Section Four

ALARA Activities at DOE

In past years, the published annual report has included descriptions of ALARA activities at DOE for the purposes of sharing strategies and techniques that have shown promise in the reduction of radiation exposure. For 2005, these ALARA activity descriptions have been moved to the HSS REMS web page to facilitate the dissemination among DOE radiation protection managers and others interested in these project descriptions. Readers should be aware that the project descriptions are voluntarily submitted from the sites and are not independently verified or endorsed by DOE. Program and site offices and contractors who are interested in benchmarks of success and continuous improvement in the context of integrated safety management and quality are encouraged to provide input.

4.1 ALARA Activities at the Fermi National Accelerator Laboratory

At the Fermi National Accelerator Laboratory (Fermilab), a policy consistent with integrated safety management and in accordance with 10 CFR 835 requirements is to conduct activities in such a manner that worker and public safety and protection of the environment are given the highest priority. Fermilab senior management is committed, in all its activities, to maintain any safety, health, or environmental risks associated with ionizing radiation or radioactive materials at levels that are ALARA. Likewise, Fermilab management supports related work planning and review activities in support of Fermilab's ALARA program. Especially notable is the willingness to endorse cool-down periods and other scheduled modifications.

During the majority of calendar year 2005, Fermilab operated under normal beam-on conditions, which involves producing, accelerating, and delivering protons to the Tevatron Collider program, the neutrino physics experiments, (MiniBooNE and NuMI/MINOS), and the 120 GeV Fixed Target experimental program in the Meson Area. Some radiological work was performed on radioactive accelerator components consisting of repairs and corrective maintenance necessary for maintaining accelerator performance. In addition, beamline components were removed from the Meson Detector Building during this year.

4.1.1 Meson Detector Building MP and ME Beamline Component Dismantle/Removal

The MP and ME beamlines located in the Meson Detector Building last operated in the early 1990s, when a high intensity 800 GeV beam was delivered to these locations. To create space for new research projects, these beamlines were dismantled and all beamline components were removed. Clean-out work involved the removal of large amounts of shielding, extraction of radioactive beam absorption components, target stations, and work inside of a radiation-induced activated cavity. Cutting, torching, blasting, and weld grinding of SM12 magnet components were required for removal. Ambient exposure rates within the cavity of the SM12 magnet were approximately 75 mR/hr, with the maximum exposure rate of 850 mR/hr measured on the beam absorber. As magnet disassembly proceeded, previously inaccessible surfaces were exposed and higher radiation levels were revealed. To reduce potential radiation exposure, concrete shielding blocks were placed in front of hot spots along the exterior surfaces of the SM12 magnet. Additionally, a portable curtain of lead blankets was moved along the magnet as work progressed. Workers used the portable shielding while cutting and drilling directly on newly exposed surfaces. As a result of effective implementation of ALARA measures, the collective dose received for this phase of the work was approximately 30 person-mrem.

The most important aspect of radiological work regarding the ME beamline required the dismantling and removal of the beam absorber inside the beam cavity of the SM12 magnet. To minimize exposure, a special rectangular steel and lead blanket shield fixture was constructed to surround personnel working inside the beam cavity (see *Exhibit 4-1*). The ambient exposure rate of 75 mR/hr was

Exhibit 4-1:
Shielding Fixture for SM12 Magnet Dismantling and Removal Project Prefabricated Seal Pot MOD.

Photo courtesy of Fermilab

reduced to approximately 15 mR/hr with use of the shielding fixture. Furthermore, time limits were instituted to minimize doses in the area of highest activity within the beam cavity. The duration of work inside the beam cavity with the shielding fixture was limited to no more than four hours (see *Exhibit 4-2*). The total collective dose for this phase of the project was 25 person-mrem which reflects an estimated dose reduction of approximately 100 person-mrem. The collective dose for all of the dismantling and removal work of the MP and ME beamlines in the Meson Detector Building was 200 person-mrem.

Exhibit 4-2:
Worker Coming Out of Shielding Fixture Within SM12 Magnet Beam Cavity.

Photo courtesy of Fermilab

4.1.2 Additional Fermilab ALARA Activities

4.1.2.1 Anti-Proton Prevault Enclosure Beam Pipe and Torroid Replacement

A vacuum leak developed in the beam pipe and the torroid instrument (a beam monitor) was damaged in the anti-proton prevault enclosure. As a result, a portion of the beam pipe and torroid needed to be replaced. Initial general area exposure rates were in excess of 2 R/hr. At these rates, the pre-job collective dose estimate for this task would have been about 1560 person-mrem. Because this preliminary dose estimate was so high, ALARA measures were instituted to require a 12-hour cool-down time before workers were allowed to enter the area to start the task. The general area exposure rate after the 12-hour cool-down period was reduced to 130 mR/hr. The total collective dose for this job was 96 person-mrem. Implementation of this required cool-down wait time ultimately saved approximately 1460 person-mrem.

4.1.2.2 Anti-Proton Prevault Enclosure Vacuum Pump Hook up to Beam Pipe

Vacuum was lost in a beam pipe, so an attempt was made to restore vacuum to the beam pipe by hooking a vacuum pump up to the beam pipe in the anti-proton prevault enclosure. A three-hour cool-down wait time was required before workers were allowed to enter the area. The exposure rates after the three-hour cool-down period were about 600 mR/hr at the hot spot near an overhead magnet and about 400 mR/hr in the aisle way. To minimize time and increase worker efficiency, each step of the task was performed separately. For example, workers entered the high radiation area and then immediately exited to a low exposure rate area after each step of the task was completed. Further controls were instituted by the Radiological Control Technician (RCT), who supervised the job, by limiting the time allowed for each step to be completed. Also, the RCT verbally called out the expired time (in seconds) to the workers. This technique kept worker awareness at a high level as well as expedited the completion of each step. These ALARA practices resulted in the job being completed in less time and at a lower collective dose than would have otherwise occurred. As a result, it is estimated that 135 person-mrem was saved. The total collective dose for this job was only 8 person-mrem.

4.1.2.3 Reduction of Contamination Levels in MiniBooNE Target Enclosure

Prior to the restart of MiniBooNE experiment following a focusing horn change, secondary sealing and wrapping containment was added to all MiniBooNE target cooling system connections and readout ports. These ALARA actions reduced the potential for airborne as well as surface beryllium-7 (Be-7) contamination. Inspections of the target cooling wrapping were made whenever radiation safety personnel made an access to the main injector, 12B enclosure. Prior to returning the system to service following maintenance activities, radiation safety personnel required leak checking of any joints in the target cooling system that could have been affected. Comparison of pre- and post-horn change contamination wipe data shows that contamination levels have been reduced from 17,000 pCi to 1,200 pCi as a result of this ALARA effort.

Exhibit 4-3:
Cylindrical Collimator Located in Center That Required Manual Insertion of Wand-Type Sources.

Photo courtesy of Fermilab

4.1.2.4 Replacement of Wand Sources in Radiation Physics Calibration Facility

Radioactive sources are used routinely for radiation instrument calibrations at the Radiation Physics Calibration Facility. Wand-type sources and use of a collimator were successfully replaced with an automated source projector (see *Exhibit 4-3*). In this way, technicians no longer handle these sources manually by placing them into the collimator. Instead, these sources are operated automatically and remotely as part of the source projector system that houses other calibration sources. Also, an electronic sign was installed that indicates when the Source Projector Facility is in use. As a result of this new source projector, a greater than 90% reduction in exposure to the operators of this facility has been achieved.

4.2 ALARA Activities at the Hanford Site

4.2.1 Knowledge Gathering and Teamwork by Fluor Hanford Workers Reduce Radiological Risk and Improve Production at Waste Receiving and Processing Complex

The Waste Receiving and Processing (WRAP) Complex receives transuranic waste from various waste streams and processes and packages that waste for disposal at WIPP in New Mexico.

To prepare waste for shipment or disposal, some containers must be opened and the waste processed. For waste in 55 gallon drums, this work is performed in a glove box, where the waste is removed from its original drum, treated, and repackaged into a new 55 gallon drum. The new "one trip" drum is specially designed for mating to the glove box. Prior to the drum disengaging from the glove box, the glove box port door mechanism places an inner lid on the new drum to confine the waste. The outer lid and ring are placed by hand after the drum has exited the glove box (see *Exhibit 4-4*).

During glove box operations, contamination can migrate out of the glove box onto the outside of the inner lid of the repackaged drum. This contamination has the potential to create airborne radioactivity, exposing the workers. It was believed that the contamination spread was caused by a buildup, over time, of contamination on the outside of the port door. To control this hazard, workers periodically donned respiratory protection to decontaminate the glove-box drum exit ports and surrounding area. The periodicity was determined through past experience or increases in area contamination levels. Air sampling identified small releases of radioactivity and sometimes occurred before decontamination was performed.

The facility reevaluated the hazards and controls associated with drum exits. This evaluation recognized that because of the isotopes involved (primarily Pu-239 and Am-241) and the potential for the contamination to be extremely "flighty," these small releases might indicate a potential for a significant release. However, the data was sparse and the accuracy poor at these very low levels. So, the problem was how to assess risk and identify improvements when traditional methods of monitoring do not provide sufficient data.

An extensive regime of personal air sampling (lapel air samplers) was initiated. In addition, a standardized survey plan that included both large area wipes (LAWs) and technical smears was developed to provide consistent contamination data on exited drums. Each positive result was followed up with a review of all workers' activities, waste profiles, and any observed anomalies.

The personal air sampling appeared to demonstrate that small releases occurred more frequently than previously realized. Personal air sample results were found to be consistent with contamination on the exited drums as identified by LAW.

To accurately assess the value of this information, the personal air sample results were compared with highly sensitive and accurate bioassay results. Bioassay results confirmed that small releases had occurred, with one worker assigned a CEDE of 1 mrem and several workers being assigned a dose of zero. The comparison found that at very low release levels personal air monitoring is a good qualitative indicator. However, these samples

Exhibit 4-4:
Cutaway of the Drum, Inner Lid, Outer Lid, Ring and Gaskets.

Photo courtesy of Hanford

are not good for quantitative analysis as the air sample results are inaccurate and always higher (and typically much higher) than bioassay and more accurate air concentration measurements.

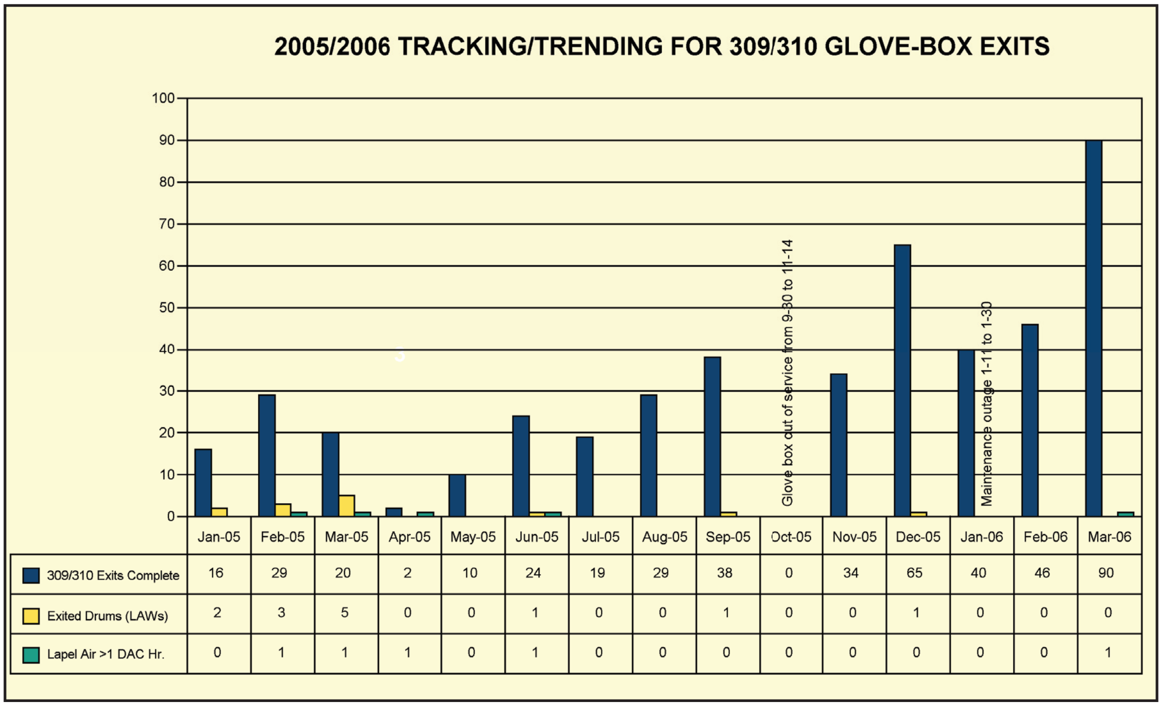
Reviews and analysis of the data identified that it is not a buildup of contamination but specific drum or process characteristics that increase the probability of contamination spread during an exit. This knowledge allowed a more accurate assessment of risk involved in each stage of exit operation. Together with worker insight and involvement, this information resulted in improved techniques, work practices, and design. Trending of the data demonstrated these improvements have been effective.

The improvements made and the reduction in positive events indicate a reduction of risk. The reduction of low-level release events and contamination spread keep chronic exposure ALARA.

Worker involvement was critical in both identifying and correcting problem areas. Workers were involved in this process from the beginning with a continual cycle of information gathering, analysis, and feedback. Open discussion between workers and radiological control staff dispelled inaccurate ideas and assumptions, allowing changes to be timely and effective. The workers' detailed knowledge of the equipment and process led directly to major improvements, including additional decontamination of critical areas within the glove box, redesign of drum lids and gaskets, and new techniques for the placement of the outer lid and ring.

The cost of this effort was approximately $3,200 for additional air sampling equipment. The cost in person-hours to collect the data and other information was minimal and greatly outweighed by time saved in others areas.

Exhibit 4-5:
This data demonstrates that the process improvements reduced spreads of contamination (fewer positive LAWs and fewer lapel air samplers > 1 DAC-hr) and increased productivity (number of drums completed).



	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06
🟦 309/310 Exits Complete	16	29	20	2	10	24	19	29	38	0	34	65	40	46	90
🟨 Exited Drums (LAWs)	2	3	5	0	0	1	0	0	1	0	0	1	0	0	0
🟩 Lapel Air >1 DAC Hr.	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1

Photo courtesy of Hanford

As anticipated, this effort resulted in an improved understanding of the risks involved during 309/310 drum exits. It had the desired effect of reducing risk. Risk is reduced by both a reduction of the hazard and a reduction in the probability of occurrence. This is demonstrated by the reduction in the number of positive LAWs and lapel air samples > 1 DAC-hr (see *Exhibit 4-5*). What was not expected as a consequence of this effort was the increase in productivity. Production steadily increased as improvements in radiological controls were made.

Though many factors can affect productivity, the improved controls have certainly contributed. The use of respiratory protection to perform decontamination has been significantly reduced. Greater understanding allows time to coordinate decontamination with other work activities. Fewer positive indications of contamination spread mean less down time investigating and fewer critiques.

For additional information about this project, contact Shawn Mellgren at (509) 373-4221 or Shawn_o_Mellgren@rl.gov.

4.2.2 Fluor Hanford, Inc., Early Work Team Involvement Saves More Than 25 Person-Rem During Grouting of K-East Basin North Load Out Pit Sludge

Radioactive sludge from the K-East Basin Spent Fuel Pool, North Load Out Pit (NLOP), has been placed in large diameter containers (LDCs) and sent to the T Plant facility for storage and treatment. The NLOP sludge grouting project was developed to pump the sludge from the LDCs into a buffer tank, pump metered quantities into 55 gallon drums, and grout the sludge for stabilized storage until it is eventually shipped to WIPP.

The sludge contains significant amounts of Cs-137 and Sr-90 as well as alpha emitters such as Pu-239 and Am-241. External dose rates from a small volume of the sludge are significant. The dose rates on the outside of the LDC exceed 100 mrem/hr. In addition, as the sludge dries out it can become resuspended and produce a considerable radiological airborne and surface contamination hazard.

Many ALARA controls and techniques were incorporated into the design of the NLOP Sludge Grouting System with input from the work team. These included shielding, remote and automated handling of the radioactive material, remote monitoring, performing as much work as possible outside the radiological areas, design of special tools, and system walk-downs, mock-ups, and dry runs. Confinement ventilation and secondary containment were used to control the spread of contamination.

Steel shielding was incorporated into the design of the sludge grouting system and was augmented with temporary lead shielding. The LDC is in a 1-inch thick stainless steel LDC Overpack container that is shielded with lead blankets (see *Exhibit 4-6*). The temporary shielding was installed prior to inserting an LDC in the Overpack container to minimize dose to the workers installing the shielding. The shielding reduced the side LDC dose rates significantly and resulted in reduced cumulative dose to workers performing work at the mixing station and buffer tank. The buffer tank secondary containment and enclosure is designed with

Exhibit 4-6:
LDC Overpack Container Additionally Shielded with Lead Wool Blankets.

Photo courtesy of Hanford

a 4-inch-thick steel shield on the sides and top to reduce the dose rates to workers working in the vicinity of the buffer tank and on the manifold assembly (see *Exhibit 4-7*). A 2-inch-thick steel shielding plate has been mounted across the front of the mixing enclosure to provide partial body shielding. The shield plate was designed to allow access to the mixing hood and also minimize exposure to the workers from the drum contents at the mixing station.

Remote handling and automation reduce dose to workers. Several aspects of the NLOP Sludge Grouting System design incorporate remote handling technologies to increase the distance between the source of radiation and the worker. The LDC is removed from the cell and installed into the Overpack remotely with the 221-T canyon crane, which is operated from the crane cab behind the 5-foot-thick concrete parapet wall. Pumps, valves, mixing motors, mixer enclosure doors, and the conveyor are all actuated remotely from control panels to allow remote handling of the waste. The drum scale was located at the end of the drum conveyor so that the drum could be weighed without repositioning. An automated pumping control system has been designed for pumping sludge and water to the drum from the buffer tank. This automated control system allows the operator to dial in the amount of sludge and water to be pumped to the drum, reducing the chances of an improper mixture that would increase overall dose due to extra handling of the waste. An automatic positioning device that positions the drum in the mixing hood directly under the mixer has been designed into the sludge grouting system to reduce the amount of drum handling required and to reduce the hazard of manually positioning the drum.

Exhibit 4-7:
Steel Plate for Partial Body Shielding (Magnets on Steel Plate for Storage and Quick Access to Tools).

Photo courtesy of Hanford

Remote monitoring reduced personnel dose. Closed circuit television cameras were installed in the buffer tank to monitor buffer tank level and in the mixing enclosure so Waste Services personnel could observe the grouting process remotely from the operations gallery camera room outside of the T-Plant canyon (see *Exhibit 4-8*). A portable mini-camera is also mounted on the spray wand to allow viewing of the inside of the LDC during pumping operations. Closed-circuit television cameras are also located on a tripod adjacent to the input conveyor to allow Waste Services to verify empty containers and on the Canyon walkway wall to record grouted drum weights and watch the grouting operations. These cameras are controlled by Waste Services personnel in the 221-T operations gallery camera room. The readout for the drum scale has a large LDC display so that the drum can be weighed and the weight recorded remotely by using the cameras.

Exhibit 4-8:
Waste Services Personnel Remotely Monitoring the Grouting Process.

Photo courtesy of Hanford

Television monitors are located on the LDC pumping platform, on the main control panel by the mixing hood, and in the 221-T operations gallery camera room. A switchbox is located on the main control panel that allows the operators to select the output location of the camera feed.

A radiation monitor is used to determine the amount of sludge required to be pumped to the drum. This is designed to ensure that dose rates on the grouted drum do not exceed requirements. The radiation monitor is mounted on a pipe in the buffer tank manifold. Sludge is circulated through the pipe while the buffer tank mixer is producing a homogeneous mixture. The radiation monitor readout is located on the outside of the buffer tank enclosure, providing remote readout.

Performing preparatory work outside the radiological areas reduced personnel exposure. The 221-T canyon facility was posted as a contamination area/radiation area/airborne radioactivity area (CA/RA/ARA). Dose to workers was reduced by prefabricating, setting up, and testing all of the parts associated with the sludge grouting system outside of the canyon facility. As a result, time to install and test the equipment in the canyon facility was greatly reduced. Additionally, preparatory work for the grouting process was performed outside radiological areas or in low dose areas. Absorbent material was prepackaged into pillows that were placed in the drums to absorb any excess moisture after the grouted sludge had been mixed, rather than scooping absorbent into the drum. This reduced the amount of time required to insert the absorbent material. Grout was prepackaged in drums and the drums pre-staged on the canyon deck so that they were readily available. The prepackaging reduced the amount of time workers spent in the canyon near the sludge to measure and prepare the grout for use.

Several special tools were designed to reduce dose to the workers. The sludge extraction wand had extension handles attached to allow operation of the wand from the side (back away from the direct beam radiation from the LDC port opening). A strain relief cable was attached to a rotating arm to support the weight of the wand, allowing the operator to easily maneuver the wand during the pumping process while maintaining adequate horizontal distance from the beam source. A drum ring spreader was designed to allow operators to single-handedly install the drum ring on the drums after they had been grouted and the lid placed on the drum. This special tool greatly reduced the amount of time required to install drum lid rings, which subsequently reduced the dose to workers. The grout loading funnel w/vibrator and drum tipper allowed the workers to set up the grout addition system and walk away from the process area while the grout was gravity fed into the drum.

System walk-downs, mock-ups, and dry runs were used to reduce worker exposure. During the design and development stages of the sludge grouting system, numerous system walk-downs were conducted to perform reviews of drawings, test equipment functionality, determine layout, and process flow parameters. Members of the work team were involved in these walk-downs to provide up-front worker input into the design of the system. These walk-downs resulted in better design reviews and improvements to the design.

In the early stages of design, the mixing hood, LDC pumping station, and LDC were mocked up to assist in development and training for the LDC pumping process. Operational tests were conducted to ensure the equipment was capable of performing its design function. These tests were conducted at the fabrication facility rather than in the canyon facility to reduce the dose to workers. A mock-up of the pumping platform was also constructed in the T Plant parking lot around an LDC Overpack to assist in developing the work process.

Once the equipment was installed in the canyon, dry runs were performed to test the operability of the equipment (post-installation) and to finalize the procedures and train individuals.

Fluor Hanford, Inc., estimated more than 25 person-rem was saved as a result of implementation of these ALARA methods.

For additional information about this project, contact David W. Andrews at (509) 373-0815 or David_W_Andrews@rl.gov.

4.2.3 Simple Tools Simply Save Dose at 222-S Laboratory

During 2005 the Analytical Technical Services (ATS) organization at 222-S Laboratory, managed by CH2M HILL Hanford Group, Inc., utilized several ALARA protective measures to reduce personnel exposure during the receipt and disposal of radioactive waste shipped from Savannah River via BWX Technologies (BWXT).

The purple container (affectionately called a “Barney Box”) is the outermost container and provides ALARA protection by providing distance from the waste carriers inside (see *Exhibit 4-9*). The white container with the blue top is called a “safesend” and is used to encapsulate the two shielded waste containers, “pigs,” and provide spill protection during shipment.

ALARA methods implemented by 222-S Laboratories included use of mock-up training, development of special tools, and use of low-dose waiting areas.

Two specific mock-ups were performed. The mock-ups simulated all of the critical factors of the job where personnel exposure could be reduced. The first mock-up was used to determine the most efficient method of receipt and breakdown of shipping containers. Additionally, the mock-up familiarized the health physics technicians (HPTs) performing the waste receipt with the radiological surveys needed for this operation. The second mock-up was used to streamline the transfer of the pigs from the sample carrier breakdown area to the point of disposal.

Exhibit 4-9:
Detailed Breakdown of the Shielded Sample Carriers.

Photo courtesy of Hanford

Several tools have been created to increase the distance between the worker and the source of radiological exposure, reducing personnel exposure to radiation.

One of the ALARA protective measures used is depicted in the picture below. The tool being used has been named a “hayhook,” as it resembles a hook used for handling bales of hay. This three-foot metal rod has a curved hook on one end and a handle on the other, allowing the user to move the box from area to area while maintaining the needed distance to reduce exposure (see *Exhibit 4-10*).

Exhibit 4-10:
Moving Box with Hayhook.

Photo courtesy of Hanford

Dose rate jigs were created to provide more accurate measurements of the radiological dose by having a premeasured distance between the source of radiation being measured and the instrument used for measuring the dose (see *Exhibit 4-11*).

The same basic design of an instrument holder is used to measure the contact and 30-centimeter dose rates on various sizes of waste containers. This tool makes it possible for the HPT to stand back while the instrument reading is stabilizing.

Exhibit 4-11:
Jig for Holding Dose Rate Meter.

Photo courtesy of Hanford

The lids to the pigs are held in place by four screws that are torqued into place. The highest dose received throughout the history of completing the disposal process was from the removal of these screws. An extension device was developed to allow the torquing of these screws from approximately 18 inches away from the pigs.

During the actual work evolution, a low dose standby area was utilized for personnel not actually performing the work, ensuring that workers were not getting any dose above the normal exposure received in the work space. In an effort to assure the minimum dose was received, each unit containing samples was moved to a separate area away from the other containers while surveys were performed.

The original collective dose estimate for disposal of this waste was calculated to be ~650 person-mrem. Through the utilization of the items listed above and good overall ALARA practices, the collective dose received from this job was 115 person-mrem. These simple tools have provided an effective means of reducing personnel exposure in the field. The most important factor is the workers' showing a questioning attitude, finding ways to lower their overall exposure, designing the tools, and developing them within their own groups. ALARA is alive and well at CH2M HILL Hanford Group, Inc.

For additional information about this project, contact Steve L. Hathaway at (509) 372-0382 or S_L_Hathaway@rl.gov.

4.2.4 Washington Closure Hanford Reduced Exposure from Radioactive Waste Burial Ground Remediation by a Factor of Three

The six former plutonium production reactor complexes situated along the Columbia River in the northern part of DOE's 586-square-mile Hanford Site contain solid waste burial grounds that date back to World War II and the Cold War era defense program operations. Remediation of the reactor area burial grounds along the Columbia River began in mid-2004. Remediation of these burial grounds and numerous other waste sites is a significant part of the work scope being performed by Washington Closure Hanford LLC (WCH), the prime contractor for the River Corridor Closure Project.

Burial ground inventory records prior to the 1970s are very limited. Waste radionuclide inventories at each burial ground were estimated in historical records, based on the major types of waste buried at the site. However, unanticipated waste forms were found during remediation of burial grounds.

Work started at the 100-B/C reactor burial trenches in mid-2004, using conventional earthwork techniques and standard health and safety plans and precautions deemed appropriate for the anticipated hazards. The work was halted in its tracks only months later when pieces of highly radioactive (high dose rate) spent nuclear fuel were discovered in the reactor burial grounds. No spent fuel had been anticipated, based on the review of historical records. Finding the fuel pieces resulted in exceeding the existing work authorization basis and approved plans.

At another burial ground in the 300 area, burial ground remediation was shut down when two RCTs received an uptake in October 2004 while performing a swipe survey of a metal cup in the 618-2 burial ground sorting area (see RL-BHI-REMACT-2004-0018). The metal cup was a piece of laboratory equipment that had plutonium and americium residue in it. The project had not anticipated finding separated plutonium at the burial ground. Large piles of unsorted material were exposed. Fixatives were applied to the sorting piles. However, high winds resulted in some spread of contamination outside the sorting area. Actions were taken to cover the excavated material while the project planned its recovery.

These two events demonstrated the need to improve the burial ground remediation process. Getting safely back to work was a first-of-a-kind project engineering and execution challenge, taken on by the 100-B/C field remediation project team during 2005. This team focused on safe handling of high dose items found in reactor burial grounds but also incorporated lessons learned from 618-2.

The 100-B/C Field Remediation Project formed a dedicated team of in-house radiological safety, industrial safety, and engineering and construction management talent to tackle the technical problems encountered and devise improved work processes.

Previously, dirt and debris dug up from the burial grounds were piled nearby in 20- to 30-foot-high mounds. Heavy equipment was used to cascade these materials down the sides of the mounds, as workers used visual observation, long-handled tools, and survey instruments to find, remove, and segregate any items that could not be accepted for disposal in Hanford's Environmental Restoration Disposal Facility (see *Exhibit 4-12*). Being situated in close proximity to the waste material, workers were at constant risk of exposure to radioactive materials and toxic substances. Also, by working on the ground near operating excavators, heavy trucks, and front-end loaders and climbing on the waste mounds among the rocks and dangerous debris, they were at a higher risk of industrial accidents and injuries.

Exhibit 4-12:
Former Method.

Photo courtesy of Hanford

Three improved processes resulted in significant improvements in safety and a reduction of worker dose:

1. Starting at the burial trench, the team devised a new approach where an excavator now spends half a day digging and mixing waste in place before any of it is removed. Enhanced air sampling is performed at the point of initial excavation and mixing. The air sample is collected adjacent to the track-hoe bucket, and the waste material is not transferred to the sorting area unless air samples demonstrate the mixing operation produced <1 DAC airborne radioactivity. This minimizes the potential for airborne exposure to the workers at the waste sorting area.

2. After the preliminary check at the burial trench is completed, instead of mounding the excavated waste material, dump trucks haul the dirt and debris to one of a series of shallow sorting cells, each 300 feet long by 20 feet wide by 3 feet deep, surrounded by a low soil berm. Waste material is spread out in the cells to a depth not exceeding 1 foot. This minimizes the amount of radioactive material workers are exposed to, and the soil berm provides shielding. With the waste materials placed below grade, exposure to surface winds is also greatly decreased and contamination control is significantly improved.

3. The team designed a PVC pipe holding 12 radiation detectors (called a gamma pipe) to remotely survey the waste material to locate high-dose-rate items (see *Exhibit 4-13*). The Bobcat-mounted gamma pipe is pulled over the layer of soil, and real-time readings are transmitted to nearby laptop computers. If unusual readings are detected, the Bobcat operator is directed back to pinpoint the location, which is then marked. A track hoe scoops up the dirt and debris from the hot area of the cell. Workers use long-handled tools to go through the loads looking for fuel pieces, high-dose material, and other anomalies. Any high-dose-rate items are removed and segregated in a secured and shielded location, pending special treatment and shipment for appropriate disposal.

The new approach has achieved a marked ALARA performance improvement. Workers, dressed in full personal protective equipment, are no longer required to walk over the waste material during the multistage sorting process. This greatly minimizes the amount of radioactive material workers are exposed to and has

Exhibit 4-13:
Improved Approach.

Photo courtesy of Hanford

significantly reduced worker dose. Using the former sorting process, the 100-B/C Field Remediation Project team experienced an average dose rate of 23 person-mrem/day (August–September 2004 data). With the revised sorting process, the average dose rate dropped to 7 person-mrem/day (September–November 2005 data).

WCH's Field Remediation Project organization is currently applying the same approach to its other burial ground remediation work at the 100-F, -K, and -D reactor sites. The new method is expected to save several person-rem a year.

For additional information about this project, contact Jeffrey L. Hunter at (509) 372-3285 or jlhunter@wch-rcc.com.

4.3 ALARA Activities at the Savannah River Site

During the period of special nuclear material production at the SRS, activated aluminum and stainless steel scrap metal were generated in the production reactors from reactor fuel and production targets. Activated metals were and continue to be generated from processing of irradiated fuel received from off-site locations. The scrap metal was remotely placed into a reusable shielded cask positioned underwater in the reactor disassembly basin (see *Exhibit 4-14*) then loaded onto a truck and transported to the SRS Burial Ground. At one of the Burial Ground disposal trenches the top was opened remotely and the cask was tilted for scrap removal and disposal. In 1990, this process was suspended due to waste packaging and transportation issues.

In 2003, a team of spent fuel projects and solid waste personnel began discussions on changes necessary to resume these shipments. Issues of concern were packaging, material exposure rates, and potential airborne and removable contamination.

Packaging. Traditional packaging for transport included a catch pan beneath the shipping cask to contain any liquids that may escape. However, this method was no longer acceptable. Therefore, cask drain plugs were installed to eliminate the need for a catch pan. In addition, engineering calculations determined that the cask could not be tilted more than 135° for emptying the activated scrap at the Burial Ground. This presented a new issue because dry runs revealed that tilting the cask to only 135° would not remove all of the activated scrap. Worker-assisted removal of the activated scrap was not an option due to the high exposure rates. A carbon steel insert was designed to fit into the cask so the insert could be lifted from the cask and disposed in the Burial Ground slit trench (see *Exhibit 4-15*).

Exhibit 4-14:
Reusable Shielded Cask Containing Activated Metals.

Photo courtesy of Savannah River Site

Exhibit 4-15:
Disposable Carbon Steel Insert.

Photo courtesy of Savannah River Site

Material exposure rates. Activated scrap exposure rates range from 0 to 500 R/hr at contact. A decision was made to dispose of the 0 to 1 R/hr (contact) activated scrap first and apply any lessons learned before disposing of the activated scrap with higher exposure rates. Resumption of improved original site process coupled with greater proficiency from dry runs will allow higher dose material disposal by increasing amounts of higher dose materials loaded in casks. The step-by-step process will continue as we dispose of higher dose rate materials first up to 200 R/hr (contact) and then >200 R/hr (contact).

Potential. Surface contamination was an issue due to long-term contact with the slightly contaminated water during storage of scrap in the disassembly basin. After the loading of contamination in the shipping cask, a passive aerosol generator was used to fog and coat the scrap with ETGS (Encapsulation Technology Glycerin Solution) Invisible Blue® to reduce the potential for airborne contamination. A mock-up determined that ETGS Invisible Blue effectively coated the scrap. The coating contains UV-Blue® and was visible using an ultraviolet light to verify a complete coating (see *Exhibit 4-16*).

In 2005 SRS resumed disposal of activated scrap. To date, five 0 to 1 R/hr (contact) shipments totaling 10 casks have been successfully disposed of at the SRS Burial Ground.

For additional information about this project, contact Mike Ellis, Spent Fuel Project Waste Program Lead, at (803) 557-6159 or michael.ellis@srs.gov or Steve Osteen, SFP Special Projects, at (803-557-6011) or ronald.osteen@srs.gov.

Exhibit 4-16:
Contaminated Scrap Coated with ETGS Invisible Blue.

Photo courtesy of Savannah River Site

4.4 Submitting ALARA Success Stories for Future Annual Reports

Individual success stories should be submitted in writing to the DOE Office of Corporate Safety Analysis. The submittal should describe the process in sufficient detail to provide a basic understanding of the project, the radiological concerns, and the activities initiated to reduce dose. The submittal should address the following:

- Mission statement
- Project description
- Radiological concerns
- Total collective dose for the project
- Dose rate to exposed workers before and after exposure controls were implemented
- Information on how the process implemented ALARA techniques in an innovative or unique manner
- Estimated dose avoided
- Project staff involved
- Approximate cost of the ALARA effort
- Impact on work processes, in person-hours if possible (may be negative or positive)
- Figures and/or photos of the project or equipment (electronic images if available)
- Point-of-contact for follow-up by interested professionals

4.5 Lessons Learned Process

DOE has a mature lessons learned process that was initially developed in 1994. The current DOE lessons learned process is described in DOE Technical Standard, DOE-STD-7501-99. The purpose of the DOE lessons learned process is to facilitate the identification, documentation, sharing, and utilization of lessons learned from a review of actual operating experiences throughout the DOE complex. This is accomplished by lessons sharing among DOE sites through a common corporate database. A recent review of the lessons learned process has led to a redesign of the process to add a more corporate component to the process. This new corporate component, modeled after the Institute of Nuclear Power Operations Significant Event Evaluation and Information Network program, has introduced an additional corporate role in the review of DOE site performance and crosscutting operating experience and has started to provide additional lessons learned information to the DOE community in addition to that already provided by DOE field sites.

The collected information is currently located on an Internet Web site. This system allows for shared access to lessons learned across the DOE complex. The information available on the system complements existing reporting systems presently used within DOE. DOE is taking this approach to enhance those existing systems by providing a method to quickly share information among the field elements. Also, this approach goes beyond the typical occurrence reporting to identify good lessons learned. DOE uses the Web site to openly disseminate such information so that not only DOE but also other entities will have a source of information to improve the health and safety aspects of operations at and within their facilities. Additional benefits include enhancing the workplace environment and reducing the number of accidents and injuries.

The Web site contains several items that are related to health physics. Items range from off-normal occurrences to procedural and training issues. Documentation of occurrences includes the description of events, root-cause analysis, and corrective measures. Several of the larger sites have systems that are connected through this system. DOE organizations are encouraged to participate in this valuable effort.

The specific Web site address may be subject to change. Information services can be accessed through the Office of Health, Safety and Security Web page as follows:

http://www.hss.energy.gov