VOLUME REDUCTION OF CONTAMINATED CONCRETE SHIELD SLABS THROUGH SURFACE REMOVAL

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ABSTRACT

During the TMI-2 accident, large areas of concrete surfaces were contaminated. Both unprotected concrete and concrete under protective coatings was affected. This paper describes the approach used to achieve both effective decontamination and significant radwaste volume reduction during clean-up of sixteen (16) concrete shield slabs. The cost-benefit analysis leading to the decision to mechanically decontaminate rather than dispose of the complete slabs is discussed. Scabbling (mechanical removal of a thin layer of concrete) from approximately 2000 ft^2 of surface is described including the various equipment and methods used. Finally, the resulting post-decontamination contamination levels, the waste volumes created and the waste collection and disposal methods are discussed.

BACKGROUND

During the TMI-2 accident, large volumes of contaminated water were released to the reactor building basement and waste systems. In order to provide a temporary post accident processing facility for the radioactive liquid wastes from the reactor building sump and through the miscellaneous waste hold-up tank (WDL-T-2), the submerged demineralizer system (SDS) was installed in the spent fuel storage pool, which is designated as fuel pool B (FPB).[1]

To provide a temporary shielded storage facility for the radioactive liquid wastes to be processed through SDS without contaminating the fuel transfer pool, the fuel pool waste storage system (FPWSS) was constructed. The FPWSS was comprised of two 25,000 gallon tanks (lower) and four 15,000 gallon tanks (upper) and various piping manifolds, valves, pipes, and pumps which facilitated the transfer of liquid between the FPWSS tanks and the SDS. The FPWSS was installed in the new and spent fuel transfer pool of the Unit 2 fuel handling building (FHB), which is designated as fuel pool A (FPA).

Shielding was required to mitigate exposures to workers required to operate, maintain, and repair the FPWSS and SDS systems. Shielding was provided by covering fuel pool A with 16 interlocking concrete slabs. The dimensions and weights of the slabs are listed in Table I.

TABLE I

Concrete Shield Slab Dimensions and Weights

	Dimension	Approximate Weight (Tons)
Concrete Slab(8)	2'x7'x16'	16
Concrete Slab(8)	2'x7'x20'	20

Figure 1 shows a plan view of the 347'-6 elevation of the TMI-2 fuel handling building with the relative locations of the SDS and concrete shield slabs.

Operation of the SDS was commenced during July of 1981. At this time the concrete shield slabs were uncoated. These slabs made an ideal area for staging material and equipment in support of SDS operations and activities related to characterization of the reactor containment building atmosphere prior to manned reentry.[2&3]

Storage of contaminated materials and subsequent leakage of packaging and systems resulted in low level contamination of the 16 shield slabs.

The surfaces of the 16 shield slabs were decontaminated insitu. Loose surface contamination was reduced to less than 1000 dpm per 100 cm^2, and the shield slabs were protected with nuclear grade epoxy coatings to prevent introduction of additional contaminants into the concrete, reduce the potential for contamination to workers, and provide a more maintainable surface for continued operations.

After the processing of the accident generated liquid wastes, it was required to restore fuel pool "A" to its original pre-accident condition in preparation for removing the fuel from the TMI-2 reactor core.[4] One of the major activities was shield slab removal.

EVALUATION OF SHIELD SLAB DISPOSAL VERSUS DECONTAMINATION COSTS

The cost of disposal for the concrete shield slabs was evaluated on burial volume fees and transportation fees to be $9,300 for each of the 7'x16' shield slabs and $10,376 for each of the 7'x20' slabs. This represented an approximate total cost of $157,400 for disposal without any attempted volume reduction.

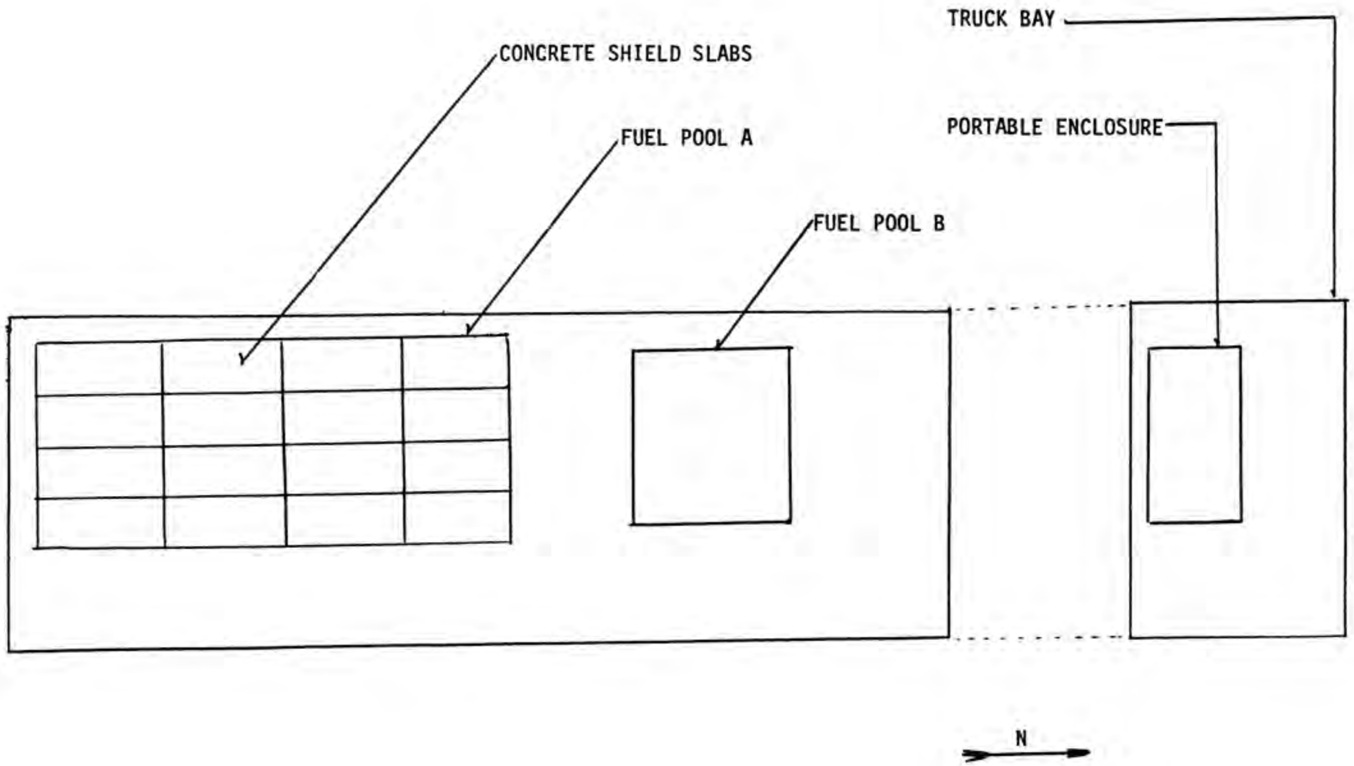

Fig. 1. TMI-2 fuel handling building elevation 347'6" (sketch).

Transportation fees reflect the requirement to ship TMI-2 wastes to Hanford, Washington by GPU Nuclear.

The results of decontaminating the shield slabs were estimated based on dose reduction and decontamination rate factors obtained in the TMI-2 auxiliary and fuel handling buildings by scabbling. [5] The estimated cost of labor and equipment for decontamination, coating and removal of slabs to outside disposal was $120,000. Based on the cost savings estimate of approximately $37,000 to mechanically decontaminate the slabs and potential volume reduction, surface removal operations were approved by GPU Nuclear Corporation.

SURFACE REMOVAL OPERATIONS

Equipment selection: the equipment required for surface removal operations included the following, which was available and previously utilized at TMI-2 for decontamination operations:

1. Portable enclosure with removable roof, 12'x12'x24' stainless steel.
2. Portable HEPA filtered ventilation unit, 1000 CFM. General dynamics.(R)
3. Portable vacuum system, with modified prefilter, Hako(R) Minuteman, Model 70255.
4. Scabbler, MacDonald Model U-5, with modifications.
5. Scabbler, MacDonald Model 3 WCD, with modifications.
6. Scabbler, MacDonald Model 1 UF.
7. Scabbler, MacDonald Model HS.
8. Chipping gun with needle tips, chicago pneumatic.
9. Work stands to hold shield blocks above floor (were fabricated on-site).
10. Portable shields.

Preparations and Set-up: The portable enclosure was erected in the fuel handling building truck bay, located to the north of the plan view in fig. 1.1, but on the 305' elevation. Portable shielding was installed in the enclosure to permit radiological surveys of slab surfaces for release to uncontrolled storage. This required less than 0.1 mR/hour contact open window readings. Prior to shielding radiation readings of approximately 2.0 mR/hour were detected in the work area of the portable enclosure. After shielding, the enclosure work area radiation levels were less than the release limits.

After installation of shielding, the portable HEPA filtered ventilation and HEPA filtered vacuum systems were connected to the enclosure. Both units were located outside the enclosure with penetrations for internal services. Filtered exhausts were discharged to the fuel handling building atmosphere. Radiological Controls personnel provided constant air monitoring equipment to monitor the fuel handling building air.

Bulkhead type connections were installed to provide compressed air to power the scabblers within the enclosure.

The integrity of the enclosure and air flow of the portable ventilation unit was functionally tested by the introduction of smoke to the enclosure by Radiological Controls personnel and proved adequate.

The floor was carefully measured and the locations of the shield slab stands were marked for working both 16 and 20 feet long shield slabs. At this point the roof was removed and the shield slab stands were placed to receive the first slab in the enclosure. The stands were covered with protective materials to prevent possible contamination and the first 20 foot long shield slab was lifted by the fuel handling building crane and lowered into position in the temporary enclosure. The roof was replaced, the ventilation system activated and work commenced.

Sequence of Operations: a radiological survey was conducted to define the contamination on each shield slab prior to any surface removal activity. The first slab exhibited fixed contamination in several small locations on the top surface only. The spots were marked and the modified 3 WCD scabbler was utilized to remove the surface and contaminants.

The subsequent radiological survey indicated that the scabbled areas were clean (less than 500 dpm/100 cm^2 beta gamma and less than 100 dpm/100 cm^2 alpha), however, other small locations of fixed contamination were detected. These spots were marked and promptly removed, again with the modified 3 WCD scabbler.

Again the radiological survey indicated that the scabbled areas were clean and again other small isolated areas of contamination were detected.

The entire top surface was then scabbled utilizing the model U-5 scabbler for the open areas, and the 3 WCD, 1 UF, and HS scabblers around the lifting lugs and edges. The slab was scrubbed and vacuumed and another radiological survey performed which released the slab for uncontrolled use.

On all subsequent shield slabs (none of which were found releasable on the initial survey) the entire top surface was scabbled then resurveyed. Fixed contamination levels ranged from less than 1 mRad/hour beta to about 300 mRad/hour beta in isolated spots.

Four of the concrete shield slabs had been exposed to contaminants which penetrated to depths of 5 inches into the concrete. This penetration occurred near edges and in an area of about 10 inches diameter or less. This contamination was removed, primarily contained within chunks of concrete, utilizing the chipping gun with the needle point and the model HS scabbler.

Deep contaminant penetration, in excess of 1 inch, was also detected at several lifting lugs. This also was removed through use of the chipping gun with the needle point and the 1 UF and HS scabblers.

Four shield slabs were found to be contaminated on the vertical faces and none were found to be contaminated on the bottoms.

Upon release of the concrete shield slabs for uncontrolled use; the portable enclosure was cleaned and surveyed. Upon achieving a clean condition in the enclosure, the roof was removed and the shield slabs moved to permit radiological surveys of the portions which had been on the stands.

One slab required the replacement of the roof and subsequent surface removal of a small area obscured by the work stand prior to release for uncontrolled use.

Description of Scabbling Operations

Scabbler descriptions [6] : Scabblers are pneumatically operated machines manufactured by MacDonald Air Tool Company to remove laitance from concrete surfaces (laitance is the crust that forms on concrete when poured concrete is allowed to set without finishing). Scabblers were designed to leave a suitable finish without damage to the underlying surface. The machines, single or multi-cylindered units, "float" on the concrete surface. The cutting bits are tungsten carbide and have an average life of about 30 hours. A detailed description of each of the units follows:

1. MacDonald Floor Scabbler - Model U-5. The model U-5 consists of 5 pneumatically operated cylinders fitted with changeable bits. A metal frame with wheels support the machine when not in use. The scabbler "floats" on the cutting bits when in use. Dimensions of the unit are: 50 inches long, 25 inches wide, and 33 inches high. The model U-5 weighs 214 pounds and has an 11½ inch working width. Air consumption is 125 cubic feet per minute at 80 psig. The unit has been modified with an enclosure around the scabbling cylinders to permit the connection of a vacuum with a HEPA filter; this modification minimizes any airborne contamination.

2. MacDonald Wall Scabbler Model 3 WCD. The model 3 WCD has 3 pneutamically operated cylinders fitted with changeable bits. This unit is used to complement the model U-5, or is used on floors when the U-5 cannot fit into an area. Vertical surfaces may be scabbled with the 3 WCD unit. The unit weighs 31 pounds and has handles mounted on either side. During vertical operation a swivelling eye-bolt provides a location for the attachment of a rope or cables to support the weight of the tool by using a cable or counterweight. The 3 WCD is 20 inches long, 8 inches wide and has a 7 inch working width. Air is used at a rate of 35 cubic feet per minute at 80 psig. A vacuum system with HEPA filtration is attached to this model.

3. MacDonald Model 1 UF Scabbler. This unit has only one cylinder equipped with a changeable bit. With a weight of 25½ pounds and length of 52 inches, it is for use on trim, or confined areas where the other larger units will not fit. The model 1 UF requires 25 cubic feet of air at 80 psig per minute.

4. MacDonald Model HS Single Piston Scabbler. The model HS is a hand-held, single cylinder scabbler. It is used for trim work, small jobs, or in highly confined areas. Its weight is only 7 3/4 pounds and air consumption is 20 cubic feet per minute at 80 psig. The model used at TMI has a 2 inch hose attached near the bit with the opposite end of the hose connected to a vacuum with a HEPA filter.

Vacuum System Description: The Hako Minuteman Model 70255 Vacuum [7] is an air operated heavy duty vacuum system. The unit features twin-jet venturi and mounts on standard 55 gallon drums. The single 70255 with collection drum weighs 127 pounds. Air consumption is 91 cubic feet per minute at 100 psig. Static lift for the model 70255 is 220 inches of water and an air flow of 364 cubic foot per minute is achieved through 2 inch diameter vacuum tubes. Modifications were made by GPU Nuclear personnel, with the manufacturers support, to protect the HEPA filter from scabble dust which caused blockage of the HEPA filter resulting in a need to clean or replace filters and test for efficiency after the canister was opened.

Operating Teams: The scabbling operation requires 2 to 3 technicians who work as a team. Each scabbling machine requires 1 individual to operate. The operator should be trained in the proper operation and maintenance of the unit.

The second technician operates the vacuum system. He is responsible for correct set-up and operation, and for keeping the compressed air lines from interfering with the work area. When any of the scabblers are in use, the operation of the vacuum system is mandatory.

The third person is utilized to remove scabbling debris on large jobs, he works with the vacuum operator to keep the work area clear. The third person may also package and remove debris from work areas to maintain lower radiation exposure levels.

POST DECONTAMINATION RESULTS

All of the concrete shield slabs were decontaminated to releasable for uncontrolled use status:

Direct survey:	less than 0.1 mR/hour open window at contact, radiation levels.
Smearable:	less than 500 dpm per 100 cm^2 beta gamma.
	less than 100 dpm per 100 cm^2 alpha.

Upon release for uncontrolled use the concrete shield slabs were individually removed from the fuel handling building and placed in storage on the southern end of the TMI site.

The waste volume generated was 20 drums of material, which included disposable plastic anticontamination clothing and trash compacted over scabbling debris, for a total volume of 150 cubic feet. Waste was disposed as dry active LSA waste. The waste disposal cost was $5,380.

The volume reduction achieved was from 2016 cubic feet to 150 cubic feet or 1866 cubic feet, net. A 93 percent volume reduction was achieved through surface removal, over disposal as radioactive waste for the 16 concrete shield slabs.

Waste burial and transportation fees were $5,380 after volume reduction. The initial cost estimate was $157,400 which produced a savings of $152,020 in transportation and burial fees.

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