BNL-52637
Formal Report

Decommissioning the Brookhaven National Laboratory Building 830 Gamma Irradiation Facility

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Under Contract No. DE-AC02-98CH10886 with the

UNITED STATES DEPARTMENT OF ENERGY

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ABSTRACT

The Building 830 Gamma Irradiation Facility (GIF) at Brookhaven National Laboratory (BNL) was decommissioned because its design was not in compliance with current hazardous tank standards and its cobalt-60 sources were approaching the end of their useful life. The facility contained 354 stainless steel encapsulated cobalt-60 sources in a pool, which provided shielding. Total cobalt-60 inventory amounted to 24,000 Curies when the sources were shipped for disposal.

The decommissioning project included packaging, transport, and disposal of the sources and dismantling and disposing of all other equipment associated with the facility. Worker exposure was a major concern in planning for the packaging and disposal of the sources. These activities were planned carefully according to ALARA (As Low As Reasonably Achievable) principles. As a result, the actual occupational exposures experienced during the work were within the planned levels.

Disposal of the pool water required addressing environmental concerns, since the planned method was to discharge the slightly contaminated water to the BNL sewage treatment plant. After the BNL evaluation procedure for discharge to the sewage treatment plant was revised and reviewed by regulators and BNL's Community Advisory Council, the pool water was discharged to the Building 830 sanitary system. Because the sources were sealed and the pool water contamination levels were low, most of the remaining equipment was not contaminated; therefore disposal was straightforward, as scrap metal and construction debris.

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1. INTRODUCTION

In 1997 it was discovered that the Building 830 Gamma Irradiation Facility (GIF) at Brookhaven National Laboratory (BNL) had an underground tank that needed to be modified to meet requirements of Article 12 of the Suffolk County Department of Health Code. These requirements apply to tanks containing hazardous or radioactive materials that may have an adverse effect on the environment if released. The facility had no direct U.S. Department of Energy (DOE) program support since 1973. It had functioned as a user facility, such that user fees and overhead funds provided for staff to monitor and maintain the facility on a part-time basis. Over the years the number of users declined, while requirements affecting operations, such as safety documentation, maintenance plans, and security increased. At the time the Facility Review Project was initiated, a study was funded which evaluated options available for the GIF. [1] Based on the recommendations of this study, BNL management decided to decommission the GIF.

1.1 Facility Description

The GIF was built in the late 1960's as an addition to Building 830, then known as the High Intensity Radiation Development Laboratory (HIRDL). Completed and commissioned in 1969, it consisted of a pool, 10 ft. by 8 ft. by 13 ft. deep, with sealed cobalt-60 gamma sources located at the bottom of the pool. The water depth provided shielding. Access to the sources for irradiation studies was through stainless steel air tubes 16 ft. x 4 in. OD x 16 gauge wall thickness. One-inch lead jackets around the air tubes above the water level counter weighed the tube buoyancy and provided shielding to personnel. Pool water was circulated through a chiller/filter system, maintaining pool temperature at 7EC to prevent algae growth. The pool was kept covered (see Figure 1) so that equipment, tools, and personnel would not fall in.

Figure 1 View of the GIF room in 1994, with shielded air tubes and cover in place.

The 354 sources in the GIF, all fabricated from cobalt-60, contained about 32,000 Curies at the time of the decision. The sources consisted of flat pieces of activated cobalt encapsulated in stainless steel sleeves that were flat or cylindrical. The sources were held in arrays in stainless steel racks at the bottom of the pool in an upright, cylindrical orientation so that air tubes could be inserted into the array. Most of the source arrays were inside open-topped lead casks, whose purpose was to provide shielding and to stabilize the racks holding the sources, so that they could not be knocked over. There were 23 source arrays containing the 354 sources. As of January 1999, the weakest array contained less than 50 Curies; the strongest had about 2,000 Curies. Dose rates at the bottom of the air tubes ranged from 100 rad/hr to 500,000 rad/hr. Figure 2 shows the pool bottom in 1994, with the sources distributed in racks and all 21 air tubes in place. Note that some of the source racks, containing relatively higher quantities of cobalt-60, exhibit the characteristic blue glow of Cherenkov radiation.

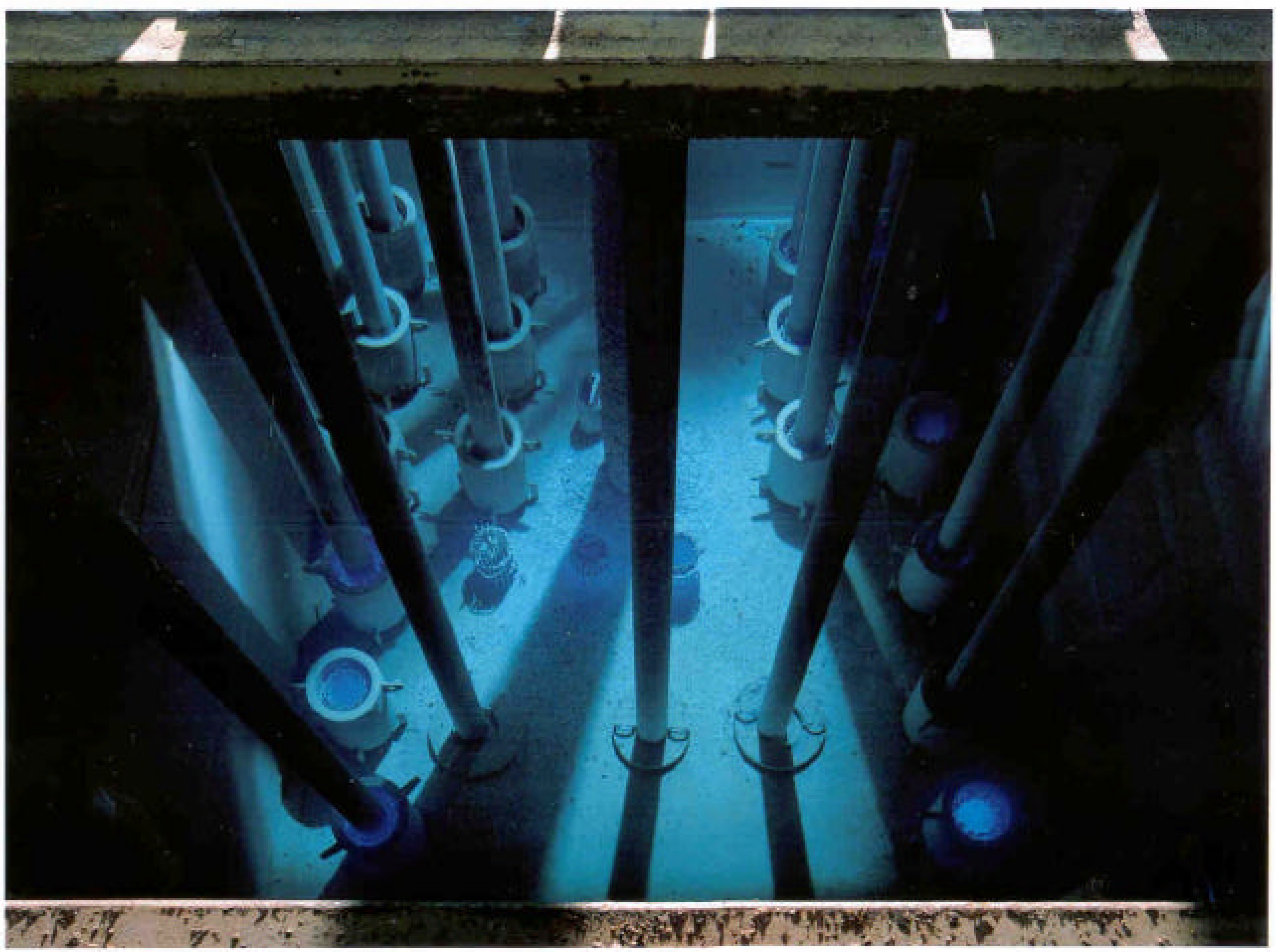

Figure 2 View of the GIF pool bottom in 1994, with air tubes in source racks.

1.2 Decommissioning Activities

The decommissioning project, initiated in February 1999 and completed in March 2000, involved three phases:

1) Preparation of the facility for source removal and planning removal,
2) Packaging and shipment of the sources for disposal, and
3) Disposal/discharge of the pool water and final dismantling.

A Request for Proposals was issued to obtain a contractor with experience in handling and shipping highly radioactive packages. The contractor was expected to provide a disposal container, transfer the sources to the container, and transport the sources according to Department of Transportation requirements to the disposal site selected by BNL. Out of four bids, GTS Duratek was chosen based on the completeness of their bid and their previous experience. The work plan specified disposal containers, shipping cask, transfer activities, worker dose assessments, and appeared to be able to meet the specified schedule of disposal by September 30, 1999.

2. PHASE 1 – PREPARATION ACTIVITIES

2.1 Planning Source Removal

Phase 1 included planning and preparation activities. Any work with the cobalt-60 sources was to be performed while the sources remained in the pool, so that occupational exposures remained negligible. A method for packaging and shipping the waste was chosen, based on the use of a Type B transport cask, model CNSI 1-13G, made and operated by Chem-Nuclear Systems, Inc. Two steel transport/disposal containers were designed and fabricated. Design considerations included sizing the containers to fit the 354 sources without exceeding the transport cask payload limit of 5,000 lbs.

A significant aspect of Phase 1 involved careful planning of the source transfer from the pool to the shipping cask by remote handling, to keep radiation exposures ALARA (as low as reasonably achievable). The two 5-inch thick steel containers, or liners, would each contain half of the total source inventory. Loading the sources into the liners and closure of the liners was to be accomplished while the sources were in the pool, resulting in minimal occupational exposures. However, transfer of the containers from the pool to the shipping cask involved potentially high radiation exposures to workers because the containers would have contact dose rates as high as 800 rad/hour, according to calculations based on the July 1999 inventory of approximately 26,700 Curies. Calculated and measured dose rates are discussed further under Phase 2 activities.

The liner transfer plan involved five steps. Because of the potential occupational exposures, the plan included maximum use of shielding and minimal exposure times. The first step consisted of lifting the container from the pool and into a 3-inch thick steel transfer box lined with 2-inch lead bricks. The 5-ton jib crane, installed next to the pool, was modified with longer control leads and a mechanical crank and cable system so that it could be operated and the jib swiveled remotely from behind a shield wall located by the roll-up door. The transfer shield box was mounted on a forklift already positioned in the room. The crane hook was fitted with a cable so that it could be detached from the container rigging remotely after the lift was completed. Miniature video cameras were installed around the room and on the crane so that the operator could observe the lift on a TV monitor behind the shield wall. Figure 3 presents a schematic plan view of the pool area, forklift, and crane.

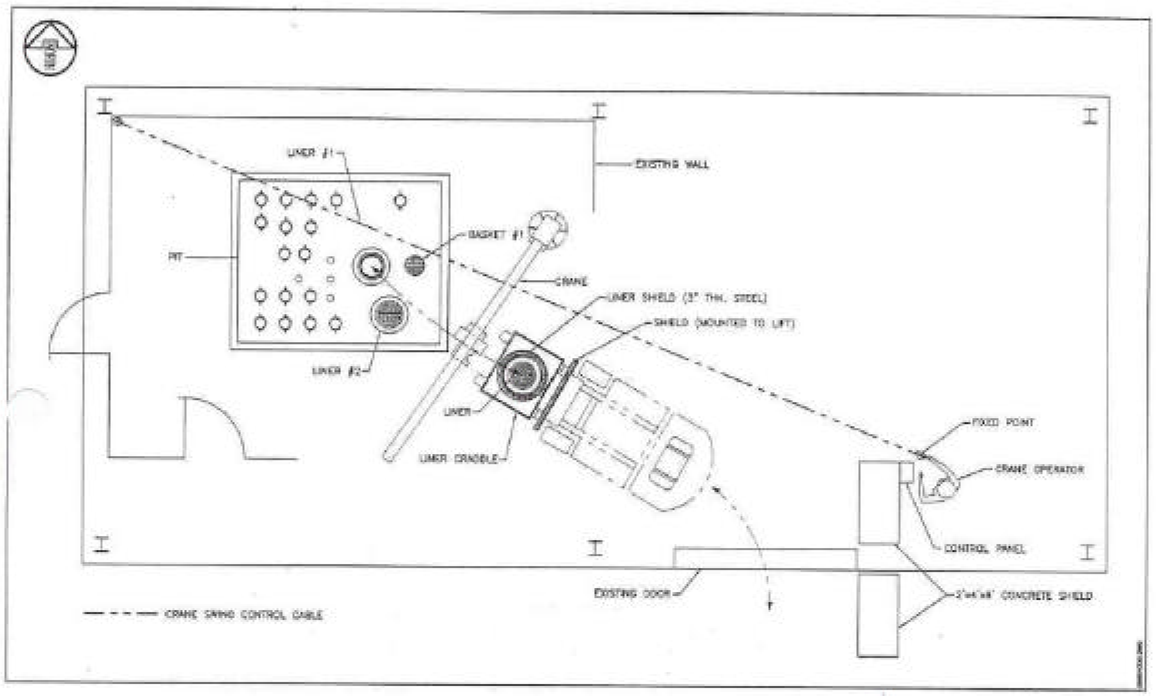

Figure 3 Plan view of GIF area ready for source liner transfer.

In the second step, after the liner was in the shield box, an operator walked from behind shielding located outside the roll-up door to the forklift and started it up. He immediately was to raise the load, drive outside to a marked position, lower the load, turn it off, and walk quickly to a temporary concrete block shield wall situated by the south fence of the Building 830 yard. For the third step, another operator came out from behind the shield wall outside the roll-up door, attached a hook for a mobile 150-ton Grove crane to the liner rigging, and walked quickly to the shield wall by the south fence. (The liner rigging was 15 feet long to minimize worker exposure by maximizing distance.) Although its weight capacity was well in excess of the load, the Grove crane was used because it had a 100-foot boom, giving the operator a safe working distance from the load. In the fourth step, the Grove operator entered the cab from behind a shield wall and lifted the liner from the shielded transfer box to the shipping cask mounted on a truck trailer. Finally, in the fifth step, the hook from the crane was removed from the rigging on the liner as it dangled outside the shipping cask. Using a remote manipulator and a video camera, the rigging for the first liner was arranged so the second liner could be placed on top of it without damage to the rigging and while maintaining access to it. Access to the rigging was necessary so that disposal site operators could remove the liner easily.

2.2 Arranging Disposal

Phase 1 activities also included arranging acceptance of the sources at a low-level radioactive waste disposal facility. The DOE Hanford disposal site was chosen because it had significantly lower disposal costs than commercial facilities, and the BNL Waste Management Division (WMD) had regular dealings with them. A waste profile for a single shipment of 27,000 Curies of cobalt-60 was prepared and submitted to Hanford by April 1999.

Phase 1 activities took significantly longer than originally scheduled, primarily because of the unique nature of the shipment. The major delay involved acceptance at the disposal site. The waste profile documentation was approved after Hanford conducted a thorough review and safety analysis of the shipping/disposal container design and consideration of the site's operational (as opposed to disposal) safety limits. The container design and the waste sources were well within Hanford's waste acceptance criteria. The extent of the review and safety analysis was not anticipated when the schedule was first developed, and added nearly six months to the original schedule. Adding to the delay was the need for the disposal site to prepare procedures specific for accepting and opening the CNSI 1-13G shipping cask. Finally, the disposal site had an operational safety limit requiring that the total source shipment inventory be less than 24,300 Curies. Decay calculations showed that this level would be reached in March 2000. The inventory limit thus led to an additional delay, waiting for the sources to decay to an appropriate level.

2.3 Facility Preparation

The room and pool were prepared for introducing the disposal containers that would hold the sources. This involved removing all the air tubes from the pool and dismantling a wall that blocked easy forklift access. The source count was verified visually at this stage, since records of the source inventory were questionable. Figure 4 shows a view of all the sources at the bottom of the pool, after the air tubes were removed. Figure 5 is the same view, taken in the dark, with a 30-minute exposure time. Although the Cherenkov radiation is still present, it is much weaker than in 1994 (see Figure 2) because the sources strength has decayed by more than half. (Cobalt-60 has a half-life of 5.23 years.)

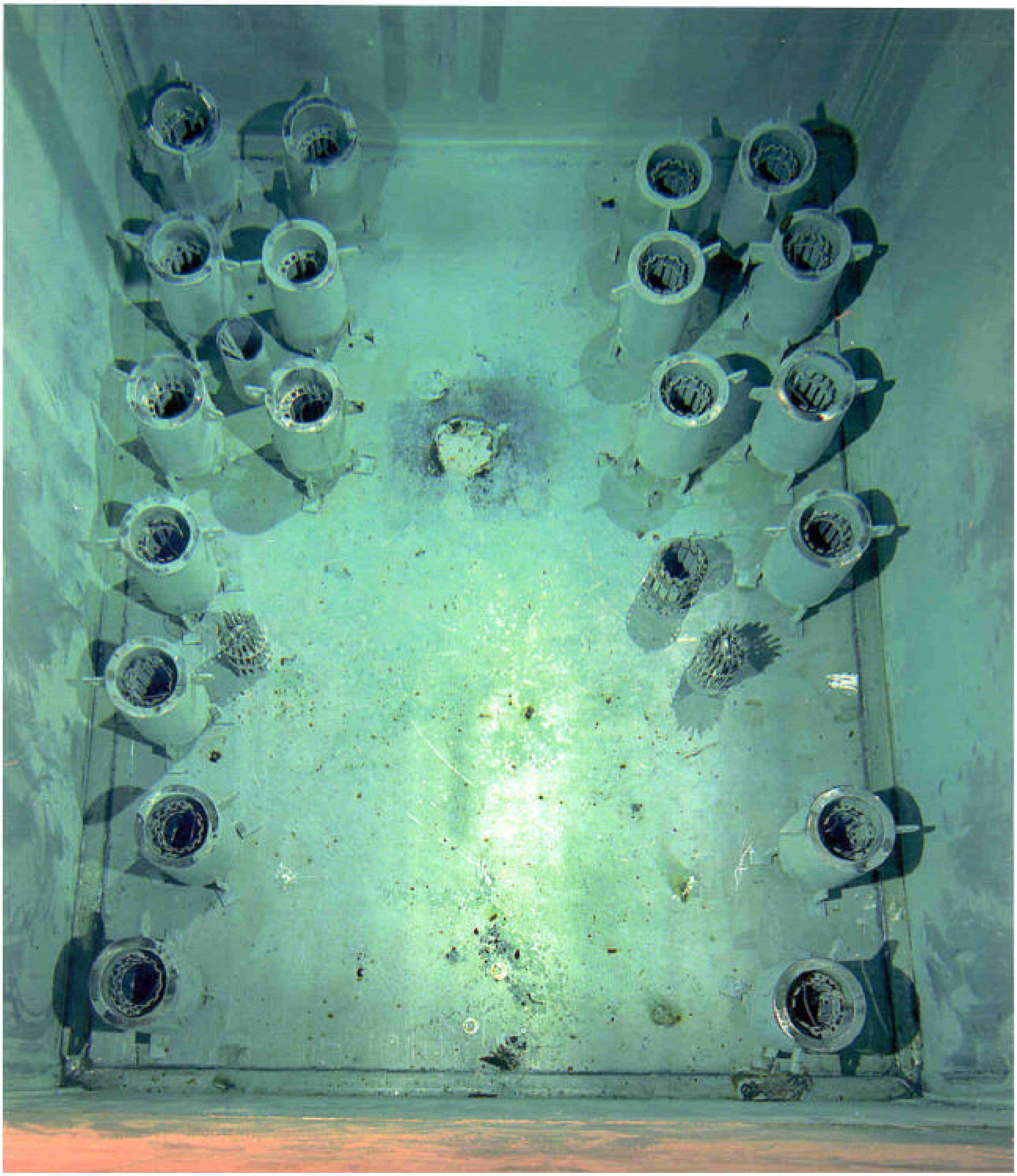

Figure 4 View of sources in racks after air tube removal, July 1999.

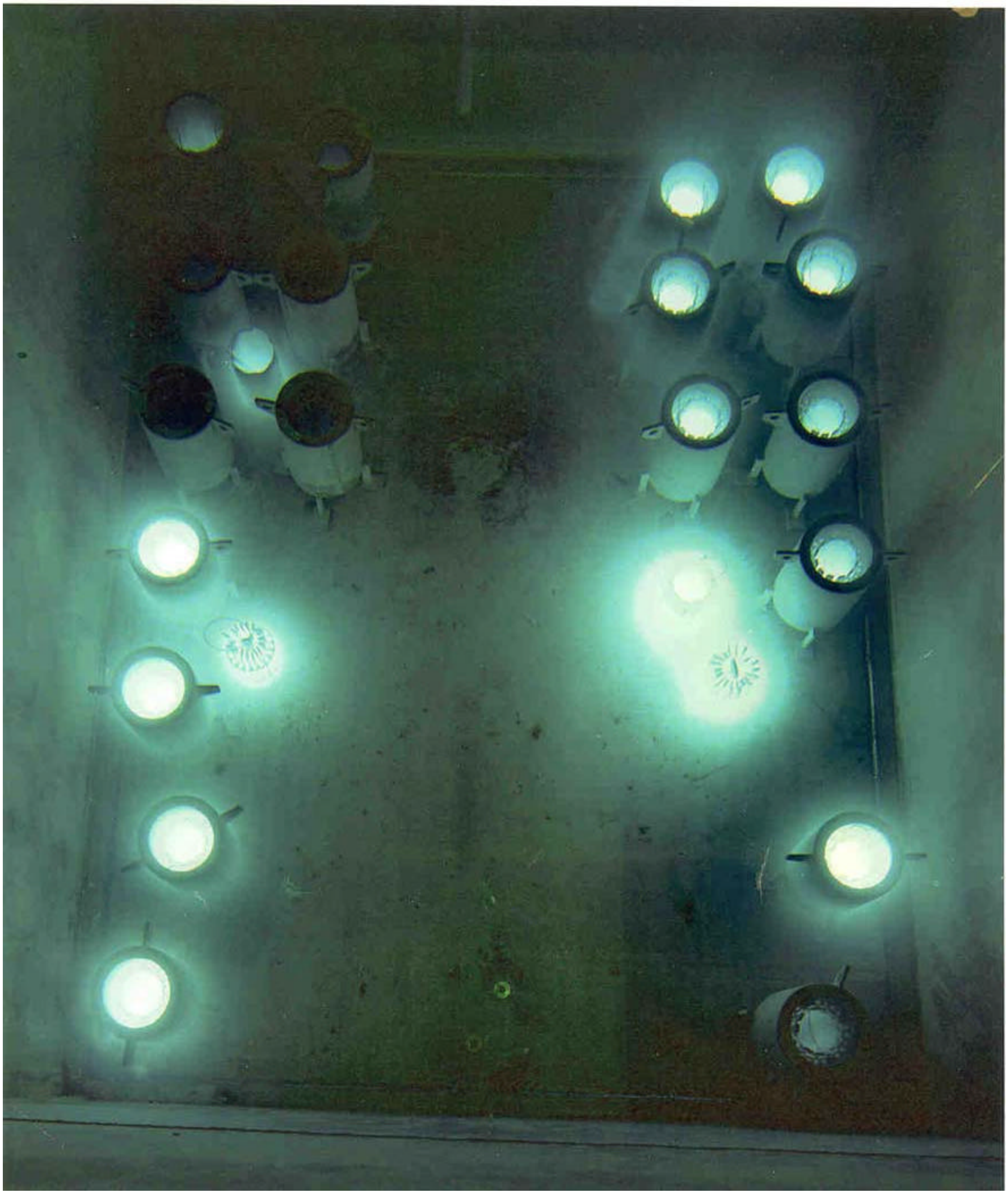

Figure 5 Room-darkened view of sources in racks after air tube removal July 1999.

3. PHASE 2 - PACKAGING, TRANSFER AND SHIPMENT OF THE SOURCES

3.1 Inventory Verification

After the air tubes were removed from the pool, the sources were transferred from the 21 cylindrical rack arrays to the two steel disposal containers (also called liners). The liner design actually included a removable steel basket. Each basket had four sections, so the sources would stand nearly upright. The two baskets were filled first, and then placed in a liner. It was known that the sources were of different strengths, and an attempt was made to divide the Curie inventory evenly between the two liners, based on the historical records of the individual source arrays.

The source transfer or packaging step was accomplished using 20-foot poles equipped with pneumatic pliers at one end. Operators handled these manipulators from a scaffolding and railing placed over the pool to allow more convenient vertical access. (See Figure 6. The operators, from Master-Lee, Inc., were experienced with spent-fuel pools and other remote manipulation work in water.) Worker exposures were minimal and the process took about three days to complete. After the racks (and lead casks) were empty of sources (Figure 7), they were brought out of the pool and surveyed (Figure 8). A few of the racks had fixed contamination and had to be disposed of as radioactive waste. The rest of the racks and the lead casks were free of contamination or had loose contamination that was removed. All these free-release items were eventually sent to an off-site metal recycling company.

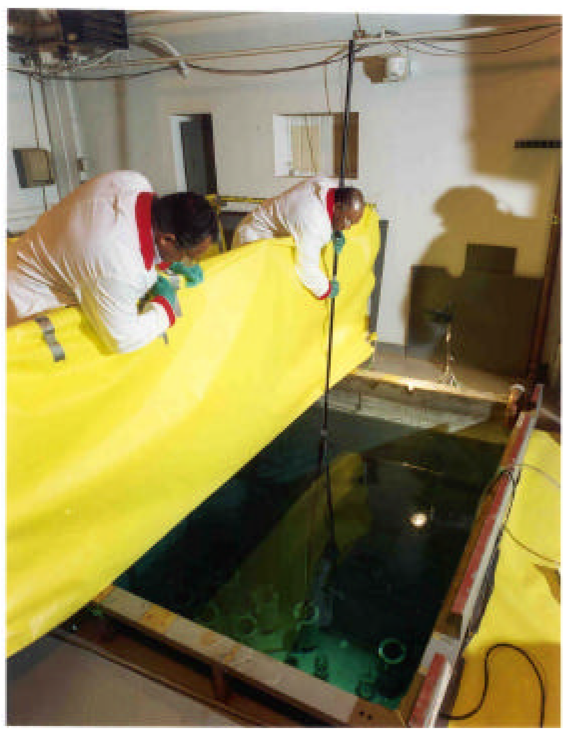

Figure 6 Operators used remote manipulators to move 60Co Sources from racks to basket.

Figure 7 A view of the empty lead casks. Some sources remain in the center rack.

Source transfer into the baskets was carried out several weeks prior to the planned March 2000 shipping date, in order to verify the Curie inventory. Records from 1969 describing the setup and operation of the facility were incomplete, especially documentation of the fabrication and Curie contents of each of the 354 sources. (Operation logs indicated one rack of eight sources was removed and transferred to Building 528 in 1979. About 15 racks of sources were placed into the pool in 1973 when the HIRDL food irradiation program was shut down. A complete and verified list of sources was not available.) Because complete documentation was not available, the disposal site agreed that a dose-to-Curie content calculation was an acceptable verification of the inventory. Dose measurements were considered to be more accurate (and easier to model) if the sources were confined to one or two containers, rather than spread over 21 source racks in arrays ranging from 4 to 36 sources. Figure 9 shows the pool after all racks and lead casks were removed, with one of the loaded baskets and a loaded, sealed liner, prior to the inventory verification measurements. Figure 10 is a view of the basket with the room lights out.

Dose measurements were made using an Eberline R07 dosimeter fitted with an underwater probe. The baskets were both sealed into the liners, and the liners separated by the maximum distance possible (about 8 feet) on the pool bottom, so that readings for one liner would not be influenced by radiation from the other. (Although the pool had more space for a greater separation, the reach of the jib crane could only give the 8-ft separation obtained.) Readings were taken at contact, at 6 inches, at 12 inches from the container, and at an elevation at which maximum readings were obtained. The elevation coincided with the midpoint of the height of the liners. Readings ranged from 550 to 1,050 Rad/hour, as shown in Table 1. Average dose rate values (753 Rad/hr) were used to calculate the Curie inventory using the Microshield computer code.

Figure 8 Operator removes lead cask from the pool.

Figure 9 The sources have been packaged, and all racks and lead casks removed.

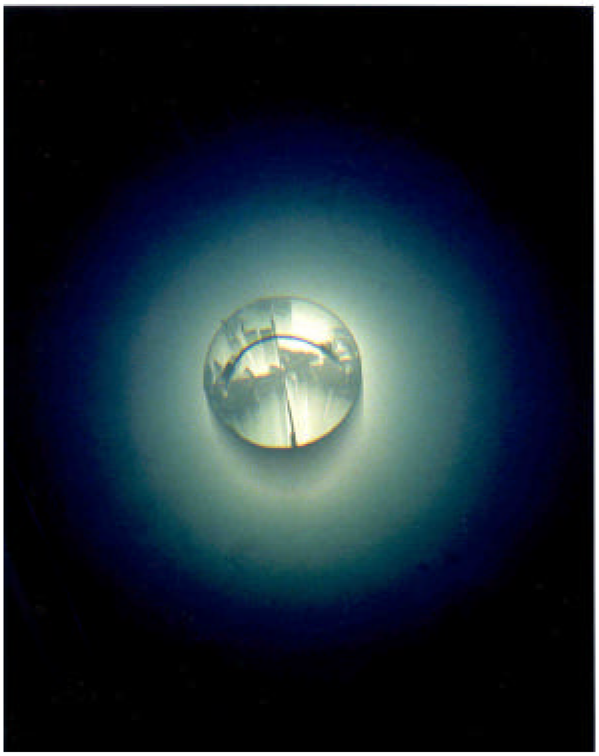

Figure 10 Cherenkov radiation from the basket of sources is obvious with the lights out.

The Microshield code requires information about the source activity, configuration, and shielding or container geometry. The normal application of Microshield is to calculate dose rates for a known radioactive inventory to determine if additional shielding is necessary for personnel protection. Calculations of Curie inventory based on measured dose rate and known source geometry and shielding properties are therefore subject to some uncertainty. Additional uncertainty is introduced because the measured variations in dose rate cannot be introduced into the model. Based on an average dose rate of 753 Rad/hr, the total inventory was calculated to be a maximum of 12,000 Curies per liner, or a total shipment (both liners) of 24,000 Curies, as of the measurement date of February 12. This was consistent with the historical records, which indicated that the total inventory would reach 24,600 Curies as of February 12, 2000.

Table 1. Summary of Dose Readings for Inventory Calculation (Rad/hour)

Liner #1						
Position*	1	2	3	4	Average	Top
@contact	750	550	660	1,050	753	850
@ 15 cm	330	270	250	450	325	
@ 30 cm	100	160	110	200		

Liner #2						
Position*	1	2	3	4		Top
@contact	990	780	620	580	743	690
@ 15 cm	370	320	290	300	320	

* Position 1 was at a taped reference mark, with other positions in 90º clockwise increments around the liner.

3.2 Radiation Safety

Phase 2 activities included the installation of the shielding and remote handling equipment described earlier. After the crank-and-pulley system was installed, and the shielding blocks and video cameras were in place, practice runs were conducted with an empty liner to verify and minimize estimated times for the different work steps. This was important for determining that exposures to the forklift operator, rigger, and crane operator would be ALARA. During the practice runs, parking positions for the forklift were marked on the ground, so that all movements during each lift would be identical and reproducible. For the whole operation, a step-by-step procedure was developed, with hold/stop points identified to separate activities involving worker movements and liner lifts. At each hold point status of radiological, mechanical, and staff conditions were verified; after this, the Operation Control Supervisor (Gamma

Control) ordered the next step to proceed. Staff within the radiation and high radiation areas (see below) communicated by radio.

A high radiation area (>100 mrem/hr) was expected when the liner was removed from the pool, extending 86 feet from the liner in all directions. The radiation area (>5 mrem/hr) boundary around this extended to 328 feet from the liner. It was decided to post the radiation area limits outside a perimeter at about 479 feet, where calculated dose rates were at 2 mrem/hr. Figure 11 shows a schematic display of the buildings, roads, and projected radiation areas. Because the radiation area included all of Building 830 and parts of others, the transfer was scheduled for a Saturday, when no other workers would be present. BNL Police and Radiation Control (RadCon) staff manned roadblocks with posted stanchions at all roads accessing the area, to prevent inadvertent intrusions. RadCon staff also traversed the areas between checkpoints to monitor radiation levels and observe for passersby.

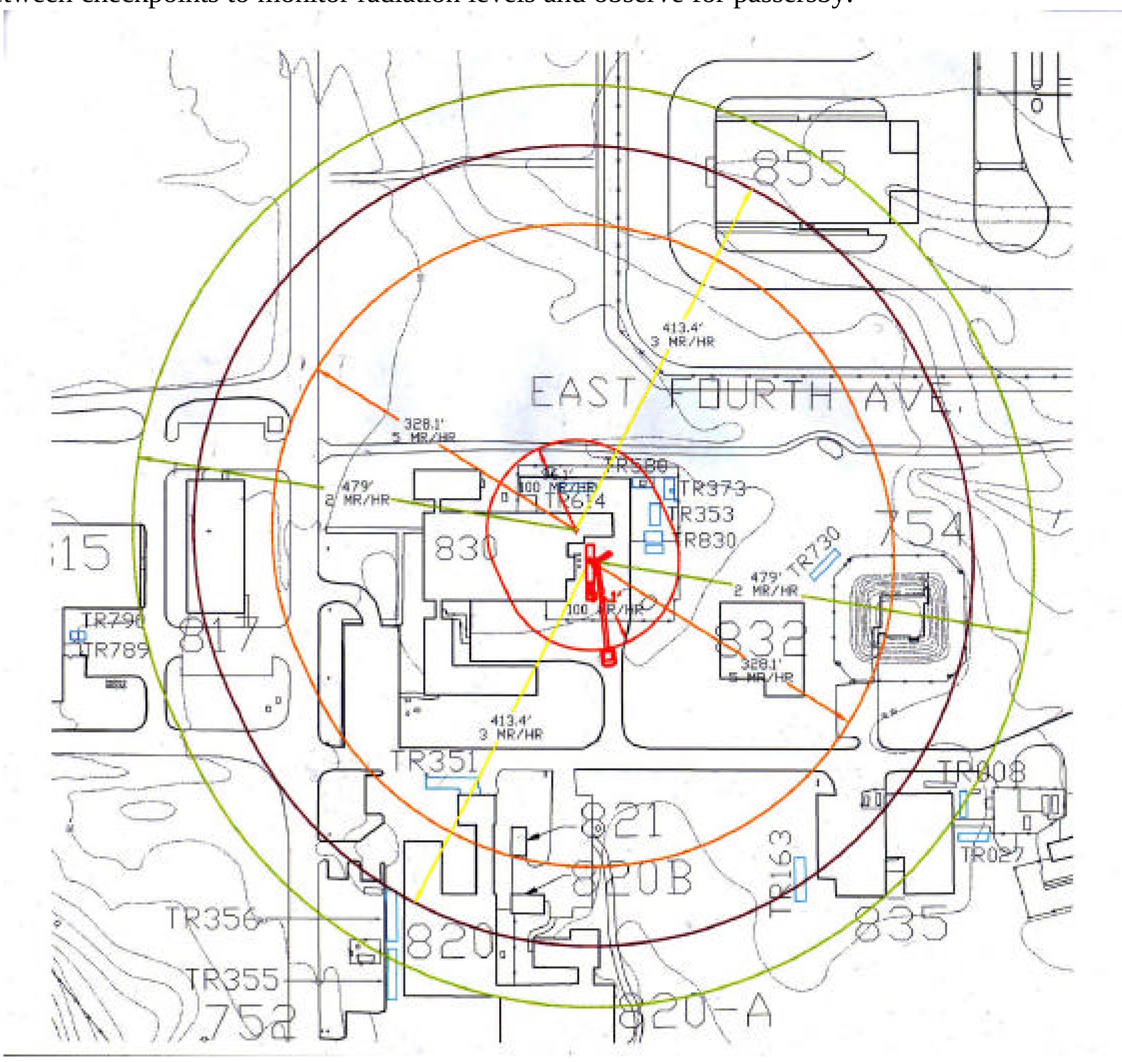

Figure 11 Radiation area layout.

3.3 Transfer of Liners Loaded with Cobalt-60 Sources

On the day of the transfer, after the morning job briefing, all personnel reported to their positions and a radio test was initiated. Just prior to giving the signal to begin, the Gamma Control received an emergency page from BNL Police Headquarters. The job had to be delayed until Sunday due to a fire at a radioactive waste storage area nearby, which required extensive RadCon support. However, on Sunday, loading of the disposal containers into the shipping cask proceeded without incident and according to the plans previously described. Photographs depicting the steps in the transfer process are shown in Figures 12 through 19. These were actually taken during the practice runs. During the “hot” transfer, the entire operation was carried out twice.

Figure 12 Shipping cask preparation – Removing the impact cover.

Figure 13 Shipping cask preparation – Removing the contamination seal cover. (Cask was wrapped because low levels of contamination were found under impact cover.)

Figure 14 Lifting liner from pool. (Rigging straps were placed remotely while liner was underwater.)

Figure 15 Operating GIF crane from behind temporary shield wall. (HP staff communicates with Control by radio. Crank used to swing crane jib. TV monitor shows position of liner.)

Figure 16 Forklift with shielded transfer box in position next to pool. (Shield wall for crane operator is visible in background to right. The roll-up door was closed for this photo.)

Figure 17 Loaded forklift in parked position outside. (Operator is leaving to go behind shield wall next to Grove crane. Note rigging straps attached to liner in shield box.)

Figure 18 Rigger attaches rigging straps to Grove crane hook before exiting the high radiation area.

Figure 19 Liner being lowered into shipping cask.

3.5 Radiation Exposure Evaluation

Dose rates measured during all activities were comparable to those calculated during the planning process, as listed in Table 2. In two instances, calculated doses were lower than those measured, and could have impacted total job exposure. These were at the GIF crane operator's position behind a shield wall inside the building and the outside crane operator's cab. Inside the building, the higher dose rate was attributed to reflection from the interior wall. The outside crane cab dose rate was higher because the distance was shorter than the total boom length that was used in the calculation.

The total job exposure was estimated at 99 person-millirems during the work planning process. The Radiation Work Permit provided a conservative limit of 200 person-millirems for the job, as summarized in Table 3. The highest single individual dose was lower than calculated.

Table 2. Comparison of Expected vs. Measured Dose Rates

Liner # 1			
Location	**Expected**	**Measured**	**Comments**
Behind Shield Wall	0.5 mrem/hr	30 hr/hr	Possible reflection
13' from Liner	6.5 R/hr	7 R/hr	RMS-II
At Crane Operator Shield Wall	1.47 R/hr	100mR/hr	Liner shielded by transfer shield
Contact with Steel/Lead Transfer Box Shield	3.2 R/hr	1 R/hr	
Fork lift Driver Seat	75 mrem/hr	35 mrem/hr	
At Crane operator	132 mrem/hr	260 mrem/hr	Actual boom distance less than calculated
Contact with shipping cask	22 mrem/hr	40 mrem/hr	
Operation Control Point	>5 mrem/hr <100 mrem/hr	12 mrem/hr	Distance was not known
Liner # 2			
Location	**Expected**	**Measured**	**Comments**
Behind Shield Wall	0.5 mrem/hr	50-70 mrem/hr	Possible reflection
13' from Liner	4.8 R/hr	5 R/hr	RMS-II
At Shield Wall	1.47 R/hr	1.4 R/hr	
Contact with Steel Shield	3.2 R/hr	10 R/hr	
Fork lift Driver Seat	75 mrem/hr	30 mrem/hr	
At Crane operator	132 mrem/hr	250 mrem/hr	Actual boom distance less than calculated
Contact with shipping cask	44 mrem/hr	50 mrem/hr	
Gamma Pool Control	>5 mrem/hr <100 mrem/hr	15 mrem/hr	Distance was not known

Table 3. Comparison of Estimated vs. Actual Dose

Totals for Project		
Dose Estimate Work Sheet	**RWP Allowance**	**Measured Dose**
99 mrem	200 mrem	140 mrem
Highest Individual Dose		
Dose Estimate Work Sheet	**RWP Allowance**	**Measured Dose**
36 mrem	100 mrem	30 mrem

3.6 Shipping the Sources

After the shipping cask was sealed, reassembled, and surveyed, the sources were transported to the DOE Hanford disposal facility without incident. Because of the one-day delay in shipping, arrival occurred on Thursday, rather than Wednesday. At the disposal facility, wind speed was above site crane operating limits on Thursday, and the facility's four-day workweek meant that if unloading were to take place on Friday, it would be on overtime.

The possibility that delays would result in the shipment arriving on Friday was anticipated and evaluated two weeks prior to shipment. Estimates for unloading the shipment on Friday were obtained from the disposal facility. The shipping contractor provided estimates for four days of demurrage costs for the truck and driver, assuming that unloading would not take place until Monday. From the two estimates, it was determined that added demurrage costs were lower than those for overtime unloading on Friday at the disposal facility. Therefore, since Thursday unloading was not possible, the driver and disposal site were told to wait until Monday.

The liners containing the sources were finally disposed of eight days after being removed from the GIF, on Monday, March 20, 2000. Figure 20 shows one of the liners being unloaded at the DOE Hanford facility.

Figure 20 Liner being unloaded at the Hanford DOE disposal facility.

4. PHASE 3 – DISPOSAL OF POOL WATER AND REMAINING EQUIPMENT

Phase 3 activities began after the sources were shipped in March 2000, and concluded in March 2001. Initial activities included removal of the security and radiation alarms. Miscellaneous equipment and plumbing were dismantled where possible. The major tasks in this part of the project were the disposal of the pool water, removal of the steel tank lining the pool, and backfilling the pit.

4.1 Pool Water Discharge

The water remaining in the pool contained low levels of cobalt-60 (<100 pCi/L), lead (~12 µg/L), and zinc (~110 µg/L). The residual zinc had to be reduced in order to be consistent with BNL's SPDES permits limiting discharges from the BNL sewage treatment plant (STP). To achieve the zinc discharge limit of 100 µg/L, the water was passed through a high-capacity (~400 L/min) diatomaceous earth pool filter. Reduced zinc concentrations were reached quickly because zeolite was mixed in with the diatomaceous earth, providing ion exchange as well as particulate filter capability. The filtration activity also reduced cobalt-60 and lead concentrations somewhat. After this treatment, discharge was permissible because the water was not contaminated above the BNL sanitary discharge limits.

However, water discharge was delayed for six months because the established BNL procedure for evaluating discharges at BNL was revised shortly after the cobalt-60 sources were shipped in March 2000. While the GIF pool water was dischargeable under the revised procedure, the procedure itself, developed by the Environmental Services Division (ESD), had not been formally approved. The procedure was approved initially by the BNL Operations Council, and was sent on to the BNL Integration Council and DOE Area Office for concurrence. These two groups requested that the procedure be presented to the Community Advisory Council and the Brookhaven Executive Roundtable, which includes Federal, State, and County regulators prior to final approval. This extensive level of review supports BNL's Environmental Policy that calls for the involvement of stakeholders, including regulators and community groups, keeping them informed of BNL activities and their effects on the environment. This is part of BNL's commitment to achieve site-wide ISO 14001 registration.

In spite of the delays, and subsequent added project management costs, discharge to the STP was the preferred management option. Two alternatives were evaluated: evaporation at the HFBR stack, and shipment to an off-site incinerator. Use of the HFBR stack was rejected because the low levels of cobalt-60 contamination in the pool water would become concentrated in the evaporator. In addition, the evaporator capacity was limited and was otherwise committed to treatment of AGS cooling water. Treating the GIF water would have taken longer than waiting for permission to discharge to the STP. Shipping to an off-site incinerator, as was done with water from the HFBR spent fuel pool, was considered too expensive, at a cost of about $8.00 per gallon.

The ESD discharge evaluation procedure was approved officially in November 2000. Water from the pool was subsequently discharged to the STP.

4.2 Tank Dismantling and Removal

After the pool was empty and dry, the stainless steel pool liner was surveyed and found to be releasable per DOE/BNL limits (<1,000 dpm/100 cm^2). Tank removal proved to be a challenge because of its size and configuration. Two scenarios for removal were considered: 1) extensive cutting and removal of small pieces of tank, or 2) removal of the tank in two large pieces. The second scenario was chosen to eliminate Confined Space considerations for welders working inside of the tank. There was some difficulty lifting the tank because the space between the tank wall and concrete-lined pit had been backfilled with sand at the time of construction. Holes were cut at the tank corners for struts to rig to the crane. Initial lifting was measured in inches, using jacks in conjunction with the crane (Figure 21). When the tank was about four feet above its original position in the pit, the sand loosened up so the crane was all that was needed to lift (Figure 22). Here the welders cut more holes for struts to allow the use of the crane to lift further, at which point the tank was cut in half, at the original welded seam (Figure 23). The top half was removed and placed outside (Figures 24 and 25). The lower half was subsequently removed in similar fashion (Figures 26, 27). Both halves of the stainless steel tank, having been surveyed and found free-releasable, were sent off-site for recycling.

Figure 21 The liner lifted slowly from its installed position.

Figure 22 The jib crane was able to lift the tank after the backfill sand loosened up.

Figure 23 Plasma torch cutting along the original weld seam.

Figure 24 Moving the tank's top half out the roll-up door.

Figure 25 The top half of the tank outside.

Figure 26 Moving the lower half of the tank out the door.

Figure 27 A tight squeeze again, and the lower half is out.

4.3 Regulatory Closure and Pit Backfill

After the tank removal, the backfill sand (between the tank and pit wall) was left in the pit (Figure 28). The Suffolk County Department of Health Services indicated that sampling and analysis of the sand was necessary to verify that the tank had not leaked and that no residualcontamination remained. Samples of the sand at the pit bottom were taken and tested by gamma spectroscopy (COC# 21012209). No radioactive contamination was detected, and backfilling the pit began.

The pit was filled with gravel, rather than sand, to provide a cost saving in reduced labor and risk. Sand would have required workers operating a motor-driven tamper in the pit to compact the sand. This would have meant confined space restrictions because of the emissions from the tamper. Gravel required minimal manual tamping (Figure 29). The last two feet of the pit were capped with reinforced concrete (Figure 30). Following this, the floor was painted to match the rest of the room. The only remaining evidence that the GIF was in the room is the 5-ton jib crane (Figure 31).

Figure 28 The empty pool pit, with original tank backfill sand.

Figure 29 Spreading and tamping the gravel backfill.

Figure 30 Installing the concrete cap.

Figure 31 The finished product, an empty room with a crane.

5. LESSONS LEARNED

The Building 830 GIF decommissioning project has been a straightforward waste (source) packaging and disposal activity in the technical sense. Challenges arose during coordination of the activities of the various parties involved and dealing with emergencies.

The unexpected fire emergency at a waste storage area at BNL caused a 24-hour delay and added to total costs because the source liner transfer team, which involved BNL police, RadCon, and riggers, were mobilized twice before the operation was completed. Prior to this, delays in obtaining waste profile approval from the disposal site added to total costs, primarily in continuing project management and pool maintenance. Similar, but relatively lower additional costs, resulted from delays in obtaining permission to discharge the pool water. During this period, additional costs were lower because pool maintenance activities associated with storing kiloCurie amounts of cobalt-60 were eliminated, since the sources were no longer present.

Although these delays resulted in increased costs, neither safety in operations nor protection of the environment was compromised. The activities with the highest hazards, those involving work with the radioactive sources, were all planned carefully and with ALARA in mind. All other wastes and discharges were handled and disposed of in compliance with BNL, DOE, federal and state requirements.

Increased costs are labeled as such for this project when compared to a baseline of activities and schedules developed in the early stages of the project. A significant lesson learned involves waste profile acceptance at the disposal facility. This proved to be a rather large schedule delay, which may have been much less if the profile had been initiated and contact made with the disposal site before the schedule was developed. With feedback from the disposal site about what information was needed and how much time was required for internal reviews for unique high activity shipments, a more realistic schedule and budget would have been developed initially.

6. ACKNOWLEDGEMENTS

This project involved the talents and cooperation of many BNL support division staff, including Plant Engineering, Radiation Control, Safeguards and Security, Waste Management, and Procurement and Property Management Divisions. All staff demonstrated a superior level of professionalism and mastery of their respective trades. In addition, all had a firm grasp of BNL work planning systems that ensure safety and protection of the environment. For their support and professionalism, I am most grateful. (In the following, staff are from PE unless otherwise noted.)

Project Planning

Planning and preparation are crucial for high-hazard projects, and the removal of the Building 830 cobalt-60 sources was expected to induce a circular high radiation area (>100 mrem/hr) with a 100-foot radius. The cranes, forklift, rigging and staff had to be ready to perform without failure (although failures were considered in the planning process). A special thanks goes to Pat Sullivan (RadCon), Jim O'Malley (PE) and Doug Moore (GTS Duratek) for their expertise, cooperation, and availability in planning a safe source transfer and critical lift. Ed Richards (WM) deserves recognition for following through on the waste profile preparation and its final acceptance.

Health Physics Support

The Facility Support group of the RadCon Division provided excellent HP coverage before, during and after the two source transfers. Joe Cracco provided immediate dose rate readings inside the building, including contact measurements of the transfer shield box and the forklift driver's position. Also within the high-rad area near the crane, John Hale monitored rad levels for the crane operator. Dennis Ryan and Greg Herman monitored the high-rad perimeter.

Crafts Support

Preparatory work was carried out by Bob Eger and Robert Durham, who modified the jib crane controls for remote use, and completed mechanical repairs, respectively. Thanks also to John Hynan for ensuring that the jib crane, which hadn't been used for years, was load-tested and certified in safe working order. Danny Carneiro and Richard Chylinski helped in the preparation of the facility by modifying the security alarms through several configuration changes. Frank Trapani modified the radiation alarm and electrical supply configurations as needed.

Jim O'Malley's rigging crew provided rigging and crane support for the actual cobalt source removal

in March 2000. This task had the greatest hazard potential, as it included conducting a critical lift in a high radiation area. The crew showed patience when the work was delayed and a willingness to work when the weather was unfavorable. This crew consisted of Tony McGill, Johnnie Turner, Bob Callister, and Oscar Mirjah, and they showed how teamwork and preparation make a potentially hazardous job go very smoothly and safely.

Following the discharge of the gamma pool water to the sanitary sewer, the next big task involved the removal of the tank. This required plumbers, to cut chiller and refill system piping out of the way, riggers to lift the tank, and metal workers to cut the tank so the riggers could move the tank out of the building in two pieces. Special thanks go to Supervisor Pete Abrams, Plumbers Eddie Diaz and Rich Froelich, and Metal Workers Steven Eckhoff, John Berry, John Lechmanski, and Anthony Mantone. The plasma torch cutting especially was a challenge, because of the thickness of the tank and the extent of the cuts to be made, totaling about 36 feet around the midpoint of the tank, plus holes for rigging struts. Again the rigging crew, this time John Sterzenbach, Johnnie Turner, Jr, Jeffrey Tabacco, Bob Callister, Kieth Detmer, Charles Edwards, and Fred Squires, displayed tremendous skill moving a large object, after getting it unstuck from its 32 year resting place, nearly effortlessly, up out of the pit and out of the building through a roll-up door with one-half inch clearance.

After the tank removal, Supervisor Mel Bonanno arranged filling the pit, using gravel rather than sand. This provided a cost saving in reduced labor and risk because the Mason crew did not have to work in the pit with a motor-driven sand tamper. Frank Gaetan, Dwayne Eleazer, Eugene Barrow, Anthony Talmore, and Darren Harris moved more than 30 yards of gravel (followed by 6 yards of concrete) into the building, placed it and tamped it (by hand), in just three days. Masons Lonnie Muldrow and Henry Jones gave the concrete cover a finished surface to match the old floor, and Painters Joanne McNaught, John Quigley, and Sylvester Dellimore gave the final coat.

Bob Jeffries coordinated the many crafts that had to work around each other during the tank removal, and did so in his own inimitable style. Although it seems simple in the description now, the job complexities combined with all crafts' already busy schedules made this a difficult task. Bob made sure that the work got done.

Project Management and Administrative Support

John Small (PPM) and Kevin Fox (PPM) were crucial in arranging the bid and contract process. With their help, the contractor (GTS Duratek) was chosen, and the contract was finalized in a very short time.

After the contract was in place, in the initial stages of the project, Hamid Talai and Ken Kentoffio arranged contractor work to remove walls and modify the facility room for source removal, under an urgent (as it was perceived at the time) deadline. The work, including safety reviews, was completed in three weeks, something of a record. For the tank removal part of the work, John Orris and Rich Kuscmarski provided accurate estimates and work planning guidance, respectively.

Throughout the project, Marty Fallier, Tom Sperry, and Tom Timko kept me on track within BNL project management systems. Their support was most crucial when the project schedule (and budget) extended well beyond what was originally anticipated. They also helped me through a maze of unanticipated regulatory requirements (Davis-Bacon – what's that?). Stu Carroll, the resident PeopleSoft wizard, was invaluable, because he could find where the money was in the new accounting system.

7. REFERENCES

1. Bowerman, B.S., M.G. Cowgill, J. Heiser, and P. Moskowitz, "Building 830 Gamma Irradiation Facility – Evaluation of Options for Its Future Disposition," Brookhaven National Laboratory, Informal Report BNL-67519 (1998).