Fluor Hanford ALARA Center

Activity Report for September 24, 2007

Assistance, Demonstrations, Research, and Tours Provided by the Center

1. Loaned John Cornelison, FH Safety, several Hexarmor cut and puncture resistant gloves to take back to D&D craft for their review, along with a Hexarmor brochure. Hexarmor sent five more models of their gloves for display. See www.hexarmor.com. All accidents are avoidable, Hexarmor gloves will help you avoid finger, hand and arm cuts if the equipment is used properly and this can save an uptake if a worker is wounded handling contaminated objects.

2. Provided tour of the ALARA Center to four senior executives from Chornobyl. They seemed very interested in the tools and equipment. After the tour, they toured the PFP Plastic Shop and saw how containments are fabricated. Provided three 2-hour training classes on Glovebag Inspection and Certification to about 36 RCTs as part of their refresher training.

New Process, Tools, or General ALARA Information

1. Attached is a lessons learned concerning a ruptured Tygon tubing and a peristaltic pump. The reason given for the tubing rupture was that is was operated for an extended time without being inspected or moved so the rollers would rub on another section of the tubing. If you're using a peristaltic pump there are other things that can be done to increase the chance the tubing will not rupture. We teach workers to: (1) inspect the tubing before it's installed. If the tubing has been stored in a connex box and is frozen, warm it until it becomes flexible before trying to use it. (2) Apply glycerin to the tubing so that the portion that is in contact with the rollers is well lubricated.
(3) Establish a frequency when the tubing has to be moved so the rollers rub on a new location. The ALARA Center recommends operating the pump for about 30 minutes and then stopping, moving the tubing, adding glycerin around the rollers, and then restarting the pump. Repeat this process until the pump is no longer needed. NOTE: Some radiological work facilities attach a kitchen timer to the pump. Workers are trained to set the timer at the specified frequency, i.e., 30 minutes, and start the timer when the pump is started. The timer will count backwards to zero and this tells the worker how much time remains before the tubing has to be moved.

2. We often get questions at the Center about non-destructive assay (NDA) from D&D Project Managers, Engineers and others. They all want to know the basics about how NDA works and how it can help them. Bruce Gillespie of Canberra Industries, www.canberra.com, gave a presentation at the American Nuclear Society meeting in Chattanooga that addresses most of those questions. SEE ATTACHMENT 2. For more information about NDA or Canberra products you can contact Bruce directly at bgillespie@canberra.com.

3. Washington Closure issued a Lessons Learned "Caution Bulletin" on a Breach in HEPA Vacuum Filters. A subcontractor working on asbestos insulation removal observed visible emissions coming from the exhaust of a Pullman-Holt vacuum cleaner. The vacuum was shutdown and later opened for inspection. The inspection revealed that the double-sided tape used to hold the HEPA filter box to the motor housing had failed and any air entering the vacuum cleaner would bypass the HEPA filter and exhaust in the immediate vicinity of the vacuum cleaner. Surveys taken revealed no spread of asbestos or radioactive contamination. Other Pullman-Holt vacuum cleaners were removed from service and several others had the same problem. New 15 gallon

ALARA information will save more dose if shared with others. Please send us your ALARA successes so we can forward them on. Everyone will benefit!

vacuums were inspected and they also had failed double-sided tape. A critique was held and the subcontractor has procured new HEPA filter boxes.

Opinion: The workers who recognized the problem and stopped work should be commended. Contractors often try and save money by purchasing inexpensive HEPA filtered ventilation and vacuum cleaner units. Experience shows **"You get What You Pay For"**. The contractror is lucky high levels of asbestos weren't spread during this incident. Using double-sided tape to hold the HEPA filter in place doesn't seem to be very smart. All of the vacuum cleaners on display at the ALARA Center use a more positive method of making sure the HEPA filter doesn't lose contact with its seal to the motor. Most are bolted in place similar to the air cleaner on an automobile carburetor.
Recommendation: If you or your subcontractors are going to use HEPA filtered ventilation and vacuum cleaners, ensure the units have been approved, have been aerosol leak tested, and RCTs/IH survey the discharge as soon as it is operated in a work area.

Decommissioning and Deactivation Activities and Information

1. Department of Energy (DOE) Occupational Radiation Exposure Report: The Office of Analysis (HS-32), within the Office of Corporate Safety Analysis has published the annual *DOE Occupational Radiation Exposure Report, 2006. See* http://www.hss.energy.gov/CSA/Analysis/rems/annual.htm . The 2006 DOE Occupational Radiation Exposure Report provides a summary and analysis of the occupational radiation exposure received by individuals associated with DOE activities. This report is intended to be a valuable tool for managing radiological safety programs, epidemiologists, researchers, and national and international agencies involved in developing policies to protect individuals from harmful effects of radiation. Hard copies of the report can be obtained at email nimi.rao@hq.doe.gov.

2. Attended an American Nuclear Society Topical Conference on Decontamination, Decommissioning and Reutilization. The Trip Report describing some of the work practices and lessons learned is attached.

3. DOE issued a new Operating Summary Report. Read it at
http://www.hss.energy.gov/csa/analysis/oesummary/oesummary2007/2007-06%20Screen%20PDF.pdf

Contacts

Come visit us at the Fluor Hanford ALARA Center; we are located on the Hanford site at 2101M/200E/226. We will do our best to help you with your radiological engineering, ALARA, and D&D challenges. You can also send us questions, comments, and your lessons learned via e-mail or you can contact us by phone. Contact information is below.

Larry Waggoner	(509) 376-0818, Cell (360) 801-6322, larry_o_waggoner@rl.gov
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ALARA Center Website: www.hanford.gov/rl/?page=974&parent=973

Please help us keep our e-mail address list current by letting us know if you would like added or removed from our distribution, and by keeping us informed of any e-mail address changes. Thank you for your help. We look forward to hearing from you.

Attachments:

NDA.pdf

1.

2. **Title: Breach in HEPA Vacuum Filters**

Date: September 18, 2007

Identifier: RCCC-07-014

Lessons Learned Statement:
For all portable HEPA vacuum cleaners prior to use:

- Ensure that the portable HEPA vacuum cleaner is on approved use list
- Ensure Vent and Balance seals are in place and current

The current single inspection process of the filter system increases the workers opportunity for exposure due to possible equipment failure.

Discussion of Activities:
After asbestos removal activities in 109N, workers were using a Pullman-Holt HEPA vacuum cleaner (15gal.) to clean up asbestos inside the containment area. A Laborer from PAS (an asbestos abatement subcontractor for Washington Closure Hanford) observed visible emissions coming from the exhaust of the vacuum cleaner. The workers personal protective equipment (PPE) included air purifying respirators and powered air purifying respirators. The vacuum was shut down and taken out of service. Area air monitors and individual lapel monitors indicated no airborne asbestos concentrations above action limits.

Analysis:
On Tuesday morning, August 14, 2007, following the Plan of the Day (POD) meeting, the work crew worked for several hours inside the Containment Area when visible emissions were noticed coming out of the exhaust port of the vacuum. The vacuum was immediately shutoff and the equipment and area was put in a safe condition. WCH management was notified and all 'like' vacuums were temporarily isolated.

On Thursday, August 16, 2007, the Vent and Balance seals were broken on the suspect HEPA vacuum cleaner and the HEPA filter was inspected. The inspection revealed that

double sided tape had failed to keep the filter box attached to the upper housing unit of the vacuum. It was also discovered that the filter box had fallen into the debris holding container, which allowed vacuumed material to exit the exhaust port.

As a result of this discovery, PAS inspected the remaining four 15 gallon vacuum cleaners and six 5 gallon vacuums. It was discovered that three out of five 15 gallon vacuum cleaners were compromised. The double sided taped had failed and the filter boxes had separated from the upper housing unit. One of the vacuums was missing the filter pr-screen on the HEPA filter. All six 5 gallon vacuums were determined to be in good condition.

Additional inspections were conducted on some brand new, 15 gallon (still in the box) vacuum cleaners from the same vendor. It was discovered the double sided tape had also failed. All suspect HEPA vacuum cleaners were taken out of service and tagged "Do Not Operate."

During the critique, it was noted that the Pullman–Holt vacuums needed to be delivered to Fluor Hanford's Vent and Balance group. This group is responsible for the DOP test, which certifies the HEPA vacuums for service. Upon successful completion of the DOP test the vacuum is closed and a seal is placed on it. The vacuums are sealed so that opening the vacuum to conduct normal inspections and bag change outs would render the DOP certification invalid.

The suspect HEPA vacuums were considered a "Single Use" item. Once they have been filled up they were disposed of properly.

Figure 1. HEPA Filter. Notice the white tape around the edge and how it lifts at the bottom of the filter, showing that it is not very adhesive.

Figure 2. Vacuum debris holding container with fallen filter in the bottom. Notice the lack of double-sided tape on the black portion of the filter.

Actions Taken or Recommended:

When these issues were identified, the work crew and WCH management implemented corrective actions to address and correct the situation.

The immediate actions taken upon discovery were:

- the suspect vacuum cleaner and work location was isolated and placed in a safe condition
- a notice was sent out to the management team about the event
- RCTs conducted surveys of the areas in and around the Containment Area for spread of any type of contamination
- the suspect and all 'like' vacuum cleaners were decontaminated, surveyed and inspected
- all suspect HEPA vacuum cleaners were taken out of service and tagged "Do Not Operate"

The follow-up actions taken to close the issue were:

- New heat wielded HEPA filter boxes were ordered and are currently in use

- Workers need to be informed about the changes in the DOP certification seal that would allow workers to open the vacuum container for inspection and bag change out

Estimated Savings/Cost Avoidance: N/A
Priority Descriptor: Yellow/Caution
Work/Function: Industrial Safety
Hazard(s): Other
ISM Core Function(s): Identify and Analyze Hazards; Feedback and Improvement
Originator: Doug Hanson, (509) 376-9850
Contact: Robert Brounstein, (509) 372-9145
Authorized Derivative Classifier: N/A
Reviewing Official: N/A
Keywords: Integrated Work Process, Occupational Safety and Health

References:
- OSHA standards for Asbestos Abatement and Containment
- operations manual for Pullman-Holt 15 gallon vacuum cleaner
- asbestos spill and clean up procedures
- air monitoring sample log sheets

3. **Trip Report from D&D Conference in Chattanooga, TN**

Memorandum for G. Perkins, Radiological Controls, L.Perkins, PFP and S. Doebler, FFTF Closure

Subject: Trip Report for the American Nuclear Society (ANS) Conference on Decontamination, Decommissioning and Reutilization

During the period of September 16-20, 2007, ANS conducted a Topical meeting in Chattanooga, Tennessee on D&D and Reutilization. Personnel from Hanford attending the conference included A. Hopkins, W. Witherspoon, S. Snyder, and L. Waggoner. Several vendors that support the nuclear industry were present and some gave presentations on their lessons learned.

We all attended a series of presentations each day and tried to document information that might have value here at Hanford. Three presentations were conducted at a time so we were unable to make it to everyone. We tried to pick the ones that sounded like they would benefit Hanford. Each of us were given a CD with all the presentations. We obtained an extra copy of the CD and forwarded it to R. Wilkinson, FH D&D.

In no particular order, here are some of our notes:

1. A copy of Radwaste Solutions magazine was distributed and it contained several articles of interest. One article described the effects of a 6.8 earthquake and damage done to their Central Waste Complex and showed photos of how the stacks of drums had fallen. Another article described the use of remote tools used in high radiation areas and the use of fuel pool divers in at the Marcoule plant in France. Several other photos show how large components were size-reduced. Page 34 had an article on "Redistributing Fernald's Government Assets. Once the Fernald cleanup was complete, heavy equipment that hadn't been claimed and the world's largest equipment auction was held to recover taxpayer's dollars. Page 40 had an article on "Designing Decommissioning into Reactor Designs". Page 47 had an article on "Gimme Shelter! This article describes the new large containment tent installed in 200 East near the Sub Trench that will be used to recover highly radioactive TRU waste drums. Copies of the magazine were forwarded to appropriate SWSD personnel and D&D Management. See http://www.ans.org/. Click on "Publications", then "Radwaste Solutions" and select an article to read, i.e. in the first magazine select the article on Reutilization of Assets from Fernald. Personnel can read the entire magazine at the ALARA Center or at the Hanford Technical Library.

2. Several important speakers gave presentations and we tried to take notes. These included:

a. Successful projects had some things in common. You need a strong project team that have experience, plant knowledge, contracting knowledge, experienced subcontractors, and personnel who know how to schedule, plan, and are concerned about safety. Managers need to be held accountable for safety, cost and schedule. Begin planning with the end in mind. The last 5% of a project takes most of the time. **"It ain't over till it's over" .**

b. Sandra Waisley, the head of EM23 at DOE HQ discussed her plans to promote new technology and the implementation of a D&D Hotline at the Hanford ALARA Center and a Website that anyone can use to get help on D&D work. DOE is focusing on Risk Reduction, cleanup, in a safe, cost-effective, prioritized and compliant manner. They have 20 million dollars they are making available for new product development.

c. ALARA Tools used at one site included acids to decon piping, underwater thermal cutting techniques, and underwater band saws.

d. A presentation discussed today's challenges: (1) Strategies are greatly affected by the waste disposal requirements, (2) Shutting down a plant is an impact to communities, (3) Threats of terrorism, (4) Need accurate cost estimates and funds need to be available on-time, (5) Must retain experienced workers and plan the downsizing, (6) Reward employees, and (7) record lessons learned and share results.

e. At one facility highly radioactive Deionizer vessels were placed in a cell, vented and concrete added until they were covered. Another layer of Deionizer vessels were added and more concrete added until the entire cell was filled with concrete encasing several layers of these vessels.

f. One scientist reported on experiments used to reduce the volume of calcined high level waste in powder form. He determined that the volume of powder could be reduced by 15% if the mixture could be vibrated.

g. A presentation was given on size-reducing a reactor moderator tank. Mechanical cutting techniques were used because they wanted no secondary waste, no fumes and felt they could capture the metal chip generated during cutting. A massive cutting tool was developed by MOTA Corp. See http://www.motacorp.com/segmentation.html . They also shielded a work platform to reduce worker dose.

h. Another successful project used water misters to control contamination, experienced heavy equipment operators, and an aggressive shipping schedule to complete work on time and under cost. Part of the work force was non-union and this presented challenges keeping the two groups separated.

i. Irradiated Reactor Components were cut up underwater using E.H. Wachs Co for support and their Guillotine hacksaw. See www.wachsco.com.

j. Cold and Dark. One presenter described the preparations needed to D&D a facility. In some cases, they allowed a physical air gap to prove a system was de-energized or depressurized. Holes were drilled in large piping to prove they were drained.

k. At one large building, the foot print was divided into 100 D&D zones. A walk down was accomplished in each zone by a team of experts and they determined what had to be done to characterize the zone and accomplish the preparations for D&D. Piping and other hazards were painted different colors to help the workers identify the hazards. Once all the information on the 100 zones was collected, they determined the remaining actions and end points. They emphasized the need to pick good people with facility knowledge. They said to assume all piping systems contain liquids. They used ultrasonic techniques to determine if there was standing water in piping. They said the rate you generate waste will soon exceed your ability to handle it. They made maximum use of portable ventilation, air conditioning and fixatives.

l. During D&D of a Physics Lab, a excavator with an extended boom and shear/hydraulic ram was leased for demolition. The basement was deep so they filled it with grout because they were concerned the basement walls would collapse if the excavator got close. Duct work insulated with asbestos was cut out manually. Reactor vessel was also filled with grout.

m. Demolition of a Concentrator building at SRS was completed by first sectioning the building into modules and then demolishing with a shear. The building was isolated, hazards removed, bolts were cut that held columns in place and rigging attached. A large machine then pulled on the rigging and toppled the building. It took a 3rd pull after cutting a few more bolts to get the building down.

n. Diamond shaving and cutting concrete with a diamond wire was discussed. See Bluegrass at http://bluegrassbit.com/clients/nuc-jobs/nuc_h.html System is cooled by CO2, liquid nitrogen or water. Diamond wire travels about 60 mph. Shrouds need to be place around the wire and negative ventilation attached to reduce the airborne concrete dust. Concrete shaving 1/8" deep over 7,500 ft2 creates one 55 gallon drum of debris. The blade is good for about 20,000 ft2 or 156 hours of operation. Shaver can go as far as ½" deep on each pass.

o. K-25 at Oak Ridge: Characterization & Measurement for Criticality Incredible. They remove high risk components that might contain holdups of Uranium and purged/vented piping. Piping <3" was foamed to reduce contamination spread during demolition. Bore scopes connected to video equipment were used to verify the quantities of residual material in systems. The building is in danger of collapsing while workers are still preparing it so bracing has been added to keep it from collapsing until the prep work is complete. A long cable has been strung through the building to provide a place to connect fall protection.

p. Another presentation reported on the D&D of a rocket lab outside Las Vegas. They encountered problems with heat stress, snakes, PCBs, asbestos, and had to dispose of 75,000 pounds of lead.

q. A presentation was given on how to decontaminate a hot cell using Sonotol chemicals. The chemical was circulated through a cup held against the surface. This

might work in theory, but it would take a long time to complete something as large as a hot cell.

r. Several presentations discussed the need for sharing lessons learned. Some people discussed how hard it was to get operations to write up a debriefing report after a job is complete. Operations personnel move on to the next job. We also discussed how we get access to the presentations made at ANS, Health Physics Society and Waste Management Conferences. These organizations have copyrights on the presentations and will be reluctant to share. DOE HQ plans on working through the Energy Facility Contractor Group (EFCOG) to identify best practices and lessons learned. In addition, there was more discussion on the D&D Hotline.

s. Two messages were repeated in several presentations, **"It is never too early to plan for D&D, start now**, and **Projects will save both time and money by close coupling D&D with deactivation."**

Keep everyone informed through the life of the project, this includes employees, regulators, and the public. They can be your best tool to be successful with completing your project.

Where possible, reduce Regulatory requirements, which include self-imposed requirements. Try to get to only the legally required requirements to reduce cost and schedule constraints.

3. ALARA Center personnel will review the other presentations that we didn't attend and forward any additional lessons learned. Thanks for the opportunity to attend.

A. Hopkins, W. Witherspoon, S. Snyder, L.Waggoner

Considerations for NDA in Waste and D & D Applications

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INTRODUCTION

Non Destructive Assay (NDA) is a common tool for waste characterization, decontamination and decommissioning (D&D) applications. However there are many things which must be considered in order to set up and run an efficient, cost effective, and successful NDA program for these applications. This paper covers some of these issues and points out examples of how they can affect the programmatic decisions.

REGULATORY ISSUES

The choice of measurement equipment, measurement plans, and measurement analysis techniques will vary widely depending on the type of facility which is being decommissioned and the programmatic requirements which must be met. Typical categories of regulatory requirements which will define the NDA program are shown below.

Typical Regulatory Issues	
NRC	**DOE**
ALARA, ES&H	ALARA, ES&H
Packaging	Packaging
Transportation	Transportation
Disposal Criteria (WAC)	Disposal Criteria (WAC)
	Criticality Safety
	Safeguards

It is important to fully understand the regulatory or customer driven data quality objectives (DQO). The following are three examples of very different types of requirements from different regulatory environments.

(1) A safeguards program must provide the most accurate answer possible in order to have an accurate inventory of the total quantity of SNM. On the other hand a criticality safety organization wants to add the most conservative uncertainty analysis to the results. Therefore one assay performed for these two organizations may need to have different reports and apply different uncertainties.

(2) Waste acceptance criteria such as the WIPP-WAC apply very strict QA requirements to the complete measurement program while others such as most low level waste facilities leave it up to the waste generator to establish their own QA requirements. However, as noted later, having a strong QA program is always important.

(3) Assays which are being used for packaging, transportation, and disposal are primarily important for ensuring that the waste falls into an acceptable range based on the categorization requirements. As an assay value approaches a limiting criteria then it is important to ensure that any biases or uncertainties are well known. For example the TRU/LLW sorting criteria is for transuranic concentrations at 100 nCi/g. Therefore if a D&D program is trying to disposition materials which may be TRU or LLW, then measurements which are in the 1 – 10 nCi/g range can have large uncertainties without affecting the disposal path. However, results in the 80 – 100 nCi/g range must be carefully considered to ensure that TRU waste is not disposed of as LLW. By the same token measurements which are in the 1000 nCi/g range and above can also have larger uncertainties without affecting the disposal path until the next upper limit is approached which is typically several orders of magnitude higher.

FACILITY ISSUES

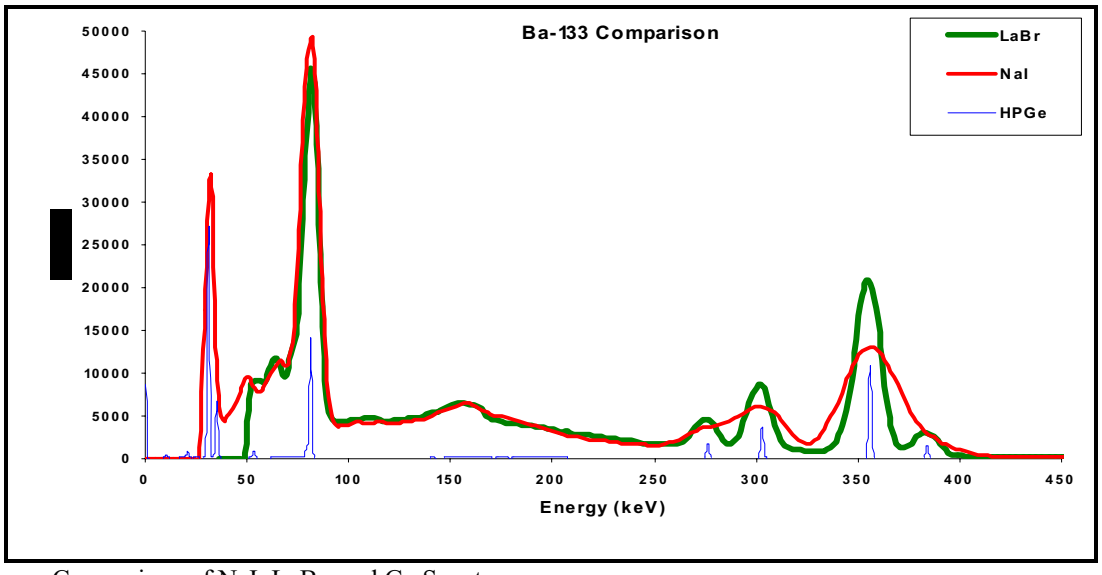
Typical facility information which needs to be considered includes the nuclides which can potentially be present, the activity range of the nuclides, and the consistency of the nuclide mix. For example a facility which painted radium onto dial gauges would probably only have radium present, but could have wide spread contamination levels. On the other hand a research facility may have performed experiments using a wide variety of nuclides with no correlation between the nuclides and or concentrations over time. This type of information will help to determine the type of detection system and analysis technique which is used, and will tend to determine what type of sampling plan may be required along with the NDA program. The sampling data is primarily needed to provide factors to apply for nuclides which may not be detectable in the NDA measurements.

All of the above information is needed to make the final evaluation of what is the most efficient and cost effective way to perform the project? Some of the typical decisions include:

- The cost of performing detailed assay measurements must be evaluated against the costs of generalizing large volumes waste into a disposal category which may be expensive.
- Weighing the quantity of sampling data and analysis vs performing NDA measurements. This tends to be highly dependent on the uniformity or consistency of the contamination levels.
- Using low resolution portable measurements and applying a large uncertainty vs performing high resolution measurements and having lower uncertainties.
- Evaluating the use of more expensive fixed or large container assay systems, vs the increased labor costs for performing portable assay measurements.

EQUIPMENT CHOICE

The above evaluation guides the choice for which NDA tools should be applied. There are a wide variety of NDA instruments available for D&D work, including fixed gamma and neutron assay systems for drums and boxes as well as low, medium and high resolution portable NDA techniques. For a facility with a small number of easily measured nuclides, typically gamma spectroscopy using NaI(Tl) detectors is adequate. However as the nuclide mix becomes more complex and potentially less consistent throughout the facility LaBr or germanium detection systems must be utilized. The NaI(Tl) detector is an inexpensive very portable spectrometer, however it is unable to differentiate peaks in a complex spectrum. The germanium detection systems can resolve complex spectra, but are more expensive and can be more difficult to handle portably due to their larger weight and size. The recent availability of LaBr detectors provides a useful compromise in many situations. The fixed assay systems can tend to be operated by lower level personnel and usually do not require the same level of data review as portable measurements. Therefore if the ultimate disposal path is through drums or boxes, these systems need to be considered. For uranium and plutonium facilities neutron measurement systems may also be a valuable tool, especially for higher concentration levels or in shielded areas.



Comparison of NaI, LaBr, and Ge Spectra

In some cases the use of a high resolution detection system, may reduce the need for performing sample analysis. Being able to detect more nuclides may help to determine what type of waste profile needs to be applied to a set of assay data. Similarly a small number of high resolution spectra used to obtain the waste profile information, may be able to be combined with low resolution measurements based on one or two key nuclides in order to provide quantification results.

MEASUREMENT PLAN

Once the type of detection equipment is specified, then it is necessary to evaluate the measurement plan. In certain cases, a simple approach with minimal measurements can be defined and very conservative assumptions utilized. However if the conservative assumptions push the waste type into a more expensive category, or significantly increases the volume of waste to be disposed then a minimal measurement plan may be a more expensive approach.

In many cases an NDA measurement program is tied to or compared against a sampling plan. This must be considered very carefully unless it is known that the overall set of material to be considered can be well represented by the sampling plan. For example measuring a sample of a small section of pipe and assuming that all of that length of pipe will have similar contamination levels, is probably a reasonable assumption, unless the pipe significantly changes orientation. Making general assumptions about the pipe in a facility based on a number of measurements would depend on how representative the measurements are over all pipe in the building and how consistent the measurement results are.

UNCERTAINTY EVALUATION

NDA especially for D&D applications has many sources of uncertainty related to the measurements. The understanding and evaluation of these uncertainties is critical to ensuring that the requirements of the regulatory organizations are properly met. In most D&D applications there are significant uncertainties related to the distribution of the contamination in an item being assayed. For example a pipe may contain a thin plating of contamination on the inside of the pipe or it could be fully plugged with a combination of residues and process materials. There could be contamination on the outside of the pipe in addition to the inside. Each of these situations would change the result of an NDA measurement performed on the pipe. For a simple measurement on this pipe a large uncertainty should be applied. On the other hand if multiple measurements are performed or high resolution spectroscopy is performed where gamma emissions of low and high energy can be compared, the overall measurement uncertainty may be significantly reduced. Other types of uncertainties may include: not being able to fully shield the radiation from other nearby items from being included in the item being measured, or inaccuracies in the measured distance of the detection system from the item being measured.

Because of all of the potential uncertainties related to NDA measurements, a good measurement may have an uncertainty of 10-15% if all parameters are well known and well controlled. At the other extreme for complex shielded items, a good measurement may have an uncertainty of a factor of 2 to 5.

In order to ensure that all uncertainties are understood, a measurement uncertainty document should be written which documents all of these uncertainties, and applies numerical values or formula for calculating these uncertainties based on the particular measurement being performed. This document is very valuable in trying to explain to a recipient of the measurement data or to a regulator why in some cases a large uncertainty is reasonable.

QUALITY ASSURANCE

In many cases NDA measurements performed for waste and D&D applications are not required to operate under any rigorous quality programs. Therefore it is very important for personnel controlling the NDA program to establish an adequate internal QA program. The elements of the program should include: calibration and operational procedures, traceable calibration standards, calibration verification, and daily performance checks.

The following is an example of why a strong QA program is important. Several years ago a very competent portable NDA program made a simple calculational mistake during a calibration.

The cause of the calculational mistake was primarily due to (1) not having a detailed calibration procedure. This was exacerbated by (2) not having a requirement for a review of the calibration and (3) not verifying the calibration with a known traceable standard. This condition caused an order of magnitude underestimation in the measured activity. The mistake went undetected for approximately 9 months. This ultimately cost the program over $1,000,000 between the effort to go back and recalculate all of the data generated over the 9 month period, paying a significant fine to the regulator, and having to pay for some of the waste to be exhumed from the disposal sight because it did not meet the waste acceptance criteria for that site. In addition the NDA program involved in the measurements lost all credibility and was audited internally and externally 6 times over the next 18 months (another expense not included in the above number).

It is also very important in the QA program to ensure that the techniques and procedures ensure that lower level operators can not make assumptions which would tend to cover problems. An example of this would be using a fixture for performing the daily performance checks to ensure that an operator does not assume that perhaps the source or detector was just placed in the wrong position when a test measurement is outside of the acceptable limits, and readjusts the positioning to pass the test and get to work.

Finally understanding and detecting changes in the work environment is also a critical issue in performing NDA for D&D. Most NDA programs were established initially based on measurements performed in a fixed geometry in a laboratory or process work environment. When the process is moved into the rugged environment of the D&D world, issues such as temperature variations, significant changes in background radiation levels, difficulties in operating the equipment when working in personal protective equipment (PPE), difficulties in setting up equipment in appropriate locations for performing measurements, all contribute to the possibility of additional measurement uncertainties or significant measurement errors which may not have been initially considered. For this reason, a good NDA program should have a strong technical lead, who is out in the field performing walk downs of the area and items to be measured, evaluating the problems which the operators are experiencing in performing field measurements, and writing easy to use measurement plans for upcoming measurements.