Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

DEC 27 1995

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Chairman Conway:

SUBJECT: Contingency Plan for Large Radioactive Spills from Savannah River Site (SRS) Tank Farms

The Contingency Plan for Large Radioactive Spills from SRS Tank Farms, Revision 1, has been approved and is provided for your information as Enclosure 1. This Plan and the completion of all action items identified in Enclosure 2 satisfy the commitments made in Revision 0 of the Plan and those identified in your letter to Thomas P. Grumbly, Assistant Secretary for Environmental Management, October 13, 1995. This Plan and the completed actions have been reviewed with your staff and the staff of the Office of the Deputy Assistant Secretary for Waste Management.

Any questions may be directed to me or to A. Lee Watkins at 803-208-6053.

Sincerely,

Mario P. Fiori
Manager

Enclosures:
1. Plan
2. Completed Actions

cc w/enclosures:
T. P. Grumbly (EM-1), HQ
R. Guimond (EM-2), HQ
S. P. Cowan (EM-30), HQ
M. Whitaker (EH-9), HQ

Westinghouse
Savannah River Company

CONTINGENCY PLAN FOR LARGE RADIOACTIVE SPILLS FROM SRS TANK FARMS (U)

Rev. 1

October 23, 1995

UNCLASSIFIED
DOES NOT CONTAIN
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NUCLEAR INFORMATION
ADC & Reviewing Official
(Name and Title)
Date 10/24/95

SAFETY · RESPONSIBILITY · SECURITY
SRS
SAVANNAH RIVER SITE

Westinghouse
Savannah River Company

CONTINGENCY PLAN FOR LARGE RADIOACTIVE SPILLS FROM SRS TANK FARMS (U)

Rev. 1

J. W. SMITH
J. A. RADDER
P. A. WOLFINGER

WESTINGHOUSE SAVANNAH RIVER COMPANY

SPILL CONTINGENCY PLAN FOR LARGE RADIOACTIVE SPILLS
FROM SRS TANK FARMS - Rev 1

APPROVALS

10/24/95

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T. J. Lex, HLWM Department Chief Engineer

10/25/95

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C. J. Baker, Manager, Facility Emergency Management Support,
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10-24-95

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J. W. Smith, HLW Training and Procedures Manager

10/25/95

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Department

EXECUTIVE SUMMARY

Analysis conducted by the Westinghouse Savannah River Company (WSRC) concludes that high level waste (HLW) tanks would remain intact following an evaluation basis earthquake. This safety margin for seismic events is consistent with that expected for a new hazard category 2 facility. However, it is possible that a low probability, beyond evaluation basis earthquake could adversely impact this demonstrated safety margin. In the worst case, complete containment of the high level waste inside the tanks would be compromised. Several accident scenarios are postulated for a loss of waste containment function.

A large above ground spill of HLW supernate is assumed to occur if a hypothetical earthquake severely damages both the waste tank and its surrounding containment berm. Such a spill represents the greatest emergency response challenge, since short term mitigative action must be taken within hours to prevent the release from entering the Savannah River. Small spills are significantly less challenging and subsurface releases are slowly evolving events, regardless of their size. During the evaluation of these postulated accident scenarios, enhancements to existing mitigation and emergency preparedness measures were identified. Enhancements consist of procedural improvements and materials acquisition that will enable WSRC to ensure that the potential effects of a HLW release are minimized.

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TABLES AND FIGURES

I. INTRODUCTION

Analysis conducted by the Westinghouse Savannah River Company (WSRC) concludes that high level waste (HLW) tanks would remain intact during seismic activity consistent with that normally assumed in review of a hazard category 2 facility. This report documents the evaluation of several beyond evaluation basis accident scenarios and the ability of site organizations and emergency facility personnel to mitigate on-site releases and prevent off-site consequences. Specifically, this report includes the following:

- Accident progression scenarios for above and below ground releases of HLW tank contents.
- Specific mitigative actions that would be taken to prevent unacceptable environmental consequences.
- Hardware and personnel resources that would be required for mitigation.
- Justification that resources required for mitigation would be sufficient and available.

II. METHODOLOGY

An evaluation of HLW tank contents was conducted to determine "worst case" combinations of location, volume, and activity, should the radioactive supernate be spilled. Neither the tanks in F-Tank Farm nor Type I and II tanks in H-Tank Farm were included in the above ground spill evaluation since they are entirely below grade. However, these tanks were considered in the below ground leak scenarios. As a conservatism, the "worst-case" above grade tank was assumed to fail concurrent with the formation of crevices in the containment berm large enough to allow surface liquid flow. The crevices in the berms were assumed to be formed at a point which minimizes the distance between the failed tank and the nearest creek.

Scenarios were developed to assess the impact of both above ground and below ground leaks. Existing analyses for subsurface transport and historical data were used as the basis for the below ground release assumptions.

The relatively slow subsurface transport rates (65 to 240 ft/yr) prevent below ground releases from posing the same short term threat of an off-site release as the above ground spills. However, consideration was given to the immediate actions which would be necessary to ensure that below to above ground pathways (stormwater diversion boxes, piping, culverts, etc.) did not develop due to the event that caused the tank failure.

Site maps and topography surrounding the HLW facilities and the nearby streams were examined to determine the likely surface runoff paths. As a conservatism, assumptions were that the surface spills would reach the nearest creek that empties into the Savannah River, as this would be the quickest way to propagate the spill and impact the environment. Aerial photographs were taken of Four Mile Branch (the creek closest to the postulated spill locations) to locate potential areas where the leak could be impounded. For analysis purposes, creek flow rates and the dilution factors were extrapolated from actual dye testing results conducted on two separate occasions (reference 3).

The above ground release scenario was found to represent the most immediate threat to the environment. For that reason, it was chosen as the bounding scenario to be used as a baseline model for the assumed accident sequence, event timing, accompanying radiation levels and likely pathways for spilled liquid waste flow.

Existing facility and site level emergency operating procedures (EOPs) were reviewed in detail to determine what procedural actions were already in place to mitigate the consequences of the postulated accidents. Applicable portions of the facility and site emergency plan implementing procedures (EPIPs) were extracted and flow-charted in order to provide a clear overall picture of mitigative actions already in place. Potential mitigative actions for large spill events were then integrated into these flow charts to show where procedural enhancements were needed.

Finally, an assessment was conducted to determine required personnel, materials, and equipment resources to prevent the postulated spill from adversely impacting the health and safety of the public.

III. POSTULATED ABOVE GROUND RELEASE

A. Assumptions

1. The event initiator causes localized damage.
2. The damaged tank is located on the periphery of the applicable facility, above grade.
3. The damaged tank contains significant supernate (a flowing liquid).

4. Sludge (consistency of axle grease) and salt (a solid) is contained within the damaged tank.
5. The event occurs with site at minimum staffing level (ERO members must be called out).
6. Road "E" is damaged between the affected tank and the nearest creek (road embankment does not abate liquid flow).
7. The berm is breached at a point closest to the ruptured tank and radioactive liquid flows toward the nearest creek.
8. Dose rates associated with the supernate spill are high and impede mitigative actions in close proximity to the liquid.
9. Operators are unable to transfer liquid from the leaking tank to an intact tank.
10. Operators are unable to close facility storm water gates to divert the spill from the creek to the retention basin.
11. Power, tank cooling and ventilation are inoperable.

B. Above Ground Release Scenario and Short Term Actions

For scenario purposes, Tank 35 was selected as a worst case tank because it contains the highest volume of supernate and is located on the periphery of H-Tank Farm, above grade. This tank is also located on the south side of the facility (side closest to Four Mile Branch).

The containment berm is assumed to be damaged at a point west of Tank 35 and south of Tank 36. The spilled radioactive liquid is assumed to flow through the damaged berm at this point and follow the natural topography of the land and the concrete drainage system.

The postulated event initiator causes damage to Tank 35 in H-Tank Farm. On-shift operators and radiation control personnel feel the ground tremble and observe structural damage to buildings. Surveillance operators report a large spill in progress. Operators attempt to realign the storm water gates to the retention basin and transfer the contents of the leaking tank to an intact tank, but both attempts are unsuccessful.

The Shift Manager notifies the Emergency Duty Officer (EDO) and the DOE Facility Representative. Radiation control personnel report high dose rates from the spilled liquid, and surveillance operators report a conspicuous crevice in the berm leading south toward Road "E". The EDO classifies the event as a Site Area Emergency (SAE) and calls out the Emergency Response Organization (ERO). Applicable federal, state and local agencies are notified.

The liquid from the fractured tank flows through the crack in the berm as H-Tank Farm personnel evacuate through the north gate. Radiation control personnel report extremely high dose rates as they monitor the dispersion of the spill. Dose rates are greater than 2 R/Hr at 200 feet from the spill, and operators are forced to abandon the control room.

ERO personnel arrive and are briefed. The Emergency Operations Center (EOC) is manned, and communications links are established. Field monitoring teams are dispatched to survey and track the spill. Three containment teams are dispatched to establish creek containments at the primary (Road C), backup (C to F-Area utility right-of-way), and upstream locations (see Figure 2). Field teams begin sampling Four Mile Branch at regular intervals.

Three containment teams arrive at the impoundment material (e.g. sandbag) storage area, load vehicles and proceed to the three preplanned containment sites on Four Mile Branch. When the impoundments are in place, the EOC is notified that the spill has been contained. Reentry and restoration actions, repair and long term cleanup efforts are implemented (see Section III.C).

The short term sequence of events and key event timing is shown in Table 2.

C. Mitigative and Remedial Actions For Above Ground Release

Liquid flow rate and dose rates would diminish as the liquid was emptied from the leaking tank. The perimeter of the area affected by the radioactive spill would be determined based on area radiation levels, surface contamination levels, and airborne contamination concentrations. Routes for reentry would be selected and reentry would be accomplished as soon as possible after a complete evacuation. The reentry routes would be selected to minimize radiation exposure and spread of contamination. The reentry routes would be prepared to reduce radiation and contamination levels as reentry proceeded. Methods to reduce radiation and contamination levels that would be considered include washing down surfaces using firehoses to flush remaining waste into contained areas and using sand to cover remaining contamination, fixing the contamination in place while minimizing further airborne releases and providing some shielding.

Operators would restore power, tank ventilation, and tank cooling. The sequence of activities would be determined based on potential hazards of specific tanks (time to lower flammability limit, decay heat load of tank, etc.). Emergency ventilation would be used if permanent ventilation was not available. Shielding would be constructed and required repairs would be assessed as soon after reentry as possible.

Various methods have been used successfully at SRS to contain and clean up radioactive liquid spills. One well documented example is the 1983 spill at Tank 13 in H-Area, which took approximately 18 months to clean up. The mitigating actions for the above ground spills postulated in this document would be similar to those taken following the Tank 13 spill, except on a much larger scale. For example, sandbags (or other material) and absorbent material would be used extensively to contain or reroute the contaminated liquid. Concrete and steel I-beam or angle iron dikes could be erected, and dump trucks filled with dirt would be available for emergencies. Temporary sumps or basins would be formed where water was impounded, and temporary pumps would be used to direct the contaminated liquid for cleanup (see Figure 4).

Some of the long term cleanup techniques used following the Tank 13 incident would also be applicable for large above ground spills. Once the spill was contained, temporary deionizers would be put in place to clean up impounded water (see Figure 5). Chemical agents would be used and, in some cases, a sealant would be applied to paved areas to fix contamination already there. Robots would be used to assist in cleanup and perform radiation/contamination surveys. Shielding would be set up at appropriate locations and television cameras would be used to remotely monitor cleanup efforts. Dirt and asphalt would be excavated and removed to the burial ground. Concrete or asphalt would be poured, where necessary.

IV. POSTULATED SUBSURFACE RELEASE

A. Assumptions

1. The event initiator causes localized damage.
2. All of the waste in the damaged tank leaks into the underlying soil.
3. Only a small fraction of the waste (0.01 to 0.1%) will flow through the soil pores with the groundwater underlying H-Area.
4. Radiological dose rates on the surface are not affected by the subsurface release; consequently, mitigative actions are unimpeded.
5. Operators are unable to transfer waste from the leaking tank to an intact tank before it all leaks out.
6. The event occurs with the site at minimum staffing level and ERO members must be called in.

B. Subsurface Release Scenario And Short Term Actions

The postulated event initiator is identical to that assumed for an above ground release. However, in this scenario, the event only damages the buried waste tank and leaves the surrounding berm intact. Waste from the damaged tank leaks into the underlying soil and is not visible to observers. Operators note a significant decrease in tank level and are able to isolate potential below to above ground leakage pathways (stormwater diversion boxes, pipes, culverts, etc.) that may have developed due to the initiating event. However, operators are not able to transfer waste to an intact tank before it all leaks out into the subsurface.

Nearly all of the waste release becomes sorbed onto immobile mineral grains or subsurface sediments and, as a result, travels orders of magnitude slower than the surrounding groundwater. However, a small fraction of the waste (0.01 to 0.1%) flows through the soil pores with the groundwater as small particles. The groundwater flows in the direction of the negative hydraulic gradient, which is perpendicular to constant head lines and in the direction of decreasing head.

Head contour maps for H-Area indicate that waste released from a tank in that area will flow in one of two directions, depending on tank location. Waste from the western sector tanks 9-16, 21-24, 29-31 and 35-37 will flow south-southwest towards Four Mile Branch. Waste from eastern sector tanks 38-43 and 48-51 will flow in the opposite direction towards McQueen Branch. Calculations show that transport rates for small waste particles (colloids) moving with the groundwater are on the order of 65 to 240 feet per year. Since the distances to the nearest streams are measured in thousands of feet, there is sufficient time (i.e., years) available to plan and implement mitigative activities. Table 1 summarizes the transport times for subsurface releases from the tanks in H-Area.

Table 1 **Best-Estimate and Conservative-Estimate Groundwater Transport Times for H-Area Tank Farm**

Estimated Groundwater Travel Time	**Tanks 9-16, 21-24, 29-31 and 35-37** (discharge to Four Mile Branch)	**Tanks 38-43 and 48-51** (discharge to McQueen Branch)
Best	45 years	85 years
Conservative	10 years	15 years

All of the F-Area waste tanks are buried entirely below-grade on the south side of the F-Area groundwater divide, which has a negative head gradient running in the direction of Four Mile Branch. Therefore, any postulated leakage from these tanks will result in a subsurface release that is transported by the surrounding groundwater in that direction. Given such a release, only a small fraction of the waste (0.01 to 0.1%) will flow as colloids with the groundwater towards a main tributary of Four Mile Branch. Calculations yield a conservative-estimate, groundwater transport time of 8.3 years for waste discharge into the tributary. This estimate is based on head contour maps for F-Area and the same retardation factors that were used for H-Area.

Tanks that represent the worst case for a subsurface release in H-Area are 35H and 39H because they contain high heat waste having the largest amount of activity. Similarly, the worst case waste tanks for F-Area are 4F and 34F.

C. Mitigative and Remedial Actions For Subsurface Release

Given a subsurface release of waste from the buried tanks, the first action would be to drill sample wells along lines that originate close to the affected tank and extend in the direction of negative hydraulic gradient for the groundwater. Such wells would be drilled with resources available from existing site drilling contractors or through emergency procurement. Only one or two drilling rigs would be needed to provide the array of sample wells that is required. Sample information would be used to determine plume size, groundwater activity levels, direction of travel, and expected transit time to the nearest discharge point. Results would be used to plan and prioritize efforts to prevent waste from entering surface streams where it could potentially jeopardize the health and safety of the public. Results would also be used to plan and prioritize environmental remediation activities.

Existing Technologies

Efforts to contain the waste would be the first mitigative actions taken following drilling of the sample wells. Mitigation and control of subsurface radioactive waste spills would be achieved by making use of any of the existing proven technologies that are described below. These technologies can be used separately or together, depending on the situation.

1. Slurry Wall Construction

Soil-bentonite slurry walls are vertical subsurface barriers that are constructed to reduce the horizontal permeability of soil to a value that is in the range of 1×10^{-7} to 1×10^{-6} centimeters per second. To construct the walls, a trench is excavated using a backhoe while filling the excavation with a slurry of bentonite (or grout/cement) at the "same time". The slurry is kept continuously in the trench, and above the level of the groundwater, to create a low permeability filter cake on the trench walls. This prevents any significant fluid flow into the adjacent ground. Trenches are typically constructed down to depths of 200 feet and are from 2 to 4 feet in width.

Backfill soil generally consists of soil that is excavated from the trench and mixed with other soil fines if required. The soil is then returned to the trench in a controlled manner using either a bulldozer or a front-end loader. The completed slurry trench is usually provided with a compacted soil cap. Slurry walls are a proven technology that could likely be constructed with existing onsite resources or, if not, by those obtained through emergency procurement.

2. Deep Soil Mixing

Deep soil mixing (DSM) is a proven barrier technique that can be used to construct cut-off or retaining walls by treating soils in-situ. DSM can be used to install a barrier within a few feet of existing structures and is capable of reaching depths of 120 feet or more. This is accomplished with a series of overlapping stabilized soil columns that are typically 36 inches in diameter. The equipment is a crane-supported set of leads which guide a series of four hydraulically driven augers and mixing paddles. As penetration occurs, a slurry (grout) is injected into the soil through the tip of the hollow stemmed augers. The auger flights both penetrate and break the soil loose, lifting it to the mixing paddles which blend the slurry and soil together. The mixing shafts are positioned to overlap each other in order to form a continuously mixed column.

A major advantage to DSM is that contaminated soil does not have to be excavated and removed to install the barrier. Also, work and staging areas are smaller than those needed with other methods since there are no trenches or above ground mixing areas. The technology is commercially available from Geo-Con Inc.

3. Reversal of Groundwater Gradient

By creating a local depression in the groundwater level within an area of contamination, groundwater will flow towards the depression rather than migrating away from the contaminated area. Radioactive contaminants are, thus, effectively prevented from being transported away from a sub-surface spill by the groundwater. Such a depression was created at SRS following the Tank 16 sub-surface leak in H-Area during the early 1960's. Water was removed from the sub-surface area near the source of the leak at a slow rate of 4 gallons per minute during the period 1961 to 1963. This removal created a local depression and reversed the groundwater gradient, which prevented radioactive contaminants from being transported outside of the local area.

This technology might be used in combination with a slurry wall or DSM barrier to achieve defense in depth for mitigative activities. Pumping the contaminated groundwater through temporary deionizers would remove the radioactive colloids and allow the water to be returned to a non-contaminated area outside the wall or barrier.

Promising Technologies

In addition to the existing technologies described above, there are two other proven barrier technologies that appear to be promising. These are discussed below.

1. Soil Freezing (Cryocell)

Cryocell is a technology for creating a frozen soil barrier that has been widely used by the mining and construction industries since the late 1880's. Most recently, it was used in a New York City water main construction project involving a 41 foot diameter shaft with 10 foot thick frozen walls, formed to a depth of 260 feet. The technology involves installing parallel rows of freeze pipes (10 to 40 feet apart) around the circumference of the site. A refrigeration unit is then attached to the pipes so that the soil around and between the pipes can be frozen. Complete freezing of the soil barrier to a temperature of approximately -45° F can take several weeks or more, depending on the following: soil moisture content, soil properties, refrigeration capacity, freeze pipe surface area, and distance between the pipes. Refrigeration cooling agents are typically calcium chloride brine or liquid nitrogen.

This technology could be used to contain the subsurface plume from a waste tank leak by constructing a freeze wall no more than several hundred feet from the waste release point. The wall could reasonably be expected to be in place at that location within a year, since the waste is expected to migrate at speeds of about 65 feet to a maximum of 240 feet per year. Cryocell ground freezing technology has been successfully demonstrated in-field by the DOE Office of Technology Development at Oak Ridge, Tennessee, and is commercially available from Scientific Ecology Group (SEG) Inc.

2. Soil Sawing

Soil sawing is an in-situ technology that is designed to construct sub-surface solid walls for isolating contaminated groundwater plumes. It is a one-step continuous process that eliminates excavation and replacement since it cuts through the soil like a knife. The soil saw, mounted on a modified bulldozer, uses high pressure grouting to cut through soil while simultaneously injecting a mixture of bentonite clay and cement into the soil. The resulting barrier is a continuous solid wall that surrounds and isolates areas of contamination.

Sponsored by EM-50, the soil saw was demonstrated as a method of containment technology at the SRS several years ago. The technology is commercially available from Halliburton NUS, and it is expected that a soil saw unit could be onsite and working within several months of any subsurface spill. Because the soil saw creates a barrier in one continuous operation, it is also expected that this technology could be used to contain the waste closer to its release point than with soil freezing.

Pumping the contaminated groundwater through temporary deionizers would remove the radioactive colloids and allow the water to be returned to a non-contaminated area outside the barrier.

V. MATERIAL AND RESOURCE AVAILABILITY

A. Material and Resources Available For Above Ground Spills

Evaluation results conclude that sandbags (or other material) should be readily available to minimize the spread of surface spills. Additionally, there may be some accident sequences in which it would be beneficial to impound a creek both upstream and downstream of where the leak enters the creek. The openings where creeks flow under man-made structures such as roads were determined to be the best downstream impoundment points. Roads are raised approximately 12 to 14 feet above natural grade at the bridges. Beyond that, main roads and right of ways are the quickest, easiest and best-known routes for transporting material to the impoundment locations.

No special transportation vehicles would be necessary to support placement of temporary impoundments. Sandbags or other appropriate material could be transported in any of the hundreds of government vehicles readily available on site. Only minimal training would be required for personnel who would transport and place material at points designated by the EOC. Procedures in the EOC will describe the location of the material and possible containment points, and maps and photographs will be available to assist in determining the best primary and secondary impoundment points.

To ensure that sandbags or other appropriate materials will be available in the event of a significant radioactive liquid spill, they will be stored in specific locations on site.

Long term recovery and cleanup actions would be based on the actual event progression. The impounded water would be cleaned up, closely monitored, and discharged downstream of the impoundments (see Figure 4). Based upon previous spill histories, a significant strategic planning effort and considerable resources would be required to clean up a spill of the magnitude postulated in this document.

B. Material And Resources Available For Subsurface Releases

In contrast to the actions required to mitigate large above ground spills, below ground liquid releases would be slowly evolving events. Mitigating actions would occur over weeks, months or even years; therefore, far more time would be available to strategize the mitigation efforts.

With significant time available and no high dose rates to impede mitigation, several techniques could be employed to minimize the spread of contaminated water. These techniques are described in Section IV.C.

VI. CONCLUSIONS AND RECOMMENDATIONS

Findings conclude that public health and safety would not be impacted in the unlikely event of a large above or below ground radioactive liquid spill in one of the HLW facilities. However, procedural improvements will be necessary to ensure that adequate direction is available to cope with large spills, and a minimum number of sandbags must be readily available to ensure that temporary creek impoundments could be built in the required time.

Large above ground leaks represent the greatest short term mitigative challenge because action would have to be taken within hours in order to prevent release from reaching the Savannah River. Smaller leaks would be less challenging, and subsurface leaks would be slowly evolving events regardless of size (i.e., transport times on the order of months and years, rather than hours).

In comparison to the spills postulated in this document, the above ground spills at SRS have been small. However, the mitigation methods used for those spills are still applicable, and the technology, equipment and expertise used for clean-up are readily available. In addition to slurry wall construction and deep soil mixing, at least two other viable commercial technologies are available to mitigate the consequences of a subsurface HLW tank leak. These techniques are soil freezing and soil sawing.

There are several actions which will be taken to enhance emergency preparedness measures at Savannah River Site:

1. A list of vendors which could provide equipment for mitigation or remediation will be prepared and readily available to ERO personnel.

2. A plan will be developed to store a minimum amount of sandbags or other materials which could be used to mitigate the consequences of a surface spill. The plan will include a basis for the amount of stored materials, as well as the storage location(s) and method of inventory. This information will be readily available to the ERO.

3. A list will be developed to show the number of personnel at selected locations on site at minimum staffing level who could be requested to assist in mitigative actions outlined in this plan.

4. Emergency Plan Implementing Procedures (EPIPs) and Emergency Operating Procedures (EOPs) will be reviewed and/or revised to ensure that they contain adequate directions for mitigating surface or subsurface spills.

5. Maps and photographs will be placed in the EOC to assist ERO personnel in identifying temporary impoundment sites and material storage locations.

6. Procedure revisions and improvements in emergency preparedness measures will be validated by an appropriate method (i.e., table-top drills, procedure walkdowns, or site exercises).

7. Personnel will be trained on procedure revisions and improvements in emergency preparedness measures.

VII. REFERENCES

1. DP-1722, Radioactive Waste Spill And Cleanup On Storage Tank At The Savannah River Plant, dated March 1986

2. Report Of The Investigation Of Tank 13 Contamination Incident On December 29, 1983 At The Savannah River Plant, dated December 1984

3. Memorandum from D.L. Kiser to J.C. Corey, Emergency Response to Aqueous Releases at SRP; Tables and Figures for Estimating the Downstream Maximum Concentrations and Travel Times, dated May 26, 1977.

4. DP-1358, Appendix F, Leakage From Waste Tank 16 - Amount, Fate, and Impact, dated November 1974

5. Liquid Waste Processing Flow Diagram, dated June 30, 1995

6. DWG. OSR3-158: Page 1, Savannah River Site, dated January 1992

7. DWG. OSR3-158: Page 11, F-Area, dated January 1992

8. DWG. OSR3-158: Page 14, H-Area, dated January 1992

9. EPIP-HTF-001, Emergency Classification, Revision 1

10. EPIP 6Q-114, Emergency Classification, Attachment 6, Revision 6

11. WSRC-TR-95-0242, Rev. 0., H-Area/ITP Safety Analysis Summary Report for Subsurface Liquid Waste Transport (U), Flach, G. P. and J. A. Radder, 1995

12. Morin, J.P., S. Brady, R.M. Satterfield, L.A. Salomone, F. Loceff, J.A. Radder, et al, H-Area/ITP Seismic Safety Issue Resolution Program Plan (U), HLW-ENG-930017, Rev. 2, November 30, 1994.

13. Flach, G. P., Conservative Attenuation Factors for F- and H-Areas (U), Q-CLC-G-00009, Rev. 0, February 1995.

Table 2: Time Line For Bounding Scenario

Event	Indications And Mitigating Actions	Time (Hrs.)
Initiation:	• On-shift operators and radiation control personnel feel shock which fractures Tank 35	0.0
Radioactive liquid is released from the tank and flows toward the breached berm	• Crevice forms in berm between Tanks 35 and 36.	
Radioactive liquid discovered by personnel on shift	• Shift Manager (SM) becomes aware of above ground leak and breached berm and notifies Emergency Duty Officer (EDO). • Site Area Emergency declared and DOE Facility Representative notified • EDO calls out Emergency Response Organization (ERO) • Nonessential personnel ordered to evacuate • Operators unsuccessfully attempt to realign the storm water gates to the retention basin.	0.3
Facility implements mitigating actions specified by emergency operating procedures	• Operators prepare to transfer contents of leaking tank to an intact tank. • RCI notifies SM that radiation levels are over 2 R/hr at 200 feet from the spill. • Control room evacuation initiated.	0.5

Table 2: Time Line For Bounding Scenario (continued)

Event	Indications And Mitigating Actions	Time (Hrs.)
Radioactive liquid flows through breached berm	• Tank 35 level continues to decrease. • Shift Manager updates Emergency Duty Officer (EDO). • H-Area evacuation complete	0.8
EOC fully staffed	• EOC personnel are briefed on the event and known conditions. • EOC directs implementation of containment actions at preplanned primary and contingency intercept points for Four Mile Branch. • Field monitoring teams dispatched • Three impoundment teams dispatched	1.3
Three four-man impoundment teams arrive at stores	• Teams load material into vehicles.	2.5
Leading edge of spill reaches Four Mile Branch tributary south of H-Tank Farm and upstream of Road 4	• Monitoring teams report liquid has reached the tributary.	3.0

Table 2: Time Line For Bounding Scenario (continued)

Event	Indications And Mitigating Actions	Time (Hrs.)
Three four-man impoundment teams arrive at primary and backup creek containment locations.	• One team begins impounding Four Mile Branch at Road C bridge. • One team begins impounding Four Mile Branch at culverts under the 115KV Right of Way (ROW). • One team begins impounding Four Mile Branch upstream of the leak.	3.5
Leakage from Tank 35 stops	• All supernate has leaked out of the tank	4.0
Backup impoundment is established	• Impoundment in place at 115 KV ROW.	4.5
Leading edge of spill reaches the Four Mile Creek bridge at Road 4.	• Four Mile Branch samples at Road 4 begin to show contamination.	6.0
Primary, backup and upstream creek impoundments complete.	• Four Mile Branch contained at Road C, and upstream of the point at which spill is entering creek.	6.0
Field teams continue to monitor and track the radioactive liquid surface dispersion	• EOC uses field team reports to map dispersion and dilution of spill	8.0
Leading edge of spill reaches Four-mile creek at Road C.	• Dispersion is tracked by dose rate measurements, creek water sample results and field observations. • Liquid samples at Road C indicate that the leading edge of the spill has reached that point	9.0

Table 2: Time Line For Bounding Scenario (concluded)

Event	Indications And Mitigating Actions	Time (Hrs.)
Liquid flow rate and dose rates diminish after liquid empties from tank	Reentry accomplished as soon as possible: • Spill perimeter and operational corridors are established • Operators restore power, tank ventilation and tank cooling	>9.0
Long term mitigation, decontamination and cleanup efforts continue	• Sampling and surveying • Soil, concrete and asphalt excavation • Chemical cleaning and flushing • Filtering and deionization • Soil stabilization • Sealing	

Figure 1: Savannah River Site Map

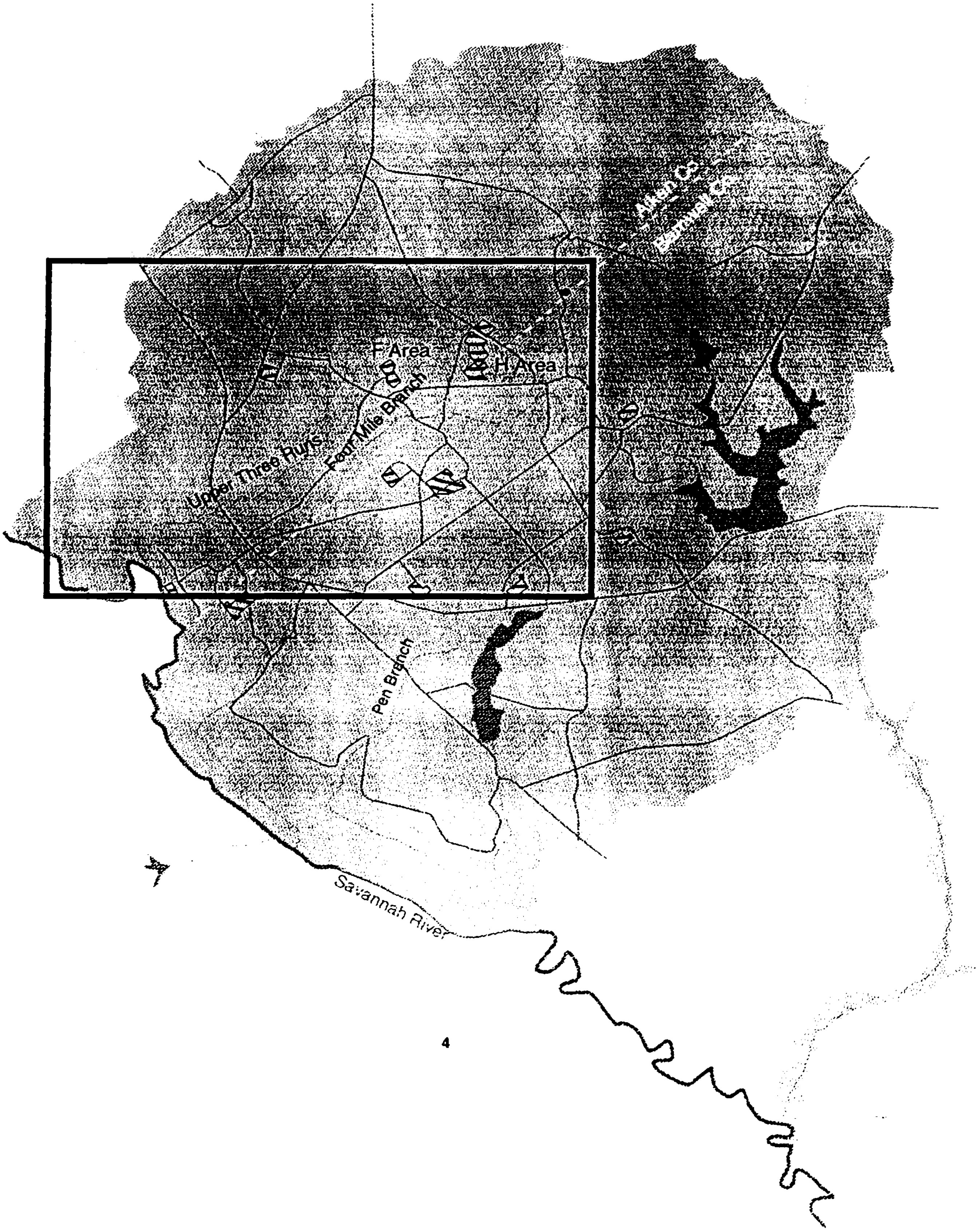

Figure 2: Spill Containment Locations

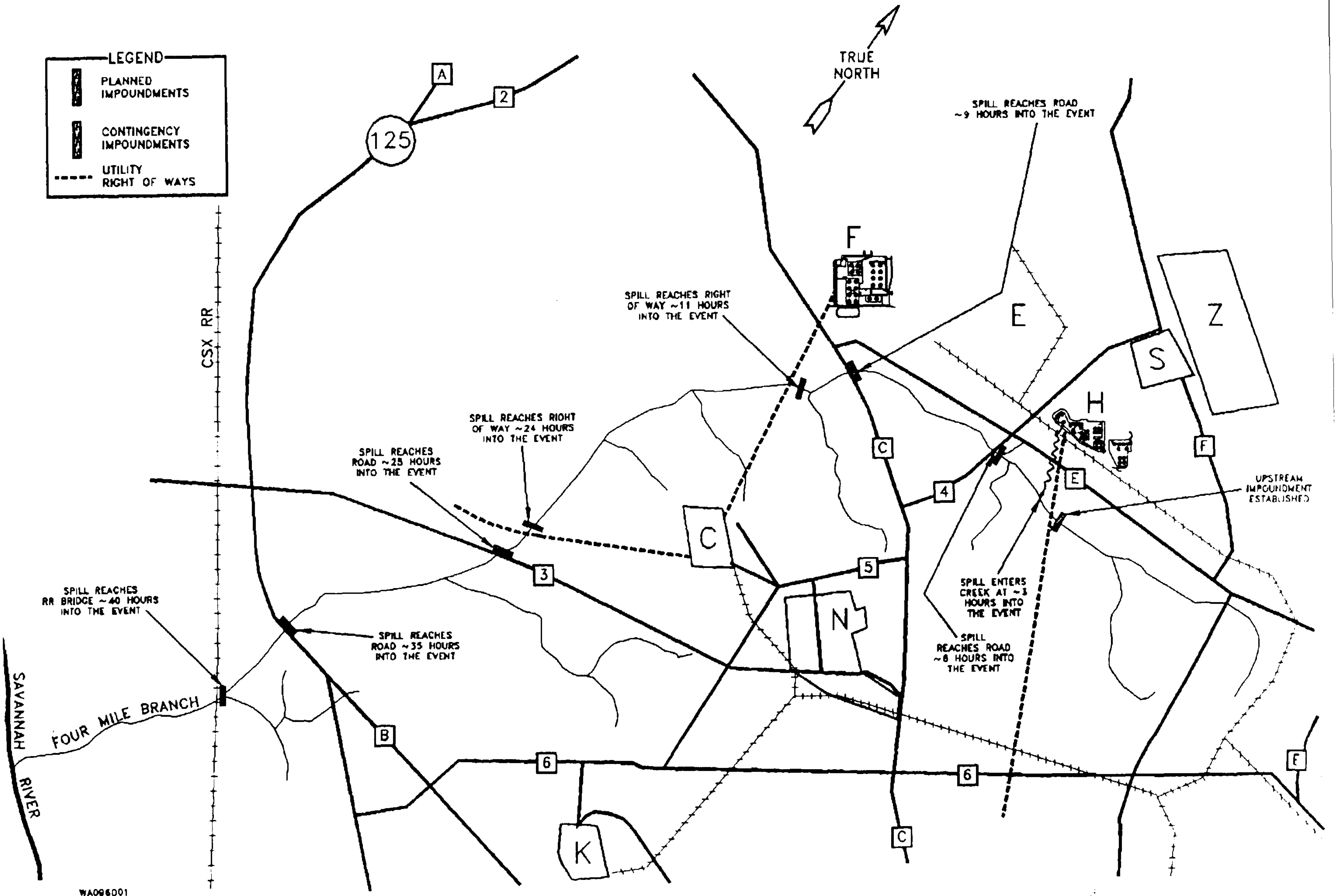

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Figure 3: Mitigation and Remedial Actions (Specific Flowchart)

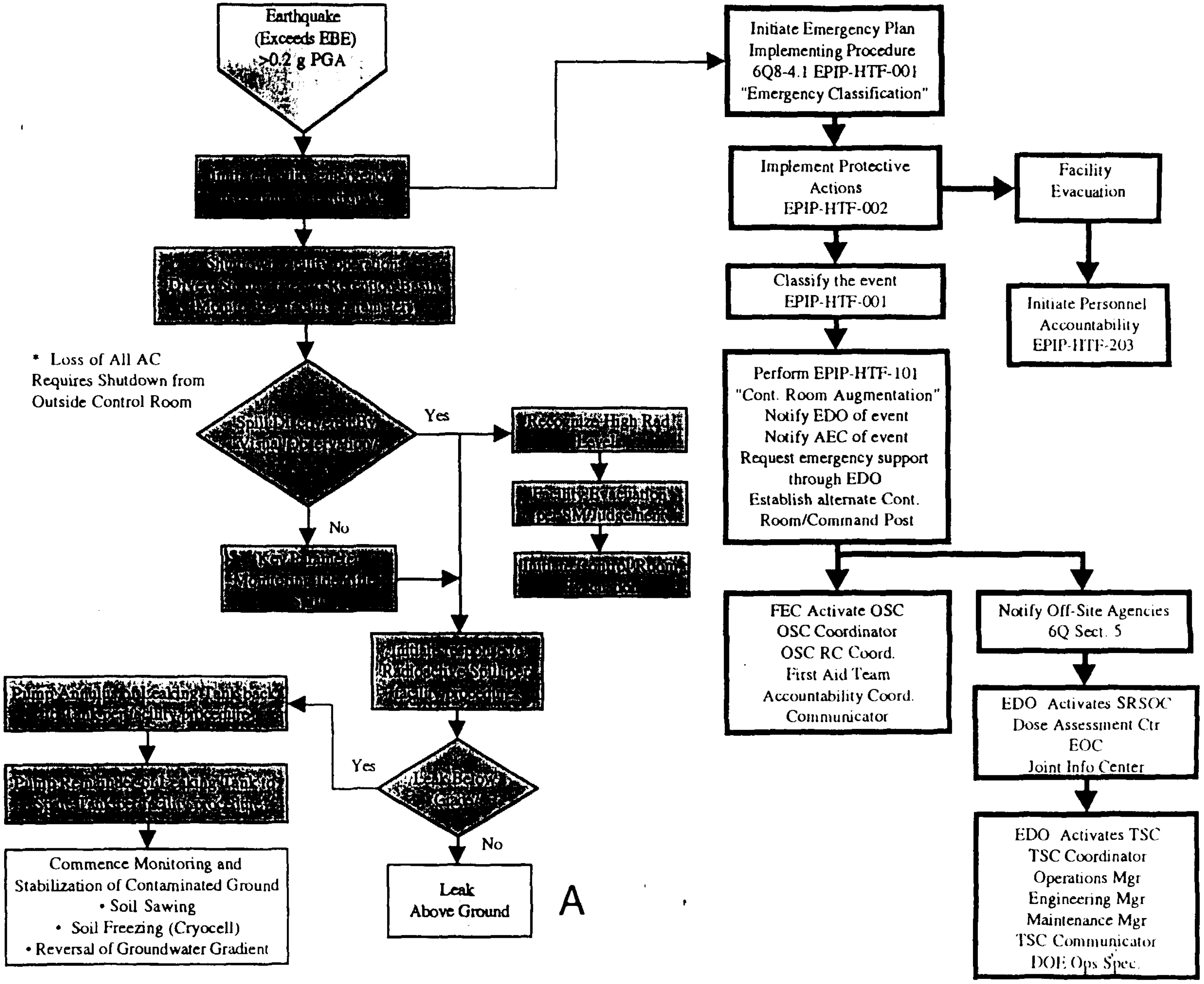

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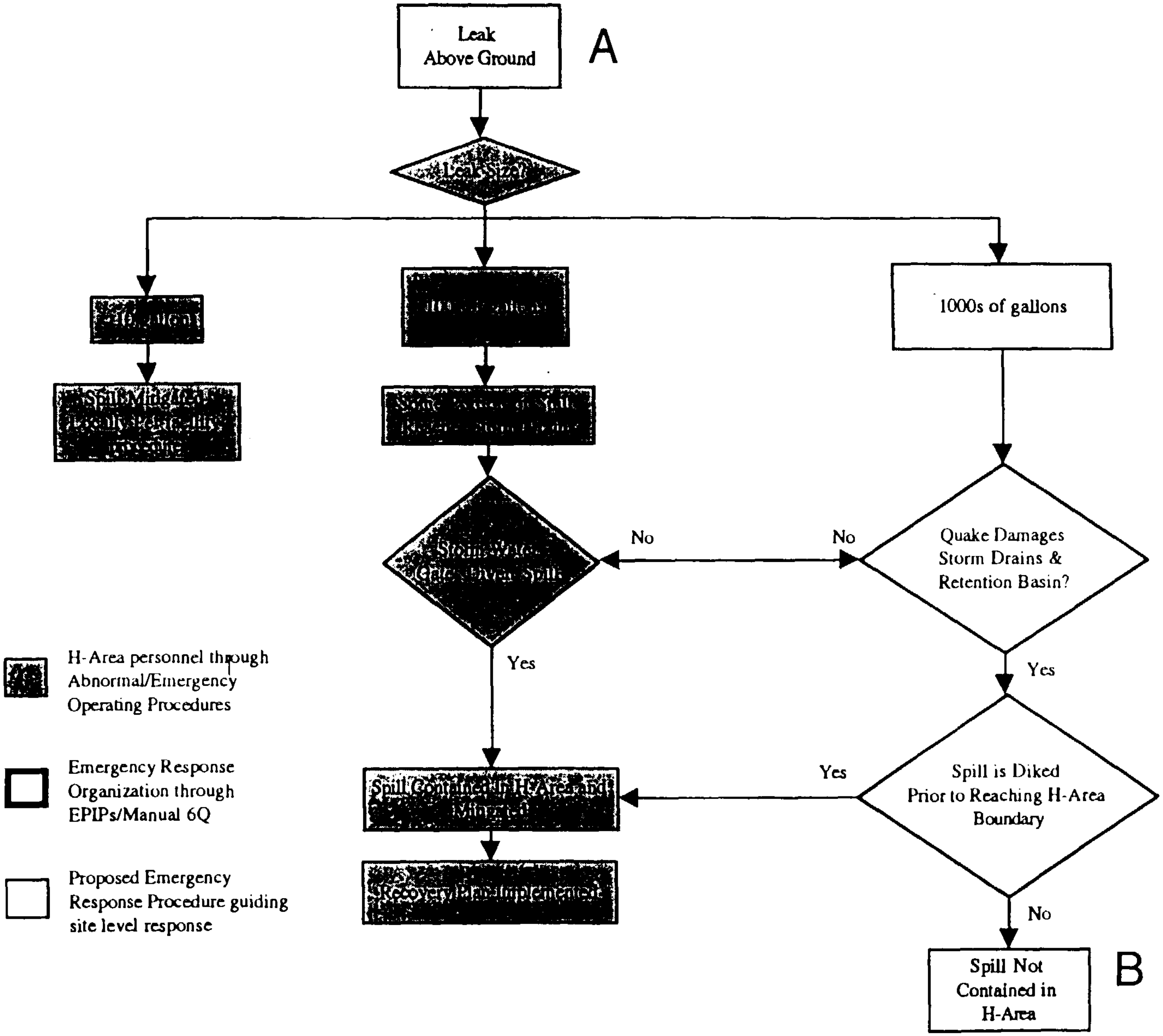
Figure 3: Mitigation and Remedial Actions (Specific Flowchart) Cont'd



9/29/95

Figure 3: Mitigation and Remedial Actions (Specific Flowchart) Cont'd

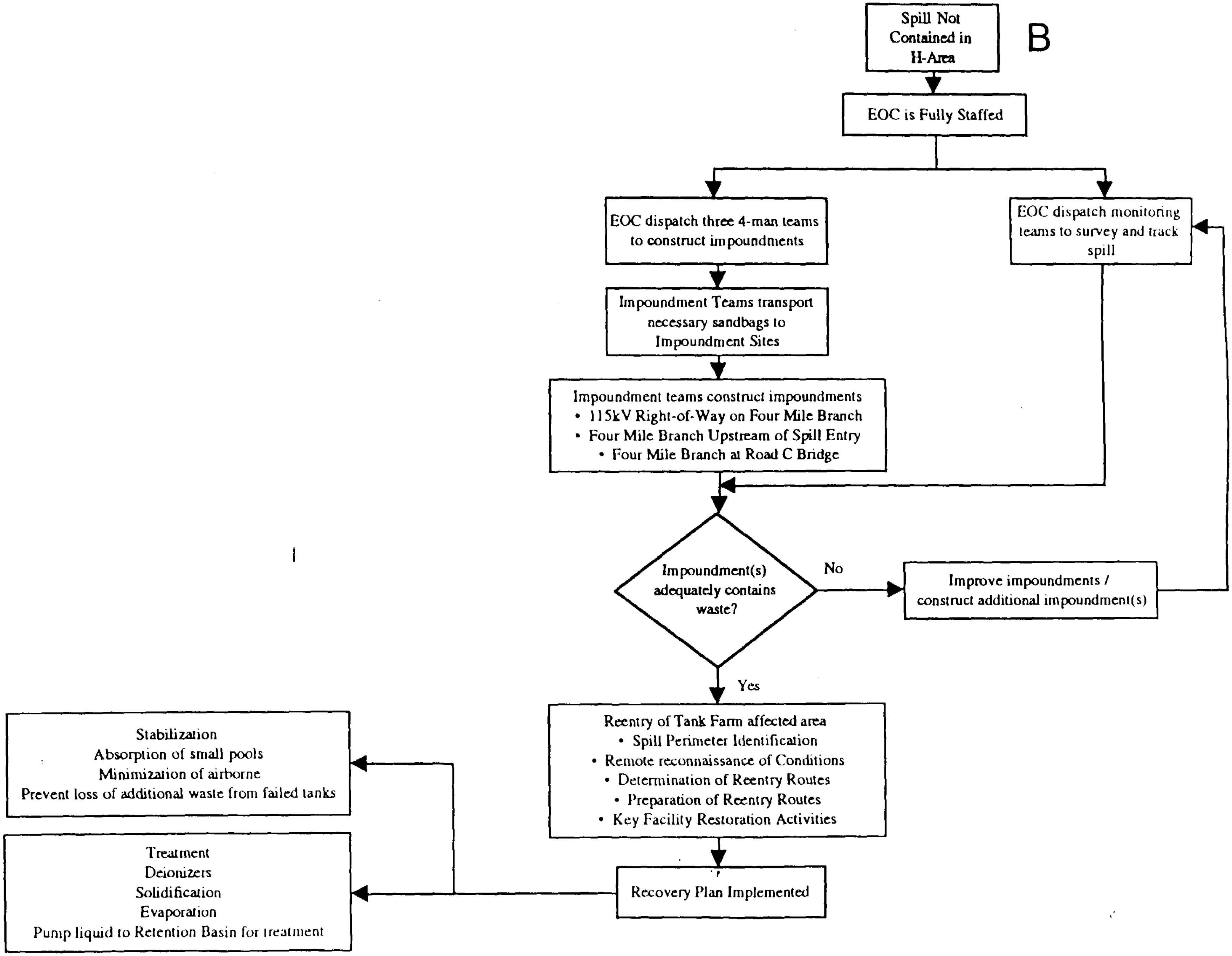


Figure 4: Area Reentry Following Large Radioactive Surface Spill

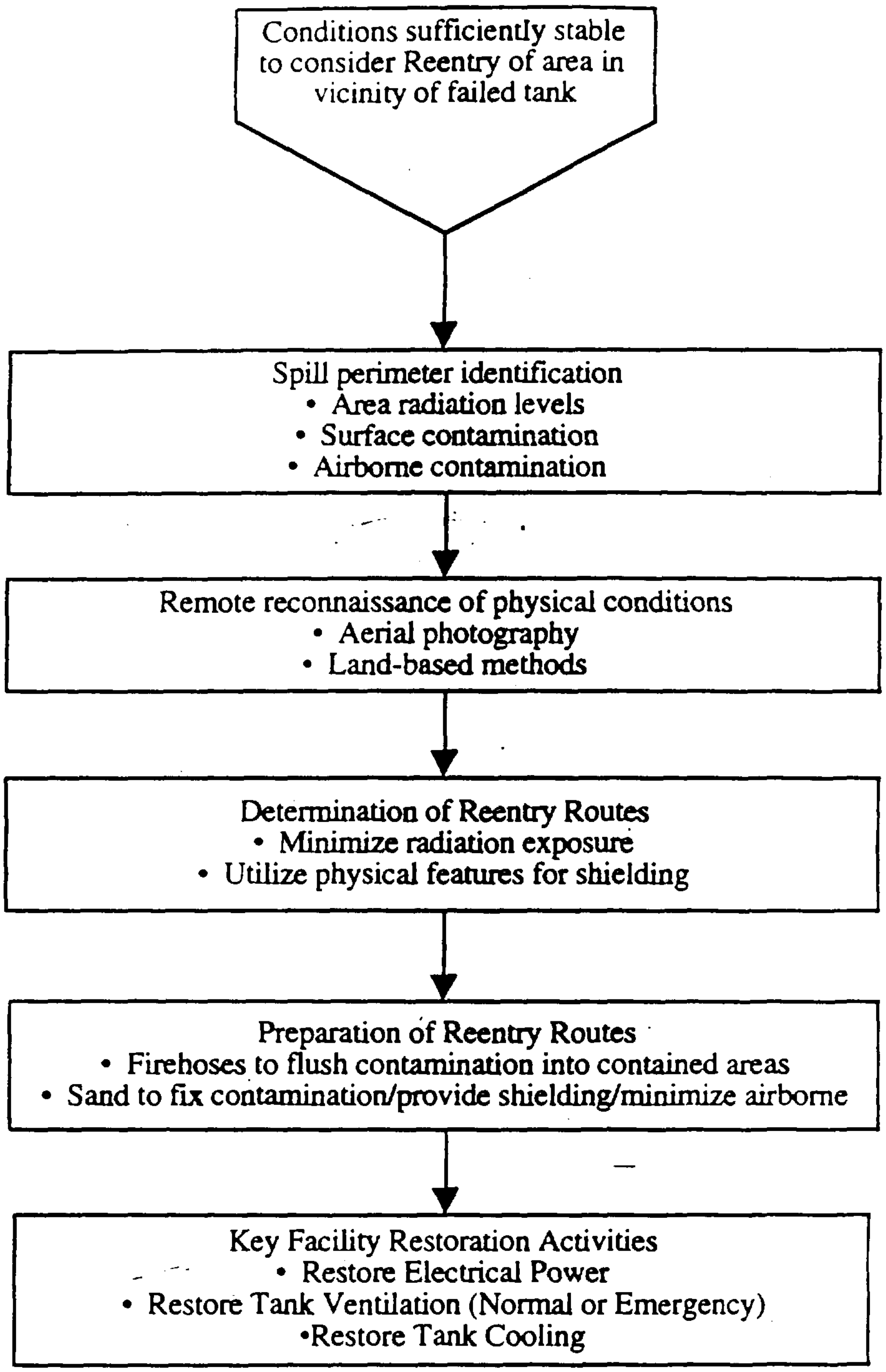
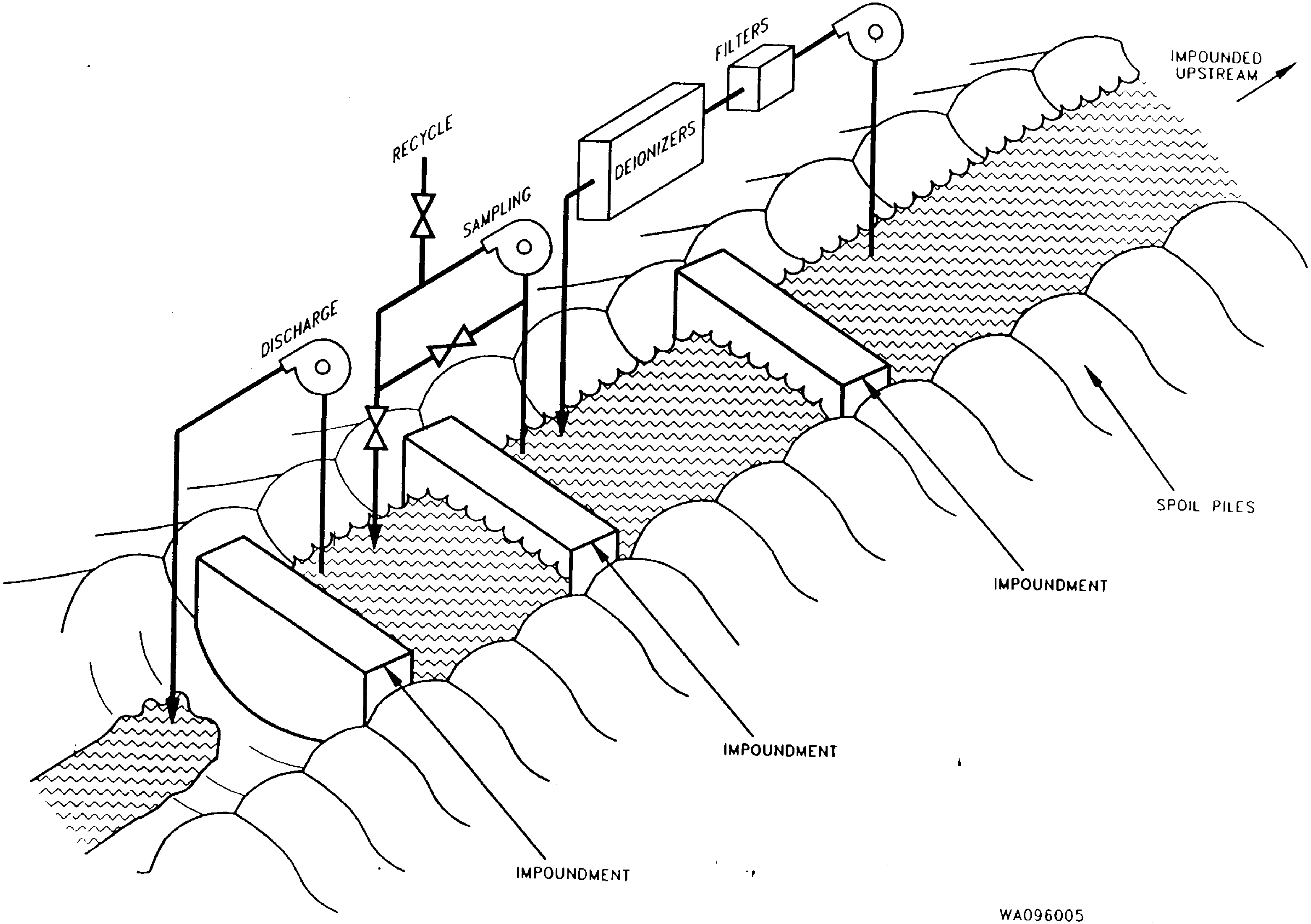


Figure 5: Example of Impounded Water Cleanup Measures



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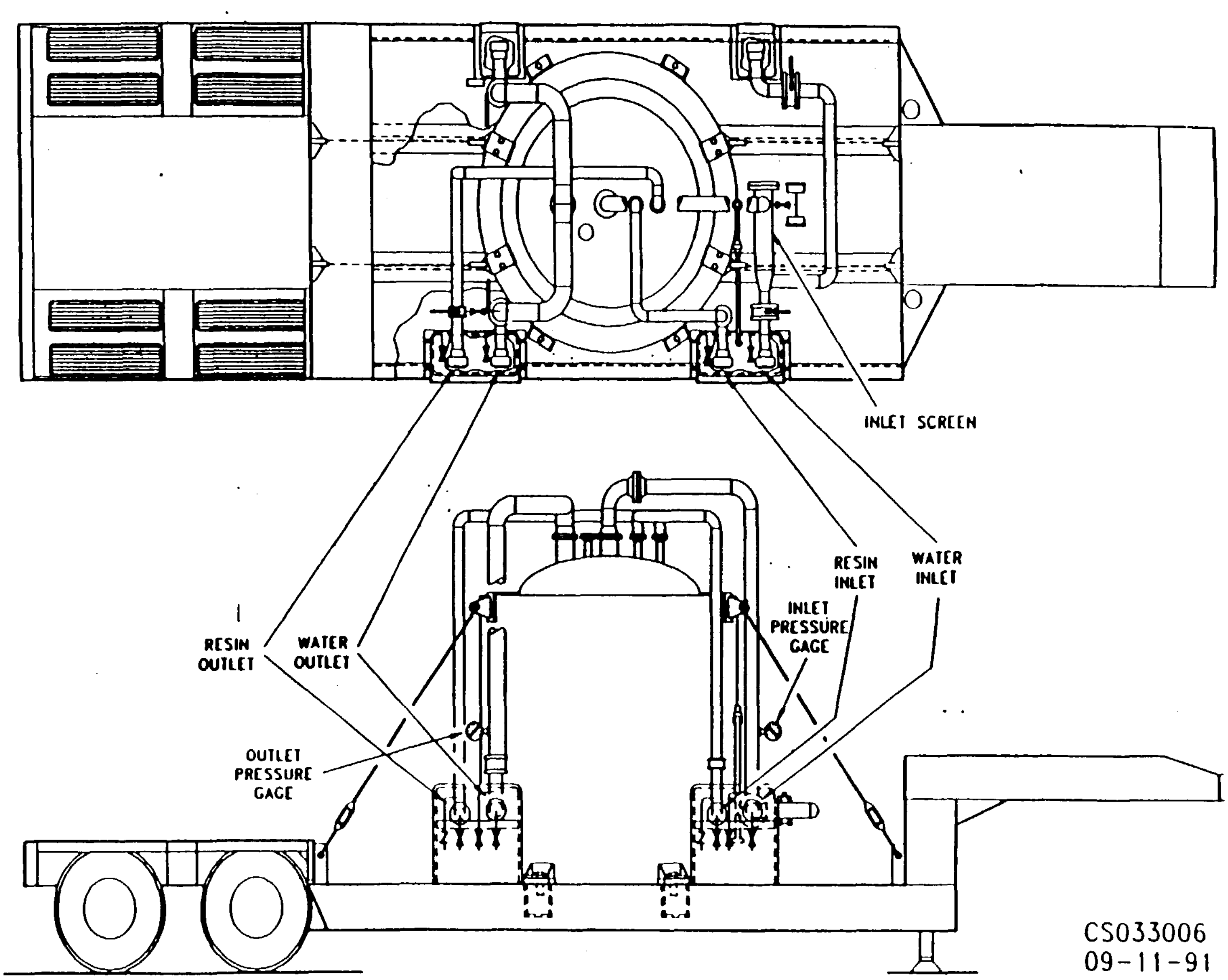
09-28-95

Figure 6: Typical Trailer-Mounted Deionizer Previously Used at SRS



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09-11-91

ENCLOSURE 2

Action Item	Resolution
1. A list of vendors who could provide equipment for mitigation or remediation of a larger radioactive spill will be prepared and provided to the Emergence Response Organization (ERO).	Completed: A list of Vendors for potential equipment and technologies that could be used in mitigation and remediation of large radioactive spills has been developed and is located in the Technical Support Room (TSR) HLW files in the Emergency Operations Center (EOC).
2. A plan will be developed to store the minimum amount of sandbags or other materials which could be used to mitigate the consequences of a surface spill. The plan will include a basis for the amount of stored materials, as well as storage location(s) and method of inventory. This information will be readily available to the ERO.	Completed: A Plan was developed based on tour of potential impoundment sites with spill team supervision (Central Services Works Engineering) and engineering estimates of holding capabilities. Approximately 100 sandbags and several thousand yards of crushed rock, clay, and dirt has been stored in N-Area (central site location). Also available in N-Area are two loaders for handling this material.
3. Develop a list of personnel needed at selected locations on site at minimum staffing level who could be requested to assist in mitigative actions outlined in the Plan.	Completed: Confirmed through the Emergency Duty Officer, HAZMAT team, and spill response team that sufficient personnel are on site to support mitigative actions until the on-call ERO Organization is activated via pager system. On-call personnel are required to respond within one hour. The ERO includes transportation and trucking personnel. A list of spill team personnel has been added to the ERO call-lists which are validated quarterly.
4. Emergency Plan Implementing Procedures (EPIPs) and Emergency Operating Procedures (EOPs) will be reviewed and/or revised to ensure that they contain adequate directions for mitigating surface or subsurface.	Completed: Existing EPIPs and EOPs used to notify applicable personnel, governments and agencies, and to mitigate the consequences of a large spill were reviewed and found to be technically adequate. Minor revisions to procedures Manual 2Q2 were made to ensure that proper direction is given, correct organizations are contacted and all procedures are correctly linked. These procedures included specific spill response procedures for the EDO, the HLW technical staff, and the HAZMAT team

Action Item	Resolution
5. Maps and photographs will be placed in the EOC to assist ERO personnel in identifying temporary impoundment sites and material storage locations.	Completed: Maps and photographs have been placed in the EOC/Technical Support Room to assist ERO personnel in identifying temporary impoundment sites and material storage locations.
6. Procedure revisions and improvements in emergency preparedness measures will be validated by an appropriate method (i.e., table-top drills, procedure walkdowns, or site exercises).	Completed: All procedures discussed in 4 above to address a large spill of radioactive waste have been approved and validated. These procedures were validated by walking through the bounding large spill scenario with EDOs, principals of the HAZMAT team, and supervisors of the spill response team as well as several members of the HLW ERO.
7. Personnel will be trained on procedure revisions and improvements in emergency preparedness measures.	Completed: All EDOs and key ERO personnel have completed the required training on mitigating large HLW spills including above and below ground spill scenarios, a large spill action matrix, locations of available equipment and potential impoundment sites, location of maps and photographs, location of vendor lists and spill containment technologies.