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7. Abstract

This document establishes the technical basis in support of Emergency Planning activities for the LERF/ETF Facility on the Hanford Site. The document represents an acceptable interpretation of the implementing guidance document for DOE ORDER 5500.3A. Through this document, the technical basis for the development of facility specific Emergency Action Levels and the Emergency Planning Zone is demonstrated.

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LIQUID EFFLUENT RETENTION FACILITY/ EFFLUENT TREATMENT FACILITY HAZARDS ASSESSMENT

G. A. Simiele

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1.0 INTRODUCTION

This report documents the hazards assessment for the Liquid Effluent Retention Facility (LERF) and the Effluent Treatment Facility (ETF) located on the U.S. Department of Energy (DOE) Hanford Site. Operation of the LERF and ETF is the responsibility of Westinghouse Hanford Company (WHC). This hazards assessment was conducted to provide the emergency planning technical basis for the LERF and ETF. DOE Order 5500.3A requires an emergency planning hazards assessment for each facility that has the potential to reach or exceed the lowest level emergency classification.

The 242-A Evaporator in the 200 East Area of the Hanford Site processes waste from the Double Shell Tanks (DST) that are located in the 200 East Area and the 200 West Area of the Hanford Site. The tank wastes have been designated as a listed dangerous waste. Current dangerous waste regulations require that residue (i.e., Evaporator process condensate [PC]) from the treatment of a listed dangerous waste be managed as regulated waste. The PC stream from the Evaporator was determined to contain listed dangerous wastes. Consequently, the PC is now managed as a regulated dangerous waste stream which cannot be discharged to the soil without pretreatment. As a result of this determination, the ETF was constructed to further treat the Evaporator PC so that the effluent resulting from the ETF process can be discharged to a state approved land disposal site (SALDS).

The ETF process reduces the concentration of ammonia, residual organics, and dissolved radionuclides in the Evaporator PC to levels that permit direct disposal of the treated liquid effluent to the soil column in the 200 Areas. The remaining dry concentrated material is placed in 208-Liters (55-gallon) drums and disposed of accordingly.

The ETF may initially treat the Evaporator PC that is stored in the LERF. The LERF has been constructed to provide permittable interim storage of the liquid effluent or PC from the 242-A Evaporator. The LERF is capable of storing up to 45,000,000 Liters (13,000,000 gallons) of effluents from the 242-A Evaporator until the ETF is operational. Upon startup of the ETF, the liquids stored in LERF may be transferred to the ETF for treatment as described in section 2.4.2, or Evaporator PC stream may be piped directly from the Evaporator to the ETF for treatment.

2.0 FACILITY AND SITE DESCRIPTION

Detailed descriptions of the Hanford Site and the LERF and ETF are found in section 3 and sections 4 through 7, respectively, of the Safety Analysis Reports (SAR) for the LERF and ETF. The following facility and site description summaries are derived from the SAR documents.

2.1 Facility Mission

The LERF and ETF are new facilities located in the 200 East Area at the Hanford Site. They will be used for interim storage and treatment process condensate from the 242-A Evaporator. The facilities are scheduled to be fully operational by 1995.

2.2 Location

The DOE Hanford Site lies at 117.5° west longitude and 47.5° north latitude within the Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 2-1). The Hanford Site occupies an area of 1,476 km^2 (570 mi^2) north of the confluence of the Snake and Yakima Rivers with the Columbia River (Figure 2-2). The size of the Hanford Site will be reduced in 1994. The new boundary will likely be the Columbia River on the north and highway 240 on the south.

The 200 East Area is a controlled area of approximately 8.4 km^2 located on a plateau at an elevation ranging from approximately 190 to 245 meters above mean sea level near the middle of the Hanford Site. The 200 East Area is about 10 kilometers from the Columbia River and 14.8 km from the nearest site boundary to the west, south, or east. Figure 2-3 shows the layout of the 200 East Area, the designations of the various facilities, and the location of the LERF and ETF. Land uses within the 200 East Area consist of fuel reprocessing and waste processing and disposal activities.

In addition to the LERF and ETF, the Hanford Site contains the following major facilities or activities: six reactor areas designated 100-B/C, 100-N, 100-KE/KW, 100-D/DR, 100-H, and 100-F, which contain eight shutdown production reactors and one shutdown dual purpose reactor (N Reactor); the 300 Area which contains a shutdown fuel fabrication facility and laboratory facilities supporting all of DOE's Hanford Programs; two areas for waste processing and waste storage designated 200 East and 200 West Areas; a commercial nuclear waste burial operation on land leased to the State of Washington; the Fast Flux Test Facility (FFTF); and an operating Washington Public Power Supply System nuclear power plant.

Major metropolitan areas within the broad vicinity of the site (see Figure 2-1) include Spokane, Washington, about 193 kilometers to the northeast; Seattle, Washington, about 209 kilometers to the northwest; and Portland, Oregon, about 241 kilometers to the southwest. Two other areas of significant population density include Moses Lake, Washington, about 48 kilometers north of the K-area and the Yakima Valley, in Washington, extending from Yakima, about 72 kilometers west of the plant, to the Tri-Cities, in Washington, about 56 kilometers southeast of the plant.

Figure 2-1 Location of the Hanford Site in the State of Washington

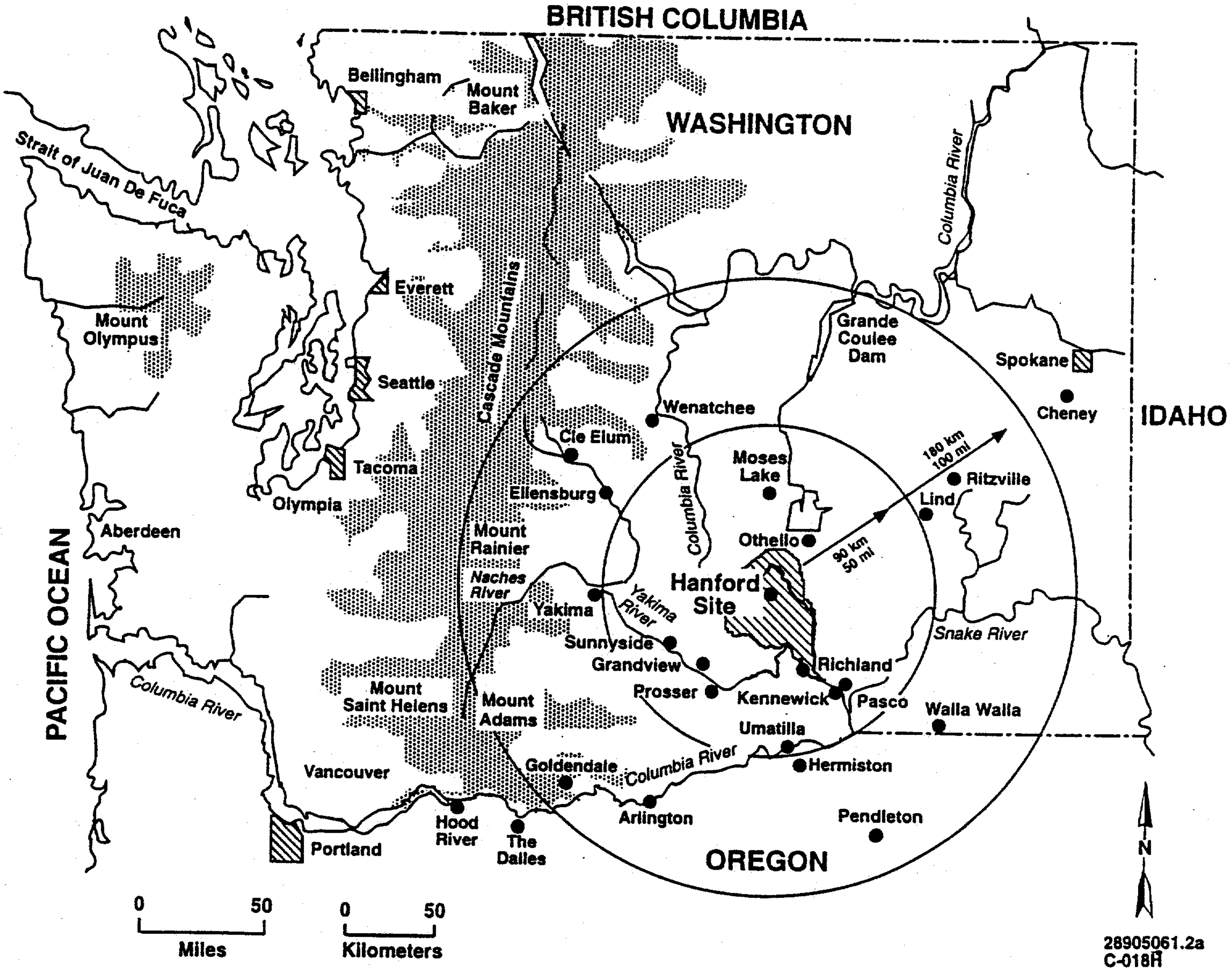

Figure 2-2 Hanford Site

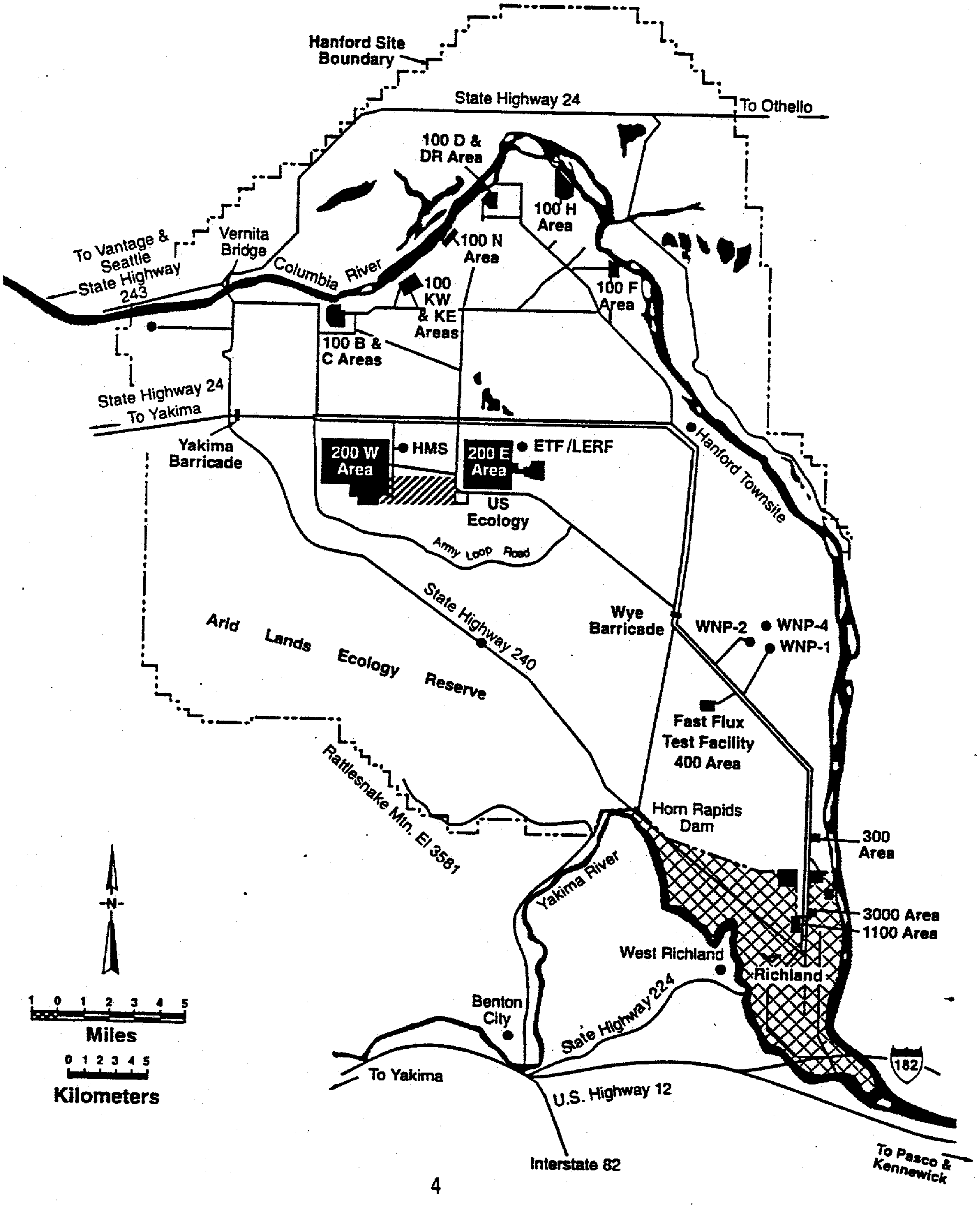

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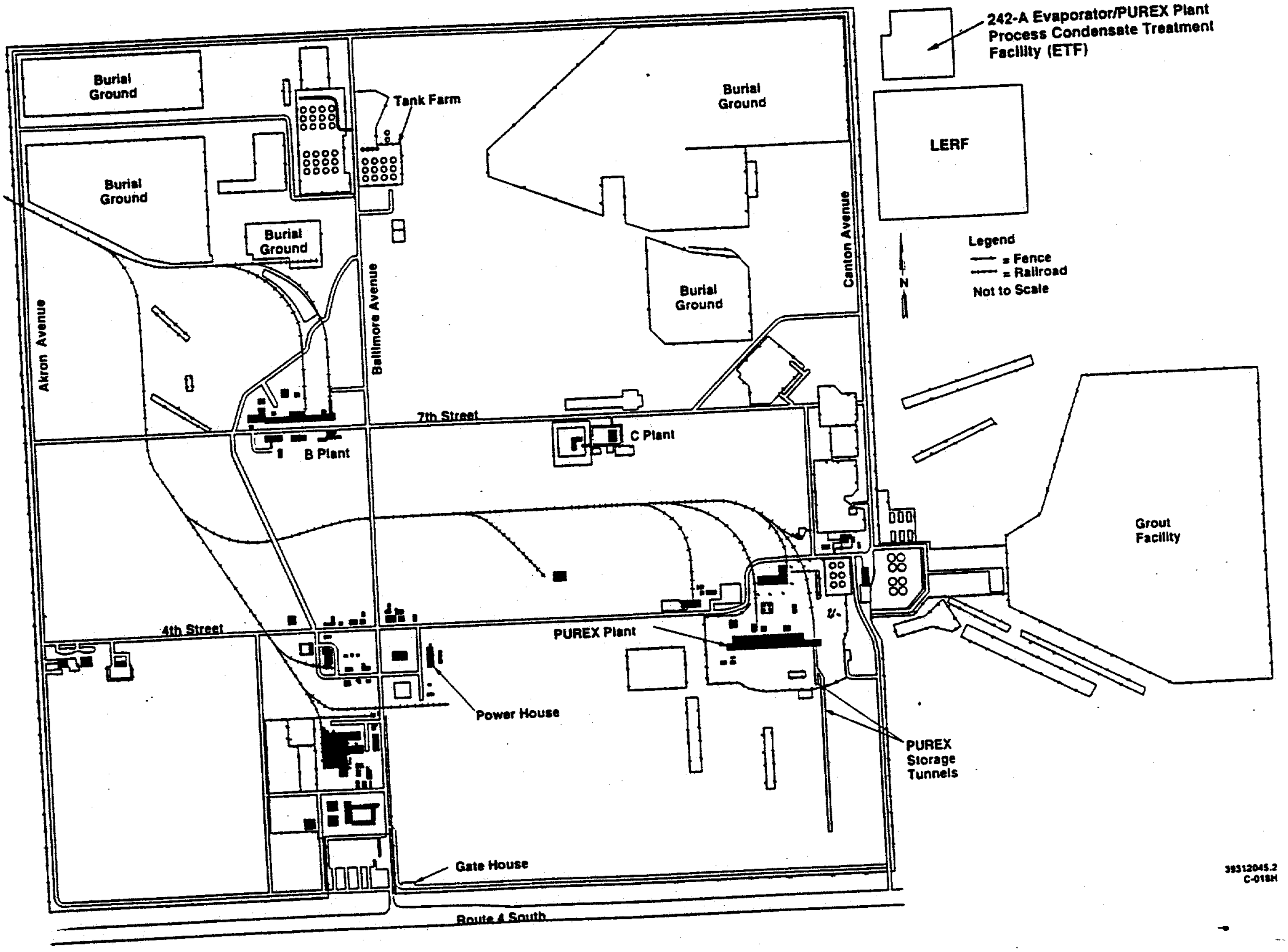
Figure 2-3 Hanford Site 200 East Area



2.2.1 Local Meteorology

Continuous observation and recording of meteorological data has been carried out at the Hanford Meteorological Station (HMS), located near the 200 West Area, since 1945. Climatological conditions on the 200 Area plateau are significantly different from those on the south end of the site, especially during the winter months when the incidence of low clouds and fog is much greater at the HMS.

The average daily maximum temperature in July, the hottest month of the year, is 33.2 °C (91.8 °F); the average minimum is 16.1 °C (61.0 °F). During January, the coldest month, the average maximum is 2.6 °C (36.6 °F), and the average minimum is -5.6 °C (21.9 °F). The daily temperature range is about 8.2 °C (14.7 °F) in January and 17.1 °C (30.8 °F) in July.

The average annual precipitation for the Hanford Site is about 16 cm (6.25 inches). Most of the precipitation occurs during the winter season with nearly half of the annual amount occurring in the months of November through February. Snowfall accounts for about 38% of all precipitation during the months of December through February.

The predominant wind direction over most of the region is southwesterly. However, because of local topographic influences, the predominant wind direction at the HMS and over much of the Hanford Site including the 200 Area Plateau is northwesterly. Monthly average wind speeds are lowest during the winter months, averaging 10 to 11 km/h (6.2 to 6.8 mph), and highest during the summer, averaging 14 to 16 km/h (8.7 to 9.9 mph).

2.2.2 Floods

Based on a study of Probable Maximum Floods (PMF) by the U.S. Army Corps of Engineers, it was determined that the 200 East Area was well above dangerous flood levels. The PMF river flow for locations on the Columbia River within the Hanford reservation is 4.1×10^4 m^3/s (1.44×10^6 ft^3/s). This would produce a water surface elevation of about 119 meters (390 feet) msl. Since 200 East Area elevation is 192 meters to 244 meters (630 feet to 800 feet) msl, it is safely above PMF levels.

2.2.3 Seismology

The Hanford Site is in a region of low to moderate seismicity. The historic record of earthquakes in the Pacific Northwest dates from about 1840. The early part of this record is based on newspaper reports of structural damage and human perception of the shaking, as classified by the Modified Mercalli Intensity (MMI) scale, and is probably incomplete because the region was sparsely populated. Seismograph networks did not start providing earthquake locations and magnitudes of earthquakes in the Pacific Northwest until about 1960.

Large earthquakes (magnitude greater than Richter 7) in the Pacific Northwest have occurred in the vicinity of Puget Sound, Washington, and near the Rocky Mountains in eastern Idaho and western Montana. A large earthquake of uncertain location occurred in north-central Washington in 1872. This event had an estimated maximum MMI ranging from VII to IX and an estimated Richter magnitude of approximately 7. The distribution of intensities suggests a location within a broad region between Lake Chelan, Washington, and the British Columbia border. Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is relatively low when compared to other regions of the Pacific northwest, the Puget Sound area and western Montana/eastern Idaho.

In the central portion of the Columbia Plateau, the largest earthquakes near the Hanford Site are two earthquakes that occurred in 1918 and 1973. These two events had magnitudes of 4.4 and intensity V and were located north of the Hanford Site.

2.2.4 Wind and Tornado

The Site is subject to frequent strong westerly winds. The all-time peak wind recorded at the Hanford Meteorology Station tower in the 200 East area at the 15-m level was a gust of 130 km/h recorded January 11, 1972. The 129 km/h gust is expected to occur once every 30 years. A peak of 137 km/h would be expected to occur once every 100 years.

The average occurrence of thunderstorms is 10/year. They are most frequent during the summer but thunderstorms have occurred in each month of the year. Only 1.9% of all thunderstorms observed at the HMS have been classified as "severe" based upon the National Weather Service criteria of wind gusts of 93 km/h or greater.

The entire State of Washington averages less than one tornado per year. Those that do occur are less severe than those affecting the Great Plains and Gulf State areas. The estimated probability of a tornado striking a point at Hanford is 9.6×10^{-6}/year. The HMS climatological summary and the National Severe Storms Forecast Center list 22 tornado occurrences within 161 kilometers of the Hanford Site from 1916 through August 1982; none of the tornadoes have resulted in major damage to property or loss of life. Within an 80-kilometers radius of the Hanford Site, only five small tornados have been recorded between 1950 and 1970.

2.2.4 Ashfall

The Hanford Site is in a region subject to ashfall from volcanic eruptions. The three major volcanic peaks closest to the project are: Mt. Adams about 161 kilometers, Mt. Rainier at about 177 kilometers away, and Mt. St. Helens approximately 209 kilometers away.

Important historical ashfalls affecting this location were from eruptions of Glacier Peak about 10,000 BC, Mt. Mazama about 4000 BC, and Mt. St. Helens about 6000 BC. The most recent ashfall resulted from the May 18, 1980 eruption of Mt. St. Helens.

2.3 Facility Descriptions

2.3.1 Liquid Effluent Retention Facility

The facility occupies approximately 20 acres of land northeast of the old 200 East Area site boundary. A site plan of the 200 East Area, showing the LERF location, is provided as Figure 2-2. The facility is located such that its capacity can be increased in size if required.

The LERF consists of three retention basins, associated transfer piping, sampling ports, valves, instrumentation and controls, and a basin support facility which includes a change trailer, a step-off pad area, and a storage building. The retention basins have a capacity to hold 25 ML each. Each basin has a double composite liner with a leachate collection system installed between the two liners. The basins receive and temporarily retain low level, low hazard liquid waste until eventual treatment at the ETF.

An operational security fence totally encloses LERF. This controls personnel access and excludes deer and other large animals from entering the facility. Additionally, the facility is surrounded on three sides by a second fence, which is the 200 East perimeter fence.

2.3.1.1 Liquid Effluent Retention Basins

Each of the three surface retention basins is categorized as a surface impoundment per Washington Administrative Code (WAC) regulations. The facility complies with applicable RCRA requirements per WAC for this category of facility.

The three basins meet the requirements of the codes and standards listed in EPA/530-SW-85-014, "Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments - Design, Construction, and Operation." The key design criteria and requirements are imposed through WAC 173-303 which complies with 40 CFR 264, Subpart K. Key design requirements imposed in 40 CFR 264, Subpart K, are related to the liner design and the monitoring capability. Additional regulatory requirements are imposed in 40 CFR 264.221 and 264.226, and WAC 173-303. The design life of the basin and associated piping systems is a minimum of 30 yr.

The basins have an active condensate retention volume of 74 ML; 49.2 ML for 242-A Evaporator process condensate and 24.6 ML for contingency use. Finish dimensions at the top of the basin are 102 meters by 82 meters. For overflow and spill prevention, a minimum of 1.2 meters of freeboard is provided at the top of each basin. The basin depth ranges from 7.3 to

8.2 meters, resulting in a maximum fluid depth of 6.1 to 7 meters. Manual level indicators are provided in each basin.

Each retention basin consists of the following: (1) cover and sample ports, (2) top composite liner, (3) bottom composite liner, and (4) leachate collection system. The leachate collection system is discussed in Section 2.4.1.3. A catch basin is provided at the northwest corner of each retention basin for the unencased transfer piping, vent piping and filter, leachate collection pump piping, and the manifolds for the contingency transfer pumps.

2.3.1.2 Cover and Sample Ports

Each basin has a mechanically tensioned cover. Covers are of Very Low Density Polyethylene (VLDPE) construction and are anchored to the perimeter concrete ring wall of the basins with batten plates. The covers were manufactured to be ultraviolet resistant. Excess slack in the cover is controlled through the use of tensioning towers located around the perimeter of the basin. The devices keep tension across the cover. The excess cover is gathered at the perimeter of the retention basin. Trapped gas can be vented to the atmosphere from underneath the cover through a single vent outlet and activated charcoal filter located at each catch basin. If necessary, the cover is designed and constructed to allow manual removal of accumulated debris.

Eight sampling ports are located around the perimeter of each basin. The minimum size of each port is 15 centimeters. The sample ports allow representative samples to be taken from any depth in the basin. Perforated pipe is used to allow free flow of the basin contents into and out of the sample port. The sample port risers are sealed to prevent air leakage through the penetration of the cover and through the sample port when not in use. Personnel access to the sample ports is from the perimeter area of the basins.

2.3.1.3 Top Composite Liner

The effluent rests on the top composite liner. The top composite liner consists of a high-density polyethylene (HDPE) liner 60-mil thick over a 6.4 millimeters layer of low permeability bentonite carpet liner. The edge of the composite liner is anchored around the entire perimeter of each basin. Slack in the HDPE liner is provided to prevent thermal contraction damage to the liner. The HDPE liners have sufficient slack to compensate for thermal expansion and contraction caused by ambient temperature variations of -40 °C to +46 °C. The composite liner extends down the side, across the bottom, and up the opposite side to the perimeter anchors. Batten plates and bolts anchor the composite liner to a concrete ring wall that surrounds the entire perimeter of the basin.

The bentonite carpet liner is installed under the primary liner and over the geotextile. The secondary liner is installed under the leachate system.

The low permeability bentonite carpet liner has an in-place saturated hydraulic conductivity of 1 x 10^{-7} cm/s or less. The carpet liner is a high-swelling clay that expands to form a monolithic seal when hydrated with water. In the hydrated state, the clay will increase in size up to 15 times its dry volume providing excellent impermeability and great resistance to flow.

2.3.1.4 Bottom Composite Liner

The bottom composite (secondary) liner consists of an upper 60-mil HDPE liner (identical in construction and material to the top HDPE composite liner) overlying a 91 centimeters thick or greater layer of compacted, low-permeability bentonite/soil with a saturated hydraulic conductivity of 1 x 10^{-7} cm/s or less. The surface of the low-permeability soil is backfilled to a 2% minimum slope to allow drainage of leachate to the removal system.

A passive gas removal system in the drainage layer in the side slopes of each basin will remove gas which may accumulate between the composite liners. This gas will escape to the air space between the primary liner and the cover through vents in the primary liner located above the liquid level. Release of this gas will be via the activated charcoal filters in the cover system.

2.3.2 Effluent Treatment Facility

The ETF is a single building containing a control room that provides the capability of monitoring and controlling the treatment process, and the collection and disposal systems. External storage is provided for the treated waste during analysis and/or verification. The building also contains a chemical makeup and storage area, secondary waste pretreatment and storage systems, and offgas and ventilation systems. There also are various support systems including fire protection, communications, sanitary and raw water, and electrical systems.

The ETF process treats low-activity radioactive water containing small amounts of ammonia, inorganics, organics, and particulates. The waste water to be treated consists of PC generated from the 242-A Evaporator and waste water in the LERF basin which originates from the 242-A Evaporator PC. Future use may also include other compatible waste streams from various Hanford facilities.

2.3.2.1 Main Treatment Train

The function of the Main Treatment Train is to reduce the concentrations of radioactive materials, ammonia, inorganics, organics, and particulates, in the influents to less than the regulated level.

The Main Treatment Train consists of the following systems:

- Surge Tank - Influent reception and pH adjustment to fix ammonia into the waste water in the form of ammonium ion

- Rough Filter - Rough removal of suspended solids
- UV Oxidation System - Decomposition of organic materials into H_2O and CO_2
- pH Adjustment Tank - pH adjustment for Reverse Osmosis
- Hydrogen Peroxide Decomposer - Decomposition of the residual hydrogen peroxide (H_2O_2) injected by UV Oxidation System
- Fine Filter - Final removal of suspended solids
- Degasification System - Removal of dissolved carbonate to reduce the load on Reverse Osmosis System and Polisher
- Reverse Osmosis System - Removal of dissolved solids
- Polisher - Polishing of the waste water and radionuclides
- Effluent pH Adjustment Tank - Final pH adjustment
- Verification Tanks - Verifying treatment targets.

Finally, the treated waste water, which meets the treatment target, is transferred to a SALDS.

2.3.2.2 Secondary Treatment Train

The secondary waste generated in the Main Treatment Train is collected and treated by the Secondary Treatment Train. The function of the Secondary Treatment Train is to minimize the volume of secondary wastes to be discharged from the ETF.

The Secondary Treatment Train consists of the following systems:

- Secondary Waste - Receiving of the secondary waste and pH Receiving Tank adjustment for evaporation
- Evaporator - Concentration of waste
- Concentrate Tank - Receiving of the concentrate
- Thin Film Dryer - Drying the concentrate
- Drum Handling System - Drum packaging of the dried solid
- Resin Dewatering System - Dewatering and packaging the spent ion-exchange.

Finally, the dried solids are packed in drums. Temporary drum storage is provided in room 137 of the ETF.

2.3.2.3 Support Systems

The ETF has the following Supporting Systems:

- Chemical Reagent Feed - Feeding chemical reagents for pH Feeding System adjustment and other chemical processes
- Sump Tank - Receiving miscellaneous liquid waste and drains before sending it to the Main Treatment Train
- Vessel Ventilation - Treatment of the vessel off-gas and Treatment System and maintaining negative pressure
- Building Ventilation - Ventilation of radiological control area (RCA) and non-radiation areas
- Process Support - Supplying supporting systems as follows:
    - Raw Water
    - Cooling Water
    - Steam
    - Compressed Air
    - Seal Water
    - Demineralized Water
- Collection System - Collection system providing transfer capabilities from the LERF and the 242-A Evaporator
- Disposal System - Disposal system providing transfer capabilities from the ETF of the processed PC to the SALDS.

2.4 Processes and Operations

2.4.1 Liquid Effluent Retention Facility

LERF is a passive facility which receives effluent from the 242-A Evaporator. The effluent stream is the condensate resulting from the evaporation process in the 242-A Evaporator that reduces the volume of waste stored in double-shell tanks. Vapors removed from the vapor-liquid separator in the evaporator are condensed, collected and passed through a filter to remove solids. The condensate then flows down an ion exchange column to further reduce the cesium and strontium content. After flowing through an in-line strainer, it then feeds into the LERF facility.

2.4.1.1 Liquid Effluent Transfer Piping

The LERF feed is pumped to the basins through double-encased, fiberglass-reinforced epoxy thermoset resin pipelines. The line from the evaporator is a 7.6 centimeter process line encased in 15.2 centimeter containment pipe, and has leak detection capability. The capability exists to transfer the contents of one basin into another basin. Sampling ports are provided at the basin perimeters and the leachate collection system.

Portions of the permanently installed piping, augmented by pre-engineered temporary piping, can be used to transfer the entire volume of a retention basin from one basin to another. Portable pumps are provided, rated at a combined total flow of 2650 liters/min. These portable pumps are submersible with wetted parts constructed of materials compatible with the basin contents. This pump flow rate provides capability of emptying a full basin within 7 d.

2.4.1.2 Leak Detection Along the Pipelines

The transfer piping is provided with a leak detection system. Single point leak detectors are placed every 305 meters along the line and monitor for leakage in the annulus between the process pipe and the encasement pipe. There are encasement test (swab) risers every 30.5 meters along the line for manual leak detection. The leak detection system in the line is interlocked with the P-C100 pump that feeds the effluent from the 242-A Evaporator facility. If a leak is detected, the pump will shut down and annunciation will be made in the 242-A Evaporator control room. Motor-operated valves at the 242-A Evaporator and the retention basin will close, stopping the flow of effluent to the retention basins and diverting to alternative holding tanks.

2.4.1.3 Basin Leakage Monitoring Systems

Monitoring for leakage is provided by four systems: (a) a level measuring system is provided to manually monitor the liquid level in the basin; (b) an electronic (automatic) level measuring system; (c) a leachate collection system is provided to extract leachate from between the composite liners; and (d) groundwater monitoring wells are provided in the vicinity of the basins.

The manual basin level measuring system provides direct indication of interim retention basin level, locally at the basin, for reading by LERF operations personnel.

The leachate collection system collects leachate from between the composite liners of each basin. The basin slopes to the leachate collection sump which collects any leakage through the top composite liner. A caisson extends down between the two liners and a submersible pump is installed into the caisson. Leachate is pumped through a piping system back to the basin. A level detector causes the pump to auto-start when needed, keeping the leachate liquid level below .30 meters. Leachate pump controls are located near the basins.

The leachate collection system measures fluid volumes pumped from the leachate collection sump of each basin. This provides indication of total leachate flow and potential leaks in the top liner. There is sampling capability in the leachate collection system to determine if liquid is leachate or moisture in the air within the liner system.

The leachate collection and removal system uses a synthetic geonet and gravel to provide space for leachate collection between the top and bottom composite liners. The geonet is placed along the sides of each basin beneath the geotextile extending to the intersection of the drainage gravel and the bottom. The purpose of the net is to provide a preferential flow path for any leachate or leak along the sides to the leachate pump.

Groundwater monitoring is conducted by a program meeting the requirements of WAC 173-303, Sections 400 and 645, and 40 CFR Part 265 for number, location, and type of groundwater monitoring wells. The monitoring program provides for detection of significant breaches in the LERF interim retention basin liner systems.

2.4.2 Effluent Treatment Facility

The ETF receives effluent from the 242-A Evaporator and the LERF. Liquid effluent from the 242-A Evaporator, or PC, is presently stored in the LERF. The evaporator PC and the waste stored in the LERF is the main source of influent into the ETF. Other waste streams, not identified at this time, may be processed by the ETF.

The ETF is an automated waste water treatment facility. A detailed discussion of the process is provided in Chapter 6 of WHC-C018H-SAR-001, "242-A Evaporator Treatment Facility Final Safety Analysis Report."

2.4.2.1 Primary System Treatment

The primary system treats and filters the effluent before it goes to land disposal. The PC is held up in the surge tank where it is sampled automatically then treated with sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH) to obtain the desired pH balance for the ultra violet (UV) oxidizer system. It is pumped through the rough filter to the UV oxidizer. The UV oxidizer uses UV light and hydrogen peroxide (H_2O_2) to breakdown the organic chemicals. The chemicals H_2SO_4 and NaOH again are added in the pH adjustment tank to bring the pH to the required level for CO_2 removal. The effluent is then pumped through the fine filter to the degasification column and drops through to the first reverse osmosis (RO) feed tank, while any dissolved carbon dioxide (CO_2) is removed by the degasification blower to the vessel ventilation system. The effluent is then pumped through the first RO storage to the second RO feed tank. From there it is pumped through the second RO storage and the polishers to the effluent pH adjustment tank. After the effluent has been adjusted to the pH level for land disposal, it is pumped to the verification tanks for testing before going to the state approved land disposal site in the 200 West Area.

2.4.2.2 Secondary Waste Treatment

The secondary system collects the backwash from the rough filter, fine filter, RO filters, and polishers in the secondary waste receiving tanks. Some of the backwash will go back to the surge tank. The waste in the secondary waste receiving tank is pH adjusted then pumped to the evaporator through the tube side of the feed heater (heat exchanger). The waste is pumped through the evaporator and the heat exchanger by the evaporator concentrate recirculation pumps. As the waste circulates it becomes concentrated, because of the evaporation of the liquid portion of the waste.

The vapor (distillate) rises from the evaporator through an entrainment separator to the vapor compressor. The entrainment separator allows the liquid portion to return to the evaporator and the vapor to go to the vapor compressor. The vapor is compressed by the vapor compressor and used to provide the heat for the evaporation process. A low yield boiler provides heat for start-up. The vapor, heated by compression passes through the shell side of the concentrate heater to the level control tank to a flash tank. The distillate "flashes" as a result of expansion allowing the gaseous portion to be pulled by the exhaust gas blower through a cooler to the offgas filters and then to the hot heating, ventilating, and air condition (HVAC) filters. The distillate in the flash tank is pumped through the shell side of the feed heater, heating the waste pumped from the secondary waste tank to the evaporator.

The concentrate is recirculated through the evaporator until it reaches the concentration suitable for the thin film dryer. The concentrate transfer pump moves the concentrate to the evaporator concentrate tank (CT). The thin film dryer concentrate recirculation pump recirculates the concentrate through a recirculation line connected to the thin film dryer feed line. The Thin film dryer feed pump moves the concentrate to the thin film dryer. The thin film dryer is heated by a steam jacket with steam provided by a closed loop boiler system. The thin film dryer rotor, driven by a motor on top of the thin film dryer, moves the concentrate down the inner wall of the thin film dryer to the powder hopper. The concentrate is spread into a thin film by the rotor allowing the liquid portion to evaporate, as it is heated by the steam jacket. The powder hopper collects the powder and loads it into 0.209 m^3 (55 gal) drums. The drums are placed on a roller conveyer system and move through an air lock into the thin film dryer room. They then move to the thin film dryer to be filled. After filling, the drums move to a capping machine where the lid is put on the drum. The drums move through an airlock to the truck bay where the lid is tightened by hand. The drums are then moved to the drum storage room.

3.0 IDENTIFICATION AND SCREENING OF HAZARDS

3.1 Liquid Effluent Retention Facility

3.1.1 Radiological Hazards

Source terms for the LERF project are presented in the 242-A Evaporator Final Safety Analysis Report. The 242-A Evaporator FSAR provides both normal operating and maximum bounding PC source terms. A more conservative accident source term based on the 242-A Evaporator Operational Safety Requirements was developed for use in the LERF FSAR. This source term is tabulated in Table 3-1 and is used for consequence analyses in this hazard assessment. An isotopic comparison of the 242-A Evaporator maximum bounding PC source term to the LERF accident source term indicated that for each isotope, the LERF accident source term is more conservative.

3.1.1.1 Contained Sources

Only sealed radioactive materials (for calibration purposes) will be allowed in this facility. Sealed sources for the purpose of response checking of portable field survey instruments are allowed, and controlled in health physics procedures. Contained sources in the LERF are the stored liquid waste within the basins, piping, and leachate collection system components and piping.

Table 3-1 Liquid Effluent Retention Facility Radionuclide Source Term

Radionuclide	DCG value[a] (µCi/mL)	5,000*DCG LERF Source Term(b) (µCi/mL)
^{3}H	2.0 E-03	1.0 E+01
^{14}C	7.0 E-05	3.5 E-01
^{60}Co	5.0 E-06	2.5 E-02
^{79}Se	2.0 E-05	1.0 E-01
^{90}Sr	1.0 E-06	5.0 E-03
^{94}Nb	3.0 E-05	1.5 E-01
^{99}Tc	1.0 E-04	5.0 E-01
^{106}Ru	6.0 E-06	3.0 E-02
^{129}I	5.0 E-07	2.5 E-03
^{134}Cs	2.0 E-06	1.0 E-02
^{137}Cs	3.0 E-06	1.5 E-02
^{144}Ce	7.0 E-6	3.5 E-02
^{154}Eu	2.0 E-05	1.0 E-01
^{155}Eu	1.0 E-04	5.0 E-01
^{226}Ra	1.0 E-07	5.0 E-04
U (gross)(c)	5.0 E-07	2.5 E-03
^{237}Np	3.0 E-08	1.5 E-04
^{238}Pu	4.0 E-08	2.0 E-04
$^{239/240}$Pu	3.0 E-08	1.5 E-04
^{241}Pu	2.0 E-06	1.0 E-02
^{241}Am	3.0 E-08	1.5 E-04
^{244}Cm	6.0 E-08	3.0 E-04

(a) The DCG values are from WHC-CM-7-5, "Environmental Compliance Manual."

(b) The 5,000 DCG concentrations represent the maximum possible concentration on an isotope specific basis. Based on the Unity Rule, the maximum concentration of LERF fluid will contain a total of 5,000 DCGs of radionuclides.

(c) Gross Uranium was assumed to be ^{234}U for conservatism.

3.1.1.2 Airborne Radioactive Material Sources

The LERF design and maintenance minimizes airborne radioactive sources. During normal operation of the facility, airborne releases will occur at the filtered vents, migration through the liner and through the sample ports when opened. Airborne radioactivity releases are expected to be very low as only liquid radioactive materials are contained in this facility.

The normal release path for the LERF is from vaporization of LERF contents under the LERF basin cover, with a consequent release path through the basin ventilation filters, diffusion through the basin cover, and through the sample ports when opened. Provision has been made for a charcoal filtration system to be included at the basin cover vents which exhaust noncondensable gases from under the LERF basin floating covers. This ventilation path will preclude the accumulation of noncondensable gases under the cover. The only anticipated emissions through this ventilation path are expected to be volatile gases and water vapor containing only tritium as a radionuclide of interest.

3.1.2 Chemical Hazards

Source terms for the LERF project are presented in the 242-A Evaporator Final Safety Analysis Report. The chemical source term is tabulated in Table 3-2 and provides the anticipated concentration of several LERF effluent chemicals for the various ETF process streams.

3.2 Effluent Treatment Facility

The inventory of potentially hazardous materials in the ETF includes chemicals added as part of the treatment process, chemicals added to prevent corrosion, antifoaming agents added to the evaporator, and chemicals and radionuclides from the LERF effluent. There are no explosives in the system, although some of the chemicals added can react violently with each other.

3.2.1 Radiological Hazards

The maximum bounding radiological inventory used in this hazards assessment has been taken from the LERF SAR and is presented in Table 3-4. The characteristics of the liquids stored in the LERF basis were developed from the expected maximum bounding 242-A Evaporator PC inventory. The PC characteristics were developed based on estimates of the wastes currently stored in the double shelled tanks and the evaporator processes; therefore, the inventories used in each of these facilities have a common origin and are consistent with each other.

Table 3-2 LERF Effluent Chemicals Incoming to ETF

Process Stream	242-A/LERF	Surge Tank	Treated liquid waste	Secondary waste	Concentrate tank	Powder drum
Organic compounds	ppm	ppm	ppm	ppm	ppm	g/Drum
1-Butanol	30	31.449	< 5.0	44.3	-	-
Acetone	1	0.931	< 0.05	0.44	-	-
Benzyl Alcohol	0.014	0.032	< 0.20	0.18	-	-
Chloroform	0.014	0.018	< 0.006	0.05	-	-
Methylene Chloride	0.14	0.128	< 0.005	0.04	-	-
Methyl Isobutyl Keytone (MIBK)	0.014	0.017	< 0.005	0.04	-	-
Pyridine	0.055	0.499	< 0.014	0.12	-	-
Tributyl Phosphate	4.1	4.615	1.00	8.86	-	-
Others[a]	1.738	6.539	5.0	44.3	-	-
Inorganic Chemicals[b] (as ions)						
Sodium Na	4.5	4.8	-	399	9,717	4,287
Potassium K	6.5	5.8	-	52	1,232	543
Calcium Ca	2.8	2.5	-	22	531	234
NH_4	511.3	477.8	-	4,230	96,969	42,783
Silicon Si	24.3	21.8	-	192	4,591	2,025
NO^3	2.3	2.1	-	18	435	192
SO_4	2.8	30.4	-	13,127	313,031	138,109
CO_2/CO_3 as CO_3	104.3	92.1	-	62	1,482	654
Chlorine Ci	1.2	1.1	-	12	186	130
Fluorine F	1.0	0.9	-	8	186	82
PO_4	1.3	1.2	-	22	525	231
Total	699.9	699.9	-	18,243	438,892	189,271

3.2.2 Chemical Hazards

The chemicals added as part of the treatment process are 92% (H_2SO_4), 50% (NaOH), 50% (H_2O_2) and ($Na_6(PO_3)_6$). The chemicals, their concentrations, quantities and locations are listed in Table 3-3. The PC inorganic and organic chemical constituents and expected concentrations are shown in Table 3-2.

Table 3-3 Chemicals Utilized in the ETF Treatment Process

Chemical	Location	kL	gal
Sulfuric acid (H_2SO_4) 92%	Outside Separate Berms	28.4	7,500
Sodium hydroxide (NaOH) 50%		18.9	5,000
Sulfuric acid (H_2SO_4) 4%	Room 131 Common Berm	2.3	600
Sodium hydroxide (NaOH) 4%		2.3	600
Sodium-hexametephosphate ($Na_6(PO_3)_6$) Dosing tank	Room 131 Next to RO filter system	1.13 0.19	300 50
Anti-Foam tank	Evaporator	0.19	50
Hydrogen peroxide (H_2O_2) 50%	Room 134	9.5	2,500

Table 3.4 ETF Design Basis Radiological Inventory

Equations isotope	242-A/LERF PC	Surge tank (ST)	Secondary waste receiving tank (SWT)	Evaporator concentrate tank (ECT)	Powder drum
	μCi/mL	μCi/mL	μCi/mL	μCi/mL	μCi/mL
			7.93 x ST	5.88 x 23.7 x SWT	2.39 x ECT
$^{3}H^{*}$	6.80 E-03	6.80 E-03	6.80 E-03	6.80 E-03	6.80 E-03
^{14}C	5.00 E-04	5.00 E-04	3.97 E-03	5.53 E-01	1.32 E+00
^{60}Co	2.40 E-03	2.40 E-03	1.90 E-02	2.65 E+00	6.34 E+00
^{79}Se	1.50 E-04	1.50 E-04	1.19 E-03	1.66 E-01	3.96 E-01
^{90}Sr	9.60 E-05	9.60 E-05	7.61 E-04	1.06 E-01	2.54 E-01
^{94}Hb	1.90 E-04	1.90 E-04	1.51 E-03	2.10 E-01	5.02 E-01
^{99}Tc	3.90 E-03	3.90 E-03	3.09 E-02	4.31 E+00	1.03 E+01

Equations isotope	242-A/LERF PC	Surge tank (ST)	Secondary waste receiving tank (SWT)	Evaporator concentrate tank (ECT)	Powder drum
^{106}Ru	1.30 E-04	1.30E-04	1.03 E-03	1.44 E-01	3.43 E-01
^{129}I*	2.60 E-03	2.60 E-03	2.60 E-03	2.60 E-03	2.06 E-02
^{134}Cs	4.10 E-04	4.10 E-04	3.25 E-03	4.53 E-01	1.08 E+00
^{137}Cs	1.60 E-06	1.60 E-06	1.27 E-05	1.77 E-03	4.23 E-03
^{144}Ce	8.30 E-05	8.30 E-05	6.58 E-04	9.17 E-02	2.19 E-01
^{154}Eu	9.80 E-03	9.80 E-03	7.77 E-02	1.08 E+01	2.59 E+01
^{155}Eu	1.40 E-02	1.40 E-02	1.11 E-01	1.55 E+01	3.70 E+01
^{226}Ra	6.40 E+05	6.40 E-05	5.08 E-04	7.07 E-02	1.69 E-01
^{234}U	2.10 E-07	2.10 E-07	1.67 E-06	2.32 E-04	5.55 E-04
^{235}U	9.04 E-09	9.40 E-09	7.45 E-08	1.04 E-05	2.48 E-05
^{238}U	5.30 E-08	5.30 E-08	4.20 E-07	5.86 E-05	1.40 E-04
^{237}Np	2.10 E-06	2.10 E-06	1.67 E-05	2.32 E-03	5.55 E-03
^{238}Pu	6.80 E-10	6.80 E-10	5.39 E-09	7.51 E-07	1.80 E-06
$^{239/240}$Pu	8.30 E-08	8.30 E-08	6.58 E-07	9.17 E-05	2.19 E-04
^{241}Pu	7.80 E-06	7.80 E-06	6.19 E-05	8.62 E-03	2.06 E-02
^{241}Am	1.40 E-06	1.40 E-06	1.11 E-05	1.55 E-03	3.70 E-03
^{244}Cm	2.50 E-05	2.50 E-05	1.98 E-04	2.76 E-02	6.60 E-02

*^{3}H and ^{129}I are not affected by concentration.

4.0 HAZARD CHARACTERIZATION

4.1 Liquid Effluent Retention Facility

4.1.1 Radiological Hazards

Limiting source terms for the LERF project abnormal occurrence and accident analyses have been developed based on WHC-CM-7-5, *Environmental Compliance Manual*, which requires that "liquid effluent streams... be shut down if the instantaneous radionuclide concentration exceeds 5,000 times DCG-public." The maximum LERF influent source strength will be such that the sum of the DCG quantities for each radionuclide will not exceed a total of 5,000. This value is consistent with 242-A Evaporator operation and associated Operational Safety Requirements (OSRs), and with the existence of and the setpoint for diversion capability at the Evaporator. Five thousand DCG concentrations of the predominant radionuclides expected to be present in LERF are provided in Table 3-1.

For accidents analyzed using the HUDU code, radiological consequences of releases from LERF are maximized utilizing U (Gross) as the isotope for analytical purposes. Gross Uranium is evaluated as though it were all ^{234}U for conservatism. Note that use of gross Uranium is for analytical purposes only, effectively setting the analytical envelope in the most conservative fashion, and does not imply that 5,000 DCGs of gross Uranium will ever be present in the LERF or transfer lines to LERF. A source strength of 5,000 DCGs (liquid) of gross Uranium equates to a value of 2.5 E-03 μCi/mL.

For scenarios which utilize evaporation as the release path for LERF basin contents, as discussed further in Section 5.1, tritium has a partition factor of 1, while all other radionuclides have a partition factor of 10^{-7}. GENII calculations have been run which demonstrate that, taking into account the partition factor, tritium becomes the predominate radionuclide of concern for basin evaporation events. A source strength of 5,000 DCGs (liquid) of tritium equates to a value of 1.0 E+01 μCi/mL.

4.1.2 Chemical Hazards

As all releases from LERF are direct fluid releases to an airborne pathway, comparison of LERF toxicological material concentrations to applicable Threshold Limit Values (TLVs) provides a direct indication of the toxicological constituents of the LERF fluid of interest for accident consequences. The results of this comparison are provided in Table 4-1. This table uses the 242-A Evaporator PC source term from the 242-A Evaporator/Crystallizer FSAR. Threshold Limit Values were obtained from *Threshold Limit Values and Biological Exposure Indices for 1989-1990.*

Table 4-1 Comparison of Maximum Toxicological Concentrations Present in Liquid Effluent Retention Facility with Threshold Limit Values

Component	Normal operating conc. (mg/L)	TLV (mg/L)	Ratio normal operating conc./TLV
Aluminum	4.1 E+01	2.0 E-03	2.1 E+04
Ammonium	2.3 E+03	1.7 E-02	1.4 E+05
Barium	3.0 E-02	5.0 E-04	6.0 E+01
Boron	3.5 E-02	1.0 E-02	3.5 E+00
Cadmium	3.1 E-02	5.0 E-05	6.2 E+02
Calcium	1.9 E+00	5.0 E-05	3.8 E+04
Carbonate	2.4 E+01	N/A	--
Chloride	2.4 E+01	N/A	--
Chromium	3.4 E-02	5.0 E-05	6.8 E+02

Copper	1.5 E-02	1.0 E-03	1.5 E+01
Cyanide	9.5 E-02	5.0 E-03	1.9 E+01
Fluoride	4.3 E-02	2.5 E-03	1.7 E+01
Hydroxide	1.4 E+02	2.0 E-03	7.0 E+04
Iron	8.5 E-02	1.0 E-03	8.5 E+01
Lead	4.6 E+00	2.0 E-04	2.3 E+04
Magnesium	4.6 E-01	1.0 E-02	4.6 E+01
Manganese	5.8 E-02	1.0 E-03	5.8 E+01
Mercury	1.6 E-02	5.0 E-05	3.2 E+02
Molybdenum	1.2 E-01	5.0 E-03	2.4 E+01
Nickel	7.9 E-02	1.0 E-04	7.9 E+02
Nitrate	6.1 E+02	N/A	--
Nitrite	7.0 E+01	N/A	--
Phosphate	1.0 E+01	N/A	--
Phosphorus	9.6 E+00	1.0 E-04	9.6 E+04
Potassium	1.0 E+01	2.0 E-03	5.0 E+03
Silicon	5.9 E-01	1.0 E-02	5.9 E+01
Sodium	1.6 E+01	2.0 E-03	8.0 E+03
Sulfate	5.0 E+00	N/A	--
Tungsten	4.1 E-01	1.0 E-03	4.1 E+02
Uranium	1.5 E-01	2.0 E-04	7.5 E+02
Zinc	9.6 E-02	5.0 E-03	1.9 E+01
Acetone	1.0 E+00	1.8 E+00	5.6 E-01
Alkyl, hydroxymethyl benzene	1.1 E-01	N/A	--
Butanedioic acid	3.6 E+01	N/A	--
1-Butanol	3.7 E-04	N/A	--
C3-Alkylbenzene	4.5 E+02	N/A	--
Chloroethyl, 2-hydroxymethyl BA	1.1 E+01	N/A	--
2-Chloromethylhydroxymethyl-benzene	1.6 E+01	N/A	--
2-Chloromethyloxylene	2.9 E+01	N/A	--
Citric acid	1.3 E+01	N/A	--
Diethylphthalates	4.4 E-02	5.0 E-03	8.8 E+00

Dimethyltoluidine	4.7 E+00	N/A	--
Dioctylphthalate	7.7 E-02	N/A	--
Dodecane	5.5 E-01	N/A	--
Dodecanoic acid	2.6 E-03	N/A	--
Ethanedioic acid	3.5 E+01	N/A	--
Ethyl, 2-methyl-hydroxymethylbenzenes	1.3 E+00	N/A	--
Ethylbenzaldehyde	9.6 E+01	N/A	--
ED3A	1.4 E-03	N/A	--
EDTA	4.0 E-03	N/A	--
Ethylxylene	1.4 E-01	N/A	--
Heptadecanoic acid	1.8 E-02	N/A	--
Heptanedioic acid	2.8 E-01	N/A	--
Hexadecanoic acid	9.4 E-03	N/A	--
Hexanedioic acid	7.5 E-03	N/A	--
Hexanoic acid	3.9 E-01	N/A	--
Hydroxyacetic acid	1.0 E+02	N/A	--
2-Hydroxymethylbenzoic acid	2.4 E+00	N/A	--
Methylbenzaldehyde	6.3 E+01	N/A	--
2-Methylbenzoic acid	3.0 E+00	N/A	--
2-Methyl, hydroxymethyl benzene	5.6 E+01	N/A	--
Methyltoluidine	1.8 E-01	N/A	--
$n\text{-}C_{22}H_{46}\text{-}C_{40}H_{82}$	3.6 E-02	N/A	--
HEDTA	1.7 E+00	N/A	--
MAIDA	1.0 E+01	N/A	--
MICEDA	5.4 E-01	N/A	--
Nitrilotriacetic acid	1.1 E-01	N/A	--
Octodecanoic acid	3.2 E-03	N/A	--
Pentadecane	4.8 E-02	N/A	--
Pentadecanoic acid	6.0 E-01	N/A	--
Pentanedioic acid	7.8 E-03	N/A	--
Propylbenzene	3.2 E+00	N/A	--
Tetradecane	3.8 E-01	N/A	--

Tributyl phosphate	1.1 E+00	2.5 E-03	4.4 E+02
Tri-n-butyl-(di-ol)-phosphate	5.4 E-01	N/A	--
Tridecane	1.8 E+00	N/A	--
1,3,5-Trimethylbenzene	1.9 E+02	1.3 E-01	1.6 E+03
Undecane	8.3 E-01	N/A	--
Unknown Phthalates	8.8 E-02	5.0 E-03	1.8 E+01

Note: Shaded box represents limiting value.
ED3A = Ethylenediaminetriacetic acid.
EDTA = Ethylenediaminetetraacetic acid.
HEDTA = N-Hydroxyethylene-diaminetriacetic acid.
MAIDA = N-(Methylamine)iminodiacetic acid.

Table 4-1 provides a comparison of maximum toxicological concentrations present in the LERF basins with applicable threshold limit values. As can be seen from the tabulation in Table 4-1, the highest toxicological constituent relative to TLV values, for LERF fluid is ammonia. Ammonia will be used as the toxicological constituent for evaluation of accident consequences in this hazards assessment. Based on the maximum concentration of ammonia relative to its TLV value, if the ammonia concentrations are acceptable all other toxicological constituent concentrations will also be acceptable.

The maximum ammonia concentration present in LERF contents is 1.36 E+04 ppm. This source term represents the maximum expected concentration of ammonia present in any discharge from the 242-A Evaporator to the LERF, and in addition is used for evaluation of releases from the LERF basins.

4.1.2.1 Ammonia Characteristics

Ammonia is a colorless gas with a pungent, suffocating odor. It is a very strong base and forms ammonium hydroxide upon contact with moisture. Ammonia's toxic effects arise generally from its strong caustic properties. Breathing ammonia can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs with severe shortness of breath. Exposure to ammonia can severely burn the skin and eyes, leading to permanent damage. Because ammonia may be harmful or fatal if inhaled, several regulatory and scientific organizations have recommended exposure limits, including OSHA, ACGIH, and NIOSH. Table 4-2 presents ammonia's physical properties and recommended exposure limits.

Table 4-2 Physical Properties of Concentrated Ammonia

Physical Properties:
Molecular Weight = 17.0
Specific Gravity = 1.39
Melting Point = -78 °C
Boiling Point = -33.4 °C
Vapor Pressure = 400 mmHg
@ -45 °C

Exposure limits:
25 ppm OSHA & ACGIH TWA
35 ppm OSHA & ACGIH STEL
300 ppm IDLH
25 ppm ERPG-1
200 ppm ERPG-2
1000 ppm ERPG-3

4.2 Effluent Treatment Facility

4.2.1 Radiological Hazards

A study of the PC from the LERF determined that the amount of ammonia in the waste stream affected the radioactive content of the evaporator concentrate tank, the thin film dryer, and the powder drums. As H_2SO_4 is added in the treatment process, ammonia becomes ammonium sulfate. Where there is no ammonia the sulfate becomes bound to other chemicals in the process. The worse case inventory for the ETF is presented in Table 3-3 and was used for all consequence analyses involving ETF radiological releases.

Table 3-3 shows the secondary waste receiving tank (SWT) 57,000 L (15,000 gal) is 7.93 times as concentrated as the surge tank (ST) 380,000 L (100,000 gal), the concentrate tank (CT) 19,000 L (5,000 gal) is 187.9 times as concentrated as the ST and the powdered waste (PW) 189 L (50 gal) is 449.2 times as concentrated as the ST. For calculation purposes, the content of the evaporator was assumed to be the same as the CT and the dryer was assumed to have the same concentration as the PW.

4.2.2 Chemical Hazards

Table 3-2 presents the expected organic and inorganic chemicals expected to be present in the ETF influent. These contaminants were identified through analytical analyses of 242-A process condensate and are documented in WHC-EP-0342, "242-A Process Condensate Stream Specific Report."

The chemicals added as part of the treatment process are 92% (H_2SO_4), 50% (NaOH), 50% (H_2O_2) and ($Na_6(PO_3)_6$). Sulfuric acid, sodium hydroxide, and hydrogen peroxide were identified in quantities exceeding the screening threshold of 40 CFR 355, Appendix A and are characterized in the following sections.

4.2.2.1 Sulfuric Acid

Sulfuric acid is a clear, colorless, odorless oily liquid when pure. It is strong mineral acid which liberates hydronium (H+) and sulfate ($SO4^{-2}$) ions upon contact with moisture. Sulfuric acid in concentrated form is a strong corrosive and oxidizer. It can cause severe and fatal burns and can destroy the eye. It is a non-combustible liquid, but capable of igniting finely divided combustible materials. It releases hydrogen on contact with many metals. The sulfuric acid is stored in an external 7,500 gallon tank in a bermed area near the process building. Because sulfuric acid may be harmful or fatal if inhaled, several regulatory and scientific organizations have recommended exposure limits, including OSHA, ACGIH, and NIOSH. Table 4-3 presents sulfuric acid's physical properties and recommended exposure limits.

Table 4-3 Physical properties of Concentrated Sulfuric Acid

Physical Properties:	Exposure limits:
Molecular Weight = 98.08	(1 mg/m^3) OSHA & ACGIH TWA
Specific Gravity = 1.8	(3 mg/m^3) OSHA & ACGIH STEL
Melting Point = -32 °C (93%)	1 mg/m^3 NIOSH 10 hr TWA
Boiling Point = 290 °C	2 mg/m3 ERPG-1
Vapor Pressure = 0.001 mmHg @ 20°C	10 mg/m3 ERPG-2
	30 mg/m3 ERPG-3
= 1 mmHg @ 146°C.	80 mg/m3 IDLH

4.2.2.2 Sodium Hydroxide

Sodium hydroxide, commonly known as "caustic soda" and "soda lye", is an alkaline salt, widely used in the home and industry. It is a colorless to white, odorless solid and is noncombustible, but when in contact with water may generate sufficient heat to ignite combustible materials. Concentrated solutions of sodium hydroxide are corrosive to all tissues. If ingested, such solutions will cause vomiting, prostration, and collapse. Inhalation of sodium hydroxide dust, or a concentrated mist, may cause respiratory damage. The sodium hydroxide is stored in a 5000 gallon tank adjacent to the sulfuric acid storage tank. Because exposure to sodium hydroxide may be harmful, several regulatory and scientific organizations have recommended exposure limits, including OSHA and NIOSH. Table 4-4 presents sodium hydroxide's physical properties and recommended exposure limits.

Table 4-4 Physical Properties of Sodium Hydroxide

Physical Properties:	Exposure limits:
Molecular Weight = 40.0	2 mg/m^3 OSHA PEL
Specific Gravity = 2.13	2 mg/m^3 NIOSH REL
Melting Point = 605 °F	2 mg/m3 ERPG-1
Boiling Point = 2534 °F	40 mg/m3 ERPG-2
Vapor Pressure = 0.0 mmHg	100 mg/m3 ERPG-3
@ 20°C	250 mg/m3 IDLH

4.2.2.3 Hydrogen Peroxide

Hydrogen peroxide is a colorless, heavy liquid with a faint odor resembling ozone. It is miscible with water and although not flammable itself, it is highly reactive as a strong oxidizing agent. As such, it can decompose violently with many organic solvents, metal ions and salts, proteins and ammonia. In its commercial form hydrogen peroxide is sold as aqueous solutions containing a stabilizer to minimize the rate of spontaneous decomposition. Even with stabilizer present, hydrogen peroxide slowly decomposes to form oxygen and water with the liberation of heat. If not properly stored in appropriate containers with pressure release valves for concentrated solutions, hydrogen peroxide at 40% or greater concentrations can explode. Hydrogen peroxide is not particularly volatile but can occur as mists or aerosols. Inhalation can produce irritation of the lungs, while effects on the skin at greater than 50% concentrations include severe burns with blistering.

H_2O_2 is considered to be a safety hazard for two reasons. First of all, it is a powerful oxidant which if mixed with combustible materials or reductants can create fires or explosions. This scenario is unlikely to occur because no such materials exist in close proximity to the H_2O_2 tank. The second hazard exhibited by H_2O_2 is its instability with respect to decomposition. It should be noted that peroxide is more unstable in the presence of strong bases, and decomposes more rapidly at higher pH's. It is also true that catalysts such as common dust, and most heavy metal ions are much more effective at promoting decomposition of H_2O_2 in alkaline solutions. The decomposition of two molecules of H_2O_2 to yield two molecules of water and one molecule of oxygen is quite exothermic, and yields 23.5 kilocalories per mole of peroxide destroyed.

Because exposure to hydrogen peroxide can be harmful, several regulatory and scientific organizations have recommended exposure limits, including OSHA, ACGIH, and NIOSH. Table 4-5 presents hydrogen peroxide's physical properties and recommended exposure limits.

Table 4-5 Physical Properties of Hydrogen Peroxide

Physical Properties:		Exposure limits:
Molecular Weight	= 34.02	1 mg/m^3 OSHA PEL
Specific Gravity	= 1.39	1 mg/m^3 NIOSH REL
Melting Point	= -0.43 °C	N/A ERPG-1
Boiling Point	= 152 °C	25 ppm ERPG-2
Vapor Pressure	= 5 mmHg	50 ppm ERPG-3
	@ 86°F	75 ppm IDLH

5.0 EVENT SCENARIOS

The barriers that maintain control over each of the hazardous materials discussed in Section 4.0 have been analyzed and the possible failure modes considered. The barrier analyses and resulting release scenarios are described in this section.

5.1 Liquid Effluent Retention Facility Events

Design of the LERF provides multiple barriers between LERF fluids and potential airborne or waterborne release pathways. Based upon LERF design, postulated breach of barriers were considered in determining credible accidents which may occur during facility life.

5.1.1 Postulated LERF Confinement Breaches

The confinement barriers present at LERF have been evaluated for credible mechanisms which could result in release of LERF contents. The barriers, and the potential mechanisms for barrier breach, are as follows:

- Basin Liner - Breach of the basin liner would result in release of LERF fluid to the leachate collection system, which directly pumps the fluid back to the basin. While this leak path is not desirable, this pathway does not result in the release of LERF fluids to either airborne or waterborne pathways. In the event of a breach, the contents will be transferred to the contingency space.

- Basin Cover - Loss of LERF contents through tears in the basin cover is bounded by the postulated case where the basin cover is lost. The most credible scenario for basin cover loss would be due to high wind. Loss of the basin cover would result in the evaporation of LERF fluids and transport via an airborne pathway to postulated occupational, onsite and offsite receptors.

- LERF Piping (Spray) - Potential release paths from the piping systems were evaluated using energy/barrier analysis. The largest energy source within the LERF during normal operation is the pumping energy used to transfer fluids from the 242-A Evaporator to the LERF basins. A leak in the piping during such pressurized transfer could result in an aerosolized release of LERF fluid.

- Miscellaneous System Breaches (Spills) - In addition to the failures noted above resulting in release of LERF fluids, there are events which may be expected to result in the release of LERF fluids due to expected activities during facility operation. This type of release includes expected leakage from operation (for example, valve packing leakage) and intentional breaches of the LERF confinement barriers for maintenance or routine operations.

Accordingly, there are three credible confinement breaches for the LERF facility which are analyzed for potential radiological or toxicological consequences to onsite or offsite personnel. These events are: (a) a spill; (b) a spray leak from the LERF piping; and (c) a loss of the LERF basin cover resulting in evaporation of basin contents. The specific scenarios selected for modeling these confinement breaches are considered in following sections.

5.1.2 Basin Evaporation Event Description

This scenario assumes that one LERF basin becomes uncovered due to high wind and is evaporated at a constant rate, representative of the LERF basin size and the expected maximum monthly average worst case evaporation at the Hanford Site.

5.1.3 Spray Leak Event Description

This scenario assumes that a piping leak exists in the LERF transfer piping during a transfer of 242-A Evaporator effluents. A cracked pipe or a leaking flange is postulated as the initiating event. This postulated accident scenario is conservatively assumed to result in an aerosolization of LERF fluid generating the maximum respirable particles.

5.1.4 Spill Event Description

Analysis of spill type accidents is provided to envelope all potential liquid releases from the LERF facility. This includes small "drip type" leaks from fluid confinement boundaries such as valve packing leaks, expected maintenance activities in which small amounts of LERF fluid may be released, and basin activities such as insertion or removal of temporary transfer pumps from the basin. Based on engineering judgement, a 379 liters volume envelopes the expected volume of LERF fluid which could be spilled during any of these postulated scenarios.

5.2 Effluent Treatment Facility Events

Most of the accidents evaluated take place in the process building. The grouping of the Secondary Train tanks and equipment, and their isolation by shield walls, reduce the probability of a release from these tanks even in an earthquake strong enough to fail some or all of the tanks. Fire is a remote possibility for a release. The effluent entering the system is a nonflammable liquid, none of the chemicals added would affect its nonflammable nature. All of the metals and organic materials in the effluent liquid from the LERF are oxidized in the Ultra-Violet (UV) oxidizer system, making the powder packaged in 0.209 m^3 (55 gallon drums) also nonflammable.

The accidents selected for analysis are a release from the surge tank (ST), a concentrate tank (CT) spray release and a release from crushed powder drums. The ST is located outside the process building and will have both radionuclides and the maximum concentration of organic chemicals that could be released. The CT has no organic chemicals but a higher concentration of radionuclides than the surge tank. The powder drums will be loaded onto trucks outside the building or just inside the truck bay with access to the outside.

Of the process chemicals only a H_2O_2 spill was selected for analysis. H_2SO_4 has very low vapor pressures and tends to lose water instead of evaporating, while NaOH is hygroscopic, attracting moisture instead of evaporating. The 92% H_2SO_4 and the 50% NaOH tanks have their own bermed area sized to hold the maximum spill. They mix with an exothermic reaction into sodium sulfate, a salt, and steam. The reaction is primary local in its effect. Therefore, H_2O_2 was analyzed as the only bulk chemical spill capable of producing significant downwind effects.

5.2.1 Surge Tank Spill

The LERF effluent chemicals in Table 3-2 for the surge tank were evaluated for effects of a release if complete failure of the tank and berm would occur, thus releasing the entire contents onto the ground.

5.2.2 Evaporator Concentrate Tank Spill

The radioactive liquid waste in the CT has the most concentrated waste in the ETF and therefore represents a bounding radioactive liquid spill case. A spill from the CT because of a large fracture in the tank or complete failure would normally not result in an airborne release. The concentrate would run down the sloped floor into a trench then to sump tank 1. Disregarding the building and drain system a significant airborne release can be calculated.

5.2.3 Evaporator Concentrate Tank Spray Release

It is postulated that a pipe leak occurred in a transfer line during the transfer of radioactive liquid from the CT in ETF to the Thin Film Dryer. This case is the worst-case bounding condition for a piping leak because the CT contains the highest concentrations of radioisotopes.

5.2.4 Powder Release

The powder releases that could potentially impact the onsite and offsite individual and the facility worker, involve drum loading and handling operations in the truck bay. Powder releases, resulting from a process upset in the dryer room, would be primarily contained within the dryer room and the effluent HEPA filtration system. Since this area is not occupied during routine operations, and as at most the dryer room will have only 3 to 4 drums of powder, this event was not selected for further evaluation. A bounding event, powder release due to a mishandling accident in the truck bay, was selected for further evaluation.

A pallet of drums, while being loaded on a truck, is postulated to be dropped and crushed by a second vehicle resulting in a spill. Scenarios for releasing the drum contents could also include major earthquakes, mishandling accidents in conjunction with improper packaging, and transportation accidents.

5.2.4.1 Hydrogen Peroxide Spill

A spill of H_2O_2 into its bermed area could result in atmospheric releases of H_2O_2 either as a vapor or as an aerosol. The primary release mechanism would be expected to be an aerosol release resulting from the effervescence of the decomposing peroxide in the pool. However, since the released aerosol has an extremely large surface, the droplets would decompose very rapidly to water and oxygen gas. Because of this, and because of catalytic effect of normal dust in the air, it would not be expected that appreciable peroxide concentrations could exist in air at distances of 100 meters and greater from the release point. Nevertheless, the H_2O_2 tank was evaluated for effects of a release if complete failure of the tank and berm would occur, thus conservatively making available the entire contents for dispersion out of the facility.

6.0 EVENT CONSEQUENCES

6.1 Calculation Models

Consequences of the events and conditions identified in Section 5.0 were estimated using two computational models. The Emergency Prediction Information (EPI) code was used to calculate the source term and dispersion for chemical releases while the HUDU program was used for radiological dose calculations and the dispersion calculation for radiological releases.

The EPI program was developed by Homan Associates, Inc. for use in hazardous material emergency planning and response. The program has five source models:

Continuous Release
Term Release
Area Continuous
Area Term
Liquid Spill

The liquid spill option calculates the source term from a pool of spilled liquid. The area continuous and area term options are also spills but the user must supply the source term. The EPI program uses both the plume and puff Gaussian dispersion models depending on the duration of the release. The program users manual documents the features of the program. The EPI spill option was used to calculate the consequences for ST and H_2O_2 spills, the area continuous release option was used to estimate the consequences of a LERF basin being uncovered.

The HUDU program was developed for use in the Hanford emergency centers to provide a rapid initial assessment of radiological emergency situations. The code employs a straight-line Gaussian atmospheric dispersion model to estimate the transport of radionuclides released from an accident site. It calculates internal doses due to inhalation and external doses due to exposure to the plume. The HUDU program was used to calculate radiological consequences discussed in this hazards assessment. Source terms were estimated by utilizing data from DOE-HDBK-013-93, "Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) at DOE Non Reactor Nuclear Facilities."

6.2 Receptor Locations

Classification of an emergency depends not only on the amount released but also the distances to the facility and site boundaries and the radiation and toxic criteria for each class of emergency. The facility boundary receptor location for both the LERF and ETF was selected to be 100 meters from the point of release.

The closest distance to the site boundary is 14.8 km (East) and was used for Hanford Site boundary calculations. The size of the Hanford Site will be reduced in 1994. The new boundaries have not been established but will probably be the Columbia River on the north and highway 240 on the south. Changing the Hanford boundary will not affect the classification of events at the LERF or ETF since the maximum possible emergency with the present inventory is a Site Area Emergency.

6.3 Criteria for Emergency Classification

The dose and concentration criteria that apply to the LERF and ETF for each emergency classification are listed below.

Alert Emergency

Radiological

A projected total effective dose equivalent (TEDE) of 100 mrem at the facility boundary to standard man, where the projected dose equivalent is the sum of the Effective Dose Equivalent (EDE) from exposure to external sources and the Committed Effective Dose Equivalent (CEDE) from inhalation during the early phase of a release.

Hazardous Material

A peak concentration in air that equals or exceeds the ERPG-1 value, or equivalent, at the facility boundary.

Site Area Emergency

Radiological

A projected TEDE of 1 rem at the facility boundary to standard man, where the projected dose equivalent is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase of a release.

Hazardous Material

A peak concentration in air that equals or exceeds the ERPG-2 value, or equivalent, at the facility boundary.

General Emergency

Radiological

A projected TEDE of 1 rem at the Hanford boundary to standard man, where the projected dose equivalent is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase of a release.

Hazardous Material

A peak concentration in air that equals or exceeds the ERPG-2 value, or equivalent, at the Hanford boundary.

6.4 Calculation Input and Results

6.4.1 Liquid Effluent Retention Facility

6.4.1.1 Basin Evaporation Consequences

The design basis monthly maximum average evaporation rate has been determined to be 11 in/mo of LERF basin fluid. Values in the range 1.0 E-11 to 1.0 E-7 are typical partition coefficients for the Hanford Site. For conservatism, a value of 1.0 E-07 has been used for all radionuclides present in LERF fluid, except for tritium where a partition coefficient of 1 was used.

The evaporating fluid is conservatively assumed to uniformly mix within the airspace volume comprised of the first three meters above the basin. Assuming a windspeed of 1 m/sec yields a maximum airborne LERF fluid concentration of approximately 3600 mg/m^3, which equates to a tritium concentration of 36 uCi/m^3 and an ammonia concentration of 49 mg/m^3.

A person standing at the basin's edge breathing 20 L/min would receive a dose rate of approximately 4 mR/hr due to tritium uptake via the inhalation and skin absorption pathways. This result is based on data found in DOE/EH-0071, "Internal Dose Conversion Factors for Calculation of Dose to the Public." It is therefore concluded that the radiological concentration of tritium at the 100 meter facility boundary is well below levels warranting emergency declaration.

EPI modeling indicates the ammonia concentration 100 meters downwind from the uncovered basin will be approximately 39 ppm. This result would be expected under the worst case dispersion conditions of F stability and 1 m/sec windspeed. Since this concentration exceeds the ERPG-1 value of 25 ppm, an

ALERT should be declared whenever a significant portion of a basin is uncovered until field measurements at 100 meters indicate ammonia concentrations are below 25 ppm.

Spray Leak Event

It is estimated that 170 L/h of LERF fluid would be released through an optimally sized orifice, of which only approximately 0.15% would be in the respirable particle range. This equates to 0.26 L/h of respirable particles being expelled, which is used as input to HUDU calculations. This results in a release rate of 260 mL/h of LERF fluid containing 2.5 E-03 μCi/mL, or a release rate of 6.5 E-01 μCi/h of ^{234}U. The release duration is conservatively assumed to be two hours before mitigation techniques successfully isolate the affected piping. HUDU modeling projects a release of 1.3 uCi of ^{234}U would impart a dose of approximately 1 mrem to a receptor at the facility boundary.

The concentration of ammonia that an exposed individual sees is determined by assuming all the ammonia in solution is volatilized upon exiting the orifice due to agitation and depressurization. This yields an ammonia source term of approximately 0.64 mL/sec. EPI modeling indicates this source term would result in a ammonia concentration of approximately 29 ppm at the facility boundary. Since this concentration exceeds the ERPG-1 value of 25 ppm, an ALERT should be declared whenever a breech in LERF piping occurs until field measurements at 100 meters indicate ammonia concentrations are below 25 ppm.

Spill Event

The methodology of NUREG-1320, was used to estimate the fraction of spilled material aerosolized during a spill event. The model assumes the postulated volume of fluid drops as a single mass from a height of 3 meters (i.e., approximately 10 feet which is representative of the maximum expected potential fall height for LERF fluids) onto the floor. This results in a fraction aerosolized of 1.14 E-05, which is equivalent to the aerosolization of 4.31 cm^3 of LERF fluid for a postulated 379 liter spill. This release is assumed to occur over a time period of one (1) second in accordance with the assumptions in NUREG-1320.

The release of 4.31 mL of LERF fluid containing 2.5 E-03 μCi/mL, or a total of 1.1 E-02 μCi of ^{234}U, results in HUDU projected-dose of less than 1 mrem at the facility boundary.

Toxicological effects of ammonia due to a spill of LERF fluid were estimated by using the EPI spill model assuming worst case dispersion conditions. EPI determined that a spill greater than approximately 170 gallons could result in an ammonia concentration greater than 25 ppm at the facility boundary; consequently, an ALERT should be declared whenever a spill of LERF fluid greater than 644 liters occurs until field measurements at 100 meters indicate ammonia concentrations are below 25 ppm.

6.4.2 Effluent Treatment Facility

The accidents selected for analysis are a release from the ST, a CT spray release and a release from crushed powder drums. The surge tank is located outside the process building and will have both radionuclides and organic chemicals that would be released. The CT has no organic chemicals but a higher concentration of radionuclides than the surge tank. The powder drums will be loaded onto trucks outside the building or just inside the truck bay with access to the outside. Of the process chemicals only a H_2O_2 spill was selected for analysis. H_2SO_4 has very low vapor pressures and tends to lose water instead of evaporating, while NaOH is hygroscopic, attracting moisture instead of evaporating. Therefore H_2O_2 is analyzed as the most worse case chemical spill.

6.4.2.1 Surge Tank Spill

A spill from the ST due to a large fracture or complete failure is assumed to fall less than 3 meters and result in an airborne release. The airborne release fraction (ARF) and respirable fraction (RF) for this event is ARF 2×10^{-4}/RF $0.7 = 1.4 \times 10^{-4}$. For the surge tank volume of 380 m^3 (100,000 gallon), this results in a release of 53 liters containing the radioisotopes listed in Table 3-3. HUDU modeling indicates such a release would result in a dose of approximately 6 mrem at the facility boundary.

Toxicological consequences were calculated based on available sources of information and using the most conservative assumptions to approximate the unmitigated release. The chemical source terms were analyzed using the EPI spill model and indicated toxicological consequences were well below levels warranting emergency declaration. Furthermore, the SAR conservatively demonstrated that a fictitious solution comprised of methylene chloride, nominally present at 0.14 ppm, at a concentration equal to the total contaminant level of 700 ppm, would still result in concentrations well below ERPG-1 values.

6.4.2.2 Concentrate Tank Spill

The CT spill source term was estimated in a similar manner to that of the ST spill, yielding a respirable release fraction of 1.4×10^{-4}. The CT volume is 19 m^3 (5,000 gal), therefore, 2.66E-03 m^3 or 2660 mL of liquid is released containing the isotopes presented in Table 3-3. For an unmitigated, unfiltered release, HUDU modeling predicts a dose of approximately 370 mrem to a receptor at the facility boundary and less than 1 mrem at the site boundary. Since concentrate tank spills would be contained within the process building, a concentrate tank release would warrant declaration of an ALERT only upon confirmation of both stack CAM and HEPA filtration DP alarms.

6.4.2.3 Concentrate Tank Spray Release

It is postulated that a pipe leak occurred in a transfer line during the transfer of radioactive liquid from the CT in ETF to the Thin Film Dryer. This case is the worst-case piping leak because the CT contains the highest concentrations of radioisotopes. In the analysis, it is also conservatively assumed that the liquid jet is issuing from a hole, i.e., a plain circular orifice, which produces the maximum aerosol release rate for the system operating temperature and pressure. This yields a maximum aerosol release rate of approximately 0.01 gallons per minute, which results in a two hour release of 2.3 liters containing the radioisotopes listed in Table 3-3. HUDU modeling projects for an unmitigated, unfiltered release, a dose to a facility boundary receptor of approximately 160 mrem and less than 1 mrem at the site boundary. Similar to a concentrate tank spill, material would be contained within the process building and an ALERT declared only upon confirmation of both stack CAM and HEPA filtration DP alarms following a concentrate tank failure.

6.4.2.4 Release of Powder from Drums

A release model utilized a combination of a "puff" airborne release fraction/respirable fraction (ARF/RF) for the initial failure of the drums and a "resuspension" airborne release rate/respirable fraction (ARR/RF) to model the effects of the air passing over the exposed waste. The puff ARF/RF for the bounding case of free fall spills from a height of 3 m or less, is 5.0 x 10^{-04}/0.5 and the ARR/RF is taken as 4.0 x 10^{-05}/hr.

Assuming the initial release is an average of 25 % of the drum contents for a puff ARF/RF of 5.0 x 10^{-5} x 0.5 x 0.25 = 6.25 x 10^{-6}. Allowing 2 hours for the cleanup, the resuspension ARR/RF would be 4.0 x 10^{-5}/hr times 2 hours = 8.0 x 10^{-5}. Adding the two releases gives a total ARF/RF of 8.63 x 10^{-5} for each radioisotope listed in Table 3-3 involved in the spill. HUDU modeling indicates the release would result in a dose of approximately 150 mrem to a receptor at the facility boundary and less than 1 mrem at the site boundary. Since powder spills would be contained within the process building, a powder release within the process building would warrant declaration of an ALERT only upon confirmation of both stack CAM and HEPA filtration DP alarms. A powder release from a mishandling accident while not within the confines of the process building warrants immediate declaration of an ALERT.

The effects of a release of chemicals in the powder are not as simple to calculate. The list shown in Table 3-2 is for ions, which can not be used to estimate toxic releases. The possible combinations of chemicals that could be present is quite large; however, they are not anticipated to be extremely reactive or present in concentrations warranting special attention. Furthermore, the radiological content of the powder will ensure it is properly handled in the event of a large release. The toxicological effects of a powder release are bounded by the effects anticipated from the more volatile organic compounds released during a surge tank spill event.

6.4.2.5 Hydrogen Peroxide Spill

A spill of H_2O_2 into the berm area around the tank would not be apt to reach the atmosphere because of the vessel ventilation system charcoal filters and the HVAC system particulate filters. Although the filters might not remove the all H_2O_2 from the air, H_2O_2 disassociates into oxygen and water, ($2H_2O_2 \rightarrow 2H_2O + O_2$) rapidly when exposed to air and agitated. The air handling fans would increase the rate of disassociation. The concentration of H_2O_2 would be considerably reduced by the time it reached the stack.

EPI was used to calculate the consequences from a H_2O_2 release from the 2500 gallon storage tank, while neglecting the berm area and building. From EPI calculations, the onsite concentration at 100 m would be 330 ppm and the offsite concentration is less than 1 ppm. It should be remembered that EPI does not calculate the amount of disassociation of the H_2O_2, giving the worse possible results. Additional analysis show that a spill from the 4000 gallon tanker car used to deliver the H_2O_2 yields a concentration of 420 ppm at 100 m. The duration of the concentration level depends on the quantity of H_2O_2 spilled and the rate of cleanup. An uncontrolled release from the H_2O_2 storage tank or tanker car warrants declaration of a Site Area Emergency until field measurements at 100 meters indicate the H_2O_2 concentrations are less than 25 ppm.

6.4.2.6 Large Earthquake

A massive spill caused by a greater than design basis earthquake was postulated as a worse case accident. For this spill the same fractional releases for tanks were used as for the single tank spill. For the powder drums and thin film dryer the same ARR was used with a 24 hour release period instead of the 2-hour release. Assuming a total spill of the surge tank, both secondary waste tanks, both concentrate tanks, all 720 powder drums, and the powder contained in the evaporator, dryer, and piping, the SAR analysis concluded the worst case accident results in a dose of 3.6 rem onsite and 0.025 rem at the site boundary. The toxic releases from H_2O_2 were previously determined to yield concentrations of 330 ppm and 0.6 ppm at the facility and site boundaries, respectively. Consequently, a large earthquake resulting in extensive damage to the facility's structure warrants declaration of a Site Area Emergency. It should be noted the consequences of a large earthquake affecting the 200 Area would be primarily influenced by the larger source terms present in the tank farms and reprocessing facilities.

6.4.3 Other Potential Release Modes

Fires, explosions, volcanic ash fall, security events, etc., may all lead to potential environmental releases. These types of events can pose serious challenges to facility barriers and affect personnel safety.

6.4.3.1 Natural Emergencies

Seismic events, high winds/tornados, floods, ash/snow roof loading, and range fires are natural phenomena with potential emergency consequences. The SAR concluded that a flood is not credible and seismic events were discussed previously. Guidance for classifying other events is provided below based on the scenario results above and the general Hanford policy on events of this type.

6.4.3.1.1 High Winds/Tornado

Some damage is expected if high winds or a tornado strike the LERF/ETF complex, but the offsite impact is not expected to be significant. The survivability varies with building; consequently, a graded precautionary approach is recommended for high winds. An Alert Emergency should be declared if sustained winds exceed 145 km/h and damage from high winds is observed. A Site Area Emergency should be declared if a tornado strikes the LERF/ETF complex and causes extensive damage. Significant offsite consequences are not expected with the current plant configuration and hazardous material inventory.

6.4.3.1.2 Range Fire

The Hanford Site is in a semiarid region with sagebrush and grasses growing between areas. Range fires periodically occur and can sweep over large regions before they are controlled. The summer months are historically the most likely time for a large fire to occur because of the combustible condition of the natural grasses.

The LERF/ETF complex would probably not be affected by a range fire since the ground near the buildings is devoid of vegetation. Furthermore, the hazardous materials are not flammable, therefore, not particularly susceptible to a fire initiated from outside the building. As a precaution, the facility could respond by initiating process shutdowns or ventilation modifications to reduce smoke distribution into the facility. Any LERF/ETF fire initiated by any cause may require declaration of an emergency depending upon the circumstances and material at risk. As a precaution, any fire which threatens hazardous or radioactive material inventories and requires Hanford Fire Department response for suppression should warrant declaration of an ALERT.

6.4.3.1.3 Abnormal Roof Loading

The roof of ETF process building provides a potential barrier to the release of significant hazardous material inventories. The roof's integrity could be challenged by accumulation of volcanic ash, snow, or water from heavy rains/melting snow. Although abnormal roof loading could lead to a structural failure which initiates a hazardous release, it is not expected that such an event would have offsite consequences. There would probably be ample warning of an approaching large ash fall or unfavorable meteorological conditions, allowing the facility ample time to be placed in a stable condition and steps taken to protect workers. For these reasons, no Emergency Action Level is recommended for abnormal roof loading at the ETF.

6.4.3.2 Security Contingencies

DOE Order 5500.3A specifies that the facility hazards assessment shall consider the broad range of emergency events that could affect the facility. These events may result from hostile attack, terrorism, sabotage, or malevolent acts as well as the more traditional accidents and natural phenomena covered in the SAR. Closely related DOE Order 5630.3 requires a graded assessment of radiological and toxicological sabotage vulnerability. Events of this type are not within the scope of a SAR. The paragraphs below reflect the general Hanford emergency preparedness policy toward events of this type and the potential for onsite and offsite significant consequences.

6.4.3.2.1 Explosive Device/Bomb Threat

The presence of an explosive device within the LERF/ETF complex is classified as an Alert Emergency. Activation of the emergency response organization will assist in building evacuation and access control. Furthermore, activation of the emergency response organization will provide essential resources in the event of a detonation.

6.4.3.2.2 Sabotage

Confirmed physical damage from sabotage which threatens facility integrity is classified as an ALERT since the level of safety has been degraded and there could be additional damage that has not yet been discovered.

6.4.3.2.3 Hostage Situation/Armed Intruder

A confirmed hostage situation or armed intruder is classified as an Alert Emergency based on the guidance for emergency classification and the potential loss of hazardous material confinement. The resources of the emergency response organization will be useful in controlling access to the area and identifying and assessing potential damage scenarios. Any release that occurs from the action of intruders should be classified based on the known or potential severity of the release.

7.0 THE EMERGENCY PLANNING ZONE

The Emergency Planning Zone (EPZ) is an area within which special planning and preparedness efforts are warranted since the consequences of a severe accident could result in Early Severe Health Effects (ESHE). DOE Order 5500.3A endorses the EPZ concept and requires that the choice of an EPZ for each facility be based on an objective analyses of the hazards associated with the facility. The Emergency Management Guide on Hazards Assessment provides several pages of guidance on establishing the size of the EPZ. The suggested approach is to determine the emergency classification of the events analyzed in the Hazards Assessment and then base the EPZ size on the larger of a default size for each emergency class or the maximum distance that an Early Severe Threshold is exceeded. A final step is to make adjustments to the area, if necessary, based on reasonableness tests in the guidance document. For example, the selected EPZ should conform to natural and jurisdictional boundaries where reasonable. The selection of the EPZ for the LERF and ETF are described below.

Values for the dose and exposure concentrations of ESHE for the purpose of emergency planning zones are listed in the DOE guidance.

<u>The radiological values are:</u>

External or uniformly distributed internal emitters	100 rem
Thyroid	3000 rad
Skin	1200 rad
Ovary	170 rad
Bone Marrow	165 rad
Testes	440 rad
Other Organs	550 rad

<u>The Non-Radiological values are:</u>

A peak concentration of the hazardous material in air that equals or exceeds the ERPG-3 value or equivalent.

7.1 The Minimum EPZ Radius

The highest emergency classification for the LERF is an ALERT; consequently, an EPZ for the LERF is not necessary. The highest emergency classification for the ETF is a Site Area emergency for a large earthquake or large spill of H_2O_2. The minimum EPZ radius for a Site Area Emergency is the larger of 2 kilometers or that distance where concentrations exceed thresholds for Early Severe Health Effects (ESHE). The only postulated accidents where ESHE levels may be exceeded involve spills of H_2O_2; however, EPI modeling indicates these levels do not extend beyond 0.6 kilometers under worst case dispersion conditions. Consequently, the EPZ for the ETF is 2 kilometers. It should be noted the ETF EPZ is encompassed by the 10 mile EPZ established for the 200 Area Tank Farm complex. The "reasonableness tests" described in the Emergency Management Guide on Hazards Assessments have been used to evaluate the larger Tank Farm EPZ and are discussed in the Tank Farm hazards assessment.

8.0 EMERGENCY CLASSES, PROTECTIVE ACTIONS, AND EMERGENCY ACTION LEVELS

A Site Area Emergency is the worst emergency classification anticipated with the present plant configuration and expected inventories. Emergency Action Levels for both the LERF and ETF are identified in Appendix A.

9.0 MAINTENANCE AND REVIEW OF THIS HAZARDS ASSESSMENT

The manager of Hanford Hazards Assessment is responsible for ensuring that this Hazards Assessment is regularly reviewed and maintained current. The review requirement is specified in Westinghouse Hanford Company Emergency Plan WHC-CM-4-1, section 2.0 (Hazards Assessment) of section 4 (Emergency Conditions).

10.0 REFERENCES

DOE Order 5500.3A, Emergency Planning and Preparedness for Operational Emergencies, 04/30/91.

DOE, 1993, Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) at DOE Non-Reactor Nuclear Facilities, DOE-HDBK-013-93, U.S. Department of Energy, Washington, D.C.

DOE, Emergency Management Guide, Hazards Assessment, 06/26/92

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EPI Code, Homann Associates, Inc., Fremont CA, 1993

Lavender, J. C., 1992, 242-A Evaporator/Crystallizer Safety Analysis Report, Rev. 1, WHC-SD-WM-SAR-023, Westinghouse Hanford Company, Richland, Washington.

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Scherplez, R. I., Hanford Unified Dose Utility computer code, 9/91.

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ATTACHMENT A EMERGENCY ACTION LEVELS

FACILITIES EMERGENCY EVENTS

RADIOACTIVE MATERIAL RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Ventilation stack release	Activation of the ETF's stack CAM alarm, and DP gage indicates HEPA filter failure. **AND** Release from Concentrate Tank or powder release during drum loading or handling operations.	**ALERT LEVEL EMERGENCY**
Powder Drum Spill	Release from powder drums during drum loading or handling operations external to the ETF.	

FACILITIES EMERGENCY EVENTS

LOSS OF FACILITY CONFINEMENT

Initiating Condition	Emergency Action Level	Event Classification
LERF Transfer Line Spray Leak*	242A to LERF transfer spray leak.	**ALERT LEVEL EMERGENCY**
LERF Basin Cover Failure*	LERF basin cover failure exposing greater than 50 % of the basin surface area and most recent sample data is unknown or indicates ammonia concentrations >8800 ppm.	
LERF Transfer Line Spray Leak*	242A to LERF transfer line spray leak.	
LERF Spill*	More than 170 gallons of LERF fluid is spilled.	

NOTE: *If applicable sampling data indicates ammonia concentrations are significantly less than the assumed value of 1.36E+04 ppm, a concentration ratio can be used to modify the predicted event consequences (39 ppm for cover failure, 29 ppm for spray leak, and 25 ppm for spill) and the need for emergency classification.

FACILITIES EMERGENCY EVENTS

ETF FIRE AND/OR EXPLOSION

Initiating Condition	Emergency Action Level	Event Classification
A fire or explosion at ETF	A FIRE or EXPLOSION within the ETF with the potential for affecting hazardous or radioactive material inventories, **AND** HFD response required for suppression.	**ALERT LEVEL EMERGENCY**

FACILITIES EMERGENCY EVENTS

HAZARDOUS MATERIAL RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Hydrogen Peroxide Spill	A spill of hydrogen peroxide greater than 50 gallons but less than 170 gallons.	**ALERT LEVEL EMERGENCY**
Hydrogen Peroxide Spill	A release of hydrogen peroxide (170 gallons or more). OR A measured hydrogen peroxide concentration in excess of 25 ppm at the facility boundary.	**SITE AREA EMERGENCY**

NATURAL EMERGENCIES

SEISMIC EVENT

Initiating Condition	Emergency Action Level	Event Classification
A seismic event*	A seismic event causes severe building damage (walls fall, underground pipes broken, ground cracked) in the 200 Areas.	**SITE AREA EMERGENCY**

Note: *A seismic event of less magnitude may warrant declaration of an ALERT as per other appropriate emergency action levels.

NATURAL EMERGENCIES

HIGH WINDS / TORNADO

Initiating Condition	Emergency Action Level	Event Classification
High winds in the 200 Areas	Sustained wind speeds greater than or equal to 90 mph in the 200 Areas, confirmed by the Hanford meteorological personnel.	**ALERT LEVEL EMERGENCY**
A tornado strikes the ETF	Tornado visually seen striking the ETF causing extensive damage.	**SITE AREA EMERGENCY**

SECURITY CONTINGENCIES

BOMB THREAT/EXPLOSIVE DEVICE

Initiating Condition	Emergency Action Level	Event Classification
Bomb threat	A credible bomb threat (with concurrence of Hanford Patrol, see note) indicating that a device is located in an ETF location containing radioactive or hazardous materials.	**ALERT LEVEL EMERGENCY**
Explosive device	A confirmed explosive device (with concurrence of Hanford Patrol, see note) located within the ETF.	
Explosive device	An explosion occurs which results in confirmed loss of ETF integrity.	**SITE AREA EMERGENCY**

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 East Area security plan does not necessarily require declaration of an operational emergency. The shift operations manager/area emergency director must coordinate with the area patrol Shift Commander for classification of the event.

SECURITY CONTINGENCIES

SABOTAGE

Initiating Condition	Emergency Action Level	Event Classification
Sabotage (industrial/radiological)	Confirmed deliberate act (with concurrence of Hanford Patrol, see note) against the ETF resulting in significant damage **AND** threat to the public health.	**ALERT LEVEL EMERGENCY**

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 East Area security plan does not necessarily require declaration of an operational emergency. The shift operations manager/area emergency director must coordinate with the area patrol Shift Commander for classification of the event.

SECURITY CONTINGENCIES

HOSTAGE/ARMED INTRUDER

Initiating Condition	Emergency Action Level	Event Classification
A hostage situation	A confirmed hostage situation (with concurrence of Hanford Patrol, see note) is occurring within the ETF.	**ALERT LEVEL EMERGENCY**
Armed intruder(s)	Confirmed hostile armed individual(s) (with concurrence of Hanford Patrol, see note) located within the ETF boundary.	

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 East Area security plan does not necessarily require declaration of an operational emergency. The shift operations manager/area emergency director must coordinate with the area patrol Shift Commander for classification of the event.