated with weapons grade Pu (Material Type 52). These isotopes included the following: Am-241 (alpha), Cs-137 (beta), Pu-238 (alpha), Pu-239 (alpha), Pu-240 (alpha), Pu-241 (beta), Pu-242 (alpha), Sr-90 (beta), U-234 (alpha), and U-235 (alpha).

Five decontamination agents were available for use during this process. Those products included the following:

- **Fantastik®[1]**
- **DeconGel™[2] 1120 Spray**: Primarily used to decontaminate the outside of the glove boxes.
- Environmental Alternatives, Inc. (EAI)
  - ♦ **Rad Release I®[3]**– Primarily used this product both inside and outside of glove boxes.
  - ♦ **Rad Release II®[3]** – Approval at the time for use inside the glove box only. Product contains a degreasing agent.
- **Aspigel 100E** – Available, but did not use because of drying time.

Fig. 6 Cleaning Hot Spots with Rad Release Agent

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[1] *Fantastik is a registered trademark of S.C. Johnson & Son, Inc. in the United States and other countries.*

[2] *DeconGel is a trademark of CBI Polymers, Inc. in the United States and other countries.*

[3] *Rad Release products are a registered trademark of Environmental Alternatives, Inc. in the United States.*

Previous Improvement Actions

The 3,706 m^3 campaign utilized some of the original actions taken to manage remediation as a production operation; these included the development of “solution packages” (the segregation of parent waste containers that have issues in common, so operations gain efficiencies by processing similar issues as a group; similar benefits can be realized downstream during the characterization and shipping processes). Scope definition documents defining precursor activities and forecasting of commodities required to complete the solution packages are being developed well in advance of the date of remediation. This facilitates a seamless transition from one waste item to the next.

During FY2013, the project realized benefits from having a flexible workforce to run back-to-back shifts (day and night, in conjunction with multiple days per week); to run multiple remediation facilities simultaneously (facilities 412, 231, and 375); and to adjust preventative maintenance schedules so maintenance was conducted outside of operating hours.

DISCUSSION

Although the 3,706 m^3 campaign encompasses a wide variety of items that were processed, the focus of this analysis is on the items that went through the SCO process, consisting of glove boxes of various sizes. The total number of glove boxes processed and completed (as of 10/28/2013) was 54. Of the 54 containers, 15 were remediated using the SSSR process (Fig. 7). These glove boxes were smaller (with FRP volumes ranging from 3.1 to 9.46 m^3) than the glove boxes that were processed using the SCO process. The SCO process was attempted on 39 glove boxes ranging in size from 4.56 to 64.89 m^3 with only 2 failures. One of the failures was attributed to the fact that the decontamination agent Rad Release was not available at the time, and time to decontaminate the glove boxes to achieve the SCO-II limits was not cost-effective. The other failure was attributed to the fact that the glove box had pinholes that resulted in high levels of external contamination on the glove box when Rad Release I was applied. The decision was made to use the SSSR process and ship the waste as TRU. Of the 37 glove boxes that were successfully processed using SCO, 35 had Pu-239 as the primary contaminant and 2 had Pu-238 as the primary contaminant.

Of the 37 glove boxes processed using SCO, Rad Release I was attempted on 25 boxes (Fig. 7). Four of those glove boxes required Rad Release II, but the others were successfully remediated. On 1 of the glove boxes, Rad Release II was used initially because of the glove box had some issues with grease, and Rad Release II contains degreasing agent. This glove box was successfully remediated.

Over the last 8 months, the project has been collecting data on the SCO process to complement the existing SSSR data and has begun to analyze the impact of remediation method on throughput (m^3 per hour in the CA). At the time of writing, the project has sufficient data to discuss preliminary findings but has an ultimate goal of pinpointing the critical factors that influence throughput. This information will be used to build a model to assist with the efficient planning of future remediation operations at LANL, after the 3,706 m^3 campaign and for use at other DOE sites.

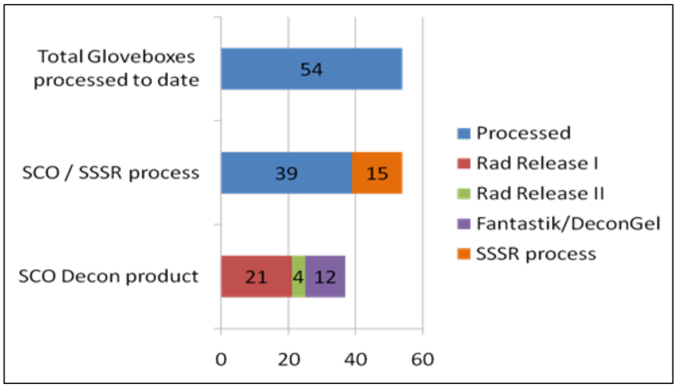

Fig. 7 Remediation method for glove boxes processed

Data Analysis

Statistical tests were used to answer some of the fundamental questions related to throughput for the SSSR and SCO processes at LANL:

Question 1: Is there a difference between the volumes remediated by SSSR and SCO at LANL?

Fig. 8 indicates the volumes remediated using the SCO processes are greater and more variable than the volumes remediated using the SSSR process. The graph shows a 12.92 m^3 (23.42 to 10.15 m^3) increase in volume remediated using SCO.

Statistical tests confirmed a difference exists between the volumes remediated by SSSR compared with SCO. However, it is suspected that some of the volume increase observed during the SCO process is a result of other factors influencing the process such as facility capabilities and container volume.

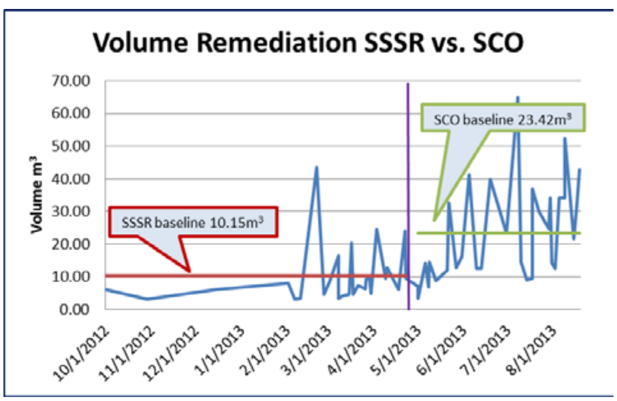

Fig. 8 Volume remediated SSR versus SCO

One of the major benefits of running waste remediation as a production operation is that LANL can run three facilities, or a combination thereof, simultaneously to maximize volume throughput.

Facility 412: Building 412 contains a Lancs structure (75.251 square meter). This facility was the first area for processing waste. Because of CA's limited size, only smaller containers were processed at the facility using only SSSR processes.

Facility 231: Dome 231 contains a Permacon with two cells (145.672 square meter). There is no door between the two cells so both are used as one cell. The limitations of this facility are the height of the Permacon to support a larger crane, which is 2.13 meters, and the size of the CA footprint for processing.

Facility 375: Dome 375 contains a large Permacon with three separate cells. The cell that is approved for use has 181.068 square meter. If a plywood box is too degraded to come out of the overpack storage container, the entire storage container is moved into 375 for processing.

Question 2: Is there a difference between volume remediated by facility (412, 231 and 375)?

Figure 9 suggests the volumes remediated increase from facility 412 to 231 to 375 and facility 375 has remediated the largest volumes of waste. Statistical tests confirmed a difference can be detected between the volumes remediated by facility 412, 231, and 375.

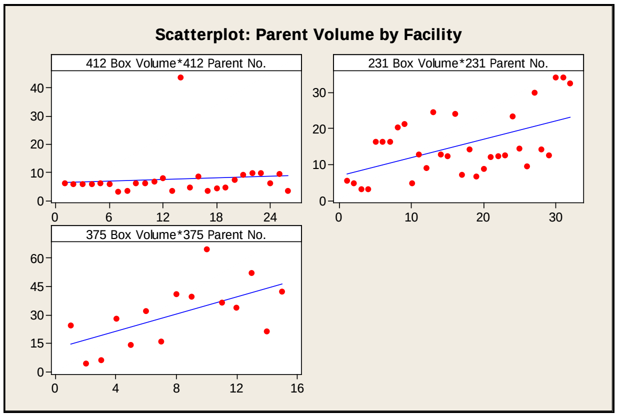

Fig. 9 Volume (m^3) remediated by facility

The analysis demonstrated the remediation method (SSSR or SCO) impacts the volume throughput and a statistical difference exists between the volumes remediated between the three facilities (412, 231, and 375), the larger the facility the greater the volume that can be remediated. However, we need to be aware these tests may be over simplifying what are complex interactions. Table 1 shows the average box volume processed by facility and remediation method. The physical size of the facility limits the size of the waste (box volume) that can be remediated inside. The table shows the average box volumes remediated by facility range from 5.7 to 31 m^3.

TABLE 1 Volume Processed by Method and Facility

Facility	Method	Av Box Volume
412	SSSR	6.4 (9.6 max)
231	SSSR	5.7 (12.7 max)
231	SCO	17.6 (30 max)
375	SCO	31 (65 max)

To eliminate the influence of facility and test if the volume remediated using SSSR versus SCO is statistically different, the data needs to be narrowed to one facility (231), the facility that has remediated waste using both SSSR and the SCO processes.

Question 3: Is the volume remediated using SSSR different from the volume remediated using SCO at facility 231?

Figure 10 shows that the volumes remediated using SSSR and SCO overlap, but the SCO process has remediated greater and more variable volumes than the SSSR process. The test result showed that a difference cannot be detected between the volumes remediated by SSSR and SCO at facility 231; however, further analysis confirmed the number of samples were not sufficient to detect a statistical difference. In other words, not enough data were available to conclusively determine that a difference exists between the volumes remediated by SSSR and SCO in Building 231.

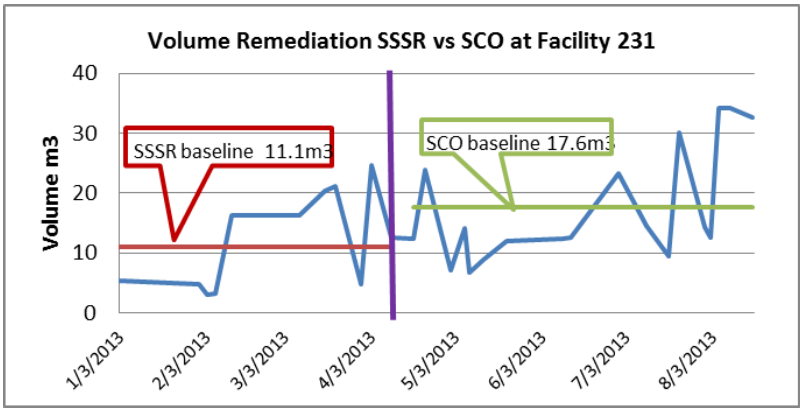

Fig. 10 Volume remediated by SSR and SCO at 231

Based on the data collected to date, the improvement in throughput attributed to the SCO method is 6.5 m^3, and the remaining difference (described in question 1) is possibly from other factors such as facility capability and the size of item remediated.

Remediation Time

The remediation time is the number of hours the waste item spends in the CA undergoing remediation. The data are recorded by the operations team supervisor in the log book at the end of each shift. This data is important when operating remediation activities on a production scale because it eliminates variables such as the time taken to prepare the line for operations, shift length, and number of shifts per day. Understanding the number of hours required in the CA to remediate 1 m^3 of waste will benefit the planning and budgeting of future waste remediation efforts at LANL and other DOE sites.

To have a better comparison, the remediation times for the 15 glove boxes remediated using the SSSR process were compared with the remediation time of the 37 glove boxes successfully remediated using the SCO process. The time for each process was documented. The average m^3 processed per hour in the CA using the SCO process was 0.46 and for SSSR was 0.24. According to these data, on average, the SCO process was twice as fast as the SSSR process. The time to complete the SCO process included moving the container into the CA; unsheathing the container; changing out all the glove ports needed to conduct the SCO process; removing all prohibited items; decontaminating the glove boxes; conducting surveys; waiting time associated with the surveys; and removing all the daughter containers from the CA.

Decontamination Factor (DF)

The DF is the ratio between the contamination before decontamination and the contamination after decontamination to measure the reduction in the contamination (DF = contamination before decon/contamination after decon). The best measure of the DF would be the surface area contamination. Although data are available for the post-remediation surface area contamination, the data for pre-remediation are not. A waste minimization/cost reduction decision was made concluding that pre-remediation surface contamination data were not worth one-time use of survey instruments. For this reason, total activity (Becquerel (Bq)) values were used in place of the surface contamination data to calculate the DF because a direct correlation exists between the two values. The average DF for the 37 glove boxes remediated using the SCO process was 49.74. The 35 glove boxes with Pu-239 as the primary contaminant had an average DF of 32.12, and the two glove boxes with Pu-238 as the primary contaminant had an average DF of 324.09. One gram of Pu-238 has a significantly greater radiological activity than the equivalent weight of Pu-239, and it is more mobile, which can prove challenging to control when remediating an item that has Pu-238 as the primary contaminant.

Daughter Container Production

As the parent container volume increases, the number of daughter containers to be shipped out as TRU waste increases. Another advantage to using the SCO process is the reduction in the production of TRU waste containers. Once the large waste item is decontaminated, it can be wrapped and put into an IP-2 container for shipment to an LLW facility. According to the data collected over the 3,706 m^3 campaign, the average number of TRU daughter containers produced per m^3 remediated using the SSSR was 0.36, and the average number of TRU daughter containers produced using the SCO process was 0.20. These values were actually calculated from the containers that were processed. Given the volume of some of the FRPs processed using SCO, had those containers been cut up using SSSR and shipped out as TRU waste in SWBs, the number of TRU waste daughter containers would have been significantly higher. Therefore, the reduction in the number of TRU daughter containers produced using the SCO process versus the SSSR process would be more significant.

Fig. 11 shows that during the SSSR process the average number of TRU waste daughters produced per m^3 of waste remediated is 0.36. In comparison, during the SCO process, the average number of MLLW daughters produced per m^3 of waste remediated is 0.1. Thus, the primary final container use drops by a factor of 27.7% (0.36 to 0.1) during the SCO process.

Secondary waste containers are also produced during both processes: SSSR produces LLW that consists mostly of FRP material (0.28 per m^3), and SCO produces TRU waste that consists of the absorbent from the decontamination process and any other container contents that is bagged out from the item (0.20 per m^3). Given the significant costs associated with daughter containers and the final disposal process, the number of daughter containers produced is an important factor in planning and budgeting for TRU waste remediation.

Complexity

Subject matter experts feel strongly that the complexity of the item to be remediated has a significant effect on remediation time for both SSSR and SCO processes (see Fig. 11). LANL does not have sufficient data to perform such an analysis, but operations did define increasing complexity for both the SSSR and SCO Process.

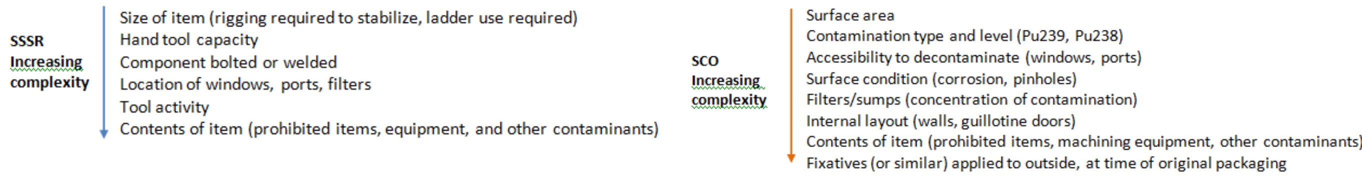

Fig. 11 Factors to consider for SCO and SSSR processes

CONCLUSION

After 6 months of running the SCO process, feedback from operations and the qualitative and statistical data analysis demonstrated the most important factors for consideration are the following (fig.12):

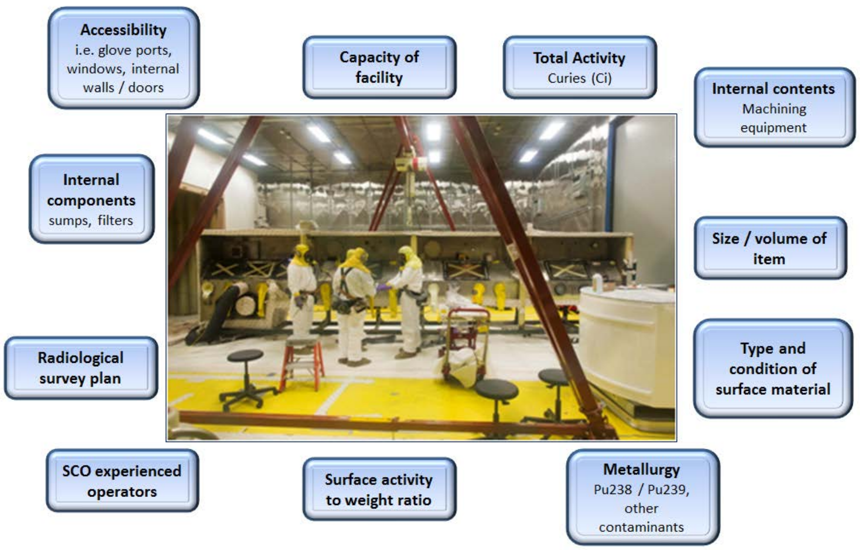

Fig. 12 Important Factors for considering SCO

Determining the type of decontamination agents for the SCO process proved critical: although Fantastik® and DeconGel™ (peelable decontamination hydrogel) could achieve some level of decontamination, Rad Release 1 and 2 had much higher levels of DF. Rad Release II was used in cases where Rad Release I was not achieving quick results within the expected performance range and where certain types of surface interference existed, (i.e., grease, oil, etc.) that influenced the effectiveness of the decontamination agent. DeconGel™ was used to address any contamination on the outside of the glove box, either by removing the contamination or temporarily fixing the contamination to access the contamination inside the glove box via the glove ports.

Key Challenges

The key challenges included:

- Adhering to an accelerated schedule to meet the 3,706 m^3 campaign commitments under a limited funding profile
- Analyzing the variability between the characteristics of the parent containers and historical documentation
- Working within the constraints of temporary small LANL facilities

- Working within the limitations of the hand tools for SSSR to size-reduce larger, more complex containers
- Identifying facilities to accommodate the SCO process
- Identifying solution packages appropriate for the SCO remediation process
- Obtaining contracts for the SCO material
- Writing procedures for using the SCO material
- Tracking data to evaluate the performance of SCO compared with SSSR
- Refining the SCO methodology
- Training personnel to use the SCO methodology
- Identifying the right SCO tools for effective application
- Determining variations in parent waste (glove boxes)
- Handling oversized and overweight glove boxes

Challenges specific to glove box remediation included the following:

- Lead-lining made the walls thicker and harder to cut using the SSSR process.
- Prohibited items left in glove boxes, prior to remediation, including highly contaminated filters, had to be removed.
- Some glove boxes contained foam, and thus additional time and care were required to remove the foam and the items safely from the glove boxes.
- Highly corroded surfaces caused pinholes that have the potential to allow contaminants to move from the inside to the outside of the glove box.
- Crystallization from heavy oxidation caused work pauses to rule out shock sensitive risks.
- Internal doors made it difficult to access all areas for decontamination.
- Applied fixatives at the time of packaging added challenges to decontamination.
- Significant number of cracked, broken, or missing windows made it difficult to control contamination and increased decontamination efforts of the outside of the box.
- Some boxes contained tritium that required more monitoring and increased the wait time for the decontamination survey results.
- Unreliable HVAC and air moving equipment.

Below is a more detailed discussion on lessons learned associated with some of the key challenges. Fig. 13 shows a picture of the operators moving a large FRP into facility 375.

Fig. 13 Operators moving large FRP into facility 375

LESSONS LEARNED

For efficiency of the SCO process:

- Operations must ensure that the SCO map, glove box weight, and surface area of the object are obtained as soon as the glove box is visible from inside and outside. This allows time to plan for the radiation surveys while the initial remediation work is ongoing.
- For the areas in the glove box that cannot be reached for surveying, a method for determining contamination levels needs to be evaluated such as the use of sodium iodide detectors, gamma spectrometry, or smears whereby it would be feasible to find small ports that are large enough to perform a few smear samples and extrapolate the results over the item. Further investigation is needed for what is required for areas with no access.
- The right combination of chemical and physical decontamination methods most appropriate for the waste stream needs to be identified.
- Data tracking enables operations to better understand waste process strengths and weaknesses, thereby enabling improvements to be made.
- It is important to know when to stop attempting decontamination through the SCO process, when the process is no longer cost effective.
- Any such operation requires a flexible cross-trained workforce.

SUMMARY

The SCO process has been used at various laboratories around the country to decontaminate waste items. The challenges at LANL included the aggressive accelerated goal, the temporary nature of the facilities, the limited capacity hand tools, the variable nature of the feedstock, and both internal and external contamination on waste items. To overcome these, LANL and ES had to implement an alternative process (SCO) and mature the operations into a continuous production process.

- SCO throughput is greater than SSSR. Preliminary analysis demonstrated that the remediation method (SSSR vs. SCO) impacts the volume throughput, and that there is a difference between the volumes remediated between the three facilities (412, 231 and 375). The improvement in throughput attributed to the SCO method is 6.5m^3 per day (based on the difference between SSSR and SCO at facility 231), or 0.24 m^3 per hour (SSSR) to 0.46 m^3 per hour (SCO); and the remaining improvement is possibly due to other factors such as facility capability and size of item remediated.

- The project developed an integrated production operation to maximize throughput without compromising safety or security of the workforce, LANL, or the public. Previously implemented methods included the development of solution packages and scope definition documents defining precursor activities and forecasting the commodities required to complete the solution packages. During FY13 the project realized benefits from having a flexible cross trained workforce to run back to back shifts (day and night) in conjunction with multiple days per week; to run multiple facilities simultaneously; and adjusted preventative maintenance support so that maintenance was carried out outside of facility operating hours. LANL and ES developed and implemented an operations measurement system to optimize productive time – measuring the time taken for start-up activities to prepare for safe and compliant remediation, and downtime events with their causes. A process improvement project recommended further steps that could be taken to become more efficient as a production operation (including optimizing activities within a shift to maximize productive time in the CA).

The primary benefits for using the SCO process over the SSSR process for large volume waste items were as follows:

- Less operator exposure to radiation (as low as reasonably achievable) given the reduced time in the CA for remediating each parent container
- Reduced risk of physical injury and puncture wounds with radiological uptake to operators because no cutting or physical lifting is required
- Increased throughput or remediation volume per hour in the CA
- Elimination of time and cost for the characterizing daughter containers
- Reduction in the cost of dispositioning daughter containers
- Potential reduction in the disposal cost as MLLW versus TRU waste

Secondary benefits were not insignificant. These include reduction in waste generated and significant reduction in the amount of time and resources to disposition waste.

SSSR may be more appropriate for smaller items such as pencil tanks, pipes, and miscellaneous debris. Factors to consider include available facilities and waste type to be remediated. In the end, each project needs to evaluate the individual situation. SCO was proved to be a more efficient process that is playing a key part in enabling LANL to meet the 3,706 m^3 goal.

REFERENCES

1. K. W. Johns-Hughes, J. S. Clemmons, D.R. Cox, K. M. Hargis, and M. L. Bishop, *Project Plan, Status, and Lessons Learned for the LANL 3,706 m^3 TRU Waste Campaign – 13085*, WM 2013 Conference, February 24 – 28, 2013.