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283E & 283W HAZARDS ASSESSMENT

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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 606595

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. L. N. Sutton Emergency Preparedness 373-2258 - R2-58		3a. USQ Required? ☐ Yes ☒ No	4. Date 7/14/95
	5. Project Title/No./Work Order No. Emergency Preparedness		6. Bldg./Sys./Fac. No. 283-E & 283-W	7. Approval Designator S
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-PRP-HA-012, Rev 1 0		9. Related ECN No(s). NONE	10. Related PO No. NONE
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A _____ Cog. Engineer Signature & Date		11d. Restored to Original Condition (Temp. or Standby ECN only) N/A _____ Cog. Engineer Signature & Date
12. Description of Change Entire document revised				
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☒ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐				
13b. Justification Details				
14. Distribution (include name, MSIN, and no. of copies) See Distribution List			RELEASE STAMP OFFICIAL RELEASE BY WHC DATE SEP 08 1995 Sta. 4	

Page 2 of 2

606595

A-7900-013-3 (11/94) GEF096

RELEASE AUTHORIZATION

Document Number: WHC-SD-PRP-HA-012, REV 1

Document Title: 283-E and 283-W Hazards Assessment

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SUPPORTING DOCUMENT1. Total Pages **30**

2. Title

283-E and 283-W Hazards Assessment

3. Number

WHC-SD-PRP-HA-012

4. Rev No.

1

5. Key Words

283-E and 283-W Hazards Assessment, Emergency Preparedness

6. Author

Name: LN Sutton

Signature

Organization/Charge Code 3A000/MD5EP

7. Abstract

This document establishes the technical basis in support of Emergency Planning Activities for the 283-E and 283-W Facilities on the Hanford Site. Through this document, the technical basis for the development of facility specific Emergency Action Levels and the Emergency Planning Zone is demonstrated.

8.

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283-E AND 283-W HAZARDS ASSESSMENT

L. N. Sutton

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1.0 INTRODUCTION

This report documents the hazards assessment for the 200 Area Water Treatment Plants 283-E and 283-W located on the U.S. Department of Energy (DOE) Hanford Site. Operation of the Water Treatment Plants is the responsibility of ICF Kaiser Hanford Company (ICF KH). This hazards assessment was conducted to provide the emergency planning technical basis for the water treatment plants. 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.

2.0 SITE AND FACILITY DESCRIPTION

2.1 Mission

Raw Columbia River water is pumped to the water treatment facilities where it is conditioned (filtered and disinfected) prior to export for use as process, fire protection and potable water. Chlorine is used for bacteria and algae control.

2.2 Location

The 283-E Facility is located in the south central part of the 200 East Area of the DOE Hanford Site. The nearest site boundary is about 13 km (8 mi) to the east (Columbia River). The 200 East Area is located on a plateau at an elevation ranging from approximately 190 to 245 meters (620 to 800 feet) above mean sea level near the middle of the Hanford Site (see Figure 2.2).

The 283-W Facility is located in the east central part of the 200 West Area of the DOE Hanford Site. The nearest site boundary is about 13 km (8 mi) to the west. The 200 West Area is located on a plateau at an elevation ranging from approximately 190 to 245 meters (620 to 800 feet) above mean sea level near the middle of the Hanford Site (see Figure 2.3).

2.3 Hanford Site Description

2.3.1 Physical Description

The DOE Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 2.1). The Hanford Site occupies an area of about 1450 km² (~560 mi²) north of the confluence of the Snake and Yakima Rivers with the Columbia River. The Hanford Site is about 50 km (30 mi) north to south and 40 km (24 mi) east to west. This land, with restricted public access, provides a buffer for the smaller areas currently used for research, waste storage, and waste disposal; only about 6% of the land area has been disturbed and is actively used. The Columbia River flows through the northern part of the Hanford Site, and turning south, it forms part of the Site's eastern boundary. The Yakima River runs along part of the southern boundary and joins the Columbia River below the city of Richland, which bounds the Hanford Site on the southeast. Rattlesnake

Figure 2.1 Location of the Hanford Site in the State of Washington

Figure 2.2 200 East Area

200 East Area

29003062.1

Figure 2.3 200 West Area with 283-W Identified

Mountain, the Yakima Ridge, and the Umtanum Ridge form the southwestern and western boundary. The Saddle Mountains form the northern boundary of the Hanford Site. There are plans to reduce the size of the Hanford reservation. The new boundary will likely be the Columbia River on the north and east and Highway 240 on the south.

Major metropolitan areas within the broad vicinity of Hanford include Spokane, Washington, about 190 km (120 mi) to the northeast; Seattle, Washington, about 210 km (130 mi) to the northwest; and Portland, Oregon, about 240 km (150 mi) to the southwest. Two other areas of significant population density include Moses Lake, Washington, about 48 km (30 mi) north of the K-Area and the Yakima Valley, in Washington, extending from Yakima, about 72 km (45 mi) west of Hanford, to the Tri-Cities, in Washington. The nearest of the Tri-Cities, Richland, is immediately south of the Site.

The Hanford Reservation 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 KE and KW Fuel Storage Facilities within the 100-KE/KW Area; two areas for waste processing and waste storage designated 200-E and 200-W Areas; the 300 Area which contains a shutdown fuel fabrication facility and laboratory facilities supporting all of DOE's Hanford Programs; the 400 Area which contains the shutdown Fast Flux Test Facility (FFTF); a commercial nuclear waste burial operation on land leased to the State of Washington; and an operating Washington Public Power Supply System nuclear power plant.

2.3.2 Floods

Large Columbia River floods have occurred in the past (DOE 1987), but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control/water storage dams upstream of the Site.

There are no Federal Emergency Management Agency (FEMA) flood plain maps for the Hanford Reach of the Columbia River. FEMA only maps developing areas, and the Hanford Reach is specifically excluded.

Evaluation of flood potential is conducted in part through the concept of the probable maximum flood (PMF), which is determined from the upper limit of precipitation falling on a drainage area and other hydrologic factors, such as antecedent moisture conditions, snowmelt, and tributary conditions, that could result in maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 40,000 cms (1.4 - million cfs) and is greater than the 500-year flood. The PMF is not expected to inundate the buildings in 300 Area but will flood the 100 F, 100 H, and part of the 100 B/C Areas. The river pumps that supply water to the K Fuel Storage Basins will also be submerged and likely destroyed. The PMF may also flood access roads and temporarily cut off electrical power to the 100 and 300 Areas (see Figure 4.2-10 in Cushing, 1992).

Potential dam failures on the Columbia River have been evaluated. Upstream failures could arise from a number of causes, with the magnitude of the resulting flood depending on the degree of breaching at the dam. The U.S. Army Corps of Engineers evaluated a number of scenarios on the effects of failures of Grand Coulee Dam, assuming flow conditions of the order of 11,000 cms (400,000 cfs). For purposes of emergency planning, they hypothesized that 25% and 50% breaches, the "instantaneous" disappearance of 25% or 50% of the center section of the dam, would result from the detonation of nuclear explosives in sabotage or war. The discharge or floodwave resulting from such an instantaneous 50% breach at the outfall of the Grand Coulee Dam was determined to be 600,000 cms (21 million cfs). In addition to the areas inundated by the probable maximum flood (see Figure 4.2-10 in Cushing, 1992), the remainder of the 100 Areas, the 300 Area, and nearly all of Richland, Washington, would be flooded (DOE 1986; see also ERDA 1976). Flooding of this magnitude would be a regional emergency along the entire downstream length of the Columbia River. Planning and assessment for flooding of this magnitude is beyond the scope of this document.

There have been fewer than 20 major floods on the Yakima River since 1862 (DOE 1986). The most severe occurred in November 1906, December 1933, and May 1948; discharge magnitudes at Kiona, Washington, were 1,870, 1,900, and 1,050 cms (66,000, 67,000, and 37,000 cfs), respectively. The recurrence intervals for the 1933 and 1948 floods are estimated at 170 and 33 years, respectively. The development of irrigation reservoirs within the Yakima River Basin has considerably reduced the flood potential of the river. The 300 Area is not within lands susceptible to a 100-year flood on the Yakima River.

2.3.3 Seismology

The Hanford Reservation 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 and the historical magnitude of these events, is low when compared to other regions of the Pacific Northwest. 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. For more information concerning the seismology and geology of this area, see Section 4.2.3 of the Hanford Site National Environmental Policy Act (NEPA) Characterization (Cushing, 1992).

2.3.4 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).

The Hanford Site is located in a semiarid region of southeastern Washington State. The Cascade Mountains beyond Yakima to the west greatly influence the climate of the Hanford area by means of their rain shadow effect; this range also serves as a source of cold air drainage, which has a considerable effect on the wind regime on the Hanford Site.

2.3.5 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 West Area at the 15-m level was a gust of 36 m/sec (81 mph) recorded January 11, 1972. The 36 m/sec (80 mph) gust is expected to occur once every 30 years. A peak of 38 m/sec (85 mph) would be expected to occur once every 100 years (Cushing, 1992).

The Site is well outside of established tornado alleys. The probability of a tornado in any year at any point within the 160 km (100 mile) radius of the Hanford Meteorology Station is 6.8×10^{-6} /yr (Stone 1972).

2.3.6 Ashfall

The Hanford Reservation is in a region subject to ashfall from volcanic eruptions. The three major volcanic peaks closest to the project are: Mt. Adams about 160 km (100 mi) away, Mt. Rainier at about 180 km (110 mi) away, and Mt. St. Helens approximately 210 km (130 mi) 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. The table below indicates the estimated ash depth deposited at the Hanford Site from past volcanic eruptions in the region.

Table 2.1 Estimated Ash Depth at Hanford from Major Eruptions

Volcano	Time	Depth of Ash	Equivalent Roof Loading	
			Dry (psf)	Wet (psf)
Glacier Peak	12,000 B.P.	1 in.	6	8.4
Mt Mazama	6,000 B.P.	6 in.	36	50
Mt. St. Helens	3,600 B.P.	1 in.	6	8.4
Mt. St. Helens	1980	0.5 in.	3	4.2

B.P. - Before Present

2.4 Facility Description

Water is provided to the 283 facilities from the 282 reservoirs. As the water is pumped to the settling basins alum (aluminum sulfate dihydrate) is added to help agglomerate impurities and sediments. If both chlorinators are in service, the stream into the settling basins may be pre-treated with chlorine to maintain a chlorine concentration of about 0.5 ppm in the basin water. From the basins, the water is gravity fed into clearwells. Chlorine is injected to maintain a concentration of about 1.5 to 2 ppm in the clearwells. Water from the clearwells is pumped into the distribution system to the various 200 Area facilities.

Chlorine is provided from one of two on-line ton containers, containing a mix of liquid and gaseous chlorine. Two other containers are available as backups. The chlorine cylinders are located in a small storage buildings (see Figures 2.5 and 2.6 for layout). One on-line container is active, the other is on standby. The system is designed so that the standby on-line container will automatically begin supplying chlorine when the active container is empty. The chlorine containers are placed horizontally on the floor in a "saddle" formed by stops imbedded in the concrete floor and oriented so that the two outlet valves are aligned perpendicular to the ground (see Figure 2.7). In this configuration, gaseous chlorine passes through the top valve.

It then passes through a vacuum actuated regulating valve that allows chlorine to flow out of the tank as long as sufficient vacuum is maintained on the system. The regulating valve is connected by flexible steel tubing, .95 cm (3/8 inch) O.D. to the chlorine manifold.

The manifold is connected to two Wallace & Tiernan series V-75 Chlorinators in the chlorination room (see Figure 2.8). The chlorinators are designed to chlorinate a small side stream of water flowing to the clearwells or settling basins to a high concentration of chlorine. The flow of the water stream generates a vacuum in the mixing chamber which draws the chlorine gas through an adjustable flowmeter (normally set at about 9 kgs [20 pounds] per day). The treated water is then routed to the clearwells or the basins depending on the valve alignment where it mixes with the non-chlorinated water providing total chlorination.

3.0 IDENTIFICATION AND SCREENING OF HAZARDS

Aluminum sulfate dihydrate is not listed as an extremely hazardous substance in Appendix A of 40 CFR 355 so there is no threshold planning quantity established. The reportable quantity (for spills) is 5,000 pounds and the chemical poses a negligible fire hazard when exposed to heat or flame. Alum will not be evaluated further.

There may be up to four ton cylinders of chlorine at each facility. The quantity stored greatly exceeds the threshold planning quantity of 45.4 kgs 100 pounds so chlorine will be evaluated further.

Figure 2.4 283 E Layout

283-E Filter Plant

Figure 2.5 283 W Layout

283-W Filter Plant

Figure 2.6 Chlorine Cylinder Layout

NOTE:

1. THIS DRAWING IS SPECIFIC TO 283E AND TYPICAL FOR 283W.
2. IN SERVICE AND STANDBY CYLINDER POSITIONS MAY VARY.

Figure 2.7 Chlorinators and Chlorine Manifold

4.0 HAZARD CHARACTERIZATION

4.1 Properties

Chlorine is a poisonous gas at normal temperatures and pressures, and may be fatal if inhaled. The Immediately Dangerous to Life and Health (IDLH) concentration is 25 parts per million (ppm). Gaseous chlorine is an extremely reactive chemical which is 2.5 times heavier than air, so it tends to flow downward and collect in low spots. The gas has a greenish-yellow color and has a very strong, disagreeable, sharp and penetrating odor. In low concentrations, gaseous chlorine appears almost colorless. Contact with the gas may cause burns to the skin and eyes.

The penetrating odor is apparent at about 0.2 part per million parts in air (ppm). At approximately 1 ppm annoying symptoms manifest; nose and throat irritation, and eye lacrimation. Because of these properties, severe industrial exposures seldom occur. People usually leave the area due to the irritation before a severe exposure occurs. At 30 ppm, chlorine causes coughing. At 1000 ppm, chlorine is fatal in a very short time. The Emergency Response Planning Guidelines ERPGs - 1, 2 and 3 for chlorine are 1 ppm, 3 ppm and 20 ppm respectively.

As a liquid, chlorine is an amber colored, oily fluid, 1.5 times heavier than water, which evaporates rapidly when exposed to the atmosphere. At atmospheric pressure, it boils at about -34 °C (-29 °F) and freezes at about -101 °C (-150 °F). Contact of skin or eyes with the liquid form will cause burns and may cause frostbite.

By itself, chlorine is not explosive or flammable. Most combustible materials, however, will burn in chlorine as they do in oxygen. It may ignite other combustible materials, such as wood, paper or oil. Mixtures of chlorine with liquid fuels may explode. Chlorine reacts explosively or forms explosive compounds with many common chemicals, especially hydrocarbons, turpentine, acetylene, ammonia, hydrogen and finely divided metals. Chlorine by itself is not corrosive, but produces highly corrosive hydrochloric (HCl) and Hydrochlorous (HOCl) acids when moisture is present.

Chlorine gas (or liquid) leaks typically get worse initially since the chlorine reacts with moisture in the air to form hydrochloric acid. The acid then corrodes the metal in the storage container or piping system causing an increase in the size of the leak. A small leak in a chlorine storage container can seal itself. As the gas (or liquid) flows out additional chlorine will evaporate in the container. The rapid evaporation may cool the liquid and container sufficiently to form an ice plug in the opening.

4.2 Ton Chlorine Containers

Ton chlorine containers have a chlorine capacity of 870 kgs (1920 pounds) and weigh approximately 1730 kgs (3800 pounds) when full. They are welded heavy walled tanks about 76 cm (30 inches) in diameter and 200 cm 80 inches long. The heads are convex inward and forge welded to the barrel. The sides are crimped inward at each end to form chimes which provide a grip for lifting beams. Each container is equipped with two identical valves near the center of one end. Each valve connects with an internal eduction pipe.

The containers are equipped with six fusible metal plugs, three in each end, spaced 120° apart. The fusible metal is designed to yield or melt between 70 °C and 74 °C (158 °F and 165 °F) to relieve pressure and prevent rupture of the container in case of fire or other exposure to high temperature. Should a plug melt, an opening approximately .87 cm (.344 inch) in diameter would be created to relieve pressure.

4.3 Conditions of Storage and Use

As described earlier, there are four containers positioned horizontally on the floor. Two are connected to the chlorine manifold and two are kept as backups. There are a total of five storage "saddles" so one is always empty. When the active container is empty, it is isolated from the manifold and moved to the open "saddle" using an installed overhead, 2700 kg (3-ton) capacity, crane and spreader bar arrangement. A full container is then moved to the standby position and connected to the manifold.

Chlorine shipments are received by truck. Empty containers are loaded out and replacement containers are loaded in using the same crane and spreader bar arrangement.

5.0 CONSEQUENCE MODEL, RECEPTOR LOCATIONS AND CLASSIFICATION CRITERIA

5.1 Computer Model

Consequences of the events and conditions identified below were estimated using the Emergency Prediction Information (EPI) code. 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.

EPI does not accurately model pure chlorine gas but can be used to predict the downwind concentration after the cloud has mixed with air. More complex heavy gas models are required close to the source of a large release. The general rule-of-thumb is that heavy gas models must be used for concentrations above 50,000 ppm (5 %). The concentrations of interest in this document are far below this value and therefore EPI is used to obtain the results.

5.2 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 toxic criteria for each class of emergency. The facility boundary receptor location for the 283 Facilities was selected to be 100 meters (328 feet) from the point of release.

The distance to the site boundary is approximately 13 km (8 mi) for each facility although in different directions. Calculations were also performed for Highway 240 distances, 5.5 km (3.4 mi) for 283-W and 6.8 km (4.2 mi) for 283-E.

5.3 Emergency Classification Criteria

A goal of the DOE emergency preparedness system is to quickly classify the severity of an accident. Preplanned actions are then implemented for each emergency class. Emergency classification is based, in part, on projected hazardous material concentrations at the facility and Hanford site boundaries for pre analyzed accident scenarios. The emergency classification criteria are shown below.

Table 5.1 Non-Radiological Release Criteria

<u>Emerg. Class</u>	<u>Criteria*</u>
Alert	> ERPG 1 at facility boundary
Site Area	≥ ERPG 2 at facility boundary
General	≥ ERPG 2 at site boundary

*The criteria apply to a peak concentration of the substance in air. If Emergency Response Planning Guideline (ERPG) values have not been established for a substance, alternative criteria specified in the Emergency Management Guide for Hazards Assessments shall be used.

There are also general criteria for emergency classification in addition to the numerical values in the tables above. The threshold between reportable occurrences and the Alert Level classification is difficult to establish based solely on a numerical value. The following general criteria apply in addition to the dose commitment and airborne release concentration values specified in the tables above.

ALERT

An ALERT LEVEL Emergency shall be declared when events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the facility with an increased potential for a release.

In general, the ALERT classification is appropriate when the severity and/or complexity of an event may exceed the capabilities of the normal operating organization to adequately manage the event and its consequences.

SITE AREA

A SITE AREA emergency shall be declared when events are in progress or have occurred which involve actual or likely major failures of facility functions needed for protection of workers and the public.

GENERAL

A GENERAL EMERGENCY shall be declared when events are in progress or have occurred that involve actual or imminent catastrophic failure of facility safety systems with a potential for loss of confinement or containment integrity.

There is additional emergency classification guidance in the Emergency Management Guide on Event Classification and Emergency Action Levels. The Hazards Assessment in the following sections is based primarily on a comparison of calculated consequences with the numerical criteria in the tables above. However, some recommendations are provided based on the more general emergency classification criteria.

This section briefly describes several scenarios from various safety documents issued in support of SWMO activities. The projected consequences from these events are used to establish the size of the emergency planning zone and to provide guidance for establishing EALs.

DOE Order 5500.3A also specifies that accidents whose consequences and probabilities fall outside the scope of traditional safety analysis reports must be considered. These events include accidents of higher probability and less consequence and those that may be classified as incredible in the SAR.

6.0 EVENT SCENARIOS AND CONSEQUENCES

6.1 Chlorine System Breach Descriptions

The ton chlorine system barriers are the tank walls, valves, piping and fusible plugs. These barriers could fail by any of several modes:

- a. The tank could be dropped while being unloaded from the transport truck. A fall could damage a valve or perhaps puncture the tank. The leak rate would depend on the size of opening and the location. A hole in the gas space would flow less chlorine (pounds/hour) than a hole of the same size below the liquid level. Liquid chlorine would evaporate rapidly upon contact with the ground but could eventually form a pool depending upon the size of the leak.
- b. Puncturing or valve damage by external impact (such as being rammed by a heavy piece of equipment). The tanks are quite sturdy and therefore not easily damaged. The valves are protected by a cover when not in use. However, the potential to damage a valve or puncture a tank still exists. A small leak would probably be patched before the entire tank contents were released. The release rate would depend on the size and location of the opening. Because the tanks are close together, it is possible that more than one tank could be damaged during a single, major accident. However, it is most likely that only one tank would be damaged by an accident.
- c. Corrosion failure of the tank structure. In most cases, this would result in a small leak. However, small chlorine leaks tend to initially grow larger since the chlorine reacts with moisture in the air to form hydrochloric acid which further corrodes the metal. Only one tank would likely be affected by such an event. A massive failure of the tank structure due to corrosion is extremely unlikely.
- d. A fire causing melting of one or more fusible plugs. Each tank has six fusible metal plugs, three in each end, spaced 120° apart. The fusible metal is designed to yield or melt between 70 °C and 74 °C (158 °F and 165 °F) to relieve pressure and prevent rupture of the tank in case of fire or other exposure to high temperature. Each plug is .87 cm (.344 inch) in diameter. The leak rate would depend upon the number of plugs that melted and whether they are venting liquid or gaseous chlorine.
- e. Natural disasters such as earthquakes, high winds, tornados, airplane crashes, etc. could result in damage to the tanks or piping. Leaks caused by natural disasters could range from very minor to catastrophic.
- f. An act of sabotage or malevolent event resulting in a release from a chlorine storage tank. This event could range from opening a valve to blowing up one or more tanks with an explosive device. The latter unlikely case is potentially the worst case release.

The chlorine tanks are located inside a building but the building provides no containment in the event of a chlorine leak.

There is a large range of possible releases from the failure modes identified. The most likely case would be a small gas leak at the valve connection or in the connecting piping within the storage building or the chlorinator room. This event also requires that the vacuum regulator valve fails to shut off the flow of chlorine. A small leak could easily be stopped before a significant quantity escaped. However, even a moderate sized opening in the liquid portion of the tank could leak a large fraction of the tank contents quickly. Three cases will be considered. The first is a relatively small gas leak of 6.8 kgs (15 pounds) per hour. This could occur from a leak at the gas valve connection, or a small hole in the liquid portion of the tank which drains liquid chlorine to the floor of the storage building. Fifteen pounds per hour was selected since experience has shown (Chlorine Manual, 1986) that this is the maximum sustainable gas flow rate through a chlorine system without freezing. However, much larger gas flow rates are possible from a hole in the tank.

The second case is a 180 kg (400 pounds) per hour leak. This leak is either a large gas leak or mid-sized liquid leak. Leak rates this large can be obtained from damage to the liquid valve, inadvertent partial opening of the liquid valve, a fusible plug leak or a small hole in the liquid portion of the tank. This case is close to an actual occurrence in the Morristown, Tennessee water treatment plant. Before the leak was capped, approximately 1,360 kgs (3,000) pounds of chlorine had escaped in seven hours from a pair of one-ton tanks connected together through a manifold. The average leak rate in this actual event was approximately 195 kgs (430 pounds) per hour.

The last case is a sudden release from a full tank. This case is an upper bound and represents a large liquid leak from the tank. Calculation of the actual leak rate from a hole is complex and depends on the hole size and geometry (circular, rectangular, smooth, or jagged edges), the containment variables (pressure, temperature), the environmental variables (atmospheric pressure, ambient temperatures and wind speed), and the thermodynamic properties of the surface below the tank. The flow through the rupture could be two-phase (liquid and gas) or single phase. The initial flow rate through even a moderate sized hole such as an open valve or melted fuse plug will be high, i.e. over 4500 kgs (10,000 lbs) per hour. The leak rate will decrease rapidly as the container pressure falls and the liquid cools. The escaping liquid will likely undergo a flashing phenomena where a part of the liquid flashes to a vapor as the liquid leaves the tank. The remainder of the liquid will puddle on the surface below the tank and evaporate. The evaporation rate will depend on the depth of the pool, the thermodynamic properties of the surface and the ambient air conditions. Chlorine has a high vapor pressure at ambient pressure and tends to evaporate rapidly.

The sudden release of the full tank contents is not an unreasonable upper bound since actual events may empty the tank quickly. The Chlorine Institute Pamphlet 74, "Estimating the Area affected by a Chlorine Release," has a scenario where a one-ton container is struck and the liquid valve is

sheared off. The tank empties in eight minutes. The consequences of this event were predicted using the SAFER/TRACE code system that models many of the phenomena mentioned above. The result reported in the pamphlet was an air concentration at the ERPG 3 level out to 5.6 kilometers (3.5 miles) for a wind speed of 1 m/sec (2.5 mph) and "F" class stability. The sudden release case calculated with the EPI program predicts ERPG 3 values out to almost 8 kilometers (5 miles) for the same meteorological conditions. This degree of conservatism is not considered unreasonable since the scenario in the pamphlet may not be the worst case.

6.2 Chlorine Breach Consequences

The EPI continuous release option was used to model the small and mid-sized chlorine releases. The instantaneous release (term release of zero duration) option was used to model the large chlorine release and saturation effects were ignored. The postulated conditions were "F" class stability, 1 m/s wind speed and a ground level standard terrain release. The results are shown in the following table.

Table 6.1 Chlorine Release Results

Leak Size	Bldg	Facility Boundary Concentration (ppm)	Site Boundary Concentration (ppm)	Highway 240 Concentration (ppm)
6.8 kgs (15 lbs) per Hour	283-E	30	.0082	.018
	283-W	30	.0082	.024
180 kgs (400 lbs) per Hour	283-E	800	.22	.48
	283-W	800	.22	.63
870 kgs (1920 lbs) Instantaneous	283-E	>500,000	4.3	28
	283-W	>500,000	4.3	58

7.0 SUGGESTED EMERGENCY ACTION LEVELS AND CLASSIFICATIONS

7.1 Chlorine System Breach

The consequences calculated in Section 6 indicate that the small and medium leak rates meet SITE AREA EMERGENCY criteria of 3 ppm at the facility boundary and the instantaneous release from a ton container meets the GENERAL EMERGENCY criteria of 3 ppm at the site boundary. An alarm inside the building from an unknown cause with some evidence of a release such as a faint odor outside the building would warrant an ALERT EMERGENCY. A slight chlorine smell is expected during cylinder changeout from residual amounts in the flexible lines and the automatic cutoff valve. This is not an emergency condition.

7.2 Fire

As previously stated, the chlorine cylinders are equipped with six fusible plugs that are designed to melt in order to relieve excess pressure in the cylinder in the event of high heat conditions. For this reason, as a precaution, it is suggested that an ALERT EMERGENCY be declared if a range fire or intra 200 Area fire threatens either 283 Facility chlorine storage area. The Alert emergency is based on the potential degradation of safety at the facility. If the fire engulfs the chlorine storage area a SITE AREA EMERGENCY should be declared due to the potential of melting a fuse plug.

7.3 Earthquake

The level of peak horizontal ground acceleration produced by the Hanford Region Historical Earthquake (HRHE) at the 200 Areas has been calculated to be 0.1 g (PUREX FSAR, Rev 3). While the chlorine storage building is expected to fail, and the piping system may fail during a major earthquake, the chlorine cylinders would survive but be subject to falling debris.

To maintain consistency with other hazards assessments, an earthquake that produces ground acceleration that can be felt by personnel, with some breakage of windows and disturbance of tall objects is classified as an ALERT LEVEL EMERGENCY. The Alert classification will remain in effect until such time as the chlorination system can be examined for damage. Any upgrade of the emergency classification would be based on actual releases of chlorine.

7.4 High Winds/Tornado

Chlorine storage building destruction is expected if high winds or a tornado strikes the facility but the offsite impact is not expected to be significant. The buildings have experienced two wind storms in recent years with gust to 36 m/sec (80 mph) in 1972 and 33 m/sec (73 mph) in 1990 with no damage.

A graded precautionary approach is recommended for high winds at the facility. An ALERT LEVEL EMERGENCY should be declared if sustained winds exceed 40 m/sec (90 mph) and damage from high winds is observed. The 40 m/sec (90 mph) wind speed is suggested for consistency with the EALs at other Hanford facilities. Any upgrade of the emergency classification would be based on actual releases of chlorine.

7.5 Aircraft Crash

Any aircraft crash at or near the facility as an ALERT EMERGENCY. Any upgrade of the emergency classification would be based on actual releases of chlorine.

7.6 Bomb Threat/Explosive Device

A confirmed (with concurrence of security personnel) bomb threat or explosive device in an area of the 283 Facilities which could threaten the chlorine containers or delivery system 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 when the device is found will speed the response if the device detonates. A confirmed detonation of an explosive device may warrant an upgrade to a GENERAL EMERGENCY if a substantial release of chlorine is possible or has occurred.

7.7 Sabotage

Confirmed physical damage from sabotage which threatens facility integrity is classified as an ALERT EMERGENCY since the level of safety has been degraded and there could be additional damage that has not yet been discovered. Any release that occurs due to sabotage is classified based on the known or potential severity of the release.

7.8 Hostage Situation/Armed Intruder

A confirmed hostage situation, armed intruder, credible security threat or ongoing security compromise involving physical attack on the building is classified as an ALERT EMERGENCY based on the guidance for emergency classification. 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.

8.0 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 (ESHEs). 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 ESHE 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 283-E and 283-W Facilities based on the previously discussed accident scenarios is described below.

8.1 The Minimum EPZ Radius

The highest emergency classification for the scenarios described above is a GENERAL AREA Emergency. The EPZ size is the larger of 5 km (the default size for a General Emergency) or the maximum radius for ESHE. The Emergency Management Guide Hazards Assessment document provides the following criteria for ESHEs.

Non-Radiological

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

Conclusion

The instantaneous release from a ton container results in consequences greater than the ESHE criteria at a distance of approximately 7.5 km. Therefore, the EPZ is a circle with a radius of 8 kilometers (5 miles) for the two facilities. The 200 Areas have a defined EPZ radius of 10 miles which is larger than the EPZ defined for 283-E and 283-W. The 283-E and 283-W EPZs would be within that of the 200 Areas so the bounding EPZ for 283-E and 283-W is that which has been defined for the 200 Areas.

8.2 Tests of Reasonableness

The radial distance selected above defines the minimum EPZ size that should be considered. Other factors should also be considered and the size and shape adjusted accordingly so that:

- (1) Are the maximum distances to PAG/ERPG-level impacts for most of the analyzed accident scenarios (i.e., all but the most severe consequence scenario for each hazardous material) equal to or less than the EPZ radius selected?

Except for the worst case accident, the PAG level of 3 ppm is not exceeded at the EPZ boundary.

- (2) Is the selected EPZ radius large enough to provide for extending response activities outside the EPZ if conditions warrant?

The 283 Facility's EPZ is within the 10 mile EPZ for the 200 Area facilities. Therefore, emergency plans are already in place to extend the Hanford emergency response well beyond the 283 Facility EPZ.

- (3) Is the EPZ radius large enough to support an effective response at and near the scene of the emergency.

Yes, the EPZ radius extends enough to support this effort.

- (4) Does the proposed EPZ conform to natural and jurisdictional boundaries where reasonable, and are other expectations and needs of the offsite agencies likely to be met by the selected EPZ?

The EPZ does not conform to natural and jurisdictional boundaries at this point in time. The geopolitical boundaries associated with all Hanford EPZs will be defined in conjunction with the State of Washington and the local county emergency management organizations.

- (5) What enhancement of the facility and site preparedness stature would be achieved by increasing the selected EPZ radius?

The proposed EPZ radius is within the 200 Area 10 mile EPZ. This larger EPZ ensures the involvement of all local agencies and governments in the planning process for Hanford emergencies.

9.0 MAINTENANCE AND REVIEW OF THIS HAZARDS ASSESSMENT

The Operating Contractor, Manager of Emergency Preparedness, is responsible for ensuring that this Hazards Assessment is reviewed annually against facility conditions. Any required revisions will be made within three months of the annual review.

10.0 REFERENCES

Chlorine Institute Handbook, 5th Edition, 1986.

Department of Energy, June 26, 1992, *Emergency Management Guide, Guidance for Hazards Assessment*, U.S. Department of Energy, Washington, D.C.

Department of Energy, April 30, 1991, *Planning and Preparedness for Operational Emergencies*, DOE Order 5500.3A, U.S. Department of Energy, Washington, D.C.

Cushing, C. E., *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 Rev 5, December 1992

U.S. Department of Energy (DOE). 1986, *Environmental Assessment, Reference Repository Location*, Hanford Site, Washington, DOE/RW-0070, U.S. Department of Energy, Washington D.C.

U.S. Energy Research and Development Administration (ERDA). 1976, *Evaluation of Impact of Potential Flooding Criteria on the Hanford Project*. RLO-76-4, U.S. Energy Research and Development Administration, Richland Washington.

Emergency Prediction Information Code, Homann Associates, Inc., Fremont, Ca.

National Institute for Occupational Safety and Health, February 1987, *Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Resources, Washington, D.C.

PUREX Final Safety Analysis Report, SD-HS-SAR-001, Rev 1 thru 5

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