Accession #: D195064272

Document #: SD-WM-RPT-202

Title/Desc:

DST WASTE RETRIEVAL SURVEY PACKAGE

Pages: 32

DEC 01 1995 (21) Sta. 21

ENGINEERING DATA TRANSMITTAL

1. EDT 608977

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) 73530	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Waste Management	6. Cog. Engr.: E. J. Berglin	7. Purchase Order No.: N/A
8. Originator Remarks: Approval for release.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Desig-nator	(G) Reason for Trans-mittal	(H) Origi-nator Dispo-sition	(I) Receiv-er Dispo-sition
1	WHC-SD-WM-RPT-202		0	Double-shell Tank Waste Retrieval Survey Package	NA	2		

16. KEY

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

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

(G) Rea-son	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Rea-son	(H) Disp.
1	1	Cog.Eng. EJ Berglin	[signature]	11/30/95	H5-61	LB McDaniels			H5-61	3	
1	1	Cog. Mgr. DE Ball	[signature]	12/1/95	H5-61	DC Ramsower			H5-61	3	
		QA				JA Yount			H5-61	3	
		Safety				~~OSTI (2)~~			~~L8-07~~	3	
		Env.				Central Files (2)			~~L8-04~~ A3-88	3	
3		PW Gibbons			H5-61	Susan Nelson			G6-14	3	
1	1	DL Lamberd	[signature]	11/30/95	H5-61						

18. EJ Berglin [signature] 11/30/95 Signature of EDT Originator / Date	19. Authorized Representative for Receiving Organization / Date	20. DE Ball [signature] 12/1/95 Cognizant Manager / Date	21. DOE APPROVAL (if required) Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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

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

Double-Shell Tank Waste Retrieval Survey Package

E. J. Berglin
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 608977 UC: 721
Org Code: 73530 Charge Code: D2007
B&R Code: EW3130010 Total Pages: 30

Key Words: tank, vendor, DST, retrieval, double-shell

Abstract: Westinghouse Hanford Company is seeking industry solutions to underground double-shell tank waste retrieval at the Hanford Site located in southeastern Washington. This is not a request for proposals; it is a request for information to facilitate continued discussion. Westinghouse Hanford Company will not reimburse any costs incurred for providing the information requested.

OFFICIAL RELEASE (21)
BY WHC
DATE DEC 01 1995
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Karen G. Noland 12/1/95
Release Approval Date Release Stamp

Approved for Public Release

DOUBLE-SHELL TANK WASTE RETRIEVAL SURVEY PACKAGE

November 1995

Acquire Commercial Technology for Retrieval
Westinghouse Hanford Company
Richland, Washington

CONTENTS

LIST OF FIGURES

LIST OF TABLES

DOUBLE-SHELL TANK WASTE RETRIEVAL SURVEY PACKAGE

1.0 INTRODUCTION

Westinghouse Hanford Company (WHC) is seeking industry solutions to waste retrieval operations involving underground double-shell tanks (DST) at the Hanford Site located in southeastern Washington. This is not a request for proposals; it is a request for information to facilitate continued discussion. Westinghouse Hanford Company will not reimburse any costs incurred for providing the information requested.

The following is provided as a guide for those wishing to respond to this request for information.

Westinghouse Hanford Company is interested in innovative, commercially available or adaptable retrieval system equipment and concepts that will add to existing Hanford Site technology and significantly reduce cost and/or risk from the baseline retrieval approach. This approach uses in-tank mixer pumps to create a homogeneous mixture of supernate and sludges in the DSTs before pumping the waste to immobilization or waste consolidation functions. The objective of this request is to gather information from industry to identify and summarize a suite of retrieval-related components and systems. This information will be used to ensure that WHC understands the various waste retrieval alternative approaches, their risks, and their application on the Hanford Site tanks where current mixer pumps are not sufficiently effective, appropriate, or cost-effective. An additional objective is to facilitate industry's understanding of the tank and site interface requirements and operational scenarios for DST waste retrieval.

This effort will identify and summarize industry DST retrieval solutions by the end of December 1996 so that a clear basis for future retrieval program decisions can be established.

2.0 DISCUSSION

Westinghouse Hanford Company seeks a full range of technical solutions, including components, subsystems, and entire systems. Information is being requested from industry in two areas of interest:

1. Existing components or subsystems that can be integrated into a cost-effective or risk-reduced solution for existing DST system operations

2. Complete technical solutions (i.e., systems) for DST waste retrieval.

The retrieval solutions may range from existing equipment or concepts through complete designs generated by industry. The solutions should emphasize simplicity and ruggedness because low maintenance and high reliability are essential for cost-effective, long-term, radioactive waste retrieval operations. Proprietary designs and information will be treated accordingly.

Westinghouse Hanford Company may elect to, during this survey, contract for limited proof of principle testing, demonstrations, performance testing, simulation, and/or analysis of proposed equipment or systems, if the result would be a significant payback in reducing cost or technical risk. For example, a candidate waste removal process could be demonstrated using simulated DST waste if that system promises technical or cost improvement over the current mixer pump baseline. In this case, WHC and the commercial firm would develop test protocol, summarize the demonstration effort, collect and report performance or cost data, and make these data publicly available. On the other hand, completion of a design for a component or system would not be a candidate for WHC funding if there was not an obvious technical "breakthrough" to be gained, or if as a result of WHC funding the design work, the vendor would be precluded from competing for future retrieval work due to current procurement restrictions. Other funding sources that specifically target technology development may be identified for these instances.

A full range of solutions is sought, including enhancements that would make waste retrieval more effective. The ability to mix, retrieve, and transport heavy settled solids without dilution will reduce downstream costs of reconcentration through evaporation.

The emphasis of the solutions must be on lowering up-front and overall cost to the government. Ultimately, system simplicity and reduced life-cycle costs will be the overriding factors in selection of DST waste retrieval systems. Other important factors include the range of tank configurations and waste types that can be accommodated by the approach, and the amount of site preparation and operational support required.

Westinghouse Hanford Company has several projects underway to retrieve waste from DSTs using mixer and transfer pumps in a time-phased approach. The retrieval actions of current WHC projects are intended to suspend the settled sludges with the liquid in the DSTs into a homogeneous pumpable mixture to allow transport of the waste from the DSTs to other waste treatment operations like pretreatment, immobilization, consolidation, and concentration for eventual disposal of the waste. The intent of the current WHC projects is to use current technology available to the Hanford Site and not to choose a specific retrieval technology. These projects will include actual demonstration of some advanced processing technologies, such as in-tank sludge washing to reduce solid content in sludges to just insoluble solids.

3.0 BACKGROUND

Twenty-eight DSTs were constructed between 1968 and 1986 for waste storage and are the latest design in large underground storage tanks in use at the Hanford Site for radioactive waste accumulation and interim storage. These DSTs perform a similar function as the 133 single-shell tanks (SST) built between 1943 and 1964 for waste storage but have an additional liner (i.e., shell) to allow enhanced leakage detection and prevention of waste leakage into the ground and can store waste with higher levels of radioactivity. These DSTs are grouped into five tank farms in the 200 East Area (identified as AN, AP, AW, AY, and AZ) and one tank farm (identified as SY) in the 200 West Area of the Hanford Site. The maximum design storage capacity of each of these tanks is near 3.8 million L (1 million gal). The total capacity is approximately 117 million L (31 million gal).

The DSTs currently receive waste from various onsite sources and also store waste from past waste transfers; this results in tank levels and contents that are constantly changing. In November 1980, SSTs discontinued the practice of accepting new tank type waste generated on the Hanford Site and the DSTs have taken over this function. The limited total storage capacity of DSTs has required waste transfers out of and between DSTs to concentrate (primarily by evaporation) and consolidate compatible waste types. The DSTs will be used for interim SST waste storage during the closure and decommissioning of the SSTs. Waste is currently transferred in and out of the DSTs through a network of underground transfer lines in slurry form (5 wt% insoluble solids maximum). The DSTs are expected to be in operation for the next 30 years in support of tank waste disposal efforts.

Radioactive and chemical waste stored in the Hanford Site SSTs and DSTs are primarily by-products of processing spent nuclear fuel for the recovery of plutonium, uranium, and neptunium, the majority generated from four major chemical processing operations. Three of these processes, the bismuth phosphate, Reduction-Oxidation (REDOX), and Plutonium-Uranium Extraction (PUREX) Plant processes, were specifically designed for plutonium recovery. The more advanced REDOX and PUREX processes recovered the uranium as well as the plutonium. The fourth process, the tributyl phosphate process, was designed for the recovery of relatively large amounts of uranium that remained in the bismuth phosphate waste. These processing wastes, which contained most of the fission products and comparatively small quantities of uranium, plutonium, and other actinides, were originally stored as liquid wastes (with significant amounts of solids in the form of precipitated sludge) in the SSTs. These large-scale recovery processes have been shut down in the last 10 to 40 years and only the relatively small waste streams from other Hanford Site processing operations continue to generate waste which is now stored only in DSTs.

4.0 DST DESCRIPTIONS

The following information is intended as a summary of the Hanford Site DSTs. Figures 4-1 and 4-2 provide additional perspectives on the range of tank conditions. Tables 4-1 and 4-2 identify some of the operating functions and constraints needed to complete DST waste retrieval as they relate to existing tank and waste conditions. These tables help define the relative importance of each criterion by considering the number of applicable tanks, specific use, etc. Photographs and descriptions of Hanford Site tanks are located in the Appendix.

4.1 TANK CONFIGURATIONS, ACCESS, IN-TANK HARDWARE

The 28 DSTs at the Hanford Site are 23 m (75 ft) in diameter and range in height from 15.2 to 15.7 m (50 to 52 ft) at their highest points. Twenty-four of the DSTs have a capacity of 4.30 million L (1.16 million gal) with a maximum waste depth of 10.7 m (35 ft); the remaining four DSTs have a capacity of 3.785 million L (1 million gal) with a maximum waste depth of 9 m (30 ft). A total of 2 to 2.4 m (6 to 8 ft) of earth cover each tank at the centerline of the dome. The minimum headspace (dome top to maximum liquid level) on the tanks is about 4 m (12 ft). The basic shape of the tank interior and typical location relative to the ground level are shown in Figure 4-1.

All DST designs are similar (see Figures 4-1 and 4-2) with a reinforced concrete shell that is 0.5 m (1.5 ft) thick, a dome that is 0.4 m (1.25 ft) thick, and an insulated concrete base. A heat-treated, stress-relieved, primary steel liner is located inside the concrete shell and is 12.7 mm (0.5 in.) on the sides and bottom. A nonstress-relieved, secondary steel liner is located inside the concrete shell and covers the bottom and sides of the primary tank; it is 9.52 mm (0.38 in.) thick on the bottom and sides. The secondary liner location creates a 0.76-m (2.5-ft) annulus on the sides outside of the primary tank.

Presently, access to the tanks is provided by risers that penetrate the domes of the tanks extending above grade or slightly below grade in pits. Although riser quantity, size, and locations vary from tank to tank, the tanks were constructed with risers varying in size from 5 to 107 cm (2 to 42 in.) in diameter with 10, 30, and 107 cm (4, 12, and 42 in.) diameter being the most common. All tanks have a center or near center riser of at least 30 cm (12 in.) in diameter. The number of currently available risers ranges from 0 to 13, with the majority of tanks having 3 to 5 of the smaller sizes. Additional or larger risers could be installed at or near the center of each tank or in a clear part of the dome with an obvious cost penalty. In addition, a cost penalty also exists for clearing existing obstructed risers and pits because many of the risers contain pumps, instruments, or other equipment.

The retrieval system must either avoid, move, or work in the presence of in-tank hardware to retrieve the waste. Most all the in-tank hardware that would create an obstruction during retrieval operations is riser installed on the DSTs. The standard equipment associated with every DST is a slurry distributor, transfer pump, thermocouple tree, manual tape, and automatic

Figure 4-1. Typical Tank Sections.

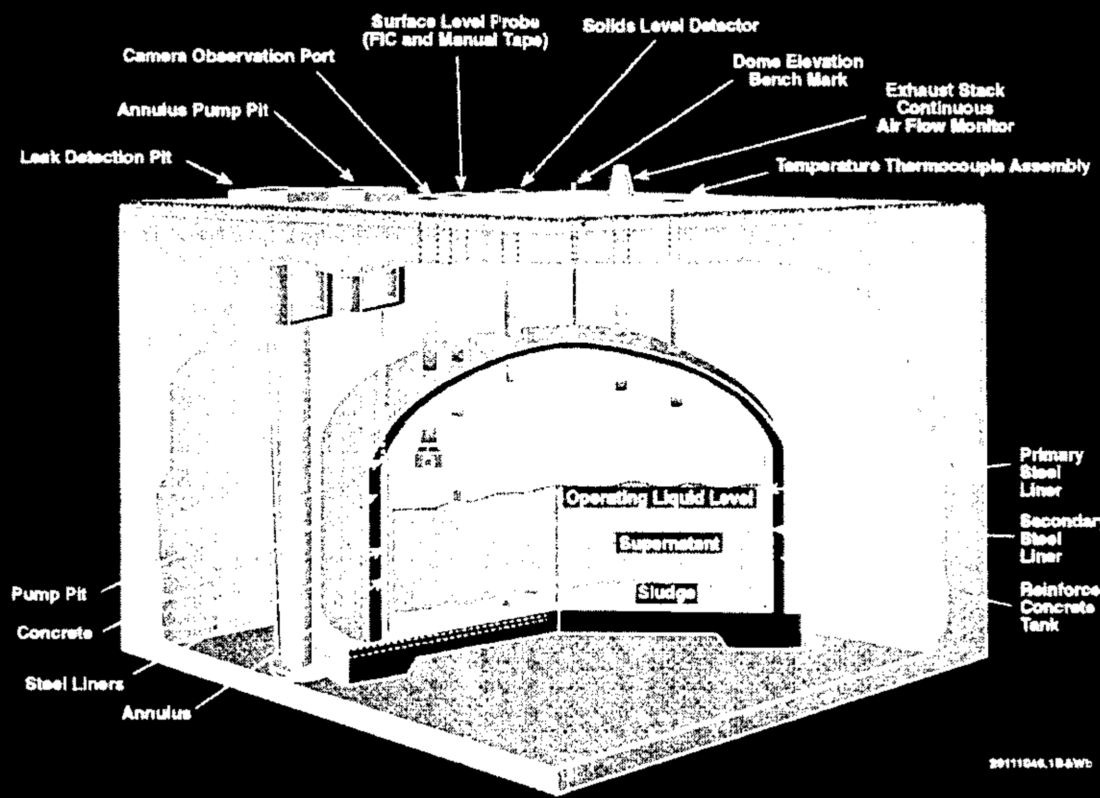
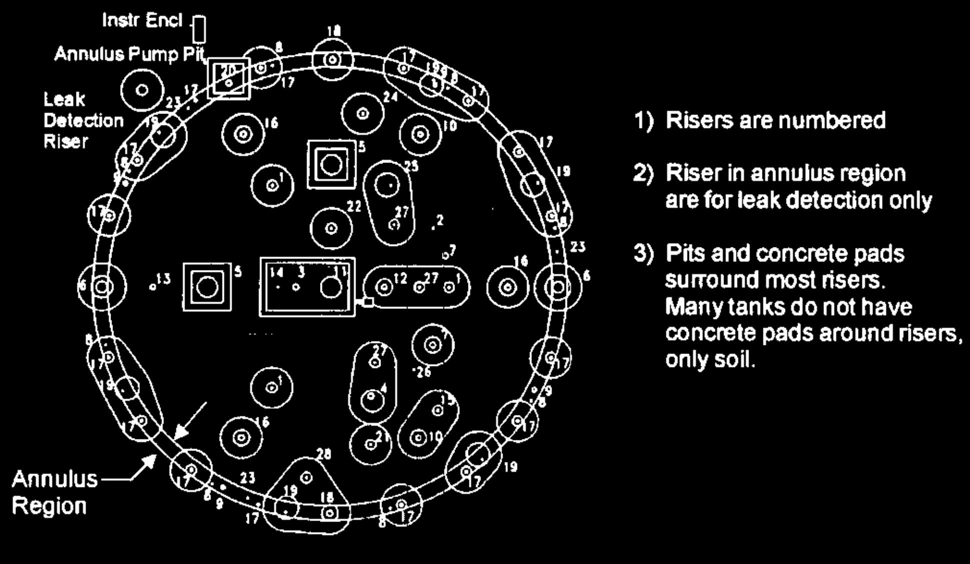
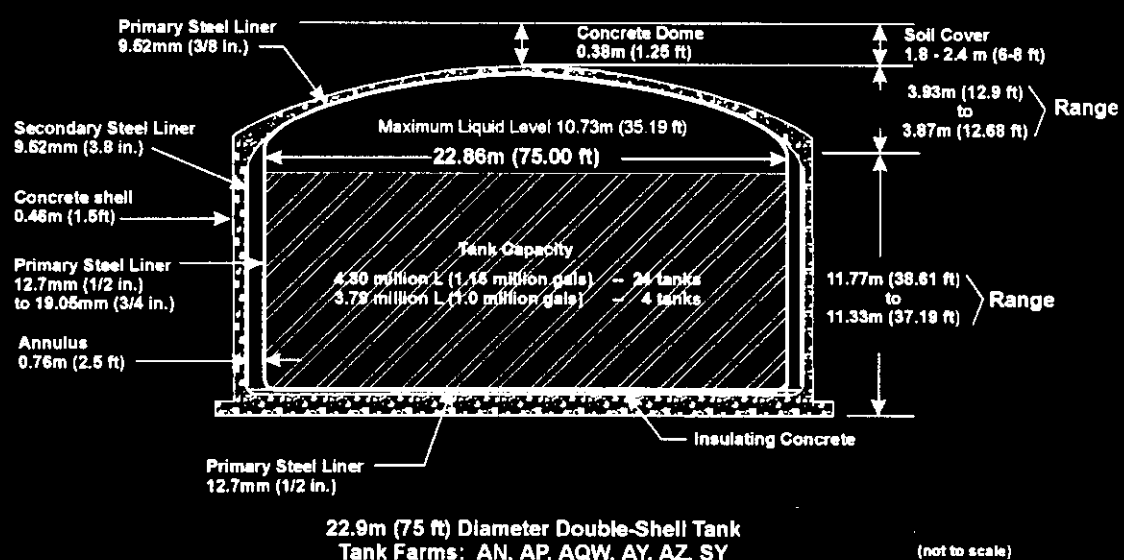


Figure 4-2. Typical Tank Construction and Dimensions (AP Tank Farm). Similar construction for other tanks; see Appendix Figure A-1 for AP Tank Farm aerial view.





Tank Cross-Section

Table 4-1. Operating Function Summary. (2 sheets)

Item no.	Operating function	Applicability [usage] (function)	Issue	Current Hanford Site technologies to meet application
A	Mobilize Waste	Most tanks, currently 16 [medium] (tank reuse)	Tank waste mixtures that have settled (i.e., sludges and salt cake) need to be mobilized with the supernatant into a pumpable slurry. This is primarily to allow the waste mixture to be available for pumping out of the tank for processing but secondarily can be used to allow soluble waste trapped in the sludge layers to return to solution. Some waste residual is acceptable in this case because new waste transfers mixed with the residual are compatible. Residuals <10% of total tank volume are desired.	Mixer pumps are used to aggressively stir waste into a slurry mix. The mixer pump jets located near the bottom of the tank typically rotate and sweep the tank floor and entrain the soft sludge with the tank liquid into a slurry. Water lancing and sluicing are other mobilization methods used.
A.1	Mobilize Soft Waste	Most tanks, currently 16 [medium high] (tank reuse)	Soft waste (i.e., sludges) settled in the tank needs to be mobilized with the supernatant to form a pumpable slurry.	Mixer pumps generally can mobilize soft waste.
A.2	Mobilize Hard Waste	Some tanks [low] (tank reuse)	Hard waste (i.e., agglomerated sludges and hard salt cake) settled in the tank needs to be mobilized with the supernatant to form a pumpable slurry.	Mixer pumps are generally ineffective in mobilizing hard waste.
A.3	Mobilize/ Dissolve Salt Cake	Some tanks, currently 6 [medium] (tank reuse)	Salt cake forming in the tank needs to be dissolved into liquid form to allow pumping of salt as a soluble solution. Fast dissolving rates may be desirable.	Sluicing, water lancing, and raising tank liquid level to submerge salt cake are methods used to mobilize/dissolve the salt cake; these dissolving methods can be slow.

Table 4-1. Operating Function Summary. (2 sheets)

Item no.	Operating function	Applicability [usage] (function)	Issue	Current Hanford Site technologies to meet application
B	Maintain Homogenous Waste Mixture	All tanks [very high] (tank reuse)	Tank waste mixtures that have a potential for settling (e.g., mobilized solid slurries) need to be maintained as a pumpable slurry. This is primarily to allow the waste mixture to be available for pumping out of the tank for processing. Maintaining the waste mixture as a homogenous slurry is most desirable. Slurries in the tank are typically generated from waste mobilization or transfer operations.	Mixer pumps are used to periodically agitate the liquid/ slurry to maintain solids suspension. Airlift circulators force air to the bottom of the tank and the air rising through the waste provides some mixing.
C	Transfer Waste	All tanks [high] (tank reuse)	Tank waste needs to be removed from the tank for processing or concentration. Some waste residual left in the tank is acceptable in this case because new waste transfers mixed with the waste residual left are compatible. Residuals <2% of the total tank volume are desired. Maximum solids slurry concentration is 5 wt% for transfer line pumping.	Transfer pumps are used to remove waste liquids and slurries. Two types of transfer pumps are used: a submersible and/or a suction. Mobilization operations create pumpable slurry mixtures of soft, hard, and salt cake waste.
D	Remove All Waste	Few tanks [low] (tank clean out)	Tank waste needs to be removed from the tank to allow the tank to be used for waste that is incompatible with the former waste. Waste to be removed would consist of liquid (supernatant and slurry) and solids (soft/hard sludges and salt cake). Only very low waste residual concentrations are allowed because of waste incompatibilities. A total waste residual of <0.05% of the total tank volume may be required.	None. Current transfer pump requires a minimum head which leaves 25 to 38 cm (10 to 15 in.) of standing liquid. A combination of waste mobilization, pumping, and dilution could possibly be used with tanks that can be fully mobilized.

Table 4-2. Operating Constraints Summary. (4 sheets)

Item no.	Operating constraint	Applicability	Issue	Information useful for evaluation
1	Operate Remotely In-tank	All tanks	The hazardous nature of the tank waste requires remote in-tank equipment operation to minimize personnel exposure.	Equipment operation description and sketch.
2	Operate in Radiation Environment	All tanks	Waste creates a radioactive environment for in-tank equipment operation. Radiation levels as high as 500 R/h can be expected in the waste, 500 R/h in the waste head space, and a maximum of 0.5 mrem/h at the surface with a closed riser. NOTE: Radiation-hardened equipment is not always required.	Radiation limitations of equipment (i.e., levels, time, etc.).
3	Operate in Caustic Environment	All tanks	All tank waste is adjusted to maintain a caustic environment of 12+ pH to avoid tank corrosion of carbon steel. A more precise definition of caustic requirement is 0.01 M free hydroxide [OH^-]. In-tank equipment should be designed to operate over a pH range of 7.0 to 14.0.	pH operation range of equipment.
4	Operate with Abrasive Waste	Most tanks	Some fraction of the waste material in the tanks can be abrasive which may cause in-tank equipment wear or failure of components. Miller numbers of ≤50 per ASTM G75-1989* have been estimated. Solid size may range from 1 to 1,000 µm.	Effects of abrasive waste on equipment components.
5	Operate with Viscous Waste	Most tanks	Some fraction of the waste material in the tanks can be viscous which may limit equipment operations. It is estimated that the viscosity of the waste may range from 1 to 500 cP, the yield stress from 0 to 200 dynes/cm^2, and the specific gravity from 1.0 to 1.7. Sludge compaction of up to 40 wt% of insoluble solids has been measured.	Viscosity range of equipment operation.

Table 4-2. Operating Constraints Summary. (4 sheets)

Item no.	Operating constraint	Applicability	Issue	Information useful for evaluation
6a	Operate in Lower In-tank Temperature Range	Most tanks, 24	In-tank equipment must operate at the elevated temperatures of the waste tank. Tank waste temperatures may range from 2 to 110 °C (35 to 230 °F).	Equipment temperature range for operation; static (non-operating) range is also desirable.
6b	Operate in Higher In-tank Temperature Range	Few tanks, 4	The 4 aging waste tanks have higher in-tank temperature for equipment operation than other DSTs. Tank waste temperatures may range from 2 to 177 °C (35 to 350 °F).	
7	Minimize Heat Generation	Some tanks (potentially all tanks)	Equipment operating in a waste tank must not add more heat than the tank was designed to dissipate; total heat load is a summation of the waste heat load and equipment load. The waste specific heat may range from 0.5 to 1 Btu/lbm.	Heat load generation of equipment dissipated inside the tank.
8a	Operate in Congested Tank	Some tanks, 3 to 8	Some tanks are quite congested with 10 to 30 items hanging vertically from the tank dome and most extending down close to the bottom of the tank; the DST in-tank equipment will need to operate around these constraints. The aging waste tanks have up to 27 airlift circulators which are approximately 15.2 cm (6 in.) in diameter and extend the full length of the tank.	Loads applied to in-tank components from equipment operation.
8b	Operate in Relatively Uncongested Tank	Most tanks, 20 to 25	Most tanks are relatively uncongested with less than ten items hanging vertically from the tank dome and some extending down close to the bottom of the tank (such as a transfer pump); the DST in-tank equipment will need to operate around these constraints.	

Table 4-2. Operating Constraints Summary. (4 sheets)

Item no.	Operating constraint	Applicability	Issue	Information useful for evaluation
9	Operate for a Long Life (High Reliability and Low Maintenance)	All tanks	The DST equipment is expected to be available for operation during the 10- to 30-year lifetime of the DSTs. Most equipment is not expected to operate continuously during this DST operational life, and the current specification for mixer pumps is a total minimum operation time of 5,000 hours. High reliability and low maintenance are major factors in DST equipment selection.	Information supporting high reliability, long life, and low-maintenance operation.
10	Operate in Tank with Loose Items	All tanks	Loose items that are not part of the tank waste could be encountered in the tank and are typically, but not limited to, things that have been dropped in or fallen off like tools, steel tapes, and even entire transfer pumps; DST in-tank equipment will need to operate in this environment. NOTE: Retrieval of loose items is not a planned task in DST operations.	Discussion of equipment protection from loose items in waste.
11	Operate in Flammable Environment	Some tanks, 6 currently (potentially all tanks)	Current Watch List DSTs have the potential for hydrogen or flammable gas accumulation above the flammability limit. Future transfers of waste from SSTs could increase the number of tanks that have flammability limits. In-tank DST equipment operations for these tanks are required to meet the requirements of the National Electrical Code, Class 1, Division 1, Group B.	Safety features of in-tank equipment for flammable environments.
12	Operate within Tank Load Restriction Limitations	All tanks	All tanks have design load limitations. The tank dome design limitations for equipment installation are currently limited to 90,700 kg (100 tons) of which 45,400 kg (50 tons) are reserved for temporary loads and 45,400 kg (50 tons) for permanent loads. Currently there may be only 9,100 to 45,400 kg (10 to 50 tons) available for permanently installed equipment. Tank risers generally are not loaded but isolated by a bellows connection.	Load of permanently installed equipment on tank dome.

Table 4-2. Operating Constraints Summary. (4 sheets)

Item no.	Operating constraint	Applicability	Issue	Information useful for evaluation
13	Operate within Tank Environmental Restrictions	All tanks	All tanks have environmental limitations within which in-tank equipment must operate. The tank maximum hydrostatic head ranges from 925 to 1,057 cm (364 to 416 in.) at a specific gravity of 2. Vapor space minimum pressure ranges from ≥-1 to -1.5 kPa (-4 to -6 in. of water) to maintain confinement.	Maximum hydrostatic head equipment operation.
14	Insert Equipment into Tank Filled with Waste	Potentially all tanks	All tanks have a potential to be completely full during their operation cycle; this results in a minimum headspace of around 3.7 m (12 ft). In general, the top surface is liquid; however, a potential exists for soft sludges or salt cake to be at the tank waste surface. Double-shell tank equipment may be required to interface with soft solids during insertion into the DST or require a preinsertion operation like water lancing to loosen up the solid.	Equipment procedures and operational requirements for insertion into sludge or salt cake solids.
15a	Access Through 30-cm (12-in.) Riser	All tanks	This riser size is in the medium range of the tank riser size spectrum. It is more likely that a riser of this size can be found in a location on the tank dome and is available for use. Risers are not always straight and a 2.5 cm (1 in.) undersize is recommended.	Maximum outside diameter of equipment inserted through riser.
15b	Access Through 107-cm (42-in.) Riser	All tanks	This riser size in the largest available on the tank. In general, three of these risers are on the DSTs with one located at or near the center and the other two nearer the tank walls. Risers are not always straight and a 2.5 cm (1 in.) undersize is recommended.	

*ASTM, 1989, *Test Method for Slurry Abrasivity by Miller Number and Slurry Abrasion Response of Materials (SAR Number)*, ASTM G75-1989, American Society for Testing and Materials, Philadelphia, Pennsylvania.

DST = Double-shell tank

SST = Single-shell tank

level gauge. Airlift circulators are located in some tanks and hang from risers located at the tank dome to near the bottom of the tank. At least three and perhaps as many as five DSTs are extremely congested with six pieces of equipment as well as at least 21 airlift circulators. Another six tanks are moderately congested with closer to ten pieces of equipment. The remaining tanks are relatively uncongested and have approximately six pieces of equipment. All tanks have loose material that has been discarded in the tanks. This material includes, but is not limited to, tools, steel tapes, and even entire transfer pumps.

4.2 WASTE

The majority of the wastes stored in DSTs was generated by chemical processing operations. Other wastes were sent to the DSTs in smaller volumes, and these include research and development program wastes, facility and equipment decontamination wastes, laboratory wastes, and Plutonium Finishing Plant wastes. The majority of future waste transfers into the DSTs is expected to come from SST retrieval efforts. In summary, DST waste can consist of any of the current DST waste streams as well as all waste components of the SSTs.

Subsequent waste management operations have created a complex intermingling of the tank wastes. In addition, natural processes have caused settling, stratification, and segregation of waste components. As a result, it is difficult, if not impossible, to precisely estimate the character of the wastes contained in the DSTs from existing operational records.

The DSTs contain three general waste types: sludge, salt cake, and liquid. Sludge consists of the solids (hydrous metal oxides) precipitated from the neutralization of acid wastes before their transfer to the DSTs. Salt cake consists of the various salts formed after the evaporation of water from the neutralized alkaline waste. Liquids exist as supernatant and interstitial liquid in the settled waste. These waste types do not necessarily exist as discrete layers, but are intermingled to different degrees. Sludges and salt cake may contain interstitial liquids and be relatively soft. Other salt cakes and sludges may be drier and harder as a result of agglomeration. Sludge, salt cake, and liquid are thus used as general descriptions and classification of a waste as one waste form; however, this does not imply that the waste does not contain any of the other waste forms.

The chemical constituents of the DST wastes consist primarily of sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate, and phosphate; and hydrous oxides of iron and manganese. The radioactive components consist primarily of heat-producing fission product radionuclides such as ^{90}Sr and ^{137}Cs, and actinide elements including uranium, plutonium, and americium and various relatively short-lived radioisotopes such as ^{106}Rh, ^{60}Co, and ^{125}Sb. These solid wastes (salt cake and sludge, with nondrainable interstitial liquid) vary considerably in physical consistency as well as in chemical and radionuclide content, not only from tank to tank, but within a tank as well.

Dose rate estimates for the different tanks vary from 0.1 to 5 Gy/h (10 to 500 R/h) at the waste surface. Higher doses are expected below the waste surface. The dose at >1 m (3 ft) from the surface is expected to be less than half of the surface reading. A dose level of several hundred R/h is a nominal expected range for most DSTs.

Not all SSTs or DSTs have been sampled to determine physical characteristics; some that have been sampled have only had supernate samples taken because of the additional cost and complexity of sludge sampling. General constraints from the waste that are applicable to waste retrieval equipment and hardware operations are found in Table 4-2.

4.3 TANK RETRIEVAL OPERATIONS

The primary function of the DST operations is to store waste while awaiting downstream waste processing functions like immobilization. A retrieval operation is necessary to move the waste from the DSTs to these downstream processes. The current Hanford Site scheme for this operation is to mobilize the settled solids in the tank into a homogenous slurry which then can be pumped from the tank through transfer lines to these other processes. Creating a pumpable slurry (maximum of 5 wt% insoluble solids) may require the addition of liquids which can result in increased downstream cost because of the need for increased storage capacity and/or the need to remove the added liquid in downstream processing. Minimizing tank waste volume and heat increases is an important consideration of <u>all</u> retrieval processes. New and different approaches to solving the DST waste retrieval issues are encouraged, if they are cost-effective.

Double-shell tank retrieval has two operational requirements:

- Tank reuse - Interim storage of waste from SSTs, waste storage for current Hanford Site operations, or partially processed waste awaiting the final process of immobilization

- Tank clean out - Tank clean out may be required for tank reuse when a tank needs to be refilled with waste that is incompatible with the former waste in the tank.

Settling has occurred in DSTs because slurry transferred to the DSTs has had time to settle out and no agitation has been provided to keep these slurries in suspension. A DST retrieval process is needed that can create and maintain a homogenous liquid or slurry state within the tank.

The limited capacity of the DSTs has required frequent decanting operations by pumping the supernatant out of the tank to evaporators to reduce the water content (i.e., water volume). Changes in water content have caused soluble solids to come out of solution and settle on the bottom or the liquid surface as sludge or salt cake. In addition, soluble solids have intermingled with insoluble solids on the bottom of the tank in the sludge and this has kept these soluble solids from returning to solution. A DST retrieval process is needed to return all soluble solids into solution.

A major problem with the DST operations is dealing with insoluble solids; these solids can never be made to go into solution and are primarily transuranic and fissile materials. In addition, these insoluble solids are generally thermally hot and if left in the tank by themselves may exceed the heat load on the tanks. As stated earlier, insoluble solids have settled to the bottom of some DSTs and trapped some of the soluble solids. A DST retrieval process is needed that provides a method of removing the insoluble solids from the tank.

Waste tanks were constructed at the Hanford Site to store and segregate the waste. One reason for waste segregation is to minimize cross-contamination of different waste types which increases the cost of disposal. Double-shell tank operations may require use of a tank for waste transfers that formerly held an incompatible waste type with the waste being transferred. Tank waste retrieval as high as 99.95% of total tank volume (0.05% waste residual left) may be required to minimize cross-contamination affects. A DST retrieval process is needed to provide a method of cleaning out a DST. This process would allow new waste transfers of any waste type into the cleaned tank without cross-contamination from any residual waste left from the cleaning process.

Westinghouse Hanford Company is looking for methods/technologies to solve each of the operational functions shown in Table 4-1. Included in that table are the function, estimated number of DSTs to which this function would be applied, reason this function is needed, and technologies that the Hanford Site is currently applying to solve these functions. Operational constraints are shown in Table 4-2 and must be addressed with each operational function in Table 4-1.

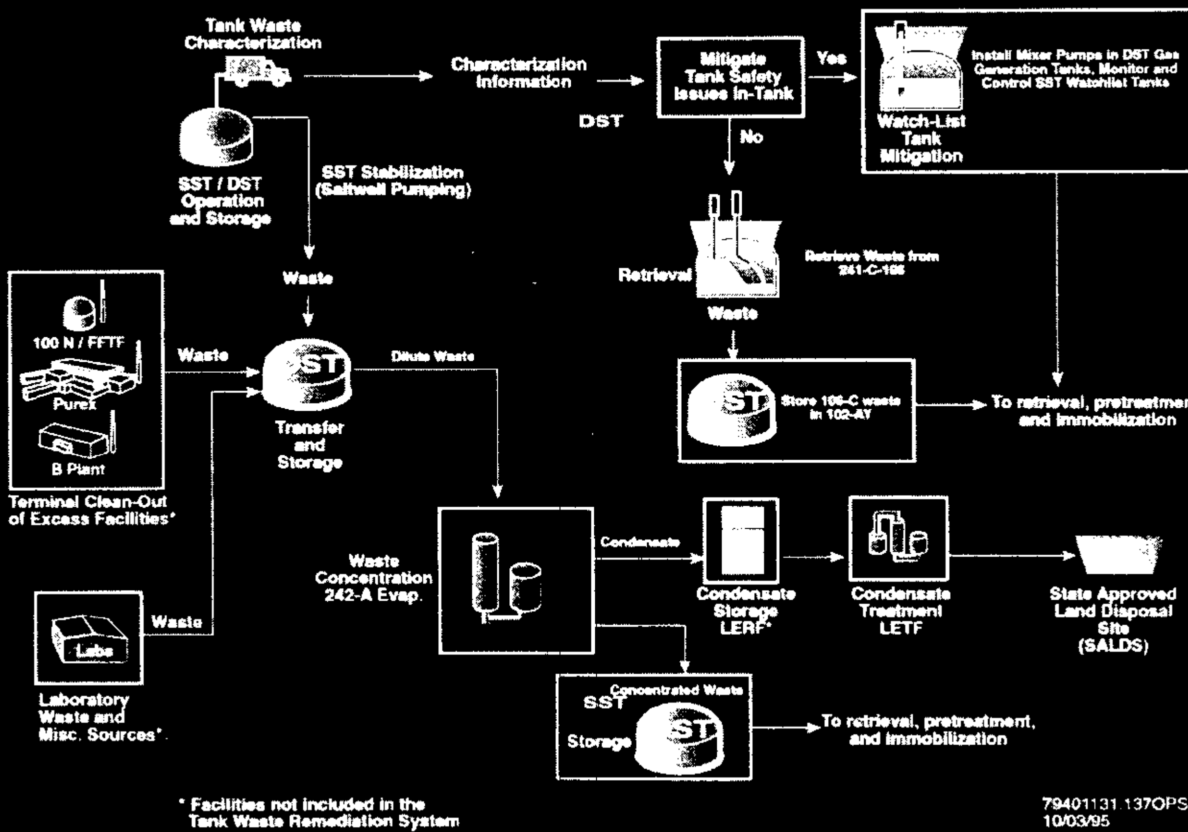
4.4 CURRENT HANFORD SITE TECHNOLOGIES AND PLANNING FOR DST RETRIEVAL

The approaches and planning for Hanford Site DST retrieval are presented to give a perspective of how the Hanford Site is addressing some of the retrieval functions. This discussion is not intended to guide the DST retrieval functions down a specific path, but to present equipment and approaches being used as <u>one</u> approach to solve some of the retrieval functions. Some general functions of the DST retrieval management and operations effort are shown in Figure 4-3.

There is presently no system in place that can remove the settled solids from the DSTs. Transfer pumps available in all tanks allow pumping of liquids only. Two types of transfer pumps are used for liquid removal: submersible and suction. Current transfer pumps have had failures and in some cases their structures are not strong enough to withstand new loads from the mixer pump jets.

The general scheme for DST retrieval of settled solids is to first make all waste contents of the tank into a homogenous mixture by dissolving soluble solids and suspending insoluble solids in the supernatant by agitation; this agitation is done using large mixer pumps. These mixer

Figure 4-3. Manage Double-Shell Tank Waste System.



pumps, in general, have an inlet close to the bottom of the tank and discharge two opposing rotating jet streams near the bottom of the tank in a sweeping action. This sweeping action of the jets is intended to break up the bottom sludge layer and keep the heavier particles in suspension. For thick sludge layers, the mixer pump may need to be incrementally lowered into the sludge and agitation performed to get the pump to the bottom of the tank. Past mixer pump performance at similar sites around the country has experienced early failures primarily in the seal area. Westinghouse Hanford Company has projects to install some modified mixer pumps into the DSTs and monitor their operation and success. An advanced design mixer pump development effort is underway to develop a high-reliability pump based on "lessons learned" from past designs and an extensive testing effort.

Sonic probe is another equipment design that could replace or supplement the same function as the mixer pumps. The sonic probe is expected to reduce the shear strength of the sludge material by vibration and allow pumping of the solids with the installed transfer pump.

Sluicing has been used in past retrieval operations, primary in SSTs, to remove the harder sludge materials. This process shoots a high-velocity stream of liquid at the hard materials to break them up. Use of this method in SSTs has been limited in some cases because the introduction of liquid into leaking SSTs is undesirable; this is not expected to be a constraint on DSTs. Schemes for dissolving the salt cake layer on the surface have included water sprays by sprinkler action on the surface, and localized spraying with water lances.

In-tank sludge washing is a processing scheme that is planned to demonstrate removal of the soluble solids trapped in the bottom sludges of the tank. A mixer pump will be used to agitate the sludge and expose the soluble solids to the tank supernatant and allow it to return to solution. This is expected to minimize the solids content of the tank to only insoluble solids.

Waste retrieval of the DSTs with mixer pumps is planned in two stages: initial waste retrieval from each DST and then subsequent waste storage of other waste. The mixer pumps are expected to leave some residual solids (i.e., heel) at the bottom of the tank. For most waste retrieval applications, this residual is expected to be acceptable because new transfers of wastes compatible with the residual can be dealt with through operational routing of waste. The Hanford Site lacks the capability at this time to retrieve waste from DSTs to a proposed cleanliness criteria of 99.95% by volume to allow reuse of any DST with any waste form.

The DSTs have a total storage capacity of 117,335,000 L (31 million gal). Although waste transfers to/from DSTs change the tank waste volumes continuously, the current inventory (in March 1995) was 61,317,000 L (16.2 million gal) of supernatant, 7,570,000 L (2.0 million gal) of slurry, 7,570,000 L (2.0 million gal) of sludge, and 3,028,000 L (0.8 million gal) of salt cake. The salt cake and sludge contain 1,414,000 L (0.4 million gal) of drainable interstitial liquid. Evaporator operations continue to reduce the liquid content occasionally as waste transfers from other sources require added liquid in the transfer operations through the transfer lines by pumping.

4.5 GENERAL NOTES, CURRENT LIMITATIONS, AND UNCERTAINTIES

- Requirements for additional risers and extensive site preparation should be minimized; however, the addition of access risers of various sizes is allowed, and may actually prove to be cost-effective in some system configurations.

- The design of waste material-handling equipment can be based on the properties of nonradioactive waste simulants, which were developed based on actual tank waste samples, as well as historical data. These recipes are available upon request from WHC.

- Undetermined downstream process requirements for initial pretreatment of waste before immobilization, and the following low- and high-level waste immobilization feed requirements, may impact the retrieved DST waste feed quantity and quality requirements. The current method for immobilization of both low- and high-level waste is the vitrification process (i.e., encapsulation of waste into glass).

- Environmental, occupational radiological exposure, safety, and quality assurance considerations will be significant factors in the DST waste retrieval system design, development, and demonstration. Control of potential radioactive and hazardous emissions to the environment and personnel radiological exposure are of utmost importance.

5.0 VENDOR RESPONSE GUIDANCE

Westinghouse Hanford Company's review will be streamlined if the information provided follows the format presented in this section. It is not necessary to address all aspects of this outline; it is presented for general guidance only.

Please consider your information as an opening for further discussion, rather than a final submittal. Westinghouse Hanford Company can supply additional information, if needed. Westinghouse Hanford Company may also respond with questions and comments should your information be unclear or if WHC is interested in more detail. You are free to update or revise your information, if you choose. Please indicate which information is proprietary, and WHC will treat it accordingly.

5.1 GENERAL INFORMATION

5.1.1 Company Name

5.1.2 Primary Contact (Include Name, Title, Telephone Number, Facsimile Number, and Electronic Mail Address)

5.2 DESCRIPTION

Provide the following information for each submittal (there may be more than one per company or team).

5.2.1 Title (Include a Few Words that will Distinguish your Effort from Similar Submittals)

5.2.2 Equipment or Systems

Discuss your equipment or system. Responses should be brief and may include brochures, concept sketches, and/or drawings. Describe the application of your equipment or system for retrieving the waste from the tanks, e.g., mobilizing the waste in the tank, removing the waste from the tank, or transporting the waste once it is outside the tank. Describe the approach taken for accessing the tanks and considerations of hole size and location that are important to your equipment or system. Describe the approach taken for control and monitoring of your equipment or system. Include your approach to operator interface with, and control of, the equipment or system.

5.3 APPLICABILITY

Using Tables 4-1 and 4-2, indicate which operating attributes and tank configurations you think can be addressed by your proposed component or system.

5.4 TECHNICAL MATURITY

Describe the maturity of the approach (equipment exists, needs to be adapted, or concept only). Where has your equipment been used? If a concept, what work remains to prove the concept? Describe any technical risks and the actions necessary/information needed to resolve those risks.

5.5 DEMONSTRATION, SIMULATION, AND TESTING

Describe tests, demonstrations, or simulations that could help resolve the risks you have previously described. Describe any cost sharing, the use of existing equipment, or other approaches that would reduce cost or improve results.

5.6 SITING

Describe buildings, support structures, and utility requirements for your equipment or system.

5.7 COMPANY/TEAM EXPERIENCE

Describe any experience in providing equipment or systems that were designed for operation in a radioactive environment. Has your company had experience designing, building, and operating equipment to be used in a radiation environment? If so, describe the application.

5.8 ROUGH ORDER OF MAGNITUDE COST ESTIMATE

What is the "off-the-shelf" cost or price for your equipment or system? If possible, provide a rough order of magnitude (+/- 50%) planning estimate for adaption of your equipment or system for retrieval of waste from tanks at the Hanford Site, and describe what is included in the estimate.

6.0 REFERENCES

ASTM, 1989, *Test Method for Slurry Abrasivity by Miller Number and Slurry Abrasion Response of Materials (SAR Number)*, ASTM G75-1989, American Society for Testing and Materials, Philadelphia, Pennsylvania.

APPENDIX

PHOTOGRAPHS AND DESCRIPTIONS OF HANFORD SITE TANKS

LIST OF FIGURES

APPENDIX
PHOTOGRAPHS AND DESCRIPTIONS OF HANFORD SITE TANKS

The following narrative describes the photographs in this appendix.

Figure A-1. AP Tank Farm, Aerial View

The eight AP Tank Farm tanks, 241-AP-101 through 241-AP-108, are shown. The tank number is centered on each tank. Tank risers and associated concrete pads and/or valve pits can seen. Not all tanks have this many risers in concrete pads and/or valve pits but the tank layout is fairly typical for a double-shell tank.

Figure A-2. Tank 241-AN-103, Detail of Relatively Uncongested Tank

Tank 241-AN-103 is typical of a relatively uncongested double-shell tank and has a high level of concentrated supernatant solids (0.9 Mgal). The minimum equipment associated with every double-shell tank is a slurry distributor, transfer pump, thermocouple tree, manual tape, and automatic level gauge.

Figure A-3. Tank 241-AZ-101, Detail of Congested Tank

Tank 241-AZ-101 is typical of a congested double-shell tank. This tank has more instruments and auxiliary equipment than other waste storage tanks because it is one of the four double-shell tanks containing aging waste. Monitoring instruments identified in this picture include three temperature probes, four level probes, and three drywell pumps. The tank contains airlift circulators, heating coils, drains, risers, and ports.

Figure A-1. AP Tank Farm, Aerial View.

Figure A-2. Tank 241-AN-103, Detail of Relatively Uncongested Tank.

Figure A-3. Tank 241-AZ-101, Detail of Congested Tank.