Water Tank Rehabilitation at LANL

RGAIHA Fall Technical Meeting

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IH Lessons Learned From Project

IH Lessons Learned From Water Tank Rehabilitation at LANL in Summer of 2013

“Lead Paint Removal & Painting of Water Tank”

TA 16 - 171 & 247 – 1,000,000 Gallon Potable Water Tanks

Contractor: Riley Industrial Services, Inc.
Objectives:

Personal Objective: Reduce accidents and injuries to a level as low as reasonably achievable while supporting productive work.

Construction IH Objective: Ensure that no employee experiences an exposure above an occupational control limit or conducts work without appropriate controls.

Safety Goal: LANL

- Conduct our work safely and responsibly to achieve our mission.
- Ensure a safe and healthful work environment for workers, contractors, visitors, and other on-site personnel.
- Protect the health, safety, and welfare of the general public.
- Do not compromise safety for personal, programmatic, or operational reasons.
Contract Issues:

Tank TA 16 -171 was the first tank to be completed.

From an IH perspective, the project was interesting, but a challenging operation to oversee.

There was a basic conflict in the contracted terms as to the question of whose confined space program & permit would be used, the subcontractor’s or LANL’s.
A question arose: Did the construction confined space regulations apply (ie. 29 CFR 1926) or should the general industry standard (ie. 29 CFR 1910.146) be followed or used for reference and suggestions for good practice?
In regards specifically to the issue of onsite rescue personnel.
Major Job Tasks

Mobilize equipment to the job site

- Tank TA16-171
- VAC Truck
- New 3 ft. Man way
- Compressed air manifold
- 20K HEPA exhaust blower
- Generator
Major Job Tasks con’t:

Removal of remaining water, silt and cathodic protection equipment from the tank
Major Task con’t:

Staging of equipment and erection of scaffolding inside of tank
Major Job Tasks con’t:

Removal of lead paint by shot-blasting / abrasive blast cleaning

- Decon trailer
- Tank before blasting
- Shot blasting
- Shot vacuuming
- Shot recovery
- Tank ventilation
Major Job Tasks

Application of coating system

- Mobile scaffold in tank
- Tank roof
- Checking floor for imperfections
Work Tasks con’t:

- Installing cathodic protection
Major Job Tasks

Clean-up site and demobilize
Major IH Hazards

- Confined Space
- Lead
- Noise
- Isocyanates
- Paint Solvents
- Vehicle & Equipment Emissions
Controls – Engineering

Ventilation Controls

A 20,000 cfm blower (suction unit) with attached bag house filter and HEPA filtering unit to exhaust tank (maintaining negative pressure) from the top hatch point was utilized during blasting.

Either a 20,000 cfm HEPA filtered exhaust system or a 10,000 or 20,000 cfm exhaust unit with a bag filter was utilized during painting.

Access & Ventilation

A new three foot diameter entry point was cut into the tank wall in addition to the existing two foot diameter man-way.
Controls - Administrative

Decontamination.

A decontamination trailer was staged adjacent to the three foot man way.

PPE

Varied by task: Minimum Level D, Maximum Modified Level C/B

Work Practices

Airborne concentration maximums were determined and were referenced to limit exposure to VOC hazards.
Evaluation / Monitoring of Work Practices

- Conducted personal and area monitoring for lead
- Collected real time area particulate data
- Analyzed work practices to identify areas of concern and validate that PPE is appropriate
- Modeled the atmospheric concentration of contaminants of concern during painting operations to determine if they would exceed IDLH concentrations
- Monitored the atmosphere inside the tank using 4 – Gas meter, in addition to a photoionization detector (PID) when painting
- Conducted personal and area monitoring for major paint constituents
- Modified work methods or stop work if necessary
Personal Exposure Monitoring / Sampling for Lead:

- Interior work: Two workers were monitored full shift for lead. Samples were taken the first day of work and submitted to an AIHA accredited analytical lab for a rush turnaround.

- One sample was collected at the blower HEPA discharge filter

- A minimum of 3 days of exposure data was collected.

- If data indicated inadequate controls, all work would stop and a new exposure control plan would be implemented.
Work Activities & PPE

1. **Creation of New Entry/Manway**

   OSHA Level 1 Lead Task: Use power tools to remove exterior paint (6” stripe) to facilitate torch cutting of new manway. Used roto-peen and/or needle scalars with shroud and HEPA filtered local exhaust vacuum.

**Personal Protection**

- **Respiratory Protection:** Negative pressure half/mask respirator with HEPA / P-100 cartridges (assigned protection factor of 10; maximum use concentration up to 10 times the PEL)

- **Protective Clothing:** Disposable Tyvek-type coveralls
Work Activities & PPE

2. Removal – Blasting of Lead Containing Coatings

OSHA Level 3 Lead Task: Bead blasted the interior of tank. The lead paint was removed by shot blasting the interior surfaces using steel grit abrasive.

Personal Protection

Respiratory Protection: Positive pressure supplied air blasting hood (assigned protection factor of 1000; maximum use concentration up to 1000 times the PEL).

Protective Clothing: Double layer Disposable Tyvek-type coveralls.
Work Activities & PPE

3. **Spent Media Collection – Waste Separation & Packaging:**

   Used steel media was collected by vacuuming into the media reclaimer unit. The media reclaiming unit separates the steel grit for reuse, and deposits the paint chips into 55 gallon drums. The exhaust was HEPA filtered.

   OSHA Level 2 Lead Task: Vacuuming and collection of dry expendable abrasives and paint debris. Sealing and changing of debris drums.

   **Personal Protection**

   Respiratory Protection: Negative pressure full face respirators with HEPA / P-100 filtration (assigned protection factor of 50; maximum use concentration up to 50 times the PEL).

   Protective Clothing: Disposable Tyvek-type coveralls
Work Activities & PPE

4: Post Blasting Cleanup – Equipment Cleaning:
OSHA Level 2 Lead Task: Scaffold system, all interior equipment and tools was HEPA vacuumed and wiped clean of all media and lead dust/debris

Personal Protection
Respiratory Protection: Negative pressure full face respirators with HEPA / P-100 filtration (assigned protection factor of 50; maximum use concentration up to 50 times the PEL).

Protective Clothing: Disposable Tyvek-type coveralls
Work Activities & PPE

5: Application of diisocyanate containing Marcropoxy 646 Epoxy system:

Airless sprayers were utilized to apply epoxy coating. Brushes were utilized to apply coating to weld seams.

Personal Protection

Respiratory Protection: Positive pressure supplied air full face respirators (assigned protection factor of 1000; maximum use concentration up to 1000 times the PEL).

Protective Clothing: Disposable Tyvek-type coveralls
Work Activities & PPE

6: Final Equipment Filter Change, Repair, Cleaning:

OSHA Level 2 Lead Task: HEPA vacuuming, wet wiping and cleaning of HEPA filtered ventilation unit and any other potentially contaminated tools or equipment. Filter replacement and maintenance.

Personal Protection
Respiratory Protection: Negative pressure full face respirators with HEPA / P-100 filtration (assigned protection factor of 10; maximum use concentration up to 10 times the PEL).

Protective Clothing: Disposable Tyvek-type coveralls
Major IH Efforts, Findings, and Results:

The following are some of the major IH efforts, findings, and results:

1. The results of the personnel monitoring for lead during the shot blasting operation demonstrated the need for a high level of respiratory protection (APF of 1000), in order to control exposure to lead.

   Full-face APR would not be sufficient for tasks conducted within the tank during blasting.
Major IH Efforts, Findings, and Results con’t:

2. In general, as workers started shot blasting from the top of the tank and worked towards the bottom of the tank, the atmospheric concentration of lead within the tank increased from a low of 1,709 to a high of 21,820 µg/m³.

Note: No worker was exposed to an airborne concentration that exceeded the APF of his respirator. The respirator limit was 50 µg/m³ (PEL) x 1000 (PF), for a maximum use concentration of 50,000 µg/m³.

The highest exposure was approximately 44% of the maximum use concentration.
Major IH Efforts, Findings, and Results con’t:

3. The attendant’s exposure was generally lower than the PEL, except when he also assisted with other tasks, such as shot recovery.
Major IH efforts, findings, and results:

4. We suggested that the blast debris developed on the tank floor be thoroughly removed before the tank floor was shot blasted to reduce re-suspension of material increasing the lead concentration.

In addition, the ventilation should be modified. The exhaust point should be closer to the tank floor (2’ entryway), instead of the roof location point, when workers are blasting below 1/2 of tank height.
5. The air monitoring sample collected at the exhaust of the 20,000 cfm bag house HEPA filter, when analyzed, resulted in non-detectable levels of lead. Therefore, lead contamination of the environment did not occurred from the bag house blower.
Major IH Efforts, Findings, and Results con’t:

6. Measurements of the airborne dust levels adjacent to and around the tank did not show elevated levels.

We suggested shrouds be placed over drums and shuts to reduce the opportunity for lead to escape the processing equipment.
Major IH Efforts, Findings, and Results con’t:

7. A mathematical model was created to facilitate the estimation of the airborne concentration of various paint constituents at steady state for the future painting operations.

The model showed that the personnel working in the tank would not be exposed to an IDLH concentration of isocyanate (ISO) or volatile organic compounds (VOCs).

- Iso- 1.4 ppm  
- VOC -638 ppm
8. Personal air monitoring was conducted to determine the airborne concentrations of isocyanates and for the specific VOCs; xylene and ethyl benzene.
Major IH Efforts, Findings, and Results con’t:

9. Preliminary results showed that the concentration of isocyanate measured as MDI varied from 0.00143 ppm to 0.00481 ppm.

The isocyanate concentrations measured as HMPI and TDI were not detectable.

MDI’s PEL is 0.02 ppm, and the IDLH limit is 2.5 ppm. The high and low concentration results for MDI represent about 7% to 24% of the PEL and less than 0.2% of the IDLH concentration.
10. Preliminary results showed that the xylene concentration varied from 11.9 to 42.2 ppm and this represents about 11% to 42% of the PEL for xylene of 100 ppm.

11. Preliminary results showed that the ethyl benzene concentration varied from 1.99 ppm to 7.19 ppm, and this represents about 2% to 7% of the PEL for ethyl benzene of 100 ppm.
Major IH Efforts, Findings, and Results con’t:

12. Ventilation was completely successful in keeping the LEL, as read on a 4-gas meter, at zero (as calculated from PID readings< 5%).

At no time during this project was any oxygen deficiency, LEL, or any other contaminants detected, except for carbon monoxide (at low levels), when a portable welding unit was stationed next to the tank.
13. Ventilation (10,000 or 20,000 CFM unit) was capable of keeping the VOC concentration below 450 ppm when one painter was employed, but was exceeded when two painters were working together.

Although the predicted steady-state levels would have exceeded 450 ppm, (known from the model) there was sufficient time (>30 minutes) to note the concentration rise and to monitor it (every 10 minutes) to stop operations when the concentration met or exceeded 450 ppm (50% of IDLH).
14. In summary, a relatively high hazard operation of blasting and painting the TA-16-171 water tank proceeded without incident.

There were no personnel overexposures or environmental releases.
Tank Atmospheric Modeling Description

Description of Model to Determine the Atmospheric Concentration of Contaminates During Painting Operations within the TA 16 - 171 Water Tank

The model was in an Excel spreadsheet format. The principal equation used was the (1) General Dilution Ventilation Equation and (2) Rate of Contaminant Concentration Buildup / Purging Equation.

The general dilution equation was rearranged to solve for the steady state concentration for a given dilution ventilation rate instead of the typical ventilation rate for a specific concentration. The purging equation was not rearranged. The same mixing factor constant was used for both equations.
Tank Atmospheric Modeling Description

When using the dilution ventilation equation, the actual calculated dilution ventilation rate was used. The amount of material applied was adjusted in determining airborne amount.

The adjustment was added in the case of isocyanate (ISO) to account for the rapid reaction rate of the material.

The module was conservative because we assumed that the evaporation rate would be equal to the amount of ISO sprayed; and that any overspray, would be completely evaporated. This is highly unlikely since the vapor pressure of the material is 1 mm Hg. But because the material would be aerosolized into relatively small droplets, we were comfortable with the conservative assumption.
Tank Atmospheric Modeling Description

To calculate the VOCs concentration we selected the two major known constituents (e.g. xylene and ethyl benzene) that make up the large portion of the paint light weight vehicle and were relatively more volatile than other constituents.

We expected the VOCs to evaporate quickly, so conservatively we derived the amount evaporated by assuming that the majority of the VOC applied would evaporate. The amount (rate of application) applied was reduced, fractionally by the drying time divided by 60 minutes to arrive at paint evaporated per hour.
Tank Atmospheric Modeling Description

Using the modified general dilution equation to determine the steady state ISO and VOC concentrations were calculated as an airborne concentration of 1.4 ppm ISO and 638 ppm VOC. The values are respectively 56% and 85% of the IDLH concentration.

Using the buildup / purging rate equation, we calculated the time to purge the tank of ISO and VOCs concentration at steady state concentration would be respectively approximately 100 and 56 minutes to relatively low levels (0.1 and 100 ppm).

Because the equation used assumes purging with clean air, it can only be used as very general estimate of the build-up time to reach the steady state concentration.
Calculating – Steady State VOC Concentration

Calculating the steady state concentration of contaminant with fixed dilution ventilation

Equation: \( C = \frac{G}{Q} \)

Concentration = generation rate / dilution ventilation

\[
Cppm = \left( \frac{(\text{Constant} \times (10^6) \times SG \times ER) \times K}{\text{Actual Ventilation Rate} \times MW \times \text{Reaction Rate (air)}} \right)
\]

Inputs

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<th>Parameter</th>
<th>Value</th>
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Vol. in ft³ that 1 pt. of liquid when vaporized will occupy at STP
Specific Gravity of Liquid
Evaporation Rate pt/hr.
Molecular Weight
Dilution Ventilation in cfm
Mixing Factor 1 to 10

Rate = 60 is the material is non-reactive or reacts > 60 min. or immediately vaporizes. R Time is = time in min for 90% of material to react in air

Calculated Cppm 638

Concentration in ppm
Calculating – Rate of Buildup

Rate of Buildup / Purge

Equation: Time (purge) = Factor × Volume/Vent Rate × ln (Conc.1 / Target Concentration)

\[ t = K\left(\frac{V}{Q}\right)\ln\left(\frac{C_1}{C_2}\right) \]

\( t \)  Time in Minutes
\( Q \)  5262  Dilution Ventilation - cfm
\( V \)  80,000  Volume of Vessel - cubic feet
\( C_1 \)  638
\( C_2 \)  100
\( t \)  Min  56.3
\( t \)  Hours  0.9
Second Tank – Not a lead job!

During the first week of work of operation in the second tank, TA 16-247, we conducted a survey of the interior paint in the tank using a XRF detector.

The XRF survey that showed that the paint was not lead containing. Later, we also received an analysis report conducted on Aug 11, 2004 with a negative lead paint result.

Thus we need to reconsider the requirements for the operation since tank TA 16-247 was no longer a “lead” job.
Q&A

Thank you for attention!

I am happy to answer any questions!
Layout sketch

Background stuff – Not for PP

General Site Plan
Additional Pictures

20,000 CFM Fan/Baghouse with HEPA Filters

Decom trailer
Additional Pictures

11 barrels steel shot

4 barrels steel shot

Steel Grit Reclaimer

Power tools with Hepa Vac
EAGLE 200 Diesel Dust Collector

20,000 CFM Diesel Dust Collector

- **AIR FLOW RATE PER UNIT**: 20,000 cubic feet per min.
- **EFFICIENCY**: 99.9% @ 0.5 microns
- **TYPE OF DUST COLLECTOR**: Reverse pulse-jet cleaning.
- **TYPE OF FILTER ELEMENTS**: Top loaded, pleated Teflon® coated polyester felt cartridge.
- **NUMBER OF CARTRIDGES**: 24
- **CARTRIDGE SIZE**: 12" diameter x 26" long
- **DUCTING PORTS**: Two 20-inch diameter connections at rear of unit.
- **ARRANGEMENT OF FILTERS**: Vertical for efficient release of dust.
- **TYPE OF DRIVE**: Banded V-belt drive with clutch
- **ENGINE TYPE OUTPUT**: Cummins Diesel 76 HP with safety shut down switches.
- **ENGINE CAPACITIES**: Fuel/50 gal. capacity.
- **WASTE CONVEYOR**: Screw conveyor emptying through valve into 55 gallon drum. Full drum indicator light and removable screw conveyor assembly.
- **CONVEYOR DRIVE**: 1 1/2 HP air motor geared 25:1 with gear box 10 scfm compressed air at 40 psig.
- **SKID MOUNT**: 8' wide x 18' long x 8'6" high/weight approx. 10,000 lbs.
- **TRAILER MOUNT**: 8' wide x 22' long x 13'0" high
  Dual 16" wheels, dual axle, hydraulic surge brakes, Pintel towing connection, leveling jack, DOT Running lights & reflector s. GVW 11,000 lbs.
- **SAFETY RAIL & ACCESS LADDER**: OSHA compliant 42" high fold-down rail with access ladder
- **ELECTRICAL**: 12 volt DC controls. totally self contained.