DECOMMISSIONING OF THE PRINCETON-PENN ACCELERATOR

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ABSTRACT

The Princeton-Pennsylvania Accelerator operated on the Princeton University Campus from 1962 to 1972 prior to being dismantled. The Accelerator Building was left with two large areas of activated concrete in a floor up to six feet thick. A decommissioning plan was filed with the New Jersey Bureau of Environmental Radiation (NJBER), and work commenced upon approval. Even though the activated concrete was very low level, the economics of waste burial dictated a technical approach whereby the radioactive concrete was "surgically" removed so that the remainder of the structure could be released for unrestricted use. The exact area and depth of concrete to be cut was predicted by the SPAN-4 code. A diamond wire saw was used to cut out precise concrete blocks which were fitted into custom sized shipping containers. This approach was successful in that the planned cut was with 5% of the actual volume removed to meet the release criteria, and the majority of the structure could then be treated as an ordinary demolition project.

BACKGROUND

The Princeton-Pennsylvania Accelerator was a 3 Gev proton synchrotron operated from 1962 to 1972 on the James Forrestal Campus of Princeton University. By 1980, the accelerator equipment had been dismantled and removed, leaving the Accelerator Building standing. During the operation of the synchrotron, neutron activation of portions of the structure had occurred. Princeton University wished to utilize the land for other purposes, and by 1988 all the surrounding buildings were demolished except for the Accelerator Building containing the residual radioactivity.

The Accelerator Building, illustrated in Fig. 1, is a circular structure with extensive shielding provisions consisting of a combination of thick concrete walls and earth cover. The concrete roof of the building is covered by 22 feet of earth fill which slopes down to grade level around sixty percent of the building circumference. The other 40 percent of the building contains outer walls up to 12 feet thick of high density (240 lbs/cf) ilmenite concrete. The building consists of one large room with a diameter of approximately 100 feet, containing 12 structural roof support columns. The floor varies in thickness from six feet where the accelerator magnet ring was supported to one foot near the center of the room. The floor consisted of reinforced concrete at 150 lbs/cf. Below the floor level, there exists a circular tunnel that previously contained accelerator utilities.

Radiation surveys had indicated that the induced radioactivity was localized around two former accelerator target areas. The bulk of the radioactivity was in the floor, but radioactivity was also in several structural columns and in the roof. Core samples indicated radioactivity in-depth consisting of Na-22, Co-60, Eu-152 and Eu-154. Specific activity was very low, with dose rates ranging from a few micro-rem/hr up to 110 micro-rem/hr over background.

Ebasco Services Inc. was hired by Princeton University to prepare a decommissioning plan, assist in obtaining necessary approvals and to carry-out the decommissioning. Although several options were considered, including allowing the radioactivity to decay to unrestricted levels after more than 20 years, the only option that would meet Princeton's plans involved immediate removal of the radioactivity to unrestricted levels accompanied by demolition of any remaining structures. This paper reports on the results of this project including the successful completion of the first phase consisting of decontaminating the floor areas.

DECOMMISSIONING PLAN

Since the facility does not have an NRC license, the decommissioning was governed by New Jersey Administrative Code, Title 7, Department of Environmental Protection, Chapter 28, Bureau of Environmental Radiation. The agency responsible for overseeing the work was the New Jersey Bureau of Environmental Radiation (NJBER). The criteria accepted by the NJBER for decommissioning the facility were: 1) that radiation exposure levels should not exceed 100 mrem/yr for all pathways collectively, 2) residual activation products should not exceed 4.3 pci/g, and 3) surface contamination should not exceed USNRC Regulatory Guide 1.86.

A radiation exposure pathways analysis was performed for inhalation dose and ingestion dose. This analysis indicated maximum possible doses to an individual from these pathways was less than .01 mrem/yr. Therefore, the governing pathway to meet the decommissioning criteria was the direct shine dose measured at 1 meter from the surface where the exposure time was assumed to be a full one year term of 8760 hours.

The key challenge in the decommissioning project was how to decommission the building in a cost effective man-

Fig. 1. Princeton-Penn Accelerator Building.

ner. The low radiation levels did not present a difficult health physics problem, but did present a problem of how to remove localized in-depth activation from a massive concrete structure. Charges for waste burial at Barnwell, including out-of-compact surcharges, were approximately $70 per cubic foot. Waste burial costs essentially dictated the technical approach which was to "surgically" remove the radioactive concrete from the structure until it met the release criteria, and then dismantle the remaining structures as a non-radiological project.

To predict the pattern of concrete removal necessary to meet the release criteria, information from core borings and dose rate surveys were used to construct a source term model that would be utilized by the SPAN-4 program (1). SPAN-4 is a three dimensional point kernel code which uses Gaussian quadrature over the source volume to calculate dose rates at selected dose points. The analysis predicted that the removal of two wedge shaped floor sections would result in meeting unrestricted release criteria for the floor. One section was 25 feet long by approximately 32 feet at the outer radius. The other was 18 feet long by approximately 25 feet at the outer radius. Depth varied up to 30 inches. This represented approximately 1925 cubic feet of concrete.

WASTE REMOVAL

Waste volume reduction was emphasized throughout, and the entire project was planned to prevent large amounts of non-radioactive or barely radioactive concrete from being treated as radioactive waste. A diamond wire saw was chosen as the primary method to cut the activated concrete from the floor. The diamond wire cutting method utilizes a wire cable studded with abrasive protrusions which, when pulled at high tension and a speed of 60 feet per second through pre-drilled holes, can produce a clean cut in reinforced concrete. A controlled water spray is used for cooling purposes, and the water can be recycled.

The diamond wire cutting method has the advantages of being able to cut with precision any thickness of concrete without producing airborne dust or spread of contaminated material. The main restriction of the method is that it requires a means of threading the wire behind the block to be cut. This was accomplished by utilizing slant drill holes to the magnet tunnel beneath the floor (Fig. 2). The wire saw is shown in operation in Fig. 3 and the planned cut pattern is shown in Fig. 4.

The high cost of waste burial made the use of custom sized rectangular steel shipping and burial containers cost effective. Six different sized containers were manufactured to allow a precise fit of each of the preplanned concrete blocks. Eye-bolts were drilled in the blocks which were then lifted into the containers. The eye-bolts were burned off prior to sealing the container. Concrete blocks weighing more than 15,000 pounds were lifted into a single container, with only one inch tolerance (Fig. 5). This allowed for an overall packing efficiency of almost 80% despite the fact of their large size (no block weighed less than 2,000 pounds)

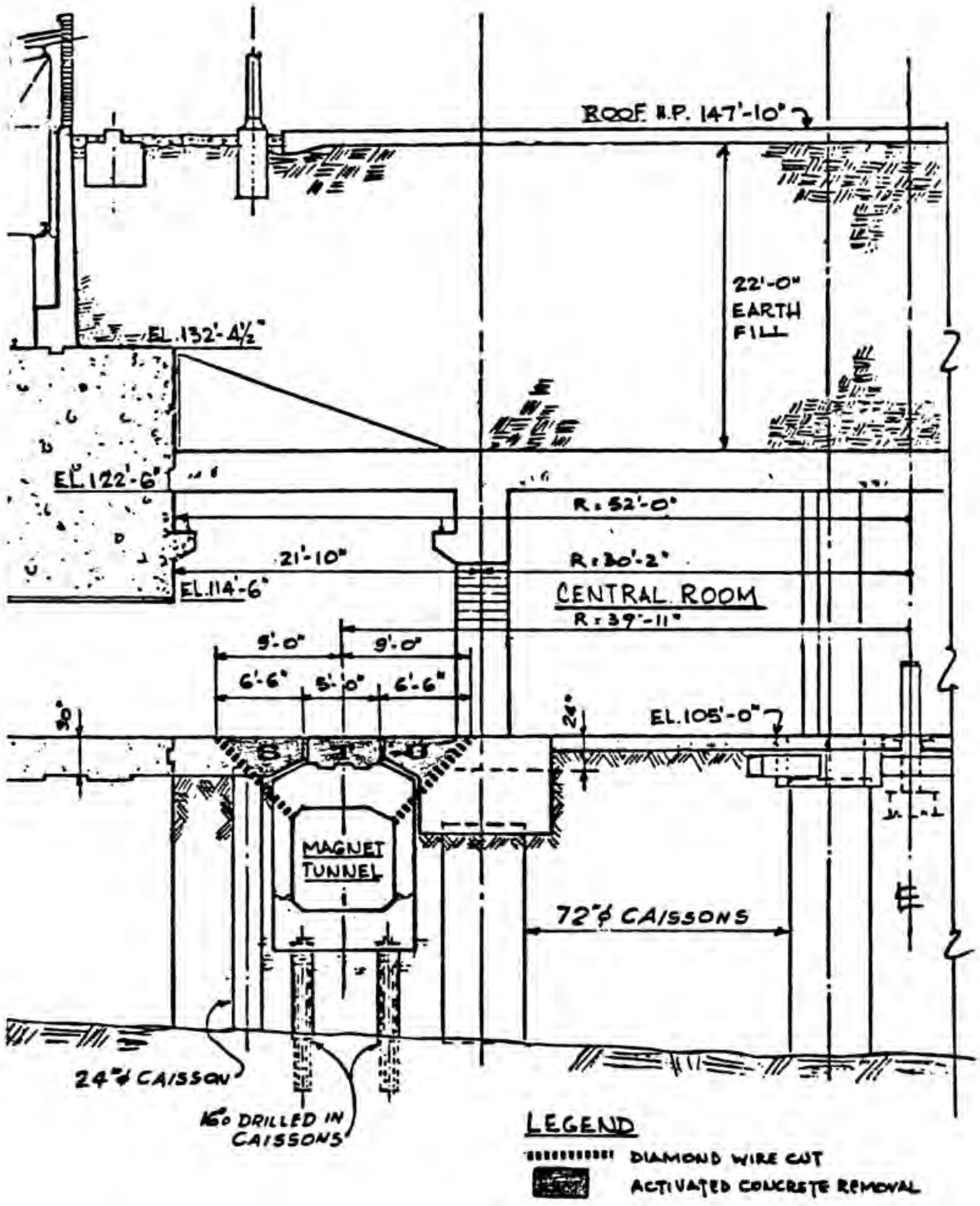
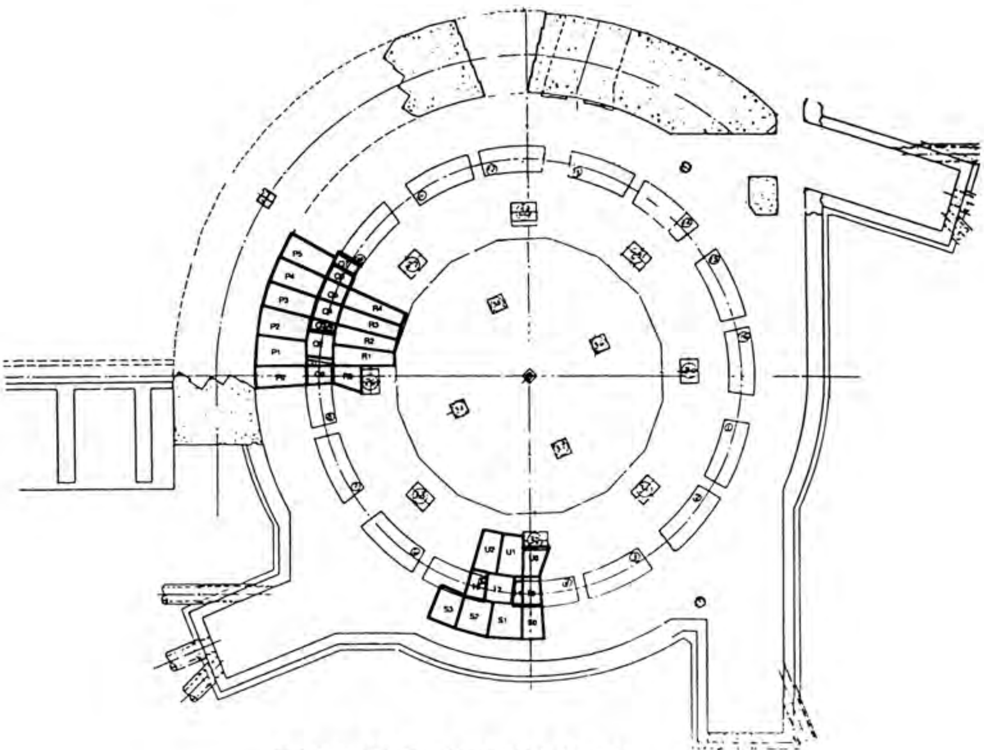


Fig. 2. Accelerator Building Cross Section

Fig. 3. Diamond Wire Saw Machine.

Fig. 5. Concrete Block Being Loaded Into Custom Sized Container.



PLAN AT ELEVATION 105'-0

Fig. 4. Wire Saw Cutting Pattern.

and the fact that the blocks were not squared due to the radial cut.

The final cut pattern and volume of waste was very close to that predicted. Table I shows that the final waste volume was within 5% of the plan. Two edges of the final cut pattern had to be enlarged by six inches and one area deepened.

TABLE I
Planned vs Actual Waste
(cubic feet)

	Planned	Actual	Container Volume
West Area	1152	1178.8	1592.1
South Area	773	716	841.5
Rubble	---	117	212.8
Total	1925	2011.8	2646.4

CONCLUSION

Waste burial charges will greatly effect projects involving the decommissioning of structures. A cost effective approach, if the radioactivity is localized, is the surgical removal of the activated material from the remaining structure. One such method that was successfully employed in the Princeton-Pennsylvania Project was the diamond wire saw combined with careful planning and custom sized shipping containers.

REFERENCES

1. O. J. WALLACE, "SPAN-4, A Point Kernel Computer Program for Shielding," Westinghouse Report WAPD-TM-809 (L), 1972.