RISK REDUCTION USING INNOVATIVE TRITIUM D&D TECHNOLOGIES AT LOS ALAMOS NATIONAL LABORATORY

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ABSTRACT

The Los Alamos Large Scale Demonstration and Deployment Project (LSDDP), in support of the U.S. Department of Energy (DOE) Deactivation and Decommissioning Focus Area, has identified and deployed eleven innovative technologies to potentially reduce the risk and cost of performing decontamination and decommissioning (D&D) in tritium-contaminated facilities. These deployments focused on techniques that supported a safer and less costly D&D of the Tritium System Test Assembly (TSTA) at Los Alamos National Laboratory (LANL) and other tritium facilities. Performance and cost savings, based on quantitative demonstrations to evaluate side-by-side performance of each innovative technology and an appropriate baseline technology, have been documented in Innovative Technology Summary Reports.

It has been recognized that many of these innovative technologies could provide an offsite public and D&D worker risk reduction benefit that is not easily quantified in the comparative cost analyses. The D&D and removal of fourteen tritium-contaminated gloveboxes from the TSTA facility at LANL was accomplished in September 2003. Using a hazard analysis approach consistent with LANL technical methodology, risk to the offsite public and to the D&D worker were evaluated. The identified risks were found to be appropriate for D&D of a non-nuclear DOE facility, provided that appropriate procedures, controls and safeguards are implemented. Reevaluation of these risks, assuming implementation of many of the LSDDP innovative technologies, indicates a reduction in risk to the offsite public and the D&D worker.

The use of these innovative technologies can benefit both the onsite and offsite receptors, through reduced risk of accidents which could result in injury as well as additional radiological exposure. Since the ambient dose during D&D of a tritium facility is very low, reduced task duration does not result in significant dose reduction. The likelihood of accidents resulting in work restrictions or lost-time injuries is reduced with the use of several of these innovative technologies. Implementation of several innovative technologies provides a method to detect or reduce the consequence of a tritium contamination incident.

Based on the D&D tasks performed to complete glovebox removal at TSTA, the conclusions from this hazard analysis are:

- The use of innovative technologies to perform cutting operations in a more efficient manner than the baseline technologies would reduce the risk of injury to the D&D workers
- The use of portable Liquid Scintillation Counters in the field to monitor tritium contamination would provide a means to reduce the consequences of a contamination spill
- Use of tritium cleanup technologies would reduce the consequences of a contamination spill.

The result of this analysis indicates that many of the innovative technologies demonstrated through this LSDDP would provide offsite public and D&D worker risk reduction if implemented during the glovebox removal activity accomplished at the Los Alamos TSTA facility.

INTRODUCTION

The LSDDP process facilitates field deployment of demonstrated technologies into actual D&D operations by comparing new or improved technologies against existing baseline technologies using a side-by-side comparison. The goal is to deploy demonstrated technologies such that they will be adopted as baseline or standard technologies.

The Tritium LSDDP [1] employed 11 technologies in 10 locations for a total of 21 deployments. Most deployments yielded cost and time savings, as well as reductions in worker dose and increased safety. The new technologies were procured through purchase, rental, loan or lease and were shipped to the deployment site. A site deployment engineer worked with local D&D Operations to establish a schedule and arrange to deploy each new technology. The technologies were then demobilized, decontaminated and returned to their source, as applicable. Several of these technologies have been previously used at LANL, although not in TSTA.

The subject D&D activity was the removal of fourteen tritium-contaminated gloveboxes from the LANL Tritium Systems Test Assembly (TSTA) facility (Technical Area 21, Building 155). The waste was packaged and transported to the waste disposal operation at TA-54, Area G during September 2003. This work required the:

- Removal of primary components
- Glove box size and volume reduction
- Packaging
- Loading
- Transportation of tritium contaminated waste items for final disposition.

Several of the innovative technologies from the Tritium LSDDP were considered and some were deployed for use in the TSTA Glovebox and Primary Component Removal Project.

PROJECT RISK

To evaluate the risk reduction associated with innovative technology deployments during the TSTA glovebox removal, a qualitative risk assessment was performed. It must be noted that the hazardous material inventory has been reduced in TSTA to the level that the facility is categorized as a RADIOLOGICAL facility under DOE facility hazard category requirements. The risk assessment described in this paper was performed using the Site-Specific Health and Safety Plan developed for this activity. The results are presented in Table I.

Table I Offsite Public and D&D Worker Risk Baseline

	Hazard	Offsite Public Consequence	D&D Worker Consequence	Likelihood	Risk Rank	
					Public	Worker
1	Breached container	negligible	minor injury	occasional	low	minimal
2	Breached container with fire	no EGs[a] challenged	lost-time injury	improbable	low	minimal
3	Fire caused by dismantlement tool use	no EGs challenged	lost-time injury	improbable	low	minimal
4	Contamination release during dismantlement	negligible	lost-time injury	probable	low	medium
5	Release of unexpected contamination encountered during dismantlement	negligible	lost-time injury	occasional	low	low
6	Contaminated oil spill during dismantlement	negligible	none measurable	occasional	low	minimal
7	PPE failure causes personnel contamination	None	minor injury	probable	minimal	low
8	Room air monitor fails	negligible	lost-time injury	occasional	low	low
9	Stack blower fails	no EGs challenged	minor injury	improbable	low	minimal
10	Erroneous tritium contamination analysis	none	lost-time injury	occasional	minimal	low
11	Personnel injury during dismantlement	none	lost-time injury	probable	minimal	medium
12	Personnel injury during waste handling	none measurable	lost-time injury	occasional	minimal	low
13	Seismic event	negligible	severe injury	remote	minimal	minimal
14	Wildfire	no EGs challenged	none measurable	improbable	low	minimal

[a] offsite evaluation guideline or EPA exposure guideline

INNOVATIVE TECHNOLOGIES

The innovative technologies deployed by the LSDDP that were deployment candidates for the TSTA Glovebox and Primary Component Removal Project are described below.

Hydraulic Crimper

The Hydraulic Crimper [2] is an AC-powered hydraulically assisted crimping tool. The cart-mounted pump enables the unit to be easily moved between job sites. The unit delivers 12 tons of force to the crimping die creating a leak-tight crimp, which nearly eliminates gas emissions and reduces worker exposures. A battery-powered unit and a manual crimper are also available.

Blade Plunging Cutter

The Blade Plunging Cutter [3] is a portable hydraulic powered cutting tool that operates as a piston-forced plunging cutter. It cuts through a recess in an anvil, severing metal in a guillotine fashion. It has a "dead man" switch for safe operation, and can be supported with a tension device when working from scaffolding, a lift or a ladder. It is powered by a hydraulic power unit, which is mounted on a cart and can be remotely located in a non-contaminated area. It is especially suited to cut metal glovebox legs and appurtenances.

Portable Liquid Scintillation Counter

The portable Liquid Scintillation Counter (LSC) [4] is used for field determination of tritium activity in smear and liquid samples from the luminescence of beta-emitting samples mixed with scintillation cocktail. Quench correction is possible in cases where the quench may vary from sample to sample, and correction is possible for "dead time" losses using a high activity mode. The unit can be battery-powered and the output port may be connected to peripherals with an RS-232 serial interface. Faster sample turnaround leads to more timely decontamination or disassembly action.

Evolution 180 Saw

The Evolution 180 Saw [5] is a portable handheld circular saw using patented blades specifically designed to cut metals such as stainless steel and aluminum up to a maximum thickness of 6 mm. The blade may be used to cut metals configured as square pipe, angle steel or flat plate. Blade life depends on the type and geometry of the material being cut; e.g., the blade life for cutting stainless steel plate is 700 minutes. It includes a dust cover to collect metal shavings.

Race-Scan EarMic System

The Race-Scan EarMic Communication System [6] was originally developed for use in auto racing with the loud environment of a racetrack. The System consists of two earpieces, a push-to-talk switch and associated wiring. It works with several types of two-way radios. One earpiece contains a speaker and the other contains a microphone, both work using voice sonics inside the ear canal. All EarMic system equipment is worn under PPE, which minimizes worker interference and prevents equipment contamination.

Vial Shredder and Disposal Process

Facilities that use Liquid Scintillation Counting (LSC) generate liquid samples containing radioactive material that are often difficult to stabilize and dispose. The Vial Shredder and Disposal Process [7] crush LSC vials, with or without their contents into a 55-gallon drum allowing mixing with absorbent material.

Portable Tritiated Water Removal Unit

The Portable Tritiated Water Removal Unit [8] consists of a centrifugal fan that can achieve flow rates in excess of 0.7 m^3/s using a 20 cm inlet duct. A reservoir (approximately 0.003 m^3) is provided at the fan suction for housing molecular sieves. At the inlet to the molecular sieve reservoir is a manually-controlled flow damper. There are a number of sample-ports available at both the inlet and the outlet side of the molecular sieve reservoir. The unit can be attached to glovebox ports to circulate air and remove tritium oxide from the atmosphere.

Tritium Cleanup Cart

The Lawrence Livermore National Lab (LLNL) Portable Tritium Processing System (PTPS) [9] Clean-Up Cart was used as a stand-alone unit for scrubbing tritium effluent. The scrubbing process is based on catalytic oxidation of elemental tritium. Tritiated water is collected on removable molecular sieve dryers, which can be shipped as low level radioactive waste (LLW). Replacement and disposal of the molecular sieves and the catalyst-containing reactor is both fast and easy. The unit provides a projected decontamination factor of greater than 1000, with a process flow rate of 45 liters/minute. The unit enclosure can function as a ventilated hood during normal operating conditions, but can be isolated when tritium concentrations inside the enclosure exceed the pre-selected control set point.

DBATS

The Dedicated Box Air Tritium Scrubber (DBATS) [10] is used to decontaminate glovebox atmospheres of tritium (HT and HTO). It is intended to be installed within a glovebox and allow for individualized large area tritium scrubbing by blowing a tritiated atmosphere through a heated catalytic reactor and condenser unit and depositing the

resulting moisture onto a molecular sieve. The unit can treat tritiated organics, which are known to be difficult to scrub.

RISK REDUCTION

Application of these technologies for the TSTA glovebox removal activity was evaluated by first matching the candidate innovative technology to those identified hazards for which the technology might reduce the risk from that hazard. This was accomplished by considering the advantages identified for each innovative technology and considering the effect of those advantages on the hazard. The result is presented in Table II.

Table II Potential Innovative Technology Application for TSTA Glovebox and Primary Removal Project

	Hazard	Innovative Technology[a]	Benefit of Technology Application
1	Breached container	*none identified*	--
2	Breached container with fire	*none identified*	--
3	Fire caused by dismantlement tool use	Evolution 180 saw Hydraulic crimper Blade plunging cutter	Saw provides more efficient cutting with few sparks, crimper and cutter produce no sparks
4	Contamination release during dismantlement	Hydraulic crimper Blade plunging cutter Portable LSC[b] PTWRU Clean-up Cart	Crimper provides sealing of contaminated pipes, crimper and cutter prevent airborne contamination Portable LSC provides early detection to mitigate contamination release, portable treatment units can be deployed to capture released contamination
5	Release of unexpected contamination encountered during dismantlement	Hydraulic crimper Blade plunging cutter Portable LSC PTWRU Clean-up Cart	Crimper seals contamination in pipe, cutter prevents airborne contamination release portable LSC provides early detection Portable LSC provides early detection to mitigate contamination release, portable treatment units can be deployed to capture released contamination
6	Contaminated oil exposure during dismantlement	Hydraulic crimper	Crimper seals any chemicals in pipe
7	PPE failure causes personnel contamination	*none identified*	--
8	Room air monitor fails	*none identified*	--
9	Stack blower fails	PTWRU	Provide localized exhaust of similar flow rate to stop contamination spread
10	Erroneous tritium contamination analysis	Portable LSC	Provides independent and rapid confirmation
11	Personnel injury during dismantlement	Hydraulic crimper Evolution 180 saw Blade plunging cutter Race-Scan EarMic	Crimper and cutter have no rotating part hazards, saw provides smooth and efficient cut, race scan provides enhanced communication during D&D activities
12	Personnel injury during waste handling	Hydraulic crimper Vial shredder[b]	Crimper allows folding, eliminating additional cutting of pipes for placement in waste containers, vial shredder provides efficient disposal of LSC vials (in TA-54)
13	Seismic event	*none identified*	--
14	Wildfire	*none identified*	--

[a] potential application of LSDDP technologies
[b] not at TSTA, at TA-54 waste processing

Once the innovative technologies were identified with respect to the identified hazards, it was possible to qualitatively reevaluate the offsite public consequence, the D&D worker consequence, and the likelihood of hazard event. In many cases, implementation of the innovative technologies on the project resulted in a reduction in the likelihood of the hazard events, and in a few cases, implementation of the innovative technology resulted in a

reduction in the consequence to the offsite public or the D&D worker. Reduction of either the likelihood or the consequence results in a reduction in the risk. The results of this analysis are presented in Table III.

Table III. Potential Consequence, Likelihood, and Risk Reduction from Innovative Technology Application

	Hazard	Offsite Public Consequence	D&D Worker Consequence	Likelihood	Risk Rank	
					Public	Worker
1	Breached container	negligible	minor injury	occasional	low	minimal
2	Breached container with fire	no EGs challenged	lost-time injury	improbable	low	minimal
3	Fire caused by dismantlement tool use	no EGs challenged	lost-time injury	improbable↓ remote	low↓ minimal	minimal
4	Contamination release during dismantlement	negligible	lost-time injury↓ minor injury	probable↓ occasional	low	medium↓ minimal
5	Release of unexpected contamination encountered during dismantlement	negligible	lost-time injury↓ minor injury	occasional↓ improbable	low↓ minimal	low↓ minimal
6	Contaminated oil spill during dismantlement	negligible	none measurable	occasional↓ improbable	low↓ minimal	minimal
7	PPE failure causes personnel contamination	none measurable	minor injury	probable	minimal	low
8	Room air monitor fails	negligible	lost-time injury	occasional	low	low
9	Stack blower fails	no EGs challenged↓ negligible	minor injury	improbable	low↓ minimal	minimal
10	Erroneous tritium contamination analysis	none measurable	lost-time injury↓ minor injury	occasional	minimal	low↓ minimal
11	Personnel injury during dismantlement	none measurable	lost-time injury	probable↓ occasional	minimal	medium↓ low
12	Personnel injury during waste handling	none measurable	lost-time injury	occasional↓ improbable	minimal	low↓ minimal
13	Seismic event	negligible	severe injury	remote	minimal	minimal
14	Wildfire	no EGs challenged	none measurable	improbable	low	minimal

CONCLUSION

Based on a qualitative risk assessment (Table I) of the hazards associated with the glovebox removal at TSTA, it can be seen that the risk associated with identified hazards are relatively low and do not present an unacceptable risk to the offsite public or the D&D workers performing the work. Using the innovative technologies deployed by the DOE LSDDP for tritium D&D (Table II) could provide a reduction in this already-low risk. Reevaluation of the qualitative risk assessment (Table III) identifies five opportunities for reduction in risk to the D&D workers, and four opportunities for the offsite public. Risk reduction results from reduced potential for exposure to contamination released and reduction of risk from injury during waste handling.

When the work was performed in TSTA, three of the identified innovative technologies were actually used:

- Hydraulic crimper
- Race-Scan EarMic system
- Vial shredder (used at waste facility to process liquid scintillation vials created on the project).

Use of these innovative technologies resulted in identified risk reduction from six hazards (numbers 3, 4, 5, 6, 11, and 12). The hydraulic crimper was fully responsible for the risk reduction with one hazard (number 6) and partially responsible for risk reduction from the other identified risks. Clearly, use of this innovative technology provided the most risk reduction for a single deployment.

Although the risk to the offsite public and the D&D worker were adequately controlled when the project was planned, the implementation of several of these innovative D&D technologies resulted in a reduction in risk to the D&D workers that performed the work.

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