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ENGINEERING CHANGE NOTICE

1. ECN 163262

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. D. C. Pfluger, 7E650, H5-52, 376-6164		4. Date 09/19/94
	5. Project Title/No./Work Order No. TWRS/N1C3A	6. Bldg./Sys./Fac. No. 241-G	7. Impact Level N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-AP-019, Rev. 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

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[] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	N/A	N/A Cog. Engineer Signature & Date	N/A Cog. Engineer Signature & Date

12. Description of Change

Entire document rewrite.

13a. Justification (mark one)	Criteria Change []	Design Improvement []	Environmental []
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13b. Justification Details

14. Distribution (include name, MSIN, and no. of copies)

See attached distribution list.

RELEASE STAMP

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DATE SEP 30 1994
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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 163262

15. Design Verification Required	16. Cost Impact		17. Schedule Impact (days)
	ENGINEERING	CONSTRUCTION	
[] Yes	Additional [] $	Additional [] $	Improvement []
[X] No	Savings [] $	Savings [] $	Delay []

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. D. C. Pfluger *DCPfluger*	9/22/94	PE	
Cog. Mgr. K. V. Scott *KVScott*	9/29/94	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other		Other	
Tank Waste Remediation System C. W. Dunbar *[signature] for*			
Facilities Operations R. E. Raymond *[signature]*	9/29/94		
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-AP-019, REV. 1
Document Title:	Double-Shell Tank Ultrasonic Inspection Plan
Release Date:	9/30/94

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

APPROVED FOR PUBLIC RELEASE

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WHC Information Release Administration Specialist:

N. L. Solis N.L. SOLIS
(Signature)

9/30/94
(Date)

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SUPPORTING DOCUMENT

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6. Author

Name: D. C. Pfluger

Signature DC Pfluger

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7. Abstract

This document describes those activities that are necessary to conduct an ultrasonic inspection of the primary and secondary tank walls of a double-shell tank.

9. Impact Level N/A

10. RELEASE STAMP

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Double-Shell Tank Ultrasonic Inspection Plan

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CONTENTS

DOUBLE-SHELL TANK ULTRASONIC INSPECTION PLAN

1.0 INTRODUCTION

The waste tank systems managed by the Tank Waste Remediation System Division of Westinghouse Hanford Company includes 28 large underground double-shell tanks (DST) used for storing hazardous radioactive waste. The ultrasonic (UT) inspection of these tanks is part of their required integrity assessment (WAC 1993) as described in the tank systems integrity assessment program plan (IAPP) (Pfluger 1994a) submitted to the Ecology Department of the State of Washington. Because these tanks hold radioactive waste and are located underground, examinations and inspections must be done remotely from the tank annuli with specially designed equipment.

This document describes the UT inspection system (DSTI system), the qualification of the equipment and procedures, field inspection readiness, DST inspections, and post-inspection activities. Although some of the equipment required development, the UT inspection technology itself is the commercially proven and available *projection image scanning technique (P-scan)*. The final design verification of the DSTI system will be a performance test in the Hanford DST annulus mockup that includes the demonstration of detecting and sizing corrosion-induced flaws.

Details of the DST design, materials, and fabrication that are of particular interest to this UT inspection plan are included as Appendix A.

The DSTI system is designed to provide real-time inspection data on both the primary and secondary tanks from within the annulus region of the DSTs. Although the P-scan portion of the DSTI system is readily available, the delivery system is unique to this project and has required significant design effort. A description of the ten major subsystems is included as Appendix B.

The basis for a DST inspection sampling plan and the six tanks to be inspected is included as Appendix C.

A list of acronym definitions for this document is contained in Section 8.0.

2.0 BACKGROUND

The 28 DSTs used to store liquid waste at Hanford are located in six tank farms and were constructed and put into service between 1968 and 1986. All of these tanks are essentially of the same design and each tank has a storage capacity of about one-million gallons. Because earlier stored waste had leaked as a result of corrosion of the carbon steel tanks at the Savannah River Plant (SRP) (Poe 1974), precautions were taken for the DSTs. The primary tank that holds the stored waste was protected against corrosion by a full stress-relief heat treatment after all welding and by maintaining controlled levels of corrosion inhibitors in the stored waste (Kirch 1984). There have been no known leaks from the 28 Hanford DSTs.

Recent corrosion assessments of the DSTs (Schwenk 1992 and Leach 1993) have postulated that the DSTs could be corroding in spite of the low residual welding stresses and the presence of corrosion inhibitors. The regions of principal concern to these authors are the vapor phase, waterline and splash-zone, sludge-liquid interface, bottom knuckle area, and tank bottom. The weldments in these regions are of particular concern because of weld zone failures found by the SRP tank failure analysis[1] (Poe 1974) and in subsequent laboratory testing at both SRP and Hanford.

A procurement contract has been issued to Raytheon Engineers and Constructors (Raytheon) to deliver a fully operational DSTI system and complete the initial inspection of the DSTs. Figure 2.1 is a schematic of this inspection system deployed in a DST annulus. The system is being completed for delivery in The first quarter of calendar year 1995. A full-scale mockup of the DST annulus region was fabricated by WHC for a performance test of the DSTI system and the demonstration of detecting and measuring corrosion-induced flaws.

3.0 SCOPE AND OBJECTIVES

This inspection plan is to document the requirements for demonstrating the readiness of the DSTI system and procedures, completing the field inspection readiness activities, inspecting the DSTs, and completing the post-inspection activities.

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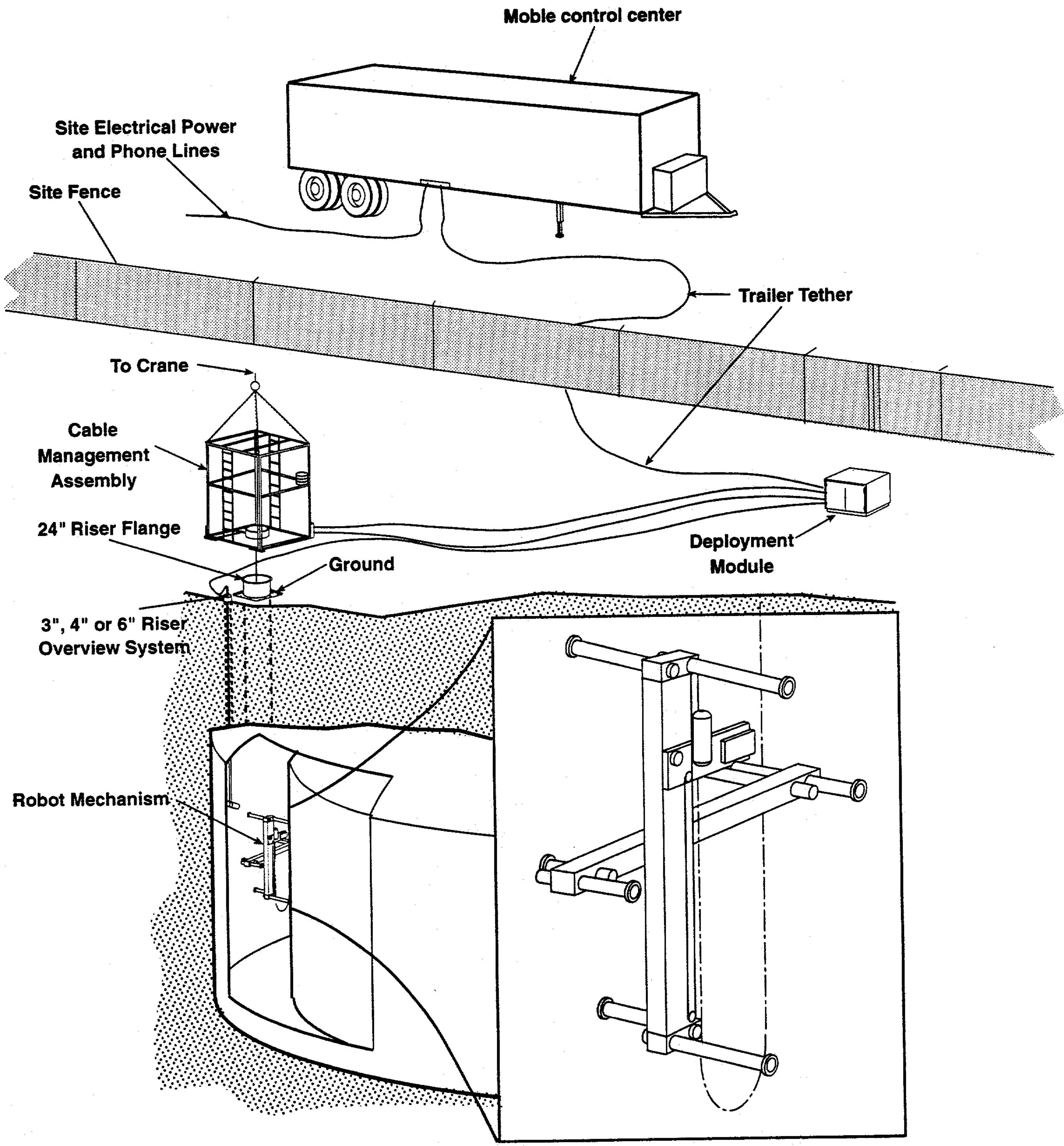
[1]These welds had not been stress relieved after welding.

Figure 2.1 Double-Shell Ultrasonic Inspection System (DSTI System).



4.0 INSPECTION PLAN REQUIREMENTS

4.1 QUALIFICATION OF EQUIPMENT AND PROCEDURES

The final design verification for the DSTI system will be a performance test to assess the system's conformance to the specification requirements (Pfluger 1993) and to demonstrate that the system/procedures/operators can detect and measure corrosion-induced flaws and wall thinning from the DST annulus during remote operation.

A quality assurance (QA) and configuration management plan (Pfluger 1994b) becomes effective at the onset of the performance test. This plan defines hardware and software baselines[2], controls any changes thereto, and provides necessary reviews and verifications. In addition, QA controls and change controls are to be exercised by the vendor (Raytheon).

There are two QA reviews associated with the performance test: a pretest review; and a post-test review of the results against the performance specification. These reviews are outlined in Sections 3.3 and 3.4 of the QA and configuration management plan.

A technical review of the performance test results will form the basis for a release of the DSTI system to inspect the DSTs.

<u>Performance Test.</u> The performance test will be conducted on the Hanford DST annulus mockup with the inspection robot (DSTI robot) operated remotely from the DSTI system's mobile control center. The performance test will follow a procedure, issued by WHC, that will implement data sheets to ensure that each feature of the DSTI system is adequately tested and that the test data are properly recorded.

The DSTI system's capability to detect and measure flaws and wall thinning in carbon steel plate will be demonstrated. Several carbon steel plate samples containing testing areas (i.e., performance grading units) with flaws will be prepared and characterized as well as defect-free testing areas (i.e., blank grading units). Some plate samples will contain corrosion-induced flaws and others will contain machined flaws that simulate corrosion pitting.

Details on the performance demonstration samples, their deployment in the mockup facility, and the pass/fail criteria will be included in the performance test procedure.

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[2]The technical baseline is the defined, approved configuration used as a reference for project planning purposes and as a point of reference for change control. The technical baseline and approved changes constitute the current configuration.

Performance Test Report. This report will cover all aspects of the DSTI system to make the technical review easier. Much of this report is expected to be data sheets provided by the performance test procedure and filled out and signed by the test engineers during the performance testing. The following subjects will be covered:

- Camera systems
  - Overview system
  - Lighting
  - Video cameras and VCRs
- DSTI systems
  - Hardware and power supplies
  - Software and procedures
  - Deployment and retrieval
  - Failsafe robot recovery
  - Navigation
  - LAN communications
  - Excessive adjustments and unexpected wear or damage
- Cleaning
  - Tank wall and air flow slot
- Inspection
  - Inspection procedures
  - Couplant adequacy and required volume
  - Inspection coverage and transducers - tank wall and air flow slots
  - Calibrations
  - Data presentation, analysis, recording, and storage/retrieval

4.2 FIELD INSPECTION READINESS

The items discussed below are either already in place or will be in place before actual tank inspections can begin.

4.2.1 Training Requirements

Raytheon UT inspectors must be certified Level II inspectors and have additional specialized training at Raytheon and at the Hanford DST mockup. All personnel shall have a minimum of 40 hours training in the setup, use, and maintenance of the P-scan hardware and software.

Robot Operational Training. Robot operators shall have had at least 40 hours of training in the operation of the DST inspection robot (DSTI robot).

Camera System Operator Training. Personnel operating the camera systems shall have specific training in operation of all cameras. Personnel performing visual examination shall have specific training in surface preparation requirements for UT inspection.

UT Operator and Analyst Training. Personnel performing UT inspections shall be certified to a minimum of Level II UT in accordance with SNT-TC-1A (ASNT 1984) and to the Electric Power Research Institute's IGSCC flaw detection and sizing criteria. In addition, they shall demonstrate the ability to detect and size flaws in the performance demonstration portion of the DSTI system performance testing as detailed in Section 4.1 above.

4.2.2 Quality Assurance and Data Management

Quality Assurance. There are several QA and software documentation reviews that are to be completed prior to tank inspections. These are described in Section 3.4 of the QA and configuration management plan.

UT Data Management. WHC will issue a data management plan to ensure that all meaningful inspection information is available for presentation, storage, and retrieval. The plan describes the policies, procedural systems, and storage requirements necessary to ensure that data are accessible, traceable, and qualified to provide a basis for decisions.

4.2.3 Safety and Readiness Assessments

Unreviewed Safety Question (USQ) Screening. The hazards associated with the deployment and operation of the DSTI system will be evaluated and compared against existing DST hazards already analyzed. The evaluation includes (1) the probability of an accident, (2) the consequences of an accident, (3) the probability of a malfunction of existing equipment, (4) the probability of accidents or equipment malfunctions different from those already analyzed, and (5) a review of the margin of safety.

Operation Readiness Assessment. The readiness assessment will be performed following concurrence by DOE-RL on scope and depth.

4.2.4 UT Data Resolution and Acceptance Criteria

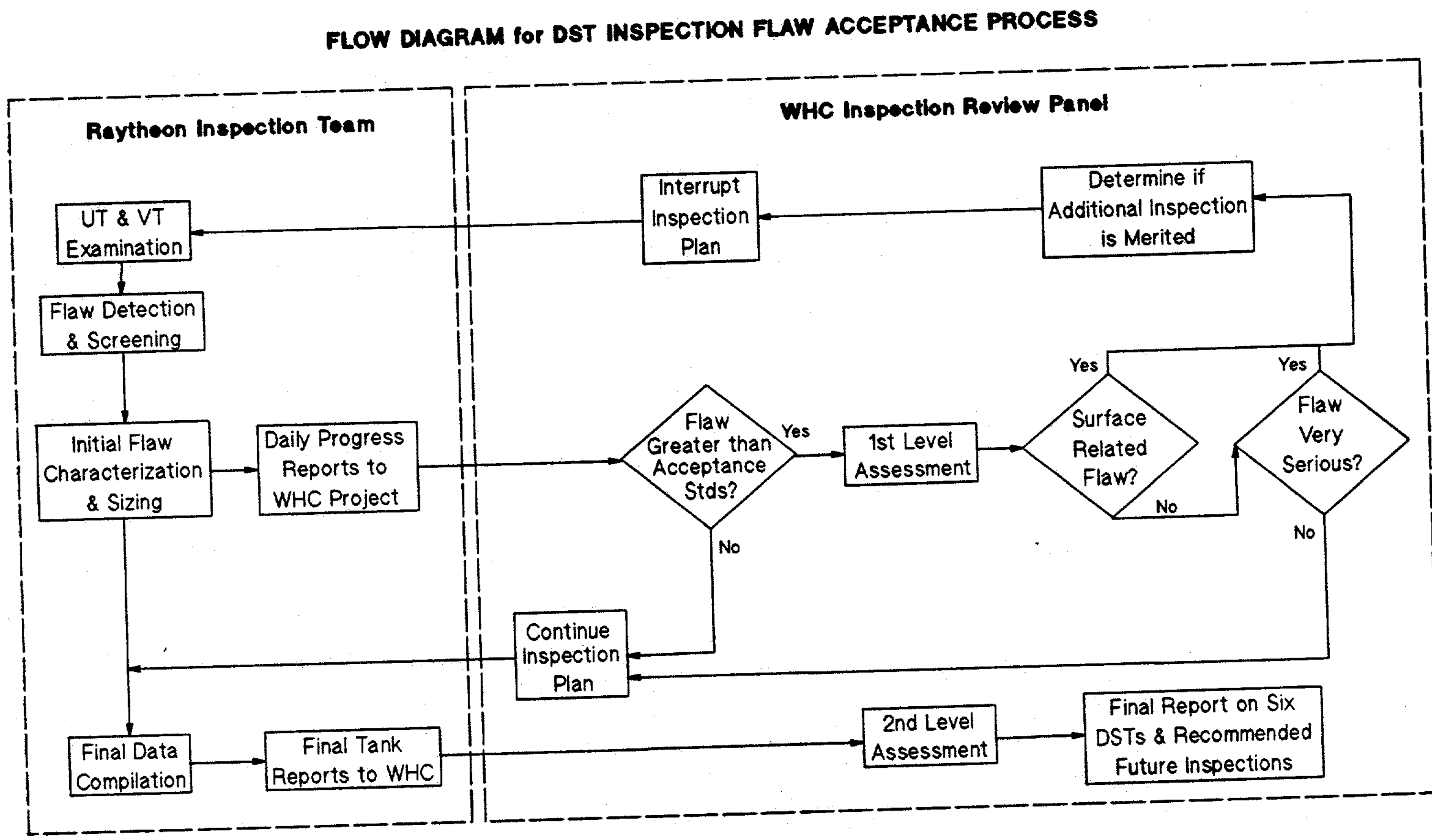
Inspection Review Panel. A three-member WHC Inspection Review Panel will be formed for these DST inspections. The qualifications are as follows:

1. An expert in structural safety analysis.
2. An expert in structural fracture analysis.
3. An expert in interpreting UT inspection results.

These individuals should be familiar with Section XI of the ASME Code. An optional fourth panel member is an expert on the DSTI system. Alternate members may be designated to assure continuous coverage. This panel will provide guidance for the inspections in the event that significant corrosion is found and will be responsible for accepting all final UT data reports for the DSTs. The panel will provide a fit-for-service disposition for each inspected DST.

UT Data Process. Figure 4.1 contains a flow chart showing the systematic process to be followed in categorizing and reporting "findings" and in formulating decisions about tank acceptance. WHC and Raytheon responsibilities are delineated in the figure.

Figure 4.1 Flow Diagram for Flaw Acceptance.



Definitions:

Inspection Review Panel: A three-member panel of WHC experts to remain on-call during any DST inspection activities. One panel member will be designated for each day to review any daily report findings that exceed the established acceptance standards. The entire panel will meet to evaluate each final tank inspection report, or as needed for daily reports.

1st level assessment: At least one member of the panel will review any flaws greater than the acceptance standard. The decision will be to; 1) proceed with the inspection plan, 2) stop inspections, or 3) change the inspection plan for this tank. The full panel will be convened as required.

2nd level assessment: The full panel together with any required expert assistance will review each final tank inspection report. The panel is required to accept the report, define additional inspections to be completed right away, and schedule all future inspections for the tank.

The Level II UT inspector will size and characterize any flaws found during inspection. Raytheon data analysts will make the initial acceptance determination by comparing the flaws to the criteria in the WHC flaw acceptance document. This document, which will account for location, orientation, and severity, is to be issued by WHC before the DST inspections begin. The Raytheon analysts then will report as "acceptable" those flaws that do not exceed the criteria.

Any flaws failing to meet the acceptance criteria will be passed on to the WHC panel for disposition. The panel will recommend to WHC management any analyses, further inspections, or other actions needed for continued use of the tank for waste storage.

WHC Flaw Acceptance Document. The report will be issued to set limits and establish criteria for UT inspection data. It will constitute the basis for flaw acceptance for UT inspections.

The report is to contain calculations of critical sizes and stresses for inner and outer surface flaws and through-wall cracks that might lead to unstable fracture. These calculations will be based on a review of the fracture mechanics methods and data used in earlier calculations (Shurrab, et al. 1991) and a compilation of existing information on the DSTs and material properties including fracture data.

4.2.5 Work Package

A work package must be completed and signed-off before any inspection equipment is inserted into a tank riser. The work package will include at least the following:

- General description of inspections
- List of tanks to be inspected and inspection sequence
- List of equipment required (Vendor & WHC)
- List of personnel required (Vendor & WHC)
- Work procedures (including inspection procedures)
- Personnel duties and responsibilities
- List of applicable documents
- Site support requirements.

4.3 DOUBLE-SHELL TANK INSPECTIONS

Initial DST inspections will be conducted on six tanks as listed in the IAPP and in Appendix C. The inspections will be conducted by Raytheon personnel using procedures approved by WHC. Deployment operations (except insertion) will be performed by WHC.

Raytheon will provide calibration standards and perform the calibration of the DSTI system.

Raytheon will gather, analyze, and present the UT data. Actual tank acceptance will be a WHC responsibility.

Raytheon will be the custodian of the DSTI system until all reports on the initial tank inspections have been completed and accepted.

4.3.1 Inspection Coverage for Each Tank

A separate inspection coverage document will be issued by WHC detailing the inspection coverage to be applied to each of the six DSTs. The inspection locations will all be near one or both of the 24-in.-diameter risers.

4.3.2 Personnel Responsibilities

The position descriptions, interface descriptions, and operator responsibilities are described below.

Level III Inspector. The Level III inspector is responsible for the accuracy and completeness of all UT data, data interpretation, and data reporting and shall also approve all inspection procedures.

Robot Operator. The robot operator is responsible for verifying the system is ready for DSTI robot startup; inserting and deploying the DSTI robot; controlling robot movement; operating the cleaning apparatus; and retrieving, maintaining, and storing the robotics system components.

UT Operator. The UT operator is responsible for operating the P-scan system; These responsibilities include system setup, calibration, deployment, data acquisition, verification of post-test system calibrations, and maintenance of UT system components. The UT operator also is qualified as a UT analyst.

Camera System Operator. The camera system operator is responsible for setting up the camera systems, verifying system sensitivity, preparing visual information for turnover to WHC, and maintaining the camera system components.

UT Analyst. The UT analyst is responsible for analyzing and reporting UT data, verifying required inspection coverage, presenting data files to WHC, and assisting the UT operator as required. The UT analyst also is qualified as an UT operator.

WHC Support Personnel. The WHC personnel are responsible for deploying, connecting, and monitoring equipment inside the tank farm fence; connecting utilities to the mobile control trailer; deploying and retrieving the overview camera system; assisting with UT calibrations, and providing radiation protection. WHC is not responsible for inserting the DSTI robot into the tank riser.

4.3.3 Flaw characterization and reporting

In support of these inspections, analyses have been completed in order to estimate the sizes of flaws necessary to precipitate tank failure by unstable fracture or to grow flaws by IGSCC (Shurrab et al. 1991, Schwenk 1992). These results were used to set flaw detection and sizing requirements for the DSTI system.

Flaw Characterization Requirements. The wall thickness will be measured and flaws or corrosion with dimensions greater than the minimums shown on the chart below must be characterized. These dimensions are consistent with those listed in Shurrab (1991).

Type of Flaw	Dimensions (t = nominal wall thickness)
Pitting	0.7 t dia. x 0.35 t deep
Cracks	t long x 0.5t deep 12 in. long x 0.2 t deep

UT Inspection Reports. A UT report shall be submitted daily on inspection activities and findings. The final data report for a tank examination will be submitted within 30 days of completion. The report will locate, characterize, and size any indications of corrosion pitting, cracking or excessive wall thinning. Data reports will include the following information:

- Conclusions and written basis
- Indication data sheets
- Calibration information and data
- P-scan processor (PSP-3) data set parameters
- Data file identification sheet
- P-scan data printouts
- Visual examination results.

4.4 POST-INSPECTION ACTIVITIES

The activities discussed below will take place after all required inspections from a given tank riser have been completed. The DSTI robot may be moved to another riser on the same DST, transported to the next DST to be inspected, or stored for future inspections.

4.4.1 System Shut Down

Shutting down the DSTI system involves the following activities.

- Robot retrieval -- covers all activities that occur after the inspection is completed until the DSTI robot is secured to the CMA, including the following:

- Move DSTI robot to home position.
- Disengage robot from tank wall and return to the folded position.
- Remove robot through riser and secure to CMA.
- Monitor robot for contamination.
- Lift CMA and replace riser plug.

- Post-retrieval -- includes removing the CMA, performing UT exit calibration, removing the overview camera from its riser and checking for contamination, securing the riser, preparing the DM and CMA for transport, and performing a tank farm exit survey.

- Equipment teardown -- involves disassembling the DSTI system and preparing it for transportation to another tank farm or to storage.

- System maintenance.

4.4.2 Storage of Inspection Data

A data management plan to be issued for this inspection program will specify the storage location and control of all data that is generated in order to facilitate future reviews and inspections.

All visual examination data (i.e., video from four different cameras) are stored temporarily on S-VHS recording tape. The visual data of particular interest from two cameras that continuously view the inspection area will be retained permanently on optical disks.

UT inspection data are stored temporarily on 3.5-in. diskettes. All UT data is to be retained permanently and is transferred to optical disks as the diskettes fill up.

4.4.3 Ownership Transfer of UT Inspection System

Ownership of the DSTI system shall be retained by Raytheon until the performance test has been satisfactorily completed. An ownership transfer will be authorized by cognizant management once the final product has been physically accounted for and the QA reviews outlined in the QA and configuration management plan have been completed. Raytheon shall complete all necessary maintenance and repair before delivery of the DSTI system.

4.4.4 Review of Initial DST Inspections

An overview of this initial UT evaluation of the DSTs will be conducted. This overview will examine the inspection plan in its entirety and summarize key improvements for consideration for the future inspections.

5.0 ROLES AND RESPONSIBILITIES

5.1 WHC Responsibilities

- Safety and readiness assessments
- QA and configuration management
- Performance demonstration test and samples
- DST inspection work package
- Inspection equipment insertion and withdrawal
- UT flaw acceptance criteria and data management
- Determine acceptance of each DST after inspection

5.2 Vendor Responsibilities

- Delivery and deployment of UT hardware and software systems
- Inspection procedures and certified inspectors
- QA and change control
- Performance testing
- DST inspections
- Data presentation and storage

6.0 SCHEDULE

The following major items remain to be completed. The status and an expected completion date is indicated for each item.

Item	Status	Expected Completion
Install performance demonstration samples	In progress	January 1995
Issue UT data management plan	In progress	October 1994
Issue performance test procedure	In progress	November 1994
Issue DST inspection sampling plan	In progress	January 1995
Issue flaw acceptance criteria	In progress	March 1995
Issue performance test report	Not yet started	April 1995
Complete all pre-inspection activities & issue work package	In progress	To be scheduled
First DST inspection report	Not yet started	September 1995

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Shurrab, M. S., et al. 1991, *Parametric Studies to Support Inspection Criteria for the Hanford Site Double-Shell Waste Storage Tanks*, WHC-EP-0508, Vol. 1, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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8.0 ACRONYM DEFINITIONS

A-scan	An analog signal presentation used for ultrasonic inspection. This is the graphical signal strength versus time plot showing the sonic impulse wave and the reflected (echo) wave returning from the opposite surface or an intervening reflector
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CMA	Cable management assembly - See Appendix B
CPU	Central processing unit
DM	Deployment module - See Appendix B
DOE-RL	U.S. Department of Energy, Richland Operations Office
DST	Double-shell tank
DSTI	Double-shell tank inspection
I/O	Input and output
IAPP	Integrity assessment program plan
IGSCC	Intergranular stress corrosion cracking
LAN	Local Area Network
MCC	Mobile control center - See Appendix B
P-scan	The three-dimensional image projection of ultrasonic inspection data
PSP-3	P-scan image processor
QA	Quality assurance
SNT-TC-1A	Nondestructive testing standard issued by the Society for Nondestructive Testing
SRP	Savannah River Plant - Department of Energy site located in Aiken, South Carolina
S-VHS	Special high-resolution VHS format
TSIP	Tank structural integrity panel formed by Department of Energy Headquarters to recommend guidelines for all DOE high-level radioactive waste storage tanks
USQ	Unreviewed safety question

UT	Ultrasonic testing or ultrasonic inspection
V&V	Verification and validation - term is used in the Site QA manual for a particular formal report
VCR	Video camera recorder used for the recording and playback of visual inspection data
VHS	Video recording tape format
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company

APPENDICES

APPENDIX A DOUBLE SHELL TANK DESCRIPTION

The 28 double-shell tanks (DST) are located in six tank farms, as listed below. The construction dates are also listed for information (Hanlon 1994). Geometry and fabrication details important to the ultrasonic testing (UT) inspection plan are discussed in the following sections.

East Area

Tank Farm AN: 7 tanks, 1980-81.
Tank Farm AP: 8 tanks, 1983-86.
Tank Farm AW: 6 tanks, 1978-80.
Tank Farm AY: 2 tanks, 1968-70.
Tank Farm AZ: 2 tanks, 1971-77.

West Area

Tank Farm SY: 3 tanks, 1974-76.

Tank Geometry and Fabrication Details

Figure A-1 is representative of a DST. Each DST consists of three concentric tank structures. The innermost freestanding tank that holds the stored waste, referred to as the primary tank, is carbon steel. It has a 75-ft diameter, and is just under 47-ft high at the dome center. The primary tank rests on an 8-in.-thick refractory pad that has integral air flow slots to allow circulating air to extract heat from the stored waste. The secondary tank, also carbon steel, is 80 ft in diameter and forms a liner for reinforced-concrete tertiary tank. A 2½-ft-wide annular space, separating the primary and secondary tanks, surrounds the primary tank's working space; these two tanks then meet at the haunch section of the primary tank. The secondary tank ends there.

The domed tertiary tank is covered with approximately 10-ft of earth. There are 60 to 65 access pipes, or risers, that penetrate the tertiary tank dome and extend above grade. Some of these open into the primary tank and others into the annulus. The risers are used for various waste and equipment monitoring, operational activities, and waste transfer activities and their size and arrangement differ from tank to tank. The risers of interest to this inspection plan are those opening into the annulus; they are described below.

The primary and secondary tanks were fabricated in place by welding. Certain segments first were fabricated from carbon steel plate in a contractor's shop and transported to the Site. These segments then were welded together along with other carbon steel plates to form the completed tanks. Three different grades of steel were used along with various plate thicknesses, as listed in Table A-1. The plates for some tanks were UT inspected to A 578, level II, at the mill before shipment. Figure A-2 is a typical weld map showing the various weld seams for the primary tank.

Full-penetration welds were made for both primary and secondary tanks. The primary tank weld joint configurations are shown in Figure A-3. All welds were inspected visually and all primary tank welds and all secondary tank knuckle welds were 100% radiographed to the acceptance requirements of ASME Section VIII, Div. 1 or Div. 2. The welds for some of the primary tank bottoms were inspected by magnetic particle and dye penetrant, again to the requirements of Section VIII, Div. 1 or Div. 2. No grinding or machining was done on any of the welds after fabrication.

The entire primary tank was given a post-weld heat treatment of 30 min. at 1,100 °F to relieve all welding stresses and then hydrotested with water. The lower portion of the secondary tank was "vacuum tested" after welding.

Double-Shell Tank Annulus Description

Figure A-4 shows the annulus region of the DSTs in more detail. The 2½-ft-wide annular space together with risers that provide access from above-grade will be used for all inspection activities described in this inspection plan.

Equipment entry to the annulus will be through the riser pipes. Each DST annulus has three sizes (diameters) of risers; two 24-in. risers located 180° apart, two 12-in. risers also 180° apart, and up to 16 smaller risers (3 in. for AY tank farm, 6 in. for AP tank farm, and 4 in. for the rest).

The primary tank is accessible for inspection from the annulus except for the bottom, which rests on the 8-in. refractory pad. Inspection access for a portion of the tank bottom is possible through the air flow slots cast into the underlying pad. The flow slots are of either a trapezoidal cross section (2.5-in. wide tapering to 1-in. wide by 2.5-in. high) or a square cross section (1.5 in. square).

Thicker plates were used for the lower levels of the primary tank wall and for the bottom knuckle, as compared with the upper wall, dome, and tank bottom. The different weld joint designs used to accommodate the different plate thicknesses are shown in Figure A-4. The UT inspection must accommodate the different weld joint configurations.

The secondary tank is readily accessible from the annulus for the inspections. The secondary tank has a uniform wall thickness except for a slightly thicker section for the knuckle.

Table A-1. Plate Material Used for Fabricating the Double-Shell Tanks.

	AN & AW Tanks	AP Tanks	SY Tanks	AY & AZ Tanks
ASTM Plate specification	A 537 Cl 1	A 537 Cl 1	A 516 Gr 65	A 515 Gr 60
<u>Primary tank plate thickness, in.</u>				
Tank dome	3/8	3/8	3/8	3/8
Tank wall	1/2,3/4	1/2-7/8	1/2,3/4	3/8-3/4
Lower knuckle region	7/8	15/16	7/8	7/8
Tank bottom	1/2	1/2	1/2	1/2
<u>Secondary Tank Wall Thickness, in.</u>				
All sections, except knuckle	3/8	3/8	3/8	3/8
Knuckle region	1/2	1/2	1/2	1/2

References

Hanlon, B. M., 1994, *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68, Westinghouse Hanford Company, Richland, Washington, February 1994.

Figure A-1. Configuration of Hanford Double-Shell Tanks.

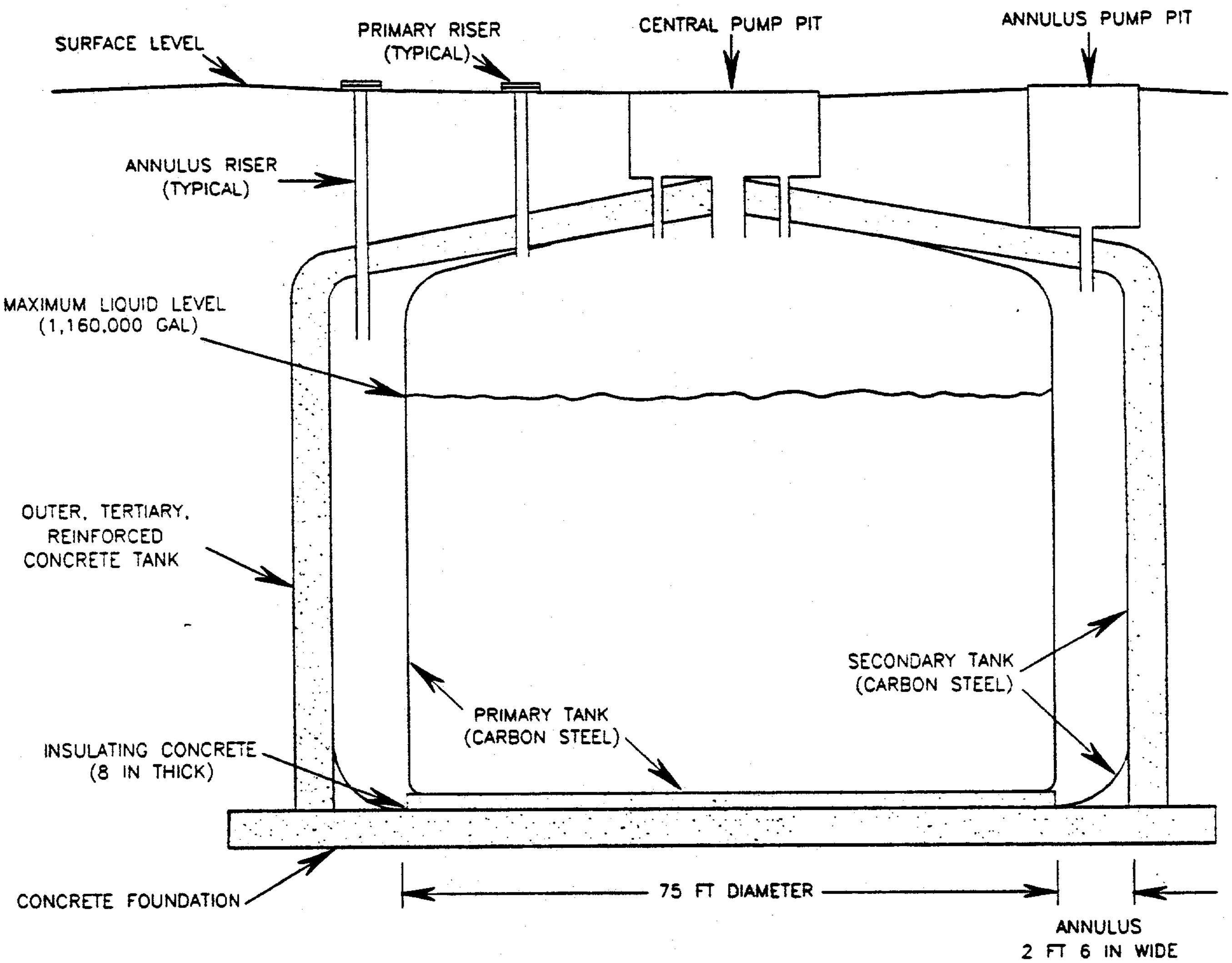


Figure A-2. Typical Weld Map for the Primary Tank of a Double-Shell Tank.

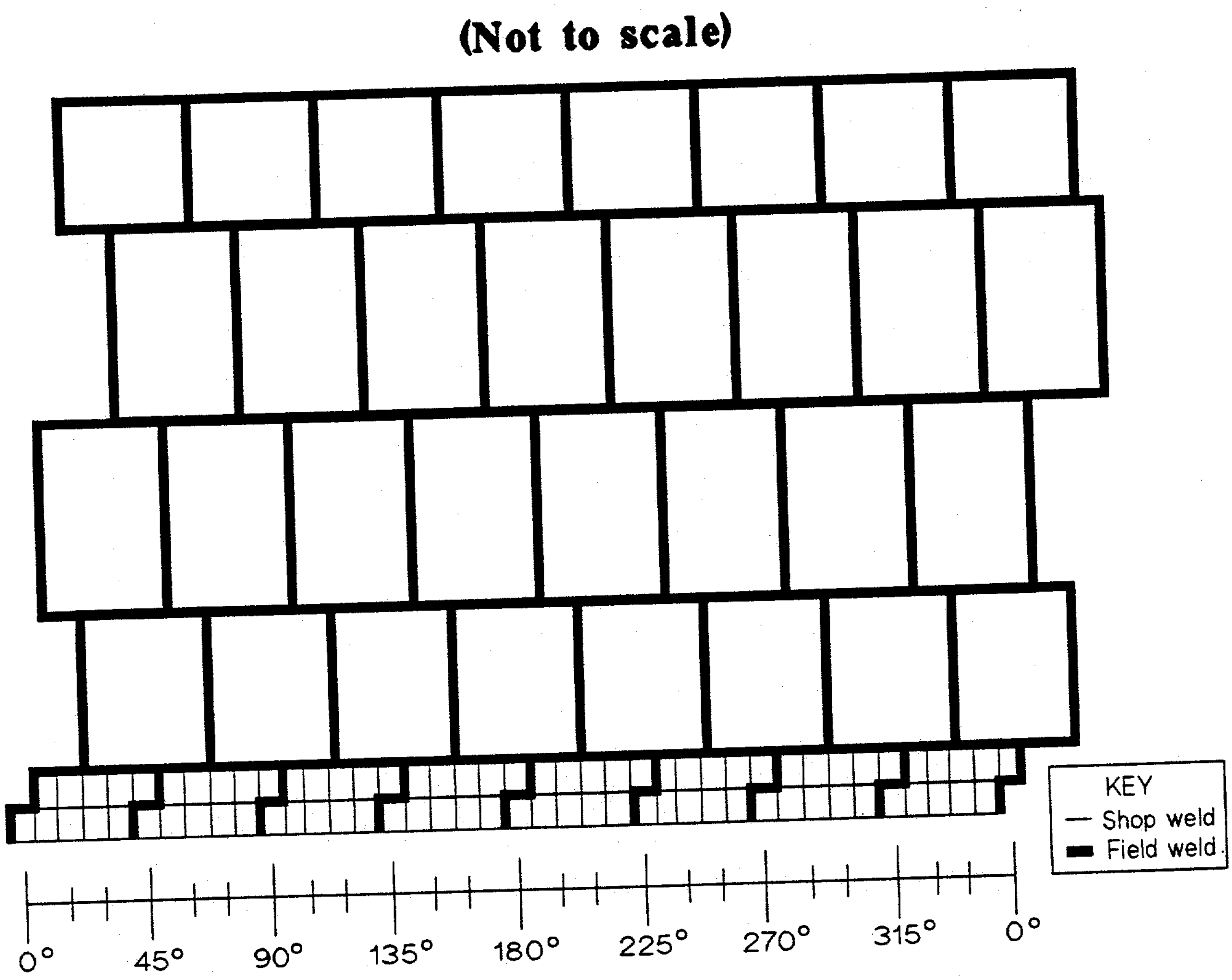
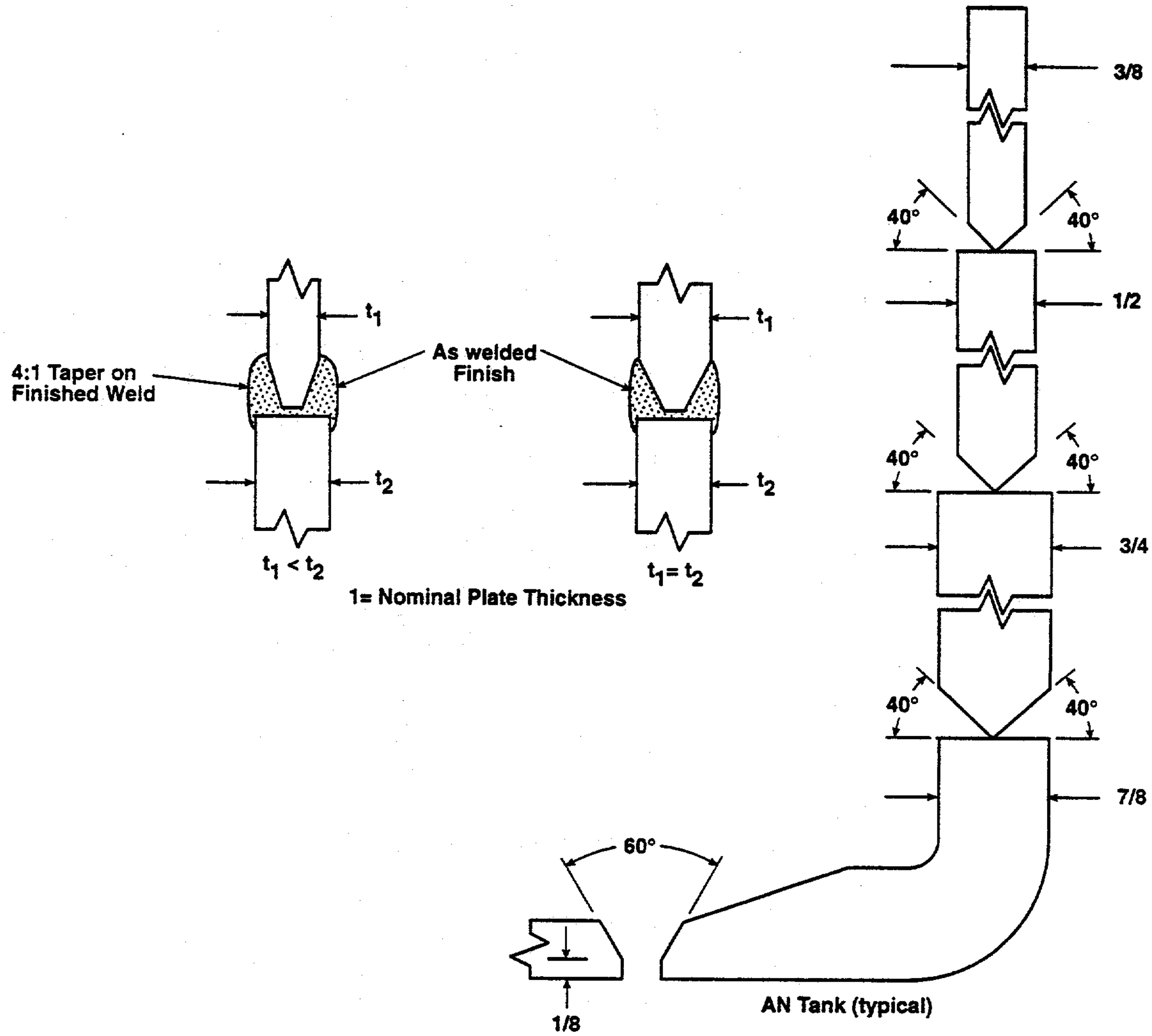
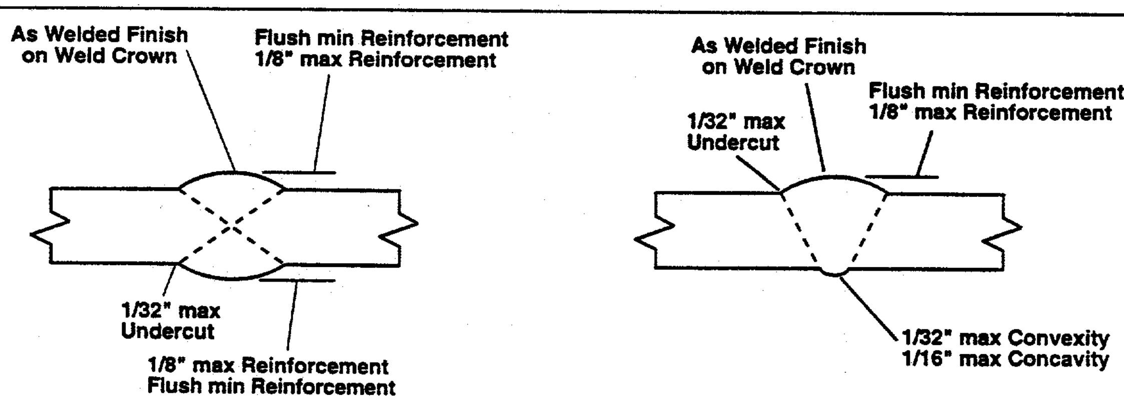


Figure A-3. Primary Tank Weld Joint Configurations for Double-Shell Tank Fabrication



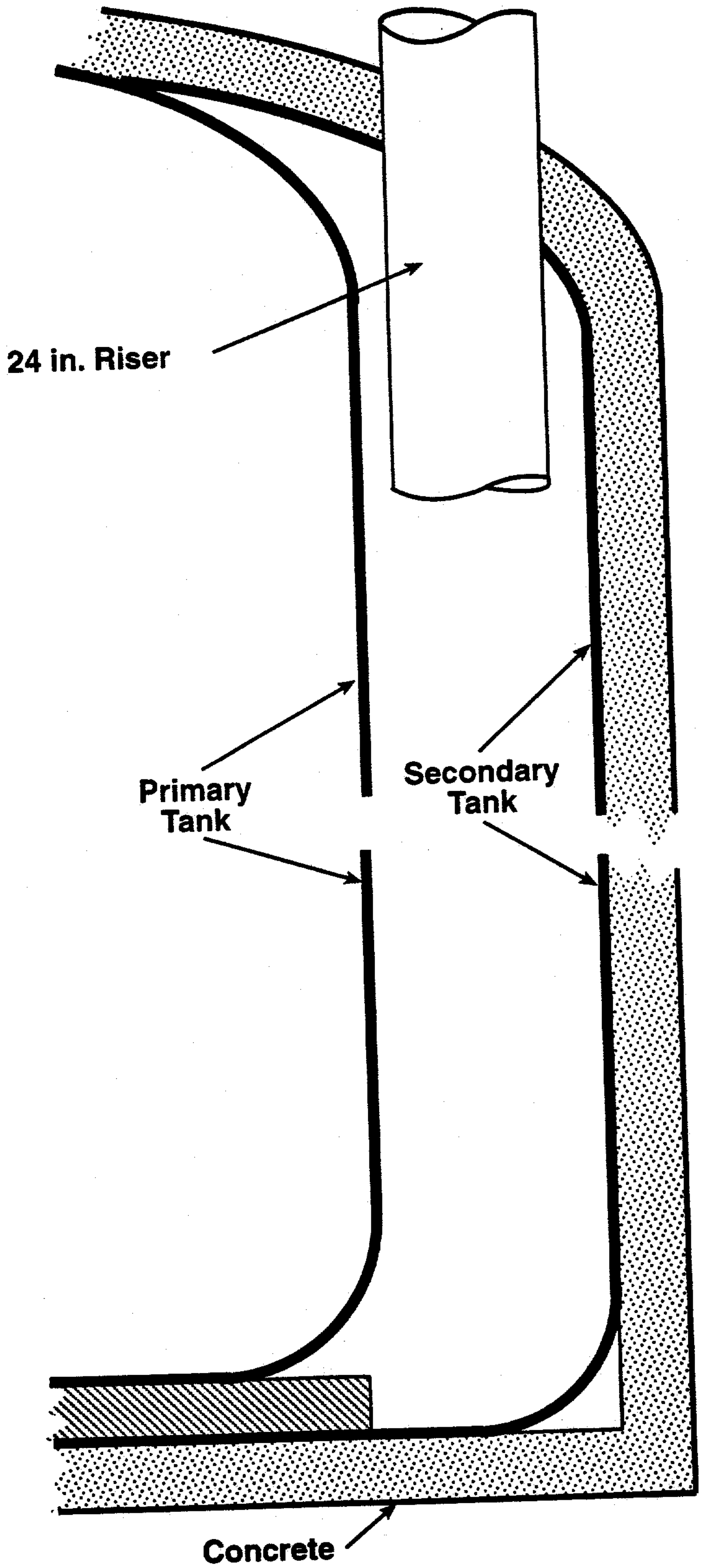
Horizontal and Knuckle-To-Bottom Plate Welds



Vertical Plate to Plate Weld

39409134.2

Figure A-4. Double-Shell Tank Annulus.



APPENDIX B EQUIPMENT DESCRIPTION

The double-shell tank DST ultrasonic inspection system (DSTI system) is designed to provide real-time inspection data on both the primary and secondary tanks from within the annulus region of the DSTs.

The ten major subsystems are described briefly below. More extensive descriptions are available in project documentation.

Mobile Control Center. The mobile control center (MCC) is a specially constructed trailer to be located outside the tank farm fence to serve as the central location for operating the robotics system and collecting and storing the UT inspection data. It houses the robot operator console, the UT console, the video console, the backup generator and the communication systems.

The UT console provides a station from which an operator can perform inspections and process UT data. The UT operator can allow the DSTI robot to traverse the inspection path automatically, or can conduct a manually controlled inspection from the console. A color monitor provides the UT operator with a view of the UT head during inspection via the inspection video camera mounted on the DSTI robot.

A 500-ft trailer tether includes LAN communication cables, 240 v. power, control wires, and cables for UT signals and video signals.

Deployment Module. The deployment module (DM), consists of a deployment housing, electrical enclosure, and the pneumatic distribution system, and can be moved by forklift, crane or flatbed truck. The deployment module will be located inside the tank farm fence and near the tank being inspected.

Cable Management Assembly. The cable management assembly (CMA), located directly over a 24-in.-diameter access riser, is used to lower the scan carriage (henceforth referred to as the double-shell tank inspection robot [DSTI robot]) into the tank annulus. It also serves as the storage and shipping container for the DSTI robot and its tether. The CMA consists of a structural frame, a reel for the DSTI robot tether, a cable hoist, a grapple mechanism for coupling and decoupling from the hoist cable, and the supply system for the UT couplant. The assembly also includes two reels for the 50 ft of tether and power cable from the deployment module. The CMA weighs approximately 3000 lbs and can be lifted on and off a flatbed truck by crane or hoist.

Overview Video System. An overview video system is lowered through a nearby 3 to 6-in.-diameter riser by WHC support personnel. The video system is mounted on a sectional composite mast and can be lowered to at least 40 ft below the riser flange. Focus, zoom, iris, and lighting are controlled from the video console.

Robot Mechanism. Once inside the tank annulus, the DSTI robot cleans, examines, and inspects prescribed paths on the primary and secondary tank walls, the primary tank lower knuckle, and portions of the floor of the primary tank (through the integral air flow slots). Two different setups for cleaning, visual examination, and UT inspection are used on the DSTI robot; one for area inspections and one that reaches into the air flow slots.

A walking platform is integral with the base of the DSTI robot and is used to move it around the annulus. A rectangular area 64-in. high by 22-in. wide is available for UT scanning for each step the DSTI robot moves. (The inspection plan may not utilize the entire available area.) Telescoping feet brace the DSTI robot between the primary and secondary tank walls during walking, cleaning, and UT scanning.

Robot Control Hardware. The DSTI robot control hardware consists of the robot operator console located in the mobile control center and the controller located in the deployment module. The operator panel controls the power for both the walking and the scanning modes. The controller consists of a card rack that houses the central processing unit (CPU), the analog and digital I/O, servo modules, motor amplifiers, power supply boards, and LAN communication.

Robot Control Software. The DSTI robot control software provides coordinated motion control, machine vision-based position estimation, and three-dimensional (3-D) graphic display. A touch-screen PC and a workstation form the user interface, a machine vision computer performs vision operations using the robot's inspection camera, and a backplane computer performs the real-time control tasks, communicating with the visual and UT interface computer through a serial line. The entire control system is operated through the touch-screen and operator panel interface.

Pneumatic System. The pneumatic system provides 200 lbf/in^2 filtered air at 5 ft^3/min to the DSTI robot at all times during operation. Two two-stage pressure-lubricated air compressors supply air to the 80-gal supply tank. The air pressure is regulated to 120 or 150 lbf/in^2 for the several robot pneumatic actuators.

Electrical System. The electrical system uses the 240 v. site power to provide the required 120 v. single-phase power to the MCC, DM, CMA, and the DSTI robot.

P-Scan System. The P-scan UT system collects and analyzes data. The multi-channel data-acquisition capabilities of the P-scan system allow for simultaneous and continuous acquisition of data from numerous transducer configurations along with their position and orientation.

Data from each transducer are stored and displayed in real time in a 3-D view of the examination area that includes a top, side, and end view. In addition, continuous A-scan echo information is available for examiner review during scanning. [P-scan data is UT images projected to a 3-D view of the region being inspected. A-scan is the pulse-echo presentation on a time base axis].

Data storage and retrieval is via a 3.5-in. magnetic diskette. As each diskette is filled, the stored data are transferred to an optical disk for permanent storage.

The transducer position and orientation information are provided via the LAN to a dedicated computer that decodes the digital information to an analog P-scan format.

APPENDIX C TANKS SELECTED FOR INSPECTION

STRATEGIC SAMPLING FOR DST ULTRASONIC INSPECTIONS

Ultrasonic inspection of the 28 DSTs will be difficult, labor intensive, and time consuming because the tanks are below grade and contain dangerous wastes. The employee effort, cost, and schedule required for 100% sampling would be prohibitive. Therefore, they will be sampled selectively so that available resources can be used effectively and efficiently. If significant degradation is detected, the sample may be extended.

The Tank Structural Integrity Panel (TSIP) has been formed by DOE-HQ to recommend guidelines for development of structural integrity programs for DOE high-level waste storage tanks. The TSIP members considered Section XI of the ASME Code when preparing these guidelines. A "final draft" of these guidelines was made available September 1994. The draft document contains recommendations for a sampling program for integrity inspections of storage tanks. A 10% sampling is recommended for tanks representing the same population.

Selection Criteria

The criteria recommended by TSIP for selecting tanks for inspection are age, severity of operating conditions, and the severity of transients. Information applicable to these criteria was gathered for the 28 DSTs and was tabulated in the integrity assessment program plan (IAPP) and provided to the State of Washington Department of Ecology (Pfluger 1994). It became clear that the 28 DSTs do not represent a single population. The extent to which each criterion applies to individual tanks varies from tank to tank.

Six DSTs Selected

The tanks finally selected for the in-depth UT inspection reflect an effort to choose those representative of conditions thought to constitute the worst cases for each of the three criteria; the six tanks chosen are listed below, along with the variable leading to its selection:

- 241AY101
  longest service history
- 241AZ101
  highest sustained temperature
- 241AN106
  phosphate waste contents
- 241AN107
  low corrosion inhibitor (low OH^- level)
- 241AW103
  high sludge level
- 241AN103
  hydrogen watch tank (potential transients).

REFERENCES

ASME, 1992, 1992 ASME Boiler & Pressure Vessel Code, Section XI Rules for Inservice Inspection of Nuclear Power Plant Components, The American Society of Mechanical Engineers, New York, New York.

Pfluger, D. C., 1994, *Tank Waste Remediation System Tank System Integrity Assessments Program Plan*, WHC-SD-WM-AP-017, Rev. 1, Westinghouse Hanford Company, Richland, Washington.