Atlantic Richfield Hanford Company
Richland, Washington 99352

MASTER

OPERATIONAL SAFETY ANALYSIS REPORT
DOUBLE-SHELL WASTE STORAGE TANKS

J. E. Mirabella
 N. P. Willis

May 20, 1977

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OPERATIONAL SAFETY ANALYSIS REPORT DOUBLE-SHELL WASTE STORAGE TANKS

INTRODUCTION

This Operational Safety Analysis has been prepared by Atlantic Richfield Hanford Company for the double-shell waste storage tank facilities. Wherever possible and logical, the information is presented in summary form and references are made to ARHCO documents.

SUMMARY AND CONCLUSIONS

The double-shell waste storage tank facilities that have been designed and constructed can be operated without undue risk to property and the health and safety of employees and the general public. Practical safety controls have been included in the design and planned operation of the double-shell waste storage tank facilities which meet or exceed the operational safety standards of Energy Research and Development Administration Manual Chapter 0550. The facilities, equipment, and personnel are subject to the hazards normally associated with the chemical processing and mechanical handling of radionuclides.

The postulated accidents that were examined have been divided into two sections, one for aging waste tanks and one for non-aging waste tanks. These accidents include:

1. Routing acid wastes to underground storage.
2. Steam coil failure.
3. Seismic activity.
4. Airlift circulator failure.
5. Loss of utilities.
6. Excessive vacuum in a waste storage tank.
7. Backflow of liquid through an airlift circulator air supply line.
8. Dresser coupling failure.
9. Tank failure.
10. Dome failure.
11. Accumulation of hydrogen in underground storage tanks.

12. Organic fire in a waste storage tank.
13. Explosion of nitrate compounds.
14. Failure of vessel ventilation exhaust filters.
15. Tornado destruction of aboveground tank farm facilities.

The maximum credible accident for an aging waste tank which was capable of causing the most serious consequences was the tornado destruction of the aboveground tank farm facilities. During a tornado, the vent system could be damaged or destroyed, which would result in the escape of unfiltered radioactive vapor. The maximum release rate was calculated to be less than 10 curies per hour, which includes 1.9×10^{-2} c/hr ^{90}Sr , 3.2×10^{-2} c/hr ^{137}Cs , and 2.0×10^{-4} c/hr ^{239}Pu . Reestablishment of control would be effected within 48 hours.

The airborne release from this event would result in a 50-year bone dose commitment of 1×10^{-1} rem, a lung dose commitment of 2×10^0 rem, and a total body dose commitment of 9×10^{-3} rem in a "maximum individual." A maximum individual is defined to be a person on the centerline path of travel of the airborne radionuclides 20 kilometers from the point of release. These estimated dose commitments are less than the protection standards for individuals in uncontrolled areas as set by ERDA Manual Chapter 0524, Part 2.

The maximum credible accident for a non-aging waste tank was the failure of the vessel ventilation exhaust filters. This type of an accident would occur as the result of excessive moisture or vessel pressurization, which could rupture the exhaust filters. The maximum release from the contaminated filters in a non-aging waste tank was calculated to be 5.3×10^{-1} curies cesium, 1.7×10^{-1} curies strontium and 8.0×10^{-5} curies plutonium. In addition, 4×10^{-3} curies cesium, 1×10^{-3} curies strontium, and 6×10^{-7} grams plutonium could be released before the failure was detected. This would result in a 50-year bone dose commitment of 5×10^{-3} rem and a lung dose commitment of 3×10^{-4} rem. These dose commitments are also less than the protection standards for individuals in uncontrolled areas as set by ERDA Manual Chapter 0524, Part 2.

GENERAL FACILITIES DESCRIPTION

SITE DESCRIPTION

Double-shell tanks are located in the 200 East and 200 West Areas of the Energy Research and Development Administration's Hanford complex, in the south central part of the State of Washington.

The tank farms of the Hanford complex are located on an interior plateau 600 to 700 feet above mean sea level and are about five miles from the Columbia River at the nearest point. The tanks are isolated within the

Hanford site and are at least eight miles from the nearest inhabited area of agricultural operations. The fenced 200 East and 200 West Areas are interspersed with radiochemical processing facilities, underground pipelines, tanks and supporting facilities. The storage tanks will not displace industrial, farming, residential or recreational activities. The site does not contain any archaeological or historical sites. Use of the land is not in conflict with known State, regional or local plans or programs.⁽¹⁾

The tank farms are located on alluvial sand and gravel deposits 150 to 300 feet above groundwater. The dry soil is capable of retaining a water volume equal to 10 to 20 percent of the soil volume before permitting drainage to the water table. The area receives very little rainfall (annual average of 6.5 inches) which evaporates before reaching the water table.⁽²⁾ These are considered important buffers in the event of a serious incident involving the release of radio-contaminants. The geology, hydrology, seismology, and meteorology of the site are described in detail in reference 2.

FUNCTIONAL DESCRIPTION

The goal of Atlantic Richfield Hanford Company and the Energy Research and Development Administration is to have all liquid radioactive wastes contained in double-shell storage tanks as soon as possible. Currently, a total of 23 double-shell tanks is planned for construction through 1978. These tanks will be used for storing aging wastes, evaporator feed, evaporator products and terminal liquor.

The four existing double-shell tanks (241-AY and 241-AZ Tank Farms) were constructed for high-level aging wastes. The three 241-SY tanks (Project 74-1-i), presently under construction, will provide a feed tank and two storage tanks for the 242-S Evaporator-Crystallizer. The six 241-AW tanks budgeted for fiscal year 1976 will provide a feed drain tank and five storage tanks for the 242-A Evaporator-Crystallizer. The six 241-AN tanks proposed for FY 1977 will store terminal liquor from the 242-A Evaporator-Crystallizer. In addition to this, four one-million gallon double-shell waste storage tanks are proposed for construction for FY 1978. Two tanks (241-AP Tank Farm) are required in the 200 East Area to store the additional terminal liquors anticipated from the updated Waste Management Model (WAMM) projections. Two additional tanks (241-SW Tank Farm) are required in the 200-West Area to eliminate a single-shell drain tank and to provide a spare double-shell tank. With the construction of these four new tanks (241-AP and 241-SW), all of the double-shell tank requirements for aging and non-aging waste storage and spare tanks; evaporator feed, drain and bottom tanks; and terminal liquor storage tanks will be fulfilled.

PROCESS DESCRIPTION

The 23 current or scheduled double-shell storage tanks are designed to safely contain all liquid radioactive waste generated at the Hanford

facility. These wastes include aging waste, evaporator feed, evaporator products and terminal liquor.

The 241-AY and -AZ Tank Farms provide storage space for high-level radioactive waste solutions which are generated at the Purex Plant and then processed through the B Plant. The radionuclide concentration in this waste is sufficiently high to cause self-boiling, which is employed to bring the waste to as high a salt content as feasible. The initial solutions contain a relatively small percentage of solids, but during self-concentration the solids-to-supernatant ratio increases. The solids, which include most of the heat-generating fission products, slowly settle out of the supernatants, and the system eventually becomes two-phase. The 241-AY and -AZ tanks are mildly agitated by a system of airlift circulators to maintain the solids in suspension for as long as possible. After sufficient aging to allow shorter lived radioisotopes to decay, the aging waste will be processed and converted to salt cake in the evaporator-crystallizers.

Evaporator feed will be stored in one of the 241-SY Tanks and one of the 241-AW tanks for processing through the 242-A and 242-S Evaporator-Crystallizers. These materials are relatively low-level waste solutions destined for concentration and conversion to salt cake. The solutions include low-level waste solutions from the Purex and B Plant processes, aged and processed boiling waste, laboratory waste, laundry waste and other low-level waste streams.

All of the remaining double-shell tanks except the 241-SW tanks are scheduled to receive evaporator products. Evaporator products, destined for double-shell tanks, fall in two groups: terminal liquor and double-shell slurry.

Terminal liquor has been defined (reference 3) as "the liquid product from the evaporation-crystallization process which upon further concentration forms an unacceptable solid for storage in single-shell tanks." Terminal liquor is characterized by a caustic concentration of approximately 5.5 M. The allowable compositions of terminal liquors can be defined to: (1) avoid precipitation of significant quantities of sodium aluminate which would form non-drainable salt cakes, and (2) avoid salt cakes which will deliquesce when exposed to average Hanford air.⁽⁴⁾

Double-shell slurry is the product of the double-shell slurry process. The double-shell slurry process will utilize the existing vacuum evaporator system to further concentrate terminal liquors. The salt cake produced by the double-shell slurry process requires storage in double-shell tankage as it is expected to be non-drainable and deliquescent. The bed of salt will be saturated with mother liquor and will remain covered with supernatant during interim storage. The estimated salt proportions are 40 percent sodium aluminate, 25 to 30 percent sodium nitrate, 25 to 30 percent sodium nitrite and small amounts of sodium carbonate and phosphate.

The remaining two double-shell tanks (241-SW Tank Farm) will be used as a drain tank for the 242-S Evaporator-Crystallizer and to provide a spare double-shell tank in the 200 West Area for emergency use. A drain tank is necessary to receive the drainage from the evaporator process and provide space for emergency dumping of the evaporator contents. The 241-AZ-101 tank will be used as a spare tank in the 200 East Area in conjunction with the 242-A Evaporator-Crystallizer.

FACILITY DESCRIPTION

Tank Structure

The double-shell tanks are basically similar to those in the other waste storage farms. Figure 1 shows a typical double-shell tank. All are designed to provide shielded storage of high-level radioactive waste in 75-foot diameter, carbon steel-lined tanks. The design life of these tanks for liquid waste or salt cake storage is at least 50 years, but they are expected to be used for only 20 years.

The tanks are constructed as a tank within a tank, as opposed to a single tank as in other Hanford tank farms. The primary tank is fabricated from carbon steel and is stress-relieved prior to use by heat annealing. All of the bottom and wall welds in both the primary and secondary tanks are radiograph inspected. An annulus is provided between the two tanks to collect leakage from the primary tank. The inner tank completely encloses the process function and rests upon an insulating concrete pad which, in turn, rests upon the secondary liner. The secondary liner is enclosed in a reinforced concrete shell. Additional benefits are the more effective and timely leak detection and the ability to more conclusively determine the tanks' integrity prior to reuse.

The tank dome is reinforced concrete with a three-eighths-inch steel liner. It is designed to withstand 40 psf plus a 50-ton concentrated load in addition to approximately six and one half feet of earth cover. Each of the tanks are designed for a maximum vacuum loading of six inches water and a maximum tank pressure of 60-inches water in the vapor space of the tank.

Tank Equipment

General

The tank equipment consists of structures, piping and equipment attached to the main tank structure. These include: risers, pump and sluice pits, airlift circulators, steam coils, and ventilation systems.

Risers

Tank risers are piping penetrations in the dome of the underground storage tanks. These provide access to the tank for necessary waste handling and monitoring equipment. The risers vary from the 42-inch diameter main pump pit riser to several 4-inch equipment access risers.

Pump and Sluice Pits

These pits are provided for each of the double-shell tanks (sluice pits for aging waste tanks only). They consist of reinforced concrete boxes set in the ground above the main risers to the tanks. They are sealed by large interlocking concrete cover blocks. The pits are provided with sprays to flush down any contaminated equipment and jumper connections which are used for transferring solutions to and from the tank. The pits enclose the pumps and sluicing equipment that are necessary for tank operations.

Airlift Circulators

The 241-AY and -AZ Tanks contain 22 airlift circulators evenly distributed throughout each tank. Five of the 22 circulators have lift risers that are 17 feet in length and require a solution volume of about 600,000 gallons for operation. The remaining 17 circulators are 22 feet long and therefore need over 800,000 gallons for total submergence. The lift riser lower ends are all 30 inches above the tank bottom.

Each of the two evaporator feed tanks (one AW tank and one SY tank) will have one airlift circulator. This will assist in mixing evaporator feed. No other double-shell tanks are expected to be equipped with airlift circulators.

The airlift circulators are relatively simple devices consisting of two basic components: a vertical lift riser pipe 30 inches in diameter, and a foot piece (air nozzle) located within and near the lower end. A six-inch pipe suspends the lift riser from the tank dome.

A one-inch pipe, which supplies the motive air, is a removable insert that extends within the six-inch pipe. This is the one component which can be replaced in the event of a plugged line. The entire unit is of mild steel construction.

The circulators operate on the principle that when a gas (air) is introduced at the lower end of the riser, the apparent solution specific gravity will be decreased. As a result, the hydrostatic head at any point within the tube will be less than that at the same elevation outside of the tube, and a vertical movement will be initiated. The vertical movement provides sufficient agitation to prevent "hot spots" and tends to keep solids entrained.

Rotameters located in the instrument buildings are used to indicate motive air flow rate to the individual circulators. An adjoining raw water header and associated valving are also provided at this location for the water flushing of the air lines. If a more rigorous flushing is required, two one-inch ball valves (one on the air line and one on a capped stub located below ground level above each circulator, see Figure 1) can be used to divert flushing water.

Steam Coils

Steam coils are installed in only the 241-AY and -AZ Tank Farms. The coils are used initially to heat up the tank contents and then to maintain either a standby temperature or to obtain a desired boil-off rate. The 225-psig steam supply header in both units is routed from a main steam line tie-in. The pressure is reduced to 50 to 60 psig for use in the steam coil.

The coils are approximately 55 feet in length and constructed of two-inch Schedule 40 ASTM-A106 Grade A carbon steel. The complete coils are hydro-tested at 300 psi and steam pressure tested at 100 psi.

Steam condensate may be routed to either the associated tank or through a diversion system. The diversion system continuously monitors the radio-activity in the condensate stream which is normally routed to the A-8 crib. If high radiation is detected, the stream is automatically diverted to a condensate hold tank. Here it can be routed back to any of the underground storage tanks.

Ventilation Systems

The ventilation system for double-shell tanks consists of two main subsystems: the main tank ventilation system and the annulus ventilation system. These systems will be considered separately. The valving is such in the 241-AY and -AZ Tank Farms, however, that the annulus can be valved into the main tank ventilation system.

The main tank ventilation system is designed to remove vapors rising from stored waste and to provide a vacuum within the tank. The vacuum prevents any uncontrolled airborne releases to the environment. Aging waste poses the most difficult ventilation problem because of the high moisture content in the ventilation air.

The 241-AY and -AZ tanks are connected to the main A Tank Farm ventilation system through 20-inch 304 L stainless steel vent lines. The lines are buried several feet underground. Each line has a seal-loop that allows the individual tank to be isolated from the main system. Vapor from the tanks is drawn off through the tank dome and fed to a York-mesh demister. The demister removes any liquid droplets that may be entrained in the stream. The demisters are provided with raw water sprays and drains to prevent

plugging. The liquid from the demisters is pumped to the 152-AX Diverter Catch Tank and from there to the underground storage tanks. The stream is then routed to three shell-and-tube surface condensers to remove excess moisture. The non-condensable stream passes through another demister and into a steam heater. The steam heater reduces the relative humidity of the stream sufficiently to prevent moisture from condensing in the remainder of the system. The stream is then passed through two high efficiency particulate air (HEPA) filters. Each of the two HEPA filters in series will remove 99.95 percent of the particulate matter in the incoming stream.^(5,6) The stream is then exhausted to the atmosphere. A stack radiation detector constantly monitors the beta and gamma radiation release.

The other double-shell tank farms have or will have similar main vent systems. The vapor-handling requirements are not as great, however, because they will not hold aging waste. The differences are that they will only have one York-mesh demister and no condensers. They will, however, have a roughing filter before the HEPA filter. Instead of seal loops, the lines will have butterfly valves.

The double-shell tanks are built such that they have a two and one-half foot annulus between the inner and outer tank walls. The bottom of the primary tank is separated from the secondary tank by insulating concrete. The concrete is slotted to allow air to pass under the main tank.

The annulus section of each double-shell tank is continuously purged with filtered air. A portion of the air is delivered to a distributor located at a central point in the insulating concrete beneath the tank's inner liner, and the remainder is routed to the annulus (aging waste tanks only). The exhaust air is vented back to the aboveground ventilation system. All of the underground duct work is spaced and sized to provide a balanced flow within the annulus. The 241-AY and -AZ Tank Farm tanks each have an associated blower system designed to supply air flow to the annulus and distributor.

The non-aging waste tanks will not have annulus supply fans because large air flowrates are not needed for heat transmission as in aging waste tanks. In addition, all of the inlet air will pass through the distributor. In all cases, the inlet air passes through roughing and HEPA filters or 10-percent and 80-percent filters before entering the annulus.

The 241-AY and -AZ tanks are unique in that the supply air passes through air dehumidifier units. The dehumidifier units operate on the principle of physical absorption, a process whereby moisture is removed from the air through use of a desiccant. The desiccant beds within the unit are rotated continuously through two compartments which are isolated by Siliastic seals. One compartment dehumidifies the air being routed to the annulus. In the other compartment, the desiccant is regenerated by an application of heated air and made ready for reuse. When the unit is operating properly, it will deliver air at less than 12 percent relative humidity.

Exhaust fans pull air from the annulus and into a filtering system. This system in all but the 241-AY and -AZ Tank Farms consists of a York-mesh demister, a steam heater and two HEPA filters. The 241-AY and -AZ Tank Farms do not have demisters or steam heaters in the annulus exhaust system. The annulus exhaust air then passes through a flow controller and out a stack. The stack has a radiation monitor as in the case of the main vent system.

The annulus and its exhaust system provide several vital needs of radioactive waste storage tanks. The annulus provides an early warning leak detection system and a secondary leak barrier. It also provides a temperature buffer to prevent thermal stress in the concrete shell.

Tank Instrumentation

General

Tank instrumentation includes all instruments connected with tank operations. These include liquid level detectors, sludge level detectors, temperature detectors, leak detection equipment, and airflow, differential pressure and radiation monitoring instruments.

Liquid Level Detectors

The aboveground equipment for liquid level measurement in aging waste tanks consists of reel-mounted calibrated tapes with attached electrodes that are housed in plexiglass enclosures. There are two of these units permanently mounted on four-inch riser flanges at each tank. One of the tapes is preset at a fixed high-level limit and connects to a high-level alarm at the tank's annunciator located in the tank farm control building. The second tape is used to obtain the actual liquid level. The readings are obtained once per shift in conjunction with a portable ohmmeter.

The non-aging waste tanks will be equipped with automatic liquid level gauges. The gauges consist of a plummet suspended on a tape, tape reel, sight glass, control box, air purge and flush sprays. The gauges are mounted on selected risers. In operation, the controls periodically and automatically adjust the plummet position at the air-liquid interface.

The plummet is in its reference position when it is located in the sight glass. The counter is set when the plummet is at the reference position. The air purge minimized vapor condensation on components of the tape take-up and sprocket wheels.

The automatic gauges are also connected to a Data Acquisition and Signal Conditioning System (DASC) which transmits the liquid levels of each tank via the IBM 1800 computer to a printer in 271-CR, Purex and 242-S Buildings. This printout gives a shiftwise listing of all Food Instrument Corporation (FIC) monitored tanks.

Sludge Level Detectors

Sludge level instruments are used to measure the depth of the sludge layer at the bottom of a double-shell tank. Each instrument has a four-inch diameter steel "doughnut" suspended by calibrated tape from a reel. The reels are housed in plexiglass enclosures that are permanently mounted to the tank riser flanges. In operation, the disc is lowered until it comes to rest on the sludge. The tape measurement relative to a fixed mark on the plexiglass enclosure is noted. The difference between this reading and the reading obtained when the tank is empty represents the sludge depth. Each of the 241-AY and -AZ tanks have a total of seven six-inch risers for measuring sludge levels. The other double-shell tanks will have sludge level detectors consisting of a "doughnut" suspended on a predetermined length of cable to which a hand-held calibrated tape can be attached. Readings will be taken manually.

Temperature Detectors

Thermocouples are used in all of the double-shell tanks for monitoring temperatures. The location of the thermocouples in the existing double-shell tanks vary because, as new tanks are built, past experience provides more efficient placement of these probes. The following discussion, however, applies to all of the double-shell tanks in general.

Thermocouples are installed within the working space of each tank. All of the 22 airlift circulators in the 241-AY and -AZ Tank Farms have attached couples that extend three inches above the liner bottom, a point where movement of waste should normally sweep the immediate area free of sludge. A circulator malfunction, which would allow the sludge to accumulate, would be indicated by a temperature rise at the associated thermocouple. Other thermocouples are installed in wells and are used to measure the temperature gradient in the stored waste at different locations within the tank. Thermocouples are also installed at equidistant locations from the tank's center and a few inches above the bottom. These are designated sludge thermocouples and are used to measure temperature at points undisturbed by the airlift circulators. The temperature elements are also installed at the bottom of each of the leak detection pits.

Temperature elements are installed in the insulating concrete pad between the primary and secondary bottom liners. The thermocouples are located close to the underside of the primary liner and are equally spaced in concentric circles. Additional thermocouples are also in contact with the outer surface of the primary shell.

Each of the tanks have structural thermocouple pairs installed in the concrete foundation beneath the secondary steel liner. These pairs are used to measure temperature gradients through the concrete shell.

The Data Acquisition and Signal Conditioning System (DASC) is designed for the long-term monitoring of the thermocouple information in the 241-AY and -AZ Tank Farms. The purpose of the DASC equipment is to scan all of the thermocouples upon command, to condition their signals, and then to either transmit all data to the Purex IBM 1800 computer or prepare a local record readout. The thermocouple inputs are linearized for direct readout in degrees Fahrenheit. A more detailed discussion of the DASC system is found in reference 7.

Non-aging waste tanks will have provisions for portable temperature indicators.

Leak Detection Equipment

The double-shell tanks have two internal facilities for the detection and recovery of any leakage in the event of a liner rupture. The actual layout of the facilities may vary from farm to farm, but the equipment will be the same.

The first system which is installed in the 241-AY, -AZ and -SY tanks is designed to detect a failure of the primary liner. Drain channels in the insulating concrete are designed to carry any leakage to the annulus space. Here three leak detection facilities, in the form of conductivity probes that extend into each tank annulus, are installed 120 degrees apart. There are 17 of these probes at each location, with readout provided at the tank farm instrument building. A determination of annulus liquid level is obtained by rotating each of three probe selector switches through the first 17 positions. Each position coincides with a different probe elevation, and turning the selector to a probe in contact with liquid will activate both an indicator light at the panelboard and an alarm at the control building annunciator. These selectors are checked one per shift. The probe elevations are as follows:

<u>Position</u>	<u>Distance from Bottom</u>	<u>Position</u>	<u>Distance from Bottom</u>
1	6'	10	1'2"
2	5'	11	1'
3	4'	12	10"
4	3'	13	8"
5	2'	14	6"
6	1'10"	15	4"
7	1'8"	16	2"
8	1'6"	17	1/8"
9	1'4"		

NOTE: The probe selector switches are normally left in the No. 17 position.

New double-shell tanks will have one or more manual liquid level tapes installed in the annulus. The tape will be adjusted to alarm at liquid levels greater than one-eighth of an inch from the bottom of the annulus.

Each annulus is surmounted by a pump pit in which a deepwell turbine pump can be installed. When in use, the pump routing is directed to a wall nozzle in the tank's pump pit. From here a standard jumper connection can be made to the tank farm pumpout header and thence to any desired tank.

Leakage through the secondary liner is received into a waffle pattern of drain slots in the concrete base pad. A 6-inch drain line originating at the tank's center and two 4-inch tie-ins from intermediate locations connect these slots to a 60-foot deep leak detection well. The well consists of a vertical section of 24-inch diameter pipe surmounting a base section one and a half feet high by four feet in diameter (see Figure 1). The 24-inch section is a pumpout riser extending to a pump pit at grade level. A deepwell pump can be installed at this location and will connect through a standard remote pipe jumper to a two-inch process waste line. From here the solution can be routed to any designated tank. Each leak detection pit is vented to its related tank annulus through a 2-inch line. Pump pit drainage is routed via a 4-inch line that extends 12 inches below the tank dome.

Normally only one annulus pump and one leak detection pit pump will be provided per farm. These pumps can be moved on short notice to any tank in which they are required.

Leak-detection pits are also provided for pipe encasements.

There are three basic instrument systems installed on each leak-detection pit. One is a radiation detection well installed adjacent to and extending to the base of the four-foot diameter section. A second is instrument dip tubes for weight factor and specific gravity measurement. Readout is provided at a panelboard in the tank farm instrument building. The third is a thermocouple installed in a well that extends to within three inches of the bottom of the pit. This thermocouple is connected to the DASC. A change in any of these three systems could mean a possible leak.

In addition to the equipment described above, a radiation monitor is installed on the annulus exhaust system to provide an early warning system. The 241-AY tanks also have liquid level tapes equipped with an alarm to provide redundancy to the permanently-mounted conductivity probes.

DESIGN CRITERIA

Each of the 23 double-shell tanks will comply with the general design criteria for their respective tank farms as listed in Table I. Specific requirements of the tanks to fulfill their individual functions are discussed under Facility Description.

NATURAL FORCES

The 241-AY and SY Tank Farms and their support facilities are designed to resist wind forces in accordance with the Uniform Building Code, Section 2308. All future double-shell tanks and their support facilities will be designed in accordance with SDC 4.1. This does not include tornado (circular) winds. A peak wind gust (straight) of 80 miles-per-hour was measured on January 11, 1972, at the 50-foot level of the Hanford Meteorology Station tower and no damage was sustained.

All new structures, equipment, and piping classified as quality assurance Level I shall be designed and analyzed for the Safe Shutdown Earthquake (SSE). The SSE shall be assumed to produce a maximum horizontal ground acceleration of 0.25 g. The simultaneous maximum vertical ground acceleration shall be taken as two-thirds of the horizontal. The structures, equipment and piping, so defined, shall be designed to withstand the SSE so the facility can be rendered to a safe status without release of radioactivity to the environs which would result in undue risk to public health and safety. Structural response to the SSE must be mainly elastic. All other structures and components shall be designed and constructed in accordance with the Uniform Building Code for Seismic Zone II.

TABLE I

DESIGN CRITERIA FOR DOUBLE-SHELL TANKS

	<u>AN</u>	<u>AP</u>	<u>AW</u>	<u>AY</u>	<u>AZ</u>	<u>SW</u>	<u>SY</u>
Number of Tanks	6	2	6	2	2	2	3
Maximum Stored Volume, Gallons	10 ⁶	10 ⁶	10 ⁶	10 ⁶	10 ⁶	10 ⁶	10 ⁶
Maximum Tank Pressure, W.G.	60"	60"	60"	60"	60"	60"	60"
Maximum Tank Vacuum, W.G.	6"	6"	6"	6"	6"	6"	6"
Uniform Live Load, psf	40	40	40	40	40	40	40
Concentrated Live Load, Tons	50	50	50	50	50	50	50
Minimum Earth Cover, Feet	6.5	6.5	6.5	7	6.5	6.5	6.5
Maximum Temperature, °F	350	350	350	350	350	350	350
Thermal Load, Btu/Hour-Tank	10 ⁵	10 ⁵	10 ⁵	10 ⁷	10 ⁷	10 ⁵	5x10 ⁴
pH							
minimum	8	8	8	8	8	8	8
maximum	14	14	14	10	10	14	14
Specific Gravity	2	2	2	1.8	1.8	2	2.0

AUXILIARY FACILITIES

UTILITIESElectrical

Electrical power requirements for the 241-AY Tank Farm operation are provided by an expansion of existing facilities. The 480 volt, three-phase 600 ampere feeder tie-in is a new direct-buried cable that connects to the existing substation located directly east of the 241-AY-271 control building. The route proceeds in a northwesterly direction, behind the 241-A-701 compressor building, and 241-A-702 filter building, and then to the 241-AY-801 instrument house in the 241-AY Tank Farm. The main bus within the building feeds electrical power to sluice and transfer pumps, floodlights, circuit breaker for the annulus ventilation systems, and a 10 kilovolt-ampere lighting transformer (480-120/240 single phase). The electrical system in the 241-AZ Tank Farm will be similar to that provided in the 241-AY Tank Farm. Power cables to motor control centers and to individual motors, lights, panels, etc. will be directly buried wherever possible. A new 13.8 kv distribution line will be extended to a new 1,000 kva, 13.8-480Y/277-volt outdoor unit substation located in the 241-AZ Tank Farm area. This line shall be connected to 13.8 kv line No. E816 near the 241-CR Tank Farm. The unit substation will have primary and secondary protection sized for the transformer capacity. The secondary bus will be protected by a main circuit breaker and secondary breakers will feed motor control centers located in the tank farm near the centers of load. The secondary switch gear will be so arranged that sections may be added for future growth.

The electrical supply in the 241-SY Tank Farm will be required to meet the power requirements to operate the following equipment running continuously: (1) three supernatant pumps, (2) one annulus pump, (3) one leak detection pump, (4) two ventilation exhaust units, (5) all electrical heat tracing, (6) all electrical lighting, and (7) outlet stations for impact wrenches.

The excess electrical power at the 242-S Evaporator Building will be supplied to the new 241-SY Tank Farm from the existing substation north of the 242-S Building.

New substations will be needed to supply electrical power to each of the 241-AN, -AP, and -SW Tank Farms. Electrical power to the various tank farms will be needed to meet the requirements to operate the following equipment running continuously:

1. 241-AP and -SW Tank Farms

- a. Two supernatant pumps
- b. One annulus pump
- c. One leak detection pump
- d. One annulus ventilation exhaust unit

- e. One primary tank ventilation exhaust unit
- f. All electrical heat tracing
- g. All electrical lighting
- h. Outlet stations for impact wrenches
- i. Air compressor, heater, and cooler in the instrument building

241-AN Tank Farms

- a. Six supernatant pumps
- b. One annulus pump
- c. One leak detection pump
- d. Two annulus ventilation exhaust units
- e. One primary tank ventilation exhaust unit
- f. All electrical heat tracing
- g. All electrical lighting
- h. Outlet stations for impact wrenches
- i. Air compressor, heater, and cooler in the instrument building

STEAM

Steam is supplied to all the tank farms for the tank and annulus ventilation heaters, steam coils (aging waste tanks), and for flushing operations. New one and one-half-inch and two-inch lines will connect to existing steam lines to supply 225 psig steam to new service pits in 241-AN, -AP, -AZ, and -SW Tank Farms. The steam supply for the 241-AY Tank Farm is routed from the main steam line tie-in at AR Vault and 241-SY Tank Farm steam is supplied from the 242-S Evaporator-Crystallizer supply line. The maximum instantaneous steam consumption of any tank farm is estimated to be less than 3,000 pounds per hour.

WATER

Raw water is supplied to the 241-AY and -AZ Tank Farms from a four-inch line that tees off from a six-inch line supplying the 241-AX Tank Farm. Both 241-AP and 241-AN Tank Farms will be supplied with raw water from an existing eight-inch line between the 241-AZ Tank Farm and the Seventh Street Road (to be relocated between the 241-AZ and -AN Tank Farms). Raw water will be supplied to the 241-SY Tank Farm from the 242-S Evaporator-Crystallizer supply line. The 241-SW Tank Farm will receive raw water and an existing four-inch line south of 241-U Tank Farm and from an existing six-inch line southeast of the 241-S Tank Farm, respectively. All raw water will be supplied at a pressure of 100 psig to each of the tank farms at a maximum estimated flow rate of 100 gallons per minute.

COMPRESSED AIR

Compressed dry, oil-free air will be provided to all of the tank farms to operate instrumentation ventilation air samplers, instrument air purging, and airlift circulators. Backup compressors are provided to assure that air is available at all times. Where backup compressors are not available, portable compressors will be used.

PERTINENT SAFETY FACTORS

WASTE CHARACTERISTICS

Wastes stored in double-shell tanks are highly alkaline solutions of sodium salts which contain radionuclides. The primary chemical compounds are sodium hydroxide, sodium nitrate, sodium nitrite, sodium aluminate, sodium carbonate, and sodium sulfate. To reduce corrosion, the following limitations will be imposed: ⁽⁸⁾

1. The pH shall be above 8.
2. The presence of sodium hydroxide shall be limited to a maximum of 8M. ⁽⁹⁾
3. The concentration of nitrite shall be maintained above 500 parts per million.
4. No restriction on phosphate or carbonate.
5. No restriction on sulfate if the nitrite concentration is maintained above 500 parts per million.
6. The concentration of nitrate shall be maintained below 6M.
7. The concentration of halides and/or strong oxidizing agents, such as permanganate, lead oxide, or chromate shall not exceed those encountered during the use of an approved plant flow sheet. Nonroutine additions of these materials which result from a new or modified process shall be investigated with respect to in-tank corrosion. The investigation will be provided by the Process Design and Development Section, and approved by the Development Engineering Department. The concentration of the aforementioned materials shall be limited to a value which will result in an average uniform corrosion rate of less than 1.0 mil per year.
8. The concentration of cations shall be limited to the concentration resulting from the use of an approved plant flow sheet.

The radionuclides found in the double-shell tanks will primarily be ¹³⁷Cs, ⁹⁰Sr, ²³⁹Pu, ⁶⁰Co, ¹⁴⁴Ce-¹⁴⁴Pr, ¹⁰⁶Ru-¹⁰⁶Rh, ¹⁵⁴Eu, and ¹²⁵Sb. The maximum concentrations expected are listed in Table II. In all cases, the radionuclide concentration will be limited such that the radiolytic thermal load will be less than the values shown in Table I. ⁽¹⁰⁾

TABLE II

MAXIMUM ANTICIPATED RADIONUCLIDE CONCENTRATIONS

<u>Radionuclide</u>	<u>Concentration</u>
¹³⁷ Cs	6.0 c/gal
⁹⁰ Sr	1.3 c/gal
⁶⁰ Co	0.01 c/gal
¹⁴⁴ Ce- ¹⁴⁴ Pr	1.0 c/gal
¹⁰⁶ Ru- ¹⁰⁶ Rh	2.0 c/gal
¹⁵⁴ Eu	0.03 c/gal
¹²⁵ Sb	0.06 c/gal
²³⁹ Pu	0.01 gm/gal

PROTECTIVE SYSTEMS

FIRE PROTECTION

Portable fire extinguishers are located in strategic positions throughout the tank farms. Fire alarm boxes are located in change rooms and all control buildings.

EMERGENCY POWER

Normal power is supplied from 13.9 kv lines to the individual farms. Limited capacity backup lines are provided in the event of a failure in the main power supply line. Other sources of limited power in the 241-AZ and -AY Tank Farms are 96-kw and 300-kw diesel generators. These will automatically start up in the event of a power failure. An automatic switching gear transfers equipment back to the main power supply when power is restored. The cooling water pumps, air compressors, exhaust fans, emergency lighting, and radiation monitoring equipment are powered by the emergency diesel generators. This is the minimum equipment required for safe operation.

EMERGENCY LIGHTING

Emergency battery-powered floodlight units are located in change rooms and control buildings to provide adequate illumination of occupied areas during periods of normal power supply interruption.

EMERGENCY WATER

The 241-AZ and -AY Tanks vent system condensers will be the only facility requiring emergency cooling water. A loss of the export water supply will require the use of the emergency cooling water equipment. The system can

be operated independently of the existing raw water and electrical installations. Water is obtained for the system from wells located northeast of the 241-AX Tank Farm. The major emergency equipment consists of the following:

1. A 100 gallons-per-minute deepwell pump located northeast of 241-AX Tank Farm.
2. A 150-kw capacity motor generator and associated switch gear and controls for the generator, pumps, and cooling tower.
3. An induced draft cooling tower capable of cooling 800 gallons-per-minute of condensate from 150° F to 90° F.
4. Warm water sump with two 1,000 gallons-per-minute, circulation pumps and valving for the deepwell pump.
5. Automatic control of all equipment, except the deepwell pump, is maintained by the vapor temperature controllers.

CONFINEMENT OF RADIONUCLIDES

AIRBORNE

Several systems are used to detect and control airborne radionuclides and to prevent their release to the environs.

All gaseous discharges are filtered through a series of High Efficiency Particulate Air (HEPA) filters. These filters are tested for particulate removal efficiency at least once per year and when operating parameters indicate significant variations in performance.

The noncondensable vapors from the exhaust system are filtered through the vent system to minimize the release of airborne radioactive contaminants from the tanks. The maximum dose rate experienced from off-gas filters, prior to changeout, is 1,000 milliroentgens per hour (mR/hour). Before this level is reached, the vessel vent filters will be changed out due to intolerable radiation readings or failure to pass the particulate removal test. Each contaminated filter is removed by placing it in a plastic bag which is contained in the filter housing. Continuous sampling provides data for determining if any radioactive contaminants are passing through the filter. Monitoring instruments will alarm when an abnormal radiation release is detected. Effluents released to the atmosphere will meet Table II, ERDA Manual Chapter 0524, concentration limits. If the instruments detect any off-standard activity in this stream, the vessel vent system is shut down immediately. Emergency portable exhausters can be brought in if this is necessary. Each exhauster contains an electric heater, HEPA filters, and an exhaust fan.

Area radiation monitors are also provided to detect airborne or surface contamination releases. These are located within 100 feet of any underground storage tank.⁽¹¹⁾

STEAM CONDENSATE

Steam condensate from the 241-AZ and -AY tank steam coils require in-line radiation monitoring. The condensate is routed through a diversion system that automatically routes the condensate to a hold tank if radiation greater than 300 counts-per-minute above background is detected. The contents of the hold tank may then be transferred to any of the underground storage tanks.

PROCESS CONDENSATE

Process condensate originates from the 241-AZ and -AY vent systems. The condensate is collected in the 217-A Catch Tank and then diverted to any of the tanks in the A Tank Farm complex or used as evaporator feed.

COOLING WATER

Cooling water from the surface condensers is sampled and discharged to the 216-A-25 Gable Mountain Pond. A portion of the cooling water is routed through a proportional sampler radiation monitor in the condenser building. The cooling water discharge line is not provided with a diversion capability and the flow must be stopped manually in the event of a high-radiation alarm (greater than 100 counts-per-minute above background). The cooling water sample results and cooling water flow records are used to determine the annual radionuclide releases in the 242-A Evaporator-Crystallizer cooling water stream.

RADIATION PROTECTION

PROGRAM

Atlantic Richfield Hanford Company is contractually obligated to take all reasonable precautions to protect the health and safety of employees and the public, and to minimize danger to life and property from all radiation and radioactive material under its control. Accordingly, radiation protection standards are established to specify requirements necessary for safe radiation control and protection. The Radiation Protection Standards and Control Manual⁽¹²⁾ describes the methods for controlling radiation exposure to employees and the public, and provides guidelines for uniform and purposeful compliance within the Company.

The Radiation Protection Standards also provide information regarding contractual requirements set forth by the United States Government, as administered by the Energy Research and Development Administration. These standards incorporate published recommendations of authoritative national and international bodies, as well as specific instructions and guides written by the Richland Operations Office of the Energy Research and Development Administration and other Hanford contractors. The interpretation of requirements in the Radiation Protection Standards and Control Manual is the responsibility of the Environmental and Occupational Safety Department.

The design of the double-shell tank farm facilities incorporates a maximum practical capability for radiation protection and control. Plant operating procedures and specifications are designed to implement all applicable radiation protection standards. Radiation work procedures and emergency procedures complement operating specifications for maximum compliance with requirements stated in the Radiation Protection Standards and Control Manual. Operation of the double-shell tank farm facilities will be consistent with applicable guides and standards to assure that present and future radiation exposures to individuals and population group are limited to the lowest levels technically and economically practical, not exceeding limits established in ERDA Manual Chapter 0524, Appendix, parts I and II.

RADIATION LEVELS

Earth cover and reinforced concrete cover blocks are provided to shield all of the double-shell tanks and associated waste handling equipment. This shielding is designed to limit radiation exposure to one rem per year per individual.

Radiation detectors and monitors are provided on all processing streams discharged to the environment. Area radiation monitors are mounted high in the tank farm at strategic locations such that all of the tanks are within 100 feet of the nearest monitor. These monitors will detect any unusual surface area radiation. Other radiation monitors are installed in all primary tank ventilation and annulus ventilation exhausters units. (Radiation monitoring of effluent streams is discussed in the Confinement of Radionuclides Section.)

NUCLEAR SAFETY

Within the current operations plan for the double-shell tank farm facilities, there is no risk of nuclear criticality. Each tank is limited to 50 kilograms of fissionable material as required by ARH-1601.⁽¹⁵⁾

Administrative operating limits are established to control the fissionable materials inventory in underground storage tanks. The low concentration of fissionable material in the waste solutions and the maximum limit specified for fissionable material accumulation in underground storage tanks combine to preclude the possibility of nuclear criticality in the waste tank systems.

INDUSTRIAL SAFETY

Normal preventive measures are used to avoid typical injuries experienced in industry. An active safety program is maintained with every effort made to encourage a favorable attitude toward safety. Technical guidance in matters pertaining to industrial safety is provided by the Environmental and Occupational Safety Department, which provides an integrated personnel program in the fields of industrial safety, fire protection, and radiation safety.⁽¹³⁾

PROCESS SPECIFICATIONS AND STANDARDS

Process specifications and standards provide administrative control guidelines and define currently known limits within which the tank farms can be safely and efficiently operated to concentrate, solidify, and store waste solutions. The basis for process specifications and standards is the establishment of process and operating limits required to protect the public, environs, operating personnel, and facilities from potential harm or damage. Process specifications and standards also define operating limits required to meet comprehensive environmental release criteria⁽¹²⁾ and for effective process control of unit operations.

Operation of the tank farm facility in compliance with process specifications and standards is considered a mandatory administrative requirement by Atlantic Richfield Hanford Company. Changes in process specifications and standards, to meet changing process or administrative requirements, may be made only with written approval and acceptance by ARHCO management as indicated on approval lists.

PROCESS PROCEDURES

Standard operating procedures (SOP's) are prepared for all process operations associated with the tank farm facilities prior to startup. Standard operating procedures provide written, stepwise instructions for safe, efficient operation of equipment and facilities. All procedural steps are designed to assure compliance with applicable process specifications and standards.

All new or revised process SOP's must be prepared by knowledgeable personnel in the Operational Process Engineering section. The procedures are reviewed by the Quality Assurance Department and the Environmental and Occupational Safety Department as required, and approved by the Tank Farm Operations Manager.

All SOP's are reviewed on a regular basis to assess their effectiveness and adequacy with respect to current plant operating modes and administrative requirements. Compliance with the procedures, which is considered mandatory by the Company, is regularly audited and documented by Quality Assurance Department.

EMERGENCY PROCEDURES

Atlantic Richfield Hanford Company has developed and maintained an emergency preparedness program to cope with the consequences of potential accidents involving the Hanford Plant areas and functions for which the Company is responsible. The program includes plans and procedures for immediate action responsive to sudden and unexpected occurrences originating on or off the Hanford Plant. Where appropriate, action level guidance is made part of operational procedures and specifications to indicate the required degree of response. The emergency preparedness program is intended to provide the maximum practicable protection for the plant employees, property, environs, and general public.

The emergency preparedness program is implemented by the Emergency Procedures Manual⁽¹⁴⁾ which provides basic information on methods of coping with many types of emergencies. These procedures define, in detail, the actions to be taken, including specific individual responsibilities, in order to achieve protection of personnel and facilities.

Emergency Procedure 2.3.12, "Radioactive Gaseous Discharges - Tank Farms," and Emergency Procedure 2.3.13, "Radioactive Liquid Discharges - Tank Farms," are directly concerned with the operational safety of the tank farm facilities. The emergency procedures provide the bases for definition of the emergency occurrences, define required actions, and assign specific responsibilities to supervisory, radiation monitoring, and engineering support personnel to cope with the occurrence.

FACILITY OPERABILITY TESTS

Operability tests are conducted on all equipment and control systems of the tank farm facilities prior to hot startup. The objectives of the operability tests are to:

1. Identify and correct plant construction deficiencies;
2. Evaluate the adequacy of process and plant design bases;
3. Provide for training of the operation and supervisory personnel; and
4. Demonstrate the operational readiness of the facility on an integrated system basis.

The operability tests are conducted according to written test procedures prepared by the Engineering Department of the Atlantic Richfield Hanford Company.

QUALITY ASSURANCE

The Quality Assurance Policy Manual⁽¹⁵⁾ delineates the policies governing the Atlantic Richfield Hanford Company quality assurance system. Implementation of this Manual provides the required system and functions to comply with Appendix B to Title 10, Code of Federal Regulations, Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

The Manager, Quality Assurance and Safety Division, is responsible for the enforcement and audit of the ARHCO Quality Assurance Program. Supplementary detailed instructions are prepared by the Quality Assurance and Safety Division and issued in the form of Quality Assurance Instructions or Quality Assurance Procedures. The intent of these instructions is to incorporate quality controls and assurance into line responsibilities and performance of ARHCO's technical and operating activities. These instructions are to be adhered to by Company personnel in the conduct of their work.

PERTINENT INFORMATION SOURCES

General

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241-AY Tank Farm

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ARH-CD-123 (unclassified), August 22, 1974, C. A. Lyneis, "Project Proposal 241-AZ-101 Tank Additions (Project B-109)."

241-SY Tank Farm

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ARH-2930 SUP1-1 (unclassified), September 20, 1974, K. H. Tanaka, "Functional Design Criteria - Supplement 1 241-SY-102 Feed Tank Conversion (Project B-101)."

ARH-CD-197 (unclassified), October 8, 1974, K. H. Tanaka, "Conceptual Design 241-SY-102 Feed Tank Conversion (Project B-101)."

241-AN Tank Farm

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ARH-CD-462 (unclassified), October 22, 1975, K. H. Tanaka, "Conceptual Design Report Additional High-Level Waste Storage and Handling Facilities for 200 East Area."

241-AP and SW Tank Farms

ARH-CD-549 1 (unclassified), March 1, 1976, K. H. Tanaka, "Functional Design Criteria Additional High-Level Waste Handling and Storage Facilities."

ARH-CD-652 RD (unclassified), April 2, 1976, K. H. Tanaka, "Conceptual Design Report Additional High-Level Waste Handling and Storage Facilities."

POSTULATED ACCIDENT SUMMARY

Due to the large differences in the accidental consequences between aging and non-aging waste tanks, the accident summary has been divided into two sections. The first section deals with non-aging waste tanks of which there will be 19 tanks. The accidental consequences for these tanks are much less than for aging waste tanks.

The second section deals with aging waste tanks. Four of the 23 existing or proposed double-shell tanks will contain aging waste. Although the accidental consequences for these tanks are much greater than for non-aging waste tanks, they can still be used safely.

POSTULATED ACCIDENT SUMMARY FOR NON-AGING WASTE DOUBLE-SHELL STORAGE TANKS

Discussed below are several postulated accidents which could conceivably occur during the operation of the new double-shell waste storage facilities designed for non-aging waste. Each accident was examined for a failure mode, or modes, a means of detecting the event, response to the accident, the immediate and/or eventual consequences of the accident, and the precautions being observed to prevent the accident from occurring.

EVENT - ROUTING OF ACID WASTE TO UNDERGROUND STORAGE

Description

Process specifications for double-shell storage tanks require that the pH of any solution transferred into these tanks be greater than nine.⁽¹⁶⁾ It is credible, however, that a batch of acidic waste could be routed to one of the double-shell tanks. This material would be generated in the Purex process and routed through the 244-AR Building or the 241-AX-151 diverter station before it would reach underground storage. The maximum size of a batch of this type would be 5,000 gallons.

Detection

The first indication of an event of this type would be a rapid generation of nitrous oxides. Nitrous oxides are dark brown in color and would be visually apparent in the vent system exhaust. Low pH would also be detected by analysis of samples taken from the waste tanks.

Response

The response to an event of this type would be to determine the pH of the solution in the tank. Caustic would then be added to adjust the pH back to nine or above.

Consequences

An event of this type would not immediately release radiation to the environment, or damage the tank. Lowering the solution pH would, however, increase the potential for corrosion in the tank. Addition of acid to a new tank with little liquid in it could cause serious corrosion. A leak from the primary tank due to corrosion is covered in the tank failure event.

Precautions

All batches that are transferred from B Plant to underground storage are sampled and analyzed for pH. These data are then double-checked by supervisory personnel before a transfer can be made. Extra precaution is taken when adding waste to new or empty tanks.

EVENT - STEAM COIL FAILURE

Discussion

Since none of the non-aging waste tanks are expected to contain steam coils, this type of an accident is not credible.

EVENT - SEISMIC ACTIVITY

Description

The maximum credible earthquake for the Hanford reservation has been postulated to be a Richter magnitude 6.8 earthquake (with an epicentral distance approximately 10-15 miles from the double-shell tanks). It would produce a maximum horizontal ground acceleration at the double-shell tanks of 0.25 gravity and a simultaneous vertical ground acceleration two-thirds of the horizontal acceleration.⁽¹⁷⁾ The 0.25 g earthquake would have an occurrence frequency associated with an unlimited time span whereas the probability of 0.20 g would be once in 16,700 years, 0.15 g once every 4,000 years, 0.10 g once every 1,850 years, and 0.05 g once every 840 years.⁽¹⁸⁾

The largest local earthquake of historical record occurred at Corfu (a few miles north of the Hanford site) in 1918. Estimates of the peak ground acceleration determined for this event range from 0.01 to 0.03 g.⁽²¹⁾

Detection

Current earthquake detection facilities consist of accelerometers which are located at the Purex Plant, C Farm, B Plant, T Plant, and the Z Plant. These instruments are read weekly to determine seismic activities in the 200 Areas. There are no other detection devices in use at this time, but four seismic detector stations are planned. These four detectors will be tied in with a recording station which will be located at B Plant. An alarm will sound whenever a 2.0 or greater Richter scale magnitude earthquake is detected. The four detectors are planned to be installed by late 1977.

Response

When an earthquake alarm is tripped, accelerometer readings will be taken immediately. Depending on the severity of the quake, a survey will be taken to determine the amount of structural damage incurred. In addition, normal leak detection measurements will be taken by Tank Farm Operations to check for tank damage.

Consequences

The consequences of a 0.25 g earthquake would be minimal, since the tanks and their related facilities are constructed to withstand such an event. Minor cracking may be experienced in some of the concrete structures, but no damage is expected which could interfere with the safe operation of the tank farms.

Precautions

All double-shell tanks and their Quality Assurance Level I facilities (pit structures including pit covers, imbedded piping and caissons) are designed to withstand a safe shutdown earthquake (0.25 g maximum horizontal ground acceleration). All other structures (including the ventilation systems) are designed and constructed in accordance with the Uniform Building Code for Seismic Zone II.

EVENT - AIRLIFT CIRCULATOR FAILURE

Discussion

Failure of an airlift circulator in a non-aging waste tank would not create a hazardous situation.

EVENT - LOSS OF UTILITIES

Description

Utility services include steam, water, electrical power, and compressed air. It is conceivable that these services could be lost by accidental severance of a utility line or breakdown of a plant supplying the utility. The loss of all utilities other than power would not result in an emergency situation. Even a power loss in the non-aging waste tanks could be tolerated.

Water and steam are supplied by the 200-East and-West powerhouses. Due to the history of high reliability of these plants, it does not seem very likely that a breakdown would occur. A more likely cause for utility failure would be the rupture of a waterline during excavation, or a steam line break caused by a vehicle accident. A probable cause for loss of Bonneville-supplied electrical power would be a line break or substation burnout during adverse weather conditions. Compressed air could be lost for a short time during an electrical power outage or if a compressor were to fail.

Detection

- Water: Water is used for flushing operations in non-aging waste tank farms and would be detected by an operator during a flushing operation.
- Steam: Steam will be used by all the tank farms for heating exhaust ventilation air. Loss of steam would allow moisture to collect on the vent HEPA filters, resulting in a high differential pressure drop.
- Electrical: An electrical power outage would be self-evident. In addition, an alarm will sound at the 200-West Area Powerhouse when Bonneville-supplied power is lost.
- Air: Loss of instrument air would result in the failure of recording instruments and pressure gauges. This would be detected during routine data collection.

Response

- Water: Loss of water would not produce any hazardous conditions in a non-aging waste tank farm. Steps would be taken to restore water service as required.

- Steam: Emergency action would center around restoring the steam supply. Vent filter DP's would have to be checked to determine if moisture were collecting on the filters.⁽⁶⁾ A deteriorating condition would call for the shutdown of the vent system and activation of a portable vent system which uses electric heating coils.
- Electrical: Loss of power would call for restoration of emergency power supply by diesel generators. Emergency Procedure 2.3.7 in document ARH-222 outlines the specific guidelines and responsibilities for dealing with this event.
- Air: Instrument air would be restored by the use of portable compressors as soon as possible. Emergency Procedure 2.3.11 in document ARH-222 outlines the specific guidelines and responsibilities for dealing with this event.

Consequences

- Water: As mentioned before, loss of water would not produce any hazard conditions in non-aging waste tank farms.
- Steam: Ventilation air is heated by steam coils to prevent moisture from condensing on the HEPA filters. Loss of steam could cause the filters to collapse due to excessive moisture, which would result in shutdown of the vent system or possibly a contamination release (see filter failure event).
- Electrical: Loss of electrical power would result in stopping all transfer operations. All instrumentation is designed for "Fail-Safe Operation" in the event of an air or electrical outage.⁽¹⁹⁾ During the time between the outage and emergency power startup, no hazardous conditions are expected to develop.
- Air: As stated earlier, all instrumentation is designed for fail-safe operation and no hazardous conditions are expected to develop.

Precautions

- Water: There are no emergency provisions for supplying water in non-aging waste tank farm.
- Steam: There are no emergency provisions for supplying steam in the 200 Areas. The potential for loss of steam is considered remote.

Electrical: Emergency power diesel generators are available in both the 200-East and 200-West Areas. They are capable of maintaining all the essential facilities required for the safe operation of the tank farms.

Air: All instrumentation requiring compressed air is designed for fail-safe operation in case air is lost. Portable compressors could be used where the air supply could not be readily repaired.

EVENT - EXCESS VACUUM

Excess vacuum in a non-aging waste tank is not considered to be credible. When considering duct system pressure drops and total system pressure losses, the ventilation fans are incapable of pulling higher than design vacuums in the storage tanks.

EVENT - BACKFLOW OF LIQUID THROUGH AIRLIFT CIRCULATOR AIR SUPPLY LINE

Discussion

Backflow of liquid through an airlift circulator air supply line is not a credible accident for a non-aging waste tank. The motive force in this type of an accident is caused by flash vaporization of liquid waste entering an air-supply line. Since liquid temperatures in non-aging waste tanks will be below the flash point of the liquid waste, backflow cannot occur.

EVENT - DRESSER COUPLING FAILURE

Discussion

Dresser couplings are not used on non-aging waste tanks (aging waste tanks only); therefore, this is not a credible accident.

EVENT - TANK FAILURE

Description

Coincidental failure of a primary tank shell and the secondary tank in which it resides, with release of radioactive solution to the surrounding soil, is not considered credible. Mechanisms studied include failure of a primary tank by stress corrosion cracking. Stress corrosion cracking is caused by an internal stress field in the metal liner and is promoted by the ionic species contained in the wastes. Stresses can be set up in the tank liner by improper heat treatment, improper structural support, and bulging, to name a few.

General corrosion of a primary tank is very slow when compared to the useful life of the tank, and is not considered to pose a threat to its integrity.

An accident that could lead to stress corrosion or actually rupture a tank could be caused by floating a tank. This could occur if the annulus were accidentally filled with water while the primary tank was empty or only slightly filled. The force of the water could bulge the tank bottom which may rupture or set up a stress field in the liner. The consequences from this type of accident would be less than those experienced by a tank leak into an empty annulus. This accident is very unlikely because there are no direct waterlines to any double-shell tank annulus. Another accident that could affect the primary tank would be the addition of liquid with a specific gravity greater than that specified in the design criteria. Failure of the primary tank would result in discharge of radioactive liquid to the annulus space. The liquid would be contained by the secondary tank, where its presence would be detected. The liquid could then be pumped directly back to the tank via the pump pit or to any other tank, through the pumpout header.

Failure of the secondary tank would occur only after the primary tank had failed. This would result in discharge of radioactive liquid to the concrete base. The liquid would flow to a leak detection pit where it would be detected and could be pumped to other tanks. An event of this type would not release contaminated material to the atmosphere and is not considered to be a credible accident during the expected 20-year use of the tank.

Detection

A leak into the annulus from the primary tank can be detected by three methods:

1. An alarming manual liquid level tape.
2. An increase (approximately two inches) in the annulus liquid level as measured by a conductivity probe.
3. An increase in the annulus vent radiation levels or a high radiation alarm.

Response

Non-aging tanks will not require the annulus vent system to be shut down during a leak. Tank Farm Operations would determine the tank to which the escaping liquid would be pumped. Action guidelines and associated responsibilities are outlined in Emergency Procedure 1.9, "Spread of Contamination," and 2.3.13, "Radioactive Gaseous Discharges Tank Farm," in ARH-222.

Consequences

Should an accident of this type occur, the release of contaminants and its impact would be expected to be less than the filter failure case presented in this report.

Precautions

The specific gravity of solutions will be controlled by an approved process flow sheet. Any unusual material will be sampled before it is transferred to the double-shell tanks.

Stress corrosion cracking has been recognized as a factor relating to the loss of tank integrity. The potential for stress corrosion cracking of primary tanks containing nitrate and caustic bearing process materials has been acknowledged. Measures have been taken to reduce this potential by use of double-shell tanks incorporating stress relieving of primary tanks. Additional steps to reduce tank corrosion in both double- and single-shell tanks include:⁽⁸⁾

1. The pH shall be above 8.
2. The presence of sodium hydroxide shall be limited to a maximum of 8M.⁽⁹⁾
3. The concentration of nitrite shall be maintained above 500 parts per million.
4. No restriction on phosphate or carbonate.
5. No restriction on sulfate if the nitrite concentration is maintained above 500 parts per million.
6. The concentration of nitrate shall be maintained below 6M.
7. The concentration of halides and/or strong oxidizing agents, such as permanganate, lead oxide, or chromate shall not exceed those encountered during the use of an approved plant flow sheet. Nonroutine additions of these materials which result from a new or modified process shall be investigated with respect to in-tank corrosion. The investigation will be provided by the Process Design and Development Section, and approved by the Development Engineering Department. The concentration of the aforementioned materials shall be limited to a value which will result in an average uniform corrosion rate of less than 1.0 mil per year.
8. The concentration of cations shall be limited to the concentration resulting from the use of an approved plant flow sheet.

In addition, the primary tank has been designed to have an adequate corrosion allowance for a 50-year tank life based on an average corrosion rate of 1.0 mil per year.

EVENT - DOME FAILURE

Discussion

Failure of an underground high-level waste tank dome is not considered to be a credible incident. Modeling tests have indicated that a safety margin of four to five times the earth load (approximately 1,500 tons) could be resisted over the tanks. Based on the life of other reinforced concrete structures (bridges, dams, etc.), a dome life of 100 years or more could be reasonably expected. Available evidence indicates that radiation has little effect on the strength of reinforced concrete.⁽²⁾

It is conceivable that the presence of heavy equipment directly above the tank domes could cause some structural damage, but liquid release is not considered credible. Strict administrative controls⁽²⁰⁾ have been in effect for some time to control this type of live loading and these controls will continue.

Based on this information and the fact that double-shell tanks will only be used for 20 years^(21,22), the dome failure accident is not considered to be credible.

EVENT - ACCUMULATION OF HYDROGEN IN UNDERGROUND STORAGE TANKS

Discussion

Hydrogen gas is produced by the radiolytic decomposition of water present in radioactive waste. Studies made on hydrogen production rates (ARH-1601, Section E) indicate that the maximum allowable amount of terminal liquor in a tank could produce as much as 1.1 cubic feet of hydrogen per hour. This hydrogen would have to reach a concentration of at least four percent and be exposed to an ignition source before it could cause a problem. From the amount of vapor space above the liquid, it can be shown that at least 100 days would be required, with the terminal liquor tank completely sealed, for hydrogen to build to the four percent limit, based on the vapor space above the liquid.

Several factors combine to make the buildup of hydrogen in a waste storage tank very unlikely. The tanks are on ventilation systems which exhaust the vapor space above the liquid. It is very unlikely that one of these systems could be down for more than 100 days. If the vent system was down, the tanks would still ventilate due to a natural breathing rate caused by changes in atmospheric pressure. This would greatly slow down the hydrogen buildup process. Coupled with this is the fact that hydrogen diffuses rapidly and would exit the tank through risers, pit drains, fill lines, and other tank dome penetrations. Along with these considerations is the fact that there are no ignition sources in the tanks. For these reasons, a failure mechanism for a hydrogen incident has not been developed. No terminal liquor with radioisotope concentrations sufficient to produce the stated hydrogen generation is available. The actual characteristics of the worst case terminal liquor can only be postulated

at this time. Studies on hydrogen generation from terminal liquor and hydrogen removal from waste storage tanks are continuing, however, to ensure safe operations.

EVENT - ORGANIC FIRE IN A WASTE STORAGE TANK

Description

Organic fires are not credible in underground storage tanks if the tanks hold terminal liquor, or any product of the Evaporator-Crystallizers. Organic compounds in terminal liquor and other products of the Evaporator-Crystallizer will be evaporated before it can be transferred to a double-shell tank. A severe process upset or operator error, however, could result in a double-shell evaporator feed tank receiving organic material. This material could ignite if present in sufficient quantity, at the proper temperature, and exposed to an ignition source. If ignited, the flame would propagate through the tank and into the vent system. Combustion in the tank and vent system would rapidly consume the available oxygen supply and self-extinguish.

Detection

At the onset of a fire, if the combustion were sufficiently rapid to pressurize the tank the high tank pressure alarm would be activated. In addition, a severe pressurization of the tank and vent system could lead to a rupture of the HEPA filters and subsequent radiation release. This would activate the stack radiation alarm.

If these alarms failed, the results of a fire would be detected in the vent system pressure data that is taken twice per shift. A change would be found in the differential pressure readings due to particulate plugging of the HEPA filters.

Response

As stated before, a fire in an underground storage tank would rapidly self-extinguish. Immediate manual shutdown of the main exhaust system would proceed upon confirmation that a fire had occurred. As rapidly as possible, after the fire is extinguished, the tanks would be placed on emergency exhausters.

Action guidelines and associated responsibilities for dealing with a fire-caused emergency of this type are delineated in Emergency Procedures 6.02 and 6.06 (ARH-222).⁽¹⁴⁾ Emergency action for coping with a contamination spread is outlined in Radiation Protection Standard Number 4, "Contamination Control," (ARH-220), and Emergency Procedures 1.10, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharges, Tank Farms," (ARH-222).

Consequences

All double-shell tanks scheduled to receive evaporator feed are exhausted through single pairs of HEPA filters. This pair of HEPA filters could be ruptured if a sufficiently large fire occurred. The consequences of the rupture of a single pair of HEPA filters is detailed in the event: Failure of Vessel Ventilation Exhaust Filters.

Precautions

There are several intrinsic precautions that make a fire in an underground storage tank very unlikely. The organic of concern is a material called normal paraffin hydrocarbon (NPH). Normal paraffin hydrocarbon has a flash point of at least 70° C. Below this temperature there is insufficient organic vapor to burn.⁽²³⁾ When a separate water phase is present, as would be the case in an underground storage tank, the water vapor pressure prevents combustion above 72° C. A tank would, therefore, have to be in the temperature range between 70° and 72° C before a fire could be started. The normal temperature range in a feed tank is 15° to 50° C. A fire would also require an ignition source. An ignition source would be an open flame or anything that could produce a spark. The underground storage tanks do not contain any such ignition sources. The introduction of a possible ignition source into any tank would be closely monitored.

Transfers made from other tanks to the evaporator feed tanks, where an organic phase is suspected, will be pumped no lower than two feet above the drain line. This will prevent organic material from entering the feed tank.

EVENT - EXPLOSION OF NITRATE COMPOUNDS

Description

Some of the wastes generated at the Hanford Project contain large amounts of sodium nitrate. This compound, if combined in the proper proportions with certain other materials, can react explosively. Several studies have been made to determine if salt cake or "worst case" organic mixtures were detonatable. These studies have shown that solid wastes at the Hanford Project will not undergo an explosion.^(24,25)

EVENT - FAILURE OF VESSEL VENTILATION EXHAUST FILTERS (MAXIMUM CREDIBLE ACCIDENT)

Description

Failure or rupture of the high efficiency particulate air (HEPA) filters could occur as the result of (1) process condensate collecting on the filters, or (2) excessive air flow due to vessel pressurization or high fan vacuum. The HEPA filters can lose their structural strength and fail if they are allowed to become damp. Failure can also be caused by an excessive pressure loading across the inlet face of the filter. These two mechanisms can result in a rupture or separation of the filter element.

Detection

Complete failure of both the primary and backup HEPA filters in any filter set would be detected by the stack radiation alarm in the respective tank farm control room. Partial failure or leakage without a radioactivity release would be detected during routine data collection. Pressure data on the vessel vent systems is collected every four hours. A partial filter failure would result in a low differential pressure reading and would be detected by tank farm personnel.

Response

Detection of high radiation in the vessel vent system by the stack radiation detector would set off an alarm in the tank farm control room. Failure of the vessel vent system to operate within procedural guidelines would require manual shutdown and standby exhaustor activation. Action guidelines and associated responsibilities are outlined in Emergency Procedure 1.9, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharge, Tank Farms" (ARH-222).

Consequences

Failure of a vessel ventilation exhaust filter would result in a maximum release to the environment of the contamination contained in one pair of HEPA filters. Current non-aging waste ventilation systems contain only one pair of HEPA filters.

Administrative controls limit the maximum radiation that can build up on a HEPA filter.

The maximum buildup in a filter would be 5.3×10^{-1} curies of cesium, 1.7×10^{-1} curies of strontium, and 1.3×10^{-3} grams of plutonium (based on the composition of worst case terminal liquor). Assuming an instrument failure in the alarm and operator error, the failure could go undetected for a maximum of one shift or eight hours. This could result in the additional release to the atmosphere of 4×10^{-3} curies of cesium, 1×10^{-3} curies of strontium, and 6×10^{-7} grams of plutonium (based on terminal liquor). This would result in the following maximum dose equivalent for the maximum individual.⁽²⁶⁾

	First Year Dose Commitment (rem)	50-Year Dose Commitment (rem)
Bone	2×10^{-4}	5×10^{-3}
Lungs	1×10^{-4}	3×10^{-4}

These estimates are well beneath the radiation protection standards for individuals in uncontrolled areas.⁽²⁷⁾

Precautions

Vessel ventilation systems are designed such that any defective filter can be replaced. Pressure and flow data are recorded and reviewed daily. Double-shell tanks can be placed on portable exhaust systems while filters are being repaired.

EVENT - TORNADO DESTRUCTION OF ABOVEGROUND TANK FARM FACILITIES

Description

The aboveground facilities of non-aging waste tanks are not capable of withstanding tornado conditions.

If a non-aging waste tank were hit by the following tornado conditions, significant damage to the aboveground facilities and utilities could be experienced.⁽²⁸⁾

1. Wind force - horizontal wind of 175 miles per hour over the full height of the structures.
2. Pressure transient - 0.75 psi atmospheric pressure drop in three seconds and return at the same rate.
3. Missiles -

Two-inch by 12-inch plank, 12 feet long, traveling end-on at 100 MPH, at any height.

Four-foot by eight-foot plywood sheet, three-fourths-inch thick, traveling end-on at 150 MPH, at any height.

Twenty-six-inch by 20-foot sheet of No. 20 corrugated steel siding, traveling end-on at 150 MPH, at any height.

The facilities and utilities include steam, normal and emergency power, instruments and controls, instrument air, vent heaters, filters, exhausters, stack, vent headers and buildings housing instruments and equipment.

Destruction or damage to the aboveground facilities could result in the release of contamination from the ventilation filters.

Detection

Detection of the tornado would be obvious and the extent of damage could be determined by visual inspection. Radioactive releases could be detected by area radiation monitors, if not destroyed by the tornado. Local radioactive hot spots would be detected by portable radiation monitors.

Response

Recovery operations following tornado damage to an aging waste tank farm include:

1. Radiation measurements to protect personnel.
2. Measurement of pressure in the tanks.
3. Liquid level measurements.
4. Reactivation of temperature measuring and leak detection devices.
5. Reactivation of electrical power and utility service.
6. Filtration of off-gases.

Action guidelines and associated responsibilities are outlined in Emergency Procedures 1.9, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharge, Tank Farms," in document ARH-222.⁽¹⁴⁾

Consequences

The surface facilities and utilities could be damaged or destroyed during a tornado, depending on the areas hit. An assessment of the impact of the tornado concludes that no structural damage would be experienced by the underground tanks and their envelope structures.⁽²⁾

Should a non-aging waste tank farm be hit by a tornado and the surface facilities damaged, contamination would escape to the atmosphere. Estimates indicate that the amount of contamination released during the tornado would be less than one curie. This would consist of contaminants contained in the filter system. The expected release would be comparable to the filter failure event.

Precautions

The low probability of a tornado hitting a non-aging waste tank (approximately six-in-a-million per year), and the non-boiling service of the tanks precludes the need of tornado resistant structures. Aboveground facilities are currently built to withstand straight winds according to the Uniform Building Code, which appears to be a sufficient safeguard.

POSTULATED ACCIDENT SUMMARY FOR AGING WASTE
DOUBLE-SHELL STORAGE TANKS

Discussed below are several postulated accidents which could conceivably occur during the operation of the new double-shell waste storage facilities containing aging waste. Each accident was examined for a failure mode, or modes, a means of detecting the event, response to the accident, the immediate and/or eventual consequences of the accident, and the precautions being observed to prevent the accident from occurring.

EVENT - ROUTING OF ACID WASTE TO UNDERGROUND STORAGE

Description

Process specifications for double-shell storage tanks require that the hydrogen potential (pH) of any solution transferred into these tanks be greater than nine.⁽¹⁶⁾ It is credible, however, that a batch of acidic waste could be routed to one of the double-shell tanks. This material would be generated in the Purex process, routed to B Plant and transferred to the 244-AR Building or the 241-AX-151 diverter station before it would reach underground storage. The maximum size of a batch of this type would be 5,000 gallons.

Detection

The first indication of an event of this type would be a rapid generation of nitrous oxides. Nitrous oxides are dark brown in color and would be visually apparent in the vent system exhaust. Low pH would also be detected by analysis of samples taken from the waste tanks.

Response

The response to an event of this type would be to determine the pH of the solution in the tank. Caustic would then be added to adjust the pH back to nine or above.

Consequences

An event of this type would not immediately release radiation to the environment, or damage the tank. Lowering the solution pH would, however, increase the potential for corrosion in the tank. Addition of acid to a new tank with little liquid in it could cause serious corrosion. A leak from the primary tank due to corrosion is covered in the tank failure event.

Precautions

All batches that are transferred from B Plant to underground storage are sampled and analyzed for pH. These data are then double-checked by supervisory personnel before a transfer can be made. Extra caution is taken when waste is added to a new or empty tank.

EVENT - STEAM COIL FAILURE

Description

The 241-AY and -AZ tanks are designed to receive aging waste. As such, they each contain a steam coil for heating the tank solution. If a leak developed in a steam coil, contaminated liquid could be introduced to the steam condensate line.

The condensate line is routed to a valve pit where it can be diverted to a condensate receiver crib or to a condensate hold tank. Contamination in the steam condensate would cause a radiation detector to automatically route the condensate to the hold tank. If the detector or valving equipment were to fail, contaminated liquid could be routed to the crib and released to the ground.

Detection

Contamination in the steam condensate would be detected by the radiation detector in the condensate diversion pit. This detector diverts the condensate to the condensate hold tank and trips an alarm in the tank farm control room. If this detector or diversion mechanism were to fail, a radiation detector in the crib sample pit would trip an alarm in the control room. Both of these systems are backed up by daily analysis of samples from the crib sample pit. Steam coil pressure data are taken once per shift. Any change in steam coil operation would be noted by Tank Farm Operations personnel with a maximum of eight hours.

Response

When a leak in a steam coil is confirmed, the coil would be immediately shut down. If contaminated condensate were to enter the sample pit and crib, action would be taken to decontaminate the sample pit. This would prevent further contamination from reaching the crib. If the crib were determined to contain more than its allotted concentration of radioisotopes, no more additions would be allowed in that crib.⁽¹⁶⁾

Consequences

All radioisotopes released in an event of this type would be contained in the waste crib. Closing the crib to further use would be the major result of this accident.

Precautions

The steam coil condensate is routed through a diversion system that automatically directs contaminated condensate to a condensate hold tank. This also sounds an alarm in the tank farm control room. Contaminated condensate may then be routed back to any of the underground storage tanks. In addition, the steam coil is equipped with a system that will automatically pressurize the coil with air if the steam pressure drops below 35 pounds pressure.

EVENT - SEISMIC ACTIVITY

Description

The maximum credible earthquake for the Hanford reservation has been postulated to be a Richter magnitude 6.8 earthquake (with an epicentral distance approximately 10-15 miles from the double-shell tanks.) It would produce a maximum horizontal ground acceleration at the double-shell tanks of 0.25 g and a simultaneous vertical ground acceleration two-thirds of the horizontal acceleration.⁽¹⁷⁾ The 0.25 g earthquake would have an occurrence frequency associated with an unlimited time span whereas the probability of 0.20 g would be once in 16,700 years, 0.15 g once every 4,000 years, 0.10 g once every 1,850 years, and 0.05 g once every 840 years.⁽¹⁸⁾

The largest local earthquake of historical record occurred at Corfu (a few miles north of the Hanford site) in 1918. Estimates of the peak ground acceleration determined for this event range from 0.01 to 0.03 g.⁽²⁾

Detection

Current earthquake detection facilities consist of accelerometers which are located at the Purex Plant, C Farm, B Plant, T Plant, and the Z Plant. These instruments are read weekly to determine seismic activities in the 200 Areas. There are no other detection devices in use at this time, but four seismic detector stations are planned to be built. These four detectors will be tied in with a recording station which will be located at B Plant. An alarm will sound whenever a 2.0 or greater Richter scale magnitude earthquake is detected. The four detectors are planned to be installed by late 1977.

Response

When an earthquake alarm is tripped, accelerometer readings will be taken immediately. Depending on the severity of the quake, a survey will be taken to determine the amount of structural damage incurred. In addition, normal leak detection measurements will be taken by Tank Farm Operations to check for tank damage.

Consequences

The consequences of a 0.25 g earthquake would be minimal, since the tanks and their related facilities are constructed to withstand such an event. Minor cracking may be experienced in some of the concrete structures, but no damage is expected which could interfere with the safe operation of the tank farms.

Precautions

All double-shell tanks and their related facilities (ventilation systems) are designed to withstand a safe shutdown earthquake (0.25 g maximum horizontal ground acceleration). Seismic analysis of the 241-AZ Tank Farm ventilation system revealed that a 0.25 g earthquake could be experienced without disabling the facility.^(29,30) Seismic analyses have not been undertaken for the double-shell annulus vent systems. Damage to one of these facilities would have minimal impact unless the primary tank were to leak at the same time. If these two events were to occur simultaneously, it would be possible to release contaminants from an aging waste tank to the environment. Because of this low probability risk, the annulus vent system for the 241-AZ Tanks has been tied into the primary vent system for backup emergency operation. If an earthquake were to incapacitate the system, normal ventilation could be restored through the tie-in line.

EVENT - AIRLIFT CIRCULATOR FAILURE

Description

Double-shell tanks that are scheduled to receive aging high-level waste are provided with 22 airlift circulators. These circulators provide agitation to prevent sludge settling and temperature gradients within the liquid waste. The loss of airlift circulator capacity in a high-heat waste tank for more than 24 hours could result in temperature gradients sufficient to cause solution rollover or "bumping." This occurs when superheated liquid at the tank bottom is suddenly carried to the surface and flashes. The result is a pressure transient that could cause stress on the tank walls and bottom. It could also result in sudden vapor release at the surface of the tank.

Airlift circulator failure would be caused by a failure of the primary compressor or their power supply, or by a break in the air supply line.

Detection

Failure of the airlift circulators in any of the double-shell tanks would trigger alarms in the respective tank farm control room. Individual airlift circulator flows are checked at least once per shift by Tank Farm Operations personnel. In the event that the alarms fail, the maximum time before an airlift circulator failure would be detected is eight hours.

Response

In the event that a failure is caused by the loss of a compressor or its power supply, emergency compressors or generators would be used. These would be operated until repairs or replacements were made on the primary system. Startup of the emergency system would take a maximum of two hours.

If the airlift circulator failure were due to line damage, emergency repairs would be implemented within 24 hours. This would be done by either repairing the line or valving in a portable compressor at the airlift circulator building. Emergency Procedure 2.3.11, "Loss of Air," in document ARH-222,⁽¹⁴⁾ outlines specific responsibilities and guidelines for dealing with an event of this type.

Consequences

The result of a solution rollover is a pressure transient within the aging waste tank. It also causes a sudden vapor release at the liquid surface. The pressure transient is expected to be less than one psi but would cause stress on the primary tank structure. No radiation release would accompany an individual rollover. The stressing of the steel tank beyond yield should not result. Potential failure of the primary tank is included in a separate event.

Precautions

Air is supplied to the airlift circulators by a series of piston-type compressors. Should the pressure start falling off, other standby compressors automatically start up in order of sequence. In the event of a power outage, an emergency generator will start automatically and provide electricity for the compressors. Should all of the main compressors fail or both a power outage and the emergency generator fail, a portable diesel-powered compressor is maintained for immediate use.

The piping and air metering system is totally enclosed, either underground or in buildings. It has been designed to prevent any damage to the pipes or valves.

EVENT - LOSS OF UTILITIES

Description

Utility services include steam, water, electrical power, and compressed air. It is conceivable that these services could be lost by accidental severance of a utility line or breakdown of a plant supplying the utility. The loss of all utilities other than power would not result in an emergency situation except for the 241-AZ and -AY Tank Farms.

Water and steam are supplied by the 200-East and-West powerhouses. Due to the history of high reliability of these plants, it does not seem very likely that a breakdown would occur. A more likely cause for utility failure would be the rupture of a waterline during excavation, or a steam-line break caused by a vehicle accident. A probable cause for loss of Bonneville-supplied electrical power would be a line break or substation burnout during adverse weather conditions. Compressed air could be lost for a short time during an electrical power outage or if a compressor were to fail.

Detection

- Water: Loss of water for aging waste tanks (241-AY and -AX Tank Farms) is detected by a drop in the 201 Tank liquid level reading, which is taken once per day. An alarm will sound in the 202-A Central Control Room.
- Steam: Steam will be used by the aging waste tanks for heating exhaust ventilation air. Loss of steam would allow moisture to collect on the vent HEPA filters, resulting in a high differential pressure drop.
- Steam will also be used for heat coils in the aging waste tanks. Loss of steam would be detected by decreasing tank temperatures or by a drop in steam pressure readings which are taken once per shift.
- Electrical: An electrical power outage would be self-evident. In addition, an alarm will sound at the 200-West Area powerhouse when Bonneville-supplied power is lost.
- Air: Loss of process air will result in setting off an alarm in the 271-A (also 202-A) Building (241-AY Tank Farm).

Response

- Water: An emergency cooling tower and associated pumping equipment powered by a 150-kilowatt generator would be activated to cool condensate from the tank farms. Water is supplied to the tower by a well located northeast of the 241-AX Tank Farm. The draft cooling tower is capable of cooling 800 gallons-per-minute of condensate from 150° F to 90° F. Emergency Procedure 2.3.8 in document ARH-222 outlines the specific guidelines and responsibilities for dealing with this event.
- Air: Loss of air requires the immediate action of reestablishing emergency process air to supply airlift circulators and pneumatic instrumentation. Emergency Procedure 2.3.11 in document ARH-222 outlines the specific guidelines and responsibilities for dealing with this event. Loss of air to airlift circulators is covered in the Airlift Circulator Failure event.
- Steam: Emergency action would center around restoring the steam supply. Vent filter DP's would be checked to determine if moisture were collecting on the filters.⁽⁶⁾ Standard operating procedures call for the shutdown of the main vessel vent system during a steam outage and activation of a portable vent system which uses electric heating coils.

Electrical: Loss of power would call for restoration of emergency power supply by diesel generators. Emergency Procedure 2.3.7 in document ARH-222 outlines the specific guidelines and responsibilities for dealing with this event.

Consequences

Water: Loss of water would result in failure of the tank condensers to cool condensate. A hazardous situation would not be expected to occur, since an emergency cooling system is available.

Steam: Ventilation air is heated by steam coils to prevent moisture from condensing on the HEPA filters. Loss of steam could cause the filters to collapse due to excessive moisture, which would result in shutdown of the vent system or possible contamination release (see filter failure event).

Electrical: Loss of electrical power would result in stopping all transfer and sluicing operations. All instrumentation is designed for "Fail-Safe Operation" in the event of an air or electrical outage.⁽¹⁹⁾ During the time between the outage and emergency power startup, no hazardous conditions are expected to develop.

Air: Loss of process air would shut down the airlift circulators. This could result in solution rollover in aging waste tanks (241-AV and -AZ) if not corrected within 24 hours. Due to the availability of standby compressors, it is estimated that there is a low probability that process air could not be restored within 24 hours.

As stated earlier, all instrumentation is designed for fail-safe operation and no hazardous conditions are expected to develop.

Precautions

Water: An emergency cooling tower and associated pumping equipment powered by a 150 kW generator is available and ready for emergency use to cool waste tank condensate.

Steam: There are no emergency provisions for supplying steam in the 200 Areas. The potential for loss of steam for extended periods is considered remote.

Electrical: Emergency power diesel generators are available in both the 200-East and 200-West Areas. They are capable of maintaining all the essential facilities required for the safe operation of the tank farms.

Air: Process air is supplied by a series of piston-type compressors. In the event of a failure, emergency air would be supplied by backup compressors. Should the backup compressors fail, portable diesel compressors are available for immediate use.

All instrumentation requiring compressed air is designed for fail-safe operation in case air is lost.

EVENT - EXCESSIVE VACUUM IN A WASTE STORAGE TANK

Description

The double-shell tanks (241-AY and -AZ) are connected to a common, primary tank ventilation system. The vacuum within the tanks is controlled by automatic diaphragm-operated valves upstream and downstream of the exhaust fans. A seal pot is connected to the system that relieves the vacuum at six inches of water negative pressure. The purpose of this seal pot could be defeated by having the pot sealed off from the vent system or by having a drain plugged such that the pot contained too much water. If this occurred simultaneously with failure of the vacuum control valve, the tanks could experience an excessive vacuum. This would also depend on all of the tanks in the system being sufficiently sealed. The excessive vacuum could create high stresses in the steel of the primary tank.

Detection

An excessive vacuum in any of the double-shell tanks (241-AY or -AZ) would trigger an alarm in the tank farm control room. If the alarm failed, the excess vacuum would be detected during routine measurements made once per shift. In this case, an excessive vacuum incident could occur for a maximum of eight hours.

Response

On detection of excessive vacuum in the 241-AY or -AZ tanks, the main exhaust system would be manually shut down. A small emergency exhaust, currently provided, would be started to provide temporary exhausting of the tanks. The exhaust contains two HEPA filters, an electric heater and sampler.

Consequences

Excess vacuum in a double-shell tank could create high stresses in the steel of the primary tank wall. The consequences of a leak in the primary tank are covered in the event of tank failure.

Precautions

As mentioned before, a seal pot is connected to the vent system which relieves the pressure at six inches of water vacuum. The liquid level in this seal pot is checked and recorded once a day. A drain line in the seal pot is left open so that it can never have more than six inches of water above the vacuum relief line. A recycle line is also provided between the exhaust system stack and the fan inlet manifold.

The probability of having the tank sufficiently sealed to allow a vacuum greater than design specifications is very small. Numerous tank penetrations and the fact that there are 14 tanks on the particular system, make it very difficult to sufficiently seal the system.

EVENT - BACKFLOW OF LIQUID THROUGH AIRLIFT CIRCULATOR AIR SUPPLY LINE

Description

One-inch air supply lines run from the central airlift circulator buildings to each of the 22 airlift circulators in the double-shell storage tanks (241-AZ and -AZ). A sudden break or opening of this air supply line could allow superheated liquid wastes to rise in the air supply line. Flash vaporization of the superheated waste could occur; resulting in a reverse air (steam) lift pumping action and the release of solution through the air supply line.

The maximum release would occur if the ball valve directly above the airlift circulator were broken or manually opened. A release could also occur if a valve or piping were removed in the airlift circulator building. From information gathered in a similar accident, a maximum of 20 gallons of contaminated liquid could be released outside of a building before the line could be blanked.

Detection

If the release occurred inside the airlift circulator building, the contamination would be contained within the building. The worst case would result if the release occurred at the ball valve directly above the airlift circulator. In both cases the accident would have to be related to some operator activity. Detection of the accident would be immediate by the personnel involved. Area radiation monitors are also provided within 100 feet of any airlift circulator. These would alarm when detecting any spill over 15 curies.⁽³¹⁾

Response

Immediately upon discovering the release of contamination, action be taken to blank the line. In the event that the valve or line were broken directly above the airlift circulator, a maximum of eight hours would be required to blank or plug the line. The valve is located in an eight-inch-diameter by 36-inch-long concrete pipe. The air supply line would be blanked if possible or the pipe could be filled with soil or concrete, sealing the air supply line. Emergency Procedure 1.9 "Spread of Contamination," and Radiation Protection Standard No. 4, "Contamination Control," provide action guidelines and outline responsibilities for coping with such an event,"(ARH-222).⁽¹⁴⁾

Consequences

From the report on a similar incident, it is estimated that a maximum of 20 gallons of liquid waste could be released to the surface of the ground in eight hours. A maximum of 0.1 percent of this amount could be entrained in the atmosphere.⁽²⁾ Assuming the worst case of aging waste, this could result in the following release:

<u>Isotope</u>	<u>c released</u>	<u>Isotope</u>	<u>c released</u>
⁸⁹ Sr	0.02	¹⁰⁶ Ru	0.52
⁹⁰ Sr	0.02	¹³⁴ Cs	0.004
⁹⁰ Y	0.02	¹³⁷ Cs	0.03
⁹¹ Y	0.40	¹³⁷ Ba	0.03
⁹⁵ Nb	1.32	¹⁴¹ Ce	0.03
⁹⁵ Zr	0.63	¹⁴⁴ Ce	2.76
¹⁰³ Rh	0.06	¹⁴⁴ Pr	2.76
¹⁰⁶ Rh	0.52	¹⁴⁷ Pm	0.63
¹⁰³ Ru	0.06	²³⁹ Pu	0.0002

The remaining amount would be retained in the soil. Dose equivalents for an event of this type would be less than a tornado event.

Precautions

The piping for the air supply to the airlift circulators runs from the tank dome, then underground to the airlift circulator building. The ball valve above the airlift circulator is below grade and protected by an 8-inch by 36-inch concrete pipe with a steel cover. The probability of breaking a valve protected in this way is very small. The valves are also provided with a pipe cap so that the cap would have to be removed as well as the valve opened to allow liquid to escape.

The metering system for the air supply to the airlift circulators is contained in a metal building. Most of the contamination release at this point would be contained within the building. The valves and piping are designed and located in the building to prevent any accidental damage. Opening or removing any valve or pipe is controlled through procedure. The piping contains check valves between the circulators and air metering system which will prevent backflow.

EVENT - DRESSER COUPLING FAILURE

Description

Dresser couplings are compression seal fittings that allow two segments of pipe to be connected. The couplings are used to make up the vapor header piping which carries ventilation air from the aging waste tanks to the primary vent system (241-AY Tank Farm). The couplings allow for expansion and contraction of the pipes, which could experience temperature variations greater than 100° F. All piping containing Dresser couplings is buried to provide shielding due to high levels of radiation associated with the ventilation air. The 241-AY and -AZ Tank Farms are the only double-shell tank farms that have Dresser couplings.

Dresser couplings act as a trap for any material which condenses or settles out on pipe surfaces. If the compression seals fail, the collected material will leak into the ground along with collected materials after the leak occurs.

A similar incident took place in 241-AX Tank Farm, where contamination was discovered when some new dry wells were being installed. The subsequent investigation indicated that a seal failure had occurred and liquid contamination had leaked out of the vent header.⁽³²⁾ The magnitude of the contamination that was released is unknown, but is estimated, at most, as a few gallons. The contamination spread was controlled by using a soil sealant. Since the addition of the soil sealant, there have been no indications of increasing ground contamination.

Detection

Detection of a Dresser coupling failure would be by routine dry well monitoring. If a source of contamination were discovered, additional dry wells could be installed to find the origin of the leak.

Response

If a contamination leak were suspected, an investigation would be initiated to determine the source and exact location of the leak. An attempt would be made to stop the leak and to repair or isolate the leaking Dresser coupling. This could involve injecting a soil sealant around the leaking area as was the case in the 241-AX Tank Farm incident. Action guidelines and responsibilities are outlined in Emergency Procedure 1.9, "Spread of Contamination," (ARH-222).⁽¹⁴⁾

Consequences

Failure of a Dresser coupling would result in a release of contaminated material to the ground. Contaminated material would not be expected to reach the water table or to become airborne. Due to the high level of radiation around the Dresser coupling, actual repairs to the coupling would be difficult. The coupling would probably have to be isolated as was done in the 241-AX Tank Farm incident.

Precautions

Precautions to be implemented to prevent or minimize additional Dresser coupling failures are:

1. Locate all Dresser couplings in the 241-AY and -AZ vapor header system.
2. Identify the Dresser coupling seal materials, their age and the service environment encountered to identify the relative deterioration of the individual couplings.
3. Continue assessment of alternate sealant materials.
4. Determine schedules and material handling procedures for soil sealant application.
5. Provide expertise as it applies to augering and emplacement of injection ports.
6. Have the tank farms surveyed to provide surface grid locations of the Dresser couplings and designate suitable sites for augering and emplacement of injection ports.
7. Evaluate alternate plans of action to isolate the present exhaust system or excavate and apply sealants directly to the surface of the Dresser couplings.

EVENT - TANK FAILURE

Description

Coincidental failure of a primary tank shell and the secondary tank in which it resides; with release of radioactive solution to the surrounding soil, is not considered credible. Mechanisms studied include failure of a primary tank by stress corrosion cracking. Stress corrosion cracking is caused by an internal stress field in the metal liner and is promoted by the ionic species contained in the wastes. Stresses can be set up in the tank liner by improper heat treatment, improper structural support, and bulging, to name a few.

General corrosion of a primary tank is very slow when compared to the useful life of the tank, and is not considered to pose a threat to its integrity.

An accident that could lead to stress corrosion or actually rupture a tank could be caused by floating a tank. This could occur if the annulus were accidentally filled with water while the primary tank was empty or only slightly filled. The force of the water could bulge the tank bottom which may rupture or set up a stress field in the liner. The consequences from this type of accident would be less than those experienced by a tank leak into an empty annulus. This accident is very unlikely because there are no direct waterlines to any double-shell tank annulus. Another accident that could affect the primary tank would be the addition of liquid with a specific gravity greater than that specified in the design criteria. Failure of the primary tank would result in discharge of radioactive liquid to the annulus space. The liquid would be contained by the secondary tank, where its presence would be detected. The liquid could then be pumped directly back to the tank via the pump pit or to any other tank, through the pumpout header.

During the time that liquid is present in the annulus, ventilation air could become saturated with moisture. Since the annulus vent system does not have condensing capabilities, the HEPA filters would become moisture laden (especially in an aging waste tank) and could rupture.

Failure of the secondary tank would occur only after the primary tank had failed. This would result in discharge of radioactive liquid to the concrete base. The liquid would flow to a leak detection pit where it would be detected and could be pumped to other tanks. An event of this type would not release contaminated material to the atmosphere and is not considered to be a credible accident during the expected 20-year use of the tank.

Detection

A leak into the annulus from the primary tank can be detected by three methods:

1. An alarming manual liquid-level tape.
2. An increase (approximately two inches) in the annulus liquid level as measured by a conductivity probe.
3. An increase in the annulus vent radiation levels or a high radiation alarm.

Response

When a leak into the 241-AY or -AZ tank annulus is detected, the annulus vent system would be immediately rerouted through the vessel vent system. Tank Farm Operations would determine the tank to which the escaping liquid would be pumped. Action guidelines and associated responsibilities are outlined in Emergency Procedure 1.9, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharges Tank Farms," in ARH-222.⁽¹⁴⁾

Consequences

Should a rupture occur in the primary tank, annulus ventilation air would become saturated. Moisture condensing on the HEPA filters could cause the filters to collapse or partially break through. Contaminated liquid entrained in the saturated ventilation air would then be released along with the contaminants contained in the filter. Should an accident of this type occur, the release of contaminants and its impact would be expected to be less than the tornado case presented in this report.

Precautions

Since the annulus vent system could become overloaded with moisture and collapse during a tank rupture, radionuclides could be released to the environment. To prevent this from happening, the annulus vent system is tied into the vessel vent system for emergency diversion.

The specific gravity of solutions will be controlled by an approved process flow sheet. Any unusual material will be sampled before it is transferred to the double-shell tanks.

Stress corrosion cracking has been recognized as a factor relating to the loss of tank integrity. The potential for stress corrosion cracking of primary tanks containing nitrate and caustic bearing process materials has been acknowledged. Measures have been taken to reduce this potential by use of double-shell tanks incorporating stress relieving of primary tanks. Additional steps to reduce tank corrosion in both double- and single-shell tanks include:⁽⁸⁾

1. pH: The pH of the tank contents shall be above 8.
2. Cations: The concentration of cations in the waste shall be limited to the concentration resulting from the use of an approved plant flow sheet.
3. Hydroxide: Hydroxide ion is a contributor to stress corrosion cracking. Therefore, the presence of sodium hydroxide shall be limited to a maximum concentration of 8M.⁽⁹⁾

4. Nitrite: The concentration of nitrite shall be maintained above 500 ppm.
5. Sulfate: As long as the nitrite concentration is above 500 ppm, the sulfate concentration need not be controlled.
6. Phosphate and carbonate: No restriction.
7. Nitrate: The concentration of nitrate shall be maintained below 6M.
8. Strong oxidizing agents and halides: The concentration of halides and/or strong oxidizing agents, such as permanganate, lead oxide, or chromate shall not exceed those encountered during the use of an approved plant flow sheet.

In addition, the primary tank has been designed to have an adequate corrosion allowance for a 50-year tank life based on an average corrosion rate of 1.0 mil per year.

EVENT - DOME FAILURE

Discussion

Failure of an underground high-level waste tank dome is not considered to be a credible incident. Modeling tests have indicated that a safety margin of four to five times the earth load (approximately 1,500 tons) could be resisted over the tanks. Based on the life of other reinforced concrete structures (bridges, dams, etc.), a dome life of 100 years or more could be reasonably expected. The dome life could be shorter for tanks containing high-heat wastes. Available evidence indicates that radiation has little effect on the strength of reinforced concrete.⁽²⁾

It is conceivable that the presence of heavy equipment directly above the tank domes could cause some structural damage, but liquid release is not considered credible. Strict administrative controls⁽²⁰⁾ have been in effect for some time to control this type of live-loading and these controls will continue.

Based on this information and the fact that double-shell tanks will only be used for 20 years^(21,22), the dome failure accident is not considered to be credible.

EVENT - ACCUMULATION OF HYDROGEN OR ORGANIC FIRE

The accumulation of sufficient hydrogen or organic to support combustion in an aging waste tank is not credible. Aging waste produces sufficient water vapor to prevent the concentration of hydrogen or a combustible organic mixture.

EVENT - EXPLOSION OF NITRATE COMPOUNDS

Description

Some of the wastes generated at the Hanford Project contain large amounts of sodium nitrate. This compound, if combined in the proper proportions with certain other materials, can react explosively. Several studies have been made to determine if salt cake or "worst case" organic mixtures were detonatable. These studies have shown that solid wastes at the Hanford Project will not undergo an explosion.^(24,25)

EVENT - FAILURE OF VESSEL VENTILATION EXHAUST FILTERS

Description

Failure or rupture of the high efficiency particulate air (HEPA) filter could occur as the result of (1) process condensate collecting on the filters, or (2) excessive air flow due to vessel pressurization or high fan vacuum. The HEPA filters can lose their structural strength and fail if they are allowed to become damp. Failure can also be caused by an excessive pressure loading across the inlet face of the filter. These two mechanisms can result in a rupture or separation of the filter element.

Detection

Complete failure of both the primary and backup HEPA filters in any filter set would be detected by the stack radiation alarm in the respective tank farm control room. Partial failure or leakage without a radioactivity release would be detected during routine data collection. Pressure data on the vessel vent systems is collected every four hours. A partial filter failure would result in a low differential pressure reading and would be detected by tank farm personnel.

Response

Detection of high radiation in the vessel vent system by the stack radiation detector would set off an alarm in the tank farm control room. Failure of the vessel vent system to operate within procedural guidelines would require manual shutdown and standby exhaust activation. Action guidelines and associated responsibilities are outlined in Emergency Procedure 1.9, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharge, Tank Farms," ARH-222.⁽¹⁴⁾

Consequences

Failure of the vessel ventilation exhaust filters would result in a maximum release to the environment of the contamination contained in six pairs of HEPA filters.

Administrative controls limit the maximum radiation that can build up on a HEPA filter.

The maximum buildup in six filter pairs would be:

<u>Isotope</u>	<u>Curies</u>	<u>Isotope</u>	<u>Curies</u>
^{89}Sr	8.58×10^{-3}	^{106}Ru	2.19×10^{-1}
^{90}Sr	8.16×10^{-3}	^{134}Cs	1.84×10^{-3}
^{90}Y	8.16×10^{-3}	^{137}Cs	1.37×10^{-2}
^{91}Y	1.67×10^{-1}	^{137}Ba	1.28×10^{-2}
^{95}Nb	5.54×10^{-1}	^{141}Ce	1.16×10^{-2}
^{95}Zr	2.66×10^{-1}	^{144}Ce	1.16×10^0
^{103}Rh	2.53×10^{-2}	^{144}Pr	1.16×10^0
^{106}Rh	2.19×10^{-1}	^{147}Pm	2.66×10^{-1}
^{103}Ru	2.53×10^{-2}	^{239}Pu	8.57×10^{-5}

This would result in the following maximum dose equivalent for the maximum individual: ⁽³³⁾

	<u>First Year Dose Commitments (rem)</u>	<u>50-Year Dose Commitments (rem)</u>
Total Body	3×10^{-4}	1×10^{-3}
Bone	3×10^{-3}	1×10^{-2}
Lung	2×10^{-1}	3×10^{-1}

These estimates are well beneath the radiation protection standards for individuals in uncontrolled areas. ⁽²⁷⁾

Precautions

Vessel ventilation systems in the 241-AZ and -AZ Tank Farms are provided with a number of pairs of HEPA filters in parallel. The systems are designed such that any defective filter pair can be isolated and replaced. Pressure and flow data are recorded every four hours and reviewed daily. Other double-shell tanks can be placed on portable exhaust systems while filters are being repaired.

EVENT - TORNADO DESTRUCTION OF ABOVEGROUND TANK FARM FACILITIES (MAXIMUM CREDIBLE ACCIDENT)

Description

The most vulnerable tank farm facility to tornado forces is an aging waste tank. The aboveground facilities are not capable of withstanding tornado conditions and the radionuclide concentration is sufficiently high to promote boiling for long periods of time.

If an aging waste tank was hit by the following tornado conditions; significant damage to the aboveground facilities and utilities could be experienced. (23)

1. Wind force - horizontal wind of 175 miles per hour, over the full height of the structures.
2. Pressure transient - 0.75 psi atmospheric pressure drop in three seconds and return at the same rate.
3. Missiles -

Two-inch by 12-inch plank, 12 feet long, traveling end-on at 100 MPH, at any height.

Four-foot by eight-foot plywood sheet, three-fourths-inch thick, traveling end-on at 150 MPH, at any height.

Twenty-six inch by 20-foot sheet of No. 20 corrugated steel siding, traveling end-on at 150 MPH, at any height.

The facilities and utilities include steam, normal and emergency power, instruments and controls, cooling water, makeup water, condensers, instrument air, circulator process air, vent heaters, filters, exhausters, stack, deentrainer vessels, liquid seals in vapor system, and buildings housing instruments and equipment.

Destruction or damage to the aboveground facilities could result in unfiltered, uncondensed, contaminated vapor being released from the aging waste tanks. All four of the aging waste tanks (241-AY and -AZ) would contribute to the contamination release since a common vent system is used.

Detection

Detection of the tornado would be obvious and the extent of damage could be determined by visual inspection. Radioactive releases could be detected by area radiation monitors, if not destroyed by the tornado. Local radioactive hot spots would be detected by portable radiation monitors.

Response

Recovery operations following tornado damage to an aging waste tank farm include:

1. Radiation measurements to protect personnel.
2. Measurement of pressure in the tank farm vapor system.
3. Addition of water to the aging tanks to replenish escaping vapor.
4. Liquid-level measurements.
5. Reactivation of temperature measuring and leak detection devices.
6. Reactivation of the airlift circulators.
7. Reactivation of electrical power and utility service.
8. Condensation of vapors.
9. Filtration of noncondensable off-gases.

Action guidelines and associated responsibilities are outlined in Emergency Procedures 1.9, "Spread of Contamination," and 2.3.12, "Radioactive Gaseous Discharge, Tank Farms," in document ARH-222.⁽¹⁴⁾

Consequences

The surface facilities and utilities could be damaged or destroyed during a tornado, depending on the areas hit. An assessment of the impact of the tornado concludes that no structural damage would be experienced by the underground tanks and their envelope structures.⁽²⁾

If the airlift circulators were disrupted and could not be reactivated within 24 hours, temperature gradients could develop and cause bumping (see airlift circulator failure event.) From past experience, the tank contents are not expected to bump.

Should an aging waste tank farm be hit by a tornado and the surface facilities damaged, contamination would escape to the atmosphere. Estimates indicate that the amount of contamination released during the tornado would be less than one curie to a few curies. This would consist of contaminants contained in the filter system. No significant adverse effects should be experienced offsite by such a release. Activity at the Hanford site boundary should be less than the maximum permissible air concentration for uncontrolled areas set by ERDA Manual Chapter 0524.⁽²⁾

Following the destruction of the aboveground facilities, the four aging waste tanks could release contamination at a rate less than ten curies per hour.^(2,34) The calculated source term for the aging wastes is given in Table V. All four tanks are considered since they use the same primary ventilation system. The release rate was estimated based on an entrainment factor 1×10^5 (suspended liquid in boiloff vapor). Reestablishment of control would be effective within 48 hours.

The 50-year dose commitment and the first year's dose equivalent received by the maximum individual are shown in Table IV.⁽³³⁾

TABLE IV

MAXIMUM DOSE EQUIVALENT FOR THE MAXIMUM INDIVIDUAL

	First Year (rem)	50-Year Dose Commitment (rem)
Bone	2×10^{-2}	1×10^{-1}
Lungs	1×10^0	2×10^0
Total Body	2×10^{-3}	9×10^{-3}

TABLE V

SOURCE TERM FOR POSTULATED TORNADO DESTRUCTION OF
TANK FARM ABOVEGROUND FACILITIES

Radio-Nuclide	Release Rate,c/hr	Quantity Released,c	Radio-Nuclide	Release Rate,c/hr	Quantity Released,c
^{89}Sr	2.0×10^{-2}	9.6×10^{-1}	^{106}Ru	5.1×10^{-1}	2.4×10^{-1}
^{90}Sr	1.9×10^{-2}	9.1×10^{-1}	^{134}Cs	4.3×10^{-3}	2.1×10^{-1}
^{90}Y	1.9×10^{-2}	9.1×10^{-1}	^{137}Cs	3.2×10^{-2}	1.5×10^{-0}
^{91}Y	3.9×10^{-1}	1.9×10^1	^{137}Ba	3.0×10^{-2}	1.4×10^0
^{95}Nb	1.3×10^0	6.2×10^1	^{141}Ce	2.7×10^{-2}	1.3×10^0
^{95}Zr	6.2×10^{-1}	3.0×10^1	^{144}Ce	2.7×10^0	1.3×10^2
^{103}Rh	5.9×10^{-2}	2.8×10^0	^{144}Pr	2.7×10^0	1.3×10^2
^{106}Rh	5.1×10^{-1}	2.4×10^1	^{147}Pm	6.2×10^{-1}	3.0×10^1
^{103}Ru	5.9×10^{-2}	2.8×10^0	^{239}Pu	2.0×10^{-4}	9.8×10^{-3}

Precautions

The low probability of a tornado hitting an aging waste tank (approximately six-in-a-million per year), and the short boiling service (about ten years), of the tanks precludes the need of tornado resistant structures. Above-ground facilities are currently built to withstand straight winds according to the Uniform Building Code, which appears to be a sufficient safeguard.

ACKNOWLEDGMENT

The authors would like to thank Mr. W. M. Harty, Sr. for his suggestions and helpful comments in the preparation of this report. We would also like to thank Mr. S. P. Stalos for his time and efforts in determining the radiological effects of the accidents.

AY-TANK FARM
101AY-102AY

3. ATOMIC ENERGY COMMISSION
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Atlantic Richfield Hanford Complex
Richland, Washington 99212

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FIGURE 1 ANNULUS VENT SYSTEM