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D&D Characterization of the 232-F Old Tritium Facility at the Savannah River Site (U)

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D&D CHARACTERIZATION OF THE 232-F "OLD TRITIUM FACILITY" AT THE SAVANNAH RIVER SITE

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ABSTRACT

The 232-F "Old Tritium Facility" operated in the 1950's as the first tritium production facility at the Savannah River Site (SRS). In 1957, the 232-F operation ceased with tritium production turned over to a larger, technologically-improved facility at SRS. The 232-F Facility was abandoned in 1958 and the process areas have remained contaminated with radiological, hazardous and mixed constituents. Decontamination and decommissioning (D&D) of the 232-F Facility is scheduled to occur in the years 1995-1996. This paper presents the D&D characterization efforts for the 232-F Facility including: 1) Development of a Characterization Information Package, a document describing the facility history, process knowledge, contaminant survey history, and the most recent radiological/hazardous contaminant status. Also included in the Characterization Information Package is a preliminary D&D waste volume estimate. The Characterization Information Package is important as it represents the "pre-characterization" baseline and it provides the prerequisite data for subsequent characterization planning; and 2) Development of a Characterization Plan, a document outlining the plan for sampling and analysis of facility structures, systems and components (SSCs) in order to determine the pre-D&D locations and levels of radiological and hazardous constituents associated with the facility.

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INTRODUCTION

The 232-F Manufacturing Building began tritium extraction operations in October 1955. Over a period of two years, tritium gas ($^3H_1$) was extracted from irradiated lithium-aluminum (LiAl) target slugs. In 1957, the operation ceased with the tritium extraction function turned over to the 232-H Tritium Facility. The 232-F Manufacturing Building, also known as the "Old Tritium Facility", was finally abandoned in 1958 without any decontamination or decommissioning (D&D) effort. Since that time, the building has sat idle, without maintenance or upkeep, and its condition has aged over the years. Today, residual levels of radiological and hazardous contamination remain within the process areas of the facility. The major contaminants are tritium and mercury. Lead shielding is present in the process areas and the stack. Also, due to the time period in which the building was constructed, transite panels (an asbestos-containing material), asbestos insulation, asbestos floor tiles, and lead-based paints are construction materials common to both the administrative and process areas of the facility. The 232-F Manufacturing Building is to undergo D&D starting in 1995.

This paper contains the prerequisite data for future characterization of the facility, i.e., historical information pertaining to the facility and the process, and a current snapshot of the radiological and hazardous constituents associated with the facility. This information represents the essential baseline for preparation of the characterization plan and subsequent facility characterization. Included are descriptions of the facility history, process knowledge, and current radiological status, as well as a D&D waste description outlining the major radiological and hazardous constituents associated with the facility, and provides waste volume estimates. This data was instrumental in the development of the Decontamination and Decommissioning Characterization Plan for the 232-F Manufacturing Building. This plan identifies how the facility structures, systems and components (SSCs) are to be characterized in order to determine the pre-D&D locations and levels of radiological and hazardous constituents within the facility. This plan provides a sampling and analysis approach for sampling facility SSCs and the test analyses required for the samples.

Note: The application of statistical grid modeling of the facility to obtain statistically valid sampling locations and numbers of samples was considered for inclusion to this characterization plan. It was thought the statistical determination of type, extent and magnitude of contamination associated with the facility prior to D&D would enhance the waste certification process during actual D&D. The project team decided, however, the application of statistical modeling to this characterization plan was not justified due to the uncertainty in consistency between the pre-D&D facility condition and the removed D&D material/waste. The approach used in this characterization plan is one that considers process knowledge and past radiological surveys (Reference 4.1) to identify the constituents of concern (i.e., contaminants, hazardous and radioactive material, etc.) and their potential/known locations. Site procedures and federal/state protocols are then specified for the sampling and analysis of the constituents of concern.

FACILITY AND PROCESS HISTORY

The 232-F Manufacturing Building was constructed in 1953 in F-Area. The facility covers 19,260 ft^2, with 17,000 ft^2 enclosed inside a building and 2,260 ft^2 of outside, exterior components including a 200 ft tall stack. The building is a single-story construction, with the exception of a balcony and a basement in the process room, of a reinforced concrete slab with a structural steel frame and transite panels.

The building is divided into administration and process area segments as shown in Figure 1. All radiological material was contained within the process segment of the facility, while the administration segment provided a clean area for administrative tasks.

Process Knowledge

The following information on the tritium extraction process employed at the 232-F Manufacturing Building is provided as a general description of material flow through the facility, and where and what types of residual material may remain. A general process flow diagram is presented in Figure 2.

Irradiated LiAl slugs in shipping containers were brought into the facility via the material handling room. Slugs were removed from shipping containers in the decanning room. It is believed each of the two lead-lined process furnaces in the process room are single-slug furnaces. A slug was placed in a crucible which in turn was placed in the furnace. The furnaces operated at high temperatures. The high temperature melting of the slugs released a mixture of helium (^3He, ^4He), nitrogen (N_2), hydrogen (H_2), deuterium (D_2), and tritium (T_2) gases along with other radioactive (beta-gamma) impurities. These radioactive impurities likely included zinc-65 (Zn-65), cobalt-60 (Co-60), and possibly cesium-137 (Cs-137). Of these impurities, Co-60 and Cs-137 would still be present; Zn-65 which has a short half-life of 245 days, would have already decayed to non-detectable levels. The radioactive impurities would likely have remained in the furnaces due to their relative immobility and would not have spread to other process components. It is recommended a pulse height analysis (PHA) be performed on interior furnace samples to identify the residual radioactive contaminants.

The gas mixture from the furnaces was pumped through mercury diffusion and sprengel pumps to diffusers. Any particulates in the gas stream were most likely captured by the mercury in the pumps. The diffusers, which are palladium (Pd) and possibly silver (Ag), operated at high temperatures and separated the gas mixture into two distinct streams. The byproduct stream, consisting of ^3He, ^4He, N_2, and traces of T_2 gases, was pumped through a sprengel pump, collected in tanks, analyzed, passed through a zeolite bed, and collected in a byproduct trailer for offsite shipment. The remaining gas mixture of H_2, D_2, and T_2 was pumped via mercury diffusion and sprengel pumps to the thermal diffusion column.

In the thermal diffusion column, tritium gas was enriched via thermal diffusion and convection processes. The process column is stainless steel with an outer shell for cooling water and an inner molybdenum (Mo) wire along the central axis of the column. The wire was heated to a high temperature during operation. There may be/have been a mercury reservoir at the bottom of the column. The product, enriched tritium gas, was removed at the bottom of the column, pumped through a sprengel pump, and containerized. The raffinate, consisting of H_2, and D_2 gases, was removed at the top of the column, pumped through a sprengel pump, collected in tanks, analyzed, and vented directly to the stack.

During operation, the process likely generated little waste for disposal, with the exception of the radioactive spent metal melt (formerly LiAl slug) and job control wastes such as personnel protective clothing. The radioactive spent metal melt was placed in waste casks and sent to the Old Burial Ground.

Other than mercury and process cooling water, no liquids or chemicals should have been introduced to the process during normal operation. Mercury was used in the pumps and in the process column, and thus, there is sound basis for considering the process piping to be mercury contaminated. Also, H-Area tritium facilities have experienced a mercury oxide build-up, in the form of a black powder/paste-like substance, on the inside of process equipment. This form of mercury contamination is likely present inside 232-F process equipment as well. During normal operation, only the mercury would have contacted the radioactive tritium gas; the process cooling water would not have. Also, tritium is practically insoluble in mercury, and therefore, any mercury remaining in the facility would be expected to have nil to trace amounts of residual tritium. Chromated water may have been utilized in the process cooling water system.

The majority of the beta-gamma impurity contaminants are expected to be associated with the process furnaces.

Facility Shutdown and Mercury Removal

The 1958 shutdown procedure and plan for the 232-F process documented: "All process vessels and piping were flushed and pressurized with argon. The process column and diffusers were cooled to ambient temperature, and all process equipment, except material handling, was de-energized. The process water lines were drained and the instrument air was turned off. The oil was changed in all oil pumps to reduce contamination levels."

In 1984 activities "105 pounds of mercury was collected and bottled, with the largest quantities coming from the (process) column, diffusion pumps, lab manometers, and process hood floors. Some additional mercury was found in clean areas."

Figure 1: Map of F-Area in the Vicinity of 232-F

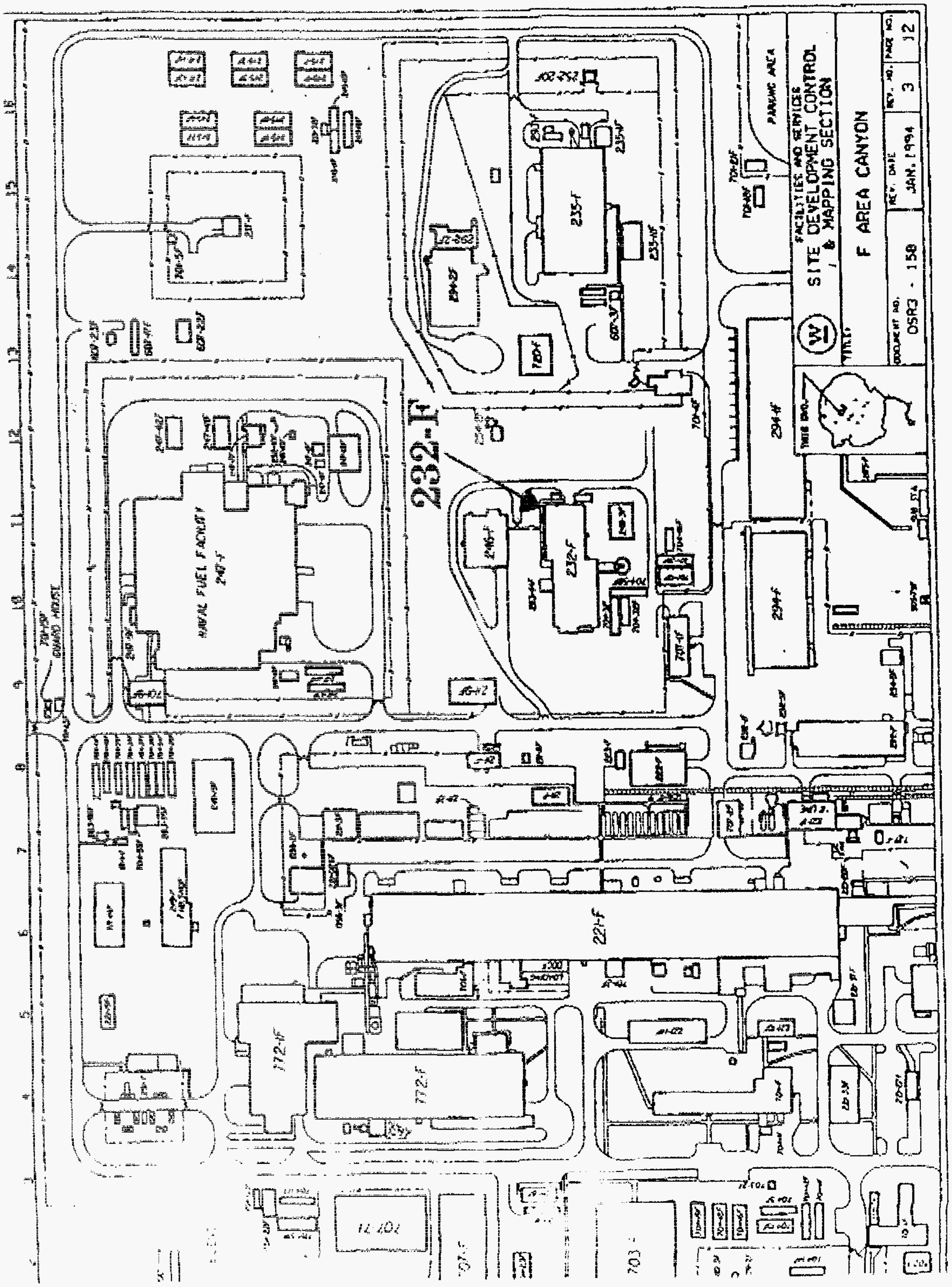

Figure 1: Floor Plan of the 232-F Manufacturing Building - Administration and Process Area Segments

Figure 2: Floor Plan of the 232-F Manufacturing Building

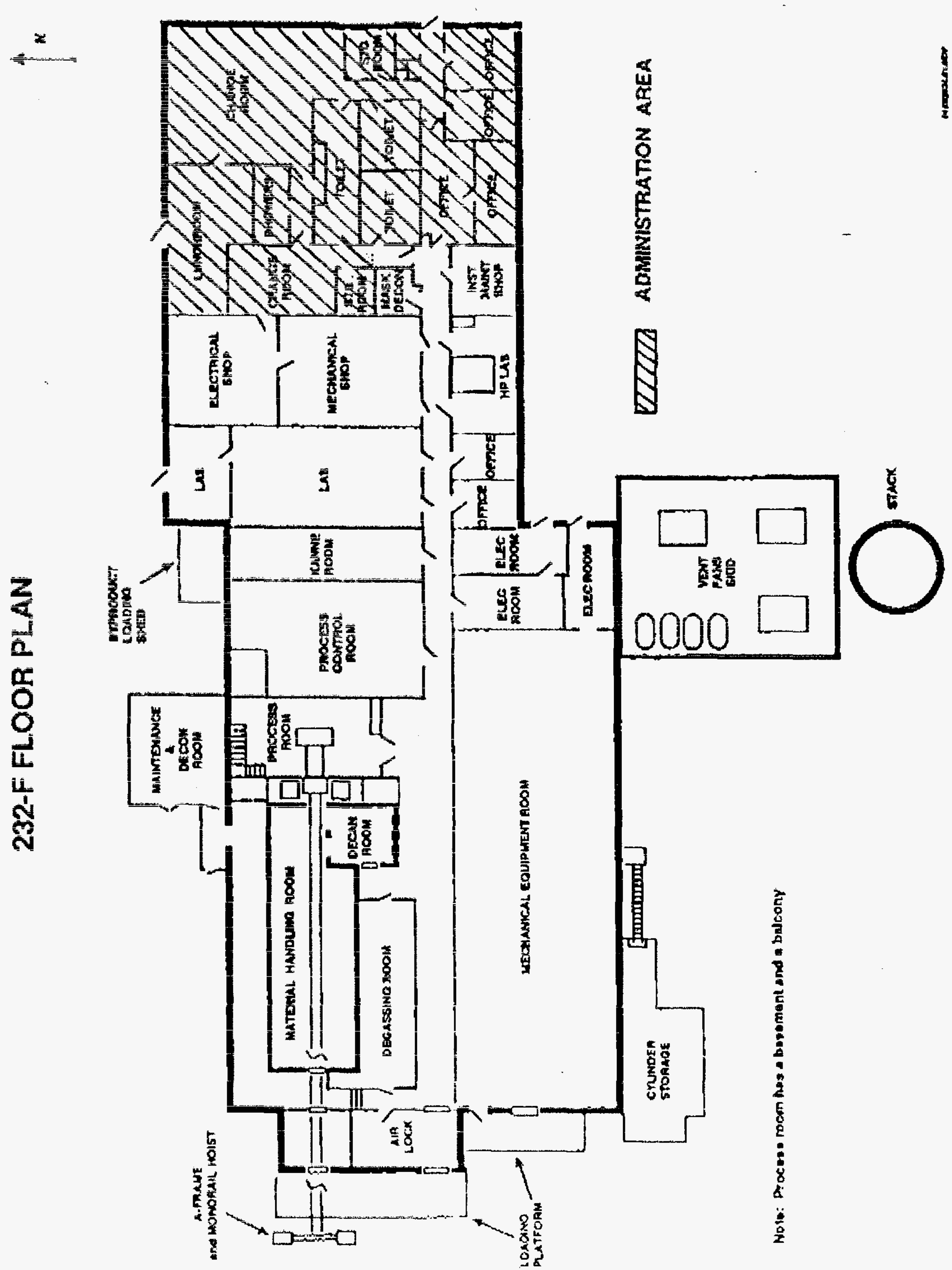

FIGURE 3 HAS Been Deleted from RPT

Figure 2: General Process Flow Diagram

Current Radiological Status

The entire 232-F Building was initially posted as a Contamination Area. The Health Protection (HP) survey conducted in May/June 1994 resulted in HP clearance of certain rooms in 232-F, as shown in Figure 3. HP clearance means no radiological contamination was detected above background in these rooms during the survey, and therefore, no personal protective equipment is required to enter these areas. This survey is not complete; additional rooms may be cleared in the future. Depending on location, the process room is at this time, posted as either a RBA or a Contamination Area. Currently, no areas have airborne contamination of any kind.

The most recent completed radiological survey involving the entire facility was conducted in 1990. The major results of the 1990 HP survey for radioactive contamination are as follows:

- Maximum transferable contamination of <500 d/m alpha and $<1x10^5$ d/m beta-gamma 0.1 m^2 detected in Room 103, Decanning Room. Maximum dose rate of 5/5 mrad/mr/hr detected in Room 103, Decanning Room.

- Swipes throughout the remainder of the building were <500 d/m alpha and <10,000 d/m beta-gamma 0.1 m^2. Dose rate of 1/1 mrad/mr/hr (background) detected in the general area. Disc smears were <10 d/m alpha and <80 d/m beta-gamma except for Room 103 which was 10 d/m alpha and 1475 d/m beta-gamma 100 cm^2.

- The tritium survey detected minimum observable readings of 145 d/m and a maximum reading of 527,916 d/m in the Process Room balcony hood.

The facility's radiological condition today in 1994 is not expected to be any worse than that in 1990.

FACISIMILE COVER SHEET

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COMMENTS: Figure 3 has been Deleted From RPT.

Figure 3: 232-F Rooms Cleared by Health Protection

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D&D WASTE DESCRIPTION

The following is an overview of the major radiological, hazardous, chemical, and toxic constituents associated with the 232-F Manufacturing Building.

Tritium and Beta-gamma Constituents

Tritium is the only radioactive isotope of hydrogen. It has an atomic weight of 3 and exists by itself as a gas or in combination with oxygen (tritium oxide) as a liquid. Tritium has a relatively short radiological half life of 12.3 years; it decays to helium-3 by the emission of a low energy beta particle. Tritium is readily dispersed in air and is a highly diffusible element that will penetrate a wide variety of substances including rubber, plastic, and metal. Tritium can be inhaled and is considered an internal hazard; externally it penetrates only 1/2000 inch of skin.

Beta-gamma radioactivity was introduced to the facility from impurities in the LiAl slugs. Beta particles are charged electrons emitted by decay of some radioactive elements such as tritium and strontium. Beta particles can travel several meters in air, can penetrate skin and cause burns, and can be ingested or inhaled. Beta particles can be stopped by a thick sheet (up to 1/2 inch) of plastic. Gamma radiation is a highly penetrating electromagnetic radiation of extremely short wavelength similar to x-rays. Gamma-emitting nuclides, such as those of cobalt and iridium, are a hazard both when ingested or inhaled and when external to the body. Lead is an effective shielding material for gamma radiation.

Mercury

Mercury is a RCRA-regulated hazardous metal. Mercury was used in the process pumps and the process column to transport gases through the equipment. It is highly probable mercury contamination exists throughout the process piping and equipment.

Lead

Lead is a RCRA-regulated hazardous metal. Lead bricks are used for shielding in the process room furnaces and the stack. The decanning room viewing windows consist of oil-filled, lead-lined glass layers. Lead buttons are used on the building exterior to hold transite panels in place. Paint throughout the facility is suspected to be lead-based paint.

Asbestos

Asbestos is regulated under TSCA. The building exterior and interior walls are transite panels. Floor tiles and mastic in the administration and process areas are suspected to contain asbestos. Wall, piping and ductwork insulation is suspected to be asbestos insulation. Electric control panels, electric boxes, breaker panels, etc. are suspected to contain asbestos components.

<u>Fluids</u>

PCBs, regulated under TSCA, may be present in lighting ballasts and transformer oils. Oil is contained between the lead-lined glass layers of the decanning room viewing windows. Hydraulic oil may be present in pumps and other motor driven components. Freon may be present in drinking fountain cooling systems. The process cooling water system may have utilized chromated water.

Assumptions Used in Waste Estimates

The following assumptions were used to develop the waste estimates. The waste estimates are based on the most current HP survey information, facility drawings, and a facility walkdown effort conducted in May/June, 1994. These estimates would require updating if HP were to clear additional rooms.

1. HP has cleared certain rooms in the administration area and process support area (May/June, 1994) as shown in Figure 3. These rooms are not radiologically contaminated.

2. No transuranic material is in the facility according to the 1990 HP survey.

3. Material removed from a radiologically/suspect contaminated room is at minimum low-level (could be mixed). Selection of radiologically/suspect contaminated rooms is based on the following:

    - 1994 HP survey of certain administration area and process support area rooms (see Figure 3)
    - 1990 HP survey of entire facility
    - Process knowledge

4. Material removed from a non-radiologically contaminated room will be declared clean (i.e., non-radioactive) by HP, and therefore, can be released as salvageable or scrap material, sanitary, or hazardous (which ever applies).

5. The building is divided into clean and radiologically/suspect contaminated areas as shown in Figure 3.

6. 10% of the concrete rubble removed from the area designated as radiologically/suspect contaminated in Figure 3 is assumed to be mixed due to residual mercury contamination.

7. Concrete rubble from clean areas in Figure 3 is classified as sanitary waste.

8. 1 ft^3 of concrete rubble weighs 150 lbs.

9. Floor tile is assumed to be 0.25 inch thick. The mastic beneath the tile is assumed to be 0.125 inch thick.

10. Floor tile and mastic are asbestos-containing material.

11. 10% of the floor tile and mastic removed from the area designated as radiologically/suspect contaminated in Figure 3 is assumed to be mixed due to residual mercury contamination.

12. Exterior transite panels are 0.25 inch thick. 30 ft^2 of transite panels (8'x4'x0.25") stack up to 1 ft^3.

13. Rockwool insulation is assumed to be 4 inches thick.

14. Metal wall studs are assumed to be on 1.33 foot centers.

15. Wooden ceiling joists (2"x4") are on 1.33 foot centers running north-south. Wooden ceiling joists (2"x4") are on 8 foot centers running east-west.

16. Lumber is stacked with a 33% stacking efficiency, i.e., 9 linear feet of 2"x4"s is equal to 1 ft^3 (construction field estimate).

17. All paint is assumed to be lead-based paint.

18. Lead, mercury, mercury contaminated equipment, and other hazardous materials removed from radiologically or suspect contaminated areas are classified as mixed.

19. 20 linear feet of up to 3 inch diameter pipe stack up to 1 ft^3.

20. 10 linear feet of 3 to 6 inch diameter pipe stack up to 1 ft^3.

21. 1.5 linear feet of 6 to 12 inch diameter pipe stack up to 1 ft^3.

22. 1 ft^3 of pipe weighs 20 lbs.

23. It was reported all mercury spills had been cleaned up. The facility walkdown effort discovered mercury goblets around process pumps and around the base of the process column. This equipment is assumed to be radiologically contaminated, and therefore, is classified as mixed. The process furnaces, which are lead-lined, are also assumed to be radiologically contaminated, and therefore, are classified as mixed.

24. All copper tubing is assumed to be soldered with silver joint. Silver is a RCRA-regulated hazardous metal; thus the copper tubing is classified as hazardous or

mixed.

25. PCBs may be present in lighting ballasts and transformers oils; thus these components are assumed to have PCB (TSCA) contamination.

26. Fluorescent lights are assumed to contain a RCRA hazardous constituent (lead is suspected in the solder).

27. 20 linear feet of up to 3 inch diameter electrical conduit stack up to 1 ft^3.

28. 10 linear feet of 3 to 6 inch diameter electrical conduit stack up to 1 ft^3.

29. 1 ft^3 of electrical conduit weighs 40 lbs.

30. 10% of the clean (i.e., non-radiologically contaminated) structural steel is assumed to have corroded to a point that it cannot be sent to scrap and is classified as sanitary.

31. 1 ft^3 of structural steel weighs 40 lbs.

32. Electric control panels, electric boxes, breaker panels, etc. are assumed to have asbestos components, and thus, are classified as TSCA material.

33. Electrical conduit and coaxial cable, structural steel, transite panels, lumber, rockwool insulation, and pipe insulation removed from the area designated as radiologically/suspect contaminated in Figure 3 are not contaminated with any RCRA hazardous constituents, and therefore, are classified as low-level.

34. Soil contamination, if present, will be handled by Environmental Restoration and is outside the scope of the D&D effort; therefore, no soil waste volume is included in this estimate.

35. This estimate does not consider any additional waste that may be generated by decontamination efforts (e.g., liquid washing).

36. HP will clear Room 109, Mechanical Shop, and no radiological contaminants are present in the room.

37. The 232-F facility is not listed as a RCRA/CERCLA Unit or as a Site Evaluation Area in the Federal Facilities Agreement.

232-F Building Waste Estimates

The 232-F building construction waste estimates (i.e., the materials of construction: concrete, steel, lumber, etc.) were derived from building drawings. The 232-F interior room component waste estimates were obtained from a room-by-room walkdown and visual inventory of room components conducted in May/June, 1994.

The volumes presented are raw volumes of the facility SSCs as they stand in their current condition. The volumes presented do not include any increase in volume that may occur during dismantling due to the disarrangement of material or during packaging due to packaging inefficiency.

Waste Estimate Totals

The following are the total waste estimates for the various waste categories:

WASTE CATEGORY	VOLUME (ft^3)
salvageable	288
scrap	5,581
sanitary	10,746
sanitary TSCA (mainly asbestos)	5,227
PCB TSCA (nonrad; transformers only)	34
hazardous	633
hazardous TSCA (lead/PCB)	152
low-level	44,827
low-level TSCA (asbestos/PCB)	5,558
mixed	8,981
mixed TSCA	285
	____
TOTAL:	82,312*

Mercury Contaminated Waste

The following identifies the volume of waste out of the total presented above that is mercury contaminated by waste category:

Waste Category with Hg Contamination	Volume with Hg Contamination (ft^3)
mixed	5,507
	____
TOTAL:	5,507*

*The volumes presented do not include any increase in volume that may occur during dismantling due to the disarrangement of material or during packaging due to packaging inefficiency.

CHARACTERIZATION METHODOLOGY

The 232-F characterization plan methodology consists of two major components: 1) sampling and analysis evaluation for radiological constituents of concern; and 2) sampling and analysis evaluation for hazardous, chemical and toxic constituents of concern. The radiological constituents of concern are identified as tritium and beta-gamma constituents. The hazardous, chemical and toxic constituents of concern are identified as mercury, lead, asbestos, PCBs, oils, CFCs, and potentially chromated water. The following sampling and analysis evaluation provides a plan for determining the location and magnitude of contamination for these constituents of concern.

SAMPLING AND ANALYSIS EVALUATION

Radiological Survey

The 232-F characterization plan radiological survey is designed such that areas having a higher potential for contamination receive a higher degree of survey effort. Process knowledge and past radiological surveys were used to distinguish rooms of 232-F belonging to one of two types of areas: 1) affected areas; and 2) unaffected areas.

Affected areas are areas having potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where radioactive materials were used and stored, and where records indicate spills or contamination incidents. Areas immediately surrounding or adjacent to locations where radioactive materials were present are included in this classification because of the potential for inadvertent spread of contamination. 232-F rooms considered affected areas for this characterization plan are the Radiological

Buffer Areas (RBA) and the Contamination Areas depicted in Figure 4.

Unaffected areas are all areas not classified as affected. These areas are not expected to contain residual radioactivity, based on a knowledge of site history and previous survey information. 232-F rooms considered unaffected areas for this characterization plan are the clean areas depicted in Figure 4. The rooms considered unaffected areas in Figure 4 have been declared clean by Radiological Control Organization/Health Protection (RCO/HP). RCO/HP may continue to survey other rooms. If RCO/HP were to declare clean any additional rooms then these rooms would be considered unaffected areas.

Figure 4: 232-F Postings as of 08/29/94

Radiological Survey of Affected Areas

Exposed surfaces, i.e., floors, walls, ceilings, and exterior and unconcealed surfaces of equipment and other room components in affected areas shall be surveyed for radiological contamination. Survey measurements for surface activity shall consist of a combination of surface scans, direct measurements, and measurements for removable (transferable) activity. Measurements shall be taken for the radionuclides of concern, i.e., tritium and beta-gamma radiation.

At minimum, the floors and lower walls (up to 2 meters (6.5 ft) from the floor) of affected areas should receive 100% coverage. The coverage provided for upper walls and ceilings will depend on the contamination potential for these surfaces. Scans of 100% of affected area floor and lower wall surfaces shall be performed for tritium and beta-gamma radiation. Once areas of elevated activity are identified, direct measurements shall be performed to define the extent and magnitude of contamination.

Unexposed surfaces, i.e., interior of filter housings on roof, process furnaces, process pumps, process piping, process exhaust ductwork, and other process equipment in affected areas shall be surveyed for radiological contamination to the extent possible. This may require the opening of equipment through cutting or unbolting. Sampling of inner equipment surfaces shall require appropriate safety controls; precautions shall be necessary for potential fluids or other material, including potential airborne radioactivity , inside piping and other equipment. Any existing access points to interior surfaces should be used over creating new ones, if possible.

Special Considerations

The 200 ft stack shall be surveyed for radiological contamination. A method for determining the magnitude and extent of contamination on the interior of the stack shall be required. Core sampling at regular intervals (e.g., every 30 ft) may be one technique used in the radiological characterization of the stack, however, it is not known if this could be accomplished in a safe and effective manner. The stack is lined with lead shielding up to a height of 10 feet from the ground. The lead shielding shall be surveyed for radiological contamination as well.

The radiological characterization of affected areas inside the building should consider core sampling of building surfaces (e.g., concrete floors) where elevated radioactive measurements are observed. Areas where elevated surface readings could occur include Room 103 (Decanning Room), the process furnaces, and Room 105 (Process Room).

Core sampling of soil outside the building in areas of highest potential contamination shall be considered. Core sampling locations to be considered in the soil radiological survey are around and beneath the ventilation pad and the stack. Core sampling of soil beneath the facility foundation should be considered, however, characterization of the soil beneath the facility at some point during the D&D operation may be more appropriate

Radiological Survey of Unaffected Areas

Radiological scans of unaffected area surfaces should cover a minimum of 10% of the floor and lower wall surface area. At least 30 randomly selected measurement locations or an average measurement of 1 per 50 m^2 (60 square yards) of building surface area, whichever is greater, for total (fixed plus removable) and removable activity, should be performed. These locations should include all building surfaces.

Radiological Survey Techniques and Analysis

WSRC RCO/HP and Environmental Monitoring Section procedures are the source documents for the information presented in this section. In all cases, the actual referenced procedure in its most up-to-date revision should be consulted when performing radiological surveys.

Note: The beta-gamma impurities associated with the slugs likely included zinc-65 (Zn-65), cobalt-60 (Co-60), and possibly cesium-137 (Cs-137). The isotopes of any remaining beta and/or gamma emitters will require identification and quantification. This process is relatively easy for gamma emitters. For beta emitters, the identification and quantification of these isotopes are more difficult. Beta analysis will require chemical separations, each based on the individual isotope of concern, in attempt to isolate individual isotopes and then radiological counting of each individual isotope to determine the magnitude of contamination resulting from that isotope. The identification and quantification of individual beta and/or gamma emitters should be established before any tritium analysis are performed as the presence of these isotopes can interfere with the tritium results.

Gamma Pulse Height Analysis (PHA)

Gamma pulse height analysis shall be used to identify and quantify the isotopic gamma impurities introduced to the facility process via the irradiated slugs. The majority of the beta-gamma impurity contaminants are expected to be associated with the process furnaces. Thus, appropriate samples of each furnace interior, smear samples and/or actual physical specimen samples, shall be analyzed via gamma PHA. Also, samples of other SSCs associated with the process and soil shall be analyzed via gamma PHA.

Removable (Transferrable) Contamination Survey and Analysis

A verification survey can be used to isolate areas of contamination. Verification surveys utilize large area (0.1 m^2 or 1.1 ft^2) smears. The large area smears shall be evaluated using portable radiation detection instruments, if possible.

A detailed survey should be used to more accurately establish extent and magnitude of contamination. Each detailed survey for removable contamination shall cover a smeared area of 100 cm^2 (16 in^2) taken by applying a disc smear with moderate pressure over the entire smear area. The 100 cm^2 smear should initially be evaluated using portable radiation detection instruments, if possible. When evaluated this way, the smear shall be held at a distance of approximately 1/4 inch from the detector. Beta-gamma readings can be taken with a pancake Geiger-Mueller (GM) tube detector and should always be taken in the lowest radiation background area available (300 c/m). Results shall be reported in units of d/m/100 cm^2.

An RO-2 or equivalent should be used if the pancake GM tube detector upper range is exceeded for beta-gamma contamination.

Fixed Contamination Survey and Analysis

A pancake GM tube detector should be used to survey fixed beta-gamma contamination. Under field conditions, the detection efficiency for the pancake GM tube detector is 10%, which correlates to minimum sensitivity of 5,000 d/m/100 cm^2 for small area contamination. The detector should be positioned approximately 1/4 inch above the surface being surveyed and moved slowly 1 to 2 inches per second. If activity is detected, the probe should be held stationary until the meter stabilizes to obtain reading.

Conduct the survey in a low background area (less than 300 c/m beta-gamma). If possible and necessary, transport the item to a low background area within the RBA for survey and take appropriate steps to prevent the possible spread of contamination. Results shall be reported in d/m/100 cm^2.

An RO-2 or equivalent should be used to survey for fixed beta-gamma contamination levels above the detection capability of the pancake GM tube detector.

An item or area is considered free of fixed contamination when no measurements above instrument background are detected.

Tritium Survey and Analysis

Smears collected for assessing the levels of tritium contamination are analyzed on the PC-5 proportional counters and/or the LSCs. Tritium smears for waste characterization purposes shall be prepared for LSC analysis by the 234-H Analytical Lab. Prepared vials are obtained from the 234-H Analytical Lab. There should be one vial for each smear collected and two vials for blank smears.

Each smear shall cover an area of 100 cm^2 (16 in^2) taken by applying a disc smear with moderate pressure over the entire smear area. All smears should first be analyzed for beta-gamma contamination (using duplicate or triplicate smears if necessary). Then, if the smear requires counting on both the PC-5 and LSC, the smear should be counted with the PC-5 scaler first. The smear should be placed in the LSC vial as soon as possible after taking the smear and counting with the PC-5 scaler. Official contamination levels are based on the LSC analysis.

A portable tritium surface monitor may be considered for use in the field; however, such instruments may not be capable of accurately measuring tritium in the presence of other radionuclides. In any case, official tritium contamination levels shall reflect the LSC results.

Airborne Radioactivity Measurements

There are currently no airborne contamination areas within the 232-F Building, the potential exists to create airborne contamination during the characterization of unexposed surfaces, i.e., interior of process equipment. Thus, portable airborne radioactivity monitors, for tritium and beta-gamma constituents, are required to obtain measurements directly at line breaks, process openings, etc. These instruments may include a portable Kanne chamber (for tritium), a Scintrex portable tritium monitor, and a portable continuous air monitor (for radioactive particulates).

Soil Survey and Analysis

Surveying of excavations and soil sampling shall be in accordance with WSRC Procedures. Samples should be taken in areas with the highest potential for contamination and where actual probed readings are the highest. Soil samples from ten locations per acre for sites 5 acres or less in size is specified in WSRC 5Q1.2, Procedure 499, Revision 1 for radiological survey of hazardous, mixed, and/or solid waste sites. Although the 232-F facility is not a waste site, the soil sampling should comply with this specified number of soil samples as a minimum.

Hazardous, Chemical and Toxic Constituent Survey

This section describes the sampling and analysis required to characterize the hazardous, chemical and toxic components of the 232-F Building.

All hazardous constituents should be identified in accordance with 40 CFR 261.

All samples obtained from an RBA/contamination area shall be screened for radiological contamination prior to release.

Note, 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)*, recommends use of a 100 g sample for analysis, but also recommends collection of extra samples in case the initial test attempt fails. Thus, a 200 g sample is recommended for collection (if such a quantity can be reasonably obtained) for all TCLP analytes addressed in this plan.

Mercury

Process Equipment

Mercury was used in the process pumps and in the process column. The potential for mercury contamination throughout the process equipment, including the process piping, is high. H-Area tritium facilities have experienced a mercury oxide build-up, in the form of a black powder/paste-like substance, on the inside of process equipment. This form of mercury contamination, as well as the elemental form, is likely present inside 232-F process equipment.

Sprengel pumps, diffusion pumps and the lower portion of the process column could be x-rayed to determine if any residual elemental mercury is present inside. There was a mercury reservoir at the bottom of the process column. If it is not possible to x-ray certain equipment, other means to determine elemental mercury content, such as swabbing or opening drain valves under appropriate safety controls, shall be required. Manometers and other mercury instruments, the process hood floor in the process room basement (Room 105), and laboratory hoods (Rooms 108 and 124) shall also be inspected for residual mercury contamination.

Representative samples from interior surfaces of all types of mercury equipment and components, i.e, process equipment, shall be obtained to determine if mercury contamination is present. Internal samples could be obtained by swabbing, scraping, washing, or slurrying. Washing or slurrying should only be considered after it has been confirmed no elemental mercury is present inside. Samples may initially be analyzed via x-ray fluorescence, which can provide a qualitative scan for confirmation of the existence of hazardous metal concentrations greater than 1 ppm (detection limit for the SRTC Analytical Lab). X-ray fluorescence can accommodate liquids, solids and a mixture of the two.

If a quantitative analysis is required and/or if the x-ray fluorescence detection limit s too high, samples shall be analyzed in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g each shall be obtained from the interior surfaces of unique pieces of process equipment. Internal samples could be obtained by swabbing, scraping, washing, or slurrying as noted previously.

Mercury is a RCRA-regulated hazardous metal. The TCLP hazardous concentration limit for mercury is 0.2 mg/L.

Lead

Lead Shielding, Lead-lined Glass and Exterior Lead Buttons

Characterization of the lead shielding in the furnaces, the stack, and the shipping and waste casks located in Room 104 (Material Handling Room), and the lead-lined glass in the process area for lead, based on configuration and process knowledge, should be sufficient. The main focus for these components will be the radiological characterization to determine if they are mixed material.

A sample of an exterior lead button may initially be analyzed via x-ray fluorescence for lead. A sample of one lead button as is upon removal would be sufficient for this analysis. If a quantitative analysis is required and/or if the x-ray fluorescence detection limit is too high, the sample shall be analyzed in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)*. A recommended 200 g sample of an exterior lead button shall be obtained. The sample should be obtained from a radiologically clean area of the building.

Lead is a RCRA-regulated hazardous metal. The TCLP hazardous concentration limit for lead is 5.0 mg/L.

Most likely, the elemental and glass forms of lead (with the exception of the shipping and waste casks) will be removed, decontaminated if necessary, and reused elsewhere onsite or recycled.

Paint

Representative samples of paint from interior walls, structural members, and equipment shall be obtained and may initially be analyzed via x-ray fluorescence for hazardous metals. It is recommended each sample be obtained by scraping the painted surface with a clean, sturdy object.

If a quantitative analysis is required and/or if the x-ray fluorescence detection limit is too high, samples shall be analyzed for hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)*. Representative samples of a recommended of 200 g each shall be obtained from unique (homogeneous) surfaces. The paint is suspected to be lead-based paint.

Fluorescent Lights

Solder from fluorescent lights shall be sampled and may initially be analyzed via x-ray fluorescence for hazardous metals. If a quantitative analysis is required and/or if the x-ray fluorescence detection limit is too high, samples shall be analyzed for hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)*. One sample of a recommended of 200 g shall be obtained from each different type of fluorescent light. Fluorescent lights throughout the building are suspected to contain lead solder and the bulbs may contain mercury vapor.

To the extent possible, samples should be obtained from unaffected areas (i.e., clean areas) depicted in Figure 4 to minimize the spread of potential contamination.

Asbestos

The WSRC Asbestos Management Policy provides the compliance criteria for onsite asbestos inspections, sampling and analysis. Onsite asbestos inspections are required to be performed by accredited asbestos inspectors. Likewise, asbestos analyses are required to be performed by accredited asbestos labs and lab analysts. This section addresses 232-F Building SSCs which are or potentially are asbestos or asbestos-containing material, and is offered as a guide to the asbestos inspector. Actual sampling of the facility SSCs for asbestos will be under the discretion of the accredited asbestos inspector.

An asbestos inspection and subsequent sampling and analysis has been performed for the 232-F Building administration area. A total of 20 samples were obtained from interior wall and ceiling panels, vinyl and ceramic floor tiles, steam line insulation, cold and hot water insulation, internal wall insulation, and textile covered wire, and were analyzed for asbestos content. The results revealed interior wall and ceiling panels, vinyl and ceramic floor tiles, steam line insulation, and cold and hot water insulation are asbestos-containing material, all in a non-friable condition.

The information contained in the asbestos inspection should be referred to for asbestos characterization of the process areas (see Figure 1). Process area SSCs which should be inspected are wall and ceiling panels, and floor tiles and mastic, if these appear to be different from those analyzed in the administration area, and any type of thermal system insulation, including insulation boards in electric control panels, electric boxes and breaker panels in Rooms 128 (Contaminated Electric Control Room) and 129 (Clean Electric Control Room). Roofing materials should also be inspected. Process area SSCs similar (non-unique) to those analyzed in the administration area may be characterized from the previous results, at the discretion of the accredited asbestos inspector. Exterior transite panels may be characterized based on a visual inspection only, at the discretion of the accredited asbestos inspector.

Asbestos inspection, sampling and analysis shall comply with 40 CFR 763, SCDHEC R.61-86.1, and AHERA/ASHARA protocols. Samples shall be homogenous, i.e., uniform in color and texture, and analyzed at the SRS Industrial Hygiene (IH) Laboratory or other accredited asbestos lab. Coordination between RCO/HP and IH shall be required for removal and release of asbestos samples obtained within an RBA/contamination area. Any samples obtained from an RBA/contamination area shall be screened for radiological contamination prior to release.

PCBs

Transformers, Switches and Relays, Fluorescent Light Ballasts
Fluids in transformers, switches and relays in Rooms 128 (Contaminated Electric Control Room), 129 (Clean Electric Control Room), and the 125 South Corridor shall be sampled for PCBs. Fluids in fluorescent light ballasts throughout the building shall be sampled for PCBs. Per 40 CFR 761.3, a fluorescent light ballast is a device that electrically controls fluorescent light fixtures and includes a capacitor containing dielectric fluid. Any other potential PCB-containing systems shall be sampled for PCBs as well.

All PCB and suspect PCB fluids shall be sampled and analyzed in accordance with 40 CFR 761. EPA Method 8080 - *Organochlorine Pesticides and PCBs* provides a gas chromatography analytical procedure which may also be considered for PCB analyses.

Oils

Hydraulic Lift Cylinders, Lines and Tanks
Hydraulic lift cylinders, lines and tanks shall be sampled to determine if any residual oil is present inside. Components to be sampled are the hydraulic lift cylinders in Room 103 (Decanning Room), the hydraulic fluid lines running from Room 101 (Mechanical Equipment Room) to Room 103 (Decanning Room), the hydraulic fluid tank in Room 101 (Mechanical Equipment Room), and the hydraulic lift cylinder located near the west exterior wall hydraulic lift. The hydraulic fluid tank associated with the exterior west wall hydraulic lift has already been removed.

Liquid samples shall be obtained, if present, and analyzed in accordance with the following: 1) total petroleum hydrocarbons (TPH) - diesel via EPA Method 3510 - *Separatory Funnel Liquid-Liquid Extraction*; 2) benzene, toluene, ethyl benzene, xylene (BTEX) via EPA Method 602; and 3) PCBs.

Oil inside Lead-lined Glass

Oil inside lead-lined glass in Room 103 (Decanning Room) and along the 125 North Corridor shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)*. A recommended 200 g sample shall be obtained.

CFCs

Refrigeration Compressors and Drinking Water Fountains

The refrigeration compressors in Room 101 (Mechanical Equipment Room) and the drinking water fountains in the 110 and 117 Corridors shall be sampled to determine if residual CFCs are present. Recovery, i.e., removal of refrigerant shall be in accordance with 40 CFR 82, *Ozone Depleting Substances (ODSs): Refrigerant Management and*

Labeling of ODS Products/Containers, and SRS Refrigerant Management Plan.

EPA Method 8010 - *Halogenated Volatile Organics* provides a gas chromatography analytical procedure which should be considered for CFC analyses, particularly CFC-11 (trichlorofluoromethane) and CFC-12 (dichlorodifluoromethane) analyses.

Chromated Water

Representative samples from interior surfaces of the chromated process cooling water system shall be obtained to determine if chromium contamination is present. Internal samples could be obtained by swabbing, scraping, washing, or slurrying. Samples may initially be analyzed via x-ray fluorescence for hazardous metals.

If a quantitative analysis is required and/or if the x-ray fluorescence detection limit is too high, samples shall be analyzed in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g each shall be obtained from interior surfaces of unique portions of the process cooling water system. Internal samples could be obtained by swabbing, scraping, washing, or slurrying as noted previously.

Chromium is a RCRA-regulated hazardous metal. The TCLP hazardous concentration limit for chromium is 5.0 mg/L.

Miscellaneous

Process and Laboratory Hoods

The hoods in Rooms 105 (Process Room), 106 (Process Control Room), 108 (Laboratory), and 124 (Health Protection Lab) shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g each shall be obtained from unique (homogeneous) inner portions of each hood (e.g, counter top, near exhaust duct opening).

Floor Surfaces

Floor surfaces (i.e., concrete, floor tiles and mastic (if present)) around all hoods and the process column shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* In addition, floor surfaces in the process segment of the building (see Figure 2) which are discolored from a possible spill shall be sampled and analyzed in accordance with TCLP for non-volatiles and hazardous metals. The floor surface of Room 101 (Mechanical Equipment Room) should be inspected and tested, if necessary. The space along the interior wall of this room adjacent to the loading dock was used as a mercury storage area. The floor surface of the Maintenance and Decon Room should be inspected and tested, if necessary. This room was used to rebuild process pumps, and therefore, has a high potential for mercury contamination. Representative samples of a recommended 200 g each shall obtained for each unique (homogeneous) surface.

Copper Tubing with Solder Joints

Copper tubing with at least one solder joint per sample shall be obtained nd may initially be analyzed via x-ray fluorescence for hazardous metals. If a quantitative analysis is required and/or if the x-ray fluorescence detection limit is too high, samples shall be analyzed for hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g shall be obtained.

The solder on the copper tubing is suspected to be silver, a RCRA-regulated hazardous metal. The TCLP hazardous concentration limit for silver is 5.0 mg/L.

To the extent possible, samples should be obtained from unaffected areas (i.e., clean areas) depicted in Figure 1 to minimize the spread of potential contamination.

Sumps and Drains

The contents (if any) and the floor surfaces of the sumps located in the process room basement within the process cabinet shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g shall be obtained. A visual inspection has revealed mercury droplets in at least one of these sumps.

The contents (if any) of the stormwater drain opening at the exterior northwest corner of the building shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).* Representative samples of a recommended 200 g shall be obtained.

Soil

Soil in the vicinity of sumps, drains and underground process piping shall be sampled and analyzed for non-volatile materials and hazardous metals in accordance with 40 CFR 261, Appendix II, *Method 1311 Toxicity Characteristic Leaching Procedure (TCLP).*

Representative samples of a recommended 200 g each shall obtained for each sampling location.

Soil in the vicinity of the exterior hydraulic lift shall be sampled and analyzed in accordance with the following: 1) total petroleum hydrocarbons (TPH) - diesel via gas chromatography - flame ionization detector (GC-FID); 2) benzene, toluene, ethyl benzene, xylene (BTEX) via EPA Method 8020 - *Aromatic Volatile Organics*; and 3) PCBs.

Soil in the vicinity of the potential diesel underground storage tank (located along the exterior southwest corner approximately 1 foot from the building structure) shall be sampled and analyzed in accordance with the following: 1) TPH - diesel via GC-FID; 2) BTEX via EPA Method 8020 - *Aromatic Volatile Organics*; and 3) naphthalene via EPA Method 8100 - *Polynuclear Aromatic Hydrocarbons*.

DEFINITIONS AND ACRONYMS

DEFINITIONS

Asbestos Hazards Emergency Response Act (AHERA)/Asbestos School Hazard Abatement Reauthorization Act (ASHARA): United States Environmental Protection Agency (USEPA) standards for asbestos abatement encompassing 40 CFR 763 and 40 CFR 61.

Chlorofluorocarbons (CFCs): An organic compound in which chlorine and fluorine atoms are bonded to carbon atom(s) such that no hydrogen atoms are bonded to the carbon atom(s). CFCs used as refrigerants (e.g., freon) include refrigerants -11, -12, -113, -114, -500, -502, and -503.

Clean Area: An area that normally has no radiation or radioactive contamination above natural background levels.

Clean Waste: Waste from areas of potential radioactive contamination having a process history which minimized the potential for radionuclide contamination, or waste which reads no more than background when monitored in an area with low background radiation [WSRC 1S Manual]. Note: Sometimes the term "clean waste" is also used to categorize wastes that are neither hazardous nor radioactive; however, if/when the term is used in this report, the WSRC 1S Manual definition is that which is meant.

Contamination Area: Any area where radioactive surface contamination levels meet the criteria specified in WSRC 5Q1.1, Procedure 518, Revision 1. An area within a Radiologically Controlled Area (RCA) where radioactive surface contamination exist.

Controlled Area: Any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive materials. Refer to WSRC 5Q1.1, Procedure 518, Revision 1. The expanse within the F-Area boundary is a Controlled Area.

Gamma Pulse Height Analysis (PHA): A quantitative analytical technique which allows isotopic identification of radionuclides based on their individual gamma energy represented as a distinct peak within a spectrum. The magnitude of contamination is determined from the peak height. Gamma PHA can accommodate smear samples and actual physical specimen samples.

Gas Chromatography: A quantitative analytical technique useful for organic compounds capable of being volatilized without being decomposed or chemically rearranged.

Hazardous Waste: As defined in the 1976 Resource Conservation and Recovery Act (RCRA), a solid waste, or combination of solid waste, that because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. The State of South Carolina is a RCRA agreement state and has promulgated RCRA hazardous waste regulations under South Carolina Law and South Carolina Hazardous Waste Regulations.

Low-level Waste (LLW): Waste containing radioactivity, and is not classified as high-level waste, transuranic waste, spent nuclear fuel, or AEA 11e(2) byproduct material as defined in DOE Order 5820.2A. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided the concentration of TRU radionuclides is less than or equal to 100 nCi/g of the waste [WSRC 1S Manual].

Liquid Scintillation Counting (LSC): A test method which detects radioactivity by measuring light produced during the interaction of incident radiation with fluorescent material. LSC is particularly useful for detection of low energy beta emitters such as tritium.

Mixed Waste (MW): Waste containing both radioactive and hazardous components [WSRC 1S Manual]. Contains both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act.

Polychlorinated Biphenyls (PCBs): Waste containing polychlorinated biphenyls as designated in 40 CFR 761.

Radiological Buffer Area (RBA): An intermediate area established within a Controlled Area to provide secondary boundaries to minimize the spread of radioactive contamination and to protect personnel from radiation exposure. Refer to WSRC 5Q1.1, Procedure 518, Revision 1. Note: The term "Radiologically Controlled Area (RCA)" became obsolete 08/12/94. RBA was a new term introduced at this time.

Resource Conservation and Recovery Act (RCRA): Regulations applying to hazardous and solid waste. Includes 40 CFR 260-268, 270-271, 280.

Salvage: Clean material which can be used as is at another on- or offsite location.

Sanitary Waste: Also termed municipal waste. Any household, residential, and commercial solid waste that is non-hazardous and non-radioactive and is disposed off in a landfill.

Scrap: Clean metal material which can be sent to the SRS scrap pile for sale and offsite recycling.

Toxic Characteristic Leaching Procedure (TCLP): A quantitative analytical procedure described in 40 CFR 261, Appendix II, used to determine if a substance is hazardous.

Toxic Substances Control Act Waste (TSCA): For this report, TSCA waste refers to asbestos, asbestos-containing material, and PCBs. The USEPA defines an asbestos-containing material as containing greater than 1% asbestos by volume (40 CFR 763.83). Components having PCBs present in concentrations greater than or equal to 50 ppm are considered to be PCB contaminated (40 CFR 761.3).

X-Ray Fluorescence: A test method which utilizes x-rays and provides a qualitative scan for confirmation of the existence of hazardous metal concentrations greater than 1 ppm. X-ray fluorescence can accommodate liquids, solids and a mixture of the two.

ACRONYMS

(other than those listed in the preceding definitions)

BTEX	Benzene, Toluene, Ethyl Benzene, Xylene
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
EPA	Environmental Protection Agency
GC-FID	Gas Chromatography - Flame Ionization Detector
GM	Geiger-Mueller
IH	Industrial Hygiene
RCO/HP	Radiological Control Organization/Health Protection
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
SRTC	Savannah River Technology Center
SSCs	Structures, Systems and Components
TPH	Total Petroleum Hydrocarbons
WSRC	Westinghouse Savannah River Company

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