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In Tank Processing Safety Analysis Program Summary Report

by
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In Tank Processing Safety Analysis Program Summary Report (U)

July, 1994

Westinghouse Savannah River Company
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SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

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Executive Summary

For earthquake levels up to and including the Evaluation Basis Earthquake (EBE), which is a 0.2g Peak Ground Acceleration (PGA) earthquake for the purpose of this report, no significant release of waste is expected. Within this range of earthquakes, transfer piping between the Filter Stripper (F/S) Building and Tank 48 is expected to remain intact and deflagration in the tanks is assumed not to occur. Assumed failure of the Filtrate Hold Tanks could result in a small offsite population dose of 9.3 person-rem from a water borne activity. This dose estimate is based on a 63 hour waste travel time from the ITP Facility to the Savannah River and no evacuation or modification of population behavior. An additional offsite population dose of 0.1 person-rem might result from an airborne release of the same hold tank liquid.

Earthquakes above the EBE but less than 0.6g PGA would produce the same consequences as described above for the EBE. Deflagration in the tanks and their annuli is assumed not to occur as are surface spills due pipe breaks (piping assumed seismically qualified). No leakage from the concrete tank vaults would occur but even if it did, the berm would be expected to retain the liquid and make the release a subsurface one. The berm might experience some onset of cracking at 0.6g PGA but no fissures are expected to open. At acceleration levels of approximately 0.6g with attendant large differential settlements, damage to the steel and the concrete tanks may occur. The concrete cells in the F/S Building might also lose their integrity and cause the small contained inventory to spill. For this extreme case, the offsite population 50 year CEDE dose would be expected to be no more than:

- 3200 person-rem from a surface spill and 43 person-rem from the airborne release of up to 800 gallons of liquid precipitate waste from the F/S Building (i.e. maximum filter and transfer line inventory)
- 9.3 person-rem from a surface spill and 0.1 person-rem from the airborne release of 24,000 gallons of low level liquid from the Filtrate Hold Tanks
- 650 person-rem from Tank 48 subsurface release occurring by groundwater transport 85 years after the earthquake
- 2600 person-rem from Tank 49 subsurface release occurring by groundwater transport 85 years after the earthquake
- 180 person-rem from Tank 51 subsurface release occurring by groundwater transport 85 years after the earthquake.

As a result of a 0.6g PGA earthquake, the total offsite population dose due to combined liquid pathway and airborne releases could reach 6,685 person-

rem if no evacuation or population behavior changes were made. The same combined dose to the maximum individual at the site boundary would be no greater than 1.3 rem. At the present time, there are no specific regulatory limits on liquid pathway doses that could result from nuclear facility accidents. The return period for such large earthquakes is long, approaching 133,000 years, compared to the planned period of operation for the ITP Facility.

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1.0 Introduction

The purpose of this summary report is to present results from the safety analysis work that was performed in support of the "Seismic Safety Issue Resolution Program Plan" for the In-Tank Processing (ITP) Facility [14]. Results from this effort include estimates of the consequences that postulated earthquakes might introduce.

The main constituents of the safety envelope for the ITP Facility consist of:

- Type IIIA Tanks 48, 49, 50, and 51
- The Filter/Stripper Building with two concrete cells and steel enclosure
- The above ground transfer lines between the Filter/Stripper Building and Tank 48
- The earthen berm that encompasses the storage tanks, and on which the Filter/Stripper Building and transfer lines rest
- The Cold Feeds Area located on natural grade beside the earthen berm.

The discussion for each of these items will be divided into two sections, one for earthquakes up to and including the evaluation basis earthquake (EBE), and one for earthquakes beyond the EBE. Tank 50 is not considered in the analysis because it contains decontaminated salt solution, which has a negligible activity at least 10^{-4} lower than ITP precipitate [8]. Detailed Geotechnical and Structural analyses have been done for earthquakes up to and including the EBE. However, sufficient calculations have already been made to form the basis for engineering judgments of happenings beyond the EBE.

2.0 Effects of Earthquakes on the Berm

<u>2.1 Damage from earthquakes at the EBE level and below</u>
The berm is discussed first because it influences all other components of the ITP Facility. Geotechnical analyses show that the berm will not be deformed by earthquakes up to and including the EBE. They also show that subsidence from either liquefaction or consolidation will not occur and hence the berm will remain intact following an EBE [1]. The probability of experiencing such an earthquake of 0.2g PGA or greater at the site is approximately 2×10^{-4} per year [5].

With the berm intact, conservative numerical simulations indicate with margin that liquid from postulated tank leaks or ruptures will not seep out the side of the berm and become surface releases. This has been shown to be true even for the unlikely event where Tanks 48, 49, 50, and 51 might catastrophically rupture and simultaneously release all of their contents within the berm [3].

Conservatism's in the numerical model include the following:

- The model is a two-dimensional slice perpendicular to the berm slope, aligned where the outer tank wall comes closest to the berm slope. No credit is taken for three-dimensional effects, namely, that on average the tank wall is further from the berm edge, and the tank extent in the direction parallel to the berm slope is limited

- The simulated volume of waste in each tank significantly exceeds the physical, and technical specification, bounds of the actual tank. The tank radius is set to 50 feet in the simulations whereas the actual inside radius is 42.5 feet. The center column has been omitted in the simulations. The height of liquid has been bounded at 33 feet

- The perforated "mudmat" has been assumed to be impermeable, which preferentially forces liquid toward the berm slope. The "mudmat" is a thin, weak concrete mat on which the tanks were constructed; it extends under and beyond the outer tank wall

- The horizontal to vertical conductivity ratio has been conservatively set to 10. A more realistic value is closer to 1

- Soil properties ranging from primarily sand to primarily clay have been considered

- The dense, viscous waste slurry has been modeled as water

- No credit has been taken for a potential reduction in permeability due to interaction between soil and high pH waste (i.e., average pH of 13.6)

- A range of initial saturation's have been considered.

2.2 Damage from earthquakes above the EBE

No significant damage to the berm is expected to occur up to an earthquake level of 0.6g PGA [1]. The probability of experiencing this level earthquake or greater at the site is 7.5×10^{-6} per year [2]. At the 0.6g PGA level, subsidence and differential settlement might occur that would affect other components of the ITP Facility even though the potential is low. At 0.6g PGA, the berm is expected to experience the onset of cracking with a 50-50 chance since the safety factor is 1.0 at this g-level. With the berm remaining intact, no seepage resulting in surface runoff would be expected just as it would not for the case of the EBE. At some earthquake level greater than 0.6g, the berm may not remain intact and unacceptable surface runoff might occur. However, this g-level is expected to be extremely high and the probability of experiencing such an earthquake acceptably low.

3.0 Effects of Earthquakes on Waste Tanks 48, 49, and 51

3.1 Damage from earthquakes at the EBE level and below

The waste tanks will not be damaged by earthquakes up to and including the EBE, and no release of stored material will occur [4]. Even though tank top supported equipment and structures may be damaged, no penetration or collapse of the tank top will occur. There is a possibility, though, that the normal purge ventilation system will become inoperative due to a loss of offsite electrical power. Such a condition is unacceptable due to the potential for buildup of flammable gas mixtures in tanks 48, 49, and 51. Emergency ventilation must be supplied within 3 days to tanks 48 and 49 before the composite lower flammability limit (CLFL) is reached [5]. However, Tank 51 does not reach CLFL until more than 9 days after losing normal ventilation [6] so the same sense of urgency in restoring ventilation is not present here.

In calculations performed for tanks 48 and 49, it is assumed that a deflagration could occur in-tank once the CLFL is reached. Using the peak gas pressure for the worst case mixture yields an upper bound 10 gallon source term release, which at 99.5% meteorology, gives the dose estimates shown in Table 1 for in-tank deflagration [7,8]. Although in-tank CLFL gas mixtures can potentially be reached with the normal ventilation system out of service, no interactions are expected that would preclude access to tank top risers for alignment and startup of emergency purge ventilation equipment (EPVE) within 3 days [5]. A deflagration in Tank 51 is not considered due to the significantly longer time (3 times longer) available to supply emergency ventilation, or even restore the normal ventilation system, prior to reaching CLFL.

3.2 Damage from earthquakes above the EBE

From a pure vibration motion aspect, the steel tanks inside the waste tank vaults are expected to remain intact up to an earthquake level of 0.4g PGA. The probability of experiencing this level earthquake or greater at the site is 2.3×10^{-5} per year [2]. With respect to vibration, the concrete vaults are also expected to remain intact until an earthquake level of 0.7g PGA is reached [4]. However, differential settlement from liquefaction or deep soil consolidation could reduce these g-values so that the tanks and vaults might be expected to fail at lower earthquake motions. At differential settlements above 5 inches but less than 12 inches, severe cracking and possible spalling of the bottoms of the concrete vaults may occur. Above 12 inches, cracking of the concrete vault wall and rupture of the steel tanks could occur; also, the potential for collapse of the concrete vault top is increased [4].

The loss of offsite electrical power will cause the tank ventilation system to become inoperative. As noted above for the EBE, such a condition is unacceptable and EPVEs are assumed to be in place and operational within 3 days for ventilation of Tanks 48 and 49 before the in-tank CLFL is reached. At earthquake levels above the EBE, there is also a possibility that the steel tanks will rupture and cause liquid waste to be released to the tank annuli. The annuli of tanks 48 and 49 could reach CLFL after 6.4 days and 3.7 days, respectively [9]. This would result in an unacceptable condition. An annulus deflagration in Tank 51 is not considered based on the same reasons stated above for the EBE (i.e., more than 9 days to reach CLFL).

Although a deflagration in the waste tank annulus has not been quantitatively analyzed, the following discussion presents a worst case qualitative evaluation. In the event of a deflagration, the geometry of the annulus (i.e., considered to be a long channel) will lead to comparatively strong flame front acceleration and short burn times. In the worst case, a high liquid fill level in the tank may lead to increased tank stability such that tank collapse does not provide significant volume expansion of the gas mixture in the annulus sufficiently early in the event to relieve pressure. Under these conditions, a deflagration-to-detonation transition could occur in the tank annulus. A bounding source term of 110 gallons of liquid waste [10] was used to estimate the doses shown in Table 1 [8]. It should be noted that the same EPVEs assumed to be used for in-tank ventilation can also be used for annulus ventilation, since only a few hours of venting are required to bring the in-tank gas mixtures below CLFL. Accessing the annulus for purge venting should be straightforward because the annulus riser plugs are significantly smaller and physically easier to handle than the tank top riser plugs. Venting the annulus precludes deflagration.

3.2.1 Consequences of subsurface release from tanks

If both the concrete vault and steel tank fail, there could be a large subsurface release of liquid waste from each of the failed tanks that transports to the underlying ground water. With the berm intact, liquid waste from this release will not seep out of the berm and create a surface runoff path. A best-estimate analysis indicates that the subsurface release would take one of two ground water flow paths from the ITP Facility to stream discharge, depending on the degree of downward flow. Ground water beneath the ITP facility flows initially downward and northeast toward the McQueen Branch. In the first path, waste moving with the ground water could continue to flow laterally and discharge to the McQueen Branch. In the second path, waste could enter a lower aquifer, if the downward flow of ground water were sufficient, flowing northwest and discharging to Upper Three Runs. For either path, the best-estimate and conservative ground water travel times are about 85 years and 15 years, respectively [3].

The analyses just described use actual well hydraulic head data taken throughout H-Area (see Figures 1 to 3) as well as analytical solutions to the governing equations for ground water flow in confined and unconfined aquifers. No credit is taken for a potentially significant reduction in soil permeability due to soil reaction with the high pH waste (i.e., average pH of 13.6). The geologic offset or discontinuity described in Reference [1] was not explicitly considered in the groundwater flow model. The offset could locally perturb hydraulic conductivity and enhance downward flow in the region of the offset. This potential effect could increase the likelihood of waste flow to deeper aquifers. However, the resulting groundwater travel time would be expected to be bounded by the same estimates given above (i.e., 15 to 85 years).

The best-estimate ground water travel time of 85 years is most sensitive to the following assumptions [3]:

- The spatial variation of hydraulic conductivity within an aquifer or confining unit is reasonably uniform over the area of interest.
- The following hydraulic conductivity and conductance are appropriate:

Water Table aquifer horizontal conductivity:	4 to 5 ft/day
Barnwell/McBean aquifer horizontal conductivity:	4 to 5 ft/day
Congaree aquifer horizontal conductivity:	40 ft/day
Tan Clay confining unit vertical conductance:	10^{-4} day^{-1}
Green Clay confining unit vertical conductance:	10^{-5} to 10^{-6} day^{-1}

- The effective soil porosity is 20%.

The conservative-estimate groundwater travel time of 15 years is obtained by assuming that: the waste is confined to the uppermost aquifer, the head profile is linear with no recharge, and the effective porosity is only 10%. This estimate is most sensitive to the following assumptions [3]:

- The spatial variation of hydraulic conductivity within the water table aquifer is reasonably uniform over the area of interest
- A hydraulic conductivity of 4 to 5 ft/day is appropriate for water table aquifer horizontal conductivity
- The effective soil porosity is not less than 10%.

The radionuclides important to dose in tanks 48, 49, and 51 are strongly sorbed onto soil particles. This phenomenon significantly retards their transport through the ground water because nearly all soil particles are immobile. The important radionuclides will travel about 1000 times slower than the ground water. Consequently, the best-estimate average contaminant transport time becomes 85,000 years (85 years x 1000). During this time span, the radionuclides with relatively short half-lives (e.g., 30 years for Cs-137, 29 years for Sr-90) decay to an insignificant activity. However, a small fraction of the soil particles (approximately 0.1 to 0.02%) may flow through soil pores with the ground water and these mobile particles facilitate radionuclide transport at the ground water velocity (i.e., 85 year travel time).

For a precipitate leak from Tank 48, the 50 year CEDE dose to a hypothetical off-site individual living on the Savannah River is 0.23 rem and the 50-mile population dose is 650 person-rem [3]. Nearly all of the dose is from the 0.1% of Cs-137 sorbed onto mobile soil particles that could discharge to either McQueen Branch or Upper Three Runs Creek about 85 years after the postulated event. For a precipitate leak from Tank 49, the 50 year CEDE dose to a hypothetical individual is 0.93 rem and the population dose is 2600 person-rem [3]. Again, Cs-137 comprises virtually all of the dose that occurs 85 years after the postulated seismic event. Transport time for the remaining 99.9% of Cs-137 retarded by the soil is 1120 times slower than groundwater velocity, which equates to a transport time of approximately 95,000 years and negligible activity levels.

The radionuclides important to dose in tank 51 (e.g., Am-241, Pu-238, Sr-90) are also strongly sorbed onto soil particles. Approximately 0.02% of these soil particles may flow through soil pores with the ground water, leading to an 85 year travel time before the radionuclides discharge to either McQueen Branch or Upper Three Runs. A leak of the entire contents of Tank 51, (265,000 kg sludge layer and 323,300 gallons supernate layer) produces a 50 year CEDE dose of 0.004 rem for an individual and 180 person-rem for the population after 85 years [3]. The remaining fraction of radionuclides retarded by the soil release at a much later time. For example, the dominant long term contributor to dose is Pu-239, which is released 68,000 years (85 years x 800) after the postulated seismic event.

Relative to other model uncertainties, the estimated groundwater travel time of 85 years is insensitive to the total volume of waste released. The maximum volume of about 4 million gallons is not large compared to the overall domain enveloping the flow path from the ITP Facility to stream discharge. Therefore, the dose estimates for subsurface release would not be affected even in the unlikely event that an earthquake produced catastrophic rupture of all four tanks. Table 1 summarizes the above dose estimates associated with the rupture of tanks 48, 49, 50, and 51.

3.2.2 Consequences of airborne release due to deflagration

For differential settlements below 23 inches, it is quite possible to supply emergency purge ventilation using EPVEs as described earlier for both the tank and annulus [4]. However, at differential settlements above this amount, riser plugs may become stuck in their holes preventing extraction for the purposes of flammable gas venting. Differential settlements of 23 inches are expected to be associated with extremely high g-level earthquakes whose probability per year is acceptably low.

4.0 Effects of Earthquakes on Cold Feeds Area

4.1 Damage from earthquakes at the EBE level and below

Damage to tanks in the cold feeds area could occur at levels below the EBE and result in the mixing of STPB and oxalic acid materials. Benzene is the worst toxic chemical that could be released from this mixing. The onsite concentration of benzene at 100 meters from the release would be 5780 mg/cu. meter (60% of IDLH) at a release rate of 1330 g/sec. Benzene released at this rate would last for about an hour. Offsite benzene concentrations would be 9.34 mg/cu. meter at the site boundary or 0.1% of IDLH [5]. It is fully expected that personnel will be able to have unlimited access to the EPVEs, which are stored in the general area of cold feeds, within 24 hours. Benzene concentration is expected to drop significantly below the peak value of 60% IDLH due to runoff or evaporation of the liquid and dissipation of the vapors. This allows personnel to access and install EPVEs on Tanks 48 and 49 well before the CLFL is reached at 3 days.

5.0 Effects of Earthquakes on the Filter/Stripper Building

5.1 Damage from earthquakes at the EBE and below

The steel superstructure of the building will not collapse at the EBE level and no damage to the filter cells is expected [4]. However, there is a chance that Hanford connectors on process piping connected to the filters could fail and result in leakage to the filter cell for earthquakes below the EBE. Since offsite electrical power may not fail at this g-level, up to 500 gpm of precipitate could flow to each filter cell if a transfer between Tank 48 and the Filter/Stripper (F/S) Building were in progress at the time. If the sump-to-pump interlocks did not automatically terminate pumping upon detection of a leak, there might be sufficient benzene and hydrogen released from the precipitate to bring the vapor concentration of the cells close to CLFL. Assuming that an ignition source is present during CLFL conditions, the consequences of a resulting deflagration in the filter cells are acceptable [5]. Should no deflagration occur, operators would have approximately 1.1 hours available to manually stop the pumps before overflowing the filter cells [11].

The F/S Building also houses filtrate hold tanks that may not survive an earthquake above 0.11g PGA. However, the radiological consequence of releasing the 24,000 gallons of liquid in the hold tanks is considered negligible. This is because the activity level of the hold tank liquid is, on average, at least 10^{-4} times that of the precipitate. The calculated 50 mile offsite population dose from the hold tank liquid is less than 10 person-rem for a combined surface spill and airborne release [8].

5.2 Damage from earthquakes above the EBE

Earthquakes above the EBE but less than 0.6g PGA would produce the same consequences as described above for the EBE except for those in the following range. At g-levels approaching 0.6g PGA, offsite electrical power would fail and thus the waste transfer pumps are not expected to contribute to the amount of precipitate that could spill inside the filter cells. The steel superstructure of the building could collapse onto the filter cell covers at 0.6g PGA and possibly breach the cell covers. This could cause damage to the filters, seal tanks, and related piping located in the cells. However, the concrete cells of the F/S building will maintain their integrity up to and including 0.6g PGA and contain any liquid precipitate waste released from damaged components contained within [4]. Containing the liquid precipitate waste will prevent any surface runoff but there is a possibility that the waste could become airborne without the cell covers or building structure in place. Table 1 gives an estimate of the airborne dose [8] associated with the 800 gallon maximum amount of waste that could be released into the concrete containment cells from the filters and associated transfer piping [12].

Above 0.6g, the concrete containment could be expected to fail and this would result in a surface spill of 800 gallons of liquid precipitate waste. However, the probability of experiencing an earthquake of 0.6g magnitude or greater is expected to be acceptably low.

6.0 Effects of Earthquakes on Transfer Lines Between the F/S Building and Tank 48.

6.1 Damage from earthquakes at the EBE and below

Analysis has shown that no damage will occur to these transfer lines up to the EBE level since differential settlement is well below even the most conservative threshold assumed for piping damage (i.e., differential settlement is a few tenths of an inch versus threshold of at least one inch). Therefore, no surface release from the transfer line piping is expected up to the EBE level [4].

6.2 Damage from earthquakes above the EBE

A conservative estimate indicates transfer line damage could occur at one inch differential settlement (i.e. damage threshold) between the first pipe support and either tank 48 or the F/S Building [4]. In the unlikely event that offsite electrical power were to remain available during an earthquake above the EBE, it is possible that up to 10,800 gallons of waste could spill onto the tank top before the pumps could be tripped. This estimate is based on two pumps running for at least ten minutes with a combined flow rate of 1,000 gpm [11] plus a maximum inventory of 800 gallons, which might be contained in both filter cells and the four transfer lines that run from Tank 48 to the F/S Building [12].

If the storm-water drainage system were to remain intact, a spill of 1,000 gpm (due to broken transfer lines) could be accommodated by the drainage system shown in Figure 4. Water from the drainage system is normally diverted to the retention basin during transfers. However, it is not clear whether the diversion gates or the retention basin will survive an earthquake above the EBE level and allow the spillage to be retained by the basin, which sits directly above Four Mile Branch. The calculated transport times from the storm water inlet to either the retention basin or storm-water outfall at Four Mile Branch are both approximately 15 minutes. In the event of storm-water drainage system failure (see Figure 5), the calculated transport time from the berm to Four Mile Branch through surface runoff is approximately 50 minutes. About 28% of the surface runoff flow for this path is lost due to infiltration. Once the spill reaches Four Mile Branch the travel time to the Savannah River is approximately 63 hours [13]. The various flow paths are depicted on Figure 6 for surface flow pathways.

Because there is much uncertainty about which surface runoff path the spilled waste might take following an earthquake above the EBE level, it was assumed that all spillage would transport to Four Mile Branch. Also, because it is difficult to predict the different percentages of waste that might contribute to a surface pathway and an airborne pathway, it was conservatively assumed that the entire amount would contribute to each release pathway (i.e. 100% contributes to surface runoff and 100% contributes to airborne release). A conservative 8 hour evaporation time was used for spills even though most of the spill would have run off to Four Mile Branch or have been absorbed into the ground by then. Figures 7 and 8 show the water ingestion dose curves for the maximum exposed offsite individual and the downstream populations, respectively. Estimates for the doses associated with the surface pathway [13] and airborne pathway [8] are both given in Table 1.

Because high level liquid waste is expected to spill onto the tank top after transfer line failure, it would provide dosage to the workers from direct shine and airborne pathways. This would be true even if offsite power were lost and the spill was limited to 800 gallons of high level waste instead of 10,800. Without unrestricted access to the tank tops, personnel may not be able to install the EPVEs in time to prevent both in-tank and annulus deflagration events. Such a condition is unacceptable.

7.0 Summary and Conclusions

7.1 Earthquakes up to and including the EBE

No significant release of waste is expected for earthquake levels up to and including the EBE. For this range of earthquakes, transfer piping between the F/S Building and Tank 48 is expected to remain intact. Deflagration in the tanks is assumed not to occur because there is sufficient time to install and operate EPVEs prior to reaching in-tank CLFL. If a deflagration were to occur in the filter cells, due to vapor buildup following Hanford connector failure, the airborne dose consequences would be acceptable [5]. The failure of the Filtrate Hold Tanks could result in a small offsite population dose of 9.3 person-rem from a water borne activity. This dose estimate is based on a 63 hour waste travel time from the ITP Facility to the Savannah River and no evacuation or modification of population behavior. An additional offsite population dose of 0.1 person-rem might result from an airborne release of the same hold tank liquid.

7.2 Earthquakes above the EBE

If differential settlement of at least one inch occurs between the first pipe support and the F/S Building or Tank 48, damage to the transfer lines may occur. Waste from these lines could be spilled onto the tank top. In the unlikely event electrical power remains available and pumping continues, a spill of up to 10,800 gallons of waste could be pumped onto the tank top in 10 minutes before corrective action could be expected. This spill would result in an offsite population dose of 41,715 person-rem from a water borne activity, based on a 63 hour waste travel time from ITP to the Savannah River and no evacuation or modification of population behavior [13]. An additional 461 person-rem could result from an airborne release [8] associated with the same 10,800 gallon spill, as shown in Table 1. The combined liquid and airborne pathway dose is unacceptable and some means should be provided to preclude such an event. As examples of what could be provided, the following are offered: a) the transfer piping could be seismically qualified to prevent its rupture, or b) a seismic trigger could be installed to stop the transfer pumps at some g-level below the threshold for piping failure.

If the transfer pumps were to shut down from a loss of offsite power, it is still estimated that up to 800 gallons of waste could flow from the broken transfer lines (if not seismically qualified) onto the tank top. This amount of waste might produce an unacceptable radiation dose for operating personnel and could prevent access to the tank top. Therefore, some means should be provided to both contain a leak of at least 800 gallons and provide shielding to personnel. Containing the spill could limit the airborne dose because of a smaller surface release area but it would not eliminate it. The offsite population dose for an 800 gallon surface spill that is allowed to spread is conservatively estimated to be 43 person-rem [8], as shown in Table 1, which is considered acceptable.

For earthquake induced acceleration values between 0.2g and 0.6g without attendant large differential soil settlement, some cracking of the steel tanks may occur, but the concrete vaults would be expected to remain intact to contain any leakage [4]. Loss of offsite power along with the normal ventilation system would also be expected. A key assumption is that the emergency ventilation system (i.e. EPVEs) would be available to prevent any buildup of vapors in tanks and their annuli to the CLFL level.

The response of the F/S Building and equipment contained therein (e.g. hold tanks , filters , Hanford connectors) would be as described above for the EBE, except for the loss of pumping in the transfer lines due to failure of offsite power. This loss of pumping would limit the amount of spill in the filter cells to 800 gallons, which is the maximum inventory of precipitate that could be held in the filters and transfer lines. For earthquakes below a g-level of 0.6g PGA, the concrete filter cells are expected to remain intact and contain any internally spilled precipitate [4].

The berm may experience some onset of cracking but no fissures would open [1]. No leakage from the concrete tank vaults would occur but even if it did, the berm would be expected to retain the liquid and make the release a subsurface one. At acceleration levels close to 0.6g with attendant large differential settlements, damage to the steel and the concrete tanks may occur [4]. The concrete cells in the F/S Building may also lose their integrity and cause the small contained inventory to spill. For this extreme case, the offsite population dose would be expected to be no more than:

- 3200 person-rem from a surface spill [13] and 43 person-rem [8] from the airborne release of up to 800 gallons of liquid precipitate waste from the F/S Building (i.e. maximum filter and transfer line inventory)
- 9.3 person-rem from a surface spill and 0.1 person-rem from the airborne release of 24,000 gallons of low level liquid from the Filtrate Hold Tanks [8]
- 650 person-rem from Tank 48 subsurface release occurring by groundwater transport 85 years after the earthquake [3]
- 2600 person-rem from Tank 49 subsurface release occurring by groundwater transport 85 years after the earthquake [3]
- 180 person-rem from Tank 51 subsurface release occurring by groundwater transport 85 years after the earthquake [3].

As a result of a 0.6g PGA earthquake, the total offsite population dose due to combined liquid pathway and airborne releases could reach 6,685 person-rem if no evacuation or population behavior changes were made. The same combined dose to the maximum individual at the site boundary would be no greater than 1.3 rem. At the present time, there are no specific regulatory limits on liquid pathway doses that could result from nuclear facility accidents. The return period for such large earthquakes is long, approaching 133,000 years, compared to the planned period of operation for the ITP Facility.

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[13] K. F. Chen, *Liquid Pathway Modeling and Exposure*, S-CLC-H-00167, Rev. 0, July 1994.

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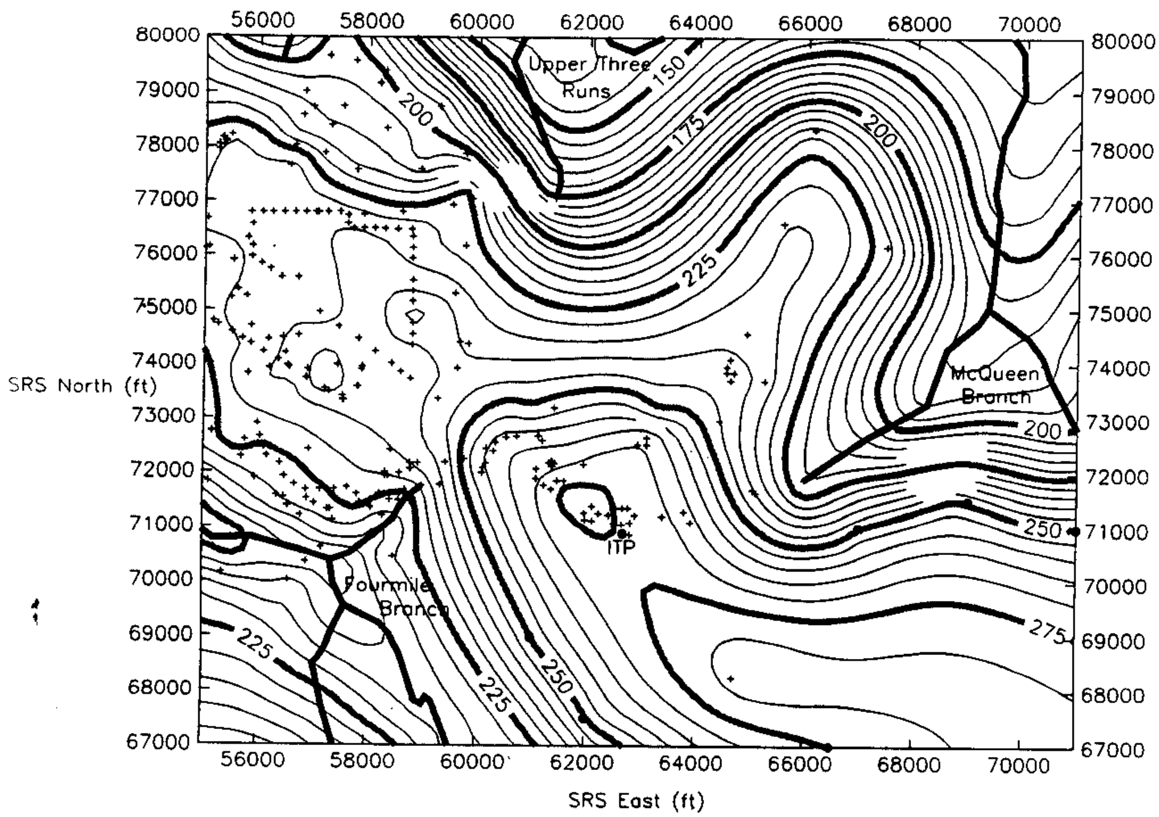
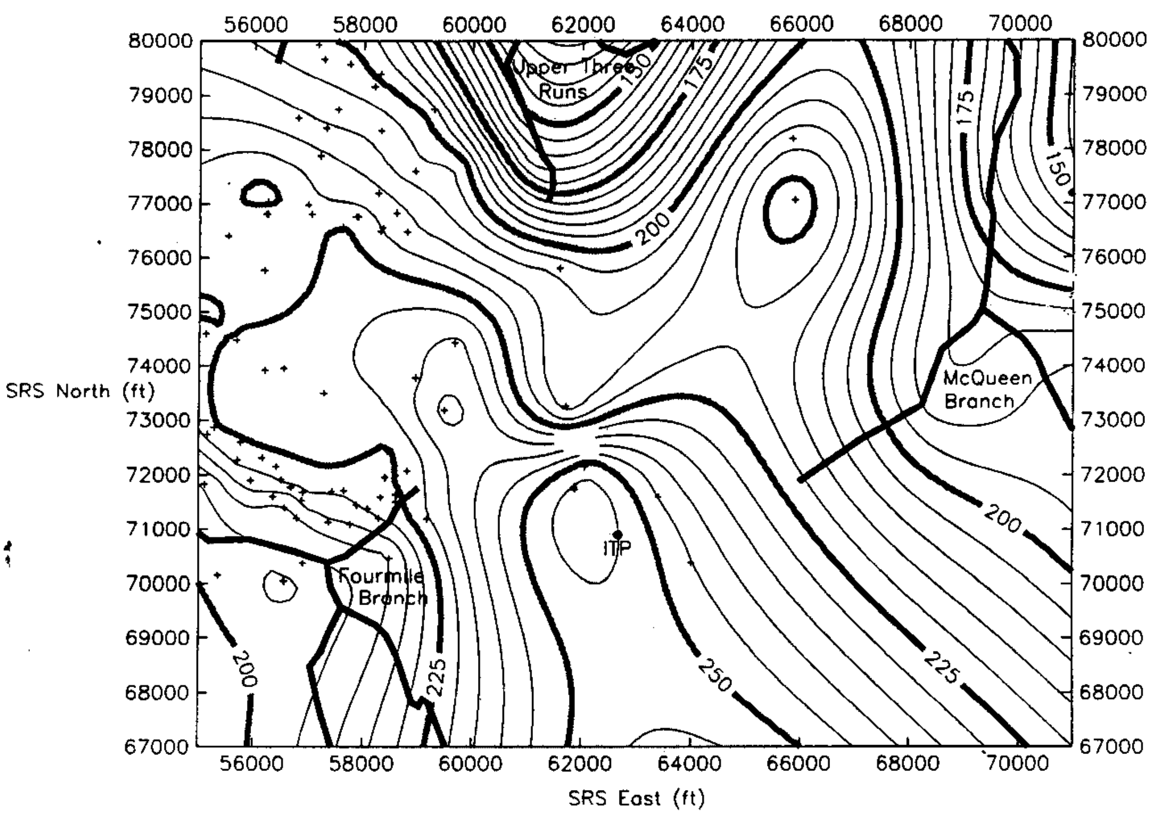
Figure 1



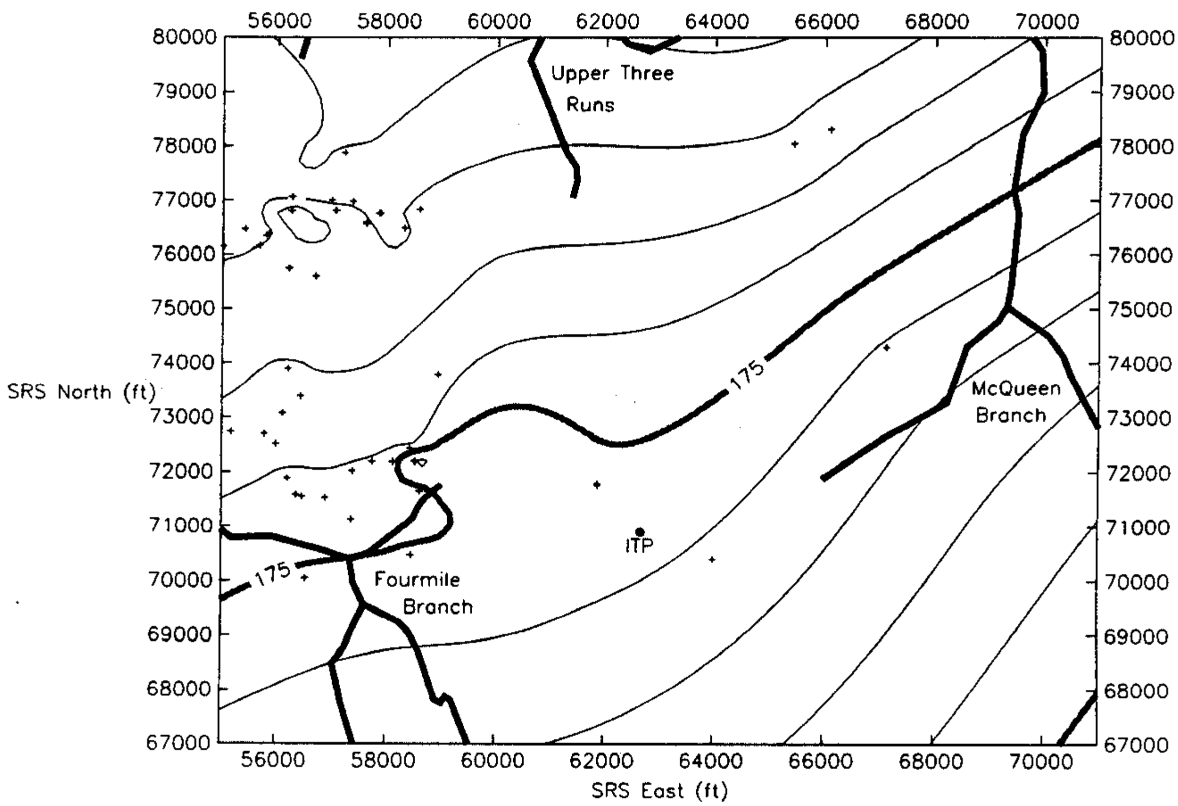
Head contour map of water table in H-area (+ denotes data, • denotes pseudo-data).

Figure 2



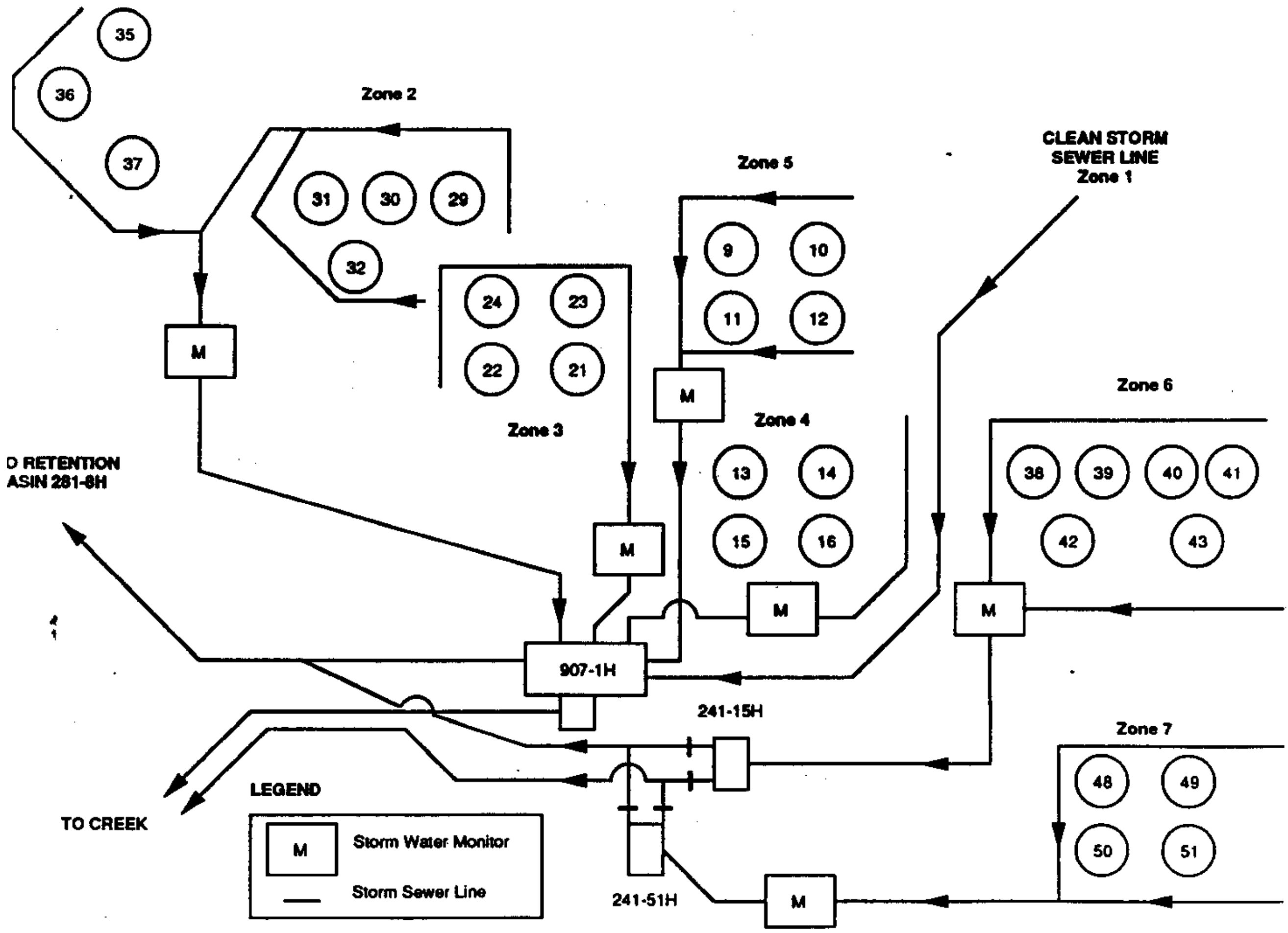
Head contour map of Barnwell/McBean aquifer in H-area (+ denotes data).

Figure 3



Head contour map of Congaree aquifer in H-area (+ denotes data).

Figure 4



H-AREA STORM WATER COLLECTION AND MONITORING SYSTEM
(For Greater Detail See Map 3309, Sheet 796)

Figure 5

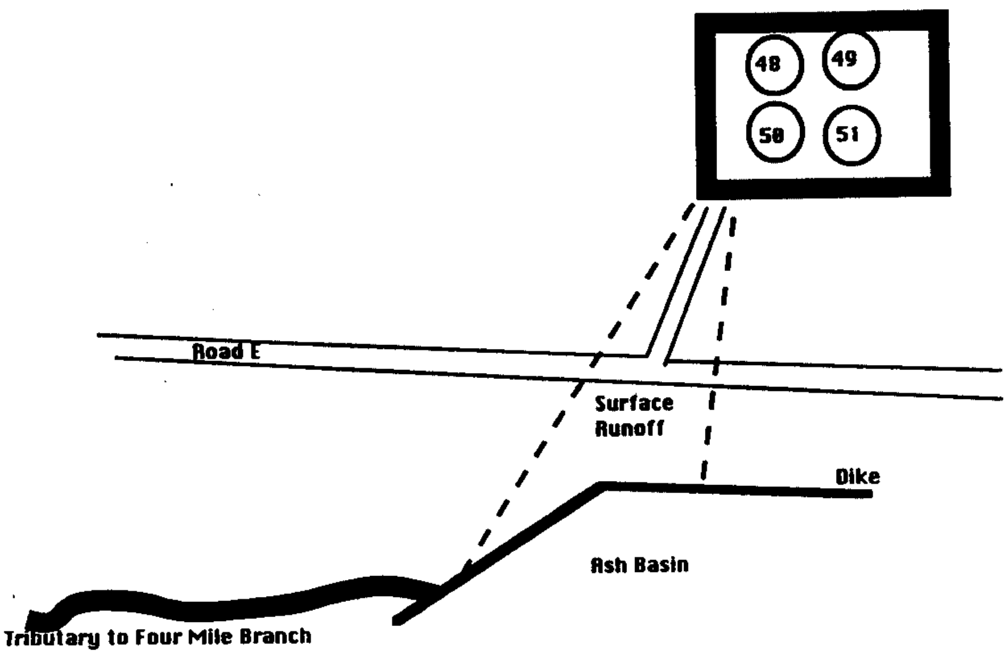
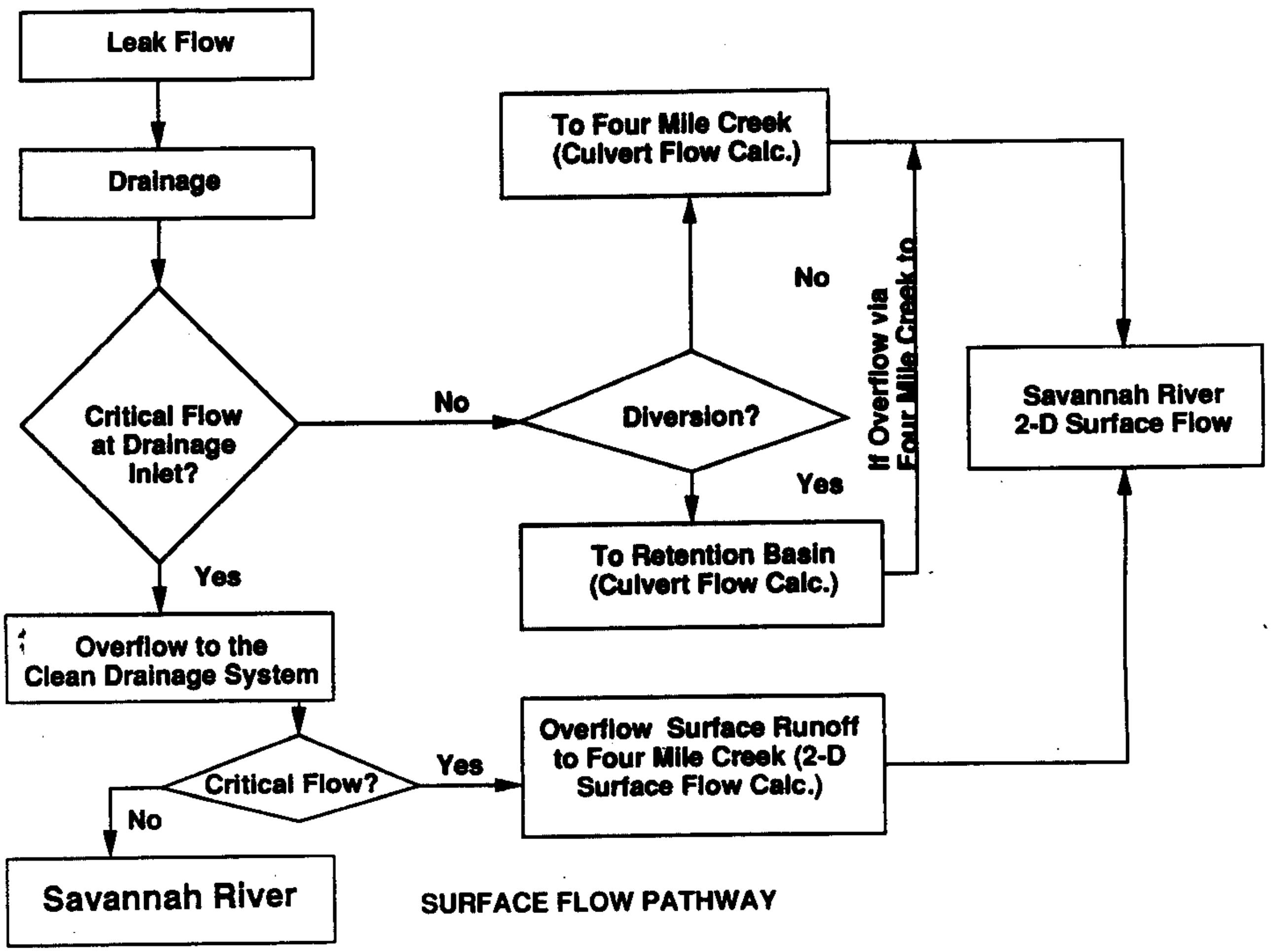


Illustration of Surface Runoff
(not to scale)

Figure 6



SURFACE FLOW PATHWAY

Figure 7

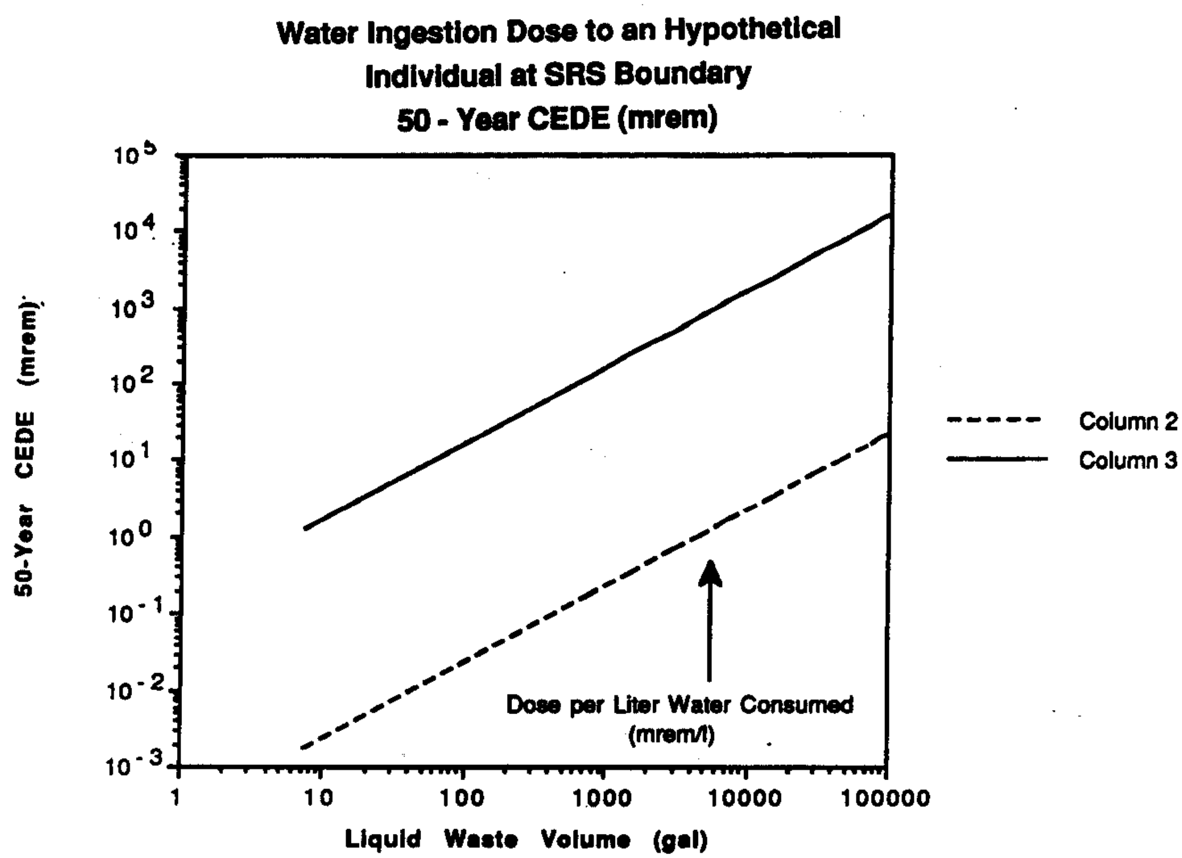

Water Ingestion Dose to an Hypothetical
Individual at SRS Boundary
50 - Year CEDE (mrem)
50-Year CEDE (mrem)
Liquid Waste Volume (gal)
Dose per Liter Water Consumed
(mrem/l)
Column 2
Column 3
1
10
100
1000
10000
100000

Figure 8

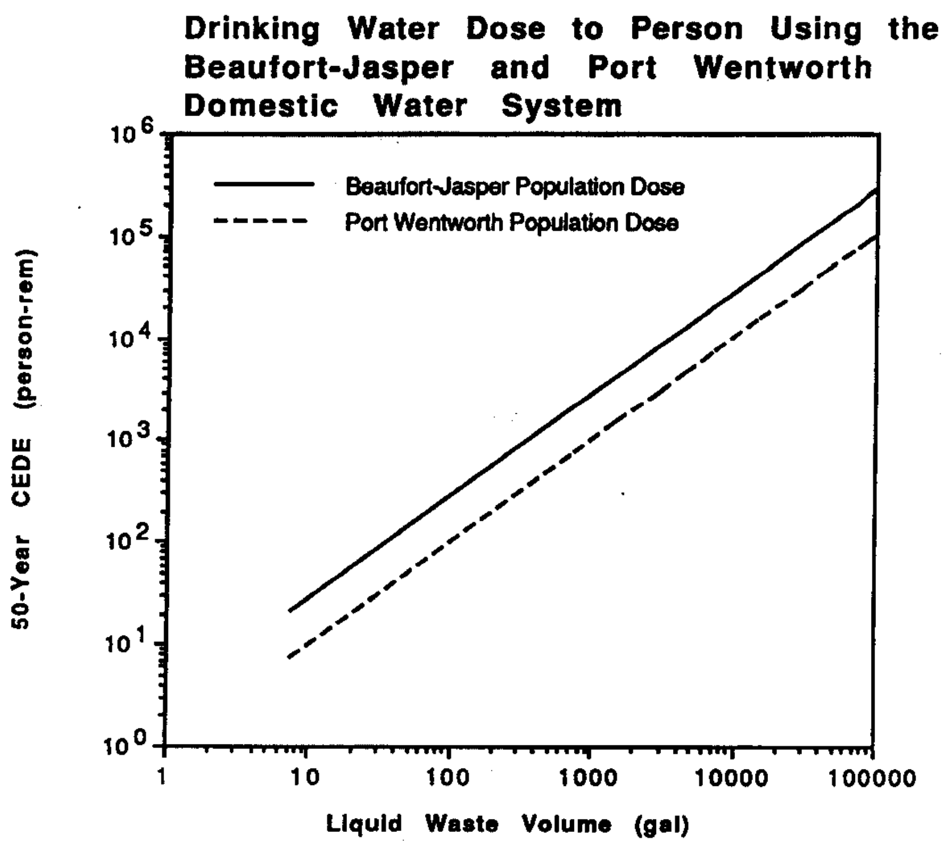

Drinking Water Dose to Person Using the Beaufort-Jasper and Port Wentworth Domestic Water System
Beaufort-Jasper Population Dose
Port Wentworth Population Dose
50-Year CEDE (person-rem)
10 0
10 1
10 2
10 3
10 4
10 5
10 6
1
10
100
1000
10000
100000
Liquid Waste Volume (gal)

Table 1

Summary of Dose Estimates by Release Category and Population Group

Release Category: Amount	Maximum Individual Dose @ 100m (rem)	Maximum Individual Dose @ Site Boundary (rem)	Offsite Population Dose @ 50 miles (person-rem)
Filtrate Hold Tank release: • Savannah River • Airborne[2]	 N/A 0.008	 3.6×10^{-4} 1.2×10^{-5}	 9.3[1] 0.1
Surface spill with pathway to Savannah River: • 800 gal. • 10,800 gal.	 N/A N/A	 0.128 1.65	 3,200[1] 41,715[1]
Surface spill with airborne release pathway[2]: • 800 gal. • 10,800 gal.	 3.23 34.9	 0.005 0.055	 43 461
In-tank deflagration with airborne release	150	0.23	1940
Tank annulus deflagratn. with airborne release	1620	2.5	21,300
Subsurface release with pathway to Savannah River[3]: • Tank 48 • Tank 49 • Tank 51 • Tank 50	 N/A N/A N/A N/A	 0.23 0.93 0.004 negligible	 650 2600 180 negligible

Notes: [1]Population dose based on persons using Beaufort-Jasper and Port Wentworth water systems.
[2]All doses based on 8 hour maximum evaporation time (all liquid assumed to be in stream by 8 hours).
[3]Dose occurs 85 years after earthquake

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