SAFETY ANALYSIS REPORT
WASTE ENCAPSULATION AND STORAGE FACILITIES
(Project HAP-631)

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December 1, 1971

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Artists' Concept of Waste Encapsulation and Storage Facilities

SAFETY ANALYSIS REVIEW
WASTE ENCAPSULATION AND STORAGE FACILITIES

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SAFETY ANALYSIS REPORT
Waste Encapsulation and Storage Facilities

I. INTRODUCTION AND SUMMARY

A. Introduction

A primary Waste Management goal for "high-level" radioactive liquid waste resulting from the processing of nuclear fuels is the long-term isolation of hazardous radioisotopes from the biosphere. The program includes the removal of the long-lived radionuclides, strontium-90 and cesium-137 from liquid radioactive wastes. Fractionization, concentration and bulk storage are currently being done in B Plant. The Waste Encapsulation and Storage Facilities (WESF), as defined by Project HAP-631, represents another step toward achieving the Waste Management goal. The project will provide capability for:

- . Purification of strontium and cesium, and their conversion to a stable solid form.
- . Encapsulation of the solidified material.
- . Storage of the strontium and cesium capsules.

Title I and II design work for the Waste Encapsulation and Storage Facilities has been essentially completed by the on-site Architect Engineer, Hanford Engineering Services. As of July 20, the analysis cut-off date, construction by J. A. Jones, a CPFF contractor, was approximately 20 percent complete. Title III inspection services are being furnished by the Architect Engineer. Construction management is by the AEC-RL with Atlantic Richfield Hanford Company (ARHCO) providing technical guidance and performing selected fabrication work.

A Safety Analysis was conducted by a task force established to evaluate the new facilities (1). Title I and Title II design were reviewed to identify the chemical, industrial and radiation hazards and to evaluate the integrity of the confinement barriers. This report presents their findings and analysis. This evaluation will be supplemented by a Hazards Evaluation that will be completed prior to operation of the facilities.

B. Summary

The Safety Analysis of the Waste Encapsulation and Storage Facilities reveals no credible incident which would create a significant hazard for workers or the general public. Practical safety controls have been included in the design and planned operation of the facilities which meet or exceed the operational safety standards of AEC Manual Chapter 0550. The facilities, equipment and personnel are subject to the hazards normally associated with the chemical processing and mechanical handling of radionuclides.

Postulated incidents that were examined (Chapter IX) include:

- . Fire
- . Hydrogen Explosion
- . Vessel Coil Failure
- . Loss of Cooling Water
- . Loss of Electrical Power
- . Encapsulation Problems
- . Capsule Failure
- . Process Solution Back-Flow

The most significant releases of radionuclides to the atmosphere postulated as maximum credible accidents (MCA) result from a gross powder spill of strontium fluoride or the pressurization of the cesium chloride equipment wherein 1.2 curies of strontium-90 or 14.4 curies of cesium-137 could be released to the atmosphere via the stack. (See Chapter VII).

Releases from all postulated incidents are well within the prescribed limits of the AEC Manual Chapter 0524. The Safety Analysis Review team evaluated the engineering safeguards designed into each system and concluded the probabilities of such release occurrences were very low; further, should an accident occur comparable to any of the postulated incidents, the resulting effects would not create a significant hazard for the workers involved nor the general public.

The Waste Encapsulation and Storage Facilities are designed to maintain required containment and allow for a safe orderly shutdown following a Design Basis Earthquake (DBE) of 0.25 g maximum horizontal ground acceleration. An Operational Basis Earthquake (OBE) producing a 0.12 g maximum horizontal ground acceleration would permit continued safe, normal operation of the facility. Appendix F - Natural Phenomenon, includes a discussion on earthquake analysis.

An independent state-of-the-art dynamic analyses of the facilities, piping and equipment were performed by a recognized earthquake engineering consultant. Recommendations have been incorporated into the design.

The wind loadings specified in Hanford Standard Design Criteria SDC-4.1 are less severe than the dynamic earthquake forces used for the design of the facility structures. Thus, the structures will exceed the wind resistance requirements of SDC-4.1. Wind loading is also discussed in Appendix F.

REFERENCE

- (1) Letter, 9-17-70, H.P. Shaw to R.A. Zinsli, et al, "Hazards Evaluation - Project HAP-631, Waste Encapsulation and Storage Facilities"

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II SITE DESCRIPTION

A General

In 1943, the United States Government obtained land in south central Washington State for siting nuclear plant facilities (Hanford Reservation). Near the center of the reservation on an upland plateau 20 miles from the nearest city, Richland, and 10 miles from the nearest inhabited agricultural area, a site was selected for construction of a radiochemical separations complex, known locally as the 200 Areas. Since the inception of the Hanford Operations a great deal of investigation and analysis of the environment at the site has been performed. Some of the specific disciplines included in this program are geology, hydrology, meteorology, analytical chemistry, and process engineering. Much of the knowledge gained regarding the Hanford environment has been documented. The information presented in this site description will be a summary of recorded data pertinent to the 200 Areas (general site of the proposed Waste Encapsulation and Storage Facilities).

1 Geography

The location of the 200 Areas in the central part of the Hanford Reservation is shown in Figure II-1. Also shown in Figure II-1 is the relationship of the 200 Areas to the surrounding communities and agricultural areas. State Highway 240 across the Hanford Project now permits public access within five miles of the USAEC nuclear facilities. The Hanford site has no residential population, and the maximum weekday work force is approximately 6,000 persons. The daily work force in the 200 Areas is about 1,500 persons. The surrounding area is sparsely populated, with several small cities within 30 miles of the 200 Areas. Should this population double in the next 20-25 years, as anticipated the population density still would be described as sparse. The 200 Areas are serviced by highways, telephone and power transmission lines, water supply lines, railroads and environmental monitoring and sampling stations.

2. Meteorology

Atmospheric and weather conditions for the Hanford region have been recorded since 1912. The Hanford Project is served by a modern meteorological station which includes a 400 foot high tower that is located approximately three miles west of the WESF site. Mountain ranges on all sides of the Hanford region form a protective barrier which results in a mild, very dry climate with moderate winters and warm summers. Prolonged extremes of temperature in summer or winter are unusual. The average rainfall in the 200 Areas is approximately six inches per year. The Hanford region frequently experiences strong atmospheric inversions at night, which

FIGURE II-1. Regional Map - waste Encapsulation and Storage Facility Site

FIGURE II-2. B-Plant Facilities

break during the day to provide unstable atmospheric conditions. Prevailing winds from the northwest average seven to eight miles per hour.⁽²⁾ Occasional strong drainage winds and cross winds, primarily from the southwest, cause distorted air flow patterns in the Hanford region. The probability of occurrence of stable conditions is about the same for all wind speeds. Thorough studies of meteorological data⁽³⁾ (wind directions, wind speeds, precipitation rates, dispersion parameters, etc.) show no unusual meteorological conditions would be expected at this site that might escalate the consequences of an accidental radioactive release.

3. Geology

Compact and locally well consolidated sediments of the Plio-Pleistocene Ringold Formation overlie the basalt bedrock beneath the 200 Areas. The sediments of the Ringold Formation are in turn overlain by generally compact, uncemented sands and gravels of the late Pleistocene and Holocene glacial outwash and fluvial deposits. The load-bearing capacity of these water deposited sediments (upon which all Hanford facilities are founded) generally exceeded the capability of the measuring equipment. Load capacity has been measured and recorded as "in excess of 6.5 tons/ft.²". After more than 25 years of plant operation there is no evidence to indicate the massive concrete and steel structures constructed at Hanford have settled appreciably. Other evidence substantiating the stability of the rocks underlying the 200 Areas is that obtained by geophysical methods. Data show elastic wave velocities through basalt bedrock attain between 15,000 and 20,000 feet per second. Velocities approaching 10,000 feet per second have been measured in the Ringold Formation and velocities between 2,000 and 5,000 feet per second have been recorded in the essentially dry glaciofluvial sediments situated above the water table. The velocities in the glaciofluvial sediments indicate a significant degree of compaction from that normally expected in alluvium.

4. Hydrology

The path of groundwater flow beneath the Hanford Reservation is from the highlands on the west to the Columbia River on the north and east. Most of the ground water flowing under the reservation flows through highly permeable glaciofluvial sands and gravels, although there are a number of areas where the groundwater flows through low permeability silts of the Ringold Formation in the west and central portions of the reservation and near the Columbia River. The discharge of large quantities of process cooling water to ground within the 200 Areas has created groundwater mounds and has modified the pre-Hanford regional water table. Water from these mounds

flow radially outward, and hence, down the hydraulic gradient toward the Columbia River. The water table ranges between 140 to 340 feet below the ground surface in the vicinity of the 200 Areas. Knowledge of the geology and hydrology beneath the Hanford Reservation is being used to develop a digital computer model which can simulate the groundwater flow system beneath Hanford. This model will simulate the water table that would result from postulated stresses on the groundwater system and will predict the new flow paths and travel times that should result. The soil moisture in the vadose zone averages less than three percent by weight. Data recently obtained in the field indicates water movement in the vadose zone is probably limited to upward vapor transport.

5. Seismology

Hanford is considered to be in a region of moderate seismicity, verging on minor seismicity. Of the three principal rock strata underlying the Hanford Reservation, viz, basalt, Ringold Formation, and glaciofluvial deposits, the one most susceptible to earthquake ground motion excitation are the glaciofluvial sediments. However, geophysical data indicate that no adverse seismic effects are anticipated in the glaciofluvial deposits at Hanford.⁽⁴⁾ Earthquakes occurring in California have shown no amplification of ground motion on firm alluvium having similar spectral characteristic as the glaciofluvial sediments.

The Hanford Reservation has not been subjected to more than weak ground shaking during historical times which corroborates the assumption that Hanford is in a region of moderate, verging on minor, seismicity. Hanford shows less response to distant shocks (hundreds to thousands of miles) of destructive magnitude than do surrounding areas. The U. S. Geological Survey recently concluded in their report⁽⁵⁾ on faulting in the Hanford region that surface displacements on the reservation occurred more than 12,000 years ago and probably more than 100,000 years ago.

In 1969 the U. S. Geological Survey National Center for Earthquake Research placed an array of highly sensitive geophones at strategic locations in the Hanford area. The geophone network covers a rectangular 50 mile radius; has been in continuous operation since March 23, 1969, and is designed to detect the epicenter and focal depth of all micro-earthquakes above a magnitude of 1.0 within the boundary of the array. Monitoring and identification of earthquake-induced ground motion within the area are continuing.

B. Proposed Plant Location

The location of the Waste Encapsulation and Storage Facilities in the 200 Areas is shown in Figure II-1 (Area) and Figure II-2 (close-up). The WESF will adjoin B Plant (221-B), the fission product separations facility. B Plant is part of the waste management facilities which includes in-tank solidification (ITS), underground waste storage tanks, a facility for the removal and handling of stored sludge from boiling waste tanks (244-AR Vault), a storage vault (244-CR) for dissolved sludge, cribs, swamps, and associated support facilities.

The function of the various facilities in the B Plant complex is as follows:

<u>Facility</u>	<u>Function</u>
211-B Chemical Tank Farm	Bulk storage area for liquid chemicals used for processing.
212-B Load-Out Facility	Cask station for waste handling.
216-B-12 Process Condensate Crib	Covered trench for the disposal of condensates from process concentrators.
216-B-55 Steam Condensate Crib	Covered trench for disposal of condensates from heating coils in process tanks.
217-B Water Demineralizer	Demineralized process water supply.
221-B Waste Fractionization Plant	Canyon facility for processing of waste to isolate selected fission products.
222-B Office Building	Administrative offices for support personnel (Finance, Property Accounting).
224-B Recovery Facility	Building used for J.A. Jones Construction field offices.
225-B Waste Encapsulation and Storage Facilities	Encapsulation of cesium and strontium and storage of the product forms.
271-B/272-B Service Building	Appendage to 221-B containing shops, offices and aqueous makeup facilities for waste processing.

<u>Facility</u>	<u>Function</u>
276-B Organic Makeup and Storage	Storage and makeup facility for organic solvent.
282-B Water Wells	Emergency raw water supply.
291-B Fans, Stack & Filters	Ventilation for Building 221-B.
292-B Instrument Building	Stack monitoring station.
2902-B Water Tank	Emergency water supply.

REFERENCES

1. Bixler, R. B., et al., "Hazards Evaluation - Waste Fractionization - B Plant", ARH-139, November 15, 1967.
2. Corley, J. P., "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1969", BNW-1505, November 1970.
3. Jenne, D. E. and Kerns, R. E., "A Climatological Study of the Hanford Area", HW-57722, November 1959.
4. Housner, G. W., "Recommended Seismic Design Criteria for the Hanford Nuclear Facility - Revised Oct. 1967", DUN-3130.
5. Bingham, J. W., et al., "Geologic Investigation of Faulting in the Hanford Region, Washington - USGS Open File Report, 1970".

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III FACILITY DESCRIPTION

A. General

The 225-B facility is designed to operate 24 hours per day and is dependent upon 221-B Building for feed streams and process waste disposal. Cells 38, 39, and 40 of the 221-B Canyon building are used for concentration and bulk storage as part of the encapsulation process.

B Architectural

1 General

The facility is described in the following drawings

HW-2-66401, First Floor Plan, Area 1 (Page E-20)
HW-2-66402, First Floor Plan, Area 2 (Page E-21)
HW-2-66403, Second Floor Plan, Area 3 (Page E-22)
HW-2-66404, Second Floor Plan, (Page E-23)
HW-2-66405, Elevation and Sections (Page E-23A)

The facility consists of four functional areas:

a) Process Area

Six process cells and canyon (including crane-maintenance area).

b) Cell Service Area

Operating gallery, service gallery, aqueous makeup and chemical storage, truck port, regulated and cold manipulator shop, and mock-up cell.

c) Service Area

Offices, lunchroom, change room, and the heating and air-conditioning (HVAC) room.

d) Capsule Storage Area

Storage pools and surveillance pool.

These areas have a combined area of approximately 20,000 sq ft including 14,000 sq. ft. on the first floor and 6,000 sq. ft. on the second floor.

2. Process Area and Process Service Area

The process area structure will be made of reinforced concrete to satisfy the biological shielding and low air infiltration requirements.

The exterior walls of the process cells and the interior walls of personnel-entry Cells A and G will be constructed of 35-inch thick high density concrete (235 lb/cu.ft.). The interior walls of the remaining cells will be constructed of ordinary concrete (150 lb/cu. ft.). For shielding purposes, concrete will be supplemented by other shielding materials where application is beneficial.

a. Process Cells

All cells will be lined to provide: corrosion resistance, ease of decontamination, and proper background for optimum cell viewing. The liner material selected for the Cells D-E is Inconel 600; AISI 304L stainless steel for Cells A, B, C, and F. Cell G will be lined with a corrosion-resistant protective coating.

Cell A - Waste Cell, 10' x 8' x 13'6"

This cell shall be equipped with a shielded personnel-entry door and an equipment pass-through, both accessible from the Service Gallery side. That portion of Cell A adjacent to Cell B includes a hooded enclosure for receiving waste from Cell B.

Cell B - Strontium, 8' x 8' x 12'10"

Cell C - Strontium, 8' x 8' x 12'10"

Cell D-E - Cesium, 8' x 18' x 12'10"

Cell F - Capsule Decontamination, 8' x 8' x 11'

Cell F is connected to the Service Gallery by means of a pass-through.

Cell G - Final Encapsulation, 8' x 16' x 13'6"

This cell will be equipped with a shielded personnel-entry door and an equipment pass-through, both accessible from the Service Gallery side. The floor of Cell G will have a transfer device allowing direct transfer of capsules to the Storage Basin.

Cells B through F will be equipped with two manipulators and one viewing window. Cell A will have four manipulators and two viewing windows, and Cell G will have four manipulators and two viewing windows. All cells will be equipped with intercell transfer devices and

spare service plugs. Removable cover blocks of high density concrete shall provide access from the Canyon. Provisions will be made to prevent drainage to the cells from canyon washdown during normal operations.

b. Operating Gallery

The Operating Gallery will be approximately 22' x 83' from which the cell process work will be controlled. Cell instrumentation panels will be located adjacent to the cell manipulator operating area. In the event of manipulator failure or breakdown, the manipulator may be repaired here or removed through the Operating Gallery to the Manipulator Repair Shop. Windows are provided for direct viewing of the cell at the Operating Gallery level. The Operating Gallery will be accessible to the offices, Change Room, Cold Manipulator Repair Shop, Capsule Storage Area, and HVAC Room. Access to second floor from the Operating Gallery is via the stairwells.

c. Service Gallery

The Service Gallery will be approximately 10' x 83' and is used to service the cells from the rear side. Access to the cells will be by transfer drawers (Cells A, F, and G) and personnel-entry doors (Cells A and G). Both personnel-entry doors are located in air locks off the Service Gallery. Access from the Service Gallery to the Regulated Manipulator Repair Shop, Canyon, Truck Port, and Change Room will be provided by air locks. The mass spectrometers will be located in the Service Gallery.

d. Aqueous Makeup (AMU)

The AMU area is located on the second floor and is accessible from the Operating Gallery by stairs and from the HVAC Room by elevator. Access will also be from the Operating Gallery of 221-B by stairs. Entry to the Canyon is provided through an air lock. Direct viewing into the Canyon is provided through viewing windows. Two Transmitter Rooms, housing instrumentation equipment connected directly to the cells, will be located in the AMU area. These rooms will provide containment protection should contamination of the immediate area occur due to a cell vessel blowback through the piping.

The equipment test facility and cell mockup facility will be provided in the AMU area. All services

normally provided for the operation of cell process equipment will be available.

e. Canyon

The Canyon will be approximately 15' x 85' and has access to the following areas by means of removable cover blocks: Process Cells, Capsule Storage Area, and Truck Port. A 15-ton capacity remotely operated crane will be capable of travelling the entire length of the Canyon. A decontamination and maintenance area will also be provided at the east end of the Canyon. The building structure is designed for future crane replacement with a 25-ton capacity crane. Access to the Canyon will be from the AMU area and the Service Gallery via air locks.

3. Capsule Storage Area

This area provides storage space for the capsules. It includes eleven water basins, ten of which are 4'5" wide x 21'9" long x 15'0" deep, and one (the surveillance basin) is 8'9" x 21'9" x 15'0". A narrow transfer aisle connects the capsule transfer device with each of the storage basins. All basins will be fully lined with Type 304L stainless steel.

The basin water will be cooled by a circulating water system, and treated by a common demineralizer system. The heat exchangers, pumps, and demineralizer system equipment will be located in the Capsule Storage Area. A 10-ton capacity bridge hoist will be provided for cask and cover block handling and equipment maintenance. A viewing window and plug-in type remote controls will be provided for emergency crane operation. The building structure is designed for a possible future crane replacement with a 15-ton capability hoist. Thirty-inch thick concrete (150 lb/cu.ft.) cover blocks will be installed over each basin.

4. Service Areas

a. Offices, Lunchroom, and Change Room

The offices consist of one two-man office, 9' x 14' and a four-man office, 12'9" x 14'. The Lunchroom will be 14'6" x 10'6", provide seating for 16 people, and be equipped with a range, sink, and refrigerator. Three drinking-water coolers will be installed in these general areas.

The Change Room, 28' x 29' will include a rest room and two showers. A personnel decontamination area will

be provided adjacent to the Change Room. The Change Room will be capable of handling the operating personnel of four shifts. Benches, personnel lockers, and clean-clothes storage shelves will be provided. A clean-clothes and dirty-clothes storage room with exterior entrances for easy supply and removal of clothes will be provided. Access will be provided from the Change Room to the Operating Gallery via a hallway off the Cold Manipulator Repair Shop, and to the Canyon Service Gallery, and Regulated-Manipulator Repair Shop via a corridor. A janitor's closet with mop sink and shelving for storage will be located adjacent to the Change Room.

b. HVAC Room

The HVAC Room will be approximately 30 x 53 and will contain the ventilation-supply equipment for all portions of the facility except the Capsule Storage Area. Capsule Storage Area air supply equipment is located on the roof above the Storage Basins. An equipment door will be provided on the north side for maintenance and for access to the elevator.

c. Manipulator Repair Shops

The Manipulator Repair Shops will be divided into two sections, a cold side for repairs to non-contaminated manipulators, and a regulated side for repairing contaminated manipulators. The rooms will be approximately 15 x 25 and 15 x 20, respectively. The Regulated Manipulator Shop will contain provisions for decontaminating, repairing and storing "hot" manipulators.

d. Truck Port

The Truck Port, located on the west side of the facility will be approximately 12 x 37 long with a five-foot wide walkway on one side. A personnel door and a motor-operated truck door will provide access to the outside. The Truck Port will also be accessible to the Service Gallery via an airlock. An opening will be provided in the Canyon deck above the Truck Port for removal of the Waste Cask and failed-equipment burial boxes. This opening, normally closed by cover blocks, will be large enough to permit passage of cell cover blocks.

5. Interior Construction and Finish

a. Floors

The following floor areas will be covered with vinyl tile: Entrance and corridor, offices, lunchroom, and

operating gallery. Floors for the locker room, HVAC room, and the cell mock-up area will be finished concrete. All other floor areas will be coated with a special protective coating (SPC). The type of SPC will be determined by the usage and decontamination requirements for each area.

b. Walls

The new facility will be of concrete construction except for the cell mock-up area and the service area which includes the HVAC room, lunchroom, offices, entrance lobby and corridor, and the change room. Concrete walls will be painted in the AMU Area. All other concrete walls will be finished with SPC. The service area walls will be painted gypsum wallboard (walls and partitions), except that walls for the personnel decontamination room, the personnel monitoring area, and the protective clothing storage rooms will be finished with SPC.

c. Ceilings

The ceilings of the entrance lobby, corridor, offices, and lunchroom will be covered with suspended acoustical tile. The remainder of the service area, the Capsule Storage Area, and the AMU Area shall have a metal deck ceiling. The Canyon and Gallery ceilings will be of concrete.

6. Viewing Windows

a. Cell Windows

Work in progress in the cells will be viewed from the Operating Gallery through shielding windows located in the front wall of the cells. The windows provide radiation shielding equivalent to the concrete front wall of the cell. Ten inches of 3.3 density glass (cell side) and 15.6 inches of 6.2 density glass will be provided for a total of 130 density inches. Since these glasses are soft and easily scratched they will be protected by cerium stabilized non-browning cover glass. The glass viewing windows will be removable from the Operating Gallery side of the cell.

b. AMU Area

The canyon crane will be remotely operated from the AMU Area or from the Operating Gallery. Four viewing

stations will be provided. The viewing windows will provide the equivalent shielding of the adjacent 30-inch ordinary concrete wall. These will be dry type lead glass shielding windows.

7. Personnel-Entry Shielding Doors

Personnel-entry shielding doors for Cells A and G are power-operated doors approximately 35 inches thick using high density concrete as the shielding material. Doorways will be designed to prevent liquid and air leakage from the cell to the air lock. Doors will be interlocked for access control.

8. Seismic Criteria

The building structure is designed to withstand a Design Basis Earthquake (DBE) which will produce a maximum horizontal ground acceleration of 0.25 g. Building stresses under these conditions will be held to 90 percent of the yield strength for steel and 85 percent of the minimum specified compressive strength for concrete at 28 days. For normal operating conditions, a 0.125 g Operating Basis Earthquake (OBE) is superimposed on other design loads. Normal Building Code design stresses will not be exceeded under these conditions. Building and piping stresses were determined using latest acceptable analytical methods.

9. Wind Criteria

The facility is designed for a wind load of 20 pounds per square foot wind pressure in accordance with the Uniform Building Code 1970. The Hanford Standards also reflect this same criteria.

10. Design Codes and Standards

The facility is designed in accordance with the following codes and standards

- a. Building Code for Reinforced Concrete (ACE 318-63)
- b. Specifications for the Design of Structural Steel (AISC Manual)
- c. Hanford Standards Design Criteria. HWS-10,000 and HES-10,008
- d. The Uniform Building Code, 1970
- e. American Standards Building Code for Masonry
- f. Underwriters Laboratories, Inc. - Standards
- g. National Fire Protection Association - Standards

C Materials Handling

1. General

The operation of the new facility will involve the handling of capsules, process samples, supplies, and waste within the cells, between the cells, from Cell G to the Capsule Storage Area and from this facility to other operating areas away from B Plant. The procedures for handling the radioactive materials will consider the thermal energy given off by the encapsulated cesium and strontium. The yearly production and unit heat from both cesium and strontium are:

Cesium - 500 capsules per year @ 1000 Btu/hr/capsule,
and

Strontium - 200 capsules per year @ 3500 Btu/hr/capsule.

2. Cranes and Hoists

a. Canyon Crane

This crane will be 15 ton capacity, bridge type, radio controlled.

Crane decontamination and maintenance will be performed at a crane-maintenance platform located at the east end of the Canyon.

b. TV Camera Installation - Canyon Crane

A television system will be installed to assist in the operation of the crane.

Three closed circuit television cameras will be provided for monitoring crane operations in the Canyon. All cameras will be remotely operated, mounted on a bracket capable of 180 degree vertical and horizontal swing, and will be equipped with zoom lens and automatic light compensation.

One of the cameras will be portable. The other cameras will be installed under the crane bridge. Signals will be transmitted from these two cameras to the stationary side of the power track installed to cover the entire travel of the crane. Portable monitoring stations will be provided for television viewing.

c. Capsule Storage Area Crane

This crane will be a 10-ton capacity bridge type, pendant operated unit with capability for emergency operation.

d In-Cell Hoist

The hoist will be 1/4-ton bridge type with electrically powered hoist and travel motors

3 Manipulators and Pass-Throughs

a Mechanical Manipulators

All cells will be equipped with mechanical manipulators similar to the Central Research Laboratory Model E and F, master-slave manipulators

A monorail track will be installed over the centerline of each manipulator in the Operating Gallery. Monorail tracks will extend by means of a switching arrangement for movement of manipulators from the gallery to the manipulator repair shop. Provisions will be made to mount a 1000 pound capacity trolley on any of the monorail tracks for withdrawal of a manipulator from the cell wall.

b Inter Cell Pass Through

A pass through device will be installed between adjoining cells, and will consist of a tray mounted on an extending track which can be moved completely into either cell for loading or unloading. Each end of the pass through will be covered by a door for ventilation control.

The pass throughs between the Cell A hood and Cell B, Cells F and G, will be similar except as modified for a 35-inch wall. All doors on pass-throughs will be interlocked so that only one pass-through can be opened at a time. The combined shielding on the two doors of each pass through will be equivalent to the wall.

c Pass Through for Test Patches

After processing the inner cans through final decontamination in Cell F, a smear test will be made for residual surface activity. Clean and contaminated smear patches will be passed between the cell and the Service Gallery via a shielded pass-through.

The tray will be capable of extending its full length into the cell and the Service Gallery. A minimum of three inches clearance will be provided above the

tray. The combined thickness of the two doors will provide shielding equivalent to the wall. The doors will be interlocked to prevent both doors from being opened at the same time.

General References

- V/HES-R-94, August 1970, Vitro/Hanford Engineering Services, "Waste Encapsulation and Storage Facilities - Title I".
- ARH-1264 (Unclassified), September 15, 1969, J. R. LaRiviere, D. C. Nelson, et al, "Facilities Design Description - Waste Encapsulation and Storage Facilities".

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IV. PROCESS DESCRIPTION

Conversion and encapsulation of cesium and strontium will require four independent processing operations. Within the cells of the 225-B facility, two parallel equipment systems will be operated -- one to convert aqueous cesium carbonate feed solution to an encapsulated cesium chloride compound, and the other to convert aqueous strontium nitrate feed solution to the form of an encapsulated fluoride compound. In addition, both the cesium carbonate and strontium nitrate feed streams will require prior processing through separate purification-concentration flowsheets, using equipment located in the 221-B canyon facility.

The chemical flowsheets and processing sequence for these four operations are briefly described below. For further flowsheet details and stream compositions, the reader should refer to the reference⁽¹⁾ on page IV-11.

A. Strontium Contaminant Removal

Strontium nitrate concentrate from the 221-B Plant first solvent extraction process is stored in tanks in B Plant cells. These stored solutions contain magnesium (Mg) and other ions in quantities about equal to or greater than the strontium, and if not removed, would present compatibility and processing problems in the encapsulation operations and would more than double the final volume. To reduce the number of capsules needed for encapsulating the strontium and to minimize the compatibility and processing problems, a flowsheet to remove these contaminants will be employed.

The process for strontium contaminant removal will feature the precipitation of the strontium sulfate compound using centrifuges for separation.

The processing operations will be conducted in B Canyon cells using existing tanks and centrifuge equipment. Process steps are as follows:

1. Crude strontium nitrate feed will be transferred to a centrifuge feed tank where sodium sulfate solution is added to effect the precipitation of the strontium sulfate compound. The pH will be adjusted to 0.9 ± 0.2 by addition of sodium carbonate or nitric acid.
2. After digestion at 60 C, the SrSO_4 slurry is processed through an existing centrifuge and the cake washed with additional sodium sulfate solution. Sulfate waste solution is collected, sampled, and transferred to interim storage.

3. Solids are transferred from the centrifuge to a second tank where they are digested with metathesis solution (1.65M NaOH - 0.6M Na₂CO₃) to convert strontium to a carbonate compound.
4. Washing, decanting, and centrifuging steps are employed to separate the strontium carbonate from the metathesis solutions.
5. The product solution is formed by dissolving the carbonate solids in a nitric acid solution.
6. After sampling to confirm purity from calcium-magnesium contaminants, the strontium solution is transferred to a storage tank in Cell 39 to await transfer to the 225-B facility for encapsulation processing.

B. Strontium Conversion, Encapsulation and Storage

Compound Selection

A number of strontium compounds have been considered as potential candidates for encapsulation⁽²⁾, and among them the oxide, fluoride, and titanate have all received extensive development toward their use as isotopic heat sources.

For Hanford waste management requirements, strontium fluoride was selected as the most suitable compound for encapsulation on the basis of:

1. The fluoride is comparatively easy to prepare and can be precipitated from an aqueous solution.
2. The method of preparation is fairly well developed and a minimum of process development time and money was required for plant design.
3. The high strontium density (2.94 g Sr/cm³) and the high melting point (1400 C) reduce the number of packages required.
4. Thermal conductivity is average and there are no phase transitions which would present an expansion problem.
5. The fluoride is very stable and radiolytic decomposition is not a problem.
6. The fluoride is not hygroscopic so the encapsulation need not be performed in a dry or inert atmosphere.

Conversion

The process used to convert the strontium nitrate to strontium fluoride and the subsequent steps up to and including encapsulation are shown on a simplified process flow diagram, Figure IV-1. The flowsheet is based on the encapsulation of 30 megacuries of ^{90}Sr isotope per year. Approximately 200 batches of strontium nitrate solution containing 150 kilocuries of ^{90}Sr per batch will be processed annually in Cells B, C, F, and G of the new facility.

Conversion operations will begin in Cell B of the 225-B facility. A feed batch (≈ 20 gallons) of concentrated strontium nitrate will be transferred from the Strontium Feed Tank, TK-39-5, by air jet to the Metering Tank, TK-B-1, in Cell B from which it will be routed by gravity to the 40 gallon Precipitator Tank, TK-B-5. There, 20 percent sodium hydroxide solution will be added to adjust the pH to approximately seven. Next, an amount of powdered sodium fluoride is added to precipitate strontium fluoride by the reaction.

which is carried out at 80 C

After completion of the reaction, the slurry of SrF_2 precipitate will be vacuum transferred through the dip legs in the precipitator and through a set of four parallel filters in series with a backup filter. The filtrate is collected in a 50 gallon hold tank, TK-B-2 which is discharged to the Strontium Waste Tank, TK-39-4, in Cell 39. Prior to transferring the filtrate to Cell 39, a sample of the solution will be obtained and analyzed for ^{90}Sr to determine the completeness of the precipitation reaction and filtering operation. Filtrate with significant strontium content will be returned to the Precipitator Tank for rework.

Next, the filtered strontium fluoride will be washed with demineralized water and then allowed to self-dry by pulling air through the cake. The filter cartridges containing the strontium fluoride will then be removed from the filter housings with the manipulators and the strontium fluoride emptied out of the cartridges into furnace boats. The boats will be placed in the furnace and heated to approximately 1100°C for sintering. It is anticipated that the furnace cycle will be 16 hours: eight hours for sintering and eight hours for heating and cooling. The sintered strontium fluoride will be removed from the furnace into Cell C where it will be placed in a powder hopper and dumped into the Compactor, C-C-4 for compaction in the inner container.

The strontium fluoride processing cells will be serviced by a steam jet to provide vent and vacuum, as needed. The process off-gases are to be mixed with the motive steam from the jet and routed to a condenser, with the condensate routed to the strontium waste header.

figure IV-1

SIMPLIFIED STRONTIUM FLUORIDE CAPSULATION PROCESS FLOW DIAGRAM

STRONTIUM
FEED
TRANSFER
TANK

TK-39-5

CAPSULE
CALORIMETRY
AND
WEIGHT CHECK

FINAL STRONTIUM CAPSULE
SPECIFICATIONS
TOTAL WT 5.0 KG
SF₂ WT 5.1 KG
SF₂ GO 1.05 KG
H₂O 102 KVA/H

TRANSFER
TO
STORAGE
BASIN

STRONTIUM
WASTE
COLLECTION
TANK

TK-39-4

VEI
COND

CELL 39
221-B CANYON

CELLS F & G
225-B BLDG

APPROVED FOR CONSTRUCTION BY		U. S. ATOMIC ENERGY COMMISSION	
WITH DES OR CHG BY		RICHLAND OPERATIONS OFFICE	
BY		Atlantic Richfield Hanford Company	
FOR		Richland, Washington 99352	
APPRO		FLOW DIAGRAM	
CHECKED		STRONTIUM FLUORIDE	
DATE		CAPSULATION	
SCALE		PROCESS	
DRAWN BY		SPE. SKETCH	
DATE		1112	
VISIONS		BLOS NO 225-B	
CHECK PREP'S E NO		PROCESS NO NONE	
TATLS		DATE	

which flows to Cell 39 in B Plant. The noncondensable vapors are to be passed through a de-entrainment section and heated prior to filtering through a HEPA filter. The filter discharge will be routed to the cell ventilation exhaust duct.

Encapsulation

The Hastelloy C-276 waste containers and end caps, both inner and outer, will be carefully prepared and tested prior to delivery to the hot cells to assure that the containers furnished for encapsulation will be of the highest quality. The containers and the end caps will be degreased, weighed, and sealed in plastic bags before being moved into the cell. The tentative dimensions of the inner containers are 2.25 inches outside diameter by 19.0 inches long with a wall thickness of 120 mils.

The strontium fluoride will be added to the containers in increments and compacted after each addition to pack the entire batch of strontium fluoride, up to 150,000 curies, into a single container. After the container has been filled and the end cap installed, it will then be placed in a tungsten inert gas (TIG) automatic welder and the end cap welded.

Following welding, each capsule will be leak-tested in the Helium Leak Detector, TK-C-3. A mass spectrometer is used to detect leakage of helium; the helium is sealed in the capsule during welding. Capsules that leak will be opened and the strontium reprocessed. The leak-free capsule will then be given a rough decontamination in the Ultrasonic Decontamination Tank, TK-C-1, after which the capsule will be passed through Cell D-E to Cell F via the inter-cell pass-throughs. In Cell F a series of two ultrasonic decontamination tanks will be used to perform the final decontamination operations.

Test smears will be taken from the capsule and passed out of the cell to determine the level of contamination. Upon satisfactory completion of the decontamination step, the capsule will be passed into Cell G for final encapsulation.

The tentative dimensions of the outer container are 2.625 inches outside diameter by 20.1 inches long with a wall thickness of 120 mils. In Cell G the inner capsule will be placed inside the outer container, positioned in the automatic TIG welder, and the end cap welded to complete the double encapsulation. The weld will be examined, using an ultrasonic weld tester, and the total heat output of the capsule will be determined using a capsule calorimeter. This final calorimeter step is a process control aid, and the data obtained can be used for material balance measurement. As an additional quality control check, the capsule weight will be determined.

Storage

The complete capsules will be transferred to the storage basin by the mechanical transfer device or temporarily be stored in the Shielded Storage Tank, TK-G7. Operators will use long-handled tools to transfer the capsules to designated locations in the basin.

The Storage Basin consists of 11 individual sections, intended to provide isolation in the event a capsule should leak. One of the sections is to be used for continuous surveillance of approximately 10 percent of the capsules. Surveillance of the effects of temperature and pressure, as well as ultrasonic testing, is envisioned.

Basin water will be circulated through individual heat exchangers to maintain an outlet temperature of 125° F, and periodically through a filter and demineralizer.

The circulated basin water will also be continuously monitored for radioactivity. The water monitoring system will be equipped with an audible alarm. Should radioactivity be detected, the contaminated water would be jetted to Cell 39 for routing to either waste or rework as appropriate. The contaminated basin would be decontaminated prior to being returned to service.

C. Cesium Contaminant Removal and Concentration

Cesium concentrates from the cesium ion exchange recovery process are stored in the 221-B Plant. These concentrates have a sodium/cesium mole ratio ranging from 5/1 to 10/1, and a potassium/cesium mole ratio ranging from 2.5/1 to 5/1. To reduce the number of capsules for final storage and to minimize the processing problems in the encapsulation operations, treatment of the cesium concentrate will be required to remove the bulk of the sodium and potassium ions. This will be done in new equipment in Cell 38, using ion exchange and concentration facilities.

The feed for the cesium treatment step is to be jetted from one of the storage vessels to Feed Tank, TK-38-1, where the solution can be adjusted with caustic to keep the pH within the range of 4-10. A controlled flow of cesium solution will then be pumped downward through an ion exchange bed of "Zeolon"* zeolite. A gamma monitor on the discharge line from the ion exchange column will detect cesium breakthrough. The waste solution from the ion exchange process is to be discharged to TK-38-2 where it is sampled and routed to either TK-17-2 for recovery of residual cesium, or to TK-39-1 for waste disposal.

After loading, the ion exchange bed will be washed with demineralized water to remove residual feed solution. The water wash

*A synthetic zeolite manufactured by the Norton Company

is followed by a dilute ammonium carbonate-ammonium hydroxide solution wash which removes the bulk of the sodium and potassium ions from the zeolite bed. The cesium loaded zeolite bed will then be eluted by up-flow with a more concentrated ammonium carbonate-ammonium hydroxide solution to remove the cesium. A gamma monitor on the discharge line from the ion exchange column will indicate the completeness of the cesium removal from the resin. The zeolite bed will be washed with demineralized water to remove residual eluant solution prior to beginning another loading cycle.

The eluant containing the cesium flows continuously to the Stripper-Concentrator, E-38-6, where steam stripping will remove the ammonia and carbon dioxide from the liquid. The stripped liquid will then fall to the thermosyphon concentrator and be concentrated, while the overhead vapors from the concentrator and stripper pass through a de-entrainer to a Downdraft Condenser, E-38-7. The overheads, containing ammonia, carbon dioxide and water vapor, are to be condensed in the downdraft condenser, reforming an ammonium carbonate-ammonium hydroxide eluant solution which may be reused or treated to recover residual cesium.

The concentrator bottoms will be cooled after reaching the desired cesium concentration and transferred by jet to a hold tank (TK-38-8) for sampling before going to the feed storage tank for use as feed in the encapsulation process.

D Cesium, Conversion, Encapsulation and Storage

Compound Selection

Following an evaluation of various cesium compounds⁽²⁾, cesium chloride was selected as the optimum compound for encapsulation and long-term storage. Compared to other compounds, the chloride appears to be the logical choice for the following reasons:

- (1) The process technology is well developed.
- (2) The compound exhibits a relatively high cesium density (3.13 g Cs/Cm³).
- (3) Compatibility of the chloride with various encapsulating materials has been demonstrated.
- (4) Radiolytic decomposition is negligible for the anhydrous compound.

Conversion

The processes for converting the cesium carbonate to the chloride and subsequent evaporation, melting and encapsulation steps are shown on Figure IV-2. The cesium process flowsheet is based on

the encapsulation of 30 megacuries of ^{137}Cs isotope per year. Approximately 60 batches of cesium chloride solution containing 480 kilocuries per batch will be processed annually. The cesium processing is accomplished in Cells D-E, F and G of the 225-B Building facility.

Twelve gallons of concentrated cesium carbonate solution, stored in tank TK-39-3 in the 221-B Building, will be transferred by air jet to the Feed Metering Tank, TK-D-1, located in Cell D. The solution contained in the Feed Metering Tank will be added by gravity flow to the 20 gallon Converter Tank, TK-D-2, where cesium carbonate will be converted to cesium chloride by the addition of 12M hydrochloric acid (HCl). The total reaction time per batch should be about one hour at approximately 90°C . The off-gas that is evolved during the conversion reaction will be vented through scrubbers in the off-gas treatment system for chloride removal.

The cesium chloride solution (14.4 gallons) will be transferred from the Converter Tank by vacuum to the 20-gallon Evaporator-Melter, E-E-1, and heated to boiling. Additional heat beyond the isotopic heat will be added to the solution with electric resistance heaters to maintain a rapid boil-off rate. Evaporation of the water will continue until the slurry approaches dryness, indicated by a rapid increase in temperature inside the melter. The water vapors and the HCl vapors that are formed during the evaporation of the cesium chloride solution are to be vacuum transferred to Condenser E-D-4 located in Cell D. The water vapors and most of the HCl vapors will be condensed; the remaining noncondensables, mostly dilution air, will be discharged to the HCl Scrubbers, T-D-5 and T D-7, where they will be contacted with a caustic scrub solution and passed through a de-entrainer, heater, and a HEPA filter before being discharged directly to the cell exhaust header. The condensate from Condenser, E-D-4, is to be neutralized before being drained to the Cesium Waste Tank, TK-39-2, located in the 221-B Building.

The cesium chloride remaining in the melter after evaporation will contain 480 kilocuries of ^{137}Cs and weigh approximately 43 pounds. The salt cake will be completely dried by holding at a temperature of 400°C . After the drying step, the temperature of the cake will be slowly raised to its melting point, (approximately 645°C), and the heating continued until the liquid melt reaches a temperature of 675°C . During the high temperature drying and melting operations (150°C - 675°C), the atmosphere inside the melter will be purged with argon gas to reduce the corrosion of the melter. During the two hour melting operation, some molten cesium chloride will be volatilized and purged from the melter by the argon gas. The melter vent line is equipped with a de-entrainer for collecting the volatilized cesium chloride. The de-entrainer and vent line are flushed with water, which is drained back to the melter for evaporation with the next batch.

CELL 39
221-B CANYON

CELLS F & G
225-B BLDG

APPROVED FOR CONFORMANCE BY DATE		U. S. S. ATOMIC ENERGY COMMISSION	
WITH SEE ON OTHER A		RICHLAND OPERATIONS OFFICE	
BY		Atlantic Richfield Hanford Company	
FOR		Richland, Washington 99352	
APPRO		FLOW DIAGRAM	
APPRO		CESIUM CHLORIDE	
CHECKED		ENCAPSULATION	
DRAFTS APPRO		PROCESS	
CHECKED		DRAWN S. HOLLEY	
SCALE NONE		SCALE NONE	
DESCRIPTION		REV NO	
EVIDENCE		LAST REV	
DATE		DATE	
CHECK PREPARE NO		CHECK NO	
STATUS		SPE SKETCH	
		2/2	

Encapsulation and Storage

The molten cesium chloride will be cast in cylindrical, type 316L stainless steel, primary containers. Tentative dimensions of the containers are 19.7 inches long, 2.25 inches outside diameter, and 95 mils wall thickness. The containers and end caps will be degreased, weighed, and sealed in plastic bags before being passed into the cell. Nine containers will be loaded into the Melt Casting Assembly, E-E-3, which will then be placed in the closed position, sealed, and the casting assembly and melt transfer lines heated with electrical resistance heaters to prevent solidification of the melt during transfer.

The melt will be vacuum transferred into the first container, which overflows into the second container. The overflows continue in series until the melter is empty. Any partially filled container will be placed in the first position for the next transfer operation. A single transfer will make about eight castings per batch of cesium chloride melt, each containing 60 kilocuries of ^{137}Cs . The volatile cesium chloride drawn through the vacuum system during melt transfer will condense in a vacuum surge tank and its de-entrainer. These two equipment pieces will then be flushed with water which drains to the Cesium Converter Tank, TK-D-2.

After the castings are cooled, the primary containers can be removed from the casting assembly and caps placed on the containers. The capsules will be sealed by welding the caps to the containers using tungsten inert gas (TIG) welding. A mixture of argon and helium inert gases is to be purged into the capsule during welding.

Each capsule will be leak-tested by placing the sealed capsule in a water-cooled vacuum chamber. After sealing the chamber, the atmosphere will be purged with argon gas and a vacuum drawn. A sample will be taken of the chamber atmosphere, filtered, and passed through a helium mass spectrometer. If helium is detected, the capsule will be opened and the cesium reprocessed. The sealed primary capsules will be decontaminated by ultrasonic cleaning. The remaining steps of final decontamination of primary capsules in Cell F, the final encapsulation, weighing, weld testing, and calorimetry in Cell G, and storage of the waste capsules in the storage basin, will be similar to those previously described for strontium (page IV-5). Tentative dimensions of the type 316L stainless steel outer containers are 20.8 inches long, 2.625 inches outside diameter, and 109 mils wall thickness.

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1. ARH-1264, September 15, 1969, J. R. LaRiviere, et al., "Facilities Design Description - Waste Encapsulation and Storage Facilities".
2. BNWL-CC 1965, June 26, 1968, T. S. Soine and H. T. Fullam, "An Evaluation of Strontium and Cesium Compounds for Waste Packaging .

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V. EQUIPMENT DESCRIPTION

A. Process Equipment - 225-B Building Process Cells

1. General

All piping will be designed in accordance with the current Hanford Standards and Design Guides. Permanent piping in the hot pipe trench or imbedded in concrete will be Type 304L stainless steel meeting the requirements of the 8000 series Hanford Standards, except permanent piping will be Inconel 625 for strontium fluoride and cesium chloride waste services and Hastelloy B for hydrochloric acid service.

Pipe sizes in the manipulator-operated cells will be as small as practicable, but in no case larger than 3/4 inch in diameter. Where larger sizes are required, consideration will be given to parallel lines of smaller size.

Cooling coils will be installed in all vessels where kilocurie quantities of radioactive materials will be handled. All materials specified for use inside the cells will be selected to withstand the radiation effects of the materials to be processed. Materials specified for permanent installation will be resistant to 10^8 Roentgens.

2 Cell A - Waste Handling

Cell A will be utilized to collect and package the bulk of the contaminated solid waste from all cells.

a Waste Load-Out Hood

The Waste Load-Out Hood will be fabricated of stainless steel. Required ventilation controls will be provided to maintain proper pressure differentials for contamination control.

b Plastic Sealer and Divider

The Plastic Sealer and Divider will be used to weld and cut the plastic drum liner upon completion of the waste container loading operation. This equipment will perform sealing and dividing operations which are similar to the present bag-out techniques used in the 200 Areas at Hanford, but the equipment will be operated remotely. A prototype is presently being tested.

c Waste Drum Transfer Dolly and Lift

The Waste Drum Transfer Dolly and Lift will be used to position the drum beneath the Load-Out Hood before loading the drum. It will also lower the drum from the Load-Out Hood and move it to the center of the cell after loading.

This lateral movement of the Dolly will be accomplished by cable and winch, controlled from the Operating Gallery. The Waste Drum Transfer Dolly and Lift will be remotely controlled from the Operating Gallery.

3. Cell B - Strontium Processing

All Cell B tanks will be fabricated of Type 304L stainless steel.

a. Feed Metering Tank, TK-B-1

The Strontium Feed Metering Tank will be a 25-gallon vessel equipped with cooling coils to remove isotopic heat (5,000 Btu/hr). It will have a common vent and overflow line, returning by gravity to the Strontium Feed Tank TK-39-5 in Cell 39, 221-B Building.

b. Precipitator, TK-B-5

The 40-gallon Precipitator will be equipped with an air jet for recirculating solution within the cell, through a pH cell and sampler, and back to the Precipitator. Agitation will be provided by an air sparger. Two dip legs will be provided for flexibility for solution draw-off. Two coils will be provided: one for cooling (25,000 Btu/hr) and one for heating (10,000 Btu/hr). These are separate units as the condensate from the heating coil will be routed to the low-level waste header while the cooling coil discharge will be routed to the high-risk cooling water header.

c. Strontium Fluoride Filters, F-B-6-1, 2, 3, 4, 5

Each of the four parallel Strontium Fluoride Filters (plus F-B-6-5 installed in series as the backup) will consist of a stainless steel filter element (5 μ pore size). The backup filter will be used as a primary filter on the next feed batch. The filters will be connected to the Supernate Holding Tank and the Precipitator with permanent transfer piping.

d. Supernate Holding Tank, TK-B-2

The Supernate Holding Tank will be 50-gallon capacity with a cooling coil (9,000 Btu/hr); the tank will be designed for an operating pressure of 20 inches Hg vacuum. Agitation will be provided by air sparging. The tank can be emptied by jet to either the Precipitator, TK-B-5 for rework, or to the strontium waste header which will be routed to TK-39-4 in Cell 39, 221-B Building. Capability for sampling the solutions in this tank will be provided.

e. Vacuum-Vent System, E-B-10, D-B-11, E-B-4, F-B-9

The vacuum equipment will consist of a steam-jet ejector, a Condenser, E-B-10 (60,000 Btu/hr), a De-Entrainer, D-B-11, a Heater, E-B-4, a single high-efficiency (HEPA) filter, F-B-9, (99.97% efficient for 0.3 micron or larger particles), and an air-jet ejector. The system will be sized for a capacity of 2 scfm at 20 inches Hg vacuum. The system will discharge to the cell exhaust duct downstream of the in-cell filters. When not in vacuum service, the system can be used for a vessel-vent. The system requirements in vessel-vent service are 4 scfm at 18 inches water vacuum at the Precipitator, referenced to the cell, with the air jet operating.

f. Furnace, E-B-8

Furnace E-B-8 will be installed in the wall between Cells B and C with one set of doors opening into each cell. The furnace boat will be placed into the furnace from the Cell B side and withdrawn from the Cell C side after sintering. An argon inert atmosphere purge will be used within the furnace. The furnace will consist of two units, each independent of the other and each capable of holding four full boats of powder (one feed batch). Each furnace unit is rated at 60 KW. The material of construction for the furnace boats is Inconel 600.

The furnace cycle will consist of elevating the temperature from 400°C to 1100°C, holding this temperature for eight hours and then reducing the temperature to 400°C. The complete cycle will take approximately 16 hours.

Furnace wall cooling (20,000 Btu/hr) will be provided. Protection of the concrete wall around the furnace will be provided in the furnace design.

Maintenance can be performed on the furnace units by pulling the assembly into one of the cells. Controls and readout units will be located in the Operating Gallery.

4. Cell C - Strontium Processing

a. Powder Tamper, C-C-4

The Powder Tamper will consist of an air-powered tamper, a capsule holder, a tamper head, and a removable hopper with feed valve. A small dust-collection system will be provided. The unit will

exhaust air to the Canyon after passing through an oil separator. An air-operated lift will raise the tamper head out of the capsule prior to recharging. Feed will be placed in the capsule in small increments and compacted to a uniform density of about 80 percent of theoretical. Care will be required to keep the capsule top clean for welding. The material of construction for the capsule (inner and outer) is Hastelloy C-276.

b. Welder, W-C-2, and Plug Welder, W-C-7

The welders will consist of a gas tungsten arc welding head, a clamping device to hold the capsule in place, and a DC drive motor. The capsule will be positioned vertically for welding of the cap to the body. A plug welder will be required to complete the sealing of the capsule by welding the gas vent hole in the end cap.

Development work on the welders is proceeding at the present time. The weld area will require mechanical cleaning prior to welding. Console equipment for welder operation will be located in the Operating Gallery.

c. Helium Leak Tester, TK-C-3

A mass spectrometer using helium as a tracer gas will be used to detect leaks in the strontium capsules after the first encapsulation seal. The unit will be capable of detecting a minimum leak rate of 1×10^{-6} standard cc/sec of helium.

The welded capsules will be placed in a water-cooled vacuum chamber. After sealing the chamber, a vacuum will be drawn and a sample of the chamber atmosphere will be filtered in the cell and passed through the mass spectrometer in the Service Gallery for analysis. The discharged air from the unit will be returned to the cell.

d. Ultrasonic Cleaner, TK-C-1

The Ultrasonic Cleaner will consist of a tank with inlet, overflow and bottom drain, transducers, and a temperature element. The Ultrasonic Generator will be located in the Service Gallery. The Ultrasonic Cleaner will have a cooling coil capacity of 8,000 Btu/hr. It will be of the same design as similar units to be installed in Cells E (one unit) and F (four units). Diluted nitric acid (0.1 M) will be used as the decontamination solution for all ultrasonic cleaners.

e. Shielded Storage, TK-C-5A, TK-C-5B

Shielded storage will be provided for Cell C by TK-C-5A and TK-C-5B, located in the cell floor. The cooling duty and shielding provided will be similar to TK-F-5, described later in Section A.6.b. However, heat removal will be accomplished by a water jacket, chill-block, or plate coil with no cooling water normally in physical contact with the capsules.

5 Cell D - E - Cesium Processing

All equipment in the cell will be fabricated of Type 304L stainless steel, except as noted.

a. Feed Metering Tank, TK-D-1

The Cesium Feed Metering Tank will be a 20-gallon vessel equipped with cooling coils (10,000 Btu/hr) to remove isotopic heat. It will have a common vent and overflow line, returning by gravity to the Cesium Feed Tank TK-39-3 in Cell 39, 221-B Building.

b. Converter Tank, TK-D-2

The Converter Tank will be 20-gallon capacity, equipped with cooling coils (14,000 Btu/hr) for the removal of isotopic heat and heat of reaction, and an air sparger for agitation. A de-entrainment section will be installed in the vent line to prevent carryover of cesium particles to the Condenser E-D-4. The construction material for the tank will be Hastelloy C-276.

An air-motivated sampler jet will be installed to circulate liquid from the tank to a sampler, located in-cell near the tank, and back to the tank. The samples will be used for performing in-cell pH analyses. Capability will also be provided for obtaining liquid samples from the Converter Tank.

c. Condenser, E-D-4

The Condenser will be a water-cooled shell-and-tube type with a design rating of 60,000 Btu/hr. Vapor flow will be tube-side down-draft; 1/2 inch diameter tubes will be used.

d. Vacuum Surge Tank, TK-D-13

The Vacuum Surge Tank for process transfers will be 3 gallon capacity. A de-entrainment section will be installed ahead of the steam jet to prevent carryover of cesium solution to the Condenser E-D-4.

e. HCl Scrubbers, T-D-5 and T-D-7

The HCl Scrubbers will be designed to provide a decontamination factor (dF) of 10 each in scrubbing hydrogen chloride vapors from the vent off-gases. Each will be 4-1/2 inches outside diameter by five feet high with four feet of packed section. In addition, an 18 inch by 18 inch tank with a cooling coil (1,000 Btu/hr) will be located beneath the scrubbers. A recirculating pump, P-D-6, will recirculate the caustic solution from the tank to the top of both columns.

f. Process Vent System, D-D-12, E-D-10, F-D-9

The Cesium Process Vent System will be comprised of an air jet, de-entrainer D-D-12, heater E-D-10, and a filter F-D-9. The exhaust gases will be routed to the cell ventilation exhaust duct. The filter will be a HEPA type designed for 99.97 percent removal of 0.3 micron size particles. The system will be designed to maintain 14 inches water vacuum in the Converter Tank. The jet capacity will be 15 scfm at 30 inches water vacuum.

g. Shielded Storage, TK-D-8

Shielded storage will be provided for Cell D-E by TK-D-8. This tank will be similar to TK-F-5, discussed later in Section A.6 b.

h. Evaporator-Melter, E-E-1

The Evaporator-Melter will be electrically heated (two elements, 1 kw upper and 3 kw lower) to evaporate the cesium chloride solution from the Converter Tank, TK-D-2, to a dry crystalline salt, heating until the salt is melted, and raising the temperature to 700°C. The Evaporator-Melter will be equipped with a packed de-entrainment section to remove the entrained cesium during the evaporation and melting cycle. The material of construction for the Evaporator-Melter will be Type 18-18-2 stainless steel; argon purging will reduce its corrosion rate to acceptable levels by minimizing oxygen

The Evaporator-Melter will be insulated to minimize heat losses to the cell and will be equipped with thermowells and electrical heat-traced transfer piping to the Melt Casting Assembly. If it becomes necessary to hold the melt in the vessel for a period of time, the hinged insulation can be temporarily removed for cooling by radiation and/or convection to the cell air (32,000 Btu/hr maximum)

A prototype has been proven and an in-cell unit is presently under design and fabrication.

i. Melt Casting Assembly, E-E-3

The Melt Casting Assembly will consist of a main frame, capsule carriage, a manipulator-operated jack, and an electrical heater.

In the open position, nine empty capsules will be placed in the carriage with the manipulator. The carriage will be rotated into the closed position and will be raised with the jack to engage the capsules with the seal.

Tubes in the cap of the frame will run to each of the container cavities in turn, with the end of the series connected to the process vacuum source; molten cesium will be drawn from the Evaporator-Melter E-E-1 into the first container. The excess from the first container will flow to the second container, then to the third, etc.

An electrical heater will be installed over the top of the Melt Casting Assembly to keep the tubes and cavities above the melting temperature of cesium chloride during the molten salt transfer.

The cycle will be completed by lowering the carriage, rotating it away from the frame, and replacing the filled containers with empty ones. The last container, which could be partially filled, will be transferred to the first position for filling in the next cycle. A refinement of the prototype with required instrumentation is presently under design. The construction material for the capsule (both inner and outer) is Type 316L stainless steel.

j. Welder, W-E-11, and Plug Welder, W-E-8

These welders are similar to the Welder W-C-2, described earlier for the strontium cell (Section A.4.b). The cesium capsule has the same diameter as the strontium capsule but different wall thickness and length. A tube cleaner is also required.

k. Helium Leak Tester, TK-E-12

The cesium capsules will be leak-tested in equipment which will be similar to the Helium Leak Tester, TK-C-3, to be used for strontium capsules and described earlier in Section A.4.c., with a smaller cooling coil.

1. Ultrasonic Cleaner, TK-E-10

The Ultrasonic Cleaner will be similar to the equipment described earlier in Section A.4.d for use in decontaminating strontium capsules, TK-C-1, with a smaller cooling coil (4,000 Btu/hr).

6. Cell F - Final Decontamination

This cell will provide facilities for the final decontamination of both cesium and strontium capsules. Four decontamination tanks and one shielded storage container will be provided.

a. Ultrasonic Cleaners, TK-F-1, 2, 3, and 4

These tanks will be similar to the Ultrasonic Cleaner described with the strontium equipment, TK-C-1 (Section A-4.d).

b. Shielded Storage Tank, TK-F-5

This tank will be placed in the floor of the cell and will provide storage for one batch of either cesium or strontium. Cooling will be provided for 15,000 Btu/hr. The cover will be hinged and will be opened with the assist of the in-cell hoist. Two inches of lead shielding will be provided in the cover. Capsules will be placed in a water bath inside of the Shielded Storage Tank. Water will be added, as required, with the assistance of the manipulator and flexible lines provided. Water will be removed by slurp lines operating in conjunction with the sump jet system. The cooling coils will be placed within the shielding and, therefore, will not come into direct contact with the water bath. Racks will be required to hold the capsules.

7. Cell G - Final Encapsulation

a. Beam Balance

A Beam Balance with a capacity of 10 Kg will be provided in the cell to weigh filled capsules before placing them in the calorimeter.

b. Calorimeter, TK-G-11

The jacket of the Calorimeter will be supplied with constant temperature water at a constant flow rate to provide a controlled heat sink (5,000 Btu/hr). The water will be maintained at constant temperature by a recirculating system and series of two baths.

The inner container, or calorimeter bath, will be provided with an overflow to maintain a fixed volume of de-ionized water.

A basket for holding the capsule and an electric heater element for calibration will be mounted permanently in the inner container. The temperature of the inner container water will be measured by three temperature elements spaced throughout the bath. A magnetic stirrer will be used to agitate the inner bath. Development work is proceeding at the present time.

c. Final Capsule Welder, W-G-1 and Plug Welder, W-G-2

These welders will be similar to the Welder W-C-2, described earlier in the strontium section (Section A.4.b) except that the capsule position will be horizontal.

d. Ultrasonic Weld Tester, TK-G-5

The Ultrasonic Weld Tester will consist of a tank and an ultrasonic testing head that can be moved across the capsule weld. The signal generator and readout will be located in the Operating Gallery. The tester will be designed such that either the cesium and strontium capsules can be tested. The unit will be similar to a weld tester under development at the present time.

e. Ultrasonic Cleaner, TK-G-13

The Ultrasonic Cleaner will be similar to the equipment described earlier for use in decontaminating strontium capsules, TK-C-1 (Section A.4.d).

f. Shielded Storage, TK-G-7

Shielded storage will be provided for Cell G in TK-G-7, similar in design to TK-F-5, described earlier in Section A.6.b, except the tank will set on the cell floor.

g. Capsule Transfer Device

The transfer of completed individual capsules to pool storage from Cell G is accomplished with the Capsule Transfer Device. A manually-operated handwheel in the Operating Gallery will lower the carrier with a contained capsule through a pipe to the bottom of the storage pool transfer aisle.

8. Mechanical Manipulators

All cells will be equipped with booted mechanical manipulators similar to the Central Research Laboratory Model E and F, nonsealed, master-slave manipulators. The manipulators will be capable of an extended reach of approximately 11 feet. Collapsed length will be about five feet, allowing the manipulator to work on the floor in front of the viewing window. For the Model E type, the maximum lifting capacity with the jaws is 20 pounds, and a load hook will be provided to allow lifting capability up to 100 pounds. The Model F type will be used where loads heavier than 20 pounds are to be handled on a routine basis.

A monorail track will be installed over the center line of each manipulator in the Operating Gallery. Provisions will be made to mount a 1000 lb. capacity trolley on any of the monorail tracks for withdrawal of a manipulator from the cell wall and transportation to the repair facility.

Cell G will be equipped with two sets of manipulators; the other cells will be equipped with one set each with the exception of Cell A which will have two sets, one within the waste loadout hood and one in the cell.

All manipulator wall tubes will be capable of receiving either Model E or Model F manipulators as specified in HWS-8954 or HWS-8955.

B. Utility and Service Equipment - 225-B Building

1. Aqueous Makeup

a. General

All piping will be installed in accordance with the current Hanford Standards and Design Guides. Permanent piping imbedded in concrete will be Type 304L stainless steel meeting requirements of the 8000 series Hanford Standards, except permanent piping shall be Hastelloy B for hydrochloric acid service. All cooling coil designs will meet the requirements of document HW-69959.

All penetrations to the cells from the Aqueous Makeup (AMU) Area will be made through the south AMU wall, either directly connected to the cell or through one of the Transmitter Rooms. Services and utilities will be extended from the 221-B Building.

Materials of construction for the AMU piping, tanks, pumps and associated equipment will be selected to be

compatible with the services for which they are installed. However, the utility tanks and associated equipment will be fabricated of ASTM Type 304L stainless steel to provide flexibility.

Chemical addition lines will not be permanently connected between the cold side tanks and the process vessels in the cells. Physical breaks will be utilized in the piping in the cells to prevent "blowbacks" to the cold side. Piping which is connected to the cold side equipment and is open to the cell on the hot side will be equipped with seal pots on the cold side to serve as ventilation barriers. Pipe jumpers and flexible piping, with and without quick disconnects, will be used in the cells for the addition of decontamination solutions or demineralized water to the vessel spray rings or to the open tanks, such as the decontamination tanks.

b. Equipment

AMU Exhauster, P-200

The AMU Exhauster will be rated at 50 scfm. It will vent all of the AMU tanks to atmosphere, except the hydrochloric acid handling tanks, which will be vented to atmosphere by a 3 scfm air-motivated jet.

Utility Tanks and Pumps, TK-201, TK-202; P-201, P-202

Two utility tanks of 600 gallon capacity each and two utility pumps rated at 30 gpm will be provided to supply Utility Headers No. 1 and No. 2. Each tank will be equipped with the following: an opening for dry chemical addition, a liquid level indicator, high and low liquid level alarms, a temperature indicator, an agitator, and a heating coil rated at 100,000 Btu/hr. Demineralized water, 50 percent sodium hydroxide, 57 percent nitric acid, and miscellaneous chemicals will be handled in these tanks.

Caustic Holding Tank, TK-203

The Caustic Holding Tank will be 50 gallons capacity and be equipped with a liquid level indicator, steam coil, and high and low liquid level alarms. The solution handled will be 50 percent sodium hydroxide.

Nitric Acid Holding Tank, TK-204

The Nitric Acid Holding Tank will be 50 gallon capacity and be equipped with a liquid level indicator and high and low liquid level alarms. The solution handled will be 57 percent nitric acid.

HCl Holding Tank, TK-205

The HCl Holding Tank will be 30 gallon capacity and fiberglass reinforced plastic construction. The solution handled will be 37 percent hydrochloric acid.

HCl Transfer Pump, P-205

The HCl Transfer Pump will be rated at three gpm. It will transfer 37 percent HCl from the shipping carboys to TK-205.

HCl Tank, TK-206

The HCl Tank will be five gallon capacity, calibrated in increments of approximately 0.1 gallon, and fiberglass reinforced plastic construction. The solution handled will be 37 percent hydrochloric acid.

Dilute Caustic Tank, TK-207

The Dilute Caustic Tank will be 100 gallon capacity and be equipped with a liquid level indicator and high and low liquid level alarms. The solution handled will be 25 percent sodium hydroxide.

Cesium Decontamination Solution Tank, TK-208 and Strontium Decontamination Solution Tank, TK-209

The Cesium and Strontium Decontamination Solution Tanks will be 50 gallon capacity, with an opening for dry chemical addition, equipped with an air sparger for agitation, and a heating-cooling coil. Solutions handled will be miscellaneous chemicals used for decontamination.

Demineralized Water Holding Tank, TK-210, P-210

The Demineralized Water Holding Tank will be 1000 gallon capacity and be equipped with the following: a liquid level indicator, a high and low liquid level alarm and a float-operated inlet control valve. Demineralized water at ambient temperature will be handled in the tank. Pump P-210 will be rated for 70 gpm at 100 foot head.

Caustic Addition Tank, TK-212

The Caustic Addition Tank will be 5 gallon capacity and be equipped with a liquid level sight glass and an air sparger. The solution handled will be 25 percent sodium hydroxide.

HCl Neutralizer Tank, TK-213

The HCl Neutralizer Tank will be 5 gallon capacity and be equipped with a liquid level sight glass. Waste and unused hydrochloric acid will be neutralized with dilute sodium hydroxide in this tank prior to discharge to the chemical sewer.

Argon Supply Station

The Argon Supply Station will be provided with a four-bottle manifold. The location for the station is south of the 225-B Building, adjacent to the Service Gallery. The argon station and piping will be in accordance with Hanford Standards AC-1-40 a, b and M-2-21.

2. Capsule Storage

a. General

All piping will be installed in accordance with the latest Hanford Standards and Design Guides. All process piping will be stainless steel, ASTM A-312 Type 304L, except where noted. All buried piping will be 8000 series stainless steel 304L. The raw water inlet line will be fabricated of carbon steel.

b. Equipment

Heat Exchangers

The Heat Exchangers (total of 11) will each be rated for a duty of 1.1×10^6 Btu/hr for cooling the basin water in each section. Raw water available at a maximum temperature of 70 F will be used as the cooling medium. The flow rates for each process water stream will be 100 gpm. The units will be fabricated of ASTM Type 304L stainless steel. No heat exchanger will be provided for the transfer aisle.

Basin Water Circulating Pumps

The Basin Water Circulating Pumps (total of 12) will be rated for 100 gpm at 100 foot head. The pumps will be vertical centrifugal type, well-mounted. All pumps will have the capability of being powered from the emergency diesel electric generating unit.

Basin Water Demineralizer System

The Basin Water Demineralizer System, sized for 15 gpm, will consist of a 100 micron filter and a mixed bed

demineralizer sized for a flow rate of 20 gpm/ft². Water quality will be maintained at the same level as the fresh demineralized water which will be routinely supplied from the 271-B Building. The system will be capable of operating on about a two-week cycle for each section of the basin. The discharge water line will be monitored with a conductivity meter. The spent resin will be discarded to waste.

3. Instrumentation

a. General

Instrument Engineering Diagrams (IED) have been prepared by detail design. (See Appendix E). They show in schematic form the complete instrumentation system for all process equipment and lines which will be controlled, measured or operated by instruments. Instrumentation drafting symbols and identification are in accordance with the Instrument Society of America Standard ISA85.1.

In general, all instruments will be new. Calibration capability will be provided on all instruments which require calibration. Instruments with direct connections into vessels containing radioactive fluids will be mounted in separate rooms (Transmitter Rooms) for containment purposes.

b. Equipment

Process Cells

Readout instruments monitoring or controlling the processes in the cells will be mounted on instrument panels located in the Operating Gallery, both on the floor and above the viewing windows.

Capsule Storage Area

Readout instruments monitoring or controlling the Capsule Storage Area will be mounted on instrument panels located in the Operating Gallery adjacent to the Surveillance Instrument Room. Panels will be fabricated as per Hanford Standard J-2-1.

Aqueous Makeup Area

The instruments for each tank will be mounted on metal plate type panels and be located near the tank being monitored in a position visible to the operator filling or draining the tank.

Annunciator Panel

An Annunciator Panel (Hanford Standard J-2-1) will be provided to monitor all alarm functions necessary for the safe operation of the facilities, i.e., building radiation, cell heat detection, building fire detection alarms, etc. The annunciators will be the multiple unit, self-contained cabinet type. The Annunciator Panel will be located along the north wall of the Operating Gallery.

Transmitter Racks

All transmitters, pressure switches, purge rotameters, and other secondary instrumentation for the Process Cells and the Capsule Storage Area will be mounted on Transmitter Racks fabricated from metal framing channel. The Transmitter Racks for Process Cells A through G will be located in the Transmitter Rooms, second floor of the building. The Transmitter Racks for the Capsule Storage Area will be located within that area.

Tubing and Cable Routing

Where applicable, multiple tubing bundles and multi-conductor electrical cable will be used for instrumentation signal and control lines and be routed and supported in cable trays or electrical conduit.

Directly buried underground instrumentation tubing and cable will be installed as per Hanford Standard J-3-11 and D-15-75.

Electrical Interlocks

Electric interlocks will be used wherever there is a possibility of damaging an agitator or a process lubricated pump by running it out of solution. Each motor circuit will be electrically interlocked with a low weight factor alarm switch in the process system to automatically shutdown the motor at a predetermined set point. Prior to shutdown, a second alarm switch contact will present a visual and audible alarm to indicate low weight factor.

Electrical interlocks controlled by radiation detectors will be provided for the personnel-entry cell shielding doors to Cells A and G. The doors for the pass-throughs into Cells A and G will be supervisory-controlled from the Operating Gallery by lock and key.

Control Valves

The Control Valves used in this facility, excluding the hot cells, will be the standard diaphragm operated control valves or piston operated ball valves, depending on whether they are on-off or throttling valves, respectively.

Electrical Door Locks

Electrical door locks operated by push buttons from the Operating Gallery will be installed on the two canyon entry doors, and on the man-entry cell shielding doors for Cells A and G. The push button stations will be located on the respective cell panel boards for the cell entry doors, and on a convenient panel board for the canyon doors.

C. Process Equipment - 221-B Building Process Cells

1. General

Process equipment and piping to be installed in the 221-B cells will be designed for remote installation and removal using the existing canyon crane and impact wrench.

Equipment design and layout must conform to the limitations imposed by the existing B Plant Canyon, and accordingly, primary considerations in the process design shall be given to the following:

- a) Maximum utilization of existing equipment.
- b) Radioactive materials to be handled.
- c) Compatibility of materials of construction with solutions to be handled.

The unused nozzles and flanged openings on vessels will be blanked for ventilation seals. Blanks will be designed for remote installation and removal.

The process equipment is referenced to a particular location by an assigned piece number. This number will be used for identification purposes. For example: TK-39-1 denotes tank (TK), Cell 39, Vessel Piece No. 1. Letter nomenclature is as follows:

TK	Tank
T	Tower or Column
E	Heat Transfer Equipment
D	De-entrainment Equipment

F	Filter
P	Pump
A	Agitator
J	Jet

2. Cell 38 - Cesium Processing

- a. Cesium Feed Tank, TK-38-1
Cesium Waste Tank, TK-38-2
Cesium Recycle Tank, TK-38-3

TK-38-1, TK-38-2, and TK-38-3 will be combined into a single remotable assembly. Each tank will be 500 gallon capacity and be equipped with the following: an air sparger, sample lines, standard canyon tank instrumentation, and a cooling coil with the following design duties: TK-38-1 and TK-38-3 at 33,000 Btu/hr and TK-38-2 at 8,000 Btu/hr. The coil in TK-38-1 will also be capable of 32,000 Btu/hr heating duty. TK-38-1 will have a mounting flange for a pump.

- b. Eluant Receiver, TK-38-4

The Eluant Receiver will be 500 gallon capacity and be equipped with the following: a cooling coil with a minimum outside area of 20 ft² for removing 25,000 Btu/hr, an air sparger, a 10 gpm pump, standard canyon tank instrumentation, mounting flanges for a pump and for Condenser E-38-7, and a Radiation Detector RE-38-4-1, to monitor the tank contents.

- c. Ion Exchange Tower, T-38-5

The Ion Exchange Tower will be 12 inches outside diameter by about 14 feet high, contain seven ft³ of zeolite, and be equipped with the following: a cooling jacket with 40 ft² of inside area capable of 13,000 Btu/hr duty, pressure taps at the top and bottom of the tower, and a temperature element for the top of the tower. Piping shall be designed to permit top or bottom feed and elution.

- d. Cesium Concentrator, E-38-6

The Cesium Concentrator will be a thermosyphon type unit containing 140 ft² of heat transfer area and rated at 1×10^6 Btu/hr heating duty. It will be equipped with the following: a cooling jacket (10,500 Btu/hr) for the recirculation loop, a 30-inch high stripping section packed with one-inch Pall rings, a de-entrainment pad and standard canyon concentrator instrumentation.

e. Condenser, E-38-7

The Condenser will be rated at 1×10^6 Btu/hr cooling duty and be mounted on top of the Eluant Receiver, TK-38-4. It will be equipped with one-inch O.D. tubes packed with 5/8 inch, Type 304 stainless steel Pall rings with a heat transfer area of 350 ft², and standard canyon instrumentation. Vapor flow will be downdraft on the tube side.

f. Cesium Product Receiver, E-38-8

The Cesium Product Receiver will have 31 gallon capacity and be equipped with the following: a cooling coil capable of 33,000 Btu/hr duty; a sparger and sample lines; and standard canyon tank instrumentation.

3. Cell 39 - Feed and Waste Storage

a. Low Level Waste Tank, TK-39-1

The Low Level Waste Tank will have 3,700 gallon capacity and be equipped with the following: an agitator; sample lines; a cooling coil, area of 200 ft², capable of 575,000 Btu/hr duty; and standard canyon tank instrumentation.

b. Cesium Waste Tank, TK-39-2

The Cesium Waste Tank will have 1,850 gallon capacity and be equipped with the following: a cooling coil capable of 300,000 Btu/hr duty; an agitator; sample lines; and standard canyon tank instrumentation. Tanks TK-39-2 and TK-39-3 shall be positioned on a common dunnage.

c. Cesium Feed Tank, TK-39-3

The Cesium Feed Tank will have 325 gallon capacity and be equipped with the following: a cooling coil capable of 260,000 Btu/hr cooling duty; an air sparger; sample lines; and standard canyon tank instrumentation.

d. Strontium Waste Tank, TK-39-4
Strontium Feed Tank, TK-39-5

The Strontium Waste Tank, TK-39-4, and the Strontium Feed Tank, TK-39-5, will be fabricated as a single remotable assembly. The Strontium Waste Tank will be sized for 1,500 gallon capacity and the Strontium Feed

Tank for 2,200 gallons. Each will be equipped with the following: a cooling coil; an agitator; sample lines; and standard canyon tank instrumentation. The cooling coil for TK-39-4 will have a design duty of 225,000 Btu/hr; the cooling coil for TK-39-5 will have a design duty of 420,000 Btu/hr.

4. Cell 40 - Process Sampling

Cell 40 of the 221-B Building will be modified to provide a shielded sample cave for obtaining high-activity level samples from the Cell 38 and 39 process vessels: Cesium Ion Exchange and Encapsulation Feed Tanks (TK-38-1 and 39-3, respectively), Cesium Concentrator Product Receiver (TK-38-8), Cesium Recycle Tank (TK-38-3), and Strontium Encapsulation Feed Tank (TK-39-5), with spares as required. The shielded sample cave will be equipped with manipulators, air jets, and capillary tube samplers, utilizing a lead-shielded pig for transport to the Analytical Laboratory. All other 221-B Building process samples will be taken with existing samplers on the canyon deck.

5. Jumpers and Piping - Hot Pipe Trench and Cells

To provide the necessary routings to and from the existing process cells, approximately 26 new jumpers installed in the existing spare piping system in the Hot Pipe Trench will be furnished.

Hot pipe trench lines 141 and 244 are presently stubbed off at the west end of 221-B Building. These two lines will be permanently connected with two-inch Schedule 40, Type 304L stainless steel piping.

Twenty-two new jumpers will be required in Cells 5, 6, 8, 14, 16, 17, 19, 21, 23, 24, 36, and 37 to provide process routings. About 160 new jumpers will be required for the new equipment in Cells 38 and 39.

D. Utility and Service Equipment - 221-B Building

1. Chemical Makeup and Addition - 271-B and 221-B Buildings

a. General

Existing chemical makeup facilities in the 271-B Building will serve the B Plant portion of the new operations without modification. New chemical addition equipment will be required in the 221-B Operating Gallery.

The design of the piping and equipment and the selection of materials of construction will be based upon the service in which the piping and equipment are used.

b. Scale Tanks - TK-38-A and TK-39-A

A 400-gallon and a 60-gallon scale tank will be installed in the 221-B Building Operating Gallery for chemical addition to canyon Cells 38 and 39, respectively. Both tanks will be equipped with agitators, heating and/or cooling coils, temperature indicators and platform scales. These tanks will handle nitric acid, sodium hydroxide and demineralized water.

2. Chemical Tank Farm - 211-B Area

The Chemical Tank Farm, 211-B Area, will serve the B Plant portion of the new operations.

3. Instrumentation and Electrical

a. General

A complete Instrument Engineering Diagram (IED) (see Appendix E) shows in schematic form the complete instrumentation system for all the process equipment and lines which are to be controlled, measured or operated by instruments. Instrumentation drafting symbols and identification are in accordance with the Instrument Society of America Standard ISA-S5-1.

b. Gamma Spectrometer

A Gamma Spectrometer will be installed downstream of the Ion Exchange Tower T-38-5 to indicate cesium breakthrough. The discharge lines from the Ion Exchange Tower will be routed so that the stream will pass in front of the detector probe.

c. pH Determination System

A stainless steel flow chamber mounted in the Canyon deck samplers from Tanks TK-39-1, 39-2, and 39-4 will have a process stream sample circulated to it. The pH sampling system will have the following features: a remotely operated valving system (air-operated ball valves) for rinsing, venting, buffering and standardizing the pH meter; fluid trapped in the flow chamber so that the electrodes are always submerged; a reservoir for rinse water storage, located in the Canyon; a

reservoir for buffer storage, located in the Operating Gallery; and the electrodes readily replaceable under short radiation time limits.

The latest improvements made in the existing pH systems will be incorporated in the new design.

d. Liquid Leak Detection System

A Liquid Leak Detection System, complete with liquid level indicators and alarms, will be installed in Process Cells 38 and 39 to detect any process equipment leakage. The leak detectors will be located in the sumps provided for each process cell; the leak detector read-out instrumentation will be mounted in the spare module openings on existing Converter Rack No. 35 located in the Operating Gallery.

e. Radiation Detectors

Radiation Detectors will be ionization chambers per Hanford Instrument Standard, J-4-2, and be installed in the following locations:

One above the Cell 38 and 39 Operating Gallery instrument panels;

One in the Pipe Gallery to monitor Cells 38, 39, and 40;

One on the Eluant Receiver, TK-38-4, to monitor the tanks contents; and

Two each in the cell walls for Cells 38, 39, and 40.

New amplifiers for the above chambers will be equipped with adjustable alarm contacts to indicate high radiation. A new multipoint radiation recorder will be installed to monitor the seven ionization chambers used in Cells 38, 39, and 40. These systems will have the capability of measuring up to 10^6 Roentgen per hour. A new two-point radiation recorder will be installed to monitor the two ionization chambers used in the galleries. These systems will have the capability of measuring from 0.01 to 100 mr/hr.

f. Miscellaneous Instrumentation

A heat detector which sets off an alarm at high temperature will be installed in Cells 38, 39, and 40. These

will be similar to the heat detectors currently in use in the other 221-B Cells.

Instrumentation will be installed to provide cell pressure measurements for Cells 38, 39, and 40. These will consist of a differential pressure indicator activated by pressure sensing from the cell and referenced to the Operating Gallery.

A pressure relief system will be installed for the Ion Exchange Tower, T-38-5. It will consist of jumper mounted transducers sensing pressure at the top and at the bottom of the Tower. These will activate a diaphragm operated valve in a vent line from the Tower which will relieve to the Cesium Feed Tank, TK-38-1.

g. Instrument Panels

It will be necessary to install new instrument panels for Cells 38 and 39 instrumentation. Panels will be installed with panel curbs and supports to match existing installations. The Cell 39 panels will be butted against the Cell 38 panels. A graphic panel arrangement will be used for Cell 38 instruments.

Finishing of the panels will be in accordance with Hanford Instrument Standard J-2-2.

h. Transmitter and Converter Racks

The Engineering Flow Diagrams and their supporting drawings indicate how the instruments will be mounted, for example, transmitter-rack or converter rack mounting. The transmitter racks and converter racks will be located in the Operating Gallery in the vicinity of Cells 38 and 39 panels, and be fabricated, finished, and supported in the same manner as existing racks.

i. Panel Audible and Visual Alarms

The visual alarms will be single- and dual-unit annunciators as required. The annunciators will be centrally mounted on top of the instrument panels. Separate audible alarms will be used with separate acknowledge test capability for the Cells 38 and 39 panels.

j. Alarm Interlocks

Electric interlocks will be used wherever there exists the possibility of damaging a process-lubricated pump

or an agitator by running it out of solution. Each motor circuit will be electrically interlocked with a low-liquid level alarm switch in the process system to automatically shut down the motor at a predetermined set point. Prior to shutdown, a second alarm switch contact will make an audible and a visual alarm to indicate low-liquid level.

k. Motor Control Center Modification

Two vertical sections will be added to existing Motor Control Center No. 19 in the Electrical Gallery. These units will provide the necessary power for operation in Cells 38 and 39 and the adjacent galleries.

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VI. SYSTEM DESCRIPTION AND ANALYSIS

A. Ventilation

1. General

a. Objectives

The heating, ventilating, and air conditioning systems (HVAC) will provide heating and cooling to maintain temperature and humidity conditions of each area as stated under the Systems Descriptions.

The HVAC systems will provide an air flow pattern to control the flow of airborne contamination. Air movement throughout the building will be from areas of lesser radioactivity to areas of greater radioactivity. Each air handling system will provide complete compatibility with other air handling systems.

b. Design Bases

The latest edition of the American Society of Heating, Refrigerating and Air Conditioning Engineers Guide (ASHRAE) will be used as the basic reference for design. Heating and cooling load calculations will be prepared by the procedure established by the ASHRAE. Heat transmission calculations will be based on 96 F DB, 68 F WB in the summer and -10 F DB in the winter. Summer make-up air will be based on 103 F DB. Evaporative cooling will be based on 103 F DB and 67 F WB. Cooling load calculations will include the area occupancy and the installed lighting and equipment loads.

c. Air Filtration

All outside air, recirculated air, and air that is exhausted from contaminated and potentially contaminated areas will be filtered. Filter ratings are based on industry standard efficiency tests.

The filtration system for contaminated air will be designed to ensure that activity in the stack gases discharged to the atmosphere will be within the release limits established for the Hanford Chemical Processing Division operations.

d. Monitoring

Instrumentation will be installed for continuous flow measurement and activity monitoring of gaseous effluents discharged from the new facility exhaust stack.

2. Description of Systems

a. Operating Area (K1)

This system will supply approximately 8,260 cfm of outside air on a once-through basis. Supply air will be filtered with 80 percent NBS (National Bureau of Standards) filters and heated or cooled to maintain 75 F DB and approximately 40 percent RH in all personnel occupied areas. Supply air will be preheated with steam-heating coils, cooled by chilled water coils, and distributed by a supply fan through reheat coils to meet the temperature and relative humidity requirements.

The air will be exhausted through a duct system. Dampers will be installed in all supply and exhaust ducts to achieve air balance control for each room and to permit isolation of the rooms when necessary. Exhaust air will be filtered with a bank of 8 percent NBS filters, a bank of 35 percent NBS filters, and two banks of high efficiency filters (HEPA) installed in series (99.97 percent efficient for removing particle size 0.3 micron and above).

The air will be exhausted from the operating areas through the filter banks by a centrifugal fan. Two fans will be installed and shall be operated alternately. Emergency power will be available to both units. Exhaust air will be discharged to the atmosphere through the exhaust stack, which also serves the K3 system, described below.

b. Service Area (K2)

This system will supply approximately 18,100 cfm of outside air. Air will be filtered with 80 percent NBS filters, preheated with steam-heating coils, cooled by chilled water coils, and distributed to the spaces by a supply fan through a reheat coil to maintain 75 F DB and approximately 40 percent RH in all personnel occupied areas. The HVAC equipment room will have approximately 5,200 cfm exhausted to the atmosphere and approximately 250 cfm shall be exhausted to the atmosphere from the lunchroom. The remaining exhaust air from the system spaces will be ducted via the system exhaust fan and stack to the atmosphere. The air from the Transmitter Rooms, which is potentially contaminated, will be filtered through a HEPA filter and exhausted to the K1 system, described above, for disposal.

c. Process Cell (K3)

The Process Cell Supply and Exhaust System will operate on a once-through basis and be designed to meet two sets of conditions: (1) routine operation, when all cell cover

blocks are in place, and (2) non-routine operation, when one or more cover blocks are removed from one of the cells.

All supply and exhaust fans in the K3 systems will be connected to the emergency power source.

1) Routine Operations

Supply air from the outside will be filtered by 80 percent NBS filters, preheated with steam-heating coils and heated as necessary through a steam reheat coil to maintain the air at 70 F DB and approximately 40 percent RH. The air will be distributed via ductwork to the canyon by a 6,550 cfm supply fan.

The canyon will furnish 0 - 250 cfm of air to each cell on a once-through basis except for Cell D-E which will be supplied 0 - 500 cfm. The cells will be equipped with dual filter systems with one set of HEPA supply and exhaust filters in service at any given time. Air will be filtered through parallel HEPA inlet filters (250 cfm each); cooled with chilled water coils to maintain the cell temperature of 125 F; filtered through parallel HEPA outlet filters and discharged via a common exhaust system. The exhaust air from this system and that from the canyon will be filtered by a bank of 35 percent NBS filters and two banks of HEPA filters installed in series. The filter exhaust will be discharged via a centrifugal fan to the atmosphere through the exhaust stack. Two exhaust fans and exhaust filter systems will be installed and shall be operated alternately.

2) Non-Routine Operation

During non-routine operation, 5,000 cfm (maximum) of canyon air will enter the open cell, bypassing the inlet filter and cooler, and will leave the cell through an unfiltered opening (manual valve) into the main exhaust duct where it will pass through the same filter system used for routine operation. Cells A and G, normally maintained essentially contamination-free, will not have the unfiltered discharge routing provided. No increase in supply or exhaust air is required during non-routine operation.

d. Capsule Storage Area (K4)

This system will supply 8,000 cfm of outside air on a once-through basis. Supply air will be filtered by 8 percent

NBS and 35 percent NBS filters in series, heated with a steam-heating coil, and cooled with an evaporative cooler to maintain approximately a 75 F inlet temperature to the Capsule Storage Area under maximum weather conditions. Air will be exhausted from the Capsule Storage Area in two ways. Approximately 7,750 cfm will be exhausted through a duct system from the space above the basin cover blocks and about 250 cfm will be exhausted from the space below the cover blocks. The combined air will be exhausted through the K1 Exhaust System, described above.

e. Compressor House - 225-BC Building

This non-contaminated area will be supplied with 5,200 cfm of outside air cooled with an evaporative cooler (wetted media). Exhaust will be to atmosphere via a power roof ventilator.

f. Chilled Water

The Chilled Water System will consist of two 80-ton centrifugal refrigeration machines, chilled water pumps, a cooling tower, and condenser water pumps. These two 80-ton refrigeration machines include an installed spare. Chilled water at 44 F will be supplied to the cooling coils in each air supply system. Chilled water will also be supplied to the vacuum surge tanks in Cells B and D. Two chilled water pumps and three condenser pumps will be provided to meet the pumping and stand-by requirements. All chilled water pumps, condenser water pumps, cooling tower fan, and refrigeration machines will be connected to the emergency power circuit.

g. Instrumentation and Control

The Instrumentation and Control Systems for HVAC will be centralized on a HVAC panel in the Operating Gallery. This centralized location will allow operation, adjustment, and viewing of major functions.

In general, the HVAC panel will contain manual controls for fans, pumps and compressors. It will indicate and record, where necessary, area static pressures, temperature and humidity. The panel will also allow centralized adjustment of certain dampers to provide flexible and safe operation of the complete facility. Pneumatic-type controls will be used.

3. Exhaust Stack

The stack will be a 70 foot high fiberglass reinforced plastic structure. A spray ring at the top of the stack will provide

flushdown capability. Stack flushes will be collected in a stack pan and routed to the low level waste facilities.

Instrumentation will be installed to give a continuous measure and record of air flow through the stack. The sensing device will be located at about the 20 foot level of the stack. In the same area, access holes will be provided for making pitot tube traverses and for gas sampling.

4. Specifications

a. Centrifugal Fan (Supply)

- The Centrifugal Fan will be a manufacturer's assembled item including motor, V-belts, and radial inlet damper. The fan will comply with AMCA standards for construction, description and testing.

b. Centrifugal Fan - Industrial (Exhaust)

The fan will be a manufacturer's assembled item including motor, V-belts, radial inlet dampers, and outlet dampers. The fan will comply with AMCA standards for construction, description and testing.

c. Power Roof Ventilator

The Power Roof Ventilator will be a manufacturer's assembled item including motor, pulleys, V-belt drive and adjustable damper. The ventilator will comply with AMCA standard test codes.

d. Range Hood Fan

The Range Hood Fan will be a manufacturer's supplied kitchen type item.

e. Heating Coils

Heating Coils will be of the steam distributing tube, extended fin surface type. Coils will be sized and rated in accordance with ASHRAE Standard 33.

f. Evaporative Cooler

The Evaporative Cooler will be a package unit consisting of two sections. One section will contain a steam-heating coil. The other section will be a fill-type evaporative cooler containing glass fiber filled cells arranged in tiers, a water spray system, metal blade eliminators and a tank or basin for collecting the spray water. The cooler will have a make-up and recirculating water system.

g. Eight Percent NBS Filter

The eight percent NBS Filter will consist of a steel framed cell with the renewable type media held in place by wire grids both front and rear. Cell size will be approximately 20 inches by 25 inches by 2 inches with the cell sides riveted together.

h. 35 Percent NBS Filter

The 35 percent NBS Filter will be a dry type and consist of a permanent galvanized steel holding frame and replaceable cartridge.

i. 80 Percent NBS Filter

The 80 percent NBS Filter will consist of an automatic renewable media roll-type prefilter and a replaceable cartridge filter. This package will be a factory fabricated single integral unit.

j. High Efficiency (HEPA) Filters

HEPA Type A filters, capable of removing 99.97 percent of particles 0.3 micron and larger, will be in accordance with Hanford Standard Specification HWS-7511-S.

k. Centrifugal Refrigeration Machine

The Centrifugal Refrigeration Machine will be a factory assembled unit consisting of compressor, condenser, evaporator, and control package suitable for use with a cooling tower.

l. Cooling Tower

The Cooling Tower will be a factory assembled, closed circuit, industrial cooler of sectional counterflow, flow-through design with galvanized steel construction throughout for wind and seismic resistance.

m. Cooling Coil, Chilled water

Cooling coils will be the straight-tube, continuous circuit type arranged for full or double circuits. Piping connections, drain and vent plugs will be extended outside the coil section casings.

n. Condenser Water Pump

Condenser water pumps may be centrifugal type, double suction, single stage, and directly connected by

a flexible coupling to the motor, or may be an in-line type.

o. Chilled Water Recirculating Pump

Chilled water recirculating pumps may be centrifugal type, base mounted, double suction, single stage, and directly connected by a flexible coupling to the motor, or may be an in-line type.

p. Compression Tank

The Compression Tank for the chilled water system will be a horizontal, cylindrical, steel tank, constructed and stamped in accordance with ASME Code Section VIII for 125 lb. working pressure.

B. Process Sampling

Samples of solutions will be required from Cells B and D operations for process control and evaluation of performance. Where practical these will be taken and analyzed within the cell. However, capability will be provided for taking samples out of the cells for laboratory analysis. Air-jets will be provided for transferring samples to pH elements (TK-B-5, SrF_2 Precipitator, TK-D-2, CsCl Converter and T-D-5, T-D-7, HCl Scrubbers) and to capillary tube samplers (5 ml. bottles) for the following tanks: TK-B-2, TK-B-5, and TK-D-2. Valves and capillary tube sampler connections will also be provided for taking samples by gravity from E-B-10, E-D-4, T-D-7, and D-D-12. Sample bottles will be transferred by manipulator via the inter-cell pass-throughs to Cell A, placed in the shielded pig, moved to the Service Gallery, Truck Port, and 222-S Analytical Laboratory.

Capability for transferring powder samples out of the cells will be provided through the installation of pass-throughs between the cells to Cell A, where a pass-through from the Service Gallery is provided for the shielded pig carrier entry into the cell. After loading the sample container, the pig is removed from the cell via the pass-through for transfer to the Truck Port and thence to the 222-S Analytical Laboratory.

C. Radiological Protection

1. Radiation Shielding

a. General

The biological shielding requirements for the Waste Encapsulation and Storage Facility process cells are based on a maximum dose rate of one mr/hr in the

Operating Gallery and the Service Gallery, and 6.5 mr/hr in the Canyon. These dose rates are based on a one megacurie point source of ^{90}Sr adjacent to the inner process cell wall, calculated at the outer cell wall surface. A smaller dose rate is experienced with one megacurie of ^{137}Cs as the source.

The thickness of the AMU wall adjacent to the Canyon is based on a dose rate of five mr/hr at the wall with a point source of 10,000 curies of ^{90}Sr located in the Canyon, 42 inches from the Canyon side wall. This dose rate would occur only when contaminated equipment is being removed from a cell. The normal dose rate in the AMU area will be less than one mr/hr.

The major shielding requirements for this facility are listed below. For those areas not covered herein, shielding requirements were established during detail design based upon the Hanford Standards for Radiation Protection currently in effect.

b. Process Cell Walls

A minimum wall thickness of 35 inches of magnetite concrete, or equivalent, is proposed for the cell outside walls. Interior walls of Cells A and G will be considered as shielding walls due to personnel-entry requirements and shall have the same thickness. All remaining separating walls will be ordinary concrete for structural purposes only.

c. Viewing Windows

The Lead Glass Viewing Windows for the process cells will provide shielding to give a dose rate of 0.3 mr/hr for a point source of one megacurie of ^{90}Sr located at the inside surface of the window.

The Viewing Windows at the AMU level, used for direct viewing of the Canyon crane operations, will provide shielding to give a dose rate of five mr/hr for a point source of 10,000 curies of ^{90}Sr located 42 inches from the Canyon wall. This dose rate will be approached only when failed equipment is removed from the cells. Normal dose rates will be less than one mr/hr.

d. Personnel-Entry Shielding Doors

The Personnel-Entry Shielding Doors into Cells A and G will be designed to furnish shielding requirements which are the same as the adjacent walls;

i.e., a maximum acceptable dose rate of one mr/hr in the Service Gallery. These doors will be electrically controlled from the Operating Gallery panel adjacent each cell. Indicating lights on the panels and outside the airlocks will denote whether doors are open or closed. Interlocks will be provided to prevent entry when high radiation fields exist in the cell. Provisions will also be made for manually opening the door from the inside of the cells.

e. Waste Transfer Cask (Cell A)

A maximum source strength of 5,000 curies of ^{90}Sr in a waste drum will be used as the basis for calculating the cask wall thickness. The dose rate at the cask surface will be less than two mr/hr.

f. Capsule Storage Basin

Waste capsules will be stored in a single layer in each section of the Capsule Storage Basin. For this configuration, sufficient depth of water cover will be provided so that: (1) the dose rate at the surface of the water will be less than 0.2 mr/hr; and (2) during the underwater transport of capsules above the stored array the dose rate at the surface of the water will be less than 6.5 mr/hr.

Cover blocks will be provided for each section of the Capsule Storage Basin to provide shielding in the event of failure of a capsule. Blocks of structural concrete (150 lbs/ft³) will be designed so that the dose rate at the surface of the blocks will be less than one mr/hr, based on the total dissolution of cesium chloride from one capsule.

g. Cell Pass-Throughs

Shielding doors on pass-throughs between cells and personnel-entry zones will be designed to provide shielding equivalent to the adjacent walls with both doors closed; i.e., the dose rates will be less than one mr/hr. Pass-throughs between non-entry cells (Cells B through F) will not require shielding.

2. Radiation Monitoring

Wall mounted radiation detectors will be located in 17 locations. Each detector will be similar to Tracerlab Model No. TA-62 with a range of one mr/hr to 10 r/hr, except that detectors for the Operating Gallery will be similar to Tracerlab Model No. TA-61 with a range of 0.01 mr/hr to 100 mr/hr.

Mounted with each detector will be a meter indicator and an alarm light, similar to Tracerlab Model No. AX-22, except that Operating Gallery meter indicators will be similar to Tracerlab Model AX-21. Detectors will be connected to a panel-mounted station indicator with an adjustable high level alarm and recorder output similar to Tracerlab Model TA-32, except station indicators for the Operating Gallery detectors will be similar to Tracerlab Model No. TA-31. They will be electrically connected to an indicating light and miniature radiation recorder such as Rustrak Model 288. The panel-mounted instruments will be located in the Operating Gallery and be mounted in a single panel for convenience in continuously monitoring all plant areas.

3. Air Sampling

Air samplers will be installed in 21 locations, 14 with detector and alarm devices. The samplers will be connected to a common header motivated by a vacuum pump located in the Service Gallery. Each sampler will have a rotameter. The pump exhaust will discharge to the Canyon. A second vacuum pump will be installed for stand-by. Both pumps will be designed for 225 scfm at five inches water vacuum.

Each air sampler equipped with a detector will be Hanford Standard N-2-26, Type II, with the addition of a built-in radiation detector. The detector probe, less handle, will be mounted face down on the inside of the air sampler access door above the outlet opening. At least five cfm of air will pass by each sampler probe. The detector will be electrically connected to a panel mounted air sampler radiation monitor which will consist of a count-rate meter, power supply, recorder and adjustable alarm contact equivalent to Technical Associates Model FM-5AB. AEC Standard NIM instrumentation may be used. An indicating light for high radiation level will be connected to the monitor. The air sampler monitor panels will be located in the Operating Gallery and racked in a single panel.

4. Cooling Water Monitoring

A combined monitoring, flow recording, and continuous sampling station (225-BD Building) will be located in both the high and low-risk cooling water lines prior to entry into the 221-B Building disposal systems. Recorders and alarms for these monitors will be located in the Operating Gallery of the Encapsulation Facility. The alarm on the high-risk cooling water monitor will divert the stream to the underground catch tank, TK-100 for collection and transfer to the Low Level Waste Tank, TK-39-1, in 221-B Building for further processing prior to disposal. All other equipment not installed

directly on the pipelines will be located in the Service Gallery. The design of the station will be based on the results of the current ARHCO development program for low level waste monitoring.

5. Storage Basin Monitoring

An in-line radiation monitoring system will be installed in the coolant circulation line for each of the 11 storage basin sections. The detectors will be capable of detecting low level concentrations of beta-gamma activity and be located as near the water exit as possible. This assembly will consist of a scintillation crystal, photo-multiplier tube, preamplifier, and lead shielding. The monitoring station for basin water radiation will be panel mounted in the Operating Gallery. Each detector input will require an amplifier, count-rate meter, alarm module, and high voltage power supply; all 11 outputs will be connected to a multi-point potentiometric recorder. The sensitivity of the monitoring devices will be as delineated by the current ARHCO development program for low level waste monitoring.

6. Ventilation Exhaust Stack Monitoring

The new Ventilation Exhaust Stack for the Encapsulation Facility will be continuously monitored for radioactivity in the effluent gases. Provisions will be made to obtain a representative stack air sample using an isokinetic probe. The system air sampler, vacuum pump and sample flow rate rotameter will be located in a small instrument building (225-BD Building) near the stack. Sample lines between the stack and vacuum pump will be heat traced or insulated to eliminate condensation. The pump discharge will be returned to the stack downstream of the sampling port. A recorder and adjustable high level alarm will be panel mounted in the Operating Gallery with other radiation instrumentation, utilizing an amplifier, count-rate meter, and high voltage power supply.

7. Personnel Monitoring

A standard beta-gamma hand-and-shoe counter will be provided at the building entrance. Two GM tube type survey instruments will be provided for personnel monitoring in the Change Rooms. These will be line operated and equipped with loud speakers and count-rate meters. In addition, portable GM tube type survey instruments will be provided for personnel monitoring at the Capsule Storage exit, the Canyon exits, and at the Truck Port exit to outside.

8. Breathing Air

Breathing air will be supplied from portable units procured

from a commercial source. Storage space will be provided near the main entrance for the units.

D. Fire Protection

1. 225-B Building

A standard wet pipe sprinkler system will be installed throughout the First Floor including the Service Gallery and Operating Gallery; Second Floor including the AMU Mezzanine Area; Crane Maintenance Area; Hot and Cold Manipulator Repair Shops; Air Locks #1, #2, #3, and #4; and the Air Lock and Change Room for the Capsule Storage Area.

Process Cells A through G will be provided with combination rate of rise and fixed temperature fire detectors, except for Cells B and C which will have fixed temperature detectors only because of the Strontium Furnace E-B-8. The temperature rating of these units will be approximately 225° F. All process cells will be provided with a fire fog nozzle system with individual solenoid valves on the water supply; manual switches on the Operating Gallery wall will activate the solenoid valves.

The Transmitter Rooms on the second floor will be provided with products of combustion, ionization type fire detectors; a sprinkler system will not be installed.

2. 225-BC Building

In addition to the areas noted above for sprinkler coverage, the detached Compressor House (225-BC Building) will also be protected. This system will be an extension of the main sprinkler system from 225-B Building. The supply line to it will be taken underground and provided with a shut-off valve at the tie-in to the system in the main building. A separate flow alarm device will be installed to alarm for this building.

A single wet pipe sprinkler system with standard alarm valve and attachments will be used for control of the automatic sprinkler system for this facility. The occupancy class using the NFPA classification system is judged ordinary hazard (Group 2) and the water supply requirement for sprinkler system usage at 750 - 1000 gpm.

3. Fire Alarms

The fire alarm system will be of the local energy type and provided with an emergency battery of sufficient capacity for operation of the system for 60 hours. It will be capable of receiving fire alarm signals from the nine separate fire zones noted below:

First Floor Sprinkler Operation - 225-B Building

Second Floor Sprinklers and Smoke Detectors -
225-B Building

Process Cells (six zones with Cells D-E as one
zone) - 225-B Building

Compressor House Sprinkler Operation - 225-BC
Building

In addition, the system will be capable of electrically supervising its operation and providing trouble signals for loss of AC power, open circuits, grounds, shorts, etc. which might affect the operability.

Fire alarm and trouble signals will be annunciated locally and by transmission of separate and distinct signals to the 200 Areas Central Fire Station. Portable fire extinguishers will be installed at selected locations.

E. Utilities and Services

1. Steam

Steam at 225 psig will be obtained from the eight-inch main supply line which feeds the 221-B Building. Two pressure-reducing stations are required to reduce the high pressure steam. One station will supply 5,000 pounds of steam per hour at 25 psig for use in the environmental heating system. The other station will supply 2,000 pounds of steam per hour at 100 psig for use in the process cells, in steam jets, and at various locations throughout the building.

2. Sanitary Water

Sanitary water will be used for the safety showers, drinking fountains, lunchroom and in the change rooms. This water will be obtained from the eight-inch sanitary water header supplying the 221-B Building. A 150-gallon hot water tank will be provided in the Change Room to supply the showers and sinks.

3. Raw Water

a. Normal

Raw water will be supplied from the 10-inch supply line serving the 221-B Building.

b. Emergency

A new diesel-driven pump is to replace the present 300 gpm pump in the existing 282-BA water well. This pump will supply water for emergency needs. The pump discharge will be tied into the 10-inch supply header to the 221-B Building. The new pump will be sized to deliver 1,100 gpm at 100 psig to the existing pipeline, actuated by low, raw water line pressure. Existing pressure switch and wiring will be utilized.

4. Electrical

a. National Standards and Federal Specifications

All components of the electrical system will be Underwriters' Laboratories listed, if available, and will be installed in accordance with the 1968 edition of the National Electrical Code (NEPA-70). Additional National Standards and Federal Specifications will govern in specific areas of work.

b. Hanford Standards and Standard Specifications

Hanford Standards and Standard Specifications, HWS-10002, will be followed.

c. Engineered Equipment and Materials

Unit Substation and Metal-Clad Switchgear

The unit substation will be a double-ended, metal-enclosed, outdoor substation consisting of two transformers with 15 kV primary fuse protection, external lightning arresters, and 12 480 V, three-phase secondary circuit breaker cubicles including cubicles for metering and instrument transformers for operation of a grounded wye secondary system, rated at 480/277 volts, three-phase, four-wire, 60 Hertz.

Transformers will be two 750 KVA, three-phase, with 13.8 kV delta primary windings, with two and one-half percent taps above and below rated voltage and with 480/277 volt secondary windings, with neutral brought out for solid grounding. Windings will be oil-immersed. Transformers will be standard impedance and self-cooled.

The primary main switches will be outdoor, metal enclosed, free-standing, three-pole, air interrupter switches with stored energy operating mechanisms,

two-position (open-closed) 13.8 kV nominal, 600 ampere continuous, equipped with one set of three power fuses.

The switchgear will be an outdoor, metal enclosed, free-standing, self-supporting double-ended assembly consisting of the following air circuit breakers and equipment:

- 2 - 1600 AF, 1000 AT, Main Air Circuit Breakers
- 1 - 1600 AF, Tie Breaker
- 5 - 600 AF, Feeder Breakers
- 2 - 600 AF, Spaces Only
- 2 - Metering Panels

Emergency Generator

The emergency power supply will consist of a diesel engine-driven 500 kw generator, delivering 480/277 volt, three-phase, four-wire, 60 Hertz service at 0.8 power factor for continuous duty. The generator will be capable of furnishing the power at voltage indicated and will be capable of 25 percent overload under emergency conditions.

A control panel will be provided with the following equipment and devices:

- (1) Remote RUN-STOP switch, ammeter, AC voltmeter, voltage adjusting rheostat, frequency meter and running time meter, and indicator lights.
- (2) For the engine, there will be an oil gauge, water temperature gauge, low oil pressure alarm, high water temperature alarm, and cranking limiter.
- (3) Other furnished equipment not on the control panel will be: 120 VAC battery charger for 24 V DC charging service and a 24 V battery.

The diesel engine generator will have an automatic starting circuit to pick up emergency load.

The diesel engine will have a forced air-cooled, liquid coolant radiator cooling system mounted on

the engine and will be capable of providing power continually to a 500 kw, three-phase generator.

An underground fuel tank of 750-gallon capacity will be supplied. A 10-gallon maximum day tank for fuel storage will be supplied.

Lightning Arresters

Three 15 kv single-phase, valve-type, outdoor, pole-mounted lightning arresters for a 13.8 kv, three-phase delta (grounded) system will be provided.

Disconnect Switch

A 15 kv, three-pole, 200 ampere, gang-operated horizontal, channel base, pole-mounted, outdoor disconnect switch will be furnished complete with remote switch operating mechanism.

Motor Control Centers

Motor control centers will consist of standardized prefabricated metal sections, completely enclosing the control equipment and assembled to provide a dead front unit. Overload devices for the motor starters will be sized for the motors to be furnished with the equipment.

One motor control center (No. 1) will provide normal service to loads not requiring emergency power. The other four centers (Nos. 2, 3, 4 and 5) to 225-B and 225-BC Buildings will serve critical loads and will be supplied via two 600-ampere automatic transfer switches from either the normal supply or the emergency generator.

Motor starters will be combination types with three overload protective elements.

Automatic Transfer Switches

The two automatic transfer switches will be totally enclosed, rated at 600 volt, 600 amp, three-phase, 60 Hertz for use on a 480/277 volt, three-phase, four-wire system to transfer critical loads to the emergency power source upon loss of normal power.

d. Major Components

13.8 KV Pole Line

Power will be provided to the new facility from

existing 13.8 kv line C8-L7 which is served from the 251 Substation. This line will be tapped approximately 4,000 feet west of the new substation.

A new, group-operated 15 kv disconnect switch will be installed at the first structure from the primary tap. The tap structure and the final tie-in will be by the Commission.

Compressor House - 225-BC Building

Electrical power will be fed to the compressor house at 480/277 volt, three-phase, four-wire, 60 Hertz from the emergency generator and the unit substation via two emergency transfer switches in the 225-BC Building. Power feeders and branch circuits within the building will be copper or aluminum depending on cost considerations. All conductors for control will be stranded copper type THW except as may be required by application. Power for lighting, miscellaneous small loads, and convenience outlets will be provided at 120/240 V, one-phase, by means of a 24 kva dry type transformer and a lighting panelboard.

Lighting will be provided by industrial fluorescent fixtures. Incandescent fixtures, weatherproof, will be installed above or adjacent to each outside door.

The Compressor House (225-BC Building) will be provided with one PAX telephone by extension of the 225-B Building system.

A complete wet pipe sprinkler system will be installed to protect the building and its contents from loss by fire. The building will annunciate as a separate alarm zone on the 225-B Building alarm system. Valves capable of rendering any portion of the system inoperative will be supervised.

225-B Building Power and Grounding

The normal and emergency power will be fed to the 225-B Building at 480/277 volts, three-phase, four-wire. Service from two emergency transfer switches in 225-BC Building will terminate in two adjacent motor control centers #2 and #3. Service from normal bus of unit substation feeder conductors will terminate in motor control center #1. Power feeders and branch circuits within the building will be copper or aluminum, depending on the cost consideration. All control conductor will be stranded copper type THW except as may be required by application.

Power for all fluorescent lighting and mercury vapor (outside) lighting loads will be provided from 277/480 volt, three-phase, four-wire lighting panelboards. Power for incandescent lighting, convenience outlets, and small loads will be provided at 120/240 volt, one-phase, by means of dry type transformers and lighting panels.

A steel cable ground mat will be installed under 225-B Building and associated buildings and all electrical equipment will be grounded in accordance with Hanford Grounding Standards.

225-B Building Lighting

General lighting will be provided in the 225-B Building. Lighting panels will be located in the Operating Gallery and will be fed from MCC No. 1. Incandescent lighting fixtures will be installed outside of each entrance to the building. Emergency battery-operated lighting units will be installed as required for personnel safety. Exit lights will be installed leading personnel to outside doors. Incandescent or mercury vapor floodlighting will be mounted on the building and associated structures as required to provide safe access to mechanical equipment and walkways. Floodlighting will be controlled with photoelectric cells. Process cell lighting will be provided by portable "Lucalux" (General Electric Co. product) fixtures.

Instrumentation Raceways and Wiring

All instrumentation signal wiring will be contained in NEC code approved raceways. Sensitive signals will be carried in shielded cables and will not be routed in common raceways with alternating current carrying conductors. Other instrument signals not sensitive to alternating current circuits may be routed in raceways containing other control wiring.

Signal and Communications

Signal and communications within the facility will be provided throughout the 225-B, 225-BC and the west end of 221-B Building utilizing the following systems as further described below: Plant Telephone System, Intercommunication System, PAX Telephone Network, and Area Radiation Detection.

The installation contractor will provide all raceways required for the telephone system. All conduit will contain a number 9 iron pull wire. All telephone

conductors and equipment will be provided by the Hanford plant telephone contractor.

The intercom system will comprise two pairs of stations, one each for Cells A and G, with master stations in the Operating Gallery and slave stations in the Service Gallery. The system will operate from a 120-volt AC power source. All wiring will be as specified by the equipment manufacturer.

A network of PAX telephones will be installed throughout the facility. Instruments will be installed in some locations while other locations will be served by jacks for the connection of portable phones.

Radiation detection and measurement units will be installed in designated locations in the process areas of the building. These units will be connected for alarm and for annunciation at a central panel.

Fire Protection - 225-B and 225-BC Buildings

Primary building fire protection will be provided by a standard wet-pipe sprinkler system. The sprinkler system will provide coverage of all portions of the building except areas where the introduction of water may create a hazard and other selected areas where risk of property loss is small. The sprinkler system will be equipped with water flow alarm switches and zone flow switches as required to notify the 200 Area Central Fire Station of any flow in the system. All electrical components of the system will be Underwriters' Laboratories (UL) and/or Factory Mutual listed and will be installed in accordance with National Fire Protection Association standards. The fire detection system will be UL and/or Factory Mutual approved and will consist of the following components:

- A fire alarm control panel capable of receiving fire alarm signals from nine alarm zones and transmitting a signal to the central station.

The panel will accept signals from flow switches, detectors, or manual alarm stations over supervised zone alarm circuits. The panel will be located within the building near the main entrance.

- The master box will be of the successive, positive, non-interfering local energy type equipped to transmit its signal over a ground return in the event of loss of one side of the area loop. The box will be located outside the building near the main entrance.

- An annunciator will be provided at the main entrance to the building to indicate the zone of the building in which the signal was initiated.
- An annunciator will be provided for supervision of the sprinkler system. All components of the sprinkler system which can render any part of the system inoperative will be supervised. System pressure and detector circuits will also be supervised. Any abnormal conditions existing in either the sprinkler system or the detection system will indicate on this annunciator which will trip a supervisory code transmitter and send a trouble signal to the central station. The sprinkler system supervisory annunciator will be located near or in the control panel.
- The supervisory code transmitter will be located near the main control panel and painted royal blue. It will have no external means of trip. It will be a successive, positive, non-interfering, local energy type, and will be capable of transmitting only one round of a signal to the control station over the 200 Area alarm loop.
- High value properties not covered by the sprinkler system will be protected by three following types of detectors which are UL approved:
 - 1) Responsive to gaseous products of combustion without the presence of smoke or heat;
 - 2) Actuated by high temperature, compensated for the rate of temperature rise;
 - 3) Fixed temperature.

They will be installed as appropriate to the hazard or installed location.

- All exits from the building will be provided with manually operated alarm stations.
- Building fire alarm evacuation will be accomplished by means of single stroke gongs. Gongs will be so located as to assure audibility in any portion of the building above the normal ambient sound level.
- All fire alarm conductors will be copper type THW and will be enclosed in conduit. All boxes and enclosures will be clearly defined as fire alarm equipment.

Control Wiring

All control of electrical equipment will be in accordance with the applicable Hanford Standards and Standard Specifications.

Indicating lights will be provided in the motor controller compartments serving remotely located motors. Additional control devices will be provided in accordance with the detail design drawings. All control conductors, except critical control circuits, will be number 14 stranded copper type THW routed in conduit. Critical control will be number 12 stranded copper type THW routed in conduit or approved metal wireways. All control conductors will be identified at all terminal points using tubular plastic wire markers.

5. Drains

a. Safety Showers, Eye Wash, Drinking Fountains, and Lunchroom Sink

The drain lines from these sources will be tied into the same drain headers as the floor drain for the room or area in which they are located. The plumbing will include traps for each drain entering the headers.

b. Floor Drains - Low Level Waste

Drains from the following areas will be tied into the underground waste catch tank, TK-100: Crane Maintenance and Wash-down Area, Canyon, Hot Manipulator Repair Shop, Personnel Decontamination, Shower and Transmitter Rooms. TK-100 (4,400 gallons capacity), located adjacent to the 225-B Building, will be equipped with a sump pump and liquid level controls. The catch tank pump will discharge to the low level waste header in the Hot Pipe Trench. The latter header will be provided with a trap installed in the Cell 39 jumper which connects the header to TK-39-1. The lines to the underground catch tank will also be suitably trapped.

c. Floor Drains - Non-contaminated Waste

Floor drains from all other areas not listed above will be tied into both the existing chemical sewer system and the low level waste underground catch tank described in paragraph b. above. The floor drains from the Operating Gallery, Service Gallery, Cold Manipulator Repair Shop and Truck Port will normally be routed to the underground catch tank. However, by a manual operation in a given area, a pipe plug, pipe cap, or similar

fitting can be shifted to effect a routing change to the chemical sewer header. All drains will be suitably trapped.

d. Tank Drains - Non-contaminated Waste

All aqueous makeup area tanks with the exception of the two hydrochloric acid tanks will be drainable directly to the B Plant chemical sewer system. A Neutralizer Tank will be provided for neutralizing hydrochloric acid prior to disposal to the chemical sewer.

e. Ventilation Exhaust Filter Housing and Stack Drains

The ventilation exhaust filter sumps and the exhaust stack drain will be routed to the Low Level Waste Header via the underground catch tank described in paragraph b., page 21.

F. Aqueous Waste Handling (Non-Radioactive)

The two principal non-radioactive aqueous waste streams are sanitary waste and chemical preparation (AMU) waste. Sanitary wastes are sent to the existing 271-B Building septic tank-tile field system. Cold chemical preparation wastes are routed to the existing 10-inch vitrified clay pipe process sewer on the north side of the 221-B Building; no known hazards are associated with the possible inter-mixing of the chemical wastes from 221-B and 225-B Building.

G. Solid Waste Handling

1. General

Solid waste disposition will be performed in accordance with the RL Appendix 0510 Waste Disposal Guide.

Two types of solid waste will be accumulated and require disposal from the Waste Encapsulation and Storage Facility: non-radioactive and radioactive.

2. Non-Radioactive Wastes

These wastes have very little or no potential for containing radioactivity, such as from the office spaces, lunchroom, AMU area, HVAC area, and Operating Gallery during normal operations. These wastes will be accumulated and disposed of in the same manner as similar wastes presently generated in the 200 Areas.

3. Radioactive Wastes

The bulk of these wastes will originate in the process cells. Other areas producing lesser amounts will be the Hot Manipulator

Repair Shop, the Canyon and other operating areas such as the Operating Gallery during periods of manipulator removal and replacement.

a. Low Level

The radioactive wastes generated outside the process cells will normally be low level wastes. They will be collected in standard plastic-lined containers located in each space of origin. When full, these containers will be sealed and disposed of with similar currently generated wastes from the 200 East Area.

b. Routine High Level

The bulk of the process cell solid wastes will comprise ventilation exhaust filters, manipulator boots and miscellaneous cleaning and handling materials. The cell exhaust filters will require periodic replacement and are supplied as parallel units to avoid shutdown of processing operations; activity levels will be routinely monitored such that the discarded filters can be safely handled in the shielded transport cask. The manipulator boots will be replaced frequently with four to eight week life expected in the cell high radiation fields.

Process cell major equipment pieces will require periodic replacement as well as some of the smaller service components such as valves, gages, jumpers, jets, filters, heaters, etc. Standard hand tools as well as special handling tools will be used in the operation and maintenance of the process cell instrumentation and equipment; those which fail normally will be discarded to high level waste.

High level solid wastes routinely removed from the process cells will be loaded by manipulator into burial cans (one gallon paint cans) in the cell of origin. For the exhaust filters and larger equipment pieces, larger burial cans will be provided. When filled, these cans will be transferred by the manipulators via the inter-cell pass-throughs to the Cell A hood. Here they will be loaded into the burial drum, a plastic-lined 55-gallon steel drum, by manipulator. Personnel entry will be required for bringing a new burial drum into Cell A from the Service Gallery, fastening the plastic bag to the hood bottom loadout port, and removing the old plastic bag remnant to the burial drum. When full, the burial drum plastic bag will be remotely sealed for removal from the hood, the drum lid remotely installed, and the drum transferred remotely into the shielded cask for the transfer to the interim storage site.

The shielded transfer cask (four to five tons total weight) will be designed to hold the burial drum with adequate shielding (about six inches of lead) for manual handling and physical contact. The cask, positioned over a canyon deck opening by the canyon crane, is loaded from the bottom. The burial drum, carried on the Cell A dolly and positioned below the opening in the canyon cover blocks, is then raised into the transfer cask and the cask bottom sliding gates closed by an operator on the canyon deck. The loaded cask is then transferred to the Truck Port by the canyon crane and the canyon cover block over the Cell A opening replaced. A flatbed truck will then be used to transfer the loaded cask to the interim disposal site, Cell 4 of 221-B Building. Entry will be through the railroad tunnel. The shielded transfer cask will be returned to 225-B Building for reuse.

c. Non-Routine High Level

Solid waste items too large to be removed from the process cells via the Cell A operation described above, such as failed larger process equipment pieces, will be decontaminated to the extent practicable in the cell of origin. After decontamination of the cell interior to the fullest practicable degree for contamination control, a cell cover block will be removed and the canyon crane used to transfer the waste item to a shielded disposal box located on the canyon deck in a "greenhouse" type enclosure for control of spread of contamination. Cell ventilation flow rates will be increased during the period when the cover block is removed. Procedures are well established at Hanford for such disposal operations.

The sealed, shielded disposal box, now containing the failed, high contaminated item will then be transferred by the canyon crane to the Truck Port and the cell cover block replaced. From the Truck Port, the box will be transported by truck to a Hanford location for interim storage in accordance with its contents and its level of radiation.

H. Confinement Philosophy

1. General

In general, the confinement philosophy for the design of the Encapsulation Plant calls for double confinement with respect to the environment. In some instances, the second confinement need not be wholly composed of the continuous material encasement; confinement may be effected by an air barrier, or by diversion to a harmless destination. The exhaust ventilation system utilizes high efficiency filtration in depth with all exhaust air streams being filtered at least twice and those

of higher potential contamination being filtered three times. The discussion which follows will show, in general, how the confinement philosophy is applied in the various areas of the Encapsulation Plant design.

2. Process

Process material fluids are transferred in welded piping to welded corrosion-resistant tanks both of which constitute the primary confinement barrier for these highly radioactive materials. The tanks are vented through the triple-filtered exhaust system to complete this confinement. The pipes are run in sloped concrete trenches and the tanks are confined in concrete cells to provide the second line of defense. The cells are ventilated with air drawn in through HEPA filters to complete the secondary confinement. To further minimize the risk of radioactive fluid leakage to the subterranean soil, a stainless steel pan of sufficient volume to retain the contents of a tank is provided as a liner for the concrete cells. The tank cells and the end portions of the pipe trenches are housed within a building. The ventilation air to the building is introduced through filters and exhausted through HEPA filters so that, in the event that the in-cell filter fails to confine airborne activity, a second and third barrier are provided by the K3 System Filter Building.

3. Capsule Storage

In the final capsule storage pool, all the sources are double-encapsulated. The pool and its demineralizing system constitute a third confinement barrier.

4. Maintenance

The concept of double confinement is, at least in part, necessarily encroached when maintenance must be performed. Where the concept can be maintained it will be, but in some instances, it is impossible to maintain as a practical matter. However, those instances in which it is not maintained generally involve quantities of activity that are many orders of magnitude removed from the primary sources confined within the process cells and the potential dangers to plant personnel and the public are correspondingly reduced.

An example of this is the Regulated Manipulator Repair Shop. Manipulators brought to the room are confined within a plastic enclosure. This enclosure must be removed for the actual decontamination operation which is done within a tank vented through a HEPA filter, which then becomes the primary confinement. Ultimately, the equipment piece must be removed; the building and its ventilation system constitute the confinement in this instance.

I. Process Equipment Maintenance Philosophy

As in any production plant with a design production rate, that block of downtime which can be allotted to equipment maintenance assumes a very real significance in the design of the Encapsulation Plant. Several maintenance-influenced criteria provide guidance for the design of the process, the process equipment, and the equipment location. Only the maintenance of equipment located within the process cells is discussed in this section due to the remote technique involved. The maintenance of most other Encapsulation Plant equipment falls in the routine category and is not treated herein. Broadly speaking, these criteria can be stated as follows:

- a) Downtime will be minimized for equipment repair, replacement, or maintenance.
- b) Equipment will be simple, sturdy, and utilize a minimum of moving parts.
- c) A preventive maintenance program will minimize breakdowns, utilizing idle equipment time insofar as possible; however, a maintenance shutdown will be scheduled at least semiannually.
- d) All equipment will be either reparable in place or removable through the canyon. Massive equipment will be dismantled as necessary to meet dimensional or weight handling requirements of the removal provisions.
- e) The decision as to whether a design will provide for removal or in-place repair must consider minimizing the use of the manipulators, which are among the most complex mechanisms in the plant, and are themselves thereby subject to breakdown and maintenance.
- f) Maximum use will be made of radiation-resistant materials.

The first limitation, that of a maximum maintenance time allocation, has been applied as a significant basic consideration. The time and programming studies establishing the optimum process and equipment for each line should be completed.

The approach to the maintenance of Encapsulation Plant equipment is basic to the plant arrangement, equipment design and equipment selection. However, no single criterion other than ultimate safety is necessarily the overriding factor to be considered. An underlying assumption of a maintenance capability is only one of the many factors considered throughout the plant design and is a strong but not a controlling influence. As an example, preventive maintenance is considered preferable to corrective maintenance as being more convenient and affording an element of schedular control. This distinction is only one of the many design aspects evaluated.

No operating facility can be considered well designed or reliable without having considered and incorporated principles of preventative maintenance. Even an experimental facility must anticipate malfunction and material failure at some time if an adequate and timely progressive preventative repair or replacement program has not been implemented. It is axiomatic that failure or malfunctions never occur at convenient times; it is therefore mandatory that provisions be made to anticipate and correct for incipient problems.

Maintenance capability is, in turn, significantly affected by the quality and design of the basic parts. It is in equipment selection that much of the maintenance problem can be circumvented. Simplicity and sturdiness are of paramount interest and especially in a remote radiation field, moving parts must be minimized. The proper choice of materials and configuration are design aspects which also affect maintainability and thereby plant availability.

J. Material Balance Techniques

1. General

The radioactive isotopes ^{137}Cs and ^{90}Sr enter the Encapsulation Plant from the feed system in the 221-B Building. They leave the plant with the product capsules, solid waste, liquid waste, and as airborne contamination. The method of material balance for radioisotopes by these routes is discussed below.

2. Feed

The ^{90}Sr and ^{137}Cs feed solutions to the Encapsulation Plant are sampled separately in the 221-B Building Feed Storage Tanks TK-39-5 and TK-39-3, respectively. With the solutions transferred by airlift (no dilution), the feed batch volume transferred is determined in the 225-B Building Feed Metering Tanks TK-B-1 and TK-D-1, respectively, for greater accuracy (smaller volume tanks). The radioisotope quantity transferred can then be calculated from the sample assay and volume.

3. Process Control

Samples taken at various points in the processing steps for assay will establish the necessary process control parameters.

4. Product Capsules

Calorimetry of the final product capsules in Cell G prior to storage will determine the quantity of contained radioisotopes. A beam balance is also provided in Cell G for weighing the final capsules.

5. Liquid Waste

The liquid waste (filtrate) from the strontium fluoride filtration is accumulated, agitated, and sampled, in 225-B Building, Supernate Holding Tank TK-B-2. If above predetermined limits for ^{90}Sr , it can be reworked through the Precipitator TK-B-5 without returning it to 221-B Building. If satisfactory for disposal, it is routed to the 221-B Building Strontium Waste Tank TK-39-4. From the volume measurement in TK-B-2 and sample assay, the quantity of ^{90}Sr returned to 221-B Building can be calculated.

The liquid waste (process condensate) from the cesium chloride Evaporator-Melter, E-E-1, is returned to the 221-B Building Cesium Waste Tank TK-39-2 for sampling, assay and volume determination prior to disposal; the quantity of ^{137}Cs returned can then be calculated.

6. Solid Waste

Solid radioactive waste will be routed through Cell A of the 225-B Building for transfer to an interim storage location.

An estimate of its contained radioactivity can be made in Cell A. It is expected to be very small.

7. Gaseous Waste

The quantity of radioactivity expected to be lost with the exhaust ventilation air is extremely small. For all practical purposes, it should be retained by the exhaust filters. The radioactivity content of the replaceable filters can be estimated with a radiation survey meter prior to disposal. A radiation probe can be inserted into the underground filter vaults for estimates of their contained radioactivity.

K Maloperations Analysis

The various processes proposed for the Encapsulation Plant have been examined from the viewpoint of potential hazards arising from operating mishaps. Each step in the various processes and systems has been examined and the necessary corrective actions have been determined. On succeeding pages are listed the significant process steps and operating systems, problems which may be encountered in each, the means of identifying failures, and the remedial operations necessary to correct the conditions. Table VI.K.1 and Table VI.K.2 treat the two isotope process lines and Table VI.K.3 treats systems and facilities other than the process lines.

TABLE VI.K.1
STRONTIUM-90 MALOPERATIONS ANALYSIS

<u>Process Flow Step</u>	<u>Operational Problem</u>	<u>Indication of Failure</u>	<u>Remedial Action</u>
1. Feed batch air-lifted into metering tank.	1. a. Transfer line fails or is plugged. b. Metering tank overflows.	1. a. Level indicators in 221-B storage tank and metering tank. b. None.	1. a. Flushline; use spare line. b. Overflow drains back to 221-B feed storage tank.
2. Feed batch dropped by gravity to precipitator.	2. Transfer line plugged.	2. Level indicators in metering tank and precipitator.	2. Drop feed batch back to 221-B feed storage tank. Repair or replace line or valve remotely.
3. NaOH solution added to feed batch in precipitator.	3. a. Transfer line fails or is plugged. b. Excess NaOH added.	3. a. Level indicator in NaOH tank and precipitator. b. pH meter, sample analysis.	3. a. Flush chem. add. line. Utilize spare line. b. Add HNO ₃ to neutralize.
4. NaF powder added to feed batch in precipitator.	4. Powder spill.	4. Visual.	4. Manually collect all visible powder with manipulator and tools.
5. SrF ₂ slurry digested for one hour at 80C.	5. Temperature controls fails.	5. Temperature alarm.	5. Manual control of steam or cooling water.
6. SrF ₂ slurry filtration.	6. a. Slurry fails to flow from precipitator. b. Supernate has excessive Sr-90 concentration.	6. a. Level indicator in precipitation and supernate hold tank. b. Chemical analysis.	6. a. Add water to precipitator and air sparge. Replace filter(s). Flush transfer line. b. Recycle to precipitator for rework.
7. SrF ₂ cake washed, air dried, and transferred to furnace boats.	7. Powder spill.	7. Visual.	7. Manually collect all visible powder with manipulator and tools.
8. SrF ₂ sintered in furnace at 1100C and cooled.	8. a. Furnace element fails. b. Temp. control fails.	8. a. Temperature recorder. b. Temperature alarm.	8. a. Element replaced remotely. b. Multiple sensors. Fail-safe mechanism.

Strontium-90 Maloperations Analysis

<u>Process Flow Step</u>	<u>Operational Problem</u>	<u>Indication of Failure</u>	<u>Remedial Action</u>
9. Sintered SrF ₂ transferred to inner capsule and compacted to 70-80 percent theoretical density.	9. a. Powder spill.	9. a. Visual.	9. a. Manually collect all visible powder with manipulator and tools.
	b. Mechanical problems.	b. Visual.	b. Repair with manipulator; replace compactor if required.
10. Inner capsule and cap welded, leak-tested, and decontaminated.	10. a. Dirty weld area.	10. a. Visual.	10. a. Manually brush and wipe clean with manipulator before welding.
	b. Capsule leaks after welding.	b. Helium leak tester.	b. Capsule opened; powder reprocessed.
	c. Excessive contamination.	c. Swipe analysis. Radiation monitor.	c. Further decontamination.
11. Outer capsule end cap welded, weld-tested.	11. Capsule leaks after welding.	11. Ultrasonic tester.	11. Outer capsule replaced, welded and tested.
12. Final capsule weighing and calorimetry.	12. a. High capsule temperature.	12. a. None	12. a. Equilibrium centerline temperature in air (900C) well below melting point.
	b. Loss of cooling water.	b. High temperature alarm on cooling water.	b. Remove capsule to shielded storage.
13. Shielded storage in cells.	13. Cooling water failure.	13. Temperature indicator with alarm.	13. Emergency cooling water available automatically from onsite well.
14. Shielded storage in water pools.	14. a. Pump failure.	14. a. Temp. rise of pool water.	14. a. No immediate action necessary (6 hours), adequate for repair or replacement.
	b. Heat exchanger failure.	b. Temp. rise of pool water.	b. Move capsules to another pool until repair or replacement can be made.
	c. Cooling water failure.	c. Temp. rise of pool water.	c. Emergency cooling water available automatically from onsite well.
	d. Capsule failure.	d. Basin water radiation monitor alarm.	d. Return failed capsule to Cell G via transfer device for rework.

TABLE VI.K.2
CESIUM-137 MALOPERATIONS ANALYSIS

<u>Process Flow Step</u>	<u>Operational Problem</u>	<u>Indication of Failure</u>	<u>Remedial Action</u>
1. Feed batch air-lifted into metering tanks.	1. a. Transfer line fails or is plugged.	1. a. Level indicators in 221-B storage tank and metering tank.	1. a. Flush line; use spare line.
	b. Metering tank overflows due to failure of level indicator.	b. None.	b. Overflow drains back to 221-B feed storage tank.
2. Feed batch dropped by gravity to converter tank.	2. Transfer line fails or is plugged.	2. Level indicators in metering and converter tanks.	2. Drop feed batch back to 221-B feed storage tank. Repair or replace line or valve remotely.
3. HCl added to feed batch in converter tank.	3. a. Transfer line fails or is plugged.	3. a. Level indicators in HCl and converter tanks.	3. a. Flush chem. add. line. Add HCl manually with manipulator.
	b. Excessive CO ₂ evolution rate.	b. HCl scrubber pressure drop instrument.	b. Decrease HCl addition rate.
4. CsCl solution transferred by vacuum to evaporator-melter.	4. a. Transfer line fails or is plugged.	4. a. Level indicators in converter tank and evaporator-melter.	4. a. Flush line. Replace line remotely.
	b. Failure of vacuum system.	b. Vacuum instrument.	b. Steam jet and condenser replaceable remotely. Tighten connectors.
5. CsCl solution evaporated to dryness, melted, and cooled.	5. a. Failure of electrical heaters in evaporator-melter.	5. a. Temperature indicator.	5. a. Heaters replaceable remotely.
	b. Failure of off-gas treatment system (condenser, HCl scrubbers, heater, filter)	b. Pressure drop and temperature.	b. Shut-off electric heater and air cool. System component is replaceable remotely.

Cesium-137 Maloperations Analysis

<u>Process Flow Step</u>	<u>Operational Problem</u>	<u>Indication of Failure</u>	<u>Remedial Action</u>
6. CsCl melt transferred by vacuum to inner capsules in casting machine.	6. a. Failure of electrical heaters in evaporator-melters and transfer lines.	6. a. Temp. indicators with alarms on transfer line, evaporator-melter, and casting machine.	6. a. Heaters replaceable remotely.
	b. Failure of vacuum system.	b. Vacuum instrument.	b. Tighten connectors. Steam jet and condenser remotely replaceable.
7. Inner capsule end cap welded, leak-tested, and decontaminated.	7. a. Dirty weld area.	7. a. Visual.	7. a. Manually brush and wipe clean with manip. before welding.
	b. Capsule leaks after welding.	b. Helium leak tester.	b. Capsule opened; contents reprocessed.
	c. Excessive contamination.	c. Swipe analysis. Radiation monitor.	c. Further decontamination.
8. Outer capsule end cap welded and weld-tested.	8. Defective outer weld.	8. Ultrasonic tester.	8. Outer capsule replaced, welded and tested.
9. Final capsule weighing and calorimetry.	9. a. High capsule temperature.	9. a. None.	9. a. Equilibrium centerline temperature (400C) well below melting point.
	b. Loss of cooling water.	b. High temperature alarm on cooling water.	b. Remove capsule to shielded storage.
10. Shielded storage in cells.	10. Cooling water failure.	10. Temp. indicator with alarm.	10. Emergency cooling water available automatically from onsite well.
11. Shielded storage in water pools.	11. a. Pump failure.	11. a. Temp. rise of pool water.	11. a. No immediate action necessary (6 hours), adequate for repair or replacement.
	b. Heat exchanger failure.	b. Temp. rise of pool water.	b. Move capsules to another pool until repair or replacement can be made.
	c. Cooling water failure.	c. Temp. rise of pool water.	c. Emergency cooling water available automatically from onsite well.
	d. Capsule failure.	d. Basin water radiation monitor alarm.	d. Return failed capsule to Cell G via transfer device for rework.

TABLE VI.K.3
UTILITIES SYSTEM MALOPERATIONS ANALYSIS

<u>Service</u>	<u>Failure</u>	<u>Indication of Failure</u>	<u>Remedial Action</u>
1. Raw water system for process cooling.	1. Loss of raw water.	1. None.	1. Automatic transfer to emergency source: deep well with diesel-driven pump.
2. Service-instrument air system.	2. a. Loss of one compressor. b. Loss of both compressors. c. Loss of normal power.	2. a. None. b. Visual. Reduced air pressure and quantity. c. Visual.	2. a. Automatic transfer to second compressor. b. Manually reduce service to non-process facilities. Tie-in portable compressor. c. Automatic transfer to emergency power: diesel-driven generator.
3. Ventilation system. Supply Fans Chilled Water Exhaust Fans	3. a. Loss of normal power to fans, pumps, compressors, etc. b. Loss of one K1 or K3 exhaust fans. c. Loss of both K1 or K3 exhaust fans.	3. a. Visual. b. Visual. c. Visual.	3. a. Automatic transfer to emergency power: diesel-driven generator. b. Automatic transfer to installed spare fan. c. Automatic shutdown of K1 system supply fan if both K1 exhaust fans fail; automatic shutdown of both the K1 and K3 supply fans if both K3 exhaust fans fail.
4. Normal electrical power.	4. Line, transformer, switch-gear.	4. Visual.	4. Automatic transfer to emergency power: diesel-driven generator.
5. Emergency electrical power.	5. Diesel-driven generator.	5. Loss of building power.	5. Evacuate building. Automatic transfer to battery-operated lighting.

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VII. PROTECTION OF THE PUBLIC

A. Introduction

1. General

The techniques utilized in the siting, design, fabrication and operation of the Waste Encapsulation and Storage Facility (WESF) described in this document are intended to protect the general public against the effects of the discharge of radioactivity to the environment in excess of the limits defined in AEC Manual (AECM) Chapters 0524⁽¹⁾ and 0510⁽²⁾. Radiological safety criteria for consideration and inclusion in the design concepts have been established to provide the consistent application of radiation protection principles in the design of the facility buildings and process equipment with the aim of providing effective contamination and radiation exposure control.

2. Safety

Safety requirements have been incorporated in design and operating criteria. Engineering safeguards included in the design are based on:

- a. Experience gained in the design and operation of similar facilities.
- b. Hazards and design analyses.
- c. The requirements defined in applicable regulations.

Specific radiation protection design criteria used in the development of the facility design (cell design, shielding, traffic control, ventilation, materials handling, decontamination area, storage areas, waste disposal, etc.) are contained in Appendix A.

During facility operation, radioactivity can leave the WESF area limits by means of the following routes:

<u>Route of Egress</u>	<u>Condition of Operation</u>	
	<u>Normal</u>	<u>Abnormal</u>
a. Stack	Yes	Yes
b. Return of liquid waste to 221-B Building control	Yes	Yes
c. Solid waste	Yes	Yes
d. Egress of personnel	No	Yes
e. Cooling water	No	Yes

The primary route of egress of concern during normal operation is activity discharged through the 70 foot stack as a result

of the various process and facility operations. Based on estimated release rates, under normal operating conditions, it is determined that the peak activity concentrations at ground level both on and off the Hanford Reservation are well below the levels established in AECM Chapter 0524. During abnormal or accident conditions, the route of egress of concern is also through the 70 foot stack. As shown in Section D of this Chapter, the exposure a person would receive standing about 100 meters from the stack would be an infinite time bone dose of 2.3 rem, which is within the guidelines of AECM Chapter 0524 for personnel in a controlled area.

B. General Design Considerations

The design criteria for radiological safety will result in the following:

1. The hazard potential occasioned by personnel transporting contamination into the environment is minimized by isolation -- using buffer zones between "clean" areas and potentially contaminated areas. A single-pass ventilation system is employed to minimize the transportation of particulate contamination to cleaner areas by directing air flow toward the areas of higher contamination probability. The handling of equipment and waste materials removed from the process cells is accomplished by remote handling devices where possible. This reduces exposure to personnel and reduces the probability of releasing contamination to the environment through personnel egress.
2. The hazard potential associated with airborne contamination is reduced by multiple filtration stages using HEPA filters which effectively filter all air flows and, to this extent, control the radioactive discharge from the exhaust stack.
3. The risk of radioactive liquid contamination of the ground and the water table is minimized through the utilization of double confinement features for liquids in storage tanks and process lines. Instrumentation will be installed to detect leakage from primary containers.

The design criteria for radiological safety have been integrated with other plant design considerations. Where a conflict in various criteria may have existed, safety requirements have governed. Chapter V, Equipment Description, lists the design standards followed for pressure vessels, radiography, classification of electrical equipment, materials compatibility, etc.

C. Normal Operations

1. General

During routine operations, the areas of chief concern with regard to potential hazards to the public are:

- a. Discharge from the stack to the atmosphere.
- b. Shipment of waste materials from the facility.
- c. Leakage of storage tanks or lines containing radioactive liquid.

2. Stack Discharge

As described in Chapter VI, the ventilation system is designed so that, under normal operation conditions, the flow of air is always from areas of least potential contamination into those of higher potential contamination. Air entering the process cell from the Canyon is filtered to reduce dust loadings on downstream HEPA filters. These filters serve as an aerosol barrier in the unlikely event of reverse flow on shutdown of the exhaust system. Replaceable filters are provided in the exhaust lines from all major sources of contamination such as the process cells, hoods, etc. All process exhaust air is then combined into a single air stream and exhausted through two final sets of high efficiency filters in the filter vault before being discharged from a 70 foot high stack. To monitor the integrity of the exhaust air filtration system, a continuous particulate radiation monitor is located at the stack inlet plenum to warn of abnormal concentrations. See Chapter VI for additional details.

An analysis of the exhaust stack design indicates that the stack height of 70 feet will provide good atmospheric dispersion under all site meteorological conditions. The once-through ventilation system, which provides for differential pressure control and volumetric flow adjustment, and a series of filters throughout the air-handling system, minimize the entrance of contamination into the exhaust air flow.

Details of the various assumptions used to calculate the potential ground concentrations of radionuclides discharged from the 70 foot exhaust stack during normal operation are presented in Appendix B. The assumptions for calculating the releases from normal operations are listed below:

- a. Contaminated air from a process cell will be discharged to the environs via three HEPA filters.

The efficiency of the first filter was taken as 99.97 percent and the efficiency of the succeeding two filters was taken as 99 percent each.

- b. The release rate of SrF_2 and CsCl per batch was estimated to be as follows:⁽³⁾

	<u>Release Point</u>		<u>Batches/Year</u>
	<u>Vessel Vent</u>	<u>Cell</u>	
$^{90}\text{SrF}_2$	250 Ci	500 Ci	200
$^{137}\text{CsCl}$	250 Ci	125 Ci	63

- c. Air flow from the stack: 20,000 cfm.

Using the above assumptions and meteorological data from the Hanford Weather Tower located about three miles west of the facility, the releases of radionuclides from the 70 foot high stack were calculated. The detailed calculations are shown in Appendix B and are summarized in Table VII-1.

TABLE VII-1

POSTULATED RELEASES OF ACTIVITY DURING NORMAL OPERATIONS

<u>Isotope</u>	<u>Release Rate*</u> <u>Total Ci/Batch</u>	<u>Discharge Rate**</u> <u>Ci/Yr</u>	<u>Stack Discharge</u>	
			<u>uCi/ml</u>	<u>% of C.G.***</u>
^{89}Sr	375	0.0023	7.4×10^{-12}	0.025
^{90}Sr	750	0.0045	1.5×10^{-11}	1.5
^{134}Cs	37.5	0.00007	2.4×10^{-13}	0.0024
^{137}Cs	375	0.00071	2.4×10^{-12}	0.024
^{144}Cs	37.5	0.00023	7.4×10^{-13}	0.013

*Estimated total amount of material released to the cell and/or the vessel vent system.

**The decontamination factor (df) for three HEPA filters in series taken as 3.3×10^7 .

***AECM Chapter 0524, Annex A, Table I - Controlled Area. (Based on lower concentration guide).

The postulated release rates may also be compared to the Atlantic Richfield Hanford Company Release Guide of 0.01

Ci/week of $^{90}\text{Sr}^{(4)}$. For average meteorological conditions in the sector from which the wind blows most frequently (NW sector), release rates (Table VII-I) result in a maximum concentration of approximately 5×10^{-16} uCi/cm³ at a distance of 200 meters (still within the boundaries of the 200 East restricted area) from the WESF facility toward the Tri-Cities area. At the Tri-Cities area, which is about 35,000 meters downwind, the contamination concentration would be reduced to about 4×10^{-18} uCi/cm³. These concentrations are well below the Concentration Guides (CG) established in AECM Chapter 0524 for unrestricted areas. For the meteorological condition which results in minimum dispersion of stack effluent, ground level concentrations are still well below the Concentration Guide levels. It is therefore concluded that normal release of activity through the exhaust stack should not result in activity concentrations in excess of the guides defined in AECM Chapter 0524.

3. Disposition of Solid Waste

The disposition of solid waste will be according to the proven procedures established in ARH-1842⁽⁵⁾ which implements the AECM Chapter 0510 and pertinent Immediate Action Directives. The material to be disposed of will be, where possible, reduced in radioactivity by extensive decontamination and then reduced in volume as much as practical before being buried or placed in interim storage. Disposal of waste would be performed as necessary to maintain good process operations and housekeeping. However, during abnormal conditions it is anticipated that the burial would be stopped or held in abeyance until such time as more favorable conditions existed. Therefore, the risk of the spread of radioactive materials to the environs is minimal and thus the hazard to the public health and safety is inconsequential.

4. Egress of Personnel

Significant release of radionuclides to the environment through the egress of personnel from the WESF is considered to be highly improbable. Administrative controls, in the form of operating procedures, will delineate the methods and equipment to be utilized in assuring effective control. Personnel traffic patterns, protective clothing and equipment, decontamination showers, and monitoring equipment will be provided for all persons working in potentially contaminated areas.

5. Cooling Water

The Cooling Water Systems for the process equipment are the once-through type. The system with the higher radionuclide release potential employs a radiation monitor which will

divert the cooling water to the floor drainage receiver tank if leakage of radionuclides is detected. The contaminated cooling water can then be transferred to B Plant for reprocessing.

6. Leakage of Storage Tanks

All bulk storage tanks containing high level feed or waste solutions will be located in the 221-B Building which has been evaluated for hazards as reported in ARH-139⁽⁶⁾. The operation of the WESF will not increase the risk of the present 221-B process.

A low level waste tank for the interim storage floor drainage will be placed in a concrete storage vault below ground level. The probability of the tank containing anything but low level waste is remote. However, if the tank should fail, the concrete vault will be designed so as to contain the solution and to permit its safe return to the process.

7. Conclusions

Based on the normal operation of the WESF described herein, there should be no discharge of radionuclides to the environment in excess of the guidelines set forth in AECM Chapter 0524.

D. Abnormal Operations

1. General

Abnormal type events which have the potential to release radionuclides to the atmosphere have been evaluated (Chapter IX, Postulated Incidents). Incidents such as gross spills and chemical explosion were considered. Data displayed in the following discussion and references indicate that there would be no adverse affects to the environment or to the public health and safety from these incidents.

2. Release to the Atmosphere

An extensive safety review of the waste encapsulation process, equipment, and building layout leads to the conclusion that the maximum credible accident (MCA) is caused by the spilling of a powder boat containing 40,000 curies (800 grams) of strontium fluoride (SrF_2) powder within a process cell. (See Chapter IX, Postulated Incidents, pages 24-25 for analysis of probable outcome of this MCA.) An analysis of the powder size indicates that as much as 10 percent or 4,000 curies could become airborne. The other 90 percent of the powder

is large enough to remain on the spilled surface or settle to the surface almost immediately.

In analysing this MCA, it was assumed that:

- 1) Two of the three in-line HEPA filters had failed, but that the third was effective and operable and had an efficiency of 99.97 percent;
- 2) The radioactive material was released during a 10 minute period which is equivalent to a "puff" type release.

From the above assumptions:

- 1) The radiation doses calculated were for the center line of the plume and represent maximum values; and
- 2) The resulting doses calculated are infinite time doses.

The results of the calculations using the above assumptions and the appropriate table and figures in Appendix B are given in Table VII-2.

A review of the calculations shows that the maximum ground concentration and maximum personnel exposure doses occur within the 200 East Area at about 100 meters from the exhaust stack. Although the maximum ground concentration is above the Concentration Guide values for air, the duration of the cloud passage is short. Thus, a person exposed to the ^{90}Sr cloud for the full ten minutes it takes to pass, would receive an infinite time bone (critical organ) dose of 2.3 rem and a first year bone dose of 0.09 rem. These exposures are well within the guideline value for exposure to bone given in AECM Chapter 0524.

The nearest large population zone is Richland at a distance of 35,000 meters. The first year bone dose due to ^{90}Sr at this distance would be about 0.002 rem, which is about one percent of the National Council for Radiation Protection value of 0.17 rem for large populations. The nearest pasture land for milk cows is at a distance of 16,000 meters. The life time bone dose due to ingestion of ^{90}Sr via the milk path is estimated to be 0.003 rem. Thus, it is concluded that the maximum credible accident will not adversely affect the public health and safety.

The evaluation of a maximum credible accident involving cesium (Chapter IX - page 25) assumes a hypothesized release of 14.4 curies to the atmosphere following one stage of HEPA filtration. The assumed ten percent release (43,000 curies) is considered

to be in excess of any actual release possible. The results of the evaluation show that the cesium release has less affect on the exposure of both the plant employee and the general public than does the Sr^{90} release. The comparison of the ^{90}Sr and ^{137}Cs calculation is shown in Table VII-2.

E. Conclusion

Based on the above analyses, it is concluded that neither the very low routine releases due to normal operation nor the postulated releases due to the maximum credible incidents will endanger the public health and safety.

TABLE VII-2
EFFECT OF STRONTIUM-90 AND CESIUM-137
RELEASE TO THE ENVIRONS

<u>Radio- nuclide</u>	<u>Release Due To Spill - Ci</u>	<u>df</u>	<u>Maximum Stack Release</u>	<u>Max. Ground** Concentration</u>	<u>Infinite Time Dose In rem</u>				
					<u>Bone</u>	<u>Lung</u>	<u>Cloud</u>	<u>Whole Body</u>	<u>First Year Dose in rem</u>
⁹⁰ Sr	4,000	3.3X10 ³	1.2 Ci	5.8X10 ⁻⁴ uCi/cc	2.3*	0.25	0.0002	-	0.09*
¹³⁷ Cs	48,000	3.3X10 ³	14.4 Ci	6.9X10 ⁻³ uCi/cc	-	-	0.002	0.03*	0.076*

*Critical organ - Isotope is assumed to be soluble.

**This maximum ground concentration occurs at about 100 meters from the exhaust stack.

REFERENCES

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VIII. PROTECTION OF FACILITY PERSONNEL

A. Summary

The Waste Encapsulation and Storage Facility (WESF) design features and characteristics have been evaluated to demonstrate that necessary consideration has been given to the development of a plant and process that provides a safe environment throughout a spectrum of conditions. The analysis has verified that the facility complies with the general requirement of no undue hazard to the health and safety of facility personnel, and includes adequate provisions for protection from external radiation and internal deposition with regard to both the operation of the process proper and the necessary maintenance operations. This protection is achieved by designing to confine radioactivity to the normally unmanned areas within the facility, and by installing adequate shielding to limit the radiation exposure of personnel to the lowest practicable level consistent with the established standards of AEC Manual Chapter 0524, and by providing a radiation monitoring and alarm system to warn personnel of the existence of an abnormal radiation condition. The accidents hypothesized in Chapter IX were analyzed with regard to plant personnel. The analyses show that no hazard, that would endanger the health and safety of facility personnel, should result.

B. Design Criteria

The design criteria of the WESF and modifications to the 221-B Building are such that the facility operation will conform to the rules and regulations specified in AECM Chapter 0524, Standards for Radiation Protection. The design of the facility provides for adequate surveillance of plant operations in order to assure that plant personnel are protected from:

- 1) External radiation
- 2) Internal deposition
 - a) Inhalation of airborne radioactivity
 - b) Ingestion, absorption or injection of radioactive contaminants

While careful and detailed monitoring by well-trained and indoctrinated personnel using proper procedures and equipment are required to provide the necessary safety, an environment conducive to such objectives is created by effective facility design. The design provides for:

- 1) Use of one or more confinement barriers between materials in process and personnel access areas;
- 2) Separate once-through ventilation systems for the potentially contaminated and contaminated areas, obtaining

supply air from outside and exhausting through increasingly potentially contaminated or more contaminated areas with final discharge to the atmosphere through high efficiency filters (HEPA) and a common 70 foot high stack;

- 3) Sufficient shielding consistent with all radionuclide inventories planned for the facility;
- 4) Isolation of "clean" areas from potentially contaminated areas by utilizing buffer zones;
- 5) Remote handling of process product and other contaminated materials;
- 6) Use of reliable radiation resistant and remotely replaceable equipment for high radiation areas with arrangement to facilitate decontamination;
- 7) Use of surface coatings and materials selected for ease of decontamination and compatibility with the chemical process for potentially contaminated areas;
- 8) Radiation monitoring and alarm systems located throughout the facility;
- 9) Interlocks on doors to potentially hazardous areas to prevent inadvertent personnel entry;

One or more confinement barriers will be employed to physically prevent the transport of radioactive material. For removal of contaminated process equipment other provisions such as prior flushing, plastic bagging, appropriate protective clothing and respiratory protection, and careful monitoring will be used to protect personnel from excessive exposure. When the material in the process is in a liquid or slurry form, the barriers consist of the tanks, piping and the concrete wall of the cell. The powder form of process material is partially contained in the process filter cartridges, furnace and other process containers, in addition to being totally contained by the concrete wall of the cell.

The ventilation systems are designed to maintain the necessary direction and velocity of air flow during intentional breaches of barriers for all operating and maintenance conditions. A minimum air velocity of 100 linear feet per minute through any breach or opening into the cells can be maintained at all times, which is adequate to prevent migration of particulate material from the cell.

C. Normal Operation

1. External Radiation

The most practical protection for the worker from penetrating radiation is a sufficient thickness of shielding between him and the radioactive material at all times. The shielding provisions are described in Chapter VI. In general, the shielding is designed for the maximum quantity of radioactive material in any particular area, such that the radiation level in normally occupied work areas will be no more than 1 mR/hr. The integrated dose received, therefore, in these areas will be below permissible exposure guides. Additional allowable exposure would be available for maintenance and other operations.

For those cells designed for personnel access, intercell shielding is provided to permit entry without the need for removing radiation sources in the adjacent cell. This shielding is designed to reduce the radiation level to less than 1 mR/hr with 1 MCi strontium-90 in the adjacent cell. The personnel entry shielding doors to these cells will provide the same shielding as the adjacent cell walls. Access to these cells and the canyon will be controlled by door interlocks to prevent entry when a high radiation field exists. Administrative controls will be utilized to prevent unplanned changes in radiation status during personnel occupancy of a cell.

The AMU area located above the Operating Gallery at the canyon level will have less shielding than does the Operating Gallery. This shielding, however, is designed to reduce the dose rate to less than 1 mR/hr except when process equipment is moved from the cell into the canyon. The design is such that the dose rate will be less than 5 mR/hr on the AMU side of the wall with a point source of 10,000 curies of strontium-90 at 42 inches from the canyon side of the wall. The 10,000 curie source is considered to be the maximum that would be encountered in the removal of process equipment from the cell.

The Capsule Storage Basin will provide sufficient shielding to reduce the dose rate at the surface of the water to less than 0.2 mR/hr under normal conditions.

Cell design provides for the transfer of material between cells. The pass-through doors between the personnel entry areas (Cells A, G, and the Service Gallery) and the adjacent cells will provide shielding equivalent to the cell walls. Mechanical interlocks are provided to prevent the doors on both sides of the walls from being opened simultaneously. The pass-through doors between the other cells

are provided primarily for intercell contamination control and afford only incidental shielding.

The sampling systems, described in Chapter IV and Chapter VI, have been designed to permit sampling to be performed within the cells. Powder and liquid samples will be transferred in sample containers to Cell A, placed in shielded carrying containers, and moved into the Service Gallery via the pass-through.

Radiation dose rates in all noncontaminated support areas, (i.e., offices, lunchroom, etc.), will be less than 0.1 mR/hr.

Maintenance work will normally contribute to the radiation exposure of plant personnel. The amount of time spent in performing maintenance is reduced by selecting surface coatings and materials for relative ease of decontamination along with equipment that is reliable, radiation resistant, and remotely replaceable.

2. Internal Deposition

a. Inhalation

To prevent inhalation of contaminated air by plant personnel the cells are designed to confine radionuclides within a separate ventilation system. This system operates at a pressure negative to that of personnel areas. Under normal operating conditions, no radioactive material should escape the confinement barriers and pass into the operating areas. The single ventilation system to be installed in the facility is a highly effective means of controlling the transport of particulate contamination from areas of high to areas of low concentration probability. Blowers, provided with a source of emergency power from a diesel motor-generator, exhaust air from the cells through multiple HEPA filters. In addition, air is pulled into each cell through individual HEPA filters to minimize contamination in case of transient backflows. The ventilation system is described in detail in Chapter VI.

Air particulate samplers and monitors are to be installed in all personnel areas where a potential for airborne radionuclides exist; i.e., operating and service galleries, etc. Two types of systems will be utilized, both of which will be connected to a common vacuum system. Fixed filter paper type samplers will be located throughout the building. Periodically, the filter papers will be manually changed and analyzed to provide qualitative and

concentration data of airborne particulate radio-nuclides. The second type will consist of fixed paper samplers with continuous monitors and recorders. These will be located throughout the facility, including one to monitor the stack effluent air. Audible and visual alarms will be set to indicate when normal levels are exceeded, so that appropriate action can be initiated to protect personnel.

b. Ingestion, Absorption or Injection

The control of radionuclide ingestion or absorption through the skin involves the development of good worker safety and personal hygiene habits in addition to use of adequate protective equipment. In those areas of the facility in which it is desired to have unrestricted personnel access, it is necessary to maintain radio-active contaminants at negligible levels. Isolation, a prime requisite for contamination control, depends upon the effectiveness of methods used to prevent transport of radioactive contaminants into the "clean" areas.

Personnel traffic patterns are designed to provide contamination control. Air locks, protective clothing, change rooms, personnel monitoring stations, and a de-contamination room are incorporated in the design. The Operating and Service Galleries, Canyon, Hot Manipulator Repair Shop, Personnel Entry Cells, Transmitter Rooms, and the Capsule Storage Basin area are the principal regions comprising the potentially contaminated areas. Precautions will be required in these areas to minimize contamination and to prevent its accidental transport to other areas. The Operating Gallery, while considered a zone of potential contamination, is expected to be maintained in a clean condition; and the use of protective clothing should not normally be required.

No difficulty is anticipated in conducting the normal operation of this plant within the framework of permissible levels of exposure.

D. Abnormal Operations

Abnormal events having the potential for releasing radionuclides to the atmosphere have been evaluated (Chapter IX). These events, in addition to minor occurrences posing no hazard to the general public, could result in increased radiation exposure to personnel within the facility.

A loss of contamination control within the building could result from cell pressurization, e.g., a chemical reaction such as a hydrogen

explosion. Airborne radionuclide concentrations in excess of controlled area concentration guides can be hypothesized in the Operating Gallery following such an incident. Air monitors and area radiation alarms would promptly alert personnel to the hazard. Should such an event occur, it may be necessary to immediately evacuate the operating area. To minimize the possibility of any movement of airborne contamination from the cells into the operating areas of the building, gaskets, sealouts, filters, and differential pressure controllers are provided.

In the postulated incidents, where airborne contamination escaped the building, it did so only through the ventilation system. The radioactive material would be dispersed dependent on the prevailing atmospheric conditions. In the area immediately beneath the exhaust stack, the air concentration will be less than it would be at a more distant point under most atmospheric conditions. Therefore, facility personnel should not receive doses from radionuclides in the ventilation exhaust air greater than those shown for the maximum hypothetical accident in Table VII-1.

Minor occurrences with the potential for causing increased exposure to facility personnel might be illustrated by:

- 1) Spilling of radioactive process samples.
- 2) Tracking of spilled radioactive materials.
- 3) Pulling of radioactive solutions into jet steam supply lines by a failure in the venting system.
- 4) Leaking feed or waste lines.

With respect to the process, a number of possible maloperational events were postulated, and the remedial action recommended in Chapter VI. These events, however, result in little or no hazard to facility personnel.

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IX. POSTULATED INCIDENTS

A. Fire

The most serious radiological hazard as a result of a fire in the Encapsulation Facility is considered to be that associated with a fire in an in-cell exhaust filter.

1. Potential Cause

During normal operation of the facility, solid waste generated in the process cells will be transferred to Cell A for disposal. Part of this waste will consist of combustible material such as clean-up swabs and manipulator boots. While the normal combustible loading in the cells will be very low, there may be occasions, (e.g., during extensive decontamination efforts) when the combustible loading could increase; thereby increasing the fire potential. Any process cell fire has the potential for involving the in-cell exhaust filters, thus, jeopardizing primary containment.

2. Path of Radionuclide Release

The path for the potential release of radionuclides to the atmosphere would be through the in-cell filter, through the double HEPA filter banks of the K-3 system, to the atmosphere via the stack.

3. Postulated Effect

a. Possible

It is possible that an in-cell filter could be breached and depleted of all the radioactive materials it contained, if sufficient fuel were available and the fire burned for a long enough period of time. The loss of integrity of the final filter bank due to a fire in a process cell is difficult to envision considering the planned protection system.

The fire is postulated to occur in one of the strontium processing cells and the following assumptions are made:

- The load on the in-cell filter is 10 KCi of ^{90}Sr (equivalent to about 1/2 lb. of $^{90}\text{SrF}_2$).
- The ^{89}Sr to ^{90}Sr ratio is 0.5.
- The final filter bank maintains a decontamination factor of 3.3×10^5 . (3.3×10^3 for the first filter and 10^2 for the second filter).

- o The release takes place over a relative short time period under adverse atmospheric conditions.

The postulated release to the atmosphere would then be 0.015 Ci of ^{89}Sr and 0.03 Ci of ^{90}Sr . The resulting maximum exposure to on-site personnel, as shown in Table IX-A-1, would be less than 0.5 percent of the Occupational Exposure Standards as stated in AEC Manual Chapter 0524. Maximum off-site exposure would be less than 0.2 percent of the Non-Occupational Exposure Standards.

b. Probable

It is not likely that sufficient fuel would be available for the fire to burn for a long enough period of time to breach an in-cell filter. Nor is it likely that the loading on the filter could approach 0.5 pounds of radioactive dust. It is probable that essentially no release to the atmosphere, in excess of that associated with normal plant operations, would occur.

4. Preventives

A number of features have been incorporated in the facility design to prevent a cell fire and to mitigate its effects should one occur. These features are discussed below:

- a) A convenient waste disposal system that lends itself to limiting the accumulation of combustible waste material in the cell.
- b) Sources of ignition are minimal in the cells. All electrical installations are compatible with the applicable electrical codes for the type of materials being handled.
- c) A fire detection and an alarm system is provided for the process cells as described in Chapter VI.
- d) A fixed manually operated cell spray system can be activated to extinguish a fire. An additional manipulator operated spray could be used in case of an in-cell filter fire.
- e) The in-cell filters are to be of the fire resistant type.
- f) Loss of containment can be prevented, should fire damage one of the in-cell filters, by routing the air flow through the alternate in-cell filter.

TABLE IX A-1

MAXIMUM EXPOSURE TO ON-SITE PERSONNEL FROM ACCIDENT

<u>Radionuclide</u>	<u>Quantity Inhaled (uCi)</u>	<u>Internal</u>			<u>External</u>	
		<u>Dose In First Year (mrem)</u>			<u>Cloud Dose (mrad)</u>	<u>Dose Rate At 1 Meter From Ground Deposition (mrad/hr)</u>
		<u>Bone⁽¹⁾</u>	<u>Lung⁽²⁾</u>	<u>Total⁽¹⁾ Body</u>		
⁸⁹ Sr	0.0025	0.25	0.45	0.007	0.001	0.0005
⁹⁰ Sr	<u>0.005</u>	<u>2.2⁽³⁾</u>	<u>5.5</u>	<u>0.15</u>	<u>0.0035</u>	<u>0.001</u>
Totals	0.0075	2.45	5.95	0.157	0.0045	0.0015

(1) Soluble form of radionuclide assumed.

(2) Insoluble form of radionuclide assumed.

(3) Consumption of milk produced in the contaminated area would add only 0.08 mrem.

B. Hydrogen Accumulation and Explosion

Throughout the encapsulation process, small quantities of hydrogen will be unavoidably generated due to the radiolytic decomposition of aqueous solutions or cooling water. Hazardous explosions could result if the hydrogen evolution from any source were allowed to accumulate in air and ignite. In analyzing where accumulations might occur and the hydrogen quantities evolved, three disparate types of hydrogen explosion incidents are identified:

- 1) In-Tank: Relatively small amounts of hydrogen (less than about five grams) collect and explode within the vapor space of a partially filled process tank, rupturing the tank but causing only minor damage to the cell and containment systems.
- 2) Storage Basin: A loss or blockage of ventilation flow through individual storage basin sections could allow a large amount of hydrogen to rapidly accumulate; the probability of ignition is low, and the potential for radiological damage is small.
- 3) Full Cell: A loss of cell ventilation allows a large amount of hydrogen to slowly accumulate in a cell atmosphere, and the resulting explosion could be postulated to breach all three HEPA filters besides causing mechanical and radiological injury to operating personnel.

Although any explosion is intolerable from an operating standpoint, it can be shown that an in-tank explosion of limited energy could be experienced with acceptable risk to the environment, plant personnel, and off-site population. However, an explosion involving a full cell accumulation must be precluded by engineered safeguards and administrative controls which make the probability essentially nil.

The following discussion covers the intrinsic safety of the encapsulation facility in regard to occurrences of in-tank explosions, basin explosions, and the probability factors related to the prevention of the larger, full cell explosion.

1. Postulated In-Tank Explosion

Despite precautions taken to prevent hazardous concentrations of radiolytic hydrogen from accumulating in process tanks, deviations from administrative procedures, or an equipment failure could lead to an explosion.

The sections below analyze the most severe in-tank explosion considered possible, describing: 1) a source of hydrogen accumulation having the maximum explosive energy, 2) the damage and pressurization that would result in the cell, 3) damage to HEPA filters and containment systems, 4) paths

for radionuclide release, 5) postulated exposure effects to personnel and the environs, and 6) preventative safeguards.

a. Postulated Cause and Source

High concentrations of radioisotopes are present in the process solutions, consequently radiolysis of water to yield hydrogen is an ever-present reaction. Air purges are normally used to keep the hydrogen concentrations in vessel atmospheres well below the lower flammability limit of four percent in dry air. However, a flammable mixture of hydrogen in air could be obtained in a tank if the purge air to that tank were stopped for a short period of time. Table IX-B-1 gives predicted values of critical accumulation times for major process tanks. Although certain cesium handling tanks could accumulate explosive atmospheres in relatively short times (6.0 minutes), the quantities of hydrogen are not the maximum as in the case where accumulation occurs in the largest volume process vessel, the strontium supernate hold tank (TK-B-2).

Under normal operating conditions, potentially explosive vessel atmospheres will not be intentionally exposed to high temperature ignition sources. However, in certain cases (TK-B5 for example) static charges, mechanical impact, or maloperation of electrical instrumentation must be recognized as potential ignition sources.

b. Explosion and Energy Release

The following assumptions are made in the analysis of the potential pressurization effects of a postulated hydrogen explosion:

- The explosion occurs in the 189-liter vapor space of the strontium supernate hold tank containing a hydrogen-air mixture at one atmosphere pressure.
- The initial pressure of the surrounding cell atmosphere (20.8 cubic meters) is -1.4 inches water.
- The concentrations of hydrogen and oxygen in the tank atmosphere prior to the explosion are in stoichiometric proportions, i.e., 29.6 percent H_2 , 14.8 percent O_2 , and 55.6 percent N_2 .
- Water vapor is absent prior to ignition.

RADIOLYTIC HYDROGEN GENERATION SUMMARY

(MAJOR PROCESS VESSELS ONLY)

Tank Name	ASSUMED TANK CONTENTS:			G_{H_2} Value (Ref. No.)	Hydrogen Generation Rate (liters/hr)	Vapor Space Over Nominal Liquid Level (liters)	Time to Accumulate 4% H_2 in Stagnant Vapor Space
	Source	Form	Solution				
Sr Feed Metering (TK-B1)	150 KCi ^{90}Sr	In Solution	3.1M NO_3^-	0.03 ⁽¹⁾	0.25	20	3.3 Hrs.
Sr Precipitator (TK-B5)	150 KCi ^{90}Sr	In Solution	3.1M NO_3^-	0.03	0.25	60	9.8 Hrs.
Sr Supernate Hold (TK-B2)	150 KCi ^{90}Y	In Solution	3.1M NO_3^-	0.03	0.21	30	5.9 Hrs.
Sintering Furnace (E-B8)	150 KCi ^{90}Sr	Wet Powder*	0M NO_3^-	0.46 ⁽¹⁾	3.9	20	13 Min.
Cs Feed Metering (TK-D1)	480 KCi ^{137}Cs	In Solution	0M NO_3^-	0.46	8.9	32	9 Min.
Cs Converter (TK-D2)	480 KCi ^{137}Cs	In Solution	2.3M Cl^-	0.46 ⁽¹⁾⁽²⁾	8.9	22	~6 Min.
Evaporator-Melter (E-E1)	480 KCi ^{137}Cs	In Solution	2.3M Cl^-	0.46	8.9	22	~6 Min.
Sr Decontamination Baths (TKS-C1, F1, F2..)	300 KCi ^{90}Sr	Capsules**	0M NO_3^-	0.46 ⁽¹⁾	0.4	---	---
Cs Decontamination Baths (TKS-E10, F1, F2..)	240 KCi ^{137}Cs	Capsules**	0M NO_3^-	0.46	3.	---	---
Shielded Capsule Storage (TK-G7)	540 KCi ^{137}Cs	Capsules** (9 capsules)	0M NO_3^-	0.46	6.6	42	16 Min.

*Abnormal Condition

**Calculations for capsules assume - 66% of Cs capsule power absorbed in water
- 05% of Sr capsule power absorbed in water

- The hydrogen is completely oxidized to water according to the reaction $2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2\text{H}_2\text{O} (\text{g})$.

The maximum pressure in the tank is estimated to occur in 0.01 second following detonation. Experimental results for similar conditions indicate a maximum pressure of about 60 psia would be obtained in the tank following an explosion.⁽³⁾ Calculations, assuming adiabatic combustion, yield a maximum pressure of 112 psia and an equilibrium temperature of about 2,500°C.⁽⁴⁾ Since detonation would likely occur, a shock wave resulting from the detonation could produce a transient maximum pressure of greater than 1,000 psia within the tank.

The pressure resulting from the detonation would probably burst the tank. The fragments of projectiles from this tank might penetrate and rupture the neighboring tanks containing strontium solution. Damage to the cell window is not expected to jeopardize containment. A fraction of this strontium-bearing solution is assumed to be dispersed into the cell atmosphere as a mist. The cell pressure, assuming attainment of equilibrium and no release via vents, would increase 1.7 psi to about 16.4 psia. This pressure would not be sufficient to lift the cell cover blocks (18.7 psia required).

c. Effect on Ventilation and Containment Systems

The containment barriers provided by the in-cell HEPA filter and the plastic manipulator boots would probably be ruptured as a result of cell pressurization and/or flying debris. Testing of fire resistant HEPA filters of various sizes has determined their ability to withstand explosive shock waves without suffering a loss of rated filtration efficiency.⁽⁵⁾ Table IX-B-2, page 8, summarizes this data, showing the highest peak over-pressures of incident pressure waves to which filters were subjected without failures (safe) and to failure (fail).

By interpolation it appears that the 12x12x11.5-inch in-cell HEPA filters might be expected to withstand the postulated cell pressurization of 16.4 psia (1.84 psi differential across filter). However, considering the lack of test data for this specific filter and the apparent low margin of safety, further analysis of this incident will make the conservative assumption that the in-cell HEPA filter does fail.

TABLE IX-B-2

"SAFE" OR "FAIL" PEAK SHOCK WAVE
OVER-PRESSURES (psi) FOR HEPA FILTERS

	<u>Filter Size</u>		
	<u>8x8x6 in.</u>	<u>12x12x6 in.</u>	<u>24x24x12 in.</u>
New Filters:			
SAFE	4.32 psi	3.47	3.12
FAIL	4.53	3.58	3.25
Dust Loaded* Filters:			
SAFE	3.90	--	2.39
FAIL	3.93	--	2.90

*Dust loading equivalent to a differential pressure drop of 4 in. water.

The exhaust HEPA filters, located in the K3 filter vault, can be expected to withstand the subsequent pressure surge without failure. Assuming all pressures generated during the explosion are instantaneously vented via the normal cell ventilation duct, the pressure in the plenum would only be increased to 15.3 psia. The differential created (0.90 psi) across the exhaust HEPA filter (24x24x11.5 in.) would be far less than the tested maximum (2.39 psi) and, thus, failure of these final two filter banks is improbable as a result of an in-tank explosion.

d. Path and Magnitude of Potential Radionuclide Release

The normal path of vessel atmosphere flow is from vessel to vent header, to vessel vent filters, to cell exhaust duct, to the exhaust HEPA filters (K-3 System), stack and to the atmosphere. In the event of an in-tank hydrogen explosion, three other release paths are postulated:

- Via a breached in-cell filter (Probable) - to cell exhaust duct, to exhaust filters, to stack, and to atmosphere;
- Via a breached manipulator boot (Possible) - to operating gallery, to gallery exhaust duct, to exhaust filters (K1 System), to stack, and to atmosphere; and

- Via a breached cell inlet filter (Possible) - to canyon, to canyon exhaust duct, to cell exhaust duct, to exhaust HEPA filters (K3 System), to stack and to atmosphere.

Release of explosion pressures to the stack via any of these three paths would result in the following maximum credible strontium (or cesium) emission. The cell atmosphere would probably carry a mist of strontium (or cesium) bearing solution. Guthrie and Nichols⁽⁶⁾ have analyzed the entrainment and filtration behavior of mists, finding that although unfiltered air may carry from 100 to 1,000 mg of mist per cubic meter, a single high efficiency filter will reduce the exiting concentration to 0.14 mg solution per cubic meter of air.

Assuming one cell volume of gas is released, carrying feed solution mist (~1.8 millicuries ⁹⁰Sr per mg solution), the quantity of radiostrontium released to the atmosphere via double HEPA filtration would be about 50 microcuries. Further, if it is assumed that the breached in-cell filter disperses a 10 KCi loading of ⁹⁰Sr powder to the cell exhaust duct, an additional 30 millicuries of ⁹⁰Sr would be released to the atmosphere.

Release of explosion pressures via path (2), a breached manipulator boot, could potentially transport airborne powder or mist to the operating gallery; several curies of ⁹⁰Sr could conceivably be introduced to the operating gallery by such a mechanism. In addition, process solutions which might be forced into AMU piping systems could create radiation levels of several R/hr. Radiation alarms would sound to warn personnel of the high radiation field.

e. Effects on Personnel and Environs

The postulated stack release of 50 microcuries ⁹⁰Sr (carried as a mist) plus 30 millicuries ⁹⁰Sr (dust) would result in maximum exposures to on-site personnel approximately equal to those predicted for the postulated fire incident (see Table IX-A-1).

f. Preventives

Purge air to all tanks and zones where hydrogen is evolved will be the principal mechanism used to prevent the attainment of flammable mixtures. In the event of an electrical outage, process air will be maintained by operating the compressors on the emergency electrical supply. Proper control and monitoring of the purge systems will be provided. A second preventive will be the absence of high

temperature ignition sources within vessels containing potentially explosive atmospheres.

2. Analysis of Storage Basin Explosions

Vapor spaces under the cover blocks of each capsule storage basin section are similar to process tanks in that explosive hydrogen-air mixtures could rapidly accumulate, if the ventilation flow was to stop. However, the potential for ignition, and the hazard consequences of an explosion are much lower as described below

a. Potential Cause and Source

Accumulation of hydrogen in a storage section vapor space (6.0 cubic meters nominal volume) would result primarily from radiolysis of the basin water shielding the cesium capsules. In a basin section containing the maximum inventory of cesium capsules (30 MCi), radiolysis would generate hydrogen gas at an estimated rate of 385 liters per hour. Thus, only 38 minutes would be required for a flammable hydrogen-air mixture to accumulate if ventilation flow through the vapor space were completely stopped. During normal periods of storage, no high temperature or spark producing source of ignition will be present in the space between the water level and the cover blocks. The infrequent task of moving cover blocks is viewed as the only conceivable mechanism which could trigger an explosion in the vapor space.

b. Explosion Effects and Radionuclide Release

Explosion of a hydrogen-air mixture in a storage basin section would create shock waves and a general pressurization which would probably lift the cover blocks. Pressurization of the storage basin area would be relieved via the normal route through the operating area ventilation exhaust system (K 1). Physical injury could obviously result to operating personnel in the storage basin area, but no release of radionuclides to the area or environs is considered probable.

c. Preventives

In the storage basin zones, prevention of explosions will rely on continuance of the ventilation flow beneath the cover blocks, and the normal absence of ignition sources. No spark producing equipment is planned in the storage basin space below the cover blocks and above the water level.

Operating controls as well as engineered safeguards will be in effect to assure proper flow, particularly during periods of maintenance or cover block movement.

- Dual exhaust fans are provided, one of which is a spare.
- Emergency power capability is provided to operate the ventilation system in the event of a normal power outage.
- An air flow measurement device and low flow alarm will be provided for each basin section exhaust port.

Thus, the probability of ever experiencing an explosion incident in this zone is essentially nil.

3. Analysis of Hypothetical Full-Cell Explosions

a. Potential Cause and Source

Large accumulations of hydrogen can be envisioned in Cells F or G, where the source of hydrogen would logically be from radiolysis of water in decontamination tanks or shielded storage tanks which vent directly to the cell.

For these cells, estimates of hydrogen evolution rate and the times to accumulate four percent hydrogen concentrations in stagnant air are shown in Table IX-B-3.

For Cells B and D-E, longer times would be necessary for hazardous mixtures to accumulate.

Accumulation of hydrogen in Cells F or G would require a double failure; both the purge flow to the tank and the ventilation flow through the cell would have to be stopped. Ignition of the explosive cell atmosphere could come from an electrical spark source (welder or leak tester motors), from the cell lights, or from manipulator work activities within the cell.

b. Explosion Effects and Radionuclide Release

Explosion of a hydrogen-air mixture in Cells F or G would create shock waves and a general pressurization which could: 1) breach all three HEPA filters in the K 3 cell ventilation exhaust system, 2) breach the manipulator boot containment barrier, and 3) lift the cell cover blocks.

TABLE IX-B-3

RADIOLYTIC HYDROGEN GENERATION
IN LARGE ("FULL CELL") ZONES

<u>Zone</u>	<u>Source (Cs Capsules Assumed)</u>	<u>Hydrogen Generation Rate (liters/hour)</u>	<u>Zone Volume (liters)</u>	<u>Time To Accumulate 4% H₂ In Stagnant Zone Air</u>
Cell F	720 KCi (4 capsules each in TKs F1, F2, F3)	9.0	20,000	3.8 Days
Cell G	540 KCi (9 capsules in TK-G7)	6.6	50,000	13 Days

Possible release paths are described in Section B-1 of this chapter. However, any pressurization release from Cell F or G would not be expected to carry significant quantities of radionuclides. Instead, the strontium and cesium dust loading on the exhaust HEPA filters (K 3 System) would be the primary concern; several curies might be released to the stack in the event these filters are ruptured.

In any cell such an explosion could also cause:

- Back-flow of process solutions into "cold" side piping systems;
- Gross contamination of the canyon and/or operating gallery;
- Mechanical damage to the cell; and
- Physical injury to operating personnel.

Process solutions released to cell sumps, the pipe trench, or forced back into gallery zones would be contained within the facility by waste collection and floor drain systems provided in the building design. (See Chapter VI.)

c. Preventives

Protection of process cells against "full cell" explosions is provided by three factors - purge flow, cell ventilation flow, and time - which combine to effect a low probability for failure.

- In every cell all sources (tanks) of potential hydrogen evolution will be protected by air purges which will dilute evolved hydrogen to nonflammable concentrations.
- In every cell only a fraction of the normal ventilation flow will be necessary to prevent the accumulation of flammable mixtures.

If both purging and ventilation flows were simultaneously reduced to zero, the time (>3.8 days for Cell F) to accumulate a flammable mixture would operate as a preventative; the probability is high that normal ventilation and instrument system surveillance will detect the abnormal flow conditions.

To minimize the potential or release of radionuclides in the event of filter failure, all HEPA filters will be replaced as dictated by radiation exposure or pressure drop.

C Vessel Coil Failure

Vessel coils and other heat exchange surfaces in the 225-B Building process cells are used for either heating or cooling service. Thermal shock factors are minimized by the use of separate single purpose coils where both heating and cooling are required. This concept differs from that used on the 221-B canyon vessels, where single coils are used alternately for both heating and cooling. The probability of coil failure is considerably greater for alternating service than for single purpose service, conservatively an order of magnitude. Air sparging is used for vessel agitation where required, minimizing the possibility of mechanical damage.

1 Potential Cause

The failure of process vessel heat transfer coils would most probably result from corrosion. Coils used for heating service would more likely experience a higher corrosion rate than those used for cooling service because of the higher coil metal temperature.

2. Path of Radionuclide Release

The routing of the cooling water and steam condensate effluents from process vessel coils depends upon the probability and consequences of their failure.

The cooling water from coils in 225-B Building process vessels containing solutions with high concentrations of

radionuclides is routed to the high-risk cooling water header. The cooling water from coils or tube bundles in process vessels, containing solutions at low radionuclide concentration or in process vessels which do not contain radioactive solutions, is routed to the low-risk cooling water header. Both the low- and high-risk headers have a continuous sampling, radiation monitoring, and flow measuring station (225-BD Building) located ahead of tie-in to the comparable B Plant systems. Upstream of the B Plant header tie-in, the high-risk header has a diverter station with capability for automatic diversion of the stream to an underground catch tank, TK-100, upon receipt of a signal from the 225-BD Building continuous radiation monitor. From TK-100, the contaminated cooling water is automatically transferred (liquid level control) to the Low Level Waste Tank, TK-39-1, in 221-B Building. From TK-39-1, routings exist to both a boiling waste tank farm and the 221-B Building Cell 23 concentrator for disposal. With processing operations suspended, the flow rate of the high-risk cooling water from 225-B Building is about five gpm. The low- and high-risk headers are normally combined downstream of the existing B Plant cooling water diverter station. The water in the combined header is then routed to parallel-operated retention basins for sampling prior to being released to the B Plant swamp or, if above swamp disposal limits, routed to a specific retention trench.

The strontium precipitator tank is the only vessel having a heating coil and also containing solutions with high radionuclide concentrations. The steam condensate from the heating coil is routed to the Low Level Waste Tank, TK-39-1, in 221-B Building.

The two process vent system heaters (E-B-4) and (E-D-12) are steam-heated and handle essentially only air having a low potential for contamination. The steam condensate from these heaters is routed to the low-risk cooling water header described in the preceding paragraph.

3. Postulated Effects

a. Possible

The quantity of radionuclides released would depend on several factors: solution concentration, the size of the hole, the pressure drop across the hole, and the time of flow through the hole. The following assumptions were made to postulate the maximum discharge of radionuclides to the high-risk cooling water header:

- The cooling water flow is stopped when a one-eighth inch diameter hole exists in the cooling coil pipe;

- The leak occurs in the coil of a tank containing ^{90}Sr feed solution (~8,000 ci/gal.);
- The failure has not been detected from a change (increase) in solution volume in the tank;
- Minimum leakage occurs while cooling water flow is maintained through the coil;
- Approximately 0.25 gallons of feed solution containing ~2,000 curies of ^{90}Sr are drawn into the coil for discharge to the cooling water header when flow is restored. If the coil is completely filled, the discharge would be ~8,000 curies of ^{90}Sr .

Upon resumption of cooling water flow, the radiation monitor on the high-risk header would alarm and send a signal to open the diversion valve for routing the contaminated water to an underground catch tank, TK-100. Procedures will be in place to promptly identify the tank with a failed coil. The solution in the faulty tank would be transferred to another vessel; the tank would then be flushed and repaired or replaced. Processing operations will be suspended immediately after cooling water diversion. Normally maintained at a low level, TK-100 has capacity (about 3500 gallons working volume) to contain approximately 12 hours of high-risk cooling water flow (~five gpm) with processing operations suspended immediately upon diversion. A process routing exists for the pump transfer of TK-100 contents to TK-39-1, 221-B Building. Steam-jet transfer of TK-39-1 contents to either the Cell 23 concentrator or the boiling waste tank farm can be made for disposal.

b. Probable

The probable effect of a radionuclide release to the environs from a failed heating or cooling coil would be much less severe than the possible effect discussed above. The failure would probably be detected by cooling water leakage into the vessel from the failed coil by tank liquid level instrumentation. The faulty vessel shall be emptied before shutting off the flow of cooling water to minimize the loss of process solution to the coil and subsequent release to the environs. The detection of cooling coil failures by liquid level increase is much more likely in the relatively small tanks used in the 225-B Building process cells than in the large 221-B Canyon tanks.

4. Preventives

Several features have been incorporated in the design to minimize the risk of process vessel heating or cooling coil failures in the 225-B Building:

- Detail design of the vessels has been performed for maximum integrity of the coils.
- Quality assurance inspection, including coil hydrostatic testing, is to be made before installation of the vessels.
- The process vessels are equipped with independent heating and/or cooling coils as required. With steam not used on cooling coils, the coil internal pressure should always be positive, insuring gross leakage of water into the vessel and not process solution into the coil. Each cooling coil discharge line has a restricting orifice not only to limit flow but to assure back-pressure on the coil for the prevention of in-leakage. A valve is also provided in each discharge line to shut off the cooling water flow after a feed batch has been processed; if a coil has failed, it should be easily detected by tank liquid level instrumentation. The cooling water supply valve would remain open. Further, the corrosion rate of the coil metal for cooling service is probably an order of magnitude less than for heating service.
- A safeguard will be provided in the steam line to the strontium precipitator tank (TK-B-5) heating coil. The steam will be purged after each use to prevent process solution back-flow to the "cold" side in the event of coil failure.

"Cold" operability tests will be conducted before the vessels are placed in radioactive service, again assuring the integrity of the coils.

D. Loss of Cooling Water

Process materials, ^{90}Sr and ^{137}Cs , require continuous cooling for the removal of heat generated by radioactive decay. This continuous cooling requirement is normally satisfied by cooling coils which transfer heat to a cooling water stream. The cooling water flow rate is adjusted manually to maintain the desired process temperature. The capsule storage basin water (demineralized) is cooled by recirculation through heat exchangers with raw water as the cooling medium. The cooling water is supplied to 225-B Building at about 100 psig from the 200 East raw water system through a

single, buried, 12-inch line, which also supplies the B Plant Waste Fractionization Facility.

1. Potential Cause

Loss of cooling water supply to the 225-B Building would most probably be from a break in the 12-inch line from the 200 East raw water system. Such a break could result from deterioration of the line or a violent physical shock such as an earthquake or a construction mishap.

2. Path of Radionuclide Release

Upon extended loss of cooling, process solutions containing sufficient quantities of radioisotopes would be heated to boiling and be evaporated to dryness. The residual dry salts would continue to heat, and it has been postulated that local temperatures could be reached which would cause vaporization of certain radioactive compounds. The resultant vapors would be condensed by the lower temperature K 3 exhaust system air, forming a dispersed aerosol. The path of potential atmospheric release for this incident is, therefore, from the tank to the process vent system containing a single HEPA filter; through the K 3 system exhaust filter banks (two in series), to the exhaust stack, and to the atmosphere.

The capsule storage basin water would boil upon extended loss of raw water for cooling with the time required to boil a function of the number of capsules in each section; a full basin section would start to boil in about 10 hours. The water vapor would be condensed by the lower temperature combined K 4 and K 1 system air flow and be filtered through the K 1 HEPA exhaust filter banks (two in series), to the exhaust stack, and to atmosphere.

3. Postulated Effects

a. Possible

The most severe effect of loss of cooling water is considered to be the atmospheric release of all dispersed radionuclides through only two stages of HEPA filters, assuming bypassing of the process vent system, which also contains a single absolute filter, and the individual cell exhaust HEPA filters. There is no postulated event caused by loss of cooling water which would affect the integrity of the final exhaust filter banks.

The quantities of radionuclides dispersed to the cell air and released to the atmosphere from the postulated incident are as follows:

<u>Radionuclide</u>	<u>Dispersed (Curies)</u>	<u>Released (Curies)</u>
^{90}Sr	300,000	0.90
^{137}Cs	1,500,000	4.5

The above values are based on the following conservative assumptions:

- Two feed batches of ^{90}Sr (150 Kci each) and three feed batches of ^{137}Cs (500 Kci each) are in the process cell tanks simultaneously.
- The ^{90}Sr and ^{137}Cs contained in the above feed batches are completely vaporized,
- Upon condensation, ^{90}Sr and ^{137}Cs are completely dispersed as an aerosol; all aerosol particles reach the final exhaust filter bank.
- The aerosol particle size is ≥ 0.3 micron, yielding a decontamination factor of 3.3×10^5 for two stages of absolute filters; 99.97 percent efficiency is assumed for the first filter stage and 99 percent for the second filter. No credit is taken for the 35 percent NBS prefilter in the final filter bank.

The release of radionuclides from failure of the raw water supply for capsule storage basin water cooling also would require the simultaneous failure of one or more capsules in the basin. Further, the fraction of capsule contents dispersed to the basin water and released via water vapor by boiling would be very small, probably orders of magnitude below those discussed above for process cell solutions.

b. Probable

The probable effect of loss of cooling water supply to the 225-B Building process cells and/or capsule storage basin heat exchangers would not result in the release of radioactivity to the environs. This conclusion is based on the following:

- Two emergency cooling water supply sources are available as backup to the normal raw water as discussed under Preventives below.

- The minimum time between loss of cooling water supply and heating to temperatures necessary for vaporization of radionuclides is about 36 hours (250 Btu/hr gal. solution) for the process cells and about 10 hours (minimum) for the capsule storage basins, sufficient to permit restoration of cooling water flow or implementation of emergency procedures.
- Even with total loss of cooling water supply, water can be trucked to the plant, from the river if necessary, and added directly to the affected process vessels and/or capsule storage basin, which would be permitted to boil but not to dryness.
- The process solution from all 225-B Building vessels can be transferred back to 221-B Building if necessary.

4. Preventives

The features of the primary and emergency systems which exist to prevent the loss of cooling water to the 225-B Building are discussed below.

a. Primary Raw Water System

The 100-B river pumping station (normal supply) maintains diesel-driven pumps on automatic standby to meet emergency requirements in the event of power failure.

Parallel supply lines, each capable of emergency requirements, exist between the river source and the 200 East Area.

A three million gallon reservoir in 200 East Area provides surge and storage capacity.

The B Plant raw water header, which furnishes the 225-B Building cooling water, is supplied at both ends; either end of the loop is capable of handling emergency requirements.

b. Emergency Supply Systems

- The 282-BA emergency well at B Plant is equipped with a diesel-driven pump to supply water at 1100 gpm and 100 psig automatically upon loss of pressure in the raw water header.

- The B Plant raw water header can be supplied from the existing 8-inch sanitary water header via hose bibbs and back-flow preventers to meet emergency requirements. The B Plant 2902-B high tank (50,000 gallon) automatically supplies water to the sanitary water header upon loss of header pressure.

E. Loss of Process or Instrument Air

Compressed air for the WESF, supplied by two parallel-operated oil-free compressors in the 225-BC Building each rated at 230 scfm and 100 psig, becomes process air after cooling and moisture separation. An air receiver tank in the process air system provides air to the instrument air system, which comprises an entrainment separator, parallel-operated dryers, a particle filter, and pressure-reducing stations. The compressors are designed to start and stop automatically to maintain the desired air receiver pressure (100 psig). Both compressors are on the emergency power supply from the diesel-driven generator. Either compressor can supply the total air requirements for normal operation so that one unit is essentially an installed spare.

Process air is used in the WESF for the following process control items:

- 1) Purging of gang valves and steam supply lines to the steam-motivated jets after use to prevent steam condensation and subsequent possible process solution back-flow.
- 2) Sparging of tanks containing process solutions for mixing; air receiver TK-F-6 is furnished in Cell F on the air supply line with individual flowmeters in Cells B and D for process vessels (which require agitation) to minimize the potential for contamination of the supply line to Cell F.
- 3) Motivating the jets required for sampling process solutions.
- 4) Dilution of the hydrogen formed by radiolysis of water in aqueous process solutions containing significant quantities of fission products to below the lower explosive limit.
- 5) Motivating Powder Tamper C-C-4 for strontium fluoride compaction in its inner capsule.

Instrument air has two major uses for process control:

- 1) Control of HVAC systems for confinement of radionuclides through the establishment of contamination zones by differential pressures.

- 2) Purge of process vessel weight factor and specific gravity dip tubes and the operation of diaphragm-operated control valves and pneumatic process instrumentation, including transducers, transmitters, indicators, recorders and controllers.

1. Potential Cause

Loss of compressed air supply could be caused by a total electrical power failure or mechanical breakdown of both compressors. The failure or improper functioning of one or more equipment components downstream of the compressors could result in the loss of process and/or instrument air.

2. Path of Radionuclide Release

Upon complete loss of process and instrument air, radioactivity could flow from process cell equipment to "cold" areas of the building, such as by-process solution back-flow in steam lines to jets following failure to purge with air after a transfer. The high radiation levels in the personnel-occupied areas would be detected by radiation monitoring equipment with an alarm to alert personnel of the radiation exposure hazard.

3. Postulated Effects

- a. Possible

It is possible that sufficient volume of feed solution could be transferred by a back-flow to result in radiation dose rates of several thousand R/hr at the source in normally occupied building areas. Processing operations would be shut down and emergency procedures put into effect. Radiation monitoring and protection procedures are well established for contamination control work in high radioactivity level facilities. Steps would then be taken to restore the affected area to normal background radiation levels, e.g., temporary shielding and flushing of the grossly-contaminated piping. Essentially no release of radionuclides to the environs would be experienced.

Loss of process air would preclude vessel purging of radiolytic hydrogen. The probabilities of an explosion, and the subsequent effects, are discussed in Chapter IX Section B.

- b. Probable

The probable effect of loss of process and instrument air would be the back-flow of extremely small quantities of radioactivity from the process cell vessels to such "cold"

areas as the Transmitter Room. However, radiation dose rates could still be at R/hr levels in normally occupied areas, necessitating suspension of all processing operations for decontamination work to restore the affected areas to normal background radiation. With at least double HEPA filtration of exhaust air from all possible affected areas, there would be no abnormal release of radionuclides to the atmosphere.

4. Preventives

The following plant design features are provided to prevent the complete loss of process and instrument air:

- 1) The two parallel-operated compressors are automatically supplied with emergency power from the diesel-driven generator in the event of normal electrical power failure.
- 2) With the mechanical failure of one compressor, the remaining compressor can supply adequate air for normal processing operations.
- 3) A diesel-driven portable compressor can be tied into the system for emergency backup, in the event of mechanical failure of both compressors, to allow resumption of processing operations or in the event of total loss of electrical power, to assure maintenance of safety and confinement systems.
- 4) All diaphragm-operated valves are designed for "fail-safe" operation in the event of loss of instrument air.

F. Loss of Electrical Power

The Bonneville Power Administration supplies power to the Midway Station and thence to the 251 Substation over 230 KV dual lines. From the 251 Substation, power is delivered over two 13.8 KV lines, C8-L7 and C8-L8, to the 252-E Substation.

Electrical power to the new 225-B Building Substation will be taken from the existing 13.8 KV line C8-L7 to the 252-E Substation. Two 750 KVA transformers at the new substation will supply power at 480/277 volts to five motor control centers (MCC), Nos. 1, 2, and 3 in 225-B Building and Nos. 4 and 5 in 225-BC Building. Individual transformers at the motor control centers will supply 120/240 volt power for lighting and regulated voltage. Only MCC No. 1 will not receive emergency power from the diesel-driven generator automatically upon loss of normal power; the services inactive upon loss of normal power to MCC No. 1 are not essential to maintenance of confinement, but would probably cause suspension of normal 225-B Building processing operation.

Since 1960, there have been four outages lasting for a total of 25 minutes on the main feeder system to the 252-E Substation, with the longest single duration being 20 minutes in May 1961. Two of the outages were the result of human error for a total outage time of less than one minute; the other two outages were caused by wind and/or lightning.

1. Potential Cause

The most probable causes of failure of the Bonneville power supply system are due to climatological phenomena, e.g., violent winds, lightning, etc.

2. Path of Radionuclide Release

The containment of radioactivity in the primary 225-B Building system is accomplished by a single-pass ventilation system, which draws filtered outside air into the canyon, through the process cells, through both individual cell HEPA filters and HEPA filter banks, and exhausts the air via a 70-foot stack to the atmosphere. Confinement is supplemented by process vessel vent systems, consisting of de-entrainers, heaters and HEPA filters in the cells, for air cleaning and filtration prior to combination with cell ventilation exhaust air for final HEPA filtration.

3. Postulated Effects

a. Possible

The complete loss of electrical power would constitute a highly improbable event. Upon loss of normal power, a diesel-driven emergency generator is automatically started to supply power for all services necessary for safety and confinement systems.

In the very unlikely event that total power is lost, no direct credible mechanism exists for the release of radionuclides to the environs. However, total loss of power coincident with other abnormal conditions could lead to other potential incidents discussed in this chapter, e.g., Hydrogen Explosion, Section B; Loss of Instrument Air, Section E; Back-Flows, Section I, etc.

b. Probable

An electrical outage from an interruption in the normal 13.8 KV supply to the 225-B Building Substation will automatically activate the diesel-driven generator for emergency power, including service to the process ventilation supply and exhaust systems.

No release of radionuclides to the environs is expected from the failure of normal electrical power.

4. Preventives

The emergency systems installed to maintain the operating continuity of critical safety and containment systems are discussed below.

a. Diesel-Driven Generator Emergency Power

Upon failure of normal power from the 225-B Building Substation, a diesel-driven generator will automatically assume the load with adequate capacity and connections for all critical equipment, including the following:

- All instruments, including those served by regulated voltage;
- Air compressors supplying both process and instrument air;
- All ventilation air supply and exhaust equipment; and
- Lighting circuits in all areas.
- The motor operated ball valve for diversion of high-risk cooling water to underground catch tank, TK-100, upon receipt of a signal from the radiation monitor in 225-BD Building.

b. Battery-Powered Lights

Portable battery-powered lights will be positioned at strategic locations for personnel evacuation; they are automatically activated upon total loss of electrical power. The batteries are recharged automatically after each use and maintained in a fully charged condition with normal electrical power.

G. Encapsulation Problems

The physical form of the ^{90}Sr and ^{137}Cs products determines the method of transfer to their primary capsules. The strontium fluoride (SrF_2), produced by precipitation, filtration, drying, and sintering, is a dry powder which is manually loaded into a hopper by manipulator and then fed incrementally into the capsule for compacting to the desired density with an air hammer. The cesium chloride (CsCl), produced by conversion, evaporation to dryness, and further heating, is a liquid melt which is transferred batch-wise by vacuum to a

series of capsules for solidification. The major hazards of the encapsulation process are connected with the transfer of these products to the primary capsules.

1. Potential Cause

The principal hazard encountered during the transfer of the dry strontium fluoride to the empty primary capsule is the inadvertent spillage of gross quantities of powder, resulting in process cell air and cell surface contamination. The most probable causes are operator inattention or manipulator mal-operation.

The primary hazard foreseen for the cesium chloride liquid melt transfer to the empty primary capsules is the undetected presence of liquid water in one or more capsules, resulting in the extremely rapid formation of steam, subsequent equipment failure, and gross process cell air and cell surface contamination.

2. Path of Radionuclide Release

With the dispersal of gross quantities of strontium fluoride or cesium chloride into the process cell atmosphere, the path for potential release with the cell ventilation air to the atmosphere would be through the individual cell single HEPA filter, through the double HEPA filter banks (K 3 System), and to the atmosphere via the stack.

3. Postulated Effects

a. Possible

The most severe environmental effect resulting from handling of strontium fluoride powder occurs as the result of the spillage of a powder boat containing a 40 kilocurie batch. Assuming (1) 10 percent (an inordinate amount) of the spill becomes airborne and (2) the aerosol is filtered thru only one of the three HEPA filters (3.3×10^3 decontamination factor), the quantity of ^{90}Sr released to the atmosphere from this postulated incident would be about 1.2 curies.

The most severe effect postulated for cesium chloride handling is considered to be the in-cell dispersal of an entire feed batch. The inadvertent addition of water

or aqueous solution to a molten feed batch in the Evaporator-Melter, E-E-1, could possibly cause the in-cell dispersal of the entire feed batch of cesium. If the steam from such an occurrence was released instantaneously to Cell D-E (approximately 2,000 ft³ volume), the cell pressure would rise about 1.5 psi and possibly cause the failure of a cell exhaust HEPA filter. If the coincidental failure of the second stage of HEPA filtration is postulated, the quantity of ¹³⁷Cs released to the atmosphere from the postulated incident would be about 14.4 curies, based on a feed batch size of 480 kilocuries and a decontamination factor of 3.3×10^3 for the one remaining stage of HEPA filtration.

b. Probable

The probable effect of maloperations during the process of transferring the purified products to the primary capsules would be much less severe than discussed above as possible. Process equipment design and operating procedures will limit such effects to minor process cell air and interior surface contamination with only routine housekeeping required, and essentially no release of radionuclides to the environment.

4. Preventives

The features of the facility design incorporated to minimize the number and severity of the postulated incidents are:

- 1) Manipulator design, construction, operation and maintenance conform to highest standards;
- 2) The ¹³⁷Cs capsules are spring-loaded in the casting position; this will enable venting of over-pressure to the process cell;

- 3) Small quantities of liquid water in the ^{137}Cs primary capsules are vaporized and exhausted by the process vacuum system;
- 4) Operating procedures and/or engineered safeguards will preclude the possibility for the introduction of water or aqueous solution into a molten cesium chloride feed batch in the Evaporator-Melter or into the empty primary capsules; and
- 5) Spring-loaded relief valves are provided on the Evaporator-Melter inlet and outlet piping to vent its over-pressurization.

H. Capsule Failure During Storage

Strontium and cesium capsules will be stored under 13 feet of water in a concrete basin equipped with cover blocks. The radiolytic heat is transferred from the capsule to the water and, subsequently, removed from the water in a heat exchanger. The water is circulated through the heat exchanger and continuous monitoring equipment at about 100 gpm.

1. Potential Causes

The following potential causes of capsule failure are postulated:

- a) Corrosion of the capsule material greater than that anticipated from corrosion tests.
- b) Failure to maintain good quality control, e.g., material, welding, inspection, etc.
- c) Inadvertent mechanical damage, e.g., dropping a cover block.

2. Path of Radionuclide Release

The only postulated release would be to the storage basin water with no airborne release to the environs.

3. Postulated Effects

a. Possible

Complete dissolution of the entire contents of a cesium chloride or strontium fluoride capsule is possible. The dissolution rate of cesium chloride could be relatively rapid due to its high solubility. The strontium fluoride is only slightly soluble in water

and, hence, the dissolution rate would be quite slow. In either case, the release of radionuclides to the cell air would be extremely low.

Thirty-inch thick shielding blocks constructed of regular concrete (150 lb/ft³) cover each basin section. Each normal storage section will contain about 10,000 gallons of water. On this basis the calculated radiation levels above a contaminated basin section would be as shown in the table below:

TABLE IX-H-1
CALCULATED RADIATION LEVELS

<u>CONTAINMENT</u>	<u>GAMMA RADIATION LEVEL</u>	
	<u>BLOCKS ON</u>	<u>BLOCKS OFF</u>
One Cs Capsule 60,000 Ci ¹³⁷ Cs	0.54 mR/hr	275 R/hr
One Sr Capsule 150,000 Ci ⁹⁰ Sr	0.24 mR/hr	400 R/hr

The storage basin will normally be covered with concrete blocks. Storage basin ventilation air is routed to the stack through two HEPA filters via the K 1 filter system. Contaminated storage basin water can be jetted to B Plant for rework. Strontium contaminated water would be concentrated in Cell 23 prior to rework in the solvent extraction columns. Cesium contaminated water would be reworked in Cells 18, 19 and 20 by ion exchange.

b. Probable

Only a single capsule failure is probable. The postulated leak is expected to be small in size; consequently, leaching will be restricted; early detection will prevent the complete dissolution of the capsule contents

4. Preventives

Several design features have been incorporated in the facility, equipment and capsules to prevent capsule failure and mitigate the effects should a capsule fail.

- a) An extensive Research and Development program has been conducted to establish a technical basis for selection

of the capsule materials. Hastelloy C-276 and type 316-L Stainless Steel have been selected as compatible capsule materials for strontium fluoride and cesium chloride, respectively. All products will be doubly encapsulated.

- b) Automatic welding equipment will be used to maintain weld quality. Inner capsules will be checked for leakage by helium leak check immediately after welding. The capsule will then be ultrasonically cleaned, inserted into the outer capsule, and welded. A final ultrasonic scan will check the weld quality.
- c) Safety features incorporated in the basin crane and cover block designs reflect the operating experience of extensive canyon type work at Hanford. Operating safety practices include routine crane inspections, e.g., cables, and brakes, etc.

Continuous monitoring of the basin water will provide for early detection of a failed capsule. The failed capsule would be confined in an underwater screw-top container and returned to a process cell for rework.

I. Process Solution Back-flow

The engineering precautions factored into the process systems to avoid the inadvertent transfer of radionuclides from the process containment systems to the "cold" side of the 225-B Building, and the related additions to the 221-B Canyon provided by Project HAP-631 have been reviewed and are considered adequate. Should there be a back-flow of radionuclides into the "cold" area, radiation warning equipment, and associated procedures will be in place so as to allow evacuation of these areas in emergencies without applicable radiation exposure limits being exceeded. The potential for process solution back-flow was examined for:

- 221-B air spargers.
- 225-B air spargers.
- High potential service connection to process vessels.
- Air jets.
- Cell vacuum equipment.
- Aqueous chemical addition system.
- Heating and cooling coils.

Process systems having back-flow potential which might present potentially serious consequences will be enclosed in transmitter rooms which enclose the system interfaces between the "cold" and "hot" side. There are two transmitter rooms provided to reduce the consequences of a contamination spread on the "cold" side of the facility. The containment barriers are located in the aqueous makeup and chemical storage area on the second floor of the building. The transmitter rooms are equipped with racks on which will be mounted the transmitters, switches, purge rotameters, and other secondary instrumentation for the process Cells A through G. Jet gang valves, heating coil steam supply gang valves, and other service connections associated with the following equipment will also be housed in the transmitter rooms:

- TK-B-1 Strontium Feed Metering Tank
- TK-B-2 Strontium Supernate Hold Tank
- TK-B-5 Strontium Precipitator Tank
- TK-D-1 Cesium Feed Metering Tank
- TK-D-2 Cesium Converter Tank
- TK-F-6 Air Accumulator
- T-D-5 Scrubber - Cell Sumps

Compressed air for the WESF, supplied by two parallel-operated oil free compressors in the 225-BC Building each rated at 230 cfm at 100 psig, becomes process air after cooling and moisture separation. An air receiver tank in the process air system provides air to the instrument air system, which comprises an entrainment separator, parallel-operated dryers, a particle filter, and pressure-reducing stations. The compressors are designed to start and stop automatically to maintain the desired air pressure. Both compressors are on the emergency power supply from the diesel-driven generator.

Process air is used in the WESF for the following process control items:

Purging of gang valves and steam supply lines to the steam-motivated jets after use to prevent steam condensation and subsequent possible process solution backflow.

Sparging of tanks containing process solutions for mixing; air receiver TK-F-6 is furnished in Cell F on the air supply line with individual flowmeters in Cells B and D for process vessels (which require agitation) to minimize the potential for contamination of the supply line to Cell F.

- Motivating the jets required for sampling process solutions.

- Dilution of the hydrogen formed by radiolysis of water in aqueous process solutions.

Instrument air has three major uses for process control:

- Control of HVAC Systems for confinement of radionuclides through the establishment of contamination zones by differential pressures.

Purge of process vessel weight factor and specific gravity dip tubes.

Operation of diaphragm-operated control valves and pneumatic process instrumentation, including transducers, transmitters, indicators, recorders and controllers.

1. Potential Cause

Loss of compressed air may cause a back-flow of process solution. Loss of compressed air supply could be caused by a total electrical power failure or mechanical breakdown of both compressors. The failure or improper functioning of one or more equipment components downstream of the compressors could result in the loss of process and/or instrument air.

2. Path of Radionuclide Release

Upon complete loss of process and instrument air, radioactivity could flow from process cell equipment to the "cold" side of the building; i.e., by process solution back-flow in the steam lines to the jets following a failure to purge with air after a transfer. The high radiation levels in the personnel-occupied areas would be detected by radiation monitoring equipment; automatic alarms would alert personnel of the radiation exposure hazard.

3. Postulated Effects

a. Possible

It is possible that sufficient volume of feed solution could be transferred by a back-flow to result in radiation dose rates of several thousand R/hr at the source in the transmitter rooms. Processing operations would be shut down and emergency procedures put into effect. Radiation monitoring and radiation protection procedures are established for contamination control work in high radioactivity level facilities. Action would be taken to restore the affected area to normal background radiation levels, e.g., temporary shielding and flushing of the grossly-contaminated piping. Essentially, no release of radionuclides to the environs would be experienced.

Loss of process air would preclude vessel purging of radiolytic hydrogen. The probabilities of an explosion and the subsequent effects are discussed in Chapter IX, Section B.

b. Probable

The probable effect of loss of process and instrument air would be the back-flow of extremely small quantities of radioactivity from the process cell vessels to such "cold" areas as the transmitter room. The transmitter room is equipped with water spray nozzles which can be operated from outside the room to wash down the contaminated surface. Liquid will drain to an underground catch tank location adjacent to the 225-B Building. This tank will be equipped with a sump pump and liquid level controls. The catch tank pump will discharge to the low-level waste header in the hot pipe through which the material will flow into the low-level waste tank, TK-39-1. With at least double HEPA filtration of exhaust air from all possible affected areas, there would be no abnormal release of radionuclides to the atmosphere.

4. Preventives

The following plant design features are provided to prevent the complete loss of process and instrument air:

- 1) The two parallel-operated compressors are automatically supplied with emergency power from the diesel-driven generator in the event of normal electrical power failure.
- 2) With the mechanical failure of one compressor, the remaining compressor can supply adequate air for maintenance of safety and confinement systems.
- 3) Piping provisions will be in place so that a diesel-driven portable compressor can be tied into the system.
- 4) All diaphragm-operated valves are designed for "fail-safe" operation in the event of loss of instrument air.

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APPENDIX A

DESIGN CRITERIA FOR RADIATION PROTECTION

1.0 Facility Design Concepts

1.1 Basic Objectives

- 1.1.1 To receive, convert, encapsulate, and store radioactive materials in a safe manner.
- 1.1.2 To limit the radiation exposure of personnel working in the plant to the lowest practicable level and in compliance with established radiation protection standards. The governing regulation for this facility is AEC Manual Chapter 0524.

1.2 General Design Considerations

While careful and detailed monitoring by well trained and indoctrinated personnel using proper procedures and equipment will be used to obtain these objectives, an environment conducive to these objectives must be created by proper facility design. The general design considerations are:

- 1.2.1 Isolation of clean areas from contaminated and potentially contaminated areas by utilizing buffer zones.
- 1.2.2 Once-through ventilation systems for potentially contaminated and contaminated areas obtaining supply air from outside or a clean area and exhausting through increasingly contaminated areas with final discharge to the atmosphere through high efficiency (HEPA) filters and a common stack.
- 1.2.3 Separation of personnel and process materials by at least one and preferably two or more containment barriers.
- 1.2.4 Surface coatings or materials of all potentially contaminated areas to be selected for ease of decontamination, radiation resistance, and compatibility with the chemical process.
- 1.2.5 Design to provide to the greatest extent feasible, for remote handling of highly radioactive and/or contaminated materials, bearing in mind (a) that simplicity of design is paramount since all mechanical equipment is subject to maintenance and repair and (b) minimization of radiation exposure to personnel.
- 1.2.6 Equipment to be employed in high radiation areas should be reliable, radiation resistant, and remotely replaceable where maintenance is anticipated.

2.0 Cell Design

2.1 Cell Shielding Requirements

- 2.1.1 Shielding shall be adequate to allow processing of one megacurie of ^{90}Sr considered as a point source against the interior face of the shield wall.

2.2 Criteria

- 2.2.1 Shielding walls and viewing windows should be designed to reduce the radiation level to manipulator operators to less than one mR/hr.
- 2.2.2 For those cells designed for personnel entry, intercell shielding should be provided to permit entry into the cell without the need of removing radiation sources in adjacent cells. This shielding should also reduce the radiation level from adjacent cells to less than one mR/hr. Pass-throughs to the adjacent cell shall be shielded.
- 2.2.3 For cells not designed for personnel entry, the intercell shielding is incidental and arises from only structural requirements.
- 2.2.4 Radiation dose rate in the service gallery shall not normally exceed one mR/hr at any point of normal access.
- 2.2.5 Radiation dose rates in all support areas (e.g., offices, lunchroom, etc.) should be less than 0.25 mR/hr.
- 2.2.6 Each cell should be equipped with an efficient wash down system and "high level" liquid waste drain or sump.
- 2.2.7 All equipment and connections in the non-entry cells should be workable by the manipulators or available hoists.
- 2.2.8 Interior surfaces of cells should be smooth, nonporous and coated with a radiation resistant covering.

3.0 Operating Gallery (Cell Operating Face)

- 3.1 Surface coatings should be smooth and nonporous to facilitate decontamination.
- 3.2 Design should minimize potential holdup of contamination on ledges, piping, conduit, light fixtures, etc.
- 3.3 Equipment and walls should be located to prevent interference with manipulator operation.
- 3.4 Sufficient clearance shall be provided to allow removal of the manipulators.

- 3.5 Equipment controls should be located convenient to the cell operating face.
- 3.6 Penetrations into the cell should not reduce the shielding value of the cell wall.
- 3.7 Capability should be provided for transporting manipulators from the operating gallery to the manipulator repair shop without leaving controlled areas.
- 4.0 Service Gallery (Rear of Cells)
- 4.1 Design should minimize potential holdup of contamination on ledges, piping, conduit, etc.
- 4.2 Process samples withdrawn from the cells for chemical analysis shall be suitably contained.
- 4.3 Air locks should be provided between potentially contaminated areas and support areas.
- 5.0 Personnel Traffic Control
- 5.1 Normal access from support areas to potentially contaminated areas should be through a personnel change room.
- 5.2 The change room shall be isolated from the service gallery by an air lock.
- 5.3 Normal exit from the service and operating galleries should be via a personnel monitoring station.
- 5.4 Emergency exits shall be provided from the service area and operating galleries.
- 6.0 Ventilation Requirements
- 6.1 The ventilation systems for potentially contaminated areas should be once-through flow from non-contaminated through progressively more contaminated areas and exhausting to a common stack.
- 6.2 The ventilation system should provide for automatic differential pressure control with provisions for manual override.
- 6.3 When a cell cover block is removed a minimum face velocity of 100 lineal feet/minute shall be maintained into the cell until the area is free of high contamination potential.
- 6.4 Air drawn into high contamination areas, which is exhausted through HEPA filters, should be passed through HEPA inlet filters.

- 6.5 A bank of two HEPA filters, in series, should be provided to filter all the exhaust air going to the stack. Air exhausted from normal sources of high potential contamination (cells and transmitter rooms) should be provided with a locally mounted HEPA filter.
- 6.6 Filter housings shall be designed for high integrity sealing and ease of replacement. Pressure drop measurements across the filter should be provided.
- 6.7 Filters not accessible due to high radiation dose rates shall be remotely replaceable.
- 6.8 The exhaust fans shall be connected to a source of emergency power.
- 6.9 The exhaust stack should be of a height sufficient to provide good atmospheric dispersion under all site meteorological conditions and should be located downwind with respect to the prevailing wind direction to minimize the recirculation of exhausted air into the building.
- 6.10 A separate ventilation system may be employed for non-contaminated areas such as office spaces, lunchroom, etc.
- 7.0 Waste Handling
- 7.1 Solid Waste
 - 7.1.1 Provisions shall be made for removing solid waste from all cells and transferring it remotely to a waste handling cell.
 - 7.1.2 The system should be sized to handle the largest piece of equipment routinely replaced in the cell.
 - 7.1.3 Waste handling facilities for preparation and accumulation of solid waste packages prior to final disposal from the WESF shall be provided.
 - 7.1.4 The exterior shielding walls for the waste handling cell shall be the same as those for the other cells; the interior walls shall be adequate for personnel entry.
 - 7.1.5 Remote handling capabilities for packaging highly contaminated items shall be provided.
 - 7.1.6 The interior construction of the waste handling cell should be smooth and nonporous to facilitate decontamination.
 - 7.1.7 Provisions shall be made for the controlled transfer of packaged waste from the cell to a disposal site.

- 7.1.8 Personnel access to the waste handling cell shall be from the service gallery.
- 7.2.1 Contaminated liquid wastes from all sources within the WESF shall be routed to the 221-B Building for reprocessing and/or disposal.
 - 7.2.1.1 All contaminated or potentially contaminated areas of the Facility provided with wash down capability (e.g., cells, canyon, service and operating galleries), shall have drains connecting to liquid waste recovery system.
 - 7.2.2 All process cooling water effluent shall be monitored.
 - 7.2.3 Cooling water effluent may normally be routed to an open pond. Capability for the diversion of this water to a retention ditch shall be provided.
- 7.3 Gaseous Waste
 - 7.3.1 Off gases containing radionuclides shall be vented through a separate off gas system with the capability of removing condensables and particulates.
 - 7.3.2 The off gas shall ultimately discharge to the ventilation exhaust stack.
- 8.0 Capsule Storage Area
 - 8.1 A facility must be provided for long term storage of strontium fluoride and cesium chloride capsules.
 - 8.1.1 The facility must be provided with a highly reliable decay heat removal system.
 - 8.1.2 Shielding must be provided to reduce the radiation dose rate to adjacent areas requiring personnel access to less than one mR/hr at design storage capacity.
 - 8.1.3 Provisions must be made for detecting, locating, and reprocessing a failed capsule.
 - 8.1.4 The facility should be designed to prevent the escape of radionuclide contaminants to the environment or adjacent building areas in the event of a capsule failure.
 - 8.1.5 Provisions for the disposal of contaminated cooling medium shall be incorporated.
- 9.0 Radiological Monitoring Requirements
 - 9.1 Area radiation monitors shall be located in strategic areas of the facility to continuously monitor the radiation dose rates.

- 9.1.1 These monitors must be equipped with both local and remote high radiation alarm provisions and remote readout capability at a central location.
- 9.2 Air particulate samplers and monitors shall be provided in all personnel areas where the potential for airborne radionuclides exists.
 - 9.2.1 Vacuum for these samplers should be provided by a central vacuum system.
 - 9.2.2 The samplers should be conveniently centralized while maintaining the shortest feasible piping run to the sampling point.
 - 9.2.3 All sample piping runs should employ long radius bends to minimize particulate holdup.
 - 9.2.4 Continuous air particulate monitors should be used to sample air in the personnel access areas and to sample air being exhausted via the exhaust stack.
 - 9.2.4.1 These monitors shall provide continuous monitoring and recording with local and remote alarms.
 - 9.2.4.2 The radiation detector should be located in a low radiation background area.
- 9.3 Personnel monitoring stations shall be provided at the main personnel exit and at other strategic locations within the facility.
- 9.4 Potentially contaminated liquid effluent will be monitored before release; contaminated liquid effluent will be routed to B Plant for processing.
- 10.0 Communication System
 - 10.1 Two-way intercommunication units should be installed between personnel entry cells, operating and service areas. Units located in the cells should be an open mike type.
 - 10.2 An audible evacuation alarm system shall be provided.

APPENDIX B

STACK EFFLUENT ATMOSPHERIC DISPERSION ANALYSIS

1.1 Introduction

This appendix contains the procedures, assumptions and results of analyses conducted to evaluate the Waste Encapsulation and Storage Facility (WESF) design with respect to ventilation exhaust stack emissions. These analyses were performed to determine the consequent radiation exposures sustained from hypothetical releases and to compare these exposures with the requirements of AEC Manual Chapter 0524. The results for accident conditions are normalized to a unit release of material, permitting evaluation on an individual incident basis. The results for normal facility operation are also included in complete form.

2.1 Basic Criteria

The release of airborne radionuclides from the stack is the only significant source of radiation exposure to the general public from the operation of the WESF. The exposure will be a function of the facility design, the nature of the effluent and the atmospheric conditions at the time of release. Data on the facility, the process, and the climatology of the area, enables such an evaluation of the potential radiological impact of the facility on the environs. The safety of the public and of plant personnel in the operation of any ARHCO facility is of primary concern. In order to meet the safety requirements for this facility, as well as contractual obligations, specific radiation exposure limits as defined by the controlling government agency must not be exceeded.

2.2 Compliance Requirements

- 2.2.1 The applicable limits on the exposure of personnel to ionizing radiation resulting from the operation of the WESF are established in AEC Manual Chapter 0524, Standards for Radiation Protection. Exposure limits applicable to personnel working on plant and to individuals or population groups in uncontrolled areas are shown in Table B-2.2.1a. The average concentration of airborne radionuclides at the point of release are also limited by AEC Manual Chapter 0524. Concentration Guides for the radionuclides of specific interest in the operation of the WESF are shown in Table B-2.2.1b.

TABLE B-2.2.1a
RADIATION PROTECTION STANDARDS
FOR EXTERNAL AND INTERNAL EXPOSURE OF INDIVIDUALS*

CONTROLLED AREAS

<u>Type of Exposure</u>	<u>Condition</u>	<u>Dose (rem) or Dose Commitment</u>
Whole body, head and trunk, active blood-forming organs, gonads, or lens of eye	Accumulated dose Calendar quarter	5 (N-18)** 3
Skin thyroid and bone	Year Calendar quarter	30 10
Hands and forearms, feet and ankles	Year Calendar quarter	75 25
Other organs	Year Calendar quarter	15 5

UNCONTROLLED AREAS

<u>Type of Exposure</u>	<u>Annual Dose or Dose Commitment (rem)</u>	
	<u>Based on Dose to Critical Individuals at Points Of Maximum Probable Exposure</u>	<u>Based on an Average Dose to a Suitable Posed Population</u>
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

* From AEC Manual Chapter 0524

** N is the age of the individual in years

TABLE B-2.2.1b
CONCENTRATION GUIDES*

Radionuclide**		Annual Average Concentration In Air	
		Controlled Area (uCi/ml)	Uncontrolled Area (uCi/ml)
Sr-89	S	3×10^{-8}	3×10^{-10}
	I	4×10^{-8}	1×10^{-9}
Sr-90	S	1×10^{-9}	3×10^{-11}
	I	5×10^{-9}	2×10^{-10}
Cs-134	S	4×10^{-8}	1×10^{-9}
	I	1×10^{-8}	4×10^{-10}
Cs-137	S	6×10^{-8}	2×10^{-9}
	I	1×10^{-8}	5×10^{-10}
Ce-144	S	1×10^{-8}	3×10^{-10}
	I	6×10^{-9}	2×10^{-10}

* From AEC Manual Chapter 0524

** Soluble (S), Insoluble (I)

2.2.2 It is shown in the following analysis that the air concentrations and the resultant doses received during normal operation of the WESF are well below the limits set by the AEC for the general public.

3.1 Analytical Data

3.1.1 Introduction

3.1.1.1 The information utilized in performing the atmospheric dispersion analysis consists of climatological data, facility characteristics, information on both normal and accidental plant operation, and parametric values for determining dosage levels.

3.1.2 Climatological Data

Records have been kept for many years on the climatological history of the Hanford area. Table B-3.1.2, obtained from Reference B-3.1.2, shows the percentage frequency distribution of wind speed and direction as determined at the 200 ft. level of the Hanford meteorological tower (located approximately three miles from the WESF) for various stability classes for 16 compass sectors. Analysis of the atmospheric dispersion under normal operating conditions was based on this data.

3.1.3 Facility Characteristics

- 3.1.3.1 The ventilation stack is 70 feet high (above local terrain), and normally exhausts approximately 20,000 cfm of air. It is located in the northwestern section of the 200 East Area with the nearest Hanford boundary about 16 kilometers distant in an easterly direction.
- 3.1.3.2 The proposed annual output of the Plant is shown in Table B-3.1.3.2. This is based on 200 batches per year of ^{90}Sr of 150 KCi each and 63 batches per year of ^{137}Cs of 480 KCi each.

TABLE B-3.1.2
PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND
DIRECTION AT 200-FOOT-LEVEL VS. ATMOSPHERIC STABILITY

WIND SPEED MPH	ATMO- SPHERIC STABIL- ITY*	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	VAR.	CALM	TOTAL
0 - 3	VS	0.20	0.21	0.15	0.20	0.26	0.38	0.23	0.24	0.19	0.22	0.22	0.41	0.35	0.44	0.37	0.35	0.21	0.47	5.12
	MS	0.17	0.18	0.16	0.21	0.34	0.42	0.21	0.19	0.12	0.13	0.13	0.21	0.22	0.32	0.28	0.30	0.12	0.50	4.21
	N	0.30	0.35	0.28	0.33	0.37	0.45	0.22	0.16	0.13	0.12	0.10	0.18	0.19	0.34	0.42	0.42	0.14	0.48	4.97
	U	0.48	0.64	0.36	0.40	0.31	0.26	0.12	0.17	0.10	0.16	0.10	0.14	0.14	0.27	0.37	0.55	0.46	0.04	5.08
4 - 7	VS	0.22	0.17	0.14	0.17	0.20	0.33	0.28	0.29	0.24	0.35	0.50	0.97	1.09	1.02	0.70	0.40	0.02	0.	7.08
	MS	0.17	0.15	0.13	0.16	0.22	0.37	0.21	0.18	0.16	0.21	0.24	0.43	0.50	0.69	0.47	0.31	0.02	0.	4.63
	N	0.12	0.13	0.10	0.12	0.20	0.27	0.15	0.10	0.07	0.10	0.11	0.17	0.27	0.56	0.33	0.18	0.02	0.	2.99
	U	0.92	0.89	0.56	0.58	0.52	0.63	0.37	0.45	0.44	0.50	0.37	0.37	0.47	1.11	1.10	1.16	0.29	0.	10.72
8 - 12	VS	0.13	0.11	0.09	0.07	0.07	0.13	0.21	0.12	0.11	0.25	0.58	1.21	1.97	1.78	0.62	0.21	0.	0.	7.66
	MS	0.11	0.08	0.03	0.06	0.10	0.21	0.19	0.13	0.20	0.34	0.50	0.97	1.49	1.54	0.38	0.14	0.00	0.	6.49
	N	0.06	0.04	0.03	0.03	0.04	0.09	0.07	0.05	0.06	0.09	0.14	0.15	0.41	0.77	0.15	0.07	0.	0.	2.25
	U	0.49	0.34	0.12	0.09	0.08	0.15	0.11	0.15	0.34	0.60	0.55	0.34	0.57	1.39	0.52	0.46	0.00	0.	6.30
13 - 18	VS	0.05	0.03	0.02	0.03	0.00	0.04	0.10	0.03	0.03	0.09	0.25	0.43	1.19	1.54	0.18	0.06	0.	0.	4.07
	MS	0.09	0.05	0.02	0.03	0.02	0.08	0.13	0.15	0.25	0.55	0.86	1.23	3.01	2.25	0.18	0.10	0.	0.	9.01
	N	0.06	0.01	0.01	0.01	0.00	0.03	0.04	0.05	0.07	0.14	0.24	0.16	0.42	0.57	0.06	0.04	0.	0.	1.91
	U	0.26	0.14	0.03	0.01	0.00	0.02	0.04	0.05	0.17	0.54	0.67	0.26	0.62	0.98	0.09	0.14	0.	0.	4.02
19 - 24	VS	0.	0.00	0.00	0.00	0.	0.00	0.01	0.01	0.01	0.02	0.03	0.02	0.06	0.19	0.00	0.00	0.	0.	0.37
	MS	0.03	0.03	0.01	0.00	0.00	0.02	0.06	0.11	0.21	0.54	0.50	0.32	1.50	1.48	0.03	0.02	0.	0.	4.88
	N	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.04	0.08	0.15	0.17	0.05	0.24	0.34	0.01	0.02	0.	0.	1.16
	U	0.06	0.05	0.01	0.00	0.	0.00	0.01	0.02	0.11	0.34	0.41	0.12	0.31	0.63	0.01	0.03	0.	0.	2.10
OVER 24	VS	0.	0.00	0.	0.	0.	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.	0.	0.	0.	0.	0.03
	MS	0.00	0.00	0.	0.	0.	0.01	0.02	0.09	0.30	0.48	0.23	0.07	0.52	0.77	0.00	0.01	0.	0.	2.48
	N	0.01	0.01	0.00	0.00	0.	0.	0.01	0.02	0.08	0.17	0.09	0.03	0.18	0.30	0.00	0.01	0.	0.	0.91
	U	0.01	0.02	0.01	0.	0.	0.	0.	0.01	0.09	0.40	0.31	0.08	0.16	0.47	0.01	0.00	0.	0.	1.56
TOTALS	VS	0.60	0.54	0.40	0.47	0.53	0.90	0.83	0.68	0.60	0.94	1.59	3.04	4.67	4.96	1.88	1.01	0.23	0.47	24.33
	MS	0.58	0.50	0.36	0.45	0.68	1.11	0.83	0.84	1.23	2.24	2.47	3.23	7.24	7.06	1.35	1.88	0.14	0.50	31.70
	N	0.57	0.56	0.42	0.50	0.61	0.84	0.50	0.41	0.49	0.77	0.85	0.74	1.71	2.89	0.96	0.73	0.15	0.48	14.19
	U	2.20	2.07	1.10	1.09	0.92	1.06	0.64	0.84	1.25	2.53	2.42	1.30	2.27	4.85	2.10	2.34	0.75	0.04	29.78

*VS - very stable; MS - moderately stable; N - neutral; U - unstable

TABLE B-3.1.3.2

ENCAPSULATION FACILITY ANNUAL PRODUCTION RATES

<u>Isotope</u>	<u>Production Rate, Ci/Yr</u>
Sr-90	30×10^6
Cs-137	30×10^6

3 1.4 Normal Plant Operating Data

- 3.1.4.1 The quantity of radioactive material exhausted in the stack effluent will be most dependent upon the type of equipment and operations utilized for the process and the effectiveness of the process ventilation air filtration system. It has been estimated, based on experience gained in development work conducted on the conversion and encapsulation processes to be used, that the rate of release to the cell and vessel vent systems under normal operating conditions would not be expected to exceed the values shown in Table B-3.1.4.1 (Reference B-3.1.4.1a and B-3.1.4.1b).

TABLE B-3.1.4.1

RELEASE RATE TO IN-CELL FILTERS AND VESSEL VENT SYSTEM UNDER NORMAL OPERATING CONDITIONS

<u>Isotope</u>	<u>Release Rate (Ci/Batch)</u>	
	<u>In-Cell Filters</u>	<u>Vessel Vent System</u>
Sr-89	250	125
Sr-90	500	250
Cs-134	12.5	25
Cs-137	125	250
Ce-144	25	12.5

- 3.1.4.2 The HEPA filters used at the WESF are expected to have an efficiency of 99.97 percent for the materials being processed. There are three filters in series between the process cells and the final stack discharge. If the filter efficiency is assumed to be 99.97 percent for the first filter and 99 percent each for the second and third filters, for an overall attenuation of 3×10^{-8} , the discharge rate of ^{90}Sr will be 1.4×10^{-10} curies per second. If this is considered the normal operating discharge rate, the total annual discharge would be less than 4.5 millicuries. Corresponding data for the other isotopes are summarized in Table B-3.1.4.2.

TABLE B-3.1.4.2
NORMAL OPERATING CONDITIONS
ISOTOPIC RELEASE FROM EXHAUST STACK

<u>Isotope</u>	<u>Discharge Rate</u>	
	<u>Ci/Sec</u>	<u>Ci/Year</u>
Sr-89	7.0×10^{-11}	0.0023
Sr-90	1.4×10^{-10}	0.0045
Cs-134	2.3×10^{-12}	0.000071
Cs-137	2.3×10^{-11}	0.00071
Ce-144	7.0×10^{-12}	0.00023

3.1.5 Potential Accidents During Facility Operation

In the following analysis of the discharges of radioactive materials from the stack, all results are normalized to a unit release in order that the consequences of each postulated accident may be determined on an individual basis. A summary of the consequences, where the release of radioactive material to the environment is involved, is presented with the details of the postulated accident in Chapter IX of this document.

3.1.6 Dosage Level Values

Values of the parameters for determining dosages associated with the dispersed stack effluent were obtained from Reference B-3.1.6 and are presented in Table B-3.1.6.

4.1 Analytical Methods and Results

The general equations and their application to these analyses are substantially in accord with those used in Safety Analysis reports and in Reference B-4.1.1a, and B-4.1.1b.

4.1.1 There are two distinct categories of stack effluent requiring analysis. One is the long term case associated with the dispersion of the normal annual plant release as previously shown in Table B-3.1.4.2. The second is the short term case which may be the result of one of the postulated incidents described in Chapter IX.

4.1.2 Normal Plant Operation

4.1.2.1 The radioactive material that passes through the air filtration system, as shown in Table B-3.1.4.2, will be entrained

TABLE 3-B.1.6

PARAMETERS FOR ENCAPSULATION FACILITY RADIONUCLIDES

Radionuclide	Character	Organ	MPBB, q uCi	Mass Of Organ, m g	f _a	ΣFE(RBE) _n	Effective Half-Life, T _e days	D' rem/uCi	K
Sr-89	Sol.	Bone*	4	7,000	.07	2.8	50.4	.104	.993
		Total Body	40	70,000	.1	.55	50.3	.0029	.993
	Insol.	Lung		1,000	.125	.55	35.5	.180	.999
Sr-90	Sol.	Bone*	2	7,000	.03	5.5	6400	11.13	.0389
		Total Body	20	70,000	.1	1.1	5700	.66	.0434
	Insol.	Lung		1,000	.125	1.1	120	1.22	.879
Cs-134	Sol.	Total Body*	20	70,000	.75	1.1	65	.0565	.981
	Insol.	Lung		1,000	.125	.57	105	.552	.910
Cs-137	Sol.	Total Body*	30	70,000	.75	.59	70	.0327	.972
	Insol.	Lung		1,000	.125	.41	120	.454	.879
Ce-144	Sol.	Bone*	5	7,000	.075	6.3	243	1.21	.647
		Total Body	20	70,000	.25	1.3	191	.0654	.734
	Insol.	Lung		1,000	.125	1.3	85	1.01	.986

*Critical organ

$$D' = \frac{73.8 f_a \times \Sigma FE(RBE)_n \times T_e}{m}$$

D' = infinite time dose, rem/uci inhaled

q = maximum allowable burden in body

f_a = fraction of activity inhaled that remains in the organΣFE(RBE)_n = energy per disintegration delivered to the organ, MeVT_e = effective half-life of the radionuclide in the organ

$$K = [1. - \exp(\frac{-0.693}{T_e} \times 365.)]$$

K = ratio of first year dose to infinite time dose

m = mass of organ

in the 20,000 cfm of ventilation exhaust air, resulting in a significant reduction of the radionuclide concentration in the stack effluent. Table B-4.1.2.1 shows the resultant stack discharge concentrations of the various radionuclides as well as the nuclide concentrations at the stack discharge expressed as fractions of the lowest concentration guide from AEC Manual Chapter 0524 for controlled areas.

TABLE B-4.1.2.1

NORMAL PLANT OPERATION STACK DISCHARGE CONCENTRATIONS

<u>Isotope</u>	<u>Concentration uCi/ml</u>	<u>Fraction of Concentration Guide</u>
Sr-89	7.4×10^{-12}	0.00025
Sr-90	1.5×10^{-11}	0.015
Cs-134	2.4×10^{-13}	0.000024
Cs-137	2.4×10^{-12}	0.00024
Ce-144	7.4×10^{-13}	0.00013

4.1.2.2 The sum of the radionuclide concentration guide fractions, equal to 0.015 for "bone seekers" and 0.00026 for "total body seekers", indicates that the concentration of airborne radioactive material is well within the limits of AEC Manual Chapter 0524 for controlled areas. Even though the airborne contribution of radioactive material to the environs, associated with the normal encapsulation facility operation, will be well within limits, analyses were conducted to show what the maximum contribution would be on a long term basis.

4.1.2.3 The annual percentage frequency distribution of wind speed and direction as a function of atmospheric stability (Table B-3.1.2) was considered in order to obtain the average air concentration in each of the 16 sectors for the normal annual stack effluent.

It should be noted that the data in Table B-3.1.2 is for the 200 foot level of the meteorological tower. Similar data for other levels is not available; however, data on the variation of wind speed with elevation (Reference B-3.1.2) indicates that the use of this data introduces an error of little consequence. Equation B-1 was utilized for the computation of the normalized air concentration.

$$\left(\frac{\bar{x}}{\bar{Q}}\right)_i = \left(\frac{0.1}{2\pi x}\right) \left(\frac{2}{\pi}\right)^{1/2} \sum_{u, \Delta T} f_{u, \Delta T, i} \left[\frac{(q/Q) \exp(-h^2/2\sigma_z^2)}{\sigma_z \bar{u}_h} \right]_{u, \Delta T} \quad (B-1)$$

where:

$\left(\frac{\bar{x}}{\bar{Q}}\right)_i$ = average annual normalized air concentration
at ground level in sector = $\frac{uCi/cc}{Ci/sec}$

x = radial distance, meters

$\bar{u}_h$ = wind speed at release height, meters/second

n = 16 (number of compass sectors)

h = effective release height = 28 meters (stack + plume rise, see paragraph 4.1.2.6)

$f_{u, \Delta T, i}$ = frequency of occurrence for wind speed $\bar{u}_h$ during atmospheric condition ΔT , with a wind direction within sector i .

σ_z = vertical dispersion coefficient, meters

(q/Q) = correction factor for cloud depletion due to ground disposition.

4.1.2.4 Two mathematical models were used in determining the atmospheric parameter σ_z . For neutral and unstable atmospheric conditions the Sutton equivalent of σ_z was used. For stable atmospheric conditions an empirical equation based on experiments performed at Hanford was used.

4.1.2.4.1 In stable atmospheres the vertical diffusion coefficient is:

$$\sigma_z = \left(a \left[1 - \exp(-k^2 x^2 / \bar{u}_h^2) \right] + \frac{bx}{\bar{u}_h} \right)^{1/2} \quad (B-2)$$

where a , b , and k^2 are a function of the degree of stability. The values used are shown in Table B-4.1.2.4.1

TABLE B-4.1.2.4.1

<u>Parameter</u>	<u>Degree of Stability</u>	
	<u>Moderate</u>	<u>High</u>
a	97 m ²	34 m ²
b	0.33 m ² sec ⁻¹	0.025 m ² sec ⁻¹
k ²	2.5 x 10 ⁻⁴ sec ⁻²	8.8 x 10 ⁻⁴ sec ⁻²

4.1.2.4.2 The neutral and unstable atmospheres the vertical diffusion coefficient is:

$$\sigma_z = \frac{C_z x^{(2-n)/2}}{\sqrt{2}} \quad (B-3)$$

where C_z and n are Sutton's parameters and the values used in this analysis are shown in Table B-4.1.2.4.2.

TABLE B-4.1.2.4.2

<u>Parameter</u>	<u>Wind Speed</u>	<u>Unstable</u>	<u>Neutral</u>
C _z	1.0 m/sec	.30	.150
	2.5 m/sec	.28	.140
	5.0 m/sec	.26	.120
	7.5 m/sec	.25	.115
	10.0 m/sec	.24	.110
	15.0 m/sec	.23	.100
n		.20	.250

4.1.2.5 Allowance was made for the depletion (q/Q) by ground deposition of radionuclides from the cloud using Equation B-4 (Reference B-4.1.2.5) for stable atmospheres and Equation B-5 for neutral and unstable atmospheres.

$$q/Q = \exp \left[- \frac{2}{\pi} \left(\frac{V_{\Delta}}{\bar{u}_o} \right) \left(\frac{\bar{u}_o}{\bar{u}_{200}} \right) \int_0^x \frac{\exp(-h^2/2\sigma_z^2)}{\sigma_z} dx \right] \quad (B-4)$$

$$q/Q = \exp \left[- \frac{2}{C_Z} \pi \left(\frac{V_{\Delta}}{\bar{u}_o} \right) \left(\frac{\bar{u}_o}{\bar{u}_{200}} \right) \int_0^x x^{(n-2)/2} \exp(-h^2 / C_Z^2 x^{2-n}) dx \right] \quad (B-5)$$

where:

V_{Δ} = the deposition velocity in meters per second

$\left(\frac{V_{\Delta}}{\bar{u}_o} \right)$ = the deposition coefficient

$\left(\frac{\bar{u}_o}{\bar{u}_{200}} \right)$ = the ratio of average wind speed at ground level ($\bar{u}_o$) to the average wind speed at 200 feet.

The values for the parameters $\left(\frac{V_{\Delta}}{\bar{u}_o} \right)$ and $\left(\frac{\bar{u}_o}{\bar{u}_{200}} \right)$ are shown in Table B-4.1.2.5.

TABLE B-4.1.2.5

Atmospheric Condition	Particulate Deposition Coefficient	Wind Speed Ratio
	$\left(\frac{V_{\Delta}}{\bar{u}_o} \right)$	$\left(\frac{\bar{u}_o}{\bar{u}_{200}} \right)$
Highly Stable	1.5×10^{-4}	.17
Moderately Stable	2.2×10^{-4}	.35
Neutral	3.0×10^{-4}	.50
Unstable	6.0×10^{-4}	.70

4.1.2.6 The magnitude of the plume rise was determined by use of the Bryant-Davidson Equation (5.1) of Reference B-4.1.1a.

$$\Delta h = d \left(\frac{V_s}{\bar{u}} \right)^{1.4} \left(1 + \frac{\Delta T}{T_s} \right) \quad (B-6)$$

Where:

Δh = plume rise, meters

d = stack diameter = 1.07 meters

V_s = stack discharge velocity = 10.6 meters/sec.

$\bar{u}$ = average wind velocity = 3 meters/sec.
 ΔT = excess temperature of stack gas = 10°R
 T_s = absolute temperature of stack gas = 500°R

Solution of Equation B-6 for the values of the parameters given, results in a plume rise of approximately 6 meters which, when added to the stack height, gives a total height of the plume above the ground at the stack location of approximately 28 meters (92 ft.).

- 4.1.2.7 The results obtained from performing the calculations indicated for Equation B-1 are shown in Figure B-4.1.2.7a. The average normalized air concentration presented in Figure B-4.1.2.7b for the worst sector (the sector from which the wind blows with the greatest frequency, NW Sector) shows that the maximum long-term on-site air concentration (3.1×10^{-6} uCi/cc per Ci/sec released) will occur at about 200 meters from the stack.

FIGURE B-4.1.2.7a
NORMAL CONDITIONS
ISOPLETHS OF AVERAGE NORMALIZED
CLOUD CONCENTRATION

4.1.2.8 Ground Deposition

The dry ground depositions were computed from the average annual air concentration using Equation B-7.

$$\left(\frac{\bar{w}}{\bar{Q}} \right)_i = \left(\frac{V_{\Delta}}{\bar{u}_o} \right) \left(\frac{\bar{u}_o}{\bar{u}_{200}} \right) u_h \left(\frac{\bar{x}}{\bar{Q}} \right)_i \quad (B-7)$$

where:

$$\left(\frac{\bar{w}}{\bar{Q}} \right)_i = \text{average normalized deposition rate in sector } i, \\ \text{Ci/m}^2\text{-sec per Ci/sec released.}$$

The other variables are as previously defined.

The results of these calculations are presented in isoplethic form in Figure B-4.1.2.8a. Figure B-4.1.2.8b shows the average normalized dry ground deposition rate in the maximum sector (NW) as a function of distance from the stack.

4.1.3 Potential Accident Condition

4.1.3.1 The short term release of radioactive material is concerned with the postulated incidents which have been described in Chapter IX of this report. Equation B-8 has been used to compute the maximum normalized cloud concentration, on the cloud center-line, associated with the incidents.

$$E/Q = \frac{(q/Q)}{\pi \sigma_z \sigma_y u_h} \exp(-h^2/2\sigma_z^2) \quad (B-8)$$

FIGURE B-4.1.2.8a

NORMAL CONDITIONS

ISOPLETHS OF AVERAGE NORMALIZED

DRY GROUND DEPOSITION RATE

where:

$\frac{E}{Q}$ = normalized time integrated air concentration,
 $\frac{uCi\text{-sec per Ci released}}{cc}$

σ_y = horizontal diffusion coefficient, meters

σ_z = vertical diffusion coefficient (from Equations B-2 and B-3), meters

$\bar{u}_h$ = wind speed at release height, assumed to be 1.0 meters/sec.

(q/Q) = cloud depletion factor (computed using Equations B-4 and B-5)

h = release height, meters

4.1.3.1.1 For stable atmospheric conditions the value of σ_y is determined from:

$$\sigma_z^2 = At - \frac{A^2}{2(\sigma_\theta \bar{u})^2} \left[1 - \exp\left(-\frac{2(\sigma_\theta \bar{u})^2 t}{A} \right) \right] \quad (B-9)$$

where:

A = a constant related to the scale of turbulence =
 $13 + 232 \sigma_\theta \bar{u}$

$\sigma_\theta \bar{u}$ = a variable relating the standard deviation of the lateral wind direction and average wind speed, radian meters/sec

t = cloud travel time = $\frac{x}{\bar{u}}$, sec

The values of the product $\sigma_\theta \bar{u}$ commonly used for a 1 m/sec average wind speed (Reference B-4.1.3.1.1) are shown in Table B-4.1.3.1.1.

TABLE B-4.1.3.1.1

<u>Assumed Duration of Release, Min.</u>	<u>$\sigma_\theta \bar{u}$</u>
10	0.024
120	0.08

4.1.3.1.2 For neutral and unstable atmospheric conditions the horizontal diffusion coefficient σ_y is given by:

$$\sigma_y = \frac{C_y}{\sqrt{2}} \times (2-n)^{1/2} \quad (B-10)$$

where C_y and n are Sutton parameters and the values used in this analysis are shown in Table B-4.1.3.1.2.

TABLE B-4.1.3.1.2

Parameter	Wind Speed	Unstable	Neutral
C_y	1.0 m/sec	.30	.15
	2.5 m/sec	.28	.14
	5.0 m/sec	.26	.12
	7.5 m/sec	.25	.115
	10.0 m/sec	.24	.11
	15.0 m/sec	.23	.10
n		.20	.25

The vertical diffusion coefficients are as given by Equation B-3 and the data from Table B-4.1.2.4.2.

Results of the computations of E/Q for the four atmospheric conditions are presented in Figure B-4.1.3.1.

4.1.3.2 The dry deposition associated with the four atmospheric conditions for the accident case was calculated using the data from Table B-4.1.2.5 and Equation B-11 which is similar to Equation B-7. The results of these computations are shown in Figure B-4.1.3.2.

$$\frac{\omega}{Q} = \left(\frac{V_{\Delta}}{u_o} \right) \left(\frac{u_o}{u_{200}} \right) u_h \left(\frac{E}{Q} \right) \quad (B-11)$$

where:

$$\frac{\omega}{Q} = \text{normalized deposition, Ci/m}^2 \text{ per Ci released}$$

4.1.3.3 A most unlikely coincidence of a postulated incident (potential accident) and adverse atmospheric conditions would be associated with a rain washout of the effluent plume. Based on a 10 minute release with constant wind direction, the plume should pass any given point along the wind direction path in a period of 10 minutes. Washout depositions were computed for stable atmospheric conditions assuming that the 10 minute period involved coincided with the onset of rain at each point. Equation B-12 (Reference B-4.1.1a) was used to compute the washout for values of Λ of 1×10^{-4} seconds⁻¹. Results of these calculations are shown in Figure B-4.1.3.3.

$$\frac{\omega}{Q} = \frac{\Lambda}{\bar{u}_h \sigma_y \sqrt{2\pi}} \quad (B-12)$$

$\frac{\omega}{Q}$ = normalized washout deposition, Ci/m²
of ground surface per Ci released

Λ = washout coefficient = 10^{-4} sec⁻¹

The other variables are as previously defined.

The values of σ_y used are those for a stable 10 minute release calculated from Equation B-9.

4.1.4 Dose Estimates

4.1.4.1 Radioactive plumes can expose human beings within their environment to both internal and external radiation. Internal radiation effects were assumed to be a function not only of the airborne material inhaled, but of that deposited on pasture grass and ultimately ingested as a result of the consumption of milk from cows grazing in the area. External radiation was evaluated considering exposure of the body to the plume as a semi-infinite cloud suspension as well as to the material deposited on the ground.

4.1.4.1.1 Internal inhalation doses were computed using the following equations considering the body organ effects for the radionuclide characteristics from Table B-3.1.6.

For normal plant operation:

$$D_i = D' \left(\frac{\bar{X}}{\dot{Q}} \right)_i \dot{Q} (BR) \frac{(\lambda_{\text{eff}} t + \exp(-\lambda_{\text{eff}} t) - 1)}{\lambda_{\text{eff}}} (8.64 \times 10^4) \quad (\text{B-13})$$

where:

D_i = equivalent dose during the first year in sector i , rem

BR = breathing rate = 350 cc/sec

λ_{eff} = effective decay constant in the organ, days⁻¹

t = time of exposure = 365 days

D' = infinite time organ dose, rem/uCi inhaled

$\left(\frac{\bar{X}}{\dot{Q}} \right)_i$ = normalized cloud concentration in sector i , uCi/cc per Ci/sec released

$\dot{Q}$ = release rate, Ci/sec

For accident conditions:

$$D = \left(\frac{E}{\dot{Q}} \right) \dot{Q} (BR) D' \quad (\text{B-14})$$

where: (E/Q) = normalized time integrated air concentration
 $\frac{\text{uCi-sec}}{\text{cc}}$ per Ci released

D = equivalent infinite time dose, rem

Q = quantity released, Ci

The first year dose resulting from the potential accident can be readily obtained by multiplying the infinite time dose by the factor K from Table 3.1.6 for each radionuclide of interest.

4.1.4.1.2 In addition to the internal dose from inhalation of released radionuclides, the ingestion of contaminated milk via the transfer of radionuclides from pasture grass to cow's milk and then to man must be considered. For normal conditions, the daily intake of radionuclides is given by Equation B-15.

$$P_i = \frac{MG}{(\text{pg})V} \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \dot{Q}IA \frac{(1 - e^{-\lambda t})}{\lambda} 8.64 \times 10^{10} \frac{\text{uCi}}{\text{day}} \quad (\text{B-15})$$

where:

P_i = daily intake from milk produced in sector i , uCi/day

M = daily milk ingestion in grams = 10^3 g/day

G = Cow's daily intake of pasture grass = 4×10^4 g/day

$\dot{Q}$ = release rate of radionuclide, Ci/sec

$\left(\frac{\bar{\omega}}{\dot{Q}} \right)_i$ = average normalized deposition rate in sector i (from equation B-7), Ci/m²-sec per Ci/sec released

I = fraction of the cow's daily intake of radionuclides that appears in the milk = .1 for cesium, .01 for strontium.

A = fraction of contaminant absorbed or adsorbed to edible part of vegetables = .2 for cesium, .4 for strontium.

λ = decay constant of radionuclide, days⁻¹

(pg) = mass of pasture grass per unit area = 10^3 g/m²

V = daily milk output = 10^4 g/day

t = time of interest = 365 days

$$P_{iSr} = 1.38 \times 10^3 \frac{(1 - e^{-\lambda t})}{\lambda} \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \dot{Q} \quad (B-16)$$

$$P_{iCs} = 6.91 \times 10^3 \frac{(1 - e^{-\lambda t})}{\lambda} \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \dot{Q} \quad (B-17)$$

The dose from milk produced in sector i is then given by Equation B-18.

$$D_i = f_w D'' P_i \frac{(\lambda_{eff} + e^{-\lambda_{eff} t} - 1)}{\lambda_{eff}} \quad (B-18)$$

where:

f_w = fractional uptake by the organ from ingestion =
1.0 for Cs, 0.023 for ^{90}Sr and 0.053 for ^{89}Sr

D'' = dose conversion factor = D'/f_a = rem/uCi in organ

λ_{eff} = efficiency decay constant in organ, days^{-1}

t = time of interest = 365 days

Excluding the small contribution from Ce-144, the equations for the internal dose from milk consumption become:

$$D_i = 4.4 \times 10^3 \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \text{ rem Bone Dose} \quad (B-19)$$

$$D_i = 1.7 \times 10^3 \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \text{ rem Total Body Dose} \quad (B-20)$$

For the postulated accident conditions the term $\frac{(1 - e^{-\lambda t})}{\lambda}$ in Equation B-15 is dropped and the constant is changed to 10^6 . The equations for the normalized first year dose then become:

$$\frac{D_{90}^{Sr}}{Q} = 9.7 \times 10^5 \left(\frac{\omega}{Q} \right) \text{ rem/Ci released Bone Dose (B-21)}$$

$$\frac{D_{137}^{Cs}}{Q} = 9.3 \times 10^5 \left(\frac{\omega}{Q} \right) \text{ rem/Ci released Total Body Dose (B-22)}$$

where:

Q = quantity released, Ci

$\left(\frac{\omega}{Q} \right)$ = normalized deposition, Ci/m² per Ci released (from Equation B-11)

4.1.4.1.3 External doses (for the postulated accident cases) and dose rates (for the normal condition) were computed using equations which are based on those presented and discussed in Section 7 of Reference B-4.1.1a. External doses or dose rates associated with the enveloping cloud were computed using the following equations:

For normal conditions:

$$\dot{D}_{i\beta} = 0.23 \bar{E}_{\beta} \left(\frac{\bar{X}}{\dot{Q}} \right)_i \dot{Q} \quad (\text{B-23})$$

$$\dot{D}_{i\gamma} = 0.25 \bar{E}_{\gamma} \left(\frac{\bar{X}}{\dot{Q}} \right)_i \dot{Q} \quad (\text{B-24})$$

where:

$\dot{D}_{i\beta}$ = beta dose rate in sector i , rad/sec

$\dot{D}_{i\gamma}$ = gamma dose rate in sector i , rad/sec.

$\left(\frac{\bar{X}}{\dot{Q}} \right)_i$ = normalized air concentration, in sector i , $\frac{\mu\text{Ci}}{\text{cc}}$ per Ci/sec

$\dot{Q}$ = release rate, Ci/sec

$\bar{E}_{\beta}$ = average beta radiation release factor for the isotope and daughters, (0.58 Mev for ⁸⁹Sr, 1.14 Mev for ⁹⁰Sr, 0.15 Mev for ¹³⁴Cs, 0.61 Mev for ¹³⁷Cs, 2.8 Mev for ¹⁴⁴Ce)

$\bar{E}_\gamma$ = average gamma radiation release factor for the isotope and daughters (1.56 Mev for ^{134}Cs , 0.56 Mev for ^{137}Cs , 0.37 Mev for ^{144}Ce)

For the potential accident cases:

$$\frac{D_\beta}{Q} = 0.23 \bar{E}_\beta (E/Q) \quad (\text{B-25})$$

$$\frac{D_\gamma}{Q} = 0.25 \bar{E}_\gamma (E/Q) \quad (\text{B-26})$$

where:

$$\frac{D_\beta}{Q} = \text{normalized beta dose, rad/Ci released}$$

$$\frac{D_\gamma}{Q} = \text{normalized gamma dose, rad/Ci released}$$

$$(E/Q) = \text{normalized time integrated air concentration, } \frac{\text{uCi-sec}}{\text{cc}} \text{ per Ci released}$$

4.1.4.1.4 External dose rates from dry ground deposition at a height of 1 meter above ground were computed using the following equations (Reference B-4.1.1b).

For normal conditions:

$$\dot{D}_i = C \left(\frac{\bar{\omega}}{\dot{Q}} \right)_i \dot{Q} \frac{(1 - e^{-\lambda t})}{\lambda} (3.11 \times 10^7) \quad (\text{B-27})$$

where:

$\dot{D}_i$ = dose rate at a height of 1 meter after time t in sector i , rad/hr

t = time since continuous deposition began, days

C = conversion factor for the isotope and daughters, rad/sec per Ci/m² (0.03 for ^{89}Sr , 0.05 for ^{90}Sr , 0.009 for ^{134}Cs , 0.0027 for ^{137}Cs and 0.09 for ^{144}Ce)

λ = decay constant for radionuclide, days⁻¹

$\left(\frac{\bar{\omega}}{\dot{Q}} \right)_i$ = average normalized deposition rate in sector i , from Equation B-7), Ci/m²-sec per Ci/sec released

For the postulated accident conditions:

$$\frac{\dot{D}_{90\text{Sr}}}{Q} = 180 \left(\frac{\omega}{Q} \right) \text{ rad/hr per Ci released} \quad (\text{B-28})$$

$$\frac{\dot{D}_{137\text{Cs}}}{Q} = 10.8 \left(\frac{\omega}{Q} \right) \text{ rad/hr per Ci released} \quad (\text{B-29})$$

where:

$\left(\frac{\omega}{Q} \right) =$ normalized deposition, Ci/m² per Ci released

4.1.4.1.5 Equations B-13 through B-29 were applied to the normal operation and potential accident atmospheric dispersion and deposition results to determine the doses and dose rates imposed on plant personnel and the general public. Results of these calculations are discussed in the following paragraphs.

4.1.4.2 Normal Plant Operation

4.1.4.2.1 Inhalation doses were computed for annual average conditions using Equation B-13 and the release rate data from Table B-3.1.4.1. The results of these calculations are presented in Figures B-4.1.4.2.1a and B-4.1.4.2.1b, and B-4.1.4.2.1c as isopleths of the dose to the bone, total body, and lung, respectively, in rem for the first year of continuous exposure. To maximize the dose the assumption was made, in the first two cases, that all of the radionuclides were in a soluble form and in an insoluble form for the last case. The maximum on-site inhalation exposure occurs at about 200 meters from the stack and would produce, for continuous occupancy, a dose of 1.4×10^{-6} rem to the bone, 4.2×10^{-6} rem to the lung and 1.0×10^{-7} rem to the total body, during the first year.

4.1.4.2.2 The internal dose from the ingestion of milk from cows pastured in the Tri-City area would amount to 2×10^{-8} rem to the bone from ⁹⁰Sr and ⁸⁹Sr during the first year. The contribution from ¹⁴⁴Ce would be negligible. The first year total body dose from all radionuclides except ¹⁴⁴Ce would amount to about 8×10^{-9} rem. A graphical representation of the results of Equations B-19 and B-20 in the form of isopleths of bone and total body dose as a result of the consumption of cow's milk is presented in Figures B-4.1.4.2.2.a and B-4.1.4.2.2.b.

FIGURE B-4.1.4.2.1a
NORMAL CONDITIONS
ISOPLETHS OF FIRST YEAR
INHALATION BONE DOSE

FIGURE B-4.1.4.2.1b

NORMAL CONDITIONS

ISOPLETHS OF FIRST YEAR

INHALATION TOTAL BODY DOSE

FIGURE B-4.1.4.2.1c
NORMAL CONDITIONS
ISOPLETHS OF FIRST YEAR
INHALATION LUNG DOSE

FIGURE B-4.1.4.2.2a
NORMAL CONDITIONS
ISOPLETHS OF FIRST YEAR
BONE DOSE FROM INGESTION
VIA THE MILK PATH

ARH-1986

B-35

FIGURE B-4.1.4.2.2b

NORMAL CONDITIONS

ISOPLETHS OF FIRST YEAR

TOTAL BODY DOSE FROM

INGESTION VIA THE MILK PATH

- 4.1.4.2.3 The isopleths of the annual external beta plus gamma dose rate in rad/hr from cloud immersion calculated using Equation B-23 and B-24 are presented in Figure B-4.1.4.2.3. Exposure by this mode amounts to a maximum of 5.8×10^{-9} rad/yr. for continuous occupancy at 200 meters from the stack, a small fraction of the inhalation internal dose.
- 4.1.4.2.4 The final mode of exposure, that from the dry deposition of radionuclides on the ground, was calculated using Equation B-28. The dose rate isopleths at the end of the first year in rad/hr. are shown in Figure B-4.1.4.2.4.
- 4.1.4.3 Potential Accident Condition
- 4.1.4.3.1 Doses for the potential accident cases were computed for the four general atmospheric conditions recognized at Hanford. The results are for the center-line of the plume and represent the maximum values expected.

FIGURE B-4.1.4.2.3

NORMAL CONDITIONS

ISOPLETHS OF DIRECT

CLOUD DOSE RATE

FIGURE B-4.1.4.2.4

NORMAL CONDITIONSISOPLETHS OF DOSE RATEFROM DRY DEPOSITEDMATERIAL AFTER 1 YEAR

- 4.1.4.3.2 Normalized inhalation internal doses were computed for ^{90}Sr and ^{137}Cs using Equation B-14. Results of these calculations, presented in Figures B-4.1.4.3.2a, B-4.1.4.3.2b, and B-4.1.4.3.2c, show that the maximum on-site dose occurs at 100 meters for a 10 minute release during moderately stable atmospheric conditions. The maximum inhalation infinite time bone dose from ^{90}Sr is 2 rem/Ci released for the 10 minute moderately stable condition. In the Tri-City area the infinite time bone dose is 0.04 rem/Ci released for the 10 minute highly stable condition.
- 4.1.4.3.3 The normalized doses for internal deposition via the milk path were computed using Equations B-21 and B-22. The results presented in Figures B-4.1.4.3.3a and B-4.1.4.3.3b show that the maximum internal doses from deposition on pasture grass at 16,000 meters from the release point (nearest Hanford boundary) would be 0.0026 rem/Ci and 0.0025 rem/Ci released for ^{90}Sr and ^{137}Cs , respectively.
- 4.1.4.3.4 Presented in Figure B-4.1.4.3.4 are the normalized external cloud doses for ^{90}Sr and ^{137}Cs calculated using Equations B-25 and B-26. The maximum on-site dose occurs for the 10 minute moderately stable condition at 100 meters from the release point and is 1.3×10^{-4} rad/Ci released for either ^{90}Sr or ^{137}Cs . In the Tri-City area the maximum dose occurs in conjunction with a 10 minute release during highly stable conditions and is 2.5×10^{-6} rad/Ci released.

FIGURE B-4.1.4.3.2b

POTENTIAL ACCIDENT CONDITION

NORMALIZED ^{90}Sr LUNG DOSE

FROM INHALATION

FIGURE B-4.1.4.3.4

POTENTIAL ACCIDENT CONDITION

NORMALIZED ^{90}Sr OR ^{137}Cs INFINITE

CLOUD DOSE

- 4.1.4.3.5 Normalized dose rates at a height of one meter above the ground from the dry ground deposition of radionuclides were calculated using Equations B-27 and B-28. The results of these calculations are shown in Figures B-4.1.4.3.5a and B-4.1.4.3.5b. The maximum dose rate occurs at 160 meters for a release under unstable conditions and is 3.1×10^{-5} and 1.8×10^{-6} rad/hr. per curie released for ^{90}Sr and ^{137}Cs , respectively.

REFERENCES

- B-3.1.2 Private Communication, E. Phinney, BNW Meteorology, to J. R. Houston, November 12, 1970.
- B-3.1.4.1a Letter, G. L. Borsheim to J. R. LaRiviere, July 24, 1970.
- B-3.1.4.1b Letter, G. L. Borsheim to J. R. LaRiviere, April 24, 1970.
- B-3.1.6 Publications of the International Committee on Radiological Protection.
- B-4.1.1a Slade, D. H., "Meteorology and Atomic Energy 1968", TID-24190, July 1968.
- B-4.1.1b "Theoretical Possibilities and Consequences of Major Accidents in U-233 and Pu-239 Fuel Fabrication and Radioisotope Processing Plants", Guthrie and Nichols, ORNL-3441, April 1954.
- B-4.1.2.5 Gamertsfelder, C. C., and Watson, E. C., "Environmental Radioactive Contamination as a Factor in Nuclear Plant Siting Criteria", HW-SA-2809, February 1963.
- B-4.1.3.1.1 Hendrickson, M. M., "EXDOSE, A Computer Program for Calculating the External Gamma Dose From Airborne Fission Products", BNW-811, September 1968.

APPENDIX C
SHIELDING CALCULATIONS

1.0 Introduction

This appendix presents the method used in determining the required shield thickness for various areas of the WESF in accordance with the shielding criteria noted in Appendix A.

2.0 Computational Method

- 2.1 Shielding calculations were accomplished using a computer program known as ISOSHL D II (Ref. C-2.0.a., C-2.0.b). Widely known and recognized as one of the better programs of its type, ISOSHL D II is capable of performing bremsstrahlung and/or decay gamma ray shielding calculations for radioisotopic sources in a wide variety of source and shield configurations. Attenuation calculations are performed by point kernel integration. Five shield regions can be handled with up to 20 materials per shield; for most geometries the source is considered to be the first shield region, i.e., bremsstrahlung and decay gamma rays are produced only in the source.
- 2.2 The program was designed to include most of the basic data required for shielding calculations. Considerable effort was expended in compiling isotopic decay, material attenuation, buildup factor, gamma ray and probabilities, maximum beta energies and probabilities and other data for these types of shielding calculations. These data are in libraries chained to the code so that, for these calculations, all basic data are supplied.
- 2.3 For most problems the user need only supply:
- The geometry and material composition of the source;
and
 - The geometry and materials of the shields.

C-2.0.a - Engel, R.L., et al., "ISOSHL D - A Computer Code for General Purpose Isotope Shielding Analysis," BNWL-236, June 1966.

C-2.0.b - Simmons, G.L., et al., "ISOSHL D-II: Code Revision to Include Calculation of Dose Rate from Shielded Bremsstrahlung Sources," BNWL-236 SUP1, March 1967.

- 2.4 Optional modes of data entry are available for solving special problems.
- 2.5 The radiation source used in the program consists of an input number of curies of radioactive material, with any combination up to 25 photon energy groups. Energy-dependent parameters relating to dose conversion, attenuation, and buildup are obtained by linear interpolation of values of the parameters found in the program library. The source distribution is considered uniform over the volume of the source region unless an exponential distribution is specified.

APPENDIX D

CRITICALITY PREVENTION

The B Plant Waste Fractionization Facility feed solutions, containing the strontium and cesium, have less than 0.01 gram of plutonium per gallon of solution, well below the minimum critical concentration of 30 grams per gallon. The strontium and cesium are subsequently isolated from this process solution; the residual waste solution, along with the plutonium, is returned to underground storage for in-tank solidification. Assurance that the plutonium has been removed from both the strontium and cesium WESF feed solutions is verified by samples from their individual B Plant canyon storage tanks. Thus, it is established that the final purified product solutions of strontium and cesium entering the WESF are essentially free from plutonium and that no criticality control problem exists.⁽¹⁾

(1) Larson, D.E., "Waste Management Program Sample Schedules", ARH-1326, Unclassified, Atlantic Richfield Hanford Company, Richland, Washington, August 1, 1969.

APPENDIX F
NATURAL PHENOMENON

1. Earthquake

Comprehensive, state-of-the-art earthquake resistant design analyses of the Waste Encapsulation and Storage Facilities, including the process piping and equipment were performed by John A. Blume and Associates, Engineers (JABE)⁽¹⁾⁽²⁾. Several design improvements were recommended by JABE upon completing their seismic analyses of the primary facility, all of which were implemented. The facility is designed to maintain required functional and containment characteristics after experiencing either of two separate hypothesized strong motion earthquakes, the Design Basis Earthquake (DBE), or the Operational Basis Earthquake (OBE).

The DBE, defined as the maximum credible earthquake motion that could occur at the site, predicted for Hanford would induce a maximum horizontal ground acceleration of 0.25 g (the maximum simultaneous vertical acceleration equals 2/3 of the horizontal). The OBE, defined as the maximum probable earthquake motion that could occur at the site, predicted for Hanford would induce a maximum horizontal ground acceleration of 0.125 g (the maximum simultaneous vertical acceleration equals 2/3 of the horizontal).

For seismic resistant design purposes, Waste Encapsulation Facility structures, piping, and equipment were separated into three categories according to the importance of their function with regard to nuclear safety, as follows:

- Type A - Those structures, piping, and equipment necessary to achieve and maintain, with no undue risk to public health and safety, a safe orderly shutdown and containment of processes involving radioactive materials.
- Type B - Those structures, piping, and equipment necessary for continued safe normal operation of the facility with no undue risk to public health and safety, but not in the Type A category.
- Type C - Those structures, piping, and equipment not necessary for normal operation and not included in the Type A and B categories.

Type A and Type B structures for the facility are designed to withstand the OBE and remain operational. According to the JABE analyses, these structures will not be stressed above code established design values when subjected to the most severe combination of dynamic OBE forces and normal operating loads.

Type A structures for the facility are also designed to withstand the DBE and be operable such that a safe orderly shutdown of the facility can be achieved and maintained with no compromise of containment. According to the JABE analyses, Type A structures will not be stressed above code established yield values when subjected to the most severe combination of dynamic DBE forces and normal operating loads.

All structures for the Waste Encapsulation Facility were categorized as either Type A or Type B, consequently, there was no need to consider seismic resistant design for Type C structures.

2. Major Floods

The 200 Area plateau has not experienced a major flood since the draining of glacial Lake Missoula some 50,000 to 100,000 years ago. The draining of Lake Missoula resulted in the creation of what is now known as the Columbia River System. Today, the Columbia River System includes a number of large hydroelectric power dams that are used for flood control and power generation. Grand Coulee Dam creates the largest water impoundment. During the past 21 years, the flow of the Columbia River has varied from a minimum of 34,000 to a maximum of 659,000 cubic feet per second. Dam projects along the Columbia River and extending into Canada will further minimize the occurrence and height of floods. By 1985 the 100-year maximum flood stage is estimated to be about 440,000 cubic feet per second. The maximum probable flood has been estimated by the Corps of Engineers to be 1,440,000 cubic feet per second, which would result in a river level of approximately 390 feet. The WESF site is located at 702 ft. above sea level. Surface flooding is not considered to be a problem.

3. Lightning

While severe lightning storms are not common to this local area, lightning does occur.

The B Plant facilities are grounded in accordance with Hanford Standard D-20-9B. Facilities are protected by common lightning rods connected by copper wire to a static ground mat consisting of buried cable and ground rods. Some of the higher structures are protected by an auxiliary ground or, like the water tower, are themselves a solid ground.

The Waste Encapsulation and Storage Facilities will be grounded with a standard ground counterpoise tied to the common grid system. The water tower and several other building structures in the immediate area are taller and would be subjected to a lightning strike should one occur in the area.

Power lines are equipped with lightning arrestors to bleed off excess energy caused by a power line strike which will provide protection to transformers and equipment.

4. Wind

Wind loadings for the Waste Encapsulation and Storage Facilities were calculated per Hanford Standard SDC-4.1. The dynamic earthquake loadings determined by the seismic analysis of the structures are more severe than those imposed by Hanford Standard SDC-4.1. (Wind loads specified in SDC 4.1 are identical to those listed in the Uniform Building Code - 1970). Since the facilities will exceed the SDC-4 1 wind resistance requirements, no further wind analysis was performed

Meteorological data for the Hanford site is well documented. A complete meteorological station is located three miles west of the WESF site. The peak wind gust measured at the 50 ft. level of the meteorological tower during the past 25 years was 72 mph. A 72 mph wind would not produce wind loading in excess of those prescribed in SDC 4.1.

REFERENCES

- (1) JABE-VITRO-01, Earthquake Analysis of the Waste Encapsulation Facility - Hanford Atomic Energy Reservation, April 1971, John A. Blume & Associates, Engineers.
- (2) JABE-VITRO-02, Piping and Equipment Seismic Study - Building 225-B of the Waste Encapsulation Facility - Hanford Atomic Energy Reservation, April 1971, John A. Blume & Associates, Engineers.

APPENDIX E - DRAWINGS

TABLE OF CONTENTS - BY CATEGORY

Note - Appendix E represents approximately nine percent of the WEST project drawings. This Table of Contents categorizes the appended "Key" drawings into eight major categories, however, the drawings are sequenced numerically by their H-2-XXX drawing number for easy reference. The drawings are preceded by the Master Index Listing H-2-66400. Those drawings selected for inclusion in this document are asterisked on the Master Index Sheets. Drawings not included are available upon request.

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SPECIFICATIONS

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APPROVED FOR RELEASE BY <i>[Signature]</i> DATE <i>6-1-71</i>	
U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
DRAWING INDEX	
DRAWING NO. <i>H-2-66400</i> SCALE <i>NONE</i> CLASSIFICATION <i>NONE</i>	PROJ NO. <i>HAP 611</i> PROJ TITLE <i>WASTE ENCAPSULATION FACILITY</i> SHEET NO. <i>221-B</i> SHEET TOTAL <i>0000</i> DRAWING NO. <i>H-2-66400</i> SHEET NO. <i>1</i> SHEET TOTAL <i>5</i>

CELL 38

PIPE JUMPER ASSEMBLIES

DWG NO	REV NO	INDEX	TITLE
H-2-66273		8405	38-(38-7)-(38-6)
H-2-66274		8405	38-55-(38-1)-B
H-2-66275	REV 1	8405	38-234-(38-1)-NN
H-2-66276		8405	38-228-(38-1)-MM
H-2-66277	REV 1	8405	38-229-(38-1)-U
H-2-66278		8405	38-241-(38-3)-S
H-2-66279	REV 1	8405	38-65-(38-3)-R
H-2-66280	REV 2	8405	38-250-(38-1)-T
H-2-66281	REV 1	8405	38-251-(38-3)-W
H-2-66282		8405	38-235-(38-2)-KK
H-2-66283	REV 1	8405	38-71-205-(38-2)-N
H-2-66284	REV 1	8405	38-218-253-(38-2)-JJ
H-2-66285		8405	38-68-(38-2)-P(38-3)-Q
H-2-66286		8405	38-73-244-(38-2)-M
H-2-66287		8405	38-239-(38-2)-L
H-2-66288		8405	38-256-(38-2)-HH
H-2-66289		8405	38-75-(38-2)-K
H-2-66290		8405	38-254-(38-1)-FF
H-2-66291	REV 1	8405	38-62-(38-3)-Z
H-2-66292		8405	38-(38-1)-E-(38-2)-CC
H-2-66293		8405	38-4-31
H-2-66294		8405	38-33-35
H-2-66295		8405	38-34-36
H-2-66296		8405	38-66-(38-2)-EE
H-2-66297		8405	38-42-(38-3)-H
H-2-66298		8405	38-231-(38-2)-K-(38-3)-F
H-2-66299		8405	38-238-3
H-2-66300		8405	38-243-(38-8)-K
H-2-66301		8405	38-252-(38-8)-E
H-2-66302		8405	38-201-(38-8)-J
H-2-66303		8405	38-237-247-(38-8)-C
H-2-66304		8405	38-83-240-(38-8)-B
H-2-66305		8405	38-223-(38-8)-H
H-2-66306		8405	38-258-(38-8)-22
H-2-66307	REV 1	8405	38-80-(38-3)-F
H-2-66308		8405	38-54-203-(38-4)-Q
H-2-66309		8405	38-221-(38-1)-GG
H-2-66310		8405	38-52-(38-4)-E
H-2-66311		8405	38-24-(38-4)-P
H-2-66312		8405	38-216-26
H-2-66313		8405	38-27-28-3J
H-2-66314		8405	38-63-(38-4)-K
H-2-66315		8405	38-236-(38-4)-N
H-2-66316		8405	38-88-(38-2)-DD
H-2-66317		8405	38-217-(38-6)-D
H-2-66318		8405	38-211-(38-6)-E
H-2-66319		8405	38-15-16
H-2-66320		8405	38-208-(38-6)-AA-SUMP
H-2-66321		8405	38-210-(38-6)-C
H-2-66322	REV 1	8405	38-45-(38-6)-K
H-2-66323		8405	38-220-(38-6)-H
H-2-66324		8405	38-214-(38-6)-B
H-2-66325	REV 1	8405	38-6-17
H-2-66326		8405	38-213-(38-6)-A
H-2-66327		8405	38-255-(SEAL POT)-L
H-2-66328		8405	38-47-(38-6)-AM
H-2-66329			
H-2-66330		8405	38-12
H-2-66331	REV 1	8405	38-202-(38-4)-Y
H-2-66332		8405	38-(38-1)-D-(38-4)-W
H-2-66333			
H-2-66334			
H-2-66335		8405	38-51-(38-7)-L
H-2-66336		8405	38-248-(38-7)-B
H-2-66337		8405	38-(38-8)-A-(38-6)-U
H-2-66338		8405	38-78-14
H-2-66339	REV 1	8405	38-232-(38-6)-F
H-2-66340		8405	38-237-(38-5)-B
H-2-66341		8405	38-249-2
H-2-66342		8405	38-1-18

CELL 38

PIPE JUMPER ASSEMBLIES (CONTINUED)

DWG NO	INDEX	TITLE
H-2-67801	8405	38-222-(38-5)-E
H-2-67802	8405	38-242-(38-5)-C
H-2-67803	8405	38-20-21
H-2-67804	8405	38-212-(38-4)-H
H-2-67805	8405	38-76-(38-5)-D
H-2-67806	8405	38-30-(38-1)-C
H-2-67807	8405	38-(38-5)-A-(38-1)-Y
H-2-67808	8405	38-233-6
H-2-67809	8405	38-29-32
H-2-67810	8405	38-13-23
H-2-67811	8405	38-64-(38-7)-D
H-2-67812	8405	38-259-(38-3)-AA
H-2-67813	8405	38-227-(38-4)-J
H-2-67814	8405	38-49-206-8
H-2-67815	8405	38-64-(38-7)-D
H-2-67816	8405	38-77-(38-4)-RE

CELL 39

PIPE JUMPER ASSEMBLIES

DWG NO	REV NO	INDEX	TITLE
H-2-66361		8405	39-1-(39-4)-G
H-2-66362		8405	39-205-(39-4)-F
H-2-66363		8405	39-2-(39-4)-J
H-2-66364		8405	39-3-(39-4)-E
H-2-66365		8405	39-239-6
H-2-66366		8405	39-236-(39-4)-D
H-2-66367	REV 1	8405	39-5-(39-4)-C
H-2-66368		8405	39-207-(39-3)-D
H-2-66369	REV 1	8405	39-224-7-(39-3)-C
H-2-66370		8405	39-209-(39-3)-G
H-2-66371		8405	39-237-(39-3)-B
H-2-66372		8405	39-9-(39-3)-A
H-2-66373		8405	39-210-(39-3)-J
H-2-66374		8405	39-235-(39-3)-H
H-2-66375		8405	39-10-(39-3)-K
H-2-66376		8405	39-218-(39-2)-C
H-2-66377		8405	39-240-7
H-2-66378		8405	39-12-(39-3)-E
H-2-66379		8405	39-238-13-(39-1)-N
H-2-66380		8405	39-14-(39-2)-A
H-2-66381		8405	39-217-2
H-2-66382		8405	39-15-(39-2)-K
H-2-66383		8405	39-214-(39-2)-L
H-2-66384		8405	39-241-5
H-2-66385		8405	39-19-(39-2)-J
H-2-67200		8405	39-216-(39-1)-J
H-2-67201	REV 1	8405	39-20-(39-2)-H
H-2-67202		8405	39-21-(39-2)-G
H-2-67203		8405	39-22-4
H-2-67204		8405	39-247-(39-1)-H
H-2-67205	REV 1	8405	39-23-(39-1)-AA
H-2-67206		8405	39-24-8
H-2-67207		8405	39-25-(39-1)-D
H-2-67208		8405	39-29-(39-3)-F
H-2-67209		8405	39-202-11

CELL 39

PIPE JUMBER ASSEMBLIES (CONTINUED)

DWG NO	REV NO	INDEX	TITLE
H-2-67210		8405	39-31-206-(39-1)-Z
H-2-67211		8405	39-226-(39-1)-W
H-2-67212		8405	39-259-(39-1)-B
H-2-67213		8405	39-244-(39-1)-V
H-2-67214		8405	39-33-(39-1)-U
H-2-67215	REV 1	8405	39-36-228-(39-5)-KK
H-2-67216		8405	39-229-(39-5)-JJ
H-2-67217	REV 1	8405	39-38-(39-5)-HH
H-2-67218		8405	39-230-(39-5)-GG
H-2-67219		8405	39-41-(39-5)-FF
H-2-67220		8405	39-232-(39-5)-EE
H-2-67221	REV 1	8405	39-233-208-(39-5)-DD
H-2-67222		8405	39-204-3
H-2-67223	REV 1	8405	39-211-(39-5)-NN
H-2-67224		8405	39-201-(39-4)-H
H-2-67225		8405	39-9-(39-1)-Q
H-2-67226		8405	39-203-SUMP
H-2-67227		8405	39-(39-3)-L-(39-1)-P
H-2-67228		8405	39-(39-2)-F-(39-4)-A
H-2-67229		8405	39-(39-5)-A-(39-4)-K
H-2-67230		8405	39-219-4-(ALT)
H-2-67231		8405	39-247-13-(ALT)
H-2-67856		8405	39-221-(39-5)-V
H-2-67870	REV 1	8405	39-234-(39-1)-S
H-2-67871		8405	39-264-10
H-2-67872		8405	39-219-39-(39-1)-T

CELLS 5 THRU 37

PIPE JUMPER ASSEMBLIES

DWG NO	INDEX	TITLE
H-2-67232	8405	5-12-7
H-2-67233	8405	5-202-39
H-2-67234	8405	5-46-(5-2)-DD-S
H-2-67235	8405	5-81-DD
H-2-67236	8405	8-201-(8-1)-11
H-2-67237	8405	8-82-6
H-2-67817	8405	14-215-3
H-2-67818	8405	14-79-(14-2)-3-BB
H-2-67819	8405	16-81-204
H-2-67820	8405	17-206-(17-2)-T
H-2-67821	8405	19-202-(19-1)-Q
H-2-67822	8405	21-203-(21-1)-Q
H-2-67823	8405	23-217-(23-1)-K
H-2-67824	8405	24-205-(24-1)-P
H-2-67825	8405	36-225-(36-1)-10-V
H-2-67852	8405	36-208-10
H-2-67856	8405	36-79-81
H-2-67857	8405	37-206-(37-3)-B
H-2-67858	8405	5-24-5-6
H-2-67859	8405	5-(E-5-2)-A-6
H-2-67873	8405	21-41-9
H-2-67874	8405	14-55-(14-1)-D
H-2-67875		
H-2-67876		

HOT PIPE TRENCH

PIPE JUMPER ASSEMBLIES

DWG NO	REV NO	INDEX	TITLE
H-2-67826		8405	15 16-11-204
H-2-67827		8405	17 18-2-206
H-2-67828		8405	19 20-7-202
H-2-67829		8405	19/20-9-12
H-2-67830		8405	21/22-4-4
H-2-67831		8405	21/22-6-11
H-2-67832		8405	23/24-1-14
H-2-67833		8405	23/24-12-217
H-2-67834		8405	25/26-5-9
H-2-67835		8405	31/32-6-12
H-2-67836			
H-2-67837		8405	27/28-6-7
H-2-67838		8405	35/36-8-79
H-2-67839		8405	36/36-9-225
H-2-67840		8405	37/38-3-220
H-2-67841		8405	37/38-5-212
H-2-67842		8405	37/38-7-206
H-2-67843		8405	37/38-8-202
H-2-67844		8405	37 38-9-205
H-2-67845		8405	39/40-3-12
H-2-67846		8405	39/40-12-4
H-2-67847		8405	39/40-5-217
H-2-67848		8405	36/40-7-204
H-2-67849		8405	39/40-6-208
H-2-67850		8405	19 20-8-101
H-2-35814	REV 1	8405	29/30-3-9 4PT 25/26-3-9

MISCELLANEOUS

DWG NO	REV NO	INDEX	TITLE
H-2-61123		8405	ELECTRICAL FLEXIBLE STANDARDS
H-2-63803		8405	JUMPER MISCELLANEOUS DETAILS
H-2-63804		8405	JUMPER MISCELLANEOUS DETAILS

APPROVED FOR RL-HS3		DATE 6-1-71	
U. S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
DRAWING INDEX			
SCALE NONE		PROJ NO. 4-2-66400	
SHEET NO. 2		SHEET 5	

ARCHITECTURAL STRUCTURAL

DWG NO	REV	INDEX	TITLE
2-66401	REV 1	0800	MODIFICATIONS COOLING WASTE CRAINS
2-66402	REV 1	0800	ARCHITECTURAL FIRST FLOOR PLAN AREA #1
2-66403	REV 1	0800	ARCHITECTURAL FIRST FLOOR PLAN AREA #2
2-66404	REV 1	0801	ARCHITECTURAL SECOND FLOOR PLAN
2-66405	REV 1	0801	ARCHITECTURAL SECTIONS
2-66406	REV 1	0801	ARCHITECTURAL EXTERIOR ELEVATIONS
2-66407	REV 1	0802	ARCHITECTURAL DOOR SCHEDULE & DETAILS INTERIOR ROOM FINISH SCHEDULE
2-66408	REV 1	0800	ARCHITECTURAL ROOF PLAN & DETAILS
2-66409	REV 1	0801	ARCHITECTURAL EXTERIOR WALL SECTION & DETAILS
2-66410	REV 1	0801	ARCHITECTURAL INTERIOR WALL SECTION & DETAILS
2-66411		0801	ARCHITECTURAL STAIR PLANS & DETAILS
2-66412		0802	ARCHITECTURAL EXTERIOR FINISH SCHEDULE & MISCELLANEOUS DETAILS
2-66413		0110	CIVIL EXCAVATION PLAN
2-66414	REV 1	1000	STRUCTURAL ROOF PLAN - AREA #1 & 3
2-66415	REV 1	0900	STRUCTURAL FLOOR PLAN & DETAILS - AREA #1
2-66416	REV 2	0900	STRUCTURAL FIRST FLOOR PLAN - AREA #1
2-66417	REV 2	0900	STRUCTURAL SECOND FLOOR PLAN - AREA #2
2-66418	REV 1	0900	STRUCTURAL ROOF PLAN AREA 2 & TYPICAL DETAILS
2-66419	REV 1	0900	STRUCTURAL SECTIONS - AREA #2
2-66420	REV 2	0900	STRUCTURAL FOUNDATION & FLOOR PLAN - AREA #3
2-66421	REV 2	0901	STRUCTURAL SECTIONS - AREA 3
2-66422	REV 1	0900	STRUCTURAL PROCESS CELLS PLANS
2-66423	REV 1	0900	STRUCTURAL PROCESS CELLS SECTIONS
2-66424	REV 1	0901	STRUCTURAL COVER BLOCKS
2-66425	REV 1	0901	STRUCTURAL SECTIONS
2-66426	REV 1	0900	STRUCTURAL LINER PLATE DETAILS
2-66427	REV 1	0901	STRUCTURAL SECTIONS - AREA #2 & #3
2-66428	REV 2	0110	CIVIL - PLOT PLAN
2-66429	REV 2	0110	CIVIL - UTILITY PLAN
2-66430	REV 2	0302,0306	CIVIL - STEAM & WATER LINES - PLAN & PROFILE
2-66431	REV 2	0900	STRUCTURAL CONCRETE FILTER BLDG K-1-1 PLAN SECTIONS & DETAILS
2-66432		0900	STRUCTURAL CONCRETE FILTER BLDG K3 PLAN SECTIONS & DETAILS
2-66433		0304	CIVIL - WASTE COOLING WATER LINES - PLAN & PROFILE
2-66434		0800, 0900	ARCHITECTURAL-STRUCTURAL, CDL & CDH COOLING WATER SAMPLING FACILITY
2-66435		0809,0900	ARCHITECTURAL-STRUCTURAL COMPRESSOR HOUSE PLANS & DETAILS
2-66436		0900	STRUCTURAL CONCRETE CATCH TANK PIT & MISC. EQUIPMENT FOUNDATIONS

ELECTRICAL

DWG NO	REV	INDEX	TITLE
2-66461		7201	ELECTRICAL ONE-LINE DIAGRAM, MCC-1, -2 & -3
2-66462		7301	ELECTRICAL POWER PLAN - 1ST FLOOR, AREA #1
2-66463		7301	ELECTRICAL POWER PLAN - 1ST FLOOR, AREA #2
2-66464		7301	ELECTRICAL POWER PLAN - 1ST FLOOR, AREA #3
2-66465		7301	ELECTRICAL POWER PLAN - 2ND FLOOR
2-66466		7301,7302 7401,7404	ELECTRICAL SAMPLER HOUSE & FILTER SYSTEMS PLAN & DETAILS
2-66467		7401	ELECTRICAL LIGHTING PLAN - 1ST FLOOR, AREA #1
2-66468		7401	ELECTRICAL LIGHTING PLAN - 1ST FLOOR, AREA #2
2-66469		7401	ELECTRICAL LIGHTING PLAN - 1ST FLOOR, AREA #3
2-66470		7401	ELECTRICAL LIGHTING PLAN - 2ND FLOOR
2-66471		7404	ELECTRICAL PANEL SCHEDULES
2-66472		5901	ELECTRICAL INSTRUMENT PLAN - 1ST FLOOR, AREA #1 & #2
2-66473		5901	ELECTRICAL INSTRUMENT PLAN - 1ST FLOOR, AREA #3
2-66474		5901	ELECTRICAL INSTRUMENT PLAN - 2ND FLOOR
2-66475		5900 7301,7401	ELECTRICAL ELEVATIONS OPERATING & SERVICE GALLERY CELL WALLS
2-66476		7308,7508	CELL BOXES AND RECEPTACLES & DETAILS
2-66477		7601	ELECTRICAL COMMUNICATIONS AND TELEVISION PLAN
2-66478		7602	ELECTRICAL COMMUNICATIONS AND TELEVISION BLOCK DIAGRAMS
2-66479		7605	ELECTRICAL COMMUNICATIONS CABLE RUN & SCHEDULES
2-66480		7701	ELECTRICAL FIRE ALARM PLANS
2-66481		7702	ELECTRICAL FIRE ALARM PLAN DIAGRAMS
2-66482		7302	ELECTRICAL ELEMENTARY DIAGRAMS
2-66483		7302	ELECTRICAL ELEMENTARY DIAGRAMS
2-66484		5900	ELECTRICAL SUPERVISORY ANNUNCIATOR WIRING DIAGRAMS
2-66485		5900	ELECTRICAL CELL PANEL ANNUNCIATOR WIRING DIAGRAMS
2-66486		7502,5900	ELECTRICAL SUPERVISORY AND FILTER PANEL ANNUNCIATOR WIRING DIAGRAMS
2-66487		7502	ELECTRICAL ELEMENTARY DIAGRAM CELLS A TO D
2-66488		7502	ELECTRICAL ELEMENTARY DIAGRAM SUPERVISORY PANEL CELLS E TO G
2-66489		5904 7505	ELECTRICAL WIRE RUN LIST AREA 3
2-66490		5904 7505	ELECTRICAL WIRE RUN LIST AREA 3
2-66491		5904 7505	ELECTRICAL WIRE RUN LIST & CONDUIT SCHEDULE
2-66492		7301,7306	ELECTRICAL CONDUIT RUN
2-66493		5904 7505	ELECTRICAL WIRE RUN LIST CONDUIT SCHEDULE
2-66494		5904 7505	ELECTRICAL WIRE RUN LIST
2-66495		5904 7505	ELECTRICAL WIRE RUN LIST
2-66496		5904 7505	ELECTRICAL WIRE RUN LIST
2-66497		5904 7505	ELECTRICAL WIRE RUN LIST
2-66498		7201	ELECTRICAL SERVICES & UTILITIES ONE-LINE DIAGRAM
2-66499		8003,8004	ELECTRICAL UTILITIES SITE PREPARATION PLOT PLAN
2-66500		7305 7505	ELECTRICAL POLE LINE PLOT PLAN & POLE DETAILS
2-66501		7301,7601	ELECTRICAL LIGHTING POWER FIRE ALARM COMMUNICATION PLAN & DETAILS
2-66502		8001 7301	ELECTRICAL PLOT PLAN & DETAILS

INSTRUMENTATION

DWG NO	REV	INDEX	TITLE
* H-2-66601		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL A
* H-2-66602		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL B
* H-2-66603		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL C
* H-2-66604		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL C
* H-2-66605		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL D
* H-2-66606		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL D
* H-2-66607		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL E
* H-2-66608		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL E
* H-2-66609		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL F
* H-2-66610		7002	INSTRUMENTATION ENGINEERING DIAGRAM - CELL G
H-2-66611		5900	FLOAT VALVE ASSEMBLY
H-2-66612			
H-2-66613		5900	LEGEND AND SYMBOL LIST
H-2-66614		5902	PANEL ARRANGEMENT - CELLS A AND B
H-2-66615		5902	PANEL ARRANGEMENT - CELLS C AND D
H-2-66616		5902	PANEL ARRANGEMENT - CELLS E AND F
H-2-66617		5902	PANEL ARRANGEMENT - CELL G
H-2-66618		5902	VIEWING WINDOW PANEL ARRANGEMENT - CELLS A,B,C,D,E & F
H-2-66619		5902	VIEWING WINDOW PANEL ARRANGEMENT - CELLS D,E,F & G
H-2-66620			
H-2-66621		5902	REAR PANEL PIPING - CELLS A AND B
H-2-66622		5902	REAR PANEL PIPING - CELLS C AND D
H-2-66623		5902	REAR PANEL PIPING - CELLS E AND F
H-2-66624		5902	REAR PANEL PIPING - CELL G
H-2-66625		5902	VIEWING WINDOW PANEL PIPING ARRANGEMENT - CELLS A,B & C
H-2-66626		5902	VIEWING WINDOW PANEL PIPING ARRANGEMENT - CELLS D,E,F & G
H-2-66627			
H-2-66628		5903	PANEL WIRING - CELLS A AND B
H-2-66629		5903	PANEL WIRING - CELLS C AND D
H-2-66630		5903	PANEL WIRING - CELLS E AND F
H-2-66631		5903	PANEL WIRING - CELL G
H-2-66632		5903	VIEWING WINDOW PANEL WIRING - CELLS A,B & C
H-2-66633		5903	VIEWING WINDOW PANEL WIRING - CELLS D,E,F & G
H-2-66634			
H-2-66635		5901	IMPULSE PIPING ARRANGEMENT PLAN - FIRST AND SECOND FLOORS
H-2-66636		5901	IMPULSE PIPING ELEVATIONS AND DETAILS - FIRST & SECOND FLOORS
H-2-66637			
H-2-66638		5901	TRANSMITTER RACKS #1 & 2 ARRANGEMENT AND PIPING
H-2-66639		5901	TRANSMITTER RACKS #3 & 4 ARRANGEMENT AND PIPING
H-2-66640			
H-2-66641			
H-2-66642			
H-2-66643			
H-2-66644			
H-2-66645			
H-2-66646			
H-2-66647		5901	AQUEOUS MAKE-UP ARRANGEMENT PLAN AND DETAILS
H-2-66648		5902	AQUEOUS MAKE-UP PANEL ARRANGEMENT AND PIPING
H-2-66649			
H-2-66650			
H-2-66651		5902	SUPERVISORY PANELS - ARRANGEMENT AND DETAILS
H-2-66652		5902	SUPERVISORY PANELS - WIRING
H-2-66653		5902	K-1, K-3 FILTER PANEL ARRANGEMENT AND DETAILS
H-2-66654		5309	K-1, K-3 FILTER PANEL WIRING
H-2-66655			
H-2-66656			
H-2-66657			
H-2-66658		5901	POOL CELL ARRANGEMENT PLANS
H-2-66659		5901	POOL CELL ELEVATIONS AND INSTALLATION DETAILS
H-2-66660		5902	POOL CELL PANELS - ARRANGEMENT AND DETAILS
H-2-66661		5903	INSTRUMENTATION REAR PANEL WIRING DOCS. CELL
* H-2-66662		7002	INSTRUMENT ENGINEERING DIAGRAM BUILDING EXHAUST SYSTEM #1
H-2-66662		7002	INSTRUMENT ENGINEERING DIAGRAM BUILDING EXHAUST SYSTEM #3
H-2-66663		5901	INSTRUMENTATION BLDG. EXHAUST SYSTEM AIR FIGHT PLAN & DETAILS
H-2-66664		5901	INSTRUMENTATION CELL EXHAUST SYSTEM ARRANG. PLAN & DETAILS
H-2-66665		5901	STOCK RADIATION MONITORING SYSTEM ARRANGEMENT & DETAILS
H-2-66666		7002	INSTRUMENT ENGINEERING DIAGRAM GAS SAMPLING MONITORING
H-2-66667		5901	WASTE MONITORING & SAMPLE DRAINING ARRANGEMENT PLAN & DETAILS
H-2-66668		5901	INSTRUMENTATION SAMPLE PACK ASSEMBLY AND PIPING DIAGRAM
H-2-66669		5902	INSTRUMENTATION CONTROL PANEL ARRANGEMENT & WIRING
H-2-66690		5901	INSTRUMENTATION TRAYS TEST PACK ASSEMBLY PIPING & WIRING

PIPING (CONTINUED)

DWG NO	REV	INDEX	TITLE
H-2-67076			
H-2-67077		2500	VACUUM VENT HEATER E-D-10 FILTER F-D-9 & DE-ENTRAINER D-D-12
H-2-67078			
H-2-67079		8407	WRAPPED & EMBEDDED STEAM PIPING
H-2-67080		8511	SHT 1 EMBEDDED PIPING NOZZLE PLATE DETAILS
H-2-67080		8511	SHT 2 EMBEDDED PIPING NOZZLE PLATE DETAILS
H-2-67080		8511	SHT 3 EMBEDDED PIPING NOZZLE PLATE DETAILS
H-2-67081			CELL ARRANGEMENT - CELL A PLAN
H-2-67082			CELL ARRANGEMENT - CELL A SECTIONS
H-2-67083			CELL ARRANGEMENT - CELL B PLAN
H-2-67084			CELL ARRANGEMENT - CELL B SECTIONS
H-2-67085			CELL ARRANGEMENT - CELL C PLAN
H-2-67086			CELL ARRANGEMENT - CELL C SECTIONS
H-2-67087			CELL ARRANGEMENT - CELL D & E PLAN
H-2-67088			CELL ARRANGEMENT - CELL D & E SECTIONS
H-2-67089			CELL ARRANGEMENT - CELL D & E SECTIONS
H-2-67090			CELL ARRANGEMENT - CELL F PLAN
H-2-67091			CELL ARRANGEMENT - CELL F SECTIONS
H-2-67092			CELL ARRANGEMENT - CELL G PLAN
H-2-67093			CELL ARRANGEMENT - CELL G SECTIONS
H-2-67094			
H-2-67095			TUBING DETAILS
H-2-67096			TUBING DETAILS
H-2-67097			TUBING DETAILS
H-2-67098			TUBING DETAILS
H-2-67099			TUBING DETAILS
H-2-67100			TUBING DETAILS
H-2-67101			TUBING DETAILS
H-2-67102			TUBING DETAILS
H-2-67103			TUBING DETAILS
H-2-67104			TUBING DETAILS
H-2-67105			TUBING DETAILS
H-2-67106			TUBING DETAILS
H-2-67107			TUBING DETAILS
H-2-67108			TUBING DETAILS
H-2-67109			TUBING DETAILS
H-2-67110			TUBING DETAILS
H-2-67111			TUBING DETAILS
H-2-67112			TUBING DETAILS
H-2-67113			TUBING DETAILS
H-2-67114			TUBING DETAILS
H-2-67115			TUBING DETAILS
H-2-67116			TUBING DETAILS
H-2-67117			TUBING DETAILS
H-2-67118			TUBING DETAILS
H-2-67119			TUBING DETAILS
H-2-67120			TUBING DETAILS
H-2-67121			TUBING DETAILS
H-2-67122			TUBING DETAILS
H-2-67123			TUBING DETAILS
H-2-67124			TUBING DETAILS
H-2-67125			TUBING DETAILS
H-2-67126			TUBING DETAILS
H-2-67127			TUBING DETAILS
H-2-67128			TUBING DETAILS
H-2-67129			TUBING DETAILS
H-2-67130			TUBING DETAILS
H-2-67131			TUBING DETAILS
H-2-67132			TUBING DETAILS
H-2-67133			TUBING DETAILS
H-2-67134			TUBING DETAILS
H-2-67135			TUBING DETAILS

* COPY INCLUDED IN ARH 1986.

PIPING (CONTINUED)

DWG NO	REV	INDEX	TITLE
H-2-67185		7001	ENGINEERING FLOW DIAGRAM - MISCELLANEOUS
H-2-67186		8500	COMPRESSOR HOUSE PIPING TO REPLACE EXISTING EQUIPMENT FOR EMERGENCY WELL
H-2-67187		8505	COMPRESSOR HOUSE PIPING ARRANGEMENT & DETAILS
H-2-67188		8510	225-B BUILDING YARD AREA PIPING & DETAILS (CATCH TANK)
H-2-67189			
H-2-67190		8405	CATCH TANK JUMPER - TRANSFER
H-2-67191		8405	CATCH TANK JUMPER - ELECTRICAL
H-2-67881		8510	DIESEL GENERATOR STORAGE TANK & INSTALLATION DETAILS
H-2-67882		8510	SERVICE PIPING, AREA #2, SERVICE GALLERY PLANS SECTIONS & DETAILS
H-2-67883		8510	SERVICE PIPING, AREA #2, SERVICE GALLERY PLANS & SECTIONS
H-2-67884		8510	SERVICE PIPING, AREA #2, TRANSMITTER ROOMS 203 & 204, SECTIONS & DETAILS
H-2-67885		8510	SERVICE PIPING, AREA #2, TRANSMITTER ROOMS, 203 & 204
H-2-67886		8510	SERVICE PIPING, AREA #2, AMU SECTIONS & DETAILS
H-2-67887		8510	SERVICE PIPING, AREA #2, AMU SECTIONS & DETAILS
H-2-67888		8505	AIR SAMPLE HEAD 4" X 4"
H-2-67889		8510	GENERAL & SERVICE PIPING AMU SECTIONS & DETAILS

SPECIFICATIONS 225 BUILDING

SPEC. NO.	REV	TITLE
HWS-8855		PANEL MOUNTED INSTRUMENTS
HWS-8856		FIELD MOUNTED INSTRUMENTS
HWS-8857		pH INDICATING SYSTEM
HWS-8858		INTEGRAL STORAGE AREA INSTRUMENTS
HWS-8859		AREA RADIATION MONITORS
HWS-8860		AQUEOUS MAKE UP TANK INSTRUMENTS
HWS-8861		COOLING WATER SAMPLING & MONITORING EQUIPMENT
HWS-8874	REV 1	THERMOCOUPLE FOR WELTER CASTING MACHINE
HWS-8875		DEMINERALIZED WATER TRANSFER PUMP
HWS-8877		MISCELLANEOUS INSTRUMENTATION
HWS-8879		ULTRASONIC DECONTAMINATION ASSEMBLY
HWS-8880		AIR SAMPLE RADIATION MONITOR
HWS-8942		POLE LINE RELOCATION
HWS-8951		SPECIFICATIONS FOR WASTE ENCAPSULATION AND STORAGE FACILITY, 200EAST AREA DIV 1-9
		SUPPLEMENT 1
		SUPPLEMENT 2
HWS-8952		STORAGE CELL CIRCULATION PUMP
HWS-8953	REV 1	LEAD GLASS VIEWING WINDOW ASSEMBLIES
HWS-8954		MECHANICAL MANIPULATOR
HWS-8955		RUGGED-DUTY MECHANICAL MANIPULATORS
HWS-8959		ULTRASONIC CLEANER
HWS-8960		ULTRASONIC INSPECTION SYSTEM
HWS-8961		HEAT EXCHANGER
HWS-8962		MASS SPECTROMETER LEAK DETECTOR
HWS-8965		CLOSED CIRCUIT TELEVISION SYSTEM
HWS-8966		POLE LINE CONSTRUCTION
HWS-8967		DIESEL ENGINE GENERATOR UNIT
HWS-8969		1500KVA DOUBLE-ENDED LOADCENTER UNIT SUBSTATION
HWS-8970		TURBINE FLOWMETERS
HWS-8971	REV 1	STAND-BY, DIESEL-ENGINE-DRIVEN, DEEP WELL PUMP
HWS-8977		STACK RADIATION MONITOR
HWS-8978		EXHAUST FILTER MONITORING INSTRUMENT K1, K3, AND STACK EXHAUST SYSTEM
HWS-8995		NICKEL-CHROMIUM-MOLYBDENUM-COLUMBIUM ALLOY SEAMLESS PIPE
HWS-8996		NICKEL-MOLYBDENUM ALLOY WELDED PIPE
HWS-8997		POURING MOLTEN LEAD FOR RADIATION SHIELDING
HWS-8998	REV 1	STRONTIUM FLUORIDE SINTERING FURNACE
HWS-8999		WROUGHT NICKEL-CHROMIUM-MOLYBDENUM-COLUMBIUM FITTINGS

APPROVED FOR RELEASE DATE 10-2-71		U.S. ATOMIC ENERGY COMMISSION	
APPROVED FOR RELEASE DATE 10-2-71		RICHLAND OPERATIONS OFFICE	
APPROVED FOR RELEASE DATE 10-2-71		HANFORD ENGINEERING SERVICES	
APPROVED FOR RELEASE DATE 10-2-71		DIVISION OF VITRO CORP. OF AMERICA	
DRAWING INDEX			
DRAWING NO. H-2-66400		PROJECT NO. 225-B	
SCALE		INDEX NO. 000	
DATE		DATE	
NEXT USED ON		DRAWING STATUS	

MECHANISM

DWG. NO.	REV.	INDEX	TITLE
4-2-66726		5001	VIEWING WINDOW VW-3, VW-4, 2ND VW-32
4-2-66727	REV. 1	3901	15 TON CANYON CRANE EPN CR-24
4-2-66728			
4-2-66729		3900	1/4-TON IN-CELL CRANE HOIST EPN CR-9
4-2-66730	REV. 3	3900	10 TON CAPSULE STORAGE EPN CR-25
H-2-66731		4705	IN-CELL SHIELDED STORAGE CONTAINER (G-CELL) EPN TK-G-7
H-2-66732		4705	DETAILS - IN-CELL SHIELDED STORAGE TK-G-7
H-2-66733	REV. 1	2204	MANIPULATOR DECONTAMINATION TANK EPN-DT-49
H-2-66734		3902	MANIPULATOR CART ASSEMBLY AND DETAIL EPN-MC-51
H-2-66735		4705	WELDER W-G-1 DETAILS
H-2-66736		4705	WELDER EPN W-G-1 ARRANGEMENT
H-2-66737		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66738		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66739		4705	WELDER DETAILS
H-2-66740		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66741		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66742		4705	LEAK CHECK ASSEMBLY EPN TK-C-3 & TK-E-12
H-2-66743		4705	LEAK CHECK DETAILS EPN TK-C-3 & TK-E-12
H-2-66744			
H-2-66745		4705	INSTALLATION, ULTRASONIC CLEANER EPN TK-F-1/4, G-13, C-1, E-10
H-2-66746		0801	OPERATING FACE ELEVATIONS - A CELL
H-2-66747		0801	OPERATING FACE ELEVATIONS - B CELL
H-2-66748		0801	OPERATING FACE ELEVATIONS - C CELL
H-2-66749		0801	OPERATING FACE ELEVATIONS - D - E CELL
H-2-66750		0801	OPERATING FACE ELEVATIONS - F CELL
H-2-66751		0801	OPERATING FACE ELEVATIONS - G CELL
H-2-66752		4701	SERVING PLUGS & LINERS - 35" WALL
H-2-66753		4701	SERVING PLUGS & LINERS - 35" WALL
H-2-66754		4705	ASSEMBLY & INSTALLATION, FURNACE E-B-8-1 & 2
H-2-66755		4702	DETAILS, SHIELDED STORAGE TK-F-5
H-2-66756		4702	CANAL MANIPULATOR EPN TG-36
H-2-66757		4702	UNDERWATER TONGS ASSEMBLY EPN TG-36-2
H-2-66758		4920	S ₁ INNER CAPSULE ASSEMBLY AND DETAIL
H-2-66759		4920	S ₂ OUTER CAPSULE ASSEMBLY AND DETAIL
H-2-66760		4921	C ₂ INNER CAPSULE ASSEMBLY AND DETAIL
H-2-66761		4921	C ₂ OUTER CAPSULE ASSEMBLY AND DETAIL
H-2-66762		0803	SHIELDING DOOR ASSEMBLY & INSTALLATION (CANYON TO AIR LOCK#4)
H-2-66763	REV. 1	0803	SHIELDING DOORS DETAILS
H-2-66764		4705	SHIELDED STORAGE ASSEMBLY AND DETAIL EPN-TK-F-5
H-2-66765		4705	SHIELDED STORAGE DETAILS EPN TK-B-7, C-5, D-8, E-9, F-5
H-2-66766		4705	IN-CELL LIGHT LF-17
H-2-66767		4701	ASSEMBLY AND DETAILS "A" CELL HOOD LIGHTS
H-2-66768			
H-2-66769		4705	ASSEMBLY AND INSTALLATION, CESIUM CASTING MACHINE, E-E-3
H-2-66770		4705	SECTIONS CESIUM CASTING MACHINE EPN E-E-3
H-2-66771		4705	DETAILS - CESIUM CASTING MACHINE
H-2-66772		4705	DETAILS - CESIUM CASTING MACHINE
H-2-66773		4705	ASSEMBLY 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66774	REV. 1	4705	ASSEMBLY & DETAILS, STR. DRIVE, SHAFT MECH. 35" TRANSFER DRAWER
H-2-66775		4705	ASSEMBLY & DETAILS, 90° DRIVE, SHAFT MECH. 35" TRANSFER DRAWER
H-2-66776		4705	DETAILS 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66777		4705	DETAILS 35" TRANSFER DRAWER EPN TK-8-1/4 & EPN TD-22
H-2-66778		4705	ASSEMBLY - POWDER TAMPER, C-C-4
H-2-66779		4705	DETAILS - POWDER TAMPER
H-2-66780		4705	DETAILS - POWDER TAMPER
H-2-66781		4705	DETAILS - POWDER TAMPER
H-2-66782		4705	DETAILS - POWDER TAMPER
H-2-66783		4705	INSTALLATION, POWDER TAMPER C-C-4
H-2-66784		5001	ASSEMBLY 12" SHIELDING WINDOW
H-2-66785		5001	DETAIL 12" SHIELDING WINDOW

MECHANISM (CONTINUED)

DWG. NO.	REV.	INDEX	TITLE
H-2-66786		3902/2500	FURNACE BOAT
H-2-66787			
H-2-66788			
H-2-66789			
H-2-66790		4701	ASSEMBLY - TRANSFER DRAWER (20") EPN TD-12
H-2-66791		4701	DETAILS - TRANSFER DRAWER EPN TD-12
H-2-66792		4701	DETAILS - TRANSFER DRAWER EPN TD-12
H-2-66793		4701	DETAILS - TRANSFER DRAWER EPN TD-12
H-2-66794		4701	DETAILS - TRANSFER DRAWER EPN TD-12
H-2-66795		5001	DETAILS, 12" SHIELDING WINDOW
H-2-66796		4700	ASSEMBLY, CELL "A" HOOD HO-5
H-2-66797	REV. 1	3902	MANIPULATOR MONORAIL MO-26-1/18
H-2-66798			
H-2-66799		4700	DETAILS - CELL A HOOD
H-2-66800		4700	"A" CELL HOOD DETAILS
H-2-66801	REV. 1	4750	ASSEMBLY, DOLLY & LIFT DJ-10, DT-11 & DL-20
H-2-66802	REV. 1	4750	DETAILS - DOLLY & LIFT
H-2-66803	REV. 1	4705	ASSEMBLY - BAG CUTTER & SEALER EPN PS-16
H-2-66804	REV. 1	4705	DETAILS - BAG CUTTER & SEALER
H-2-66805	REV. 1	4750	DETAILS, DOLLY & LIFT
H-2-66806		4705	CAPSULE TRANSFER DEVICE ASSEMBLY EPN-UT-23
H-2-66807		4705	DETAILS - CAPSULE TRANSFER DEVICE EPN-UT-23
H-2-66808		4750	UNDERWATER TRANSFER PORT ASSEMBLY - EPN-TP-33
H-2-66809		4750	DETAILS, TRANSFER PORT EPN-TP-33
H-2-66810		4705	DETAILS 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66811		4705	DETAILS 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66812		4705	DETAILS 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66813		4705	TRANSFER DRAWER LINER (35 INCH) EPN TD-8-4
H-2-66814		4705	WELDER W-G-1 ASSEMBLY
H-2-66815		4705	MISCELLANEOUS ASSEMBLY WELDER
H-2-66816		4705	WELDER W-G-1 DETAIL
H-2-66817		4705	WELDER W-G-1 DETAIL
H-2-66818		4705	WELDER W-G-1 DETAIL
H-2-66819		4705	WELDER W-G-1 DETAIL
H-2-66820		4705	WELDER W-G-1 TABLE
H-2-66821		4705	WELDER DETAILS
H-2-66822		4705	DETAILS LEAK CHECKER TK-E-12
H-2-66823			
H-2-66824		4705	DETAILS IN-CELL SHIELDED STORAGE CONTAINER EPN TK-G-7
H-2-66825		4705	DETAILS, IN-CELL SHIELDED STORAGE CONTAINER TK-G-7
H-2-66826			
H-2-66827			
H-2-66828			
H-2-66829			
H-2-66830			
H-2-66831			
H-2-66832			
H-2-66833		4705	WELDER ARRANGEMENT AND PARTS LIST EPN W-C-2 & W-C-11
H-2-66834		4705	WELDER ASSEMBLY EPN W-C-2 & W-C-11
H-2-66835		4705	MISCELLANEOUS WELDER ASSEMBLIES EPN W-C-2 & W-E-11
H-2-66836		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66837		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66838		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66839		4705	WELDER DETAILS EPN W-C-2 & W-E-11
H-2-66840		4705	WELD JOINT CLEANER ASSEMBLY
H-2-66841		4705	WELD JOINT CLEANER DETAILS
H-2-66842		4705	WELD JOINT CLEANER DETAILS
H-2-66843		4705	"G" CELL PLUG WELDER ASSEMBLY EPN PW-38-1 & 2
H-2-66844		4705	DETAILS PW-38-1/2
H-2-66845		4705	DETAILS PW-38-1/2
H-2-66846		4705	DETAILS PW-38-1/2

MECHANISM (CONTINUED)

DWG. NO.	REV.	INDEX	TITLE
H-2-66847		4705	FILTER DUMP ASSEMBLY EPN FO-B-41
H-2-66848		4705	FILTER DUMP DETAILS EPN-F D-B-41
H-2-66849		4705	FILTER DUMP DETAILS EPN-F D-B-41
H-2-66850		4705	EQUIPMENT LAYOUT-A-CELL
H-2-66851		4705	EQUIPMENT LAYOUT 'B' CELL
H-2-66852		4705	DETAILS, IN-CELL SHIELDED STORAGE TK-E-9
H-2-66853		4705	EQUIPMENT LAYOUT C-CELL
H-2-66854		4705	EQUIPMENT LAYOUT D-E CELL (PLAN)
H-2-66855		4705	EQUIPMENT LAYOUT - F-CELL
H-2-66856		4705	EQUIPMENT LAYOUT - G-CELL (PLAN)
H-2-66857		4705	EQUIPMENT LAYOUT - G-CELL (ELEVATIONS)
H-2-66858			
H-2-66859			
H-2-66860		4705	DETAILS, CESIUM CASTING MACHINE
H-2-66861		4705	DETAILS, CESIUM CASTING MACHINE
H-2-66862		4702	UNDERWATER TONGS DETAILS EPN TG-36-2
H-2-66863		4705	EQUIPMENT LAYOUT D & E CELL (ELEVATIONS)
H-2-66864		4705	DETAILS 35" TRANSFER DRAWER EPN TD-8-1/4 & EPN TD-22
H-2-66865		0803	SHIELDING DOOR, ASSEMBLY AND INSTALLATION CELLS "A" & "G"
H-2-66866		0803	SHIELDING DOOR LINER
H-2-66867		4705	DOOR OPENER (35" TRANSFER DOORS)
H-2-66868		4705	ASSEMBLY SHIELDED STORAGE TK-C-5
H-2-66869		4705	DETAILS SHIELDED STORAGE TK-C-5
H-2-66870		4705	ASSEMBLY IN-CELL SHIELDED STORAGE TK-E-9
H-2-66871		4705	DETAIL IN-CELL SHIELDED STORAGE TK-E-9
H-2-66872		4705	C & E CELL PLUG WELDER PW-43-1 & 2 DETAILS
H-2-66873		0803	CANYON SHIELDING DOOR LINER
H-2-66874		0803	SHIELDING DOOR DETAILS
H-2-66875		0803	SHIELDING DOOR DETAILS
H-2-66876		0803	SHIELDING DOOR DETAILS
H-2-66877		0803	SHIELDING DOOR DETAILS
H-2-66878		4705	WELDER W-G-1 DETAILS
H-2-66879		4705	C & E CELL PLUG WELDER ASSEMBLY PW-43-1 & 2
H-2-66880		4705	C & E CELL PLUG WELDER PW-43-1 & 2 DETAILS
H-2-66881		4705	C & E CELL PLUG WELDER PW-43-1 & 2 DETAILS
H-2-66882		4705	ULTRASONIC CLEANING TANK EPN TK-C-1, E-10, G-13, F-1/4
H-2-66883			
H-2-66884			
H-2-66885			
H-2-66886			
H-2-66887			
H-2-66888			
H-2-66889			
H-2-66890			
H-2-66891		4705	DETAILS, SHIELDED STORAGE TK-C-5

MECHANISM (CONTINUED)

DWG. NO.	REV.	INDEX	TITLE
H-2-66703		3902	DETAILS, WASTE CASK
H-2-66704		3902	WINCH, WASTE CASK
H-2-66705		3902	ASSEMBLY, WASTE CASK
H-2-66706		3902	DETAILS, WASTE CASK
H-2-66707		3902	WASTE CASK DOORS
H-2-66708		0402/0803	CAISSON COVER DOOR, ASSEMBLY, EPN SC-30
H-2-66709		0402/0803	CAISSON COVER DOOR, DETAILS, EPN SC-30
H-2-66710		4705	WASTE DRUM, ASSEMBLY & DETAILS EPN-WD-34
H-2-66711		4101	CASK TRANSPORT VEHICLE

APPROVED FOR RL N.E.S. <i>[Signature]</i> DATE 6-2-71		U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
DRAWN <i>[Signature]</i> CHECKED <i>[Signature]</i>		SCALE 1" = 1'-0"	
TWO NO. 225-B		INDEX NO. 0000	
CLASSIFICATION		DRAWING STATUS	
NEXT USED ON		DRAWING STATUS

CONTINUED AT LEFT
ZONES D8, E8

K 38 RELAYS
LOCATED IN
RELAY CABINET
*38 - REF
DWG H-2-66204

K 39 RELAYS
LOCATED IN
RELAY CABINET
*39 - REF
DWG H-2-66205

NOTE:
FOR SYMBOLS & GENERAL NOTES,
SEE DWG H-2-66201

CELL 38 RELAY PNL. ALARM DIAGRAM
* MOUNTED ON PANEL Δ IN CELL # 38
ALL OTHER SWITCHES MTD ON TRANSMITTER BACK

CELL 39 RELAY PANEL ALARM DIAGRAM

TYPICAL PUMP & AGITATOR ELEM DIAG
○ TYPICAL FOR P-38-1, P-38-4, A-39-1, A-39-2, A-39-4, A-39-5 ONLY
▲ TYPICAL FOR P-38-4, A-38-4, P-39-4, A-39-4
□ LOCATED ON INSTRUMENT PANEL
○ TYPICAL FOR P-38-1, P-38-4, A-39-5, A-39-1, A-39-2, A-39-4,
* FOR PUMP P-35-1 ONLY
PREFIX WIRE NUMBERS WITH RESPECTIVE PUMP OR
AGITATOR NUMBER (EXAMPLE: P-35-1-E)

APPROVED FOR RL-NES 377	DATE 11-12-70
U. S. ATOMIC ENERGY COMMISSION	RICHLAND OPERATIONS OFFICE
HANFORD ENGINEERING SERVICES	DIVISION OF VITRO CORP. OF AMERICA
ELECTRICAL	ONE LINE AND ELEMENTARY
DIAGRAMS	
REVISIONS	
1. 11-12-70	2. 11-12-70
3. 11-12-70	4. 11-12-70
5. 11-12-70	6. 11-12-70
7. 11-12-70	8. 11-12-70
9. 11-12-70	10. 11-12-70
11. 11-12-70	12. 11-12-70
13. 11-12-70	14. 11-12-70
15. 11-12-70	16. 11-12-70
17. 11-12-70	18. 11-12-70
19. 11-12-70	20. 11-12-70
21. 11-12-70	22. 11-12-70
23. 11-12-70	24. 11-12-70
25. 11-12-70	26. 11-12-70
27. 11-12-70	28. 11-12-70
29. 11-12-70	30. 11-12-70
31. 11-12-70	32. 11-12-70
33. 11-12-70	34. 11-12-70
35. 11-12-70	36. 11-12-70
37. 11-12-70	38. 11-12-70
39. 11-12-70	40. 11-12-70
41. 11-12-70	42. 11-12-70
43. 11-12-70	44. 11-12-70
45. 11-12-70	46. 11-12-70
47. 11-12-70	48. 11-12-70
49. 11-12-70	50. 11-12-70
51. 11-12-70	52. 11-12-70
53. 11-12-70	54. 11-12-70
55. 11-12-70	56. 11-12-70
57. 11-12-70	58. 11-12-70
59. 11-12-70	60. 11-12-70
61. 11-12-70	62. 11-12-70
63. 11-12-70	64. 11-12-70
65. 11-12-70	66. 11-12-70
67. 11-12-70	68. 11-12-70
69. 11-12-70	70. 11-12-70
71. 11-12-70	72. 11-12-70
73. 11-12-70	74. 11-12-70
75. 11-12-70	76. 11-12-70
77. 11-12-70	78. 11-12-70
79. 11-12-70	80. 11-12-70
81. 11-12-70	82. 11-12-70
83. 11-12-70	84. 11-12-70
85. 11-12-70	86. 11-12-70
87. 11-12-70	88. 11-12-70
89. 11-12-70	90. 11-12-70
91. 11-12-70	92. 11-12-70
93. 11-12-70	94. 11-12-70
95. 11-12-70	96. 11-12-70
97. 11-12-70	98. 11-12-70
99. 11-12-70	100. 11-12-70

FOR GENERAL NOTES & LEGENDS SEE H-2-66206

APPROVED FOR PL. NAME	DATE
APPR. MOD. DISCONTINUATION WITH REAS. AND CRITERIA <i>Noted</i>	7-27-70
DATE	
U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE	
Vitro	HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA
INSTRUMENT	
ENGINEERING DIAGRAM	
CELL 38	
TK-38-4 E-38-7 & TK-31-8	
PAGE NO.	PAGE TITLE
RPT. NO.	RECAPSULATION FACILITY
NO. REV.	MODEL NOS.
221-B	7002
DWG. NO.	SHEET NO. (TOTAL)
H-2-66207	

[illegible]

MATCH LINE H-2-66207

MATCH LINE H-2-66210

TK-38-1
CESIUM FEED TANK
3' 0" x 4' 0" x 7' 0" HIGH
CAPACITY 500 GAL
DESIGN DUTY 33,000 BTU/HR COOLING
DESIGN DUTY 32,000 BTU/HR HEATING

TK-38-2
CESIUM WASTE TANK
3' 0" x 4' 0" x 7' 0" HIGH
CAPACITY 500 GAL
DESIGN DUTY 33,000 BTU/HR COOLING

TK-38-3
CESIUM RECYCLE TANK
2' 8" x 4' 0" x 7' 0" HIGH
CAPACITY 500 GAL
DESIGN DUTY 33,000 BTU/HR COOLING

NO.	DESCRIPTION	DATE	BY	CHKD
1	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
2	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
3	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
4	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
5	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
6	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
7	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
8	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
9	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.
10	REVISED PER DCN NO 28	7/11/71	W. J. H.	W. J. H.

APPROVED FOR RL H-2-66207	DATE 7-11-71
U. S. ATOMIC ENERGY COMMISSION	
RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES	
DIVISION OF YITCO CORP. OF AMERICA	
INSTRUMENT	
ENGINEERING DIAGRAM	
CELL 38	
TX-38-1 TX-38-2 & TX-38-3	
SCALE NONE	
221-B	
H-2-66208	

DRAWING DATA		REVISIONS		REFERENCE DRAWINGS	
DATE	7-7-70	NO.	2	NO.	1
BY	W. J. HARRIS	DESCRIPTION	REVISED PER DCN H-2-39	NO.	2
CHECKED	W. J. HARRIS	DATE	7-7-70	NO.	3
APPROVED	W. J. HARRIS	DATE	7-7-70	NO.	4
U.S. ATOMIC ENERGY COMMISSION		RICHMOND OPERATIONS OFFICE		HANFORD ENGINEERING SERVICES	
INSTRUMENT		CELL 39		TK-39-1 & TK-39-2	
H-2-66210		221-B		7002	

FOR GENERAL NOTES & LEGENDS, SEE H-2-66206

MATCH LINE H-2-66211

MATCH LINE H-2-66208

DETAIL B
TYPICAL pH SYSTEM
* pH SYSTEM NUMBER
EXAMPLE PHV-39-1-1

1 2 3 4 5 6 7 8 9 10 11 12	13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200	201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300	301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400	401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500	501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600	601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700	701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800	801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900	901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

[illegible]

DETAIL "A" JET GANG VALVE ASSY (JGV)
FOR INST CONN. SEE DET A H 2-66207
• JET IDENTIFICATION N2

NOTE: FOR GENERAL NOTES & LEGEND SEE DWG H 2-66250

TO NOZ 254		TO NOZ 291		TO NOZ 257		APPROVED FOR RL H & S 11		DATE -	
APPR. PLAN PERFORMANCE WITH DESIGN CRITERIA FOR <i>EL-254</i>						U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES A DIVISION OF VITRO CORP. OF AMERICA
PROJ # HAP 631 REVISED PER DCN = 46						2		ENGINEERING FLOW DIAGRAM CELL 38	
HAP 631 REVISED PER DCN #3						1		TK-38-A-E-38-7 & TK-38-7	
DRAWING TITLE OR INDEX NO. H-2-66251						SCALE NONE		PROJ. NO. H-2 ASP B31 UNIT C-BA FACIL.	
REVISIONS DATE CHECK PRF ISSUE NO. 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12 / 13 / 14 / 15 / 16 / 17 / 18 / 19 / 20 / 21 / 22 / 23 / 24 / 25 / 26 / 27 / 28 / 29 / 30 / 31 / 32 / 33 / 34 / 35 / 36 / 37 / 38 / 39 / 40 / 41 / 42 / 43 / 44 / 45 / 46 / 47 / 48 / 49 / 50 / 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 / 61 / 62 / 63 / 64 / 65 / 66 / 67 / 68 / 69 / 70 / 71 / 72 / 73 / 74 / 75 / 76 / 77 / 78 / 79 / 80 / 81 / 82 / 83 / 84 / 85 / 86 / 87 / 88 / 89 / 90 / 91 / 92 / 93 / 94 / 95 / 96 / 97 / 98 / 99 / 100						DATE 01-1		SHEET NO. 1001	
DRAWING STATUS LAST REV. 2						H-2-66251		SHEET NO. 1001

DETAIL B

NOTE. FOR GENERAL NOTES & LEGEND SEE DNL 4-2-66250

[illegible]

[illegible]

REVISIONS

NO.	DATE	DESCRIPTION
1	10/1/68	REVISED PER DCH #43
2	10/1/68	REVISED PER DCH #5

PROJECT INFORMATION

U. S. ATOMIC ENERGY COMMISSION
 RICHMOND OPERATIONS OFFICE
 HANFORD ENGINEERING SERVICES
 A DIVISION OF VITRO CORP. OF AMERICA

ENGINEERING FLOW DIAGRAM
 CELL 39
 TK-39-1 & TK-39-2

SCALE
 NONE

DATE
 10/1/68

BY
 H-2-66345

CHKD BY
 H-2-66345

APP'D BY
 H-2-66345

REVISIONS

NO.	DATE	DESCRIPTION
1	10/1/68	REVISED PER DCH #43
2	10/1/68	REVISED PER DCH #5

PROJECT INFORMATION

U. S. ATOMIC ENERGY COMMISSION
 RICHMOND OPERATIONS OFFICE
 HANFORD ENGINEERING SERVICES
 A DIVISION OF VITRO CORP. OF AMERICA

ENGINEERING FLOW DIAGRAM
 CELL 39
 TK-39-1 & TK-39-2

SCALE
 NONE

DATE
 10/1/68

BY
 H-2-66345

CHKD BY
 H-2-66345

APP'D BY
 H-2-66345

PLAN AT ELEVATION 102'-0" (UNLESS NOTED OTHERWISE)

NOTE: THIS REIN. REQ'D WHEN HORIZ. EXCEEDS 2" FOR ALL CEMENTS CONTAINING ZEPH WITH STOU.

TYP REINFORCING AT OPNGS

NO SCALE

H 2-66405

LEGEND

- 1" CONCRETE BLOCK WITH 2" WOOD FLOORING & 24" C. 3.142" INSULATION & 90% GYPSUM WALLBOARD
- 8" CONCRETE BLOCK (INSULATION NOTED)
- REINFORCED CONCRETE
- H DENSITY CONCRETE
- 55% WTL. STUD & 24" C. W/ 90% GYPSUM WALLBOARD

225-3 3L2A-KEY PLAN
FIRST FLOOR

APPROVED FOR RELEASE		DATE 2-18-71	
U. S. ATOMIC ENERGY COMMISSION		HANFORD OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
ARCHITECTURAL		FIRST FLOOR PLAN	
AREA 1		225-8	
CLASSIFICATION		0000	
REVISIONS		1-2-66401	

DRAWING INDEX	REVISIONS
H 2-66400	1
HMS 8951	2
REVISIONS	3
DESCRIPTION	4
DATE	5
CHECKED BY	6
DATE	7
APPROVED BY	8
DATE	9

225-3 BLDG KEY PLAN
FIRS - 002

[illegible][illegible]

PLAN AT ELEVATION 718'-6" (UNLESS NOTED OTHERWISE)
SCALE 1/4" = 1'-0"

225 3 BLOC KEY PLAN
SECOND FLOOR

APPROVED FOR RL H.S. / 1/11/71	DATE 2/18/71
U.S. ATOMIC ENERGY COMMISSION RICHMOND OPERATIONS OFFICE	
HAYDON ENGINEERING SERVICES DIVISION OF YECO CORP. OF AM. CA.	

ARCHITECTURAL
SECOND FLOOR PLAN

NO.	DATE	BY	FOR	REV.	DESCRIPTION
1	1/11/71	DAE	FOR	1	AS SHOWN
2	2/18/71	DAE	FOR	2	REVISIONS
3		DAE	FOR	3	CHECK PRT 30 END
4		DAE	FOR	4	DATE
5		DAE	FOR	5	LAP
6		DAE	FOR	6	DATE
7		DAE	FOR	7	LAP
8		DAE	FOR	8	DATE
9		DAE	FOR	9	LAP
10		DAE	FOR	10	DATE

PROJ. NO. 225 3	HAP. 311	NO. 0800
DATE 2/18/71	DATE 2/18/71	DATE 2/18/71
NO. 0800	NO. 0800	NO. 0800
NO. 0800	NO. 0800	NO. 0800

2
H 2 66403
H 2 66404

4

H	2	GG401
H	2	GG402
H	2	GG403

							INDEX USED ON		DRAWING STATUS							
13	12	11	10	9	8	7	6	5	4	3	2	1

OUTSIDE STRUCTURES	
BUILDING	DRAWING NUMBER
KH EXHAUST FILTER	H-2-66432
K-3 EXHAUST FILTER	H-2-66433
SAMPLER HOUSE	H-2-66435
COMPRESSOR HOUSE	H-2-66436
CATCH TANK PIT	H-2-66437
COOLING TOWER FNDN.	H-2-66437
GENERATOR FNDN.	H-2-66437
ELECT. SUB-STATION FNDN.	H-2-66437
STACK	HWS-8991
EXHAUST DUCT - U G	H-2-66433
PUMP FOUNDATION	H-2-67831
DIESEL OIL TANK	JG

NO.	DATE	DESCRIPTION
1	11/11/71	REV PER DCN N52 (HAP-631-207)
2	11/11/71	REV PER DCN N52 (HAP-631-207)

APPROVED FOR RL-HAS-71		DATE 1-11-71
U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE		
HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA		
CIVIL		
PLOT PLAN		
PROJECT NO.	225-B	INDEX NO.
0110		
H-2-66429

NO.	DATE	BY	CHKD.	APP'D.	REV.	DESCRIPTION
1	11/1/71	ARH				CIVIL - PLOT PLAN
2	11/1/71	ARH				STEAM & WATER LINES PLAN & PROF
3	11/1/71	ARH				WASTE COOLING WATER PLAN & PROF
4	11/1/71	ARH				DRAINING INDEX

REV PER DCN N° 3 (HAP-631-207)

REV PER DCN N° 3 (HAP-631-207)

REFERENCE DRAWINGS

DRAWING STATUS

DATE

LAST REV

APPROVED FOR RL N° 1

DATE 11-1-71

U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE

HANFORD ENGINEERING SERVICES
DIVISION OF VITRO CORP. OF AMERICA

CIVIL
UTILITY PLAN

225-B

0110

H-2-66430

SEE DWG H-2-66511

ARH - 1986
PAGE E-26

SYMBOL LIST

SYMBOL	DESCRIPTION
	DISCONNECT SWITCH SIZE AS SHOWN
	CIRCUIT BREAKER MOLDED CASE 3P 480V 100 A P FRAME UNLESS OTHERWISE NOTED
	POWER TRANSFORMER SIZE AS SHOWN
	CURRENT TRANSFORMER SIZE AS SHOWN
	MAGNETIC MOTOR CONTROLLER NUMBER INDICATES FRAME SIZE
	MOTOR, NUMBER INDICATES HORSEPOWER
	CONTROL TRANSFORMER AND OPERATING COIL (120V)
	PUSH BUTTON CONTROL STATION
	SELECTOR SWITCH CONTROL STATION
	CONTROL EQUIPMENT BY HVAC CONTROL CONTRACTOR
	AMMETER 0 5 AMP MOVEMENT 0 10 AMP SCALE

NOTES

1. MOTOR CONTROL CENTER SHALL COMPLY WITH THE REQUIREMENTS OF HANFORD STANDARD HWS-8000-S AND HWS 8951. ALL COMPONENTS CONTAINED WITHIN THE DASHED LINES SHALL BE PROVIDED BY THE MCC SELLER. THE CONTACTORS IN ALL CONTROLLERS SHALL BE PROVIDED WITH TWO NORMALLY OPEN AND TWO NORMALLY CLOSED SPARE AUXILIARY CONTACTS. ALL MOTOR CONTROLLERS SHALL BE PROVIDED WITH THREE OVERLOAD RELAYS.
2. SEE H-2-66484 AND H-2-66485 FOR ELEMENTARY DIAGRAMS.

REV	DATE	BY	DESCRIPTION
1	11/11/86	ARH	CONSTRUCTION SPECIFICATION
2	11/11/86	ARH	SERVICE & UTILITIES ONE LIT
3	11/11/86	ARH	DRAWING 100%
4	11/11/86	ARH	DRAWING 100%
5	11/11/86	ARH	DRAWING 100%
6	11/11/86	ARH	DRAWING 100%
7	11/11/86	ARH	DRAWING 100%
8	11/11/86	ARH	DRAWING 100%
9	11/11/86	ARH	DRAWING 100%
10	11/11/86	ARH	DRAWING 100%
11	11/11/86	ARH	DRAWING 100%
12	11/11/86	ARH	DRAWING 100%
13	11/11/86	ARH	DRAWING 100%

APPROVED FOR RL-465	DATE 11-11-86
U.S. ATOMIC ENERGY COMMISSION	
RICHMOND OPERATIONS OFFICE	
HANFORD DIVISION	
DIVISION OF VITRO CORP. OF AMERICA	
ELECTRICAL	
ONE LINE DIAGRAM	
MCC-1 - 2 3-3	
SCALE	1" = 100'
225-B	7201
H-2-66461	

LEGEND	
SYMBOL	DESCRIPTION
AS	AUXILIARY STATION - MANUAL
FAS	FLOW ALARM SWITCH - PRESSURE OPERATED
FS	FLOW SWITCH - VANE TYPE
PC	DETECTOR - PRODUCT OF COMBUSTION
TD	DETECTOR - TEMPERATURE ACTUATED
LS	LIMIT SWITCH
PS	PRESSURE SWITCH

NOTE:
1. FOR GENERAL NOTES AND SYMBOLS SEE DRAWING H-2-66481

REV	DATE	DESCRIPTION
1	10/1/71	INITIAL DESIGN
2	11/1/71	REVISION
3	12/1/71	REVISION
4	1/1/72	REVISION
5	2/1/72	REVISION
6	3/1/72	REVISION
7	4/1/72	REVISION
8	5/1/72	REVISION
9	6/1/72	REVISION
10	7/1/72	REVISION
11	8/1/72	REVISION
12	9/1/72	REVISION
13	10/1/72	REVISION
14	11/1/72	REVISION
15	12/1/72	REVISION
16	1/1/73	REVISION
17	2/1/73	REVISION
18	3/1/73	REVISION
 
77	2/1/78	REVISION
78	3/1/78	REVISION
79	4/1/78	REVISION
80	5/1/78	REVISION
81	6/1/78	REVISION
82	7/1/78	REVISION
83	8/1/78	REVISION
84	9/1/78	REVISION
85	10/1/78	REVISION
86	11/1/78	REVISION
87	12/1/78	REVISION
88	1/1/79	REVISION
89	2/1/79	REVISION
90	3/1/79	REVISION
91	4/1/79	REVISION
92	5/1/79	REVISION
93	6/1/79	REVISION
94	7/1/79	REVISION
95	8/1/79	REVISION
96	9/1/79	REVISION
97	10/1/79	REVISION
98	11/1/79	REVISION
99	12/1/79	REVISION
100	1/1/80	REVISION

APPROVED FOR RL H-2-66482	DATE 5-10-71
U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES DIVISION OF WITCO CORP. OF AMER. CA	
ELECTRICAL FIRE ALARM DIAGRAM	
SCALE NONE	PROJECT NO. HAP 831
225-8	7702
H-2-66482

COOLING TOWER PUMP (S-1)
COOLING TOWER FAN (S-1-1) (2EA)
CELL SUPPLY FAN, K3-6-1
CELL EXHAUST FANS K2-7-1, K2-11-4
CELL SUPPLY FANS K1-6-1, K2-6-1, K4-6-1
AIR COMPRESSOR #1 & 2

K5-15-1 HEATERS
(TYP. OF 2)
ALL DEVICES SHOWN
LOCATED AT MCC'S 415

CONDENSER WATER PUMP K5-16-1
ALL DEVICES SHOWN
LOCATED AT MCC'S 415

CONDENSER WATER PUMP K5-16-2
ALL DEVICES SHOWN
LOCATED AT MCC'S 415

CONDENSER WATER PUMP K5-16-3
ALL DEVICES SHOWN
LOCATED AT MCC-5

CHILLED WATER PUMP K5-17-1
ALL DEVICES SHOWN
LOCATED AT MCC'S 415

CHILLED WATER PUMP K5-17-2
ALL DEVICES SHOWN
LOCATED AT MCC-4

CHILLED WATER PUMP K5-17-3
ALL DEVICES SHOWN
LOCATED AT MCC'S 415

EXHAUST FAN K6-11-1
ALL DEVICES LOCATED AT MCC-4

STORAGE BASIN RECIRC PUMP P-5*-1
TYP. OF 12

* DENOTES APPROPRIATE CELL NUMBER (1 THRU 12)
▲ LOCATED AT MCC'S 213
○ LOCATED ON MONITOR PANEL
● LOCATED IN POOL CELL AREA

NOTES

- ALL SYMBOLS ARE ANSI STANDARD UNLESS OTHERWISE NOTED
- SEE DWG H-2-66485 FOR EMERGENCY STARTING SEQUENCE SEE DWG H-2-66511 & H-2-66461 FOR ONE LINE DIAGRAMS
- PREFIX ALL WIRE NO'S WITH EQUIPMENT NO.
EXAMPLE K5-16-1-A

NO.	DESCRIPTION	DATE	BY	CHKD	APPD
H-2-66485	ELECTRICAL ELEMENTARY DIAGRAMS	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS
H-2-66486	BUILDING 225-B 1ST FL. P.W. 2. PLAN	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS
H-2-66514	BUILDING 225-BC POWER PLAN	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS
H-2-66481	MCC-1 - 2 - 3 ONE LINE DIAGRAM	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS
H-2-66511	SERVICE & UTILITIES ONE LINE DIAGRAM	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS
H-2-66480	DRAWING INDEX	12/1/71	W. J. HARRIS	W. J. HARRIS	W. J. HARRIS

REV	DATE	DESCRIPTION
1	12/1/71	ISSUED FOR CONSTRUCTION
2	12/1/71	REVISIONS
3	12/1/71	REVISIONS
4	12/1/71	REVISIONS
5	12/1/71	REVISIONS
6	12/1/71	REVISIONS
7	12/1/71	REVISIONS
8	12/1/71	REVISIONS
9	12/1/71	REVISIONS
10	12/1/71	REVISIONS
11	12/1/71	REVISIONS
12	12/1/71	REVISIONS

APPROVED FOR RL-HAS 71-27-11a		DATE 12-17-71	
U.S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
MANFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
ELECTRICAL		ELEMENTARY DIAGRAMS	
SCALE: 1" = 120'		SHEET NO. 7302	
DRAWING NO. H-2-66484		SHEET NO. 7302

EXHAUST FAN K1-7-1

ALL DEVICES SHOWN
LOCATED AT MCC'S 243

EXHAUST FAN K1-7-2

ALL DEVICES SHOWN
LOCATED AT MCC'S 243

CELL EXHAUST FAN K3-7-1

ALL DEVICES SHOWN
LOCATED AT MCC'S 243

CELL EXHAUST FAN K3-7-2

ALL DEVICES SHOWN
LOCATED AT MCC'S 243

VACUUM PUMP P-AS-1

ALL DEVICES LOCATED
AT MCC'S 243

VACUUM PUMP P-AS-2

ALL DEVICES LOCATED
AT MCC'S 243

AGITATOR A-201A-202
PUMP P-201, P-202, P-210, P-230, P-231

▲ LOCATED AT MCC
○ LOCATED AT AMU INSTRUMENT PANEL

SEE NOTES 2 THRU 5

STARTING SEQUENCE	
GROUP 1	IMMEDIATELY AFTER GENERATOR START ALL FIXED LOADS ON MCC 2, 3, 4 & 5 EITHER K3-7-1 OR K3-7-2 K3-6-1 EITHER K1-7-1 OR K1-7-2 K1-6-1 K2-7-1 EITHER P-AS-1 OR P-AS-2
GROUP 2	60 SECONDS AFTER GENERATOR START TD-1A, TD-1B EITHER AIR COMPRESSOR #1 OR AIR COMPRESSOR #2 EITHER K5-16-1 OR K5-16-2 K5-16-3 K5-17-1 EITHER K5-17-2 OR K5-17-3 K5-15-1 FAN #1 K5-15-1 FAN #2 K5-15-1 PUMP
GROUP 3	90 SECONDS AFTER GENERATOR START TD-2A, TD-2B EITHER K5-14-1 OR K5-14-2
GROUP 4	120 SECONDS AFTER GENERATOR START TD-3A, TD-3B P-S1-1 THRU P-S12-1
EITHER/OR COMBINATION HAVE ONE UNIT ON STANDBY AND ONLY ONE UNIT RUNNING.

CATCH TANK PUMP P-100-1

▲ LOCATED AT MCC
■ LOCATED AT SUPERVISORY PANEL
● LOCATED AT 225 BD

EMERGENCY MOTOR STARTING
SEQUENCE - MCC #2 & #4

SEE H-2-66484 FOR CONTROL
CIRCUIT IN WHICH SEQUENCE
CONTROL CONTACTS APPEAR

EMERGENCY MOTOR STARTING
SEQUENCE - MCC #3 & #5

NOTES

- ALL SYMBOLS ARE ANSI STANDARD UNLESS OTHERWISE NOTED.
- RELAYS K-SSC-1, K-SSC-3, K-SSC-4 AND K-SSC-6 ARE LOCATED IN THE TERMINAL BLOCK SECTIONS OF THE MCC'S IN BUILDINGS 225-B & 225-BC DRAWING H-2-66514 AND H-2-66482.
- RELAYS K-SSC-2 AND K-SSC-5 ARE LOCATED AT THE REFRIGERATION CONTROL PANEL IN BUILDING 225-BC, DRAWING H-2-66514.
- RELAYS 59NX1 & 59NX2 AND TRANSFORMERS ET1 & ET2 ARE IN THE TRANSFER SWITCHES LOCATED AT THE GENERATOR. CVI-
- RELAYS K-SW1, K-SW2 AND TIME DELAY RELAYS TD-1A, TD-2A, TD-3A, TD-1B, TD-2B AND TD-3B ARE LOCATED IN ELECTRICAL ENCLOSURES AT THE GENERATOR. DRAWING H-2-66514.
- PREFIX ALL WIRE NUMBERS WITH EQUIPMENT NUMBER. EXAMPLE P-AS-2-A

NO.	DATE	BY	FOR	DESCRIPTION
1	11/11/71	W. J. HARRIS	W. J. HARRIS	AREA POWER PLAN
2	11/11/71	W. J. HARRIS	W. J. HARRIS	225-BC POWER PLAN
3	11/11/71	W. J. HARRIS	W. J. HARRIS	MCC'S 4 & 5 ONE LINE DIAGRAMS
4	11/11/71	W. J. HARRIS	W. J. HARRIS	EMERGENCY GENERATOR
5	11/11/71	W. J. HARRIS	W. J. HARRIS	ELECTRICAL ELEMENTARY DIAGRAMS
6	11/11/71	W. J. HARRIS	W. J. HARRIS	2ND FLOOR POWER PLAN
7	11/11/71	W. J. HARRIS	W. J. HARRIS	1ST FLOOR POWER PLAN
8	11/11/71	W. J. HARRIS	W. J. HARRIS	K1 & K2 SYSTEM ELECTRICAL PLAN
9	11/11/71	W. J. HARRIS	W. J. HARRIS	MCC-1 - 2 - 3 - 4 LINE DIAGRAMS
10	11/11/71	W. J. HARRIS	W. J. HARRIS	DRAWING INDEX

REV.	DATE	BY	FOR	DESCRIPTION
1	11/11/71	W. J. HARRIS	W. J. HARRIS	AREA POWER PLAN
2	11/11/71	W. J. HARRIS	W. J. HARRIS	225-BC POWER PLAN
3	11/11/71	W. J. HARRIS	W. J. HARRIS	MCC'S 4 & 5 ONE LINE DIAGRAMS
4	11/11/71	W. J. HARRIS	W. J. HARRIS	EMERGENCY GENERATOR
5	11/11/71	W. J. HARRIS	W. J. HARRIS	ELECTRICAL ELEMENTARY DIAGRAMS
6	11/11/71	W. J. HARRIS	W. J. HARRIS	2ND FLOOR POWER PLAN
7	11/11/71	W. J. HARRIS	W. J. HARRIS	1ST FLOOR POWER PLAN
8	11/11/71	W. J. HARRIS	W. J. HARRIS	K1 & K2 SYSTEM ELECTRICAL PLAN
9	11/11/71	W. J. HARRIS	W. J. HARRIS	MCC-1 - 2 - 3 - 4 LINE DIAGRAMS
10	11/11/71	W. J. HARRIS	W. J. HARRIS	DRAWING INDEX

APPROVED FOR RL-HSS/11/11/71 DATE 11-17-71

U.S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
HANFORD ENGINEERING SERVICES
DIVISION OF VITRO CORP OF AMERICA

ELECTRICAL
ELEMENTARY DIAGRAMS

SCALE: NONE

PROJ. NO. HAP-531

PROJ. TITLE: 225-B

DATE: 11-17-71

7302

H-2-66485

ARH - 1986
PAGE E-30

SYMBOL	SYMBOL DESCRIPTION
---	CONCEALED CONDUIT
---	EXPOSED CONDUIT
--DB--	DIRECT BURIAL CABLE (SEE NOTE 4)
---FA---	EXISTING FIRE ALARM CABLE
---TEL---	EXISTING TELEPHONE CABLE
⊙	GROUND ROD PER HANFORD STANDARD D-20-96
⌘	GROUND CONDUCTOR EXOTHERMIC WELD
⌘	GROUND PLATE & #4 STRANDED BARE COPPER GROUNDING CONDUCTOR PER HANFORD STANDARD D-20-96
⌘	JUNCTION BOX, WALL MOUNTED
---	FLEXIBLE CONDUIT, 1/2" WITH INTEGRAL GROUND
⌘	LIGHTING FIXTURE, WEATHERPROOF, WITH AMBER GLOBE & 200W LAMP MTS NGT +8'-0"

ENLARGED PLAN - 282-BA BUILDING

SCALE: 0 1 2 FT
SEE H-2-61001 FOR EXISTING INSTALLATION
H-2-67186 FOR PIPING

- NOTES:
1. INSTALLATION SHALL CONFORM TO 1968 EDITION OF THE NATIONAL ELECTRICAL CODE (NFPA 70) UNLESS OTHERWISE NOTED
 2. ALL CONDUIT SHALL BE RIGID GALVANIZED STEEL, HEAVY WALL, UNLESS OTHERWISE NOTED. ALL CONDUCTORS SHALL BE COPPER UNLESS OTHERWISE NOTED. 600V WIRE #1 AWG & SMALLER SHALL HAVE TYPE THWN INSULATION. 600V WIRE #1/0 & LARGER SHALL HAVE TYPE RHV INSULATION & SHALL CONFORM TO HANFORD STD. SPECIFICATION HWS-8003-3. 15KV SHIELD CABLE SHALL CONFORM TO HANFORD STANDARD SPECIFICATION HWS-8008-3.
 3. ALL CONDUIT THAT ENTERS THE UNIT SUBSTATION SHALL BE FLUSH COUPLED AND EXTENDED 8" ABOVE THE CONCRETE PAD.
 4. MULTI-CONDUCTOR DIRECT BURIAL CONTROL AND POWER CABLE SHALL BE RATED 600 VOLT, 75°C MINIMUM. POWER CABLE SHALL BE FURNISHED WITH NEC SIZE GROUND WIRE. BOTH SHALL MEET THE REQUIREMENTS OF TYPE UF DESCRIBED IN THE 1968 EDITION OF THE NATIONAL ELECTRICAL CODE.
 5. GROUNDING SHALL CONFORM TO HANFORD STANDARDS D-20-10b & -10c, UNLESS OTHERWISE NOTED
 6. INTERCEPT EXISTING CONDUIT AND INSTALL NEW JUNCTION BOX. EXTEND STARTING CIRCUIT TO NEW DIESEL ENGINE CONTROL PANEL AND RECONNECT PER VENDORS WIRING DIAGRAM. COIL SPARE 3/C #12 DB CABLE IN NEW JUNCTION BOX.
 7. ABANDON THE EXISTING ENGINE OIL HEATER RECEPTACLE AND THE CONDUIT FROM THE RECEPTACLE TO THE EXISTING "T" CONDUIT. EXTEND THE EXISTING 2 #12 WIRES VIA A NEW 1/2" FLEXIBLE CONDUIT TO THE DIESEL ENGINE HEATER THERMOSTATS IN THE NEW CONTROL PANEL. RECONNECT THE WIRING AT THE EXISTING PANELBOARD "LL" FROM 2P-20A BREAKER (CKT-2) TO 1P-20A BREAKER (SPARE CKT 6).

PLOT PLAN

UNIT SUBSTATION ENLARGED PLAN
(HANFORD SPEC HWS-8763)
NTS
(SEE NOTE 3)

SECTION A-A
NTS

NO.	DATE	DESCRIPTION
H-2-66515	8	CONSTRUCT ON SPECIFICATIONS
H-2-66516	8	225-B COMMUNICATIONS PLAN
H-2-66517	8	225-B FIRE ALARM PLAN
H-2-66518	8	UNIT SUBSTATION SPECIFICATION
H-2-66519	8	COMPRESSION & PIPING PLAN
H-2-66520	8	SITE PREPARATION & P.D. PLAN
H-2-66521	8	ONE LINE DIAGRAM
H-2-61001	2	ELECTRICAL, 712 BA
H-2-66508	8	DRAWING, 712E

NO.	DATE	DESCRIPTION
H-2-66515	8	CONSTRUCT ON SPECIFICATIONS
H-2-66516	8	225-B COMMUNICATIONS PLAN
H-2-66517	8	225-B FIRE ALARM PLAN
H-2-66518	8	UNIT SUBSTATION SPECIFICATION
H-2-66519	8	COMPRESSION & PIPING PLAN
H-2-66520	8	SITE PREPARATION & P.D. PLAN
H-2-66521	8	ONE LINE DIAGRAM
H-2-61001	2	ELECTRICAL, 712 BA
H-2-66508	8	DRAWING, 712E

APPROVED FOR RL H-2-66515 DATE 2-10-71

U.S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
HANFORD ENGINEERING SERVICES
DIVISION OF VITRO CORP. OF AMERICA

ELECTRICAL
PLOT PLANS & DETAILS

SCALE: AS SHOWN
DATE: 2-10-71
DRAWN: H-2-66515
CHECKED: H-2-66515
REVISIONS: NONE
DRAWING STATUS: NEXT USED ON

- LEGEND**
- K 2 - 3 - 1
 PART NUMBER
 EQUIPMENT IDENTIFICATION
 SYSTEM NUMBER
 HVAC EQUIPMENT
- EQUIPMENT IDENTIFICATION**
1. FILTER 80% NBS
 2. FILTER 99.97% DOP
 3. COOLING COIL
 4. PREHEAT COIL
 5. REHEAT COIL
 6. CENTRIFUGAL FAN
 7. INDUSTRIAL CENTRIFUGAL FAN
 8. SEPARATOR
 9. FILTER 8% NBS
 10. FILTER 35% NBS
 11. POWER ROOF VENTILATOR
 12. EVAPORATIVE COOLER-ROTARY
 13. EVAPORATIVE COOLER - WETTED PAD
 14. REFRIGERATION UNIT
 15. COOLING TOWER
 16. PUMP - CONDENSER WATER
 17. PUMP - CHILLED WATER
 18. COMPRESSION TANK
 19. UNIT HEATER
 20. HEAT EXCHANGER
 21. CENTRIFUGAL FAN, CEILING

APPROVED FOR RL H-3111		DATE 2-1-71
U. S. ATOMIC ENERGY COMMISSION		
RICHLAND OPERATIONS OFFICE		
HANFORD ENGINEERING SERVICES		
DIVISION OF VITRO CORP. OF AMERICA		
HVAC		
AIR FLOW		
DIAGRAM		
SCALE	225-3	8900
DATE	2-1-71	DATE
REV	NOVE	REV
DRAWING STATUS

FIRST FLOOR PLAN

SECTION E-E
SCALE 3/16" = 1'-0"

SECTION F-F
SCALE 3/16" = 1'-0"

SECTION G-G
SCALE 3/16" = 1'-0"

SECTION C-C
SCALE 3/16" = 1'-0"

SECTION A-A
SCALE 3/16" = 1'-0"

SECTION D-D
SCALE 3/16" = 1'-0"

SECTION H-H
SCALE 3/16" = 1'-0"

SECTION B-B
SCALE 3/16" = 1'-0"

DETAIL I (TYPICAL)
SCALE: NONE

DETAIL II (TYPICAL)
SCALE: NONE

LEGEND	
SYMBOL	DESCRIPTION
○	UPRIGHT SPRINKLER
●	PENDENT SPRINKLER
○	UPRIGHT & PENDENT SPRINKLER IN SAME VERTICAL PLANE
○	UPRIGHT SPRINKLER INSTALLED BELOW DUCT OR EQUIPMENT
○	PENDENT SPRINKLER INSTALLED BELOW DUCT OR EQUIPMENT
○	SPRINKLER TEMPERATURE RATING OTHER THAN ORDINARY
○	SPRINKLER ELEVATION FROM HIGH POINT OF FINISHED FLOOR TO DEFLECTOR
△	ALARM CHECK VALVE
△	EXCESS PRESSURE PUMP ASSEMBLY
△	ALARM GONG W/HOOD
△	FIRE DEPARTMENT CONNECTION
△	AUTOMATIC BALL DRIP
△	SWING CHECK VALVE
△	FLEXIBLE COUPLING
△	GATE VALVE
△	ANGLE VALVE
△	RETARD CHAMBER
△	FLOW SWITCH (VANE TYPE)
△	PRESSURE SWITCH
△	ELEVATION OF PIPE FROM HIGH POINT OF FINISHED FLOOR AT THE POINT SHOWN
△	PIPE SIZE
△	DIMENSION & TO & OF FITTINGS OR PIPE (NOT CUTTING LENGTH)

NOTE
1. FOR FIRE PROTECTION & GENERAL CONSTRUCTION SPECIFICATIONS SEE HVS-8951

DESIGN AUTOMATIC SPRINKLER QUANTITIES				
LOCATION	UPRIGHT		PENDENT	
	ORDINARY RCC RATING	INTERMEDIATE RCC RATING	ORDINARY RCC RATING	INTERMEDIATE RCC RATING
FIRST FLOOR	85	6	20	1
SECOND FLOOR	28	4	1	0
TOTAL AUTOMATIC SPRINKLERS ON RISER				112

APPROVED FOR RL-HAS 7/2/71 DATE 2-8-71

U.S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
MANFORD ENGINEERING SERVICES
DIVISION OF VITRO CORP. OF AMERICA

FIRE PROTECTION
SPRINKLER SYSTEM
FIRST FLOOR & DETAILS

SCALE 3/16" = 1'-0"

225-B 8405

H-2-66544

NO.	DATE	BY	CHKD.	DESCRIPTION
1	7/2/71	RL-HAS	RL-HAS	POINT DRAIN 4 LOWER CORNER 2ND FLOOR HAS 6' 6" ZONE R10 (1) ADDITIONAL 6" DIM HAS 6" ZONE R10 (1) ELEV
2	7/2/71	RL-HAS	RL-HAS	REVISIONS
3	7/2/71	RL-HAS	RL-HAS	REVISIONS
4	7/2/71	RL-HAS	RL-HAS	REVISIONS
5	7/2/71	RL-HAS	RL-HAS	REVISIONS
6	7/2/71	RL-HAS	RL-HAS	REVISIONS
7	7/2/71	RL-HAS	RL-HAS	REVISIONS
8	7/2/71	RL-HAS	RL-HAS	REVISIONS
9	7/2/71	RL-HAS	RL-HAS	REVISIONS
10	7/2/71	RL-HAS	RL-HAS	REVISIONS
11	7/2/71	RL-HAS	RL-HAS	REVISIONS
12	7/2/71	RL-HAS	RL-HAS	REVISIONS
13	7/2/71	RL-HAS	RL-HAS	REVISIONS
14	7/2/71	RL-HAS	RL-HAS	REVISIONS
15	7/2/71	RL-HAS	RL-HAS	REVISIONS
16	7/2/71	RL-HAS	RL-HAS	REVISIONS
17	7/2/71	RL-HAS	RL-HAS	REVISIONS
 

[illegible]

The diagram shows a cross-section of a roof truss. The roof slope is indicated as 5°. The vertical height from the base to the peak is labeled as 11'-0". The horizontal distance from the base to the peak is labeled as 8'-0". The roof slope is also labeled as 50%. The horizontal distance from the base to the peak is labeled as 7'-6".

(TYP FOR 20') 1'-0"

3'-0"

6"

3"

1'-0"

SEE DET. II

CONTINUED FROM 1st FLOOR
SEE DWG. H-2-66546

INSTALL ESCUTCHION
PLATES IN PERSONNEL
AREAS ONLY

PIPE SIZE
VARIES

PARTITION
WALL

NON SAG TYPE (BOTH SIDE)

DETAIL V
(TYPICAL)
SCALE NONE

[illegible]

INSTRUMENT SYMBOL TABLE		
SYMBOL	PROCESS VARIABLE 1ST LETTER	INSTRUMENT FUNCTION 2ND & 3RD LETTERS
A	AMPERE	ALARM
AMP		AMPLIFIER
AN		ANALYZER
C	CONDUCTIVITY	CONTROLLER
CVT	CONVERTER	
D	DIFFERENTIAL	
E		ELEMENT
F	FLOW	
H	HEATER	
HD	HEAT DETECTION	
HLD	HELIUM LEAK DETECTION	
I		INDICATOR
J	JET	
K	RELAY	
L	LEVEL	
LD	LEAK DETECTION	
M	MANUAL	METER
MK	MICROPHONE	
ND	NULL DETECTOR	
P	PRESSURE	PRESSURE
PH	ACIDITY	
R	RADIATION	RECORDER
S	SELECTOR	SWITCH
SG	SPECIFIC GRAVITY	
T	TEMPERATURE	TRANSMITTER
UC	ULTRASONIC CLEANER	
UT	ULTRASONIC TRANSDUCER	
W	WATT	
WF	WEIGHT FACTOR	
CRM	COUNT RATE METER	
PHAN	PULSE HEIGHT ANALYZER	
RAU	RADIATION ALARM UNIT	
RPAMP	RADIATION PRE-AMPLIFIER	
SPK	SPEAKER	

FLOW DIAGRAM SYMBOLS (CONTINUED)	
SYMBOL	DESCRIPTION
	DIAPHRAGM OPERATED VALVE (DOV)
	PRESSURE REGULATING VALVE (PRV)
	LINE STRAINER Y TYPE
	PROCESS LINE
	MAIN PROCESS LINE
	INSTRUMENT PNEUMATIC LINES
	ELECTRICAL LINES
	INSTRUMENT CAPILLARY TUBING
	PURGE ROTOMETER
	AGITATOR
	INSTRUMENT AIR (20+)
	ELECTRICAL POWER
	JET
	ELECTRIC OPERATED VALVE (EOV)
	SAFETY RELIEF VALVE (SRV)
	PANEL MOUNTED IN OPERATING GALLERY
	LOCAL MOUNTED
	JET GANG VALVE
	MOTOR CONTROL CENTER
	RESTRICTING ORIFICE
	VIEWING WINDOW PANEL MOUNTED

MATCH LINE H-2-66211

MATCH LINE H-2-66602

REV	DATE	DESCRIPTION
1	11/17/71	REVISED PER DCN NO. 41
2	11/17/71	REVISED PER DCN NO. 41
3	11/17/71	REVISED PER DCN NO. 41
4	11/17/71	REVISED PER DCN NO. 41

APPROVED FOR RL	DATE	U. S. ATOMIC ENERGY COMMISSION
U. S. ATOMIC ENERGY COMMISSION	DATE	RICHMOND OPERATIONS OFFICE
MANFORD ENGINEERING SERVICES	DATE	DIVISION OF VITRO CORP. OF AMERICA
INSTRUMENT ENGINEERING DIAGRAM CELL A		
PROJECT NO.	PROJECT TITLE	PROJECT NO.
225-B	225-B	225-B
H-2-66601	H-2-66601	H-2-66601

APPROVED FOR RL - H-2-66601 DATE 3-11-71

U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
HANFORD ENGINEERING SERVICES
DIVISION OF VITRO CORP. OF AMERICA

INSTRUMENT
ENGINEERING DIAGRAM
CELL B

REVISIONS

REV	DATE	DESCRIPTION
1	3-11-71	REVISED PER DEN N2 42

REFERENCE DRAWINGS

DWG. NO.	DWG. TITLE
H-2-66601	CELL B AND
H-2-66602	CELL B
H-2-66603	CELL B
H-2-66604	CELL B
H-2-66605	CELL B

FOR GENERAL NOTES & LEGENDS, SEE H-2-66601

225-B
H-2-66602

FOR GENERAL NOTES & LEGENDS, SEE N 2 66601

2 66601	E F B CELL B
2 66602	E F B CELL C
2 66603	E F B CELL D
2 66604	E F B CELL E
2 66605	E F B CELL F
2 66606	E F B CELL G
2 66607	E F B CELL H
2 66608	E F B CELL I
2 66609	E F B CELL J
2 66610	E F B CELL K
2 66611	E F B CELL L
2 66612	E F B CELL M
2 66613	E F B CELL N
2 66614	E F B CELL O
2 66615	E F B CELL P
2 66616	E F B CELL Q
2 66617	E F B CELL R
2 66618	E F B CELL S
2 66619	E F B CELL T
2 66620	E F B CELL U
2 66621	E F B CELL V
2 66622	E F B CELL W
2 66623	E F B CELL X
2 66624	E F B CELL Y
2 66625	E F B CELL Z

REV	DATE	BY	CHKD	DESCRIPTION
1	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
2	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
3	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
4	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
5	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
6	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
7	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
8	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
9	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
10	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
11	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
12	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
13	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
14	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
15	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
16	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
17	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
18	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
19	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43
20	11/11/71	W. J. SWAN	W. J. SWAN	REVISED PER DCN NO 43

APPROVED FOR RELEASE BY DATE 11/11/71 BY W. J. SWAN	U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA
INSTRUMENT ENGINEERING DIAGRAM CELL B	
SCALE: NONE	ENCLOSURE FACILITY
225-B	7002
H-2-66603

FOR GENERAL NOTES & LEGENDS, SEE H-2-66601

H-2-66600	E.T.D. ARH
H-2-66601	E.T.D. CELL C
H-2-66602	E.T.D. CELL D
H-2-66603	E.T.D. CELL E
H-2-66604	E.T.D. CELL F
H-2-66605	E.T.D. CELL G
H-2-66606	E.T.D. CELL H
H-2-66607	E.T.D. CELL I
H-2-66608	E.T.D. CELL J
H-2-66609	E.T.D. CELL K
H-2-66610	E.T.D. CELL L
H-2-66611	E.T.D. CELL M
H-2-66612	E.T.D. CELL N
H-2-66613	E.T.D. CELL O
H-2-66614	E.T.D. CELL P
H-2-66615	E.T.D. CELL Q
H-2-66616	E.T.D. CELL R
H-2-66617	E.T.D. CELL S
H-2-66618	E.T.D. CELL T
H-2-66619	E.T.D. CELL U
H-2-66620	E.T.D. CELL V
H-2-66621	E.T.D. CELL W
H-2-66622	E.T.D. CELL X
H-2-66623	E.T.D. CELL Y
H-2-66624	E.T.D. CELL Z

REV	DATE	DESCRIPTION	BY	CHKD
1	11/11/71	REVISED PER DEN NR 44	ARH	ARH
2	11/11/71	REVISED PER DEN NR 44	ARH	ARH
3	11/11/71	REVISED PER DEN NR 44	ARH	ARH
4	11/11/71	REVISED PER DEN NR 44	ARH	ARH
5	11/11/71	REVISED PER DEN NR 44	ARH	ARH
6	11/11/71	REVISED PER DEN NR 44	ARH	ARH
7	11/11/71	REVISED PER DEN NR 44	ARH	ARH
8	11/11/71	REVISED PER DEN NR 44	ARH	ARH
9	11/11/71	REVISED PER DEN NR 44	ARH	ARH
10	11/11/71	REVISED PER DEN NR 44	ARH	ARH
11	11/11/71	REVISED PER DEN NR 44	ARH	ARH
12	11/11/71	REVISED PER DEN NR 44	ARH	ARH
13	11/11/71	REVISED PER DEN NR 44	ARH	ARH
14	11/11/71	REVISED PER DEN NR 44	ARH	ARH
15	11/11/71	REVISED PER DEN NR 44	ARH	ARH
16	11/11/71	REVISED PER DEN NR 44	ARH	ARH
17	11/11/71	REVISED PER DEN NR 44	ARH	ARH
18	11/11/71	REVISED PER DEN NR 44	ARH	ARH
19	11/11/71	REVISED PER DEN NR 44	ARH	ARH
20	11/11/71	REVISED PER DEN NR 44	ARH	ARH
21	11/11/71	REVISED PER DEN NR 44	ARH	ARH
22	11/11/71	REVISED PER DEN NR 44	ARH	ARH
23	11/11/71	REVISED PER DEN NR 44	ARH	ARH
24	11/11/71	REVISED PER DEN NR 44	ARH	ARH
25	11/11/71	REVISED PER DEN NR 44	ARH	ARH
26	11/11/71	REVISED PER DEN NR 44	ARH	ARH
27	11/11/71	REVISED PER DEN NR 44	ARH	ARH
28	11/11/71	REVISED PER DEN NR 44	ARH	ARH
29	11/11/71	REVISED PER DEN NR 44	ARH	ARH
30	11/11/71	REVISED PER DEN NR 44	ARH	ARH
31	11/11/71	REVISED PER DEN NR 44	ARH	ARH
32	11/11/71	REVISED PER DEN NR 44	ARH	ARH
33	11/11/71	REVISED PER DEN NR 44	ARH	ARH
34	11/11/71	REVISED PER DEN NR 44	ARH	ARH
35	11/11/71	REVISED PER DEN NR 44	ARH	ARH
36	11/11/71	REVISED PER DEN NR 44	ARH	ARH
37	11/11/71	REVISED PER DEN NR 44	ARH	ARH
38	11/11/71	REVISED PER DEN NR 44	ARH	ARH
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40	11/11/71	REVISED PER DEN NR 44	ARH	ARH
41	11/11/71	REVISED PER DEN NR 44	ARH	ARH
42	11/11/71	REVISED PER DEN NR 44	ARH	ARH
43	11/11/71	REVISED PER DEN NR 44	ARH	ARH
44	11/11/71	REVISED PER DEN NR 44	ARH	ARH
45	11/11/71	REVISED PER DEN NR 44	ARH	ARH
46	11/11/71	REVISED PER DEN NR 44	ARH	ARH
47	11/11/71	REVISED PER DEN NR 44	ARH	ARH
48	11/11/71	REVISED PER DEN NR 44	ARH	ARH
49	11/11/71	REVISED PER DEN NR 44	ARH	ARH
50	11/11/71	REVISED PER DEN NR 44	ARH	ARH

APPROVED FOR RL	H-2-66605	DATE	3-11-71
U.S. ATOMIC ENERGY COMMISSION			
RICHMOND OPERATIONS OFFICE			
HANFORD ENGINEERING SERVICES			
DIVISION OF VITRO CORP. OF AMR			
INSTRUMENT			
ENGINEERING DIAGRAM			
CELL C			
REV	DATE	DESCRIPTION	BY
1	11/11/71	REVISED PER DEN NR 44	ARH
2	11/11/71	REVISED PER DEN NR 44	ARH
3	11/11/71	REVISED PER DEN NR 44	ARH
4	11/11/71	REVISED PER DEN NR 44	ARH
5	11/11/71	REVISED PER DEN NR 44	ARH
6	11/11/71	REVISED PER DEN NR 44	ARH
7	11/11/71	REVISED PER DEN NR 44	ARH
8	11/11/71	REVISED PER DEN NR 44	ARH
9	11/11/71	REVISED PER DEN NR 44	ARH
10	11/11/71	REVISED PER DEN NR 44	ARH
11	11/11/71	REVISED PER DEN NR 44	ARH
12	11/11/71	REVISED PER DEN NR 44	ARH
13	11/11/71	REVISED PER DEN NR 44	ARH
14	11/11/71	REVISED PER DEN NR 44	ARH
15	11/11/71	REVISED PER DEN NR 44	ARH
16	11/11/71	REVISED PER DEN NR 44	ARH
17	11/11/71	REVISED PER DEN NR 44	ARH
18	11/11/71	REVISED PER DEN NR 44	ARH
19	11/11/71	REVISED PER DEN NR 44	ARH
20	11/11/71	REVISED PER DEN NR 44	ARH
21	11/11/71	REVISED PER DEN NR 44	ARH
22	11/11/71	REVISED PER DEN NR 44	ARH
23	11/11/71	REVISED PER DEN NR 44	ARH
24	11/11/71	REVISED PER DEN NR 44	ARH
25	11/11/71	REVISED PER DEN NR 44	ARH
26	11/11/71	REVISED PER DEN NR 44	ARH
27	11/11/71	REVISED PER DEN NR 44	ARH
28	11/11/71	REVISED PER DEN NR 44	ARH
29	11/11/71	REVISED PER DEN NR 44	ARH
30	11/11/71	REVISED PER DEN NR 44	ARH
31	11/11/71	REVISED PER DEN NR 44	ARH
32	11/11/71	REVISED PER DEN NR 44	ARH
33	11/11/71	REVISED PER DEN NR 44	ARH
34	11/11/71	REVISED PER DEN NR 44	ARH
35	11/11/71	REVISED PER DEN NR 44	ARH
36	11/11/71	REVISED PER DEN NR 44	ARH
37	11/11/71	REVISED PER DEN NR 44	ARH
38	11/11/71	REVISED PER DEN NR 44	ARH
39	11/11/71	REVISED PER DEN NR 44	ARH
40	11/11/71	REVISED PER DEN NR 44	ARH
41	11/11/71	REVISED PER DEN NR 44	ARH
42	11/11/71	REVISED PER DEN NR 44	ARH
43	11/11/71	REVISED PER DEN NR 44	ARH
44	11/11/71	REVISED PER DEN NR 44	ARH
45	11/11/71	REVISED PER DEN NR 44	ARH
46	11/11/71	REVISED PER DEN NR 44	ARH
47	11/11/71	REVISED PER DEN NR 44	ARH
48	11/11/71	REVISED PER DEN NR 44	ARH
49	11/11/71	REVISED PER DEN NR 44	ARH
50	11/11/71	REVISED PER DEN NR 44	ARH

FOR GENERAL NOTES & LEGENDS, SEE H-2-66601.

[illegible]

FOR GENERAL NOTES & LEGENDS, SEE H-2-66601

REV	DATE	DESCRIPTION
1	3-11-71	REVISED PER DCN NO 46
2	3-11-71	REVISED PER DCN NO 46
3	3-11-71	REVISED PER DCN NO 46
4	3-11-71	REVISED PER DCN NO 46
5	3-11-71	REVISED PER DCN NO 46
6	3-11-71	REVISED PER DCN NO 46
7	3-11-71	REVISED PER DCN NO 46
8	3-11-71	REVISED PER DCN NO 46
9	3-11-71	REVISED PER DCN NO 46
10	3-11-71	REVISED PER DCN NO 46

REV	DATE	DESCRIPTION
1	3-11-71	REVISED PER DCN NO 46
2	3-11-71	REVISED PER DCN NO 46
3	3-11-71	REVISED PER DCN NO 46
4	3-11-71	REVISED PER DCN NO 46
5	3-11-71	REVISED PER DCN NO 46
6	3-11-71	REVISED PER DCN NO 46
7	3-11-71	REVISED PER DCN NO 46
8	3-11-71	REVISED PER DCN NO 46
9	3-11-71	REVISED PER DCN NO 46
10	3-11-71	REVISED PER DCN NO 46

APPROVED FOR RL H-2-66605		DATE 3-11-71	
U. S. ATOMIC ENERGY COMMISSION		RICHMOND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
INSTRUMENT		ENGINEERING DIAGRAM	
CELL D		ENCLOSURE FACILITY	
225-8		7002	
H-2-66606		SHEET NO. 1

FOR GENERAL NOTES & LEGENDS SEE H-2-66601

REV	DATE	BY	FOR	DESCRIPTION
1	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
2	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
3	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
4	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47

REV	DATE	BY	FOR	DESCRIPTION
1	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
2	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
3	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47
4	11/11/71	W. J. SWAN	FOR	REVISED PER DCN N2 47

APPROVED FOR RL - H & S 11/11/71		DATE 3-11-71	
U. S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SEP/HCS		DIVISION OF VITRO CORP. OF AMERICA	
INSTRUMENT		ENGINEERING DIAGRAM	
CELL E		ENCLOSURE FACIL	
225-B		7002	
H-2-66607		SHEET 43

H-2-66601	E F B ARH
H-2-66602	E F B CELL E
H-2-66603	I E J CELL F
H-2-66604	I E K CELL E
H-2-66605	I E L CELL A
H-2-66606	DRAWING INSET

REV	DATE	DESCRIPTION	BY	CHKD
1	11/70	REVISED PER DCN NS 48	1	1
2	11/70	REVISED PER DCN NS 48	1	1
3	11/70	REVISED PER DCN NS 48	1	1
4	11/70	REVISED PER DCN NS 48	1	1
5	11/70	REVISED PER DCN NS 48	1	1

APPROVED FOR RL H-2-66607		DATE 3-11-71	
U. S. ATOMIC ENERGY COMMISSION			
RICHLAND OPERATIONS OFFICE			
HARTFORD ENGINEERING SERVICES			
DIVISION OF VITRO CORP. OF AMERICA			
INSTRUMENT			
ENGINEERING DIAGRAM			
CELL E			
SCALE	NONE	BLANK NO	225-B
INDEX NO	7002	SHEET NO	1
NONE

FOR GENERAL NOTES & LEGENDS, SEE H-2-66601

W-2-66601	E D CELL A
W-2-66602	E D CELL B
W-2-66603	E D CELL C
W-2-66604	E D CELL D
W-2-66605	E D CELL E
W-2-66606	E D CELL F
W-2-66607	E D CELL G
W-2-66608	E D CELL H
W-2-66609	E D CELL I
W-2-66610	E D CELL J
W-2-66611	E D CELL K
W-2-66612	E D CELL L
W-2-66613	E D CELL M
W-2-66614	E D CELL N
W-2-66615	E D CELL O
W-2-66616	E D CELL P
W-2-66617	E D CELL Q
W-2-66618	E D CELL R
W-2-66619	E D CELL S
W-2-66620	E D CELL T
W-2-66621	E D CELL U
W-2-66622	E D CELL V
W-2-66623	E D CELL W
W-2-66624	E D CELL X
W-2-66625	E D CELL Y
W-2-66626	E D CELL Z

REV	DATE	DESCRIPTION
1	3-11-71	REVISED PER DCN N2 49
2	3-11-71	REVISED PER DCN N2 49
3	3-11-71	REVISED PER DCN N2 49
4	3-11-71	REVISED PER DCN N2 49
5	3-11-71	REVISED PER DCN N2 49
6	3-11-71	REVISED PER DCN N2 49
7	3-11-71	REVISED PER DCN N2 49
8	3-11-71	REVISED PER DCN N2 49
9	3-11-71	REVISED PER DCN N2 49
10	3-11-71	REVISED PER DCN N2 49
11	3-11-71	REVISED PER DCN N2 49
12	3-11-71	REVISED PER DCN N2 49
13	3-11-71	REVISED PER DCN N2 49
14	3-11-71	REVISED PER DCN N2 49
15	3-11-71	REVISED PER DCN N2 49
16	3-11-71	REVISED PER DCN N2 49
17	3-11-71	REVISED PER DCN N2 49
18	3-11-71	REVISED PER DCN N2 49
19	3-11-71	REVISED PER DCN N2 49
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25	3-11-71	REVISED PER DCN N2 49
26	3-11-71	REVISED PER DCN N2 49
27	3-11-71	REVISED PER DCN N2 49
28	3-11-71	REVISED PER DCN N2 49
29	3-11-71	REVISED PER DCN N2 49
30	3-11-71	REVISED PER DCN N2 49
31	3-11-71	REVISED PER DCN N2 49
32	3-11-71	REVISED PER DCN N2 49
33	3-11-71	REVISED PER DCN N2 49
34	3-11-71	REVISED PER DCN N2 49
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37	3-11-71	REVISED PER DCN N2 49
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46	3-11-71	REVISED PER DCN N2 49
47	3-11-71	REVISED PER DCN N2 49
48	3-11-71	REVISED PER DCN N2 49
49	3-11-71	REVISED PER DCN N2 49
50	3-11-71	REVISED PER DCN N2 49

APPROVED FOR RL H-2-66601		DATE 3-11-71	
U. S. ATOMIC ENERGY COMMISSION		HANFORD ENGINEERING SERVICES	
RICHLAND OPERATIONS OFFICE		DIVISION OF Y-12 CORP. OF AMERICA	
INSTRUMENT		ENCLOSURE FACILITY	
ENGINEERING DIAGRAM		CELL F	
SCALE NONE		BLOCK NO. 225-B	
SHEET NO. 7002		H-2-66609	

[illegible]

INSTRUMENT LEGEND

- CRM COUNT RATE METER
- DPI DIFFERENTIAL PRESSURE INDICATOR
- DPR DIFFERENTIAL PRESSURE RECORDER
- DPT DIFFERENTIAL PRESSURE TRANSMITTER
- FI FLOW INDICATOR
- MS MANUAL SWITCH
- PI PRESSURE INDICATOR
- PT PRESSURE TRANSMITTER
- PWS POWER SUPPLY (HIGH VOLTAGE)
- RA RADIATION ALARM
- RAMP RADIATION AMPLIFIER
- RE RADIATION ELEMENT
- RR RADIATION RECORDER
- TE TEMPERATURE ELEMENT
- TR TEMPERATURE RECORDER
- PAID MOUNTED INSTRUMENT (IN BLDG. 225-B OPERATING GALLERY)
- LOCAL MOUNTED INSTRUMENT
- INSTRUMENT LINE (PNEUMATIC)
- ELECTRICAL LINE
- BACK MOUNTED INSTRUMENT (IN BLDG. 225-B)
- RAMP RADIATION PRE-AMPLIFIER
- ME MOISTURE ELEMENT
- MR MOISTURE RECORDER
- MT MOISTURE TRANSMITTER
- MPS MOISTURE POWER SUPPLY

BUILDING EXHAUST SYSTEM K1

REV	DATE	DESCRIPTION
1	10/1/66	ISSUED FOR CONSTRUCTION
2	10/1/66	REVISED TO SHOW CHANGES
3	10/1/66	REVISED TO SHOW CHANGES
4	10/1/66	REVISED TO SHOW CHANGES
 

U.S. ATOMIC ENERGY COMMISSION RICHMOND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA INSTRUMENT ENGINEERING DIAGRAM CELL EXHAUST SYSTEM K3 SCALE: 1" = 10'-0" DRAWN: R. C. SWAN CHECKED: J. L. SWAN DATE: 3-2-71 APPROVED FOR RL: H. A. S.		REVISIONS NO. DATE DESCRIPTION 1 3-2-71 REVISED PER DCN H2 30		NEXT USED ON NO. DATE DESCRIPTION H-2-66990 3-2-71 AIR SAMPLING H-2-66991 3-2-71 HVAC CONTROL BUILDINGS H-2-66992 3-2-71 EXHAUST SYSTEM K1	
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CELL EXHAUST SYSTEM K3

FOR COM7 SEE 4-2-66978

[illegible]

FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-66513

APPROVED FOR RL-NAS 7/7/71		DATE 3-10-71	
U. S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM			
CELL "B"			
DRAWN BY J. M. JACKSON		CHECKED BY J. M. JACKSON	
SCALE NONE		DATE 3/10/71	
DRAWING STATUS		DRAWING NO. 225-B	
NEXT USED ON H-2 66400		DRAWING STATUS

FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-66613.

APPROVED FOR RELEASE		DATE 3-10-71	
U. S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
HAFORD ENGINEERING SERVICES		DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM			
CELL "C"			
PROJECT NO. H-2-66979		DRAWING NO. 7001	
SCALE NONE		DATE	
REVISIONS		DRAWING STATUS	
NEXT USED ON H-2-6400		DRAWING STATUS

FOR CONT. SEE H-2-66979

FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-66613

APPROVED FOR RL-MS 71 U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF WTRD CORP. OF AMERICA ENGINEERING FLOW DIAGRAM CELL "D"		DATE 3-10-71 DRAWN J.M. JICKA CHECKED J.M. JICKA SCALE NONE REVISIONS COMMENTS INCORPORATED REFERENCE DRAWINGS NEXT USED ON 1-2-71	PROJECT NO. HAF 831 ALFA NO. 225-8 SHEET NO. 7001 H-2-66980
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FOR GENERAL NOTES AND LEGEND SEE H-2-66613

APPROVED FOR RL-48571771111		DATE 5-10-71	
U.S. ATOMIC ENERGY COMMISSION		U.S. ATOMIC ENERGY COMMISSION	
RICHMOND OPERATIONS OFFICE		RICHMOND OPERATIONS OFFICE	
MANFORD ENGINEERING SERVICES		MANFORD ENGINEERING SERVICES	
DIVISION OF VITRO CORP. OF AMERICA		DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM			
CELL "D"			
SCALE: NONE		SCALE: NONE	
CLASSIFICATION: NONE		CLASSIFICATION: NONE	
H-2-66981		H-2-66981

FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-66613.

APPROVED FOR RELEASE BY DATE 3-10-71	
U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HARTFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM	
CELL "E"	
DRAWN BY: R. H. H. H.	
SCALE: NONE	
CLASSIFICATION: 225-B	
H-2-66982	

NO.	DATE	DESCRIPTION
1	11/17/66	ISSUED FOR CONSTRUCTION
2	11/17/66	ISSUED FOR CONSTRUCTION
3	11/17/66	ISSUED FOR CONSTRUCTION
4	11/17/66	ISSUED FOR CONSTRUCTION
5	11/17/66	ISSUED FOR CONSTRUCTION
6	11/17/66	ISSUED FOR CONSTRUCTION
7	11/17/66	ISSUED FOR CONSTRUCTION
8	11/17/66	ISSUED FOR CONSTRUCTION
9	11/17/66	ISSUED FOR CONSTRUCTION
10	11/17/66	ISSUED FOR CONSTRUCTION
11	11/17/66	ISSUED FOR CONSTRUCTION
12	11/17/66	ISSUED FOR CONSTRUCTION
13	11/17/66	ISSUED FOR CONSTRUCTION
14	11/17/66	ISSUED FOR CONSTRUCTION
15	11/17/66	ISSUED FOR CONSTRUCTION
16	11/17/66	ISSUED FOR CONSTRUCTION
17	11/17/66	ISSUED FOR CONSTRUCTION
18	11/17/66	ISSUED FOR CONSTRUCTION
 

APPROVED FOR RL - H-2-66984		DATE 3-10-71	
U. S. ATOMIC ENERGY COMMISSION		RICHLAND OPERATIONS OFFICE	
HAFNORD ENGINEERING SERVICES		DIVISION OF VTD CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM			
CELL G			
DRAWN BY J. M. JACKSON		CHECKED BY R. L. JACKSON	
SCALE NONE		PROJ. NO. 225-8	
SHEET NO. 7001		DATE 3-10-71	

NO.	DATE	BY	FOR	REVISIONS	COMMENTS
1	3-10-71	J. M. JACKSON	R. L. JACKSON		INITIAL DESIGN
2	3-10-71	J. M. JACKSON	R. L. JACKSON		REVISED FOR CELL G

APPROVED FOR RL - H-2-66984	DATE 3-10-71
U. S. ATOMIC ENERGY COMMISSION	RICHLAND OPERATIONS OFFICE
HAFNORD ENGINEERING SERVICES	DIVISION OF VTD CORP. OF AMERICA
ENGINEERING FLOW DIAGRAM	
CELL G	
DRAWN BY J. M. JACKSON	CHECKED BY R. L. JACKSON
SCALE NONE	PROJ. NO. 225-8
SHEET NO. 7001	DATE 3-10-71

FOR CONTINUATION SEE H-2-66985

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-66985

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-66985

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-67185

APPROVED FOR RELEASE		U.S. ATOMIC ENERGY COMMISSION	
BY: [Signature]		RICHLAND OPERATIONS OFFICE	
DATE: 11/20/66		HANSFORD ENGINEER NO. 57	
BY: [Signature]		DIVISION OF VITRO CORP. OF AMERICA	
DATE: 11/20/66		ENGINEERING FLOW DIAGRAM	
DRAWING NO. 4-2-66986		STORAGE POOLS 1, 2, 3	
REVISIONS		DRAWING STATUS	
BY: [Signature]		DATE: 11/20/66	
CHECKED: [Signature]		DATE: 11/20/66	
APPROVED: [Signature]		DATE: 11/20/66

APPROVED FOR RELEASE BY U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HAFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
DATE 4-12-71	
ENGINEERING FLOW DIAGRAM	
STORAGE POOLS 4, 5 & 6	
SCALE 1" = 10'	
SHEET NO. 22-3	
TOTAL SHEETS 7000	
H-2-56987	
* 4	

REV	DATE	DESCRIPTION
1	4-12-71	ISSUED FOR CONSTRUCTION

REV	DATE	DESCRIPTION
1	4-12-71	ISSUED FOR CONSTRUCTION

REV	DATE	DESCRIPTION
1	4-12-71	ISSUED FOR CONSTRUCTION

NOTES

ALL LIQUID LEVEL INSTRUMENTS MUST BE LOCATED ADJACENT TO CHEMICAL FILL VALVES FOR ACCURATE LIQUID ADDITIONS.

ALL LINES NOT IDENTIFIED ARE INSTRUMENT TUBING LINES.

ALL INSTRUMENT LINES FROM MAIN SUPPLY HEADER TO BLOCK VALVES WILL BE 1/2".

FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-66613.

APPROVED FOR RL H-2-66989		DATE 11/1/11	
BY J. M. JACKA		DATE 11/1/11	
U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA			
ENGINEERING FLOW DIAGRAM AQUEOUS MAKE UP			
PROJECT NO. 225-8		SHEET NO. 7001	
DATE 11/1/11		DATE 11/1/11	
REVISIONS		DRAWING STATUS	
NONE		NONE	

REGULATED
MANIPULATOR
SHOP

UNES CONT TO 221-B
SEE DWG H-2-66346

FOR CONT. SEE H-2-66989

FOR CONT. SEE H-2-67135

ARH - 1986
PAGE E-58

NOTES

ALL LIQUID LEVEL INSTRUMENTS MUST BE LOCATED ADJACENT TO CHEMICAL FILL VALVES FOR ACCURATE LIQUID ADDITIONS

ALL LINES NOT IDENTIFIED ARE INSTRUMENT TUBING LINES

ALL INSTRUMENT LINES FROM MAIN SUPPLY HEADER TO BLOCK VALVES WILL BE 1/2\"/>

APPROVED FOR RL H-65		DATE 11/1/77	
U. S. ATOMIC ENERGY COMMISSION		HANFORD ENGINEERING SERVICES	
RICHLAND OPERATIONS OFFICE		DIVISION OF VITRO CORP OF AMERICA	
ENGINEERING FLOW DIAGRAM		AQUEOUS WASTE-UP	
PROJECT NO. 225-B		BLOCK NO. 7001	
DRAWN BY J.M. LONE		CHECKED BY K. ZAMA	
SCALE 1"=10'		DATE 11/1/77	
CLASSIFIED BY		DATE	
NONE		NONE	

REV	DATE	DESCRIPTION
1	11/1/77	GENERAL REVISION (DCN#46)

REV	DATE	DESCRIPTION
1	11/1/77	GENERAL REVISION (DCN#46)

REV	DATE	DESCRIPTION
1	11/1/77	GENERAL REVISION (DCN#46)

- NOTES:
- 1. ONLY THOSE RADIATION SYSTEMS SHOWN WITH ASTERISK (*) SHALL BE RECORDED.
 - 2. FOR LEGEND AND SYMBOL LIST SEE DRAWING H-2-66613.
 - 3. ALL AIR SAMPLE STATIONS TO BE AS PER DWG H-2-67888 UNLESS OTHERWISE INDICATED.

APPROVED FOR RELEASE BY THE U.S. ATOMIC ENERGY COMMISSION		DATE 4-2-71	
U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE		U.S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA		HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM		ENGINEERING FLOW DIAGRAM	
AIR SAMPLING		AIR SAMPLING	
SCALE 1/2" = 1'		SCALE 1/2" = 1'	
DRAWN BY COCK		DRAWN BY COCK	
CHECKED BY		CHECKED BY	
DATE		DATE	
REVISIONS		REVISIONS	
COMMENT PRT ISSUE NO. 1		COMMENT PRT ISSUE NO. 1	
DRAWING STATUS		DRAWING STATUS

U. S. ATOMIC ENERGY COMMISSION RICHMOND OPERATIONS OFFICE MANFORD ENGINEERING SERVICES DIVISION OF NITRO CORP. OF AMERICA		DRAIN SYSTEM PIPE PLAN & SECTIONS FIRST FLOOR	
REVISIONS NO. 1 DATE 11/11/71 BY J. CAMPBELL FOR J. CAMPBELL	GENERAL REVISION (DCA #51) NO. 1 DATE 11/11/71 BY J. CAMPBELL FOR J. CAMPBELL	APPROVED FOR RL H-2-67003 DATE 11/11/71 BY J. CAMPBELL FOR J. CAMPBELL	SCALE AS NOTED CLASSIFICATION UNCLASSIFIED DATE 11/11/71

APPROVED FOR RL-1986		DATE 10-1-77		U. S. ATOMIC ENERGY COMMISSION	
BY DATE		FOR DATE		RICHLAND OPERATIONS OFFICE	
BY DATE		FOR DATE		HANFORD ENGINEERING SERVICES	
BY DATE		FOR DATE		DIVISION OF VITRO CORP. OF AMER. CA	
BY DATE		FOR DATE		DRAIN SYSTEM	
BY DATE		FOR DATE		PIPING PLAN & SECTIONS	
BY DATE		FOR DATE		SECOND FLOOR	
BY DATE		FOR DATE		225-8	
BY DATE		FOR DATE		8509	
BY DATE		FOR DATE		H-2-67007	
BY DATE		FOR DATE		NONE	
BY DATE		FOR DATE		GENERAL REVISION (DCN 53)	
BY DATE		FOR DATE		DESCRIPTION	
BY DATE		FOR DATE		REVISIONS	
BY DATE		FOR DATE		CHECK PRT ISSUE NO.	
BY DATE		FOR DATE		DRAWING STATUS	
BY DATE		FOR DATE		NEXT USED ON

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-66987

FOR CONTINUATION SEE H-2-67011

FOR CONTINUATION SEE H-2-67011

FOR CONTINUATION SEE H-2-67011

APPROVED FOR H-2-67011 DATE 12-71	
U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE	
HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AM & CA	
ENGINEERING FLOW DIAGRAM	
STORAGE POOL 7 8 9	
SCALE: NONE	PROJ. TITLE: ENCLOSURE FACIL. Y
225-8	7000
H-2-67010	

REV.	DATE	DESCRIPTION
1	12-71	AS SHOWN
2	12-71	AS SHOWN
3	12-71	AS SHOWN
4	12-71	AS SHOWN
5	12-71	AS SHOWN
6	12-71	AS SHOWN
7	12-71	AS SHOWN
8	12-71	AS SHOWN
9	12-71	AS SHOWN
10	12-71	AS SHOWN
11	12-71	AS SHOWN
12	12-71	AS SHOWN
13	12-71	AS SHOWN
14	12-71	AS SHOWN
15	12-71	AS SHOWN
16	12-71	AS SHOWN
17	12-71	AS SHOWN
18	12-71	AS SHOWN
19	12-71	AS SHOWN
20	12-71	AS SHOWN

FOR CONTINUATION SEE H-2-67010

FOR CONTINUATION SEE H-2-67010

FOR CONTINUATION SEE H-2-67010

- 10 RW-6400-M5-7
- 2 DW-6000-M17-7
- 2 S(100") 8000-M2-7
- 1 U-1-8400-M9-7
- 1 1/2 A(100") 5300-M7-7
- 1 U-2-8400-M9-7

- 1 P-8008-M9-7
- 1 P-8004-M9-7
- 3 RW-6487-M5-7

- 4 CDL-3500-M5-7
- 2 LLW-4000-M9-7
- 2 LLW-4001-M9 (52022)-7

LOCATED IN STORAGE POOL #11

FOR CONTINUATION SEE H-2-67010

DETAIL 'A'

DETAIL 'B'

DETAIL 'C'

1RH 1936
PACE E 03

APPROVED FOR RL-NE-277/11/12 DATE 11/27/11	
U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE	
HANSFORD ENGINEER NO. SERVICES DIVISION OF VITRO CORP. OF AMERICA	
ENGINEERING FLOW DIAGRAM STORAGE POOL #10 & #11 & TRANSFER AISLE #12	
SCALE: NONE	
DRAWN: J. JACKA	
CHECKED: J. JACKA	
DATE: 11/27/11	
REVISIONS: NONE	
DRAWING STATUS: H-2-67011

GENERAL NOTES
1. FOR FLOW DIAGRAM SYMBOLS AND INSTRUMENT SYMBOL TABLE SEE H-2-66613

- * FURNISHED WITH DYE
- * CO. TENSION TO AUTOMATICALLY ALTERNATE START.

APPROVED FOR PL. H-2-66613		U. S. ATOMIC ENERGY COMMISSION RICHMOND OPERATIONS OFFICE HANFORD ENGINEERING SERVICES DIVISION OF VITRO CORP. OF AMERICA	
BY DATE	CHKD BY DATE	REV. NO.	REV. DATE
11/11/51	11/11/51	1	11/11/51
DRAWING STATUS			
NEXT USED ON			
REFERENCE DRAWINGS			
COMMITTEE REPORT NO. 11			
CHECKED BY DATE			
SCALE			
H-2-67135			