DECOMMISSIONING OF SURPLUS FACILITIES AT THE HANFORD SITE

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ABSTRACT

In 1943, as part of the war effort, the U.S. Army Corps of Engineers selected the Hanford Site as the area to construct the first full-scale plutonium production facilities. Between 1943 and 1955, eight production reactors were built at the Hanford Site, along with numerous support facilities including major facilities used for the fuels separation process.

Currently, over 100 of these facilities at the Hanford Site have been declared surplus and are to be decommissioned. This includes eight shutdown production reactors located in the 100 Area and two large fuels separation/process facilities located in the 200 Area.

Other than the ongoing required surveillance and maintenance work, there are three significant decommissioning project activities currently under way: the decommissioning of the Strontium Semiworks Pilot Fuel Reprocessing Plant, the closure/cleanup of the 183-H Solar Evaporation Basins, and the planning for decommissioning of the eight surplus production reactors.

PAST DECOMMISSIONING WORK AT HANFORD

The decommissioning of reactor and fuels processing support facilities (commonly referred to as ancillary facilities) began in 1976 and, to date, over 35 contaminated structures have been decommissioned. The Hanford Site geographic location, area designations, and facilities locations are shown on Fig. 1. These facilities were used to support the reactors or processing plants during operations and included laboratories, exhaust stacks, filter buildings, etc. The 100-F reactor before and after the decommissioning of support facilities is shown on Fig. 2. The 105-F reactor building and 108-F laboratory are the only two main structures that remain.

Most of the demolition work was completed using heavy equipment (i.e., crane with wrecking ball, front loader, dump truck, etc.). In addition, some of the thick reinforced concrete walls and 13 of the exhaust stacks were demolished using explosives.

PROJECT PLANNING

The surplus facilities are categorized into projects based on size, complexity of the work, and, in some cases, similarity or likeness of facilities. Decommissioning is prioritized based on criteria developed by the U.S. Department of Energy (DOE)-Defense Facilities Decommissioning Program Office. Because of similarity in design, the eight reactors have been grouped together as a single project. The planning, characterization, and engineering work completed to date has been for all eight reactors, thereby eliminating duplication of these tasks for each separate reactor facility. The strategy at the Hanford Site has been to complete the decommissioning of the smaller support facilities and then use this experience to decommission the more complex reactors and process facilities.

Several decommissioning alternatives have been considered for the Hanford Site surplus facilities and include the following:

(1) Decontamination for re-use

(2) In situ decommissioning

(3) Total dismantlement

(4) No action (continued surveillance and maintenance).

Variations of these four main alternatives have been or are being considered for the individual projects before actual decommissioning begins.

In situ decommissioning using the allowable residual contamination limits (ARCL) method developed by Pacific Northwest Laboratory (1) for the DOE has been the prevalent methodology for decommissioning facilities at the Hanford Site. The ARCL method defines the amount of radioactive material that may remain safely after a facility has been decommissioned. The ARCL method utilizes relative exposure scenarios, based on an analysis of potential radiation exposure pathways. The scenarios consider numerous ways in which persons could be exposed to the remaining radioactive materials during or after institutional control of the facility site.

The radiological inventory of the facility is estimated from sampling data and then, using the appropriate dose pathways, a dose, along with a 90 percent upper-confidence limit, is estimated. If the predicted potential dose at a site to an individual, as determined by this method, is less than 25 mrem/yr, no further actions will be required for that site. If the predicted potential dose exceeds the limit, additional

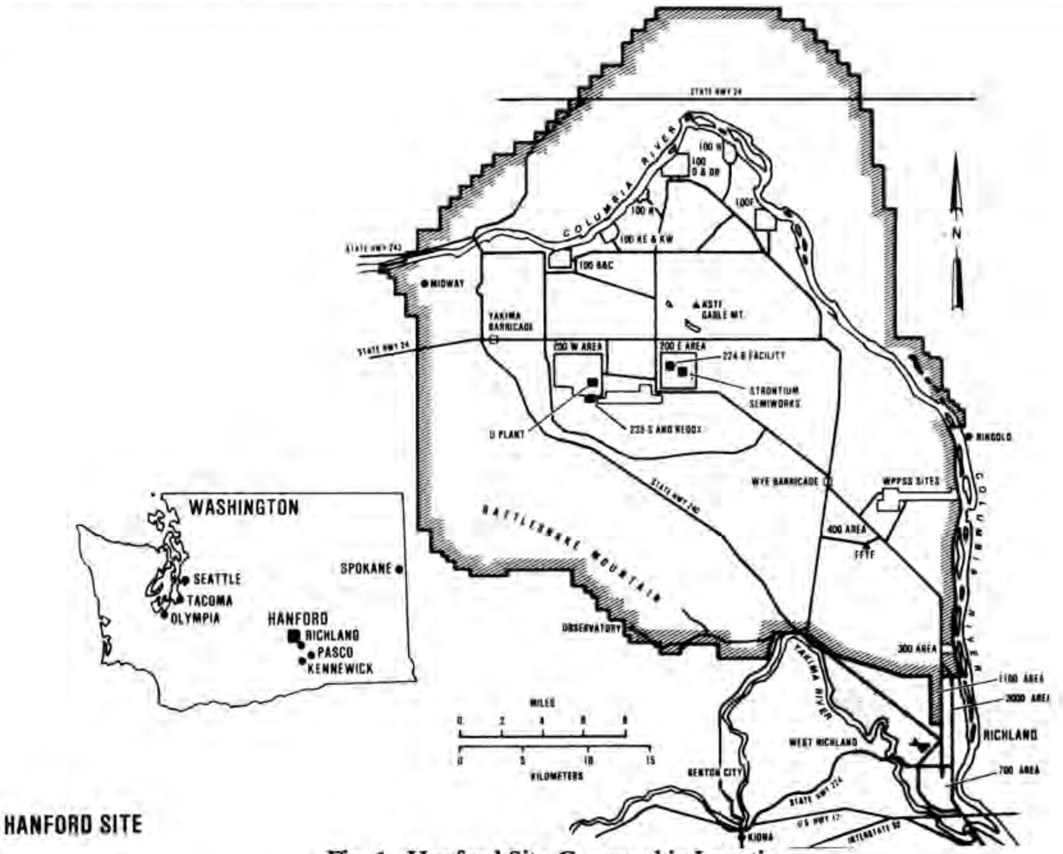

Fig. 1. Hanford Site Geographic Location.

remediation action, such as more decontamination work or equipment removal, must be taken.

Before a decommissioning alternative is implemented, the appropriate level of National Environmental Policy Act (NEPA) (2) documentation must also be completed and approved. Depending on the proposed project, the DOE may specify one of three levels of documentation, including an environmental evaluation or memo-to-file, environmental assessment, and environmental impact statement. The DOE may also advise that an action description memorandum be prepared to serve as a basis for determination of the required level of NEPA documentation. With the exception of the eight reactors and the Strontium Semiworks, all other decommissioning has been completed based on environmental evaluations (memos-to-file).

An environmental assessment resulting in a finding-of-no-significant-impact was prepared for the Strontium Semiworks project. Currently, the DOE is processing an environmental impact statement (EIS) (3) for the decommissioning of the eight surplus production reactors at the Hanford Site.

REACTOR DECOMMISSIONING

The eight surplus production reactors (designated as 105-F, -H, -D, -DR, -KE, -KW, -B, and -C) were constructed between 1944 and 1955, and all were shut down by 1971. Following shutdown, the reactors were deactivated and the fuel was removed. The reactors have been maintained in a safe condition pending final disposition.

Surveillance and maintenance include industrial, environmental, and radiological safety inspections on a predetermined frequency. Inspection results are documented and corrective actions are taken as required to maintain the facilities in a safe condition. Hazardous waste, such as mercury and polychlorinated biphenyls, and some of the friable asbestos have been removed from the reactor buildings to minimize hazardous conditions to the surveillance and maintenance personnel.

All eight reactors have similar designs and operating characteristics. A typical reactor facility (Fig. 3) is a reinforced concrete structure approximately 76 m long by 70 m wide by 29 m high. The reactor facility is divided into two major parts: the reactor block and the fuel storage basin. Each reactor block contains thermal and biological shields, process tubes, and a graphite moderator stack. Nearly all of the fuel storage basins have been drained, and the water and sludge have been disposed of as radioactive waste at designated disposal areas at the Hanford Site. The remaining fuel storage basins will be prepared for decommissioning before work begins on the reactors.

A typical reactor block (Fig. 4) consists of a graphite moderator stack encased in cast-iron thermal shielding (20

Fig. 2. Hanford 100-F Area Before and After the Decontamination of Support Facilities.

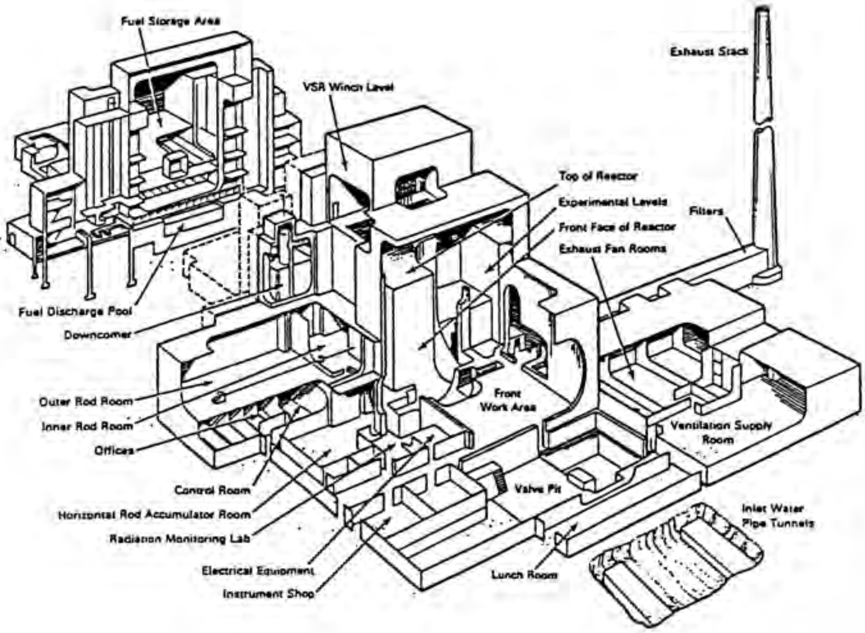

Fig. 3. Reactor Building Layout.

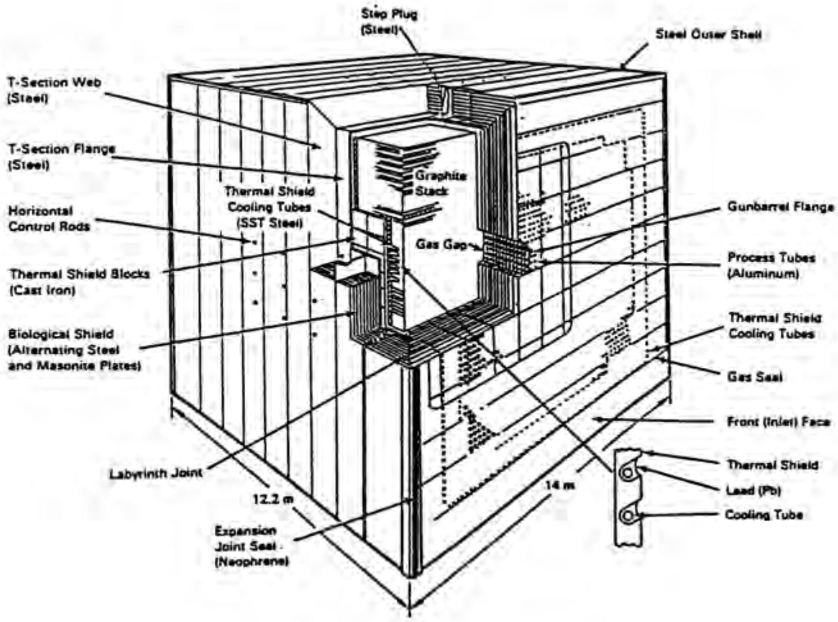

Fig. 4. Reactor-Block Construction.

to 25 cm thick) and a biological shield (alternating layers of steel plate and masonite or heavy, high-density, aggregate concrete, 101 to 210 cm thick). The entire block rests on a massive concrete base and foundation. A typical reactor block assembly weighs 9,000 tons. Overall, the reactor block dimensions are 14 m high by 14 m wide by 12 m deep.

Radionuclide inventories have been estimated for the eight reactor facilities. The radionuclides of primary interest are cobalt-60 and cesium-137 because they would be the major contributors of occupational doses to decommissioning workers. Carbon-14, chlorine-36, and uranium-238 are of interest because of their long half-lives and their contribution to long-term doses. Tritium is of interest because it is present in large amounts.

In 1983, a decommissioning alternative assessment study was prepared for the eight reactors. In 1985, DOE published a Notice of Intent in the Federal Register, to prepare an EIS. The EIS was drafted and was released for public review in April 1989. The draft EIS included the following alternatives:

(1) Safe storage followed by deferred one-piece removal

(2) Immediate one-piece removal

(3) Safe storage followed by deferred dismantlement

(4) In situ decommissioning

(5) No new action. (The no-action alternative is one that must be evaluated for comparison purposes in all EISs.)

Safe storage followed by deferred decommissioning would allow the decay of radioactive materials in the reactor block, resulting in reduced radiation exposure for workers during either one-piece removal or complete dismantlement. A safe storage period of 75 yr is assumed in this alternative.

In the one-piece removal alternative, each reactor block is transported intact on a tractor transporter from its present location to a low-level waste disposal facility located on the Hanford Site. This could be accomplished either immediately or up to the assumed 75 yr safe-storage period.

Actual dismantlement of the reactor block is considered feasible only after a period of storage sufficient to reduce worker radiation exposure to acceptable levels. In the dismantlement process, each reactor block would be disassembled piece by piece, and all contaminated equipment and components would be packaged and transported to a low-level waste disposal facility on the Hanford Site.

The in situ disposal alternative involves covering the reactor block with a protective mound. The mound would include engineered barriers designed to meet applicable state and federal specifications and regulations. The mounds would include rip-rap on the sides to ensure long-term structural stability in the event of Grand Coulee Dam failure.

Table I shows a comparison of the five alternatives.

The DOE has received comments on the draft and is presently evaluating those comments for inclusion in the final EIS. The current schedule calls for a record of decision (ROD) in October 1990. Decommissioning work will be initiated based on the ROD.

STRONTIUM SEMIWORKS DECOMMISSIONING

The Strontium Semiworks plant is located in the 200 East Area of the Hanford Site. Constructed in 1949, the plant operated until 1967. During that time it was used as a pilot plant for two nuclear fuel separations processes and also for separating strontium from high-level liquid radioactive waste. Following shutdown, the plant was maintained in a safe condition, and decommissioning planning was initiated in 1983.

The Strontium Semiworks plant complex consisted of 11 structures (Fig. 5). The 201-C process building was the main facility; other structures included a solvent-handling building, exhaust stack, and underground storage tanks.

In 1985, the DOE completed an environmental assessment and issued a finding of no-significant-impact. The decommissioning alternative selected for the Strontium Semiworks was partial dismantlement, followed by entombment. The major decommissioning project activities completed to date include (1) decontamination, demolition, and entombment of the main process building, (2) demolition of ancillary support buildings, and (3) decontamination and demolition of the exhaust stack.

The main process building (201-C) consisted of several cells and process galleries and also housed the process tanks, piping, and columns. The decommissioning of this building proved most challenging because of the high levels of contamination and high radiation dose rates in specific areas. Decommissioning consisted of removing contaminated equipment and piping, decontaminating concrete walls, entombing below-grade cells, and demolishing of the B-cell to approximately 10 ft above grade (4).

The 200-ft exhaust stack was decontaminated from the top down using a remote sandblast system designed specifically for this work. The stack was built as a stack within a stack. The outer structure was made of concrete and steel and the inner stack was constructed of brick and mortar. During the decontamination phase, the airflow in the stack was reversed to draw the dust created by the sandblasting down the stack and through a temporary filter system. The sandblast grit was removed from the stack base using a

TABLE I
COMPARISON OF ALTERNATIVES[a]

Alternative	Occupational radiation dose (person-rem)	Total cost(millions of 1986 $)	Population dose over 10,000 yr[b] (person-rem)	Maximum well dose[c] (rem/yr)
No action (continue present action)	24	41	50,000	1.2
Immediate one-piece removal	159	191	1,900	0.04
Safe storage followed by deferred one-piece removal	51	198	1,900	0.04
Safe storage followed by deferred dismantlement	532	217	1,900	0.04
In situ decommissioning	33	181	4,700	0.03

[a]Quantities are for all eight reactors. Costs are for 100 yr.
[b]The same population would receive 9 billion person-rem over 10,000 yr from natural radiation.
[c]This amount is the maximum dose rate to a person drinking waterfrom a well drilled near the waste form at any time up to 10,000 yr.

vacuum system, was transferred into burial boxes, and was disposed of as low-level waste.

The sandblasting/decontamination was successful because it reduced overall radiation levels from approximately 250 to 350 mrad/h down to levels of about 10 mrad/h. Before demolition, the remaining contamination was fixed by painting the inner stack using a remote rotary spray system.

The stack was demolished (felled) using explosives and the rubble was covered with earthen materials.

In addition to the buildings and the stack decommissioning, there are three below-grade waste tanks at the Strontium Semiworks that require cleanout/remediation. These tanks include 241-CX-70, -71, and -72. The tanks are scheduled to be sampled and, based on the sample analyses, the residual waste will be stabilized or removed and disposed of.

The project plan calls for an engineered barrier to be constructed over the entombed 201-C process facility, the stack rubble, contaminated support structures, and waste tanks. The barrier will be constructed of earthen materials and must be 15 ft above the surface of any buried waste or contaminated surface. The barrier placement is currently on hold, pending cleanout and remediation of the three waste tanks.

183-H Solar Evaporation Basins

The 183-H Basins were originally constructed as part of the 183-H Filter Plant and supported the operation of the 105-H reactor operations from 1949 to 1965. The filter plant provided water treatment, filtering, and reservoir capacity for the reactor process water system. The filter plant consisted of a head house and chemical building, 16 sedimentation basins, filter building, and clearwell storage area with pumps.

Following shutdown of the 105-H reactor in 1965, the filter plant was demolished with the exception of four of the 16 sedimentation basins and the clearwells.

In 1973, the four remaining sedimentation basins were designated to be used as solar evaporation basins and were named "183-H Solar Evaporation Basins." The basins received byproduct liquid chemical wastes from the Hanford 300 Area fuels fabrication process. The intent was to reduce the volume of liquid waste by using a passive evaporation process.

In 1985, DOE stopped shipment of waste to the basins and filed a Part A Permit Application under EPA/Ecology Identification Number WA 7890008967. This filing initiated the "interim status" closure process. A 183-H Solar Evaporation Basins Interim-Closure/Post-Closure Plan was prepared and submitted to Ecology. The final closure plan and permit application are currently being prepared. In addition to preparing these documents, cleanout of the basins was initiated in 1985. Cleanup involves several major activities including: sampling and analysis, liquid and solid waste removal, packaging and shipping, decontamination, demolition and landfill cover installation. During the operational life, approximately 2,500,000 gal of wastes were discharged into the 183-H basins. When cleanup was initiated in 1985, there were approximately 500,000 gal of liquid waste and 220,000 gal of solid waste remaining in the basins.

The waste was sampled and analyzed and designated as radioactive mixed waste. The main constituents include:

- Low-level waste - uranium
- Extremely hazardous waste - sodium fluoride and chromium
- Dangerous waste - nitrates
- Listed waste - formic acid, cyanides and vanadium pentoxide.

The major physical work completed to date includes:

- Removal of approximately 162,000 ft3 of solid waste
- Installation of Hypalon liner in Basins Nos. 2 and 3 (to contain liquids)
- Decontamination (sandblasting) of the concrete walls in Basins Nos. 1 and 4.
- Solidification and removal of over 1500 drums of liquid waste
- Sampling of Basins Nos. 1 and 4.

The main project activity in 1989 was the solidification of the liquid waste. The liquid was solidified using an agent known as LPC-II*. The solidification process involved pumping the liquid into a specially made batch mixer, adding the LPC-II and packaging the waste in approved 55-gal drum containers. See Fig. 6 for an outline of the process.

The most significant tasks remaining include completing the removal of the solid crystallized waste, decontamination of Basins Nos. 2 and 3, basin demolition, and installation of the landfill cover. The landfill cover will be an engineered barrier that will enhance the moisture storage and lateral draining while minimizing water infiltration, erosion, differential settling and sedimentation, and long-term maintenance. A cross section of the cover is shown in Fig. 7. In addition, there will be ongoing groundwater monitoring required for a minimum of 30 yr from the date of closure (5).

SUMMARY

A *significant amount* of decommissioning work has been completed at Hanford over the past 14 yr and there are currently some major projects underway, i.e., 183-H Solar Evaporation Basin Project, Strontium Semiworks, etc.

The number one priority will continue to be the safe and cost-effective maintenance and surveillance of these surplus facilities until such time as they can be decommissioned. The actual decommissioning work has been organized over the years to include major tasks such as planning, engineering waste removal or decontamination, NEPA and other regulatory compliance, and facility demolition. This work is currently projected to continue at the Hanford Site for over 30 yr. The estimate is based on the inventory of surplus facilities and the expected level of resources.

REFERENCES

1. B. A. Napier, G. F. Piepel, W. E. Kennedy, Jr., and R. G. Schreckhise, "A Manual for Applying the Allowable Residual Contamination Level Method for Decommissioning Facilities on the Hanford Site," PNL-6348, Pacific Northwest Laboratory, Richland, Washington (1988).
2. National Environmental Policy Act of 1969, as amended, Public Law 91-190, 83 Stat. 852, 42 USC 4321, et seq.
3. DOE, 1989, "Draft Environmental Impact Statement Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington," DOE/EIS-0119D, U.S. Department of Energy, Washington, D.C.
4. W. F. Heine and D. R. Speer, Westinghouse Hanford Company, "Decontamination and Decommissioning of a Fuel Reprocessing Pilot Plant, CONF-881008, Richland, Washington (1988).
5. E. W. Powers and G. W. Jackson, Westinghouse Hanford Company, "RCRA Closure Experience With Radioactive Mixed Waste 183H Solar Evaporation Basins at the Hanford Site," WHC-SA-0705-S, Richland, Washington (1990).

* Sorbond LPC-II is a trademark of American Colloid Company.

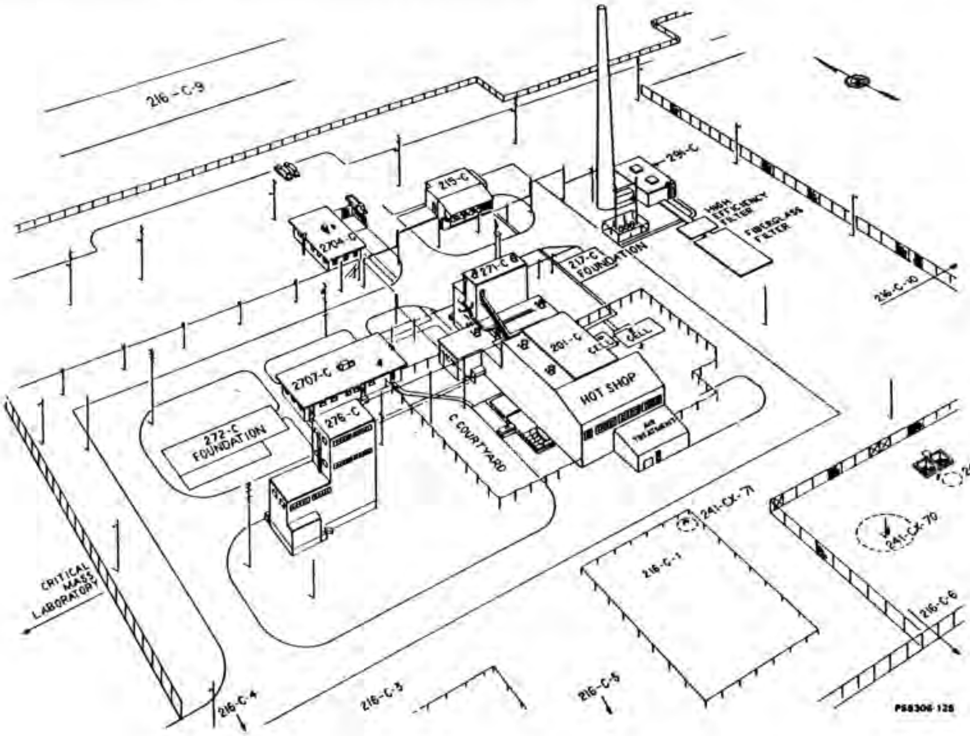

Fig. 5. Strontium Semiworks Complex.

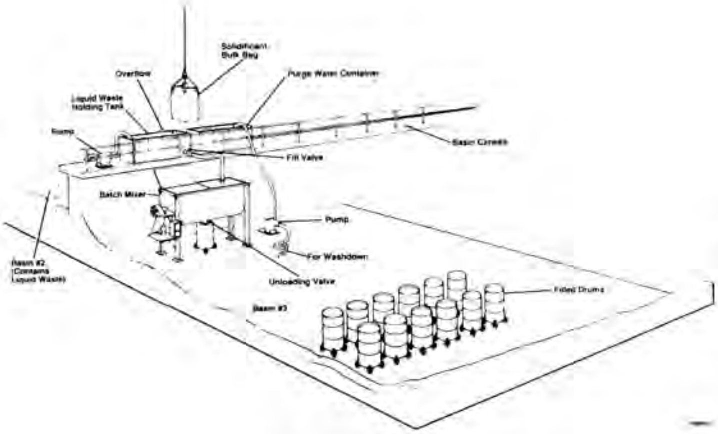

Fig. 6. Liquid Solidification.

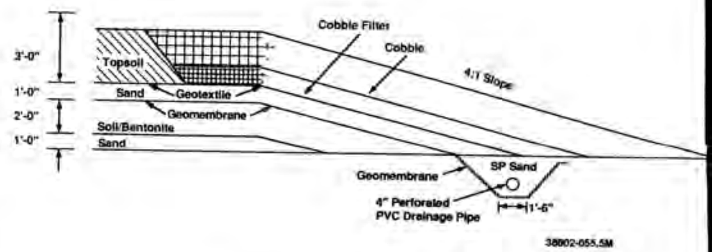

Fig. 7. Cross Section of Cover.