# DISTRIBUTION SHEET

| To | From | Page 1 of 1 |
|---|---|---|
| DISTRIBUTION | HAZARDS ASSESSMENT | Date 9/26/94 |
| Project Title/Work Order | | EDT No. 608143 |
| 283-E and 283-W HAZARDS ASSESSMENT | | ECN No. N/A |

| Name | MSIN | Text With All Attach. | Text Only | Attach./Appendix Only | EDT/ECN Only |
|---|---|---|---|---|---|
| R. E. Broz | A3-05 | X | | | |
| L. R. Campbell | A3-05 | X | | | |
| M. L. Deichman | R3-54 | X | | | |
| J. U. Greenough III | S2-61 | X | | | |
| D. A. Marsh (2) | A3-05 | X | | | |
| R. H. Palmer | R2-58 | X | | | |
| L. N. Sutton | R2-58 | X | | | |
| Unified Dose Assesment Center | A3-05 | X | | | |
| OSTI (2) | L8-07 | X | | | |

A-6000-135 (01/93) WEF067

Sta #10
SEP 23 1994

(23)

# ENGINEERING DATA TRANSMITTAL



1. EDT 608143

| | | |
|---|---|---|
| 2. To: (Receiving Organization) Distribution | 3. From: (Originating Organization) Hanford Emergency Preparedness Hazards Assessment | 4. Related EDT No.: N/A |
| 5. Proj./Prog./Dept./Div.: Emergency Preparedness | 6. Cog. Engr.: Leslie N. Sutton | 7. Purchase Order No.: N/A |
| 8. Originator Remarks: Emergency Preparedness Hazards Assessment for the 283-E and 283-W Power Houses | | 9. Equip./Component No.: N/A |
| | | 10. System/Bldg./Facility: 283-E and 283-W |
| 11. Receiver Remarks: | | 12. Major Assm. Dwg. No.: |
| | | 13. Permit/Permit Application No.: |
| | | 14. Required Response Date: |

15. DATA TRANSMITTED

| (A) Item No. | (B) Document/Drawing No. | (C) Sheet No. | (D) Rev. No. | (E) Title or Description of Data Transmitted | (F) Approval Designator | (G) Reason for Transmittal | (H) Originator Disposition | (I) Receiver Disposition |
|---|---|---|---|---|---|---|---|---|
| 1 | WHC-SD-PRP-HA-012 | | 0 | 283-E and 283-W Hazards Assessment | 3S | 1/2 | 1 | |
| | | | | | | | | |
| | | | | | | | | |

16. KEY

| Approval Designator (F) | Reason for Transmittal (G) | Disposition (H) & (I) |
|---|---|---|
| E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7) | 1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required) | 1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged |

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

| (G) Reason | (H) Disp. | (J) Name | (K) Signature (M) MSIN | (L) Date | (J) Name | (K) Signature (M) MSIN | (L) Date | (G) Reason | (H) Disp. |
|---|---|---|---|---|---|---|---|---|---|
| 4,1 | | Cog.Eng. L. N. Sutton | R2-58 [signature] | 9/22/94 | | | | | |
| | | Cog. Mgr. D. A. Marsh | A3-05 [signature] for | 9/22/94 | | | | | |
| | | QA | | | | | | | |
| | | Safety M. L. Deichman | R3-54 [signature] | 9/22/94 | | | | | |
| | | Operations J. U. Greenough III | R2-61 [signature] | 9/22/94 | | | | | |
| | | | | | | | | | |

| 18. | 19. | 20. | 21. DOE APPROVAL (if required) |
|---|---|---|---|
| L. N. Sutton [signature] 9/22/94 Signature of EDT Date Originator | Authorized Representative Date for Receiving Organization | D. A. Marsh [signature] for 9/22/94 Cognizant Manager Date 9/22/94 | Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments |

BD-7400-172-2 (04/94) GEF097

BD-7400-172-1 (07/91)

# RELEASE AUTHORIZATION

| | |
|---|---|
| **Document Number:** | WHC-SD-PRP-HA-012, Revision 0 |
| **Document Title:** | 283-E and 238-W Hazards Assessment |
| **Release Date:** | 9/22/94 |

* * * * * * * * * * * * *

**This document was reviewed following the procedures described in WHC-CM-3-4 and is:**

**APPROVED FOR PUBLIC RELEASE**

* * * * * * * * * * * * *

**WHC Information Release Administration Specialist:**

Christine Willingham

C. Willingham — 9/22/94

**(Signature)** — **(Date)**

A-6001-400 (07/94) WEF256

# SUPPORTING DOCUMENT

1. Total Pages ~~43~~ 39

| 2. Title | 3. Number | 4. Rev No. |
|---|---|---|
| 283-E and 283-W HAZARDS ASSESSMENT | WHC-SD-PRP-HA-012 | 0 |

**5. Key Words**

Emergency Preparedness, 283-E and 283-W Power Houses, Hazards Assessment, Chlorine


**6. Author**

Name: L. N. Sutton

Signature

Organization/Charge Code 3A200/MD5EP


**7. Abstract**


This document establishes the technical basis in support of Emergency Planning activities for the 283-E and 283-W Power Houses 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.




9. Impact Level 3S

10. RELEASE STAMP

# 283-E AND 283-W HAZARDS ASSESSMENT

TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# 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 BUILDING DESCRIPTION

## 2.1 Mission

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

## 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 283-E facility is located in the southwest quadrant of the 200 East Area near the center of the DOE'S Hanford site. The 283-W facility is located just east of the center of the 200 West Area. The 200 East and West Areas are controlled areas 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 nearest site boundary is 13.2 km (8.2 mi) west of 283-W however, the size of the Hanford Site will be reduced in 1994. The new boundary will likely be highway 240 on the west. Highway 240 is 5.5 km (3.4 miles) to the Southwest. The Columbia River will likely be the Northern boundary. Figures 2-3 and 2-4 show the layout of the 200 East and West Areas, the designations of the various facilities, and the location of 283-E and 283-W. Land uses within the 200 Areas consists primarily of waste processing and disposal activities.

Major metropolitan areas within the broad vicinity of the site (see Figure 2-1) include Spokane, Washington, about 120 air miles to the northeast; Seattle, Washington, about 130 air miles to the northwest; and Portland, Oregon, about 150 air miles to the southwest. Two other areas of significant population density include Moses Lake, Washington, about 30 miles north of the K-area and the Yakima Valley, in Washington, extending from Yakima, about 45 miles west, to the Tri-Cities, in Washington, about 35 miles southeast.

### 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 $4.1 \times 10^4$ $m^3/s$ ($1.44 \times 10^6$ $ft^3/s$). This would produce a water surface elevation for the river of about 119 meters (390 feet) above mean sea level. Since 200 East Area elevation is 192 meters to 244 meters (630 feet to 800 feet) above mean sea level, it is safely above PMF levels.

### 2.2.3 Seismic Event

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 81 mph recorded January 11, 1972. The 80 mph gust is expected to occur once every 30 years. A peak of 85 mph 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 X $10^{-6}$/year. The HMS climatological summary and the National Severe Storms Forecast Center list 22 tornado occurrences within 161 kilometers (100 miles) 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 (50 miles) radius of the Hanford Site, only five small tornados have been recorded between 1950 and 1970.

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

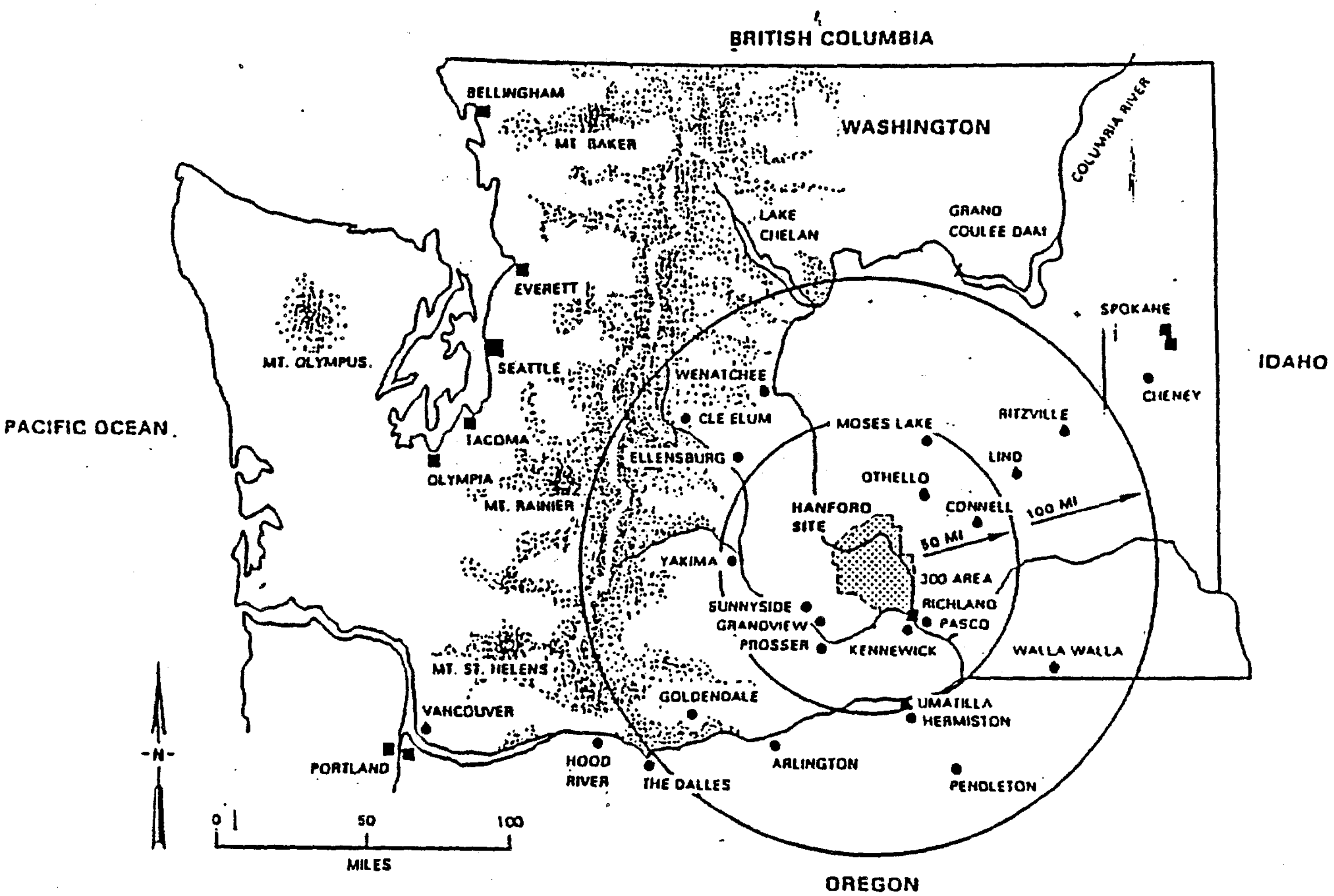
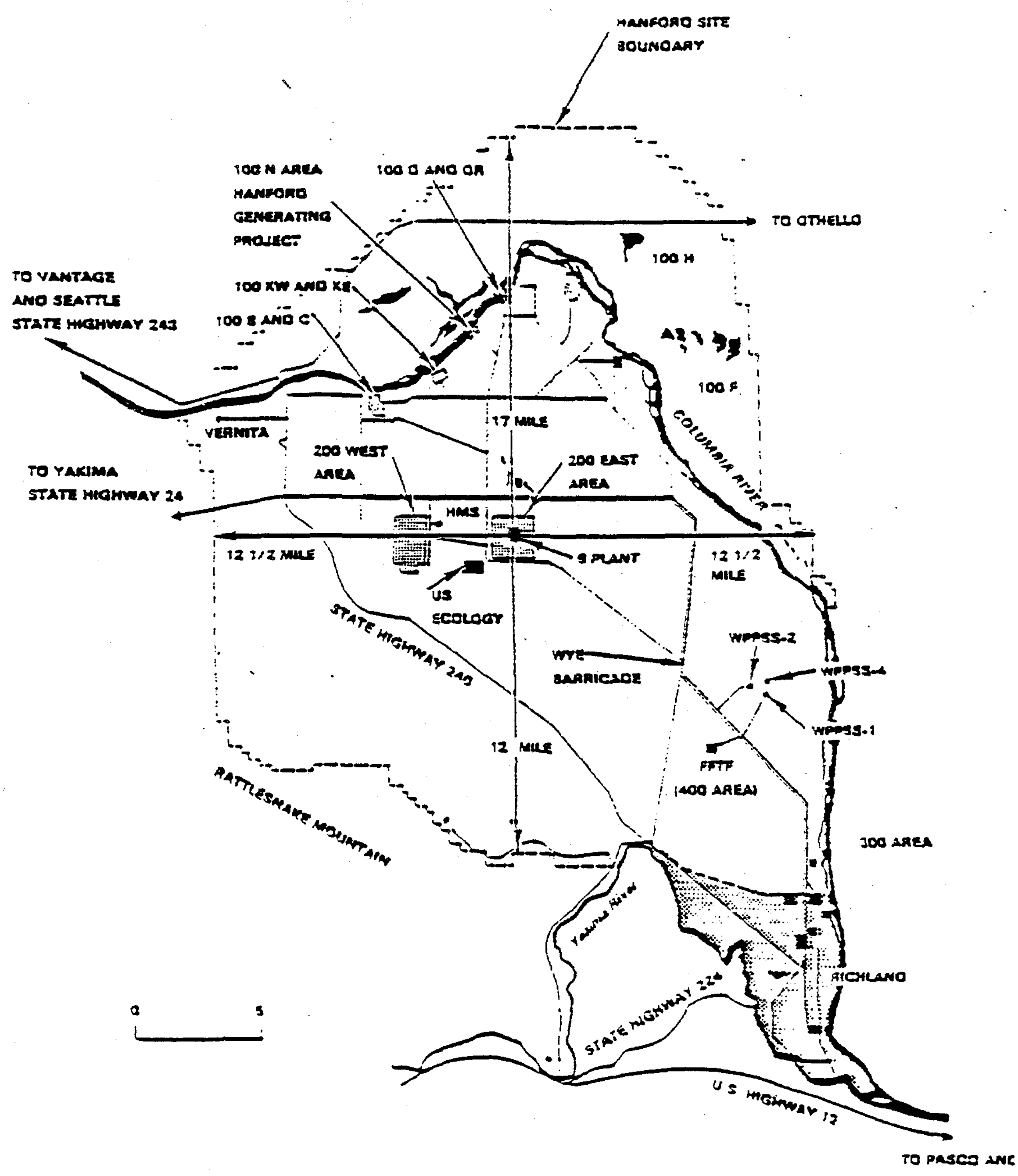


Figure 2-2 Hanford Site



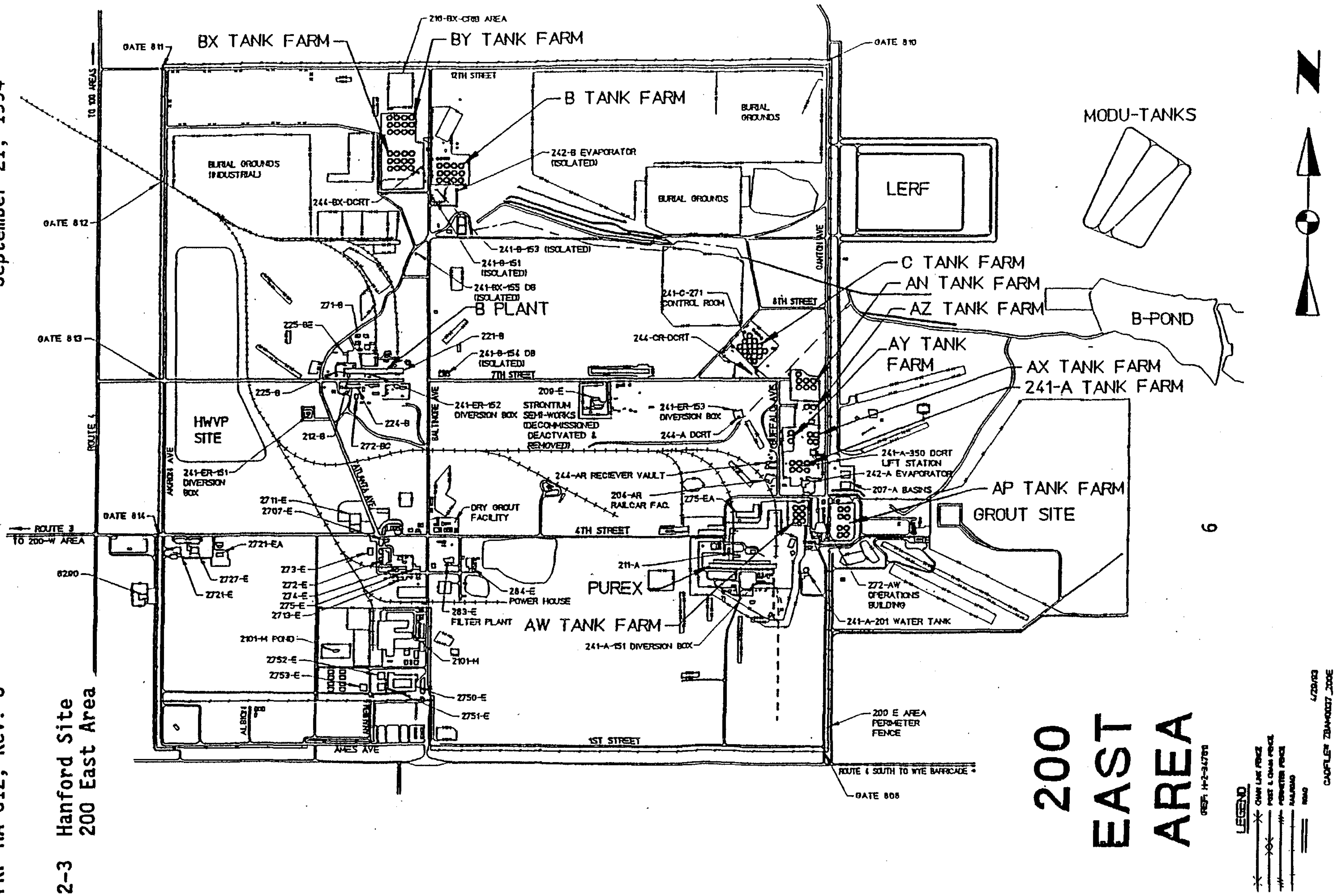
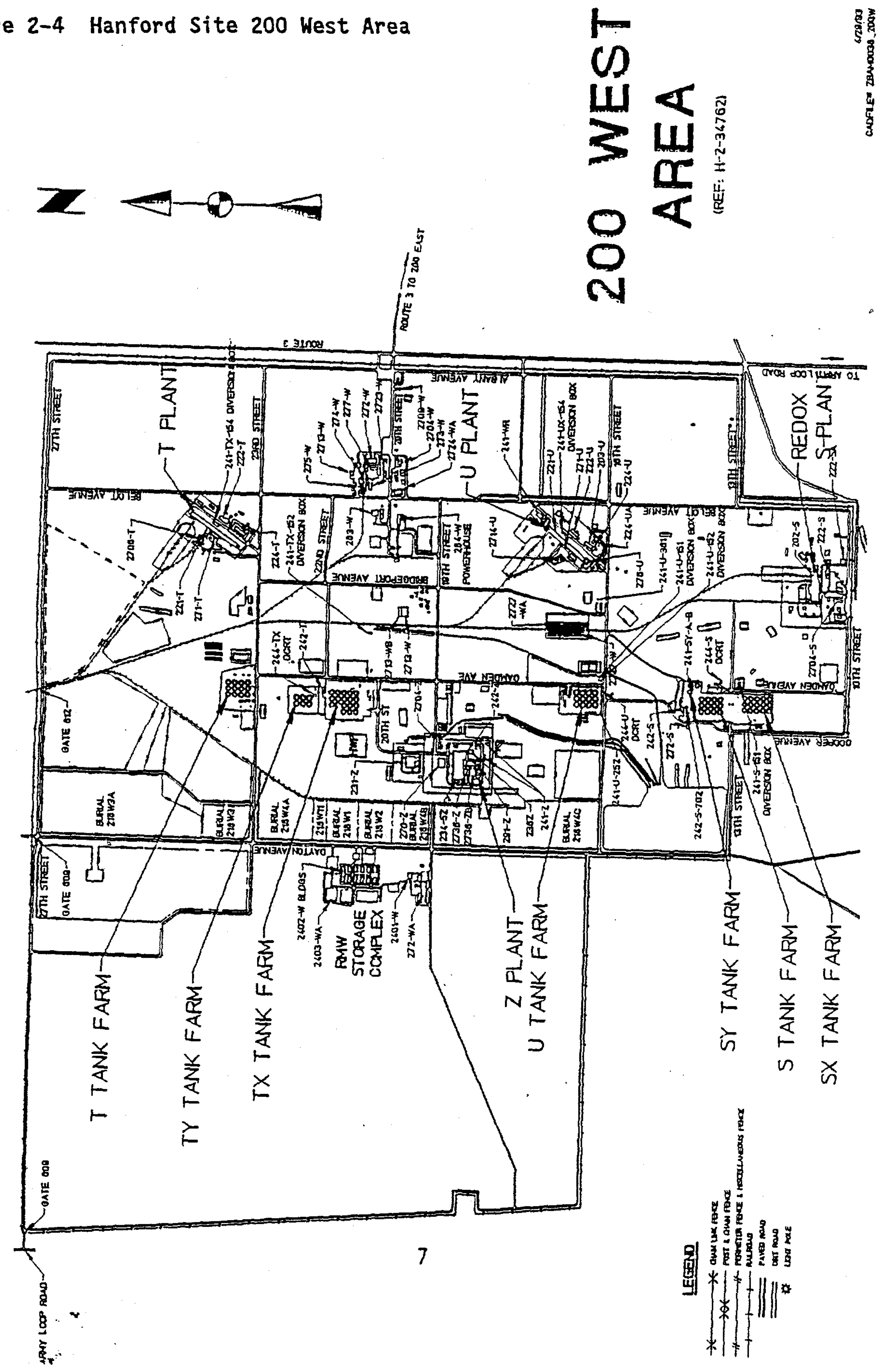



Figure 2-3 Hanford Site
200 East Area

Figure 2-4 Hanford Site 200 West Area



### 2.2.5 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 100 miles away, Mt. Rainier at about 110 miles away, and Mt. St. Helens approximately 130 miles 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 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, 2000 pound 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, 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 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 one ton cylinders of chlorine at each facility. The quantity stored greatly exceeds the threshold planning quantity of 100 pounds so chlorine will be evaluated further.

## 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 -29 °F and freezes at about -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. Mixture 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 1920 pounds and weigh approximately 3800 pounds when full. They are welded heavy walled tanks about 30 inches in diameter and 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 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 1/3 inch in diameter would be created to relieve pressure.

Figure 2-5 283-E Layout

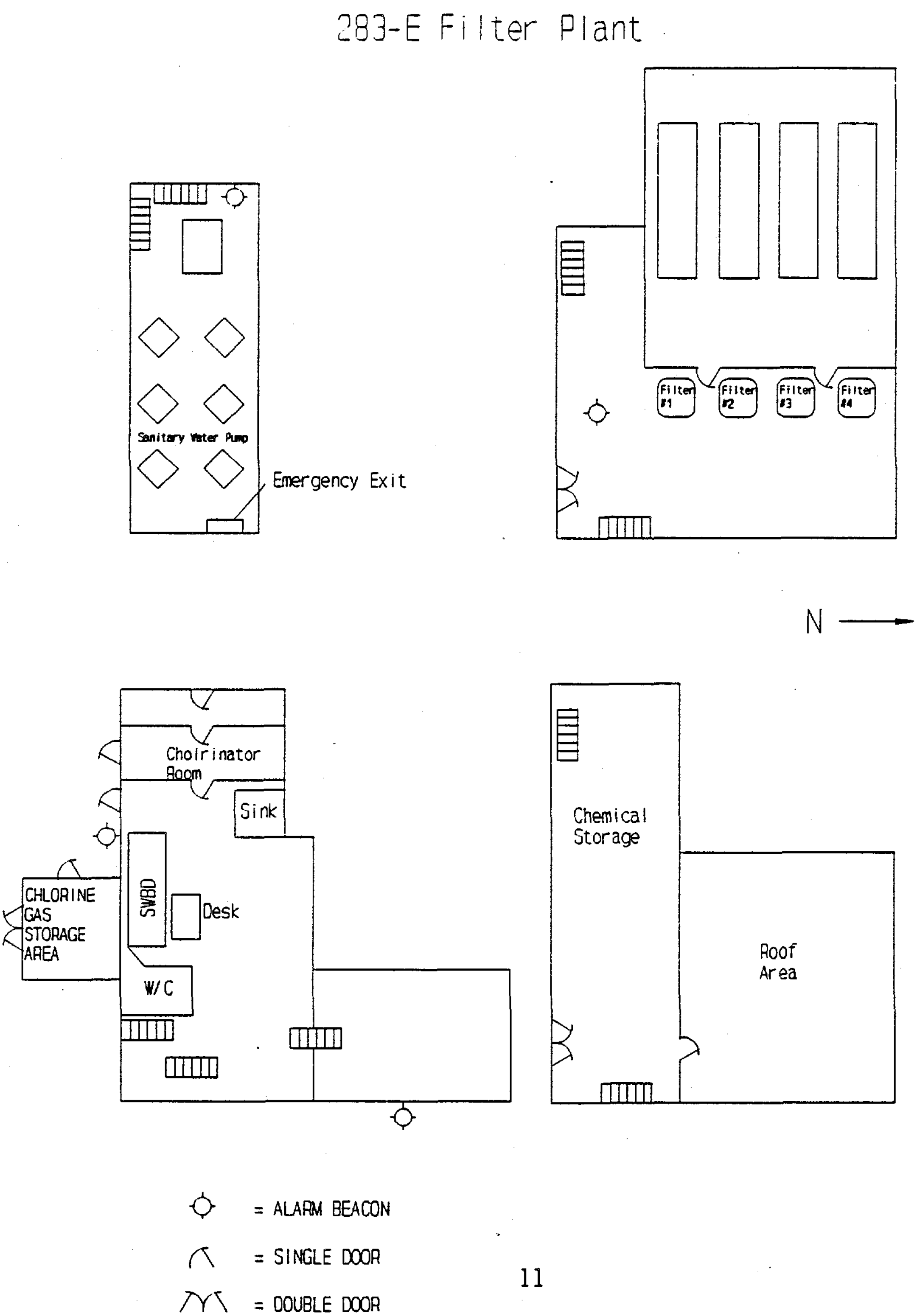


Figure 2-6 283-W Layout

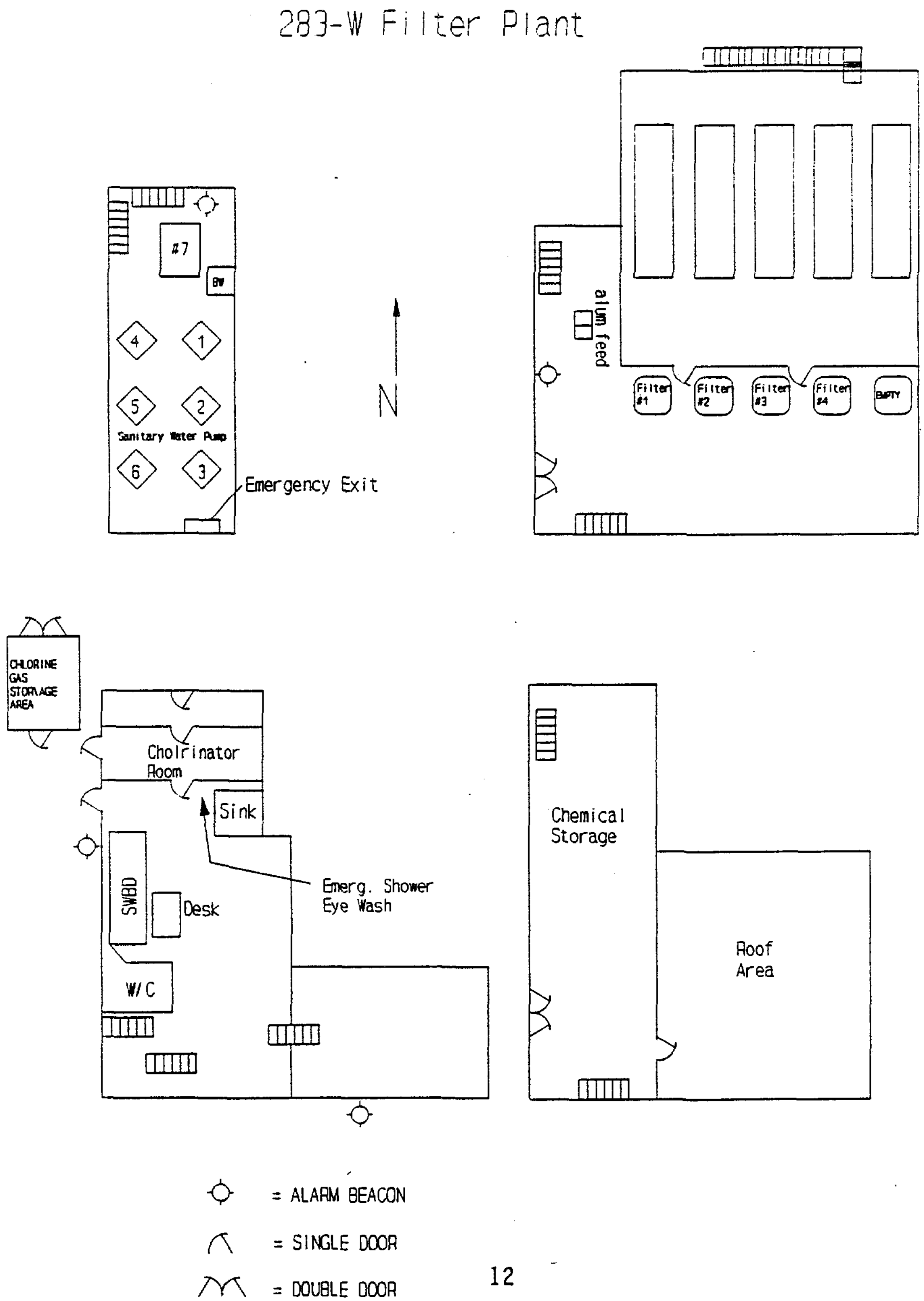
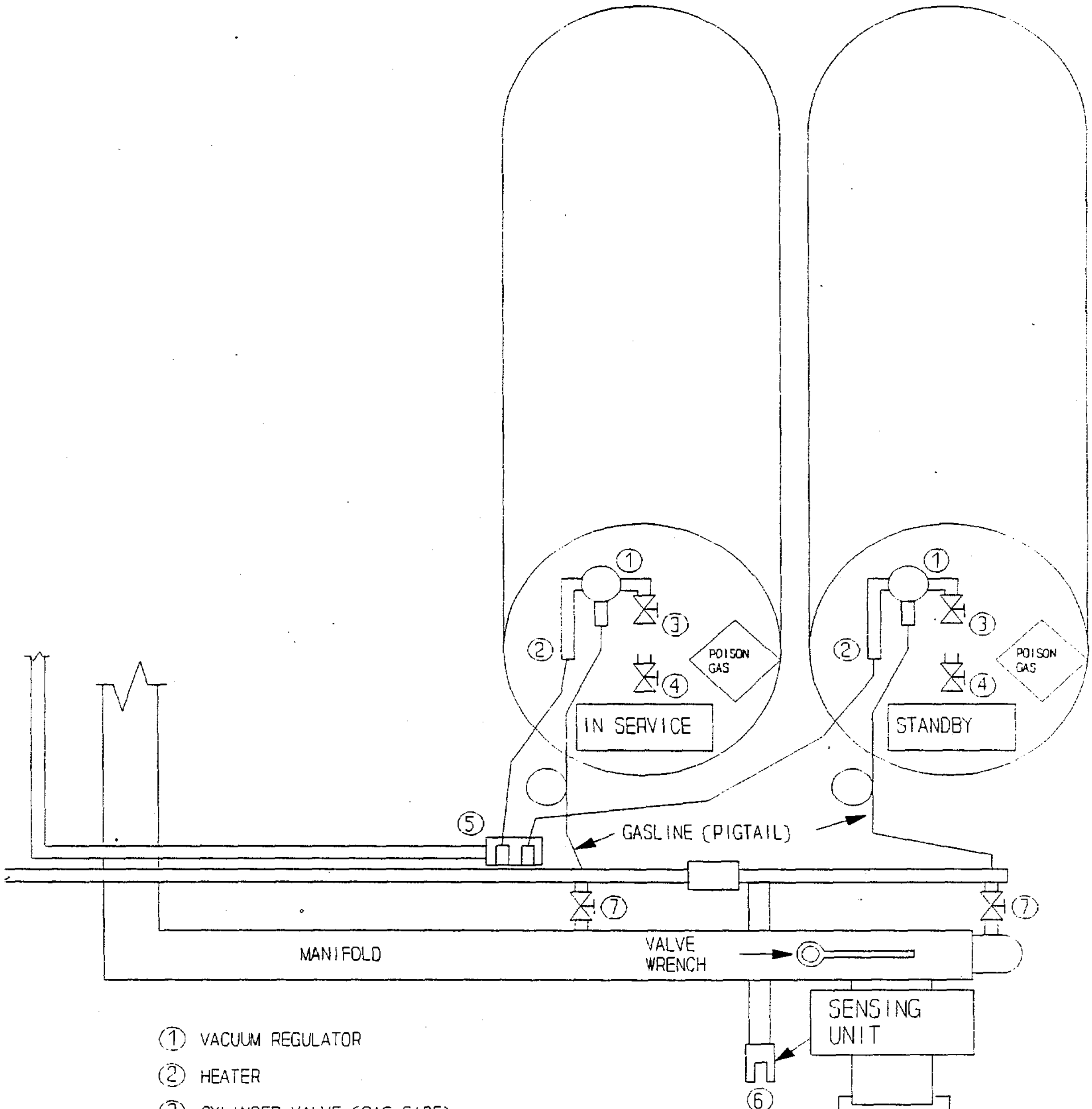


Figure 2-7 Chlorine Cylinder Layout




(1) VACUUM REGULATOR

(2) HEATER

(3) CYLINDER VALVE (GAS SIDE)

(4) CYLINDER VALVE (LIQUID SIDE)

(5) 120 VAC ELECTRICAL RECEPTICLE

(6) CHLORINE GAS DETECTOR SENSING UNIT

(7) MANIFOLD VALVES (2)

NOTE:

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

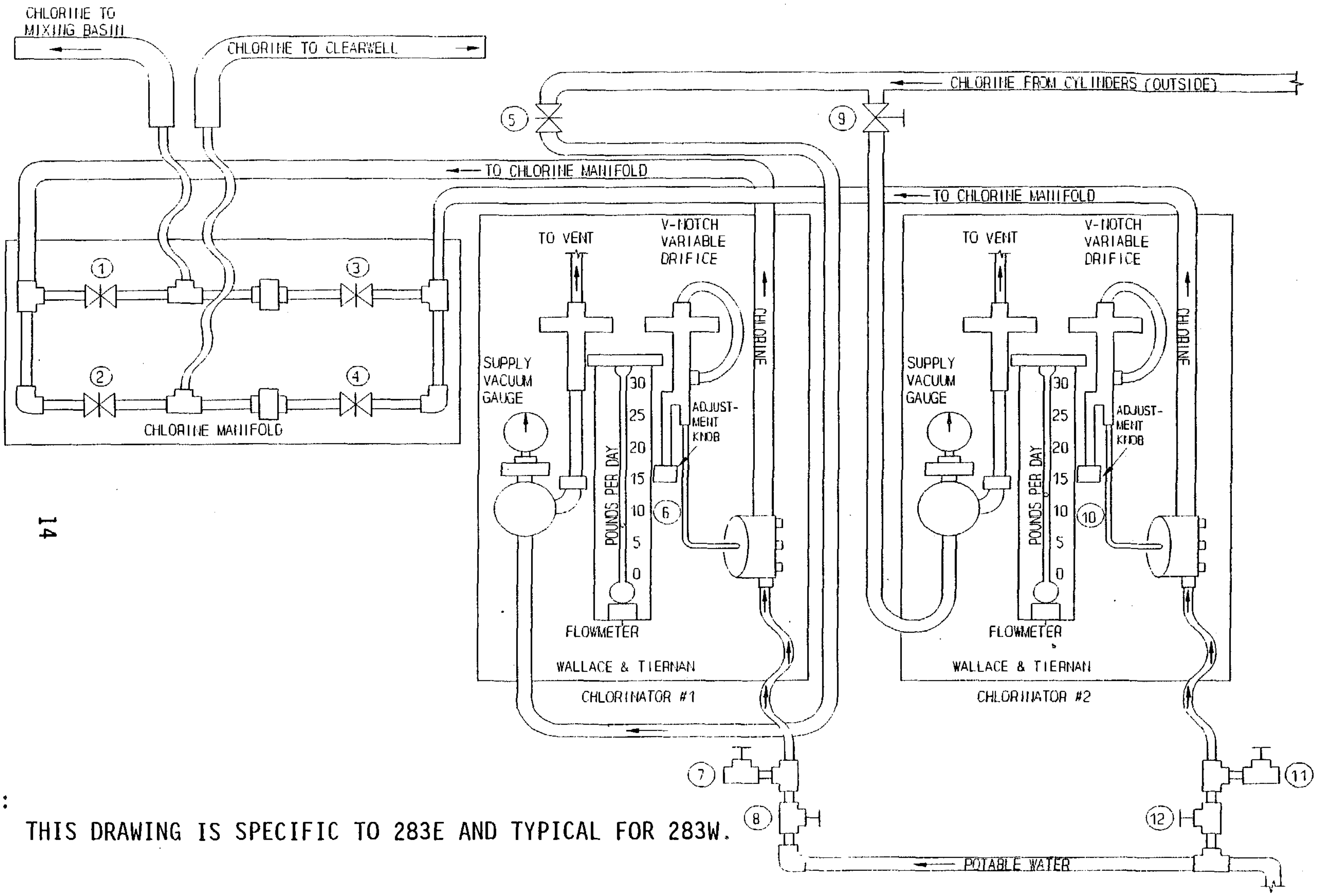



Figure 2-8 Chlorinators and Chlorine Manifold

NOTE:
1. THIS DRAWING IS SPECIFIC TO 283E AND TYPICAL FOR 283W.

### 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 crane (3-ton capacity) 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 EVENT SCENARIOS

### 5.1 Chlorine Release Scenarios

#### 5.1.1 Failure of Primary Barrier

The one 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 158 °F and 165 °F (70°C and 74°C) to relieve pressure and prevent rupture of the tank in case of fire or other exposure to high temperature. Each plug is 0.344 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.

### 5.1.2 Effects of Other Barriers

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

### 5.1.3 Range of Possible Releases

There is a large range of possible releases from the failure modes identified above. 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 below. The first is a relatively small gas leak of 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 400 pound 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 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 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 ten thousand pounds 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 3.5 miles for a wind speed of 2.5 mph (1 m/s) and "F" class stability. The sudden release case calculated with the EPI program predicts ERPG 3 values out to almost five 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.

# 6.0 CONSEQUENCE ASSESSMENT AND CLASSIFICATION OF EVENT SCENARIOS

## 6.1 Calculation Models

Consequences of the events and conditions identified in Section 5.0 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.

## 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 toxic criteria for each class of emergency. The facility boundary receptor location for the 283 facilities was selected to be 200 meters from the point of release. This is a default value recommended by the Hazards Assessment guidance document to determine emergency classes for facility events. This default guidance applies when a physical boundary is not obvious or logical for a particular facility.

The distance to the site boundary is 13.2 km for 283-W and 16.1 km for 283-E. Both distances were evaluated. 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. Calculations were also performed for highway 240 distances, 5.5 km for 283-W and 7.6 km for 283-E.

### 6.3 Chlorine Release Results

The EPI continuous release option was used to model the small (15 pounds/hour) and mid-sized (400 pounds/hour) chlorine releases. The instantaneous release (term release of zero duration) option was used to model the large chlorine release. The postulated conditions were "F" class stability, 1 m/s wind speed and a ground level standard terrain release. The results, shown in the following table, indicate that the ton container release meets the General Emergency criteria of 3 ppm at the site boundary.

Table 6-1 Chlorine Release Results

| Leak Size | BLDG | Facility Boundary Concentration (ppm) | Site Boundary Concentration (ppm) | Highway 240 Concentration (ppm) |
|---|---|---|---|---|
| 15 Pounds per Hour | 283-E | 7.5 | .0063 | .016 |
| | 283-W | 7.5 | .0080 | .024 |
| 400 Pounds per Hour | 283-E | 200 | .17 | .42 |
| | 283-W | 200 | .21 | .63 |
| 1920 Pounds Instantaneous | 283-E | 500,000 | 2.9 | 19 |
| | 283-W | 500,000 | 4.2 | 58 |

### 6.4 Natural Emergencies

#### 6.4.1 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 between .02 and .05g should be classified as an Alert Emergency, an earthquake that produces ground acceleration of .05g to .12g should be classified as a Site Area Emergency and an earthquake that produces ground acceleration greater than .12g should be classified as a General Emergency.

### 6.4.2 High Winds/Tornado

Chlorine storage building destruction is expected if high winds or a tornado strike 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 80 mph (1972) and 73 mph (1990) with no damage.

A graded precautionary approach is recommended for high winds at the facility. An Alert emergency should be declared if sustained winds exceed 90 mph and damage from high winds is observed. The 90 mph wind speed is suggested for consistency with the EALs at other Hanford facilities.

Site Area or General Emergency declaration would be based on actual chlorine releases.

### 6.4.3 Range Fire

The 283 facilities would probably not be affected by a range fire since the ground near the buildings is devoid of vegetation. As a precaution, it is suggested that an Alert 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.

### 6.4.4 Aircraft Crash

To maintain consistency with other hazards assessments, the suggested approach is to classify any aircraft crash near or at the facility as an Alert Emergency. Any upgrade of the emergency class would be based on actual releases of chlorine.

## 6.5 Security Contingencies

### 6.5.1 Explosive Device

The presence of an 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.

### 6.5.2 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.

### 6.5.3 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.

## 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 (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.

### 7.1 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 one 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 7.5 kilometers for the two facilities. The Tank Farm facility however has a defined EPZ of 10 miles which is larger than the EPZ defined for 283-E and 283-W. This EPZ would be within that of the Tank Farm EPZ so the bounding EPZ for 283-E and 283-W and the 200 Areas is that which has been defined for the Tank Farms.

## 7.2 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 <u>most</u> 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?

The EPZ bounds all analyzed accident scenarios, and includes the most severe events postulated.

(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.

## 8.0 EMERGENCY CLASSES, PROTECTIVE ACTIONS, AND EMERGENCY ACTION LEVELS

### 8.1 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. The emergency classification is based, in part, on projected dose and concentration values at the facility and Hanford site boundaries for preanalyzed accident scenarios. The emergency classification criteria are shown below.

**Table 8-1 Non-Radiological Release Criteria**

| Emergency Category | Criteria* |
|---|---|
| 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 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 classification is difficult to establish based solely on a numerical value. The following general criteria apply in addition to the 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 (EALs). The preceding Hazards Assessment was based primarily on a comparison of calculated consequences with the numerical criteria in the tables above. However, some recommendations were provided based on the more general emergency classification criteria.

## 8.2 Protective Actions

Table 8-2 contains the protective actions that have been developed for classifiable emergencies in the 200 areas.

## 8.3 Emergency Action Levels

Appendix A contains the EALs developed from this assessment.

# 9. 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.

Table 8-2 Protective Actions

| | |
|---|---|
| **Alert Level Emergency** | Restrict access to impacted 200 Area at the main entrances.<br><br>Evacuate or shelter affected facility nonessential personnel and shelter the remainder of personnel in the affected 200 Area, (that is, 200 East or 200 West). For security events, contact the Patrol Operations Center to determine actions.<br><br>Ensure protective actions consistent with affected 200 Area actions are provided to all 600 Area residents for areas immediately adjacent to the event area (include US Ecology (377-2411) and ICF KH personnel). |
| **Site Area Emergency** | Restrict access to Hanford Site northern areas by closing Route 4S at the Wye Barricade and Route 11A at the Yakima Barricade.<br><br>Evacuate or shelter affected facility nonessential personnel.<br><br>Shelter all nonessential personnel in the affected 200 Area (i.e. 200 East or 200 West) and plan for area evacuation upon activation of the Northern Area ECC.<br><br>Verify the ONC has initiated Columbia River alerting, closure of the Hanford Airspace and Highway 240, as appropriate.<br><br>Ensure protective actions consistent with affected 200 Area actions are provided to all 600 Area residents within areas immediately adjacent to the event area, to include U.S. Ecology (377-2411) and ICF KH personnel, and to residents of the other 200 Area (via crash alarm).<br><br>Shelter and/or provide appropriate protective equipment to essential personnel remaining within the affected 200 Area. |
| **General Emergency** | Implement all site area emergency actions.<br><br>Shelter all personnel in unaffected areas north of the Wye Barricade and plan for evacuation of nonessential personnel north of the Wye Barricade once the Northern Area ECC is activated.<br><br>Provide appropriate protective equipment to essential personnel remaining north of the Wye Barricade. |
| Sheltering (take cover) is an alternative action if evacuation is not immediately possible. Sheltering is to be with ventilation control. (Ventilation control means placing fans in recirculation made or turning off air conditioners or fans and closing door and windows, thus limiting inflow of outside air). | |

## 10.0 REFERENCES

Chlorine Institute, Public Information Handbook for Emergency Planning & Community Right-to-Know, received July 1993

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.

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

# APPENDIX A EMERGENCY ACTION LEVEL TABLES

FACILITY EMERGENCY EVENTS

# HAZARDOUS MATERIAL RELEASE

| Initiating Condition | Emergency Action Level | Event Classification |
|---|---|---|
| A chlorine leak/release | Any significant leak from a 1 ton chlorine cylinder or the chlorine system, which results in a strong detectable odor<br><br>**AND**<br><br>observation of a yellowish/green vapor outside the facility. | **ALERT LEVEL EMERGENCY** |
| A chlorine leak/release | Rapid release of chlorine from a 1 ton cylinder by any of the following:<br>• Unmitigated shearing of connecting piping.<br>**OR**<br>• Unmitigated valve failure<br>**OR**<br>• Fusible plug melt | **SITE AREA EMERGENCY** |
| A chlorine leak/release | A catastrophic failure of a 1 ton chlorine cylinder which has totally released its contents to the environment. | **GENERAL EMERGENCY** |

NATURAL EMERGENCIES

# SEISMIC EVENT

| Initiating Condition | Emergency Action Level | Event Classification |
|---|---|---|
| A seismic event | A seismic event is felt by personnel, with some breakage and disturbance of tall objects at the facilities.<br><br>OR<br><br>The seismic event produces ground acceleration between .02g and .05g, confirmed by the Hanford Meteorological personnel. | **ALERT LEVEL EMERGENCY** |
| A seismic event | A seismic event felt by personnel with evidence of falling building debris at 283-E or 283-W.<br><br>OR<br><br>The seismic event produces ground accelerations between .05g and .12g, confirmed by the Hanford Meteorological personnel. | **SITE AREA EMERGENCY** |

| | | |
|---|---|---|
| A seismic event | A seismic event causes severe building damage (walls fall, pipes broken, ground cracked at the facilities.<br><br>**OR**<br><br>The seismic event produced ground acceleration greater than .12g, confirmed by the Hanford Meteorological personnel. | **GENERAL EMERGENCY** |

# 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 a the chlorine storage facility | Tornado visually seen striking the chlorine storage facility which causes extensive damage. | **SITE AREA EMERGENCY** |

# AIRCRAFT CRASH

| Initiating Condition | Emergency Action Level | Event Classification |
|---|---|---|
| Aircraft crash | Aircraft crashes near the chlorine storage buildings. | **ALERT LEVEL 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 within 283-E or 283-W. | **ALERT LEVEL EMERGENCY** |
| Explosive device | A confirmed explosive device (with concurrence of Hanford Patrol, see note) located within 283-E or 283-W. | |

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 West 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.

# SABOTAGE

| Initiating Condition | Emergency Action Level | Event Classification |
|---|---|---|
| Sabotage (industrial) | Confirmed deliberate act (with concurrence of Hanford Patrol, see note) against the 283-E or 283-W facility resulting in significant damage | **ALERT LEVEL EMERGENCY** |

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 West 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.

# HOSTAGE SITUATION/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 283-E or 283-W. | **ALERT LEVEL EMERGENCY** |
| Armed intruder(s) | Confirmed hostile armed individual(s) (with concurrence of Hanford Patrol, see note) located within 283-E or 283-W. | |

NOTE: Security status declarations by Safeguards and Security personnel or implementation of the 200 West 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.