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 2007, 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 Fermi National Accelerator Laboratory (Fermilab)

At the Fermi National Accelerator Laboratory (Fermilab), a policy consistent with integrated safety management and in accordance with 10 CFR Part 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 As Low As Reasonably Achievable (ALARA). Likewise, Fermilab management supports related work planning and review activities in support of Fermilab's ALARA program.

During CY2007, the primary activities at Fermilab that resulted in occupational radiation exposures were associated with maintenance activities of the accelerator. Nearly all dose to personnel was due to exposures to items activated by the accelerated beams. Many maintenance activities were necessary as the Fermilab accelerator complex was challenged to meet the scientific objectives of the Tevatron Run II Collider Program, while simultaneously operating the proton beam needed for the Neutrinos at the Main Injector (NuMI) and Booster Neutrino (MiniBooNE and SciBooNE) experiments. Fermilab safely accomplished many essential accelerator upgrades during the summer of 2007 shutdown. These upgrades included, but were not limited to, replacement of the antiproton target, lithium lens transformer assembly rebuild and drive shaft replacement, replacement of Booster long corrector magnets and quadrupole magnets, and work on NuMI target chase ventilation system. Additionally, Main Injector large electron-positron magnet upgrades were completed, Main Injector collimators were installed, and sections of beam pipe were replaced. Extensive ALARA pre-job planning, implementation of specific ALARA activities during radiological work, and post-job analyses were integral to all work conducted during calendar year 2007.

The following activities highlight Fermilab's continued commitment to keeping exposures ALARA.

4.1.1 Preliminary Assessment of Potential Absorbed Dose to Complete Tasks

A preliminary assessment of potential collective dose that would be incurred as a result of the summer 2007 shutdown was projected prior to the shutdown. This preliminary collective dose assessment to completed tasks slated for shutdown 2007 was estimated to be approximately 22.5 person-rem. The number of personnel available to complete the proposed work was viewed to be less than what would be required to properly complete several of the tasks. As a result of this information, it was determined that numerous shutdown tasks should be scaled back and/or postponed in order to maintain exposures ALARA. Successful planning with ALARA at the forefront of upper management's decision-making process resulted in a collective dose reduction of approximately 10 person-rem.

4.1.2 Main Injector Large Electron-Positron (LEP) Magnets Replacement and Multiwire Chamber Repair

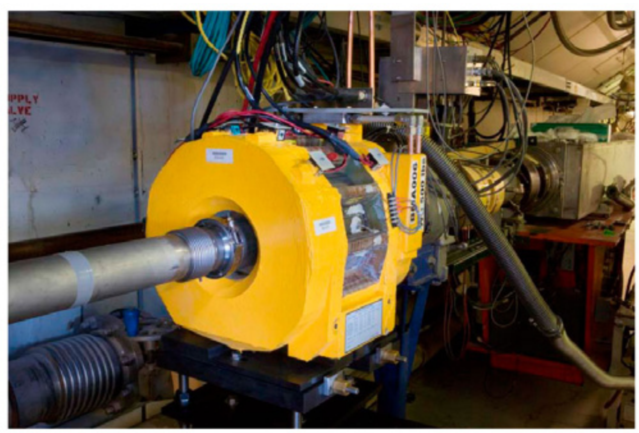
Replacement of the weak LEP corrector magnets and repair of the 851 multiwire proportional chamber improved the performance of the Main Injector 8 GeV collimator system (see *Exhibit 4-1*). The small aperture LEP dipole magnets were replaced with rebuilt LEP corrector magnets that can run more current than the previously installed LEP magnets. This improvement will help to reduce losses in the Main Injector. The multiwire at 851 measures the transverse beam prior to injection into the Main Injector. The mechanical system that moved the multiwire into and out of the beam was repaired. This job required radiological control technician (RCT) coverage, and radiation surveys were conducted as needed to monitor exposure rates during the work. There were five persons assigned to this job in addition to the RCT. The job went as planned, so the estimated collective dose of 64 person-mrem matched extremely well with the actual collective dose received of 61 person-mrem. This LEP magnet replacement and multiwire repair is estimated to reduce future doses by 300 person-mrem annually.

Exhibit 4-1:
Main Injector Multiwire Paddle

4.1.3 Booster Long 4 Prototype Corrector Magnet Replacement

The Booster is the first circular accelerator, or synchrotron, in the chain of accelerators at Fermilab. It consists of a series of magnets arranged around a 75-meter radius circle (see *Exhibit 4-2*). A prototype corrector magnet was installed in the Booster during the summer of 2007. A total of 15 people participated in this work. The estimated collective dose for this job was 310 person-mrem and the actual collective dose received was 163 person-mrem. Actual doses were lower than estimated for several reasons. First, the general area exposure rates were estimated to be 10 mR/hr. In actuality, general area exposure rates were less than half of the estimate. Second, the surveyors and electricians completed their work much faster than estimated in the ALARA plan. A third reason for actual doses being lower is that the shielding placed in the 8 GeV beamline was more effective than the ALARA plan had estimated. This task was very successful because basic radiation dose reduction principles of time and shielding were integrated into the work.

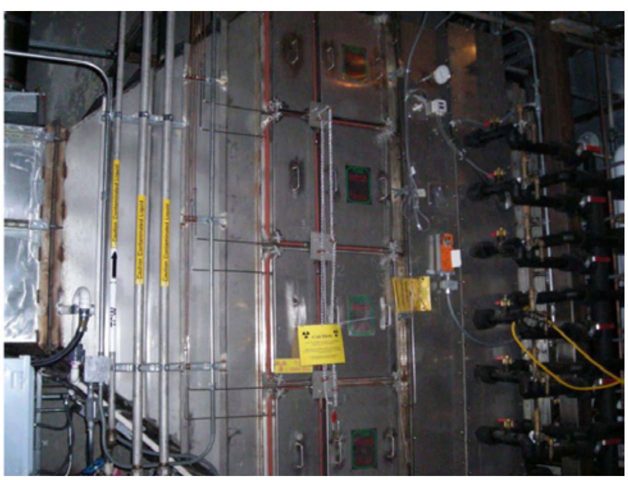
Exhibit 4-2:
Booster Corrector Prototype Installation



4.1.4 Neutrinos at the Main Injector (NuMI) Ventilation System High-Efficiency Air Filter Replacement

During the summer 2007 shutdown, work was performed to change out high-efficiency air bank filters in the NuMI target chase inside the NuMI target hall (see *Exhibit 4-3*). The air filter banks consisted of four levels of filters with each containing three pre-filters and three high-efficiency filters. The three pre-filters measured approximately 20 mR/hr at 1 foot. The other filters read about 2 mR/hr at 1 foot. The procedure used a bag-in bag-out procedure to prevent airborne contamination. Because the air filters were known to be highly contaminated, workers wore forced-air hoods, personal air monitors, and full anti-contamination clothing. The collective dose estimate for this work was 100 person-mrem and the actual collective dose received was 34 person-mrem. The reason the actual dose was much lower than estimated is that the workers were very efficient in their work despite the difficult conditions of the job. Also, the bag-in bag-out procedure for changing the filters proved to work well because no airborne radioactivity was created. Analysis of the worker's personal air monitors showed no detectable airborne activity.

Exhibit 4-3:
NuMI Target Chase Ventilation Bank



4.1.5 Antiproton Area (AP0) Target and Drive Shaft Replacement

Fermilab creates antiprotons by striking a nickel target with protons. It takes 100,000 to a million protons to make an antiproton. Over time, these nickel targets become damaged by the proton beam and must be replaced (see *Exhibit 4-4*). In May of 2007, work was performed to replace a target and also replace a drive shaft. Before the work began, the Accelerator Division ordered beam to be shut off from the area approximately 4 hours to allow for cool down. Plastic was placed on the floor and the alcove before the target module was moved. When the used target was removed and placed into the alcove, it measured approximately 300 R/hr at 1 foot from the upstream side of the target. It is interesting to note that several pieces of the target were observed on the antiproton target stand frame. When the target was placed into the coffin, it measured about 150 mR/hr at 1 foot. The coffin was wrapped in plastic to contain any highly activated material fragments. Once the work was completed, the plastic on the floor between the alcove and the lower vault was placed into a bag. The bag measured approximately 700 mR/hr on contact from highly activated particles. Next, the drive shaft on the target module was replaced (see *Exhibit 4-5*). Plastic was placed over the old shaft and the shaft was transferred to the storage vault. The drive shaft measured about 600 mR/hr at 1 foot. All areas were carefully surveyed to ensure that there were no highly activated material fragments present. During this work, pictures of the lithium lens and the pulsed magnet were also taken. Unexpected difficulties in obtaining photos of these items added 16 person-mrem to the overall collective dose. The collective dose estimate for the target and drive shaft replacement was 285 person-mrem and the actual collective dose was 290 person-mrem. This actual dose was well within the contingency estimate of 340 person-mrem. This job was carefully planned, well-executed, and workers diligently followed ALARA. The time estimated for this work was 12 hours, but it was completed in 10 hours.

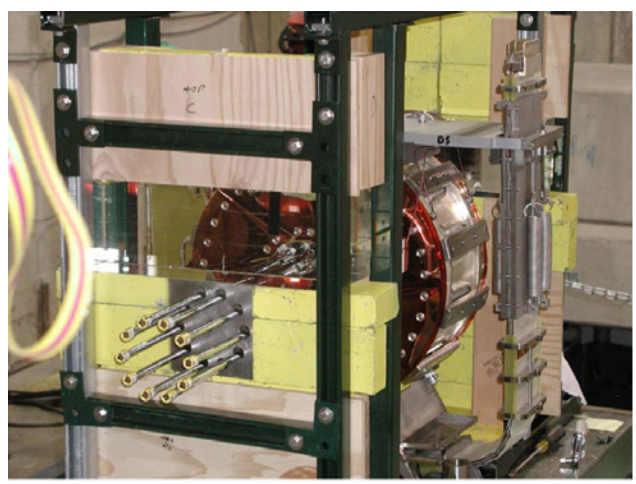
Exhibit 4-4:
Used Nickel Antiproton Target

Exhibit 4-5:
New Nickel Antiproton Target

4.1.6 Antiproton Area (AP0) Lithium Lens Installation in New Transformer Assembly

The purpose of a lithium lens is to focus newly created antiprotons into a beam. In September of 2007, a used lithium lens was placed into a new transformer (see *Exhibit 4-6*). This work required continuous Radiological Control Technician coverage and an extensive, detailed ALARA plan. The dose rate on contact with the lithium lens was approximately 10 R/hr (2.8 mR/sec). The dose rate at 1 foot upstream and downstream of the lens was approximately 2.8 R/hr (0.8 mR/sec). Due to the high exposure rates, ALARA plan time estimates were made in seconds rather than minutes. The work was completed in about 5 hours. During the work, circles were drawn on the floor to indicate the lowest exposure rates in each of the work areas. The workers were very careful to stand inside these circles to minimize their exposure. The collective dose estimate for this job was 114 person-mrem and the actual collective dose received was 65 person-mrem. The workers practiced installing the new transformer on a mock setup of the lens assembly prior to performing the work. The primary reasons the actual doses were almost half of the dose estimate were due to thorough prior job planning, successful use of a mock-up, and conscientious ALARA work practices.

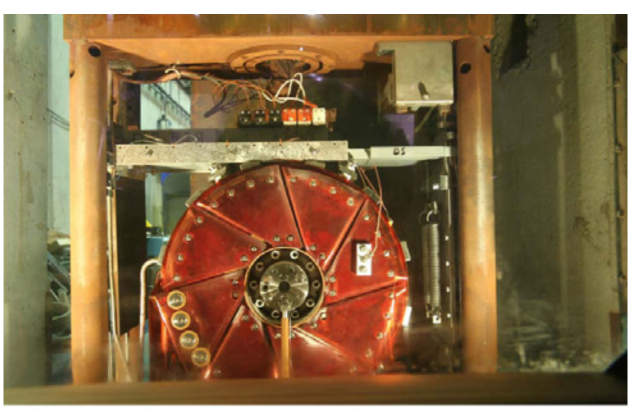
Exhibit 4-6:
Lithium Lens in New Transformer



4.1.7 Antiproton Area (AP0) Spare Lithium Lens Module Replacement with New Pre-Attached Lithium Lens

A spare lithium lens module was refurbished complete with a replacement lens already attached (see *Exhibit 4-7*). In the past, when a lithium lens failed, the lens was replaced with a new lens on the same highly radioactive lens module. In this case, a new lens was attached to a previously used spare lens module. In the future, when a lens failure does occur, the entire lens module will be switched out by remote crane operations and replaced with another less radioactive lens module. In this ALARA job, the highly radioactive lens module was placed directly in the storage vault for cool down. The exposure rate at the downstream side of the lithium lens was about 200 R/hr at 1 foot. The estimate for this job was 257 person-mrem and the actual collective dose received was 234 person-mrem. Another unique ALARA feature of this job was fabrication of a screwdriver with long extension to reduce exposure. Additionally, there was effective use of temporary shielding in the AP0 alcove. Another feature of this work was careful pre-planning and use of a mock-up to practice the job before it was performed. The mock-up work was performed on a radioactive spare module with a much lower exposure rate than the lens module being replaced. The highest dose rate on the spare mock-up lens module was about 4 R/hr at 1 foot. The use of a spare lithium lens module will save both time and dose in future lens replacements. It is anticipated that the refurbishment of a spare replacement lens module will require about 50 person-mrem. A typical lithium lens replacement job results in a collective dose of approximately 300 person-mrem. Therefore, a spare lens module with a new lens will save an estimated dose of about 250 person-mrem.

Exhibit 4-7:
Lens Module Replacement with New Pre-Attached Lithium Lens



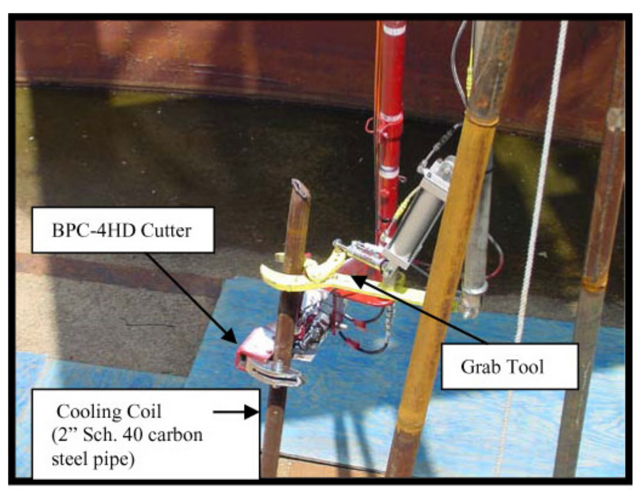
4.2.1 ALARA Activities at the Savannah River Site

4.2.1 Teamwork Results in F-Area Tank Farm ALARA Success Story

Recently, construction was tasked to install two submersible pumps at Tank 5 in F Tank Farm (FTF). To ensure no obstructions were present in the Tank risers that would restrict the installation of two submersible pumps, cameras were inserted into access ports at Risers 3 and 8. A review of the videos revealed that cooling coils in both risers had moved and would hinder the installation of the pumps. Knowing this and keeping ALARA and Safety foremost, the construction team, led by engineer Tom France, consulted with the Savannah River Site (SRS) ALARA Center and selected the Mega-Tech Blade Plunging Cutter (BPC-4HD) as the cooling coil cutting tool (see *Exhibit 4-8*). The BPC-4HD was modified to add a deployment system for positioning the cutter on the coil. A pneumatic grab tool was designed by construction to grab the coils as they were cut to control where they landed in the tank. A special riser shield plate was also designed to reduce occupational radiation exposure. These tools would enable the workers to cut the cooling coils remotely through the open tank risers.

Operation of the cutting and grab tools was successfully demonstrated at T Area, also known as TNX, prior to use in FTF. Below is a picture taken during the mock-up.

Exhibit 4-8:
Mock-up of Mega-Tech Blade Plunging



In addition, the following work planning proved noteworthy both during the mock-up and field execution activities.

- The riser was closed during the cutting activities, which eliminated the need for fall protection. The shield plate designed for the riser opening would reduce overall exposure to the individuals performing the task from 2 rem/hr to 28 mrem/hr.
- A stainless steel sleeve was fabricated and inserted into the riser opening to reduce spread of contamination from the riser wall to the cutting tool. A camera was inserted inside the riser with the tools. The workers were able to view a split screen monitor inside the hut, which enabled them to manipulate the mechanical arms of the tools.

4.2.2 HPICL Removal of the 1 Ci Co-60 Source and Rabbit

The Gamma Beam Irradiator (GBI) (see *Exhibit 4-9*) is located in building 735-2B at the Health Physics Calibration Laboratory. It contains 3 cobalt-60 and 3 cesium-137 sources and 1 dummy source (non-radioactive). Each source is encapsulated in a rabbit, a small aluminum container, and stored in a carousel 10 feet below the floor. The center of the rabbit contains a source, 2 washers, and a spacer (see *Exhibit 4-10*). The rabbit lid is screwed down and held in place with a set screw. These sources are used to calibrate radiation monitoring instruments used at the Savannah River Site.

Exhibit 4-9: GBI System

During GBI operations, a source is moved pneumatically to the top of a transfer tube, where it is captured and held in place via a suction cup and vacuum to allow instrument calibration.

During routine operation, in June 2007, the vacuum failed to capture and hold one of the Co-60 sources (1 Ci) at the suction cup. Several attempts were made, but all attempts failed. The carousel was then rotated to another source position and an attempt was made to transport it to the top of the transport tube. Instead, the carousel jammed. A time-out was called and the HPS Technical Director was notified.

The HPS Technical Director decided to insert a boroscope into the source transfer tube to determine the cause of the obstruction. The boroscope revealed the rabbit's lid containing the 1 Ci Co-60 source had become unscrewed causing the obstruction (see *Exhibit 4-11*). The HPS Technical Director notified the vendor and scheduled an appointment to come out to resolve the jam.

During the vendor's visit, the rabbit lid was removed (see *Exhibit 4-12*) from the GBI and the source was returned to the rabbit until the vendor, HPS Director, and Radiation Controls Operation (RCO) could determine a path forward for removing the rabbit and source from the GBI.

Exhibit 4-10: Rabbit, spacer, source, washer and set

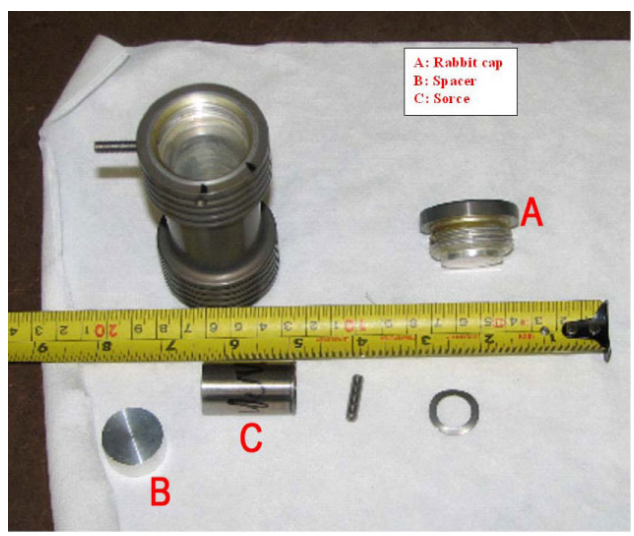


Exhibit 4-11:
Boroscope view of rabbit lid and source.

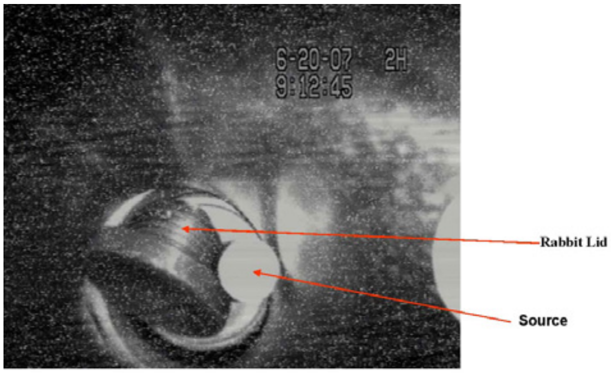
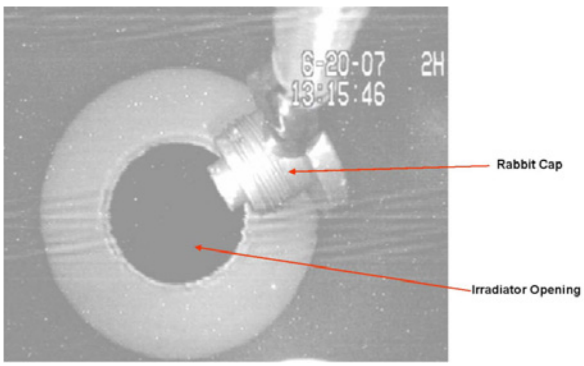
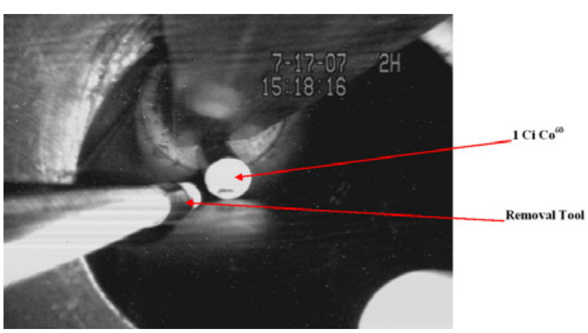


Exhibit 4-12:
The Rabbit Lid being removed from the



Radiological conditions of the GBI were determined before the rabbit and source were removed. Dose rate calculations were performed based on decay of the source (0.254 Ci). It was determined that at 5 cm the unshielded dose would be 150 R/hr and at 30 cm this rate would be 3.6 R/hr. Based on these dose rates, RCO determined that an extension tool had to be used to remove the 1 Ci Co-60 source and place it into a storage carousel (see *Exhibit 4-13*).

Exhibit 4-13:
Source removed from the GBI.



In July 2007, the vendor returned to remove the source and rabbit from the GBI. The vendor used the appropriate tools and removed the source and failed rabbit from the GBI. All rabbit internal parts (2 washers and spacer) were accounted for.

The rabbit and associated internal parts smeared <20 dpm α/100 cm^2, <200 dpm $\beta\gamma$/100 cm^2 and probed no detectable. A visual inspection of the sealed source via boroscope indicated the source was not compromised. The source is currently inside an engineered shipping cask, temporarily stored in the GBI Room.

The job was completed by the vendor using a Maintenance Instruction/Safe Work Permit and an approved Task Specific Plan, resulting in a collective dose of less than 2 mrem to the workers.

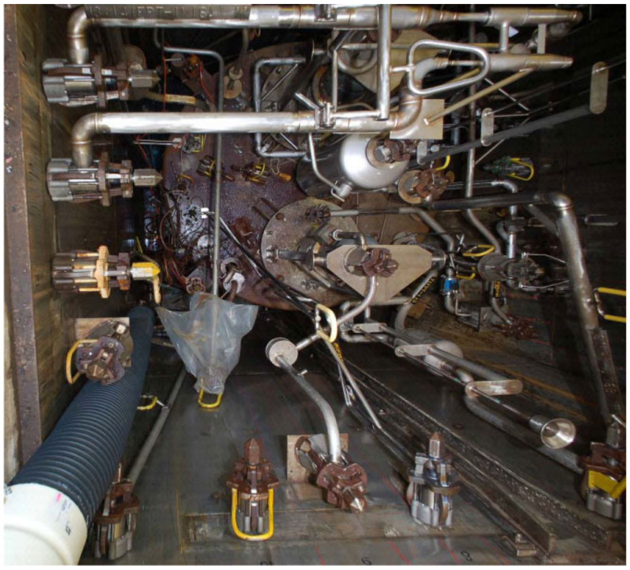
All other sources in the GBI had a second, longer set screw added to ensure that their rabbit's lid would remain intact during operation of the GBI.

4.2.3 FPP-1 Jumper Repair & Replacement

Because F Area Tank Farm is an outside facility, the majority of the radiological work is performed in containment huts and windbreaks. In conjunction with these containments, heavy sleeving and sleevers are used. The containments being used were a specific design and fabricated onsite at CFF. F Area Tank Farm was designed for waste processing, and liquid waste is stored in waste tanks and then processed to reduce the volume. Waste transfers between tanks are conducted through pump pits. The pump pit contains jumpers and valves to align the tank to tank waste transfers (see *Exhibit 4-14*). Concrete cell covers weighing approximately 22,000 lb. are installed over the pump pit, to provide shielding during waste transfers.

Due to tank closure missions to re-direct waste transfers, a plan was developed to re-configure the jumper alignment, which would include repairing and replacing several jumpers. A total of 13 jumpers had to be removed from the highly contaminated 15'x 15' x 25'deep pit cell. The size of the cell opening created a very prohibitive maintenance of negative airflow.

Exhibit 4-14:
Pump pit with jumpers and valves.



Historical data has shown a Price-Anderson Amendments Act (PAAA) investigation was performed, due to contamination being detected outside the containment (e.g., windbreak), which resulted in a personnel contamination case. During the past, the pump pit collected spent equipment (e.g., sump pumps, cords, jumpers, ventilation duct, etc), making it very difficult to remove any jumper from the pit area. Recent waste transfers from the F Canyon included Am/Cm (americium/curium). These isotopes increased the risk of spreading contamination, once the jumpers were disconnected.

The plan provided the following controls to reduce the potential for the contamination spread:

- An initial flush of the pump pit area was performed, allowing time to dry, followed by an application of ETGS (Encapsulation Technology Glycerin Solution) Invisible Blue®.
- Applied Blue Fog (Localize) after each nozzle disconnect, throughout the job.
- Sleevers with sleeving for the spent jumpers were used.
- Two 2500 cfm HEPA exhausters were used to increase the negative airflow in the pit cell.
- Localized ventilation during the nozzle brushing.
- Glove bags were used for the reinstallation of jumper gaskets.
- Wind speed limit.
- A ROVER was setup for the command post at the job site.
  - Plasma screens to support all camera feeds
  - Tele Trax system (tracking dose)
  - Communication center
  - Used headsets and hand held radios to communicate into the work area
  - Plasma screen with multiple camera angles (see *Exhibit 4-15*).

Exhibit 4-15:
Plasma screen with multiple camera

The plan included the following dose reduction methods:

- An internal flush of each jumper was provided and specific valves were manipulated to allow flush water through the valve bonnet, to remove any trapped waste in the valve.
- Staged spent jumpers in their respective disposal containers or separate storage hut away from the pump pit.
- Shield wall around the JB-1 box (disposal container).
- Included in the windbreak was a rigid barricade with lead blankets installed to provide shielding around two sides of the pit/cell.
- Layout of the equipment was planned, due to anticipated high dose rates.
- Camera inspections.

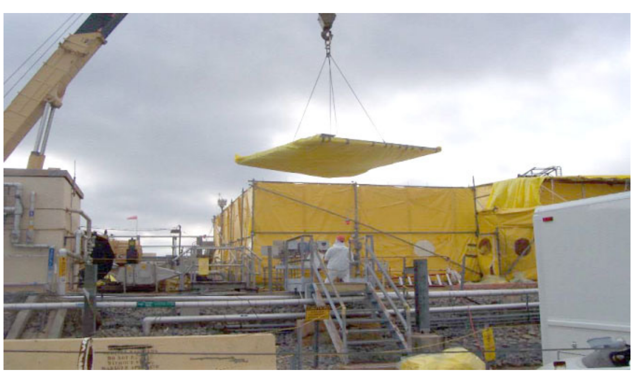
Containments are the main engineered control in the Tank Farm for preventing the spread of contamination, including protection from inclement weather. During the pump pit jumper replacement, the containments used were as follows:

- A windbreak was installed around pump pit-1 and diversion box-2 (see *Exhibit 4-16*).
- Two (2) separate huts were installed.
  - A repair hut was connected to the windbreak (via false wall).
  - Storage hut (storing large jumpers prior to de-sizing) prior to cutting valve stems to fit in JB-2 box, pending the completion of the photomultiplier tube (PMT).

Exhibit 4-16:
Windbreak and two separate huts

- Removable roofs were installed to allow access for installation and removal of the jumpers (see *Exhibit 4-17*).
- A wind speed limit of 8 mph was enforced throughout the evolution (during the open pit/cell and while the hut roofs were removed), to minimize the risk of spreading contamination.

Exhibit 4-17:
Removable roofs to allow access.



Ventilation is another engineered control used in the Tank Farm in conjunction with the containments to prevent the spread of contamination.

- The installed pump pit ventilation system was the primary ventilation with the secondary ventilation of 2 newly designed 2500 cmf portable HEPA exhausters (see *Exhibit 4-18*). (Note: The negative airflow into the pit was at a minimum at best).

Exhibit 4-18:
Secondary portable HEPA exhausters.

- Mock-ups were performed to design an adapter (see *Exhibit 4-19*), to be lowered into the cell area (approximately 3 ft.).

Exhibit 4-19:
Mock-up of adapter design.

A uniquely designed containment for sleeving the jumpers was a Sleever Device (see *Exhibit 4-20*).

- Mock-ups were performed with the sleever and improvements were made to the sleever during the mock-ups and throughout the job.
- The sleever was staged across the pump pit (including the heavy sleeving and choker).
- After the choker was connected to the jumper, the crane started lifting the jumper through the sleever. The sleeving deployed off the sleever with a hands-off approach.

Exhibit 4-20:
Sleever containment for jumpers.

- The jumpers being replaced with newly fabricated ones were directly placed in their respective disposal container (e.g., Sealand, JB-2 Box, etc.).
- Sleevers provided a hands-off approach to sleeving the jumpers (over an open pit 15' x 15' x 25').
- The sleeving deployed off the sleever (positioned over the pit) as the jumper was lifted out of the pit (see *Exhibit 4-21*).

Exhibit 4-21:
Sleeved jumper lifted out of the pit.

Difficulties encountered during replacement of the jumpers.

- During removal, one of the jumpers would not lift through the opening at the PTA (pump tank agitator). A time out was declared and a revised plan was developed to remove the jumper. The new plan included the use of a 2nd crane to hold the PTA, while the jumper was being relocated in the pit. Once the jumper was re-positioned, the sleever was lowered in place and the jumper was removed through the sleever.
- Due to the spent equipment being overlapped on the jumpers, contamination was released inside the walls of the windbreak and on the extra layers of plastic flooring. Work was temporarily suspended for decontamination activities. Contamination was not released outside of the windbreak.
- While the jumpers were being re-installed, one of the jumpers would not connect to the wall nozzle. A time out was declared and upon investigation, it was determined the jumper identification plate was interfering with the alignment. A plan was developed to remove the name and a section of the jumpers lifting bail.
- Mock-ups were performed to determine the cutting tool required to handle the weight on a 25' rod (see *Exhibit 4-22*).
- A minimum amount of dose was received.
- The mechanics were stationed behind the shield wall.

Exhibit 4-22:
Cutting Tool with Extension Handle

In summary, a project team was assembled with a person in charge and 3 to 4 lead work group supervisors. The workers in the field were rotated frequently and kept informed of the hazards of their individual task.

With a dedicated team exemplifying a teamwork atmosphere and the engineering controls in place, the PP-1 re-jumpering outage was a success. There was no spread of transferable or airborne contamination during this project and all work was completed safely without incident.

Radiological Concerns

- Primary internal hazards are Pu-239, Am-241, and Cm-244.
- Primary external exposure concerns are Cs-137, Am-241, and Sr-90.
- The total exposure for the job was 3.640 rem with the highest individual of .200 rem.
- This major scope of work was staffed by a total of 130 workers.
- Estimated man hours 4,400.
- Dose Rates
  - 1 rem/hr. @ 5 cm (Jumper)
  - 8 rem/hr. @ 5 cm (Jumper)
  - .400 rem/hr. General Area
  - .170 rem/hr. (JB-2 Box)

4.2.4 HDB-2 and Tank 11

Due to the complex nature of storing and processing waste in HDP, it is necessary to transfer liquid from one location to another. The waste is transferred through diversion boxes to waste tanks and facilities. This capability is necessary to carry out the transfer of waste safely and effectively as needed to continue operations and processing throughout the facility and site. Failure to transfer waste could result in the delay or possible shutdown of waste processing in other facilities such as S-Area, Z-area, or H-Canyon.

The H Diversion Box 2 (HDB-2) re-jumpering activity and Tank 11 transfer pump replacement accomplished key milestones by providing tank space and waste transfer flexibility needed to implement the Liquid Waste Operations (LWO) Lifecycle Liquid Waste Disposition System Plan.

HDB-2 re-jumpering and Tank 11 transfer pump replacement field activities were completed without incident and with minimum personnel exposure (see *Exhibit 4-23*).

Exhibit 4-23:
HDB-2 and Tank 11 Overview

The following radiological controls were implemented and successfully executed to minimize exposure, contamination spread, and airborne radioactivity:

- An initial flush of the diversion box cell area, allowing time to dry, followed by an application of ETGS (Encapsulation Technology Glycerin Solution) Invisible Blue® was applied to the diversion box to reduce the potential for airborne contamination.
- A modified containment hut with sliding roof panels was erected around the diversion box (see *Exhibit 4-24*). The sliding roof panels minimized the containment roof opening during jumper removal. A wind speed limit of 8 mph was maintained during the job.
- An expandable bladder was installed in the sump drain, which allowed a covering of water to be added to the diversion box floor thus reducing high beta dose rates.
- A coating of Sherwin Williams ProBlock Primer Sealer paint was applied to all jumpers prior to removal to further fix contamination (see *Exhibit 4-25*).
- A Plenum duct was fabricated from sheet metal and lowered in diversion box. Eight HEPA filtered coppus exhausts provided negative airflow through the plenum.
- Two framed grids made out of PVC and plastic were utilized to cover the open diversion box. The grids were raised and lowered by a series of ropes. The grids reduced the size of the opening, which provided better negative ventilation.
- Eleven cell covers were removed, 12 jumpers were removed and disposed (see *Exhibit 4-26*), 3 new jumpers were installed (see *Exhibit 4-27*), and the 11 cell covers were replaced.
- Open ended and slotted boxes were fabricated out of Lexan. These boxes were placed over Hanford connectors with high beta rates.
- Low dose areas were built from tubeloc with lead blankets inside and outside the containment.
- All personnel exposure was monitored utilizing the TeleTrak computer system. In addition, TeleTrak EPDs were used on extended poles to determine exposure rates from jumpers before removal from diversion box.

- The HDB-2 re-jumpering activities were planned and executed in conjunction with the Tank 11 pump replacement, which was adjacent to HDB-2. The dismantlement and removal of this transfer pump required it to be suspended in the riser and separated in two smaller sections for disposal.
- A total of 1,461 radiological entries were made for the HDB-2 work. The estimated total exposure was 11.2 rem. The actual exposure was 4.44 rem.
- A total of 159 radiological entries were made for the Tank 11 work. The estimated total exposure was 2.48 rem. The actual exposure was 0.114 rem.

Exhibit 4-24:
Sliding roof panels

Exhibit 4-25:
Jumpers prior to removal

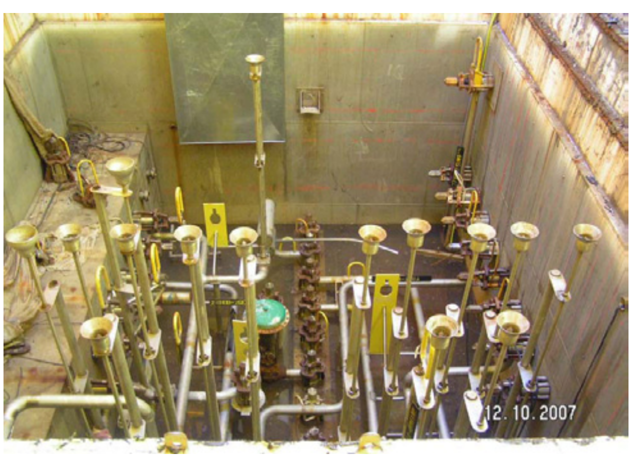


Exhibit 4-26:
Removed jumper

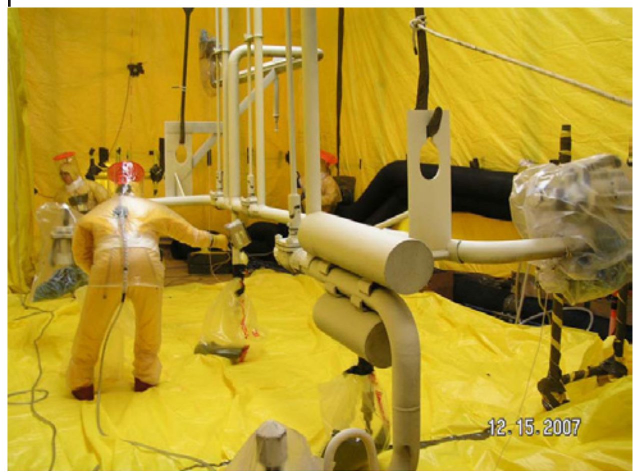


Exhibit 4-27:
New jumpers installed