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HAZARDS REVIEW
PHASE I FISSION PRODUCT PROCESSING IN B-PLANT

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HAZARDS REVIEW
PHASE I FISSION PRODUCT PROCESSING IN B-PLANT

I. INTRODUCTION

Future operation of B-Plant for Phase I fission product processing involves many of the hazards associated with current Chemical Processing Department activities in both the Purex and Redox Plants.

Revisions to B-Plant and supporting facilities for Phase I processing are defined in Reference 1. The overall Phase I process entails: 1) the recovery of a strontium-90-rare-earth-cerium fraction from 1WW solution at the Purex Plant; 2) transfer of this solution to the 221-B Building via the 244-CR Vault; 3) various precipitation-centrifugation steps in 221-B Building; 4) concentration and storage of fission product concentrates; 5) transfer of B-Plant wastes to the 241-B Tank Farm Complex; and 6) release of process off-gas through filtration systems to the atmosphere. The overall Phase I process is essentially the process in use today for interim strontium-90 operations at Purex and the 244-CR Vault.

The Reference 1 revisions to B-Plant comprise reactivation of 8 of the 40 cells; improved ventilation for these cells; modification of the Hot Pipe Trench for Sections 3 through 8 inclusive; new shielded deck-level sampling equipment; a new vessel vent system; reactivation and construction of direct buried lines for solution transfer; provision of an SWP Lobby, locker room, maintenance shop, and building telephone system; and miscellaneous reactivation items.

The specific B-Plant hazards under Phase I operations are discussed below from the standpoint of comparable Purex and Redox hazards.

II. RADIOLOGICAL HAZARDS

A. Normal Activity Levels

Solutions handled in B-Plant and the 244-CR Vault will range in activity level from Purex 1WW to a factor of 10 higher than 1WW. The 9-foot thick cell walls and 6-foot thick cell covers (compared to 6-feet and 3-feet at Purex, respectively) are adequate to protect operating personnel from gamma radiation.

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1. HW-69011, "Project CGC-897 - Title I Design - Fission Product Storage in B-Plant," by HL Caudill and LL Zahn, dated April 3, 1961.

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B. Criticality

No criticality hazard will exist since B-Plant feed stocks will contain only traces of plutonium, as represented by normal Purex processing losses.

C. Radioiodine

The major portion of radioiodine in metal feed to Purex is released in the dissolver and vessel vent systems. Gross iodine evolution has not been noted to date from Purex vessels which handle LWV and fission product concentrates. Likewise, iodine evolution has not been noted to date from storage vessels in the 244-CR Vault. Radioiodine release is not considered a problem in Phase I.

D. Containment of Particulate Material

B-Plant has an existing sand filter for removal of particulate activity from cell ventilation exhaust air. A new vessel vent system will be provided to vent all process gas through a heater and fibrous glass filter prior to discharge to the ventilation tunnel and sand filter. Thus, two stages of off-gas filtration will be provided for process gases, as in Purex and Redox.

The function of all access doors into the 221-B Canyon should be reviewed. All doors needed for routine entry, emergency exit, etc, should be converted into air-locks by provision of secondary doors. All other entries should be sealed off.

E. Hydrogen Evolution

Aqueous solutions containing fission product concentrates generate hydrogen gas. Sampling of gas above the solutions in B-Plant and CR-Vault tanks will be necessary to establish purge air requirements to maintain the atmosphere below the lower explosive limit.

III. OPERATING HAZARDS

A. Ventilation

The present canyon ventilation equipment will handle about 30,000 cfm. After new openings are constructed into the air tunnel for Cells 5 through 12, inclusive, most of the 30,000 cfm can be directed into a single cell during maintenance periods with the cell covers removed. This will provide a face velocity of about 120 feet per minute if all the cover blocks are removed from the specific cell. The concentrator in Cell 5 should be cooled prior to opening Cell 5 cover blocks to prevent thermal currents. The 120 feet per minute velocity during cell maintenance should be adequate for Phase I to maintain activity below deck level.

A new emergency steam turbine exhaust system is provided with 35,000 cfm capacity at 12-inches of water static pressure, for assured ventilation on failure of electrical power supply.

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B. Sampling

New portable shielded Gilmont sampling equipment and pH probes are provided for deck-level sampling of the high activity streams under controlled SWP conditions. The success of sampling (and all B-Plant operations) is contingent on the maintenance of low activity levels on the deck for direct personnel access. The ventilation changes discussed above are aimed at keeping the canyon deck free of particulate activity.

C. Chemicals

Chemicals used currently in Chemical Processing Department operations, sodium hydroxide, nitric acid, sodium carbonate, hydrogen peroxide, etc, will be employed in Phase I processing. These chemicals must be handled in accordance with established safety procedures. Special attention should be given to the detailed design and operation of the hydrogen peroxide handling system to avoid pressure buildup through peroxide decomposition.

Purex solvent will be effectively removed from B-Plant feed stocks by centrifugation operations at Purex. No organic solvents are added at B-Plant in Phase I. Thus, no solvent fire hazard is anticipated in Phase I B-Plant operations.

D. Cooling Water Failure

Failure of cooling water supply could result in boiling of concentrates in B-Plant storage vessels. However, failure of cooling water supply is considered unlikely since the sanitary water system presently parallels the raw water system and can be tied in during emergency. To guard against simultaneous failure of both the raw water and sanitary water supply lines, a new emergency well is to be drilled near B-Plant and a pump driven by a combustion engine installed. Pump discharge from the well is tied into the raw water header. Special bibs and isolating valves must be provided in the operating gallery for the attachment of fire hose sections from the pump in the event of failure of major cooling water headers within the 221-B Building.

IV. SPECIAL HAZARDS

A. Waste Tank Farm

During initial Phase I operations when the strontium-90 and rare-earths concentrates are processed in B-Plant, the cerium-144 wastes will be discharged to the 241-B Waste Tank Farm complex. Since the tanks within this complex are not designed for boiling operation, wastes must be distributed into these tanks in a judicious manner to prevent solution boiling. This will require jumper changes as often as once a week at the tank farm diversion boxes or provision of special valve manifold jumpers in the diversion boxes for distribution of high heat producing process wastes. In former B-Farm operations, activity escaped from tank risers when solution temperature exceeded about 1700 F. Experience must be obtained, through addition of small increments of waste to tanks during operations to ascertain ultimate heat dissipation characteristics of B-Farm tanks.

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Positive operating procedures must be developed to guard against over-filling of a tank from a heat-inventory standpoint. The inadvertent over-filling would probably result in gross contamination of the tank farm area.

B. 244-CR Vault

In Phase I operations, the 244-CR Vault will serve as an intermediate pumping station between Purex and B-Plant, and possibly also between B-Plant and Hot Semiworks. The 244-CR Vault will be operated under essentially the same conditions as at present under the Interim Strontium-90 Program and accordingly no new operating or radiological hazards are introduced through inauguration of Phase I operations at B-Plant. It is pointed out, however, that operation of the vault ventilation system to date has been marginal with respect to decontamination of particulate material from vault off-gas. During a recent 2-month test, particulate activity in vault stack gas varied between limits of one and 70×10^{-10} $\mu\text{c}/\text{cc}$ compared to MPC values for continued exposure of 1×10^{-9} $\mu\text{c}/\text{cc}$. Accordingly, it may be necessary in the future to provide additional gas filtration facilities.

C. Underground Lines

Solution transfers between Purex, B-Plant, B-Tank Farm, and the CR Vault will be made largely through use of existing underground lines. Large sections of these lines are direct-buried. These lines have several shortcomings, as follows:

1. The 4000-foot direct-buried cross-country line between the 241-C-151 and 241-B-154 Diversion Boxes is 16 years old and had been buried for about two years before cathodic protection was applied. There are essentially no expansion joints in this line. Although this line successfully withstood a 200 psig pressure test recently, the long-range integrity of the line in fission product transfers cannot be guaranteed.
2. The line and jumper system between the 241-A-152 Box at the Purex Tank Farm and the 244-CR Vault has several badly trapped sections. This line, which is shown on SK-2-18646 of Reference 1, serves not only for routing fission product concentrates between Purex and the CR Vault, but also as the only spare Purex coating-waste line from Purex to C-Farm.
3. Preliminary tests indicate leakage of the line from Nozzle 11 Cell 5-J to Diversion Box 154; this line is intended for routing B-Plant wastes to the B-Tank Farm. If further tests confirm the presence of a leak, a new routing must be selected or the leak repaired.

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The following precautions are considered necessary for operation of underground lines:

1. All lines intended for transfers must be pressure tight and should be pressure tested at routine intervals during operation.
2. Strict solution inventory control should be maintained on transfers between the CR-Vault, B-Plant, and B-Tank Farm to detect possible line leakage.
3. Where lines are trapped, jet transfers should be "chased" through the lines with steam and air purges to aid in the removal of materials which could cause plugging.
4. Routine surveillance should be made of the ground above the lines.

Leakage from a direct-buried line, if undetected, could cause serious trouble either through contamination of ground water or through percolation of liquid to the surface with resulting creation of air-borne activity. A leak of about 50,000 gallons would be required before activity would reach ground water; a leak of this magnitude is considered unlikely if strict inventory control is invoked on solution transfers. However, a leak of only about 200 gallons would probably result in activity seeping up to the surface of the ground. Since a 200 gallon discrepancy might not be detected by solution inventory control, considerable reliance must be placed on routine surveillance of the area over the buried lines. Should radiostrontium percolate to the surface, it would be necessary to employ emergency measures to cover the area with a layer of dirt, or other protective barrier.

Direct buried lines are subjected to compressive stresses with increasing line temperature, since backfilled soil around the lines largely restrains pipe movement. For example, a 50° F rise in temperature for Type 347 stainless steel pipe will subject the pipe to a compressive stress of about 14,000 pounds per square inch, which is roughly about 42 per cent of the yield strength and 16 per cent of the ultimate strength. Several failures of direct buried lines have already occurred adjacent to B and T-Plants. Failure was postulated to have occurred as a result of stresses induced from direct steam injection into the line following jet transfer. While a rise in temperature of only 50° F would have little effect on new high integrity buried pipe, the same temperature rise could be harmful to older pipe if corrosion has made much headway.

Plugging of the afore-mentioned trapped line at the CR Vault could happen inadvertently. The trapped section itself could contain about 500 gallons of solution. If the line were to plug prior

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to the start of a transfer from the Purex Plant, conceivably, solution could back up in the line towards Purex. Emergency maintenance procedures to restore flow through the line could be quite hazardous. For example, connectors might have to be removed at the low points in the system to permit drainage or the line might have to be pressurized to free the obstruction. If solution were to back up into the encased sections of the line, boiling could occur at the flowsheet concentration of 240 BTU/hour/gallon.

The use of old direct-buried lines for transfer of high activity level solutions is considered an interim measure only. Fully encased lines of high integrity as defined in Reference 2, should be provided as soon as construction funds can be obtained.

V. SUMMARY

In summary, B-Plant hazards are similar in many respects to present Purex and Redox hazards. During operation, primary concern should be directed to the safe control of fission heat decay both in B-Plant equipment and the B-Tank Farm. Maintenance of a clean canyon deck is necessary to permit personnel access for Phase I sampling and for future construction activities both for fission product recovery and waste processing. Finally, routine procedures should be developed for surveillance of buried lines for early detection of possible line failure.

VI. REFERENCES

1. HW-69011, "Project CGC-897 - Title I Design - Fission Product Storage in B-Plant," by HL Caudill and LL Zahn, dated April 3, 1961.
2. HW-67666, "Engineering Study - Strontium-90 and Rare-Earth Processing in B-Plant," by HL Caudill, JR LaRiviere, and LR Michels, dated January 17, 1961.

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