APR 3 1997
Sta. 37 22

# ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT 617606

| 2. To: (Receiving Organization) | 3. From: (Originating Organization) | 4. Related EDT No.: |
|---|---|---|
| Distribution | T. W. Staehr, SESC | NA |
| 5. Proj./Prog./Dept./Div.: | 6. Design Authority/ Design Agent/Cog. Engr.: | 7. Purchase Order No.: |
| Hanford Tanks Initiative | S. A. Krieg 376-0931 | NA |
| 8. Originator Remarks: | | 9. Equip./Component No.: NA |
| | | 10. System/Bldg./Facility: NA |
| 11. Receiver Remarks: 11A. Design Baseline Document? [ ] Yes [X] No | | 12. Major Assm. Dwg. No.: NA |
| | | 13. Permit/Permit Application No.: NA |
| | | 14. Required Response Date: |

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 Designator | (G) Reason for Transmittal | (H) Originator Disposition | (I) Receiver Disposition |
|---|---|---|---|---|---|---|---|---|
| 1 | HNF-SD-HTI-ES-002 | - | 0 | Hanford Tanks Initiative Test Facility site Selection Study | NA | 1,2 | 1 | 1 |
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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 4. Review<br>2. Release 5. Post-Review<br>3. Information 6. Dist. (Receipt Acknow. Required) | 1. Approved 4. Reviewed no/comment<br>2. Approved w/comment 5. Reviewed w/comment<br>3. Disapproved w/comment 6. Receipt acknowledged |

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

| (G) Reason | (H) Disp. | (J) Name (K) Signature (L) Date (M) MSIN | (G) Reason | (H) Disp. | (J) Name (K) Signature (L) Date (M) MSIN |
|---|---|---|---|---|---|
| | | Design Authority | | | |
| | | Design Agent | | | |
| 1 | 1 | Cog.Eng. T. W. Staehr H5-61 | | | |
| 1 | 1 | Cog. Mgr. B. Root H6-12 | | | |
| | | QA | | | |
| | | Safety | | | |
| | | Env. | | | |

| 18. | 19. | 20. | 21. DOE APPROVAL (if required) Ctrl. No. |
|---|---|---|---|
| T. W. Staehr 3/28/97 | L. B. McDaniel 4/4/97 | B. Root 4/3/97 | [ ] Approved<br>[ ] Approved w/comments<br>[ ] Disapproved w/comments |
| Signature of EDT Originator Date | Authorized Representative for Receiving Organization Date | Design Authority/ Cognizant Manager Date | |

BD-7400-172-2 (05/96) GEF097

# Hanford Tanks Initiative Test Facility Site Selection Study

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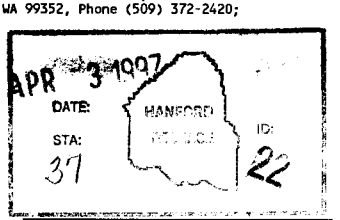
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 617606 UC: 721
Org Code: 74710 Charge Code: D26A2
B&R Code: EW3130010 Total Pages: 22

Key Words: HTI, test facility, retrieval, site selection

Abstract: The Hanford Tanks Initiative (HTI) project is developing equipment for the removal of hard heel waste from the Hanford Site underground single-shell waste storage tanks. The HTI equipment will initially be installed in the 241-C-106 tank where its operation will be demonstrated. This study evaluates existing Hanford Site facilities and other sites for functional testing of the HTI equipment before it is installed into the 241-C-106 tank.






Chris Dillingham 4-3-97
Release Approval Date

Release Stamp

**Approved for Public Release**

HNF-SD-HTI-ES-002
Revision 0

# HANFORD TANKS INITIATIVE TEST FACILITY SITE SELECTION STUDY

March 1997

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Prepared for
U.S. Department of Energy
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## *EXECUTIVE SUMMARY*

*The Hanford Tanks Initiative Test Facility Functions and Requirements (Krieg 1997) defined the need and requirements for a facility for functional and operational testing of the single-shell tank waste retrieval equipment being developed by the Hanford Tanks Initiative (HTI) project. Numerous engineering studies, facility evaluations, and site selection reports have been previously issued to determine the availability of existing facilities or site locations for similar single-shell tank waste retrieval equipment testing and training facilities (see references). These documents were reviewed to assess their validity against the current HTI criteria for a testing and training facility. In addition, other facilities that were not previously looked at were investigated.*

*Based on the reviews and investigations performed for this report, it is concluded that there is no one existing facility that meets the minimum requirements for testing of the HTI equipment. The facility that is closest to meeting the minimum requirements is the Maintenance and Storage Facility located in the 400 Area. An alternative to using an existing facility would be to construct a new facility. A site adjacent to the existing cold test facility in the 600 Area is the preferred site for construction of a new test facility that will meet requirements for both present and future retrieval system testing.*

*A detailed cost study needs to be performed to determine if constructing a new facility is feasible, or if an existing facility can be adapted to meet testing needs. Other options include construction of a temporary facility for specific HTI tests, using an existing test*

*facility with less than optimum conditions; using more than one existing test facility (such as using the cold test facility for equipment set up and installation and another facility to demonstrate operation); or using a vendor's facility.*

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## LIST OF TERMS

| | |
|---|---|
| 337HB | 337 High-Temperature Sodium Test Facility Highbay |
| CCTV | Closed-circuit television |
| CTF | Cold Test Facility |
| DOE | U.S. Department of Energy |
| FFTF | Fast Flux Test Facility |
| FMEF | Fuels and Materials Examination Facility |
| GDF | Grout Disposal Facility |
| HTI | Hanford Tanks Initiative |
| M&D | Maintenance and decontamination |
| MASF | Maintenance and Storage Facility |
| PHMC | Project Hanford Management Contractor |
| SST | Single-shell tank |
| TWRS | Tank Waste Remediation System |

# HANFORD TANKS INITIATIVE TEST FACILITY SITE SELECTION STUDY

## 1.0 INTRODUCTION

State-of-the art equipment for retrieval of hard-heel waste in the Hanford Site single-shell underground waste storage tanks (SST) will be developed by private vendors as part of the Hanford Tanks Initiative (HTI) project. Two concepts currently under consideration for the HTI retrieval systems both incorporate a remote mechanism for directing and controlling a "confined sluicer" for breaking up the waste in the tanks. The first concept (Figure 1) is a crawler-based waste retrieval system that uses a crawler vehicle to move the sluicer inside the tank. The second concept (Figure 2) uses a manipulator arm to move the sluicer inside the tank. Both devices will be operated by a remote control system located outside of the waste tank, using a closed-circuit television camera to verify location and operation.

Under the current plan, fabrication and preliminary testing of the retrieval equipment will be performed at the vendor's facility. This preliminary testing will include any required developmental testing, acceptance testing, and qualification testing. Before actual installation and operation of the equipment in an SST, (SST 241-C-106 is scheduled to be the first tank to be retrieved), additional testing will be required at an onsite test facility to demonstrate functionality and operability in a physical environment approximating that of the SST. The *Hanford Tanks Initiative Test Facility Functions and Requirements* (Krieg 1997) defined a need for a test facility to perform this additional testing of the HTI retrieval equipment. Future testing for procedure development, operator training, and for mock-up of various SST configurations may also be required during the retrieval of the 149 SSTs.

Numerous studies have been performed in the past to evaluate development of an onsite testing facilities for similar retrieval equipment concepts including the long-reach manipulator and the light-duty utility arm. These studies have included evaluation of the potential use and/or renovation of existing facilities, and the evaluation of sites for location of a newly constructed testing facility.

Figure 1. Vehicle-Based Waste Retrieval System.

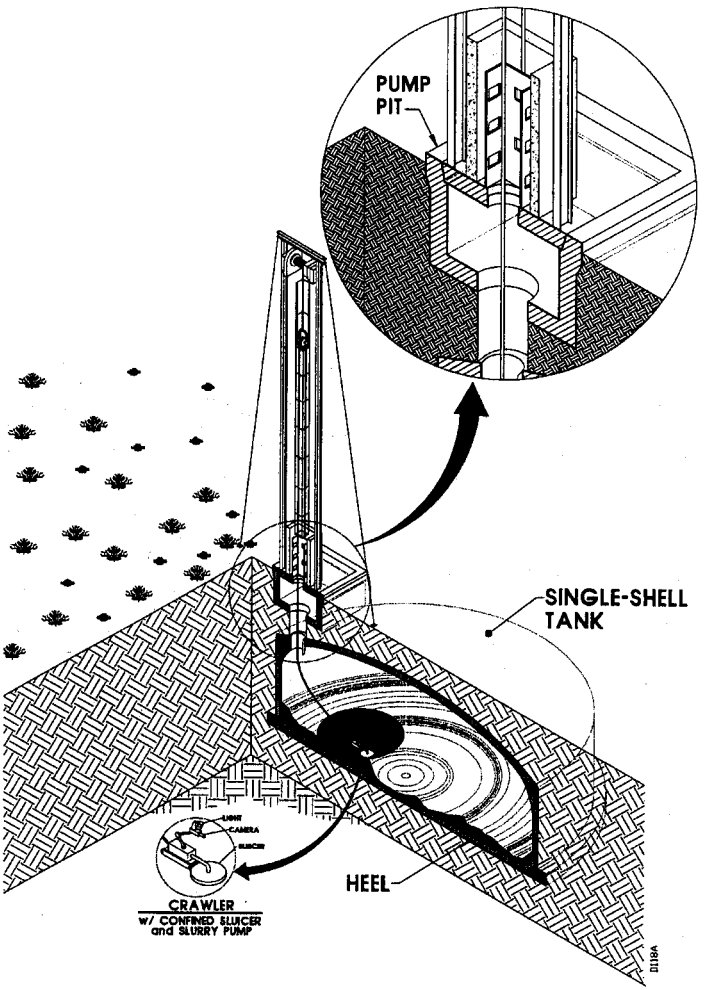
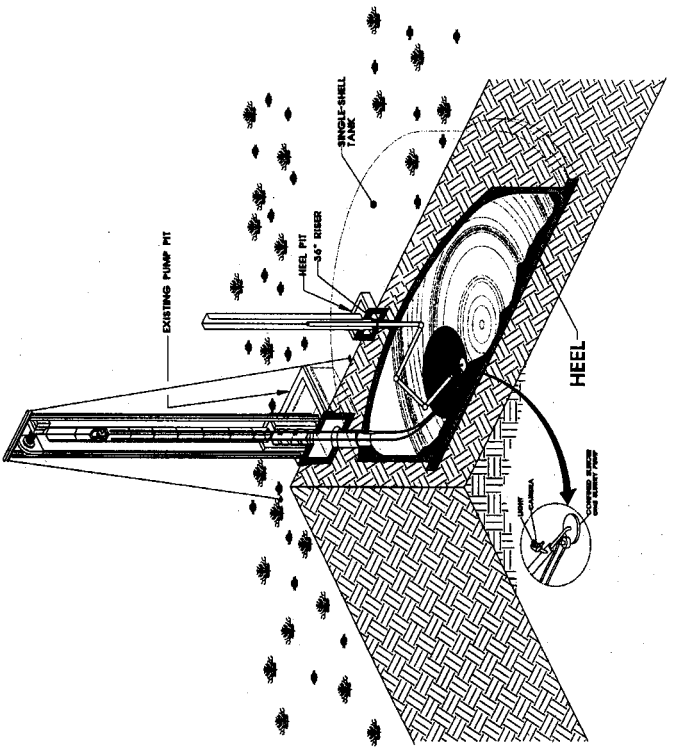


Figure 2. Arm-Based Waste Retrieval System.



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## 2.0 PURPOSE AND SCOPE

The purpose of this study is to recommend a path forward for providing a facility for operational and functional testing of the HTI waste retrieval equipment. The scope of the study includes a review of the *Hanford Tanks Initiative Test Facility Functions and Requirements* (Krieg 1997) to determine minimum requirements for the test facility, analysis of previous studies that evaluated existing facilities and construction sites as potential SST waste retrieval equipment test facilities, evaluation of new facilities not previously analyzed, and provide options for using an existing facility on or near the Hanford site, or locating a site where a test facility could be constructed, that will meet HTI requirements.

## 3.0 ASSUMPTIONS

The following assumptions were adopted to bound the scope of this study.

- The need for a test facility is based on the requirements for testing equipment developed by the HTI program for retrieving waste from the 241-C-106 tank.
- The test facility is required to be operational by November 1998 to accommodate testing of the HTI retrieval systems provided by the two HTI commercial vendors.
- HTI equipment testing will take from four months up to facility operational life of two years beginning in November 1998. Future operational life may be extended to 2018 to accommodate the retrieval of all the SSTs.
- Sluicing equipment will not be tested in the HTI test facility except as a component of a retrieval system, i.e., confined sluicers with vehicle. Testing of sluicing equipment can be accomplished at a vendor's facility or at any of a number of existing Hanford Site facilities, i.e., the cold test facility. Deployment, installation, and operation of this type of equipment in the SSTs is a low-risk, low-tech activity that has been done numerous times in the past.
- Testing activities to be performed at the HTI facility include deployment and setup of the system(s), insertion of the equipment into the simulated SST through the appropriate "risers," limited operational demonstration, and removal of the system/equipment from the test facility. The testing is assumed to be performed in three phases:

1. **Test Set Up.** This phase will include assembling a mock up of the C-106 test pit and other risers. Utilities and any other ancillary equipment that is provided at the 241-C-106 tank will also be made available at the test set up. This phase will also include the set up of any test tanks and simulant provision.

2. **Equipment Installation.** The equipment will be installed in the test pit in this phase of testing, including the deployment of the in tank hardware, i.e., tractor or arm hardware.

3. **Equipment Operation.** This testing phase will include the operation of the test equipment and functional testing.

- Cost and schedule considerations will need to be analyzed as a follow on to this study.

## 4.0 FACILITY AND SITE EVALUATION

### 4.1 HANFORD TANKS INITIATIVE TESTING FACILITY REQUIREMENTS

The requirements for the HTI SST Waste Retrieval Equipment Test Facility are specified in the *Hanford Tanks Initiative Test Facility Functions and Requirements* (Krieg 1997). To meet the functional requirements, the test facility must meet the following minimum criteria:

1. Provide a test space to accommodate testing of the HTI arm-based waste retrieval system at the maximum arm extension of 11.4 m (37.5 ft) (assuming center riser installation) resulting in a minimum facility length of about 12.8 m (42 ft). Testing of arm radial movement through 90° also results in a minimum facility width of about 12.8 m (42 ft). HTI system testing requires a facility 12.2-m (40-ft) deep to simulate tank 241-C-106.

2. Provide a test facility that can be "mocked up" to simulate the physical conditions in the tank farm, including pits, risers, and other features in the tank farms. Since many tanks are configured differently, the test facility needs to provide the versatility simulating specific tank conditions.

3. Provide for vehicle access to the "ground" surface adjacent to the top of tank to demonstrate cold setup, assembly, checkout, operation, disassembly and removal of the waste retrieval system in a manner similar to that to be used in the tank farms. The operating clearance below the crane hook needs to be a minimum of

18.3 m (60 ft) to allow insertion and removal of the equipment into/out of the risers.

In addition to the fundamental requirements listed above, several attributes have also been specified that would be highly beneficial, including the following:

4. Manned access inside the test facility is needed for set-up of test equipment/simulants, visual evaluation of test progress, and trouble shooting of the retrieval equipment. Adequate ventilation would be required to decrease the potential for confined space conditions such as an oxygen deficient atmosphere.

5. Comparable water, electrical power, telephone service, etc., as will be available at the 241-C-106 tank is required to operate the waste retrieval system and accommodate Vendor Control Systems.

6. Accommodation for the use of simulant testing should be available.

7. Windows/observation galleries or closed circuit television system that includes sufficient space for at least 10 visitors to simultaneously view the test activities should be available.

## 4.2 EVALUATION OF EXISTING FACILITIES

Numerous studies and reports have been issued in the past to determine whether existing facilities and sites would be suitable for testing SST waste retrieval equipment. Several of these reports are quite extensive and detailed, and were used as part of this analysis, since many of the previous requirements are similar or comparable to existing requirements for the HTI test facility. The functional requirements for the HTI Test Facility, were in fact, developed from a review of previous test facility requirements, and from requirements identified in an HTI Test Facility Functions and Requirements workshop, conducted on January 23, 1997.

Over 40 facilities both on and off the Hanford site, have been evaluated for use as a SST waste retrieval test facility. The requirements used to evaluate these facilities have generally been the same, even though there are some differences depending on the proposed equipment to be tested. The general consensus of the studies conclude that the older facilities built 30 years ago or earlier have outlived their design life and would require major renovation and expense to adapt them to a test facility meeting the HTI requirements. Based on those studies, three existing facilities, the 337 High Temperature Sodium Test Facility Highbay (337HB) located in the 300 Area, the Maintenance and Storage Facility (MASF), and the Fuels and Materials Examination Facility (FMEF) both located in the 400 Area, were considered for HTI equipment testing. In addition, the Grout Disposal Facility (GDF) located in the 200 East Area, and the Cold Test Facility (CTF), located in the 600 Area

between the 200 East and West Areas, were also considered. Table 1 lists minimum critical requirements and physical attributes of the facilities under consideration.

Table 1. Requirements and Physical Attributes of the Facilities.

| Requirement/ attribute | 337 High-Temperature Sodium Test Facility Highbay | Fuels and Materials Examination Facility | Maintenance and Storage Facility | Grout Disposal Facility | Cold Test Facility |
|---|---|---|---|---|---|
| 1. Ceiling height 18.3 m (60 ft) (min) | 27.4 m (90 ft) | 14.5 m (47.5 ft) | 25.9 m (85 ft) | unlimited outside facility | unlimited outside facility |
| 2. Cell depth below floor 11.3 m (37 ft) to 12.2 m (40 ft) | 11.6 m (38 ft) | 12.9 m (42.5 ft) | 12.6 m (41.5 ft) | 11.0 m (36 ft) | 16.1 m (53 ft) |
| 3. Cell size 12.8 m (42 ft) x 12.8 m (42 ft) min | 8.2 m (27 ft) dia. | 9.1 m (30 ft) x 12.2 m (40 ft) | 4.9 m (16 ft) x 11.0 m (36 ft) | 15.2 m (50 ft) x 37.5 m (123 ft) | 1.7 m (5.5 ft) dia. |
| 4. Floor load | 12.0 kPa (250 psf) | 251.4 kPa (5,250+ psf) | high | 14.4 kPa (300 psf) | unlimited |
| 5. Crane capacity 27,215.5 kg (30 t) | 9,071.8 kg (10 t) | 68,038.9 kg (75 t) | 181,436.9 kg (200 t) | limited to mobile cranes | limited to mobile cranes |

### 4.2.1 337 High-Temperature Sodium Test Facility Highbay

The south end of the 337 Highbay is reserved for Fast Flux Test Facility (FFTF) equipment and activities. However, the facility is currently in the process of removing process sodium piping that takes up a large portion of the facility. This operation may go well into fiscal year (FY) 1998. After the FFTF equipment is removed, the remaining floor area can provide a large working and viewing area that adequately meets the demands of the test requirements and minimizes any infringement on the future FFTF needs. The HTI equipment would have to be suspended from an elevated support structure and the facility floor would simulate the bottom of an SST. However, there is not sufficient ceiling height to provide for the deployment mast and testing of the HTI equipment arm at the full tank depth. The 45,359.2 kg (50-t) and 90,718.5 kg (100-t) cranes are currently nonfunctional, and the usable crane capacity is limited to the two 9,071.8-kg (10-t) cranes that can service the area in which the test bed will be located. Estimates for repair of the cranes are between $50,000 and $100,000 for each. Structural framework will be required to support the equipment to be suspended and will require spanning the width of the building for safe load transfer and distribution. The 337HB was chosen as the recommended choice for testing of the tank waste retrieval manipulator system (Robles 1993).

### 4.2.2 Maintenance and Storage Facility

The MASF has a highbay area on the north end of the building (see drawing H-4-62153), which appears suitable for HTI equipment testing. There are two adjacent cells, the Test Cell and the Air cell, which could be used for mock up of the SST conditions. The two cells are each approximately 4.9 m (16 ft) wide by 5.5 m (18 ft) long and the bottom floor is 12.6 m (41.5 ft) below the operating deck. The cells are divided by a metal wall that is removable to provide an overall testing area of 4.9 m (16 ft) by 11.0 (36 ft). The test cell also has access platforms at 3.0 m (10 ft), 6.0 m (19.5 ft), and 8.8 m (29 ft) above the cell floor, which also can be removed. The Operating deck will provide for ample floor loading and space to perform the HTI testing. The two cells each have 3.0-m (10-ft) access hatches on the operating floor, which can be modified to provide any size opening. There are two overhead cranes that are available, a 54,431.1-kg (60-t) capacity crane with 9.1 m (30 ft) of headspace, and a 181,436.9-kg (200-t) capacity crane with over 24.4 m (80 ft) of headspace. The area has been used for testing of 150 hp mixer pumps for the 241-SY-101 tank mitigation, and 300 hp mixer pumps for the 241-AZ-101 retrieval system, and is also scheduled for testing of the project W-211 mixer pumps.

### 4.2.3 Fuels and Materials Examination Facility

The Maintenance and Decontamination (M&D) cell (see drawing H-4-104046, room 351) is the area best suited for testing of the HTI equipment in the FMEF. The cell is approximately 12.2-m (40-ft) long by 9.1-m (30-ft) wide, and has a depth of 12.9 m (42.5 ft) from the operating deck above. There is an 18,143.7-kg (20-t) overhead crane that services the cell. The operating deck above the M&D cell provides ample space for set up of equipment. The operating deck has several penetrations, the largest of which is 91.4 cm (36 in.) in diameter, and also has a 2.4-m (8-ft) by 3.0-m (10-ft) construction opening for mockup of larger penetrations. The operating deck is serviced by a 68,038.9-kg (75-t) overhead crane, which can also be used to access a truck bay for easy unloading and installation of equipment. The major drawback of the facility is that the maximum ceiling height at the operating deck is around 13.7 m (45 ft), which is far less than the 18.3 m (60 ft) required for the HTI equipment. The M&D Cell is now being used for testing of the Light-Duty Utility Arm, but should be available to meet the HTI testing schedule.

### 4.2.4 Grout Disposal Facility

The GDF has a large underground cell that most adequately meet the space requirement for the HTI equipment testing of the existing facilities that were evaluated. The GDF is located outside and thus there would be no limitation on head space. Floor loading on top of the vaults is limited to 14.4 kPa (300 psf). Therefore, a supporting structure would most likely be required to span the vault. There are four existing pits with a 61.0-cm (24-in.) diameter risers located at the corners of the vault. The only access to the inside of the vaults is through a 71.1-cm (28-in.) diameter manway and any viewing of the testing would have to

be done via a closed-circuit television (CCTV) through an existing riser. Removal of roof panels to gain access would require extensive modification.

The current plans are to use the GDF vaults for low-level waste disposal. Access to the vaults for low-level waste logs or canisters would be gained by excavating one side of the vault and cutting an access opening in the side wall. There is a possibility of using the modified vaults for HTI testing before being used for low-level waste disposal, thus decreasing extensive renovation costs for the HTI program. However, the low-level waste disposal project is just entering the conceptual design phase, and modification of the vaults would not be started until after the HTI testing need date. In addition, use of the vaults for low-level waste disposal would preclude the use of the vaults to accommodate future testing.

### 4.2.5 Cold Test Facility

The CTF has recently been used to successfully demonstrate the removal and installation of mocked up 241-AZ-101 thermocouples, the operation of the flexible receiver system, and the installation of large mixer pumps. The CTF may be able to be used to demonstrate equipment installation and set up, however, the cell size is to small to be used to demonstrate equipment operation. The test facility consists of a test pit resembling a tank farm pump pit, an underground caisson approximately 16.1-m (53-ft) deep and 1.7 m (5.5 ft) in diameter, and an adjustable riser cover for mocking up different sized openings.

Comparison of the minimum requirements of the HTI facility versus the physical attributes of the facilities under evaluation (Table 4.2) shows that no one facility meets all the requirements. The facility that most meets all the requirements for testing, without major renovation is the MASF. The major drawback of the facility is that the cell size is quite a bit smaller than what is required for testing of the equipment at full extension and through 90° radial movement. The FMEF facility should be considered if the final design for the mast height is under 13.7 m (45 ft).

## 4.3 EVALUATION OF SITES FOR NEW FACILITY CONSTRUCTION

Evaluation of various sites for construction of a new test facility was performed to support Project X-008, Single-Shell Tank Waste Retrieval Development and Operational Verification Facility (Trost and Jordan 1990). This project has since been canceled, however, the evaluation is still valid as applied to the HTI test facility needs and requirements, since the Project X-008 facility requirements meet the needs of the HTI test facility. The conceived facility consists of a full size prototype SST, two support buildings, a double wide support trailer, equipment maintenance and assembly facility, and liquid simulant storage tanks. The facility required a total of approximately 3.2 hectares (8 acres)--1.6 hectares (4 acres) for the planned facilities (versus 1.2 hectares (3 acres) for the HTI site) and an additional 1.6 hectares (4 acres) for future expansion.

Five sites were evaluated for construction of a testing facility--two located in the 300 Areas and three located in the 200 East and West Areas. Criteria for site selection were established based on guidelines in DOE Orders 6430.1A and 4320.2B. The criteria used as the basis for site selection included the following:

- Construction Costs
- Operating Costs
- Future Expansion
- Personnel/Occupational Safety
- Visitor and Vendor Access
- Shop Support
- Environmental Impact
- Long-Range Plan compliance.

The site selected is located in the 600 Area next to the former J. A. Jones batch plant, and is between the 200 East and West Areas. The site is in a former borrow pit in order to keep earthwork to a minimum and is close to existing utilities. The site is also adjacent to the Cold Test Facility.

The recommendation for selecting this site assumed that there would be no problems related to soil contamination, or cultural resources. There is not expected to be any problems in these areas, however, investigation of these areas, as well as subsurface soil characterization, should take place in conjunction with preliminary design activities.

## 4.4 FUTURE/PRIVATIZATION FUNCTIONS AND REQUIREMENTS

There is an additional future/privatization requirement related to the fundamental function that the test facility "provide a test space of adequate size." Future/privatization tank retrieval activities include tanks with capacities of 1,892.7 $m^3$ (0.5 Mgal), 2,839.1 $m^3$ (0.75 Mgal), and 3,785.4 $m^3$ (1 Mgal). This requires a depth of approximately 16.8 m (55 ft) to reflect the depth of the 3,785.4-$m^3$ (1-Mgal) tanks. HTI currently plans to retrieval the waste heel from tank 241-C-106, a 1,892.7-$m^3$ (0.5-Mgal) tank. If the HTI retrieval tank is changed to a 3,785.4-$m^3$ (1-Mgal) tank, this requirement would be included in the HTI requirements.

Future/privatization secondary functions and requirements fall into two general areas, training and engineering development. The training activities include the following:

- Operator certification/recertification
- Procedure validation
- Practice/develop off-normal event recovery procedures

- Training in maintenance activities.

The engineering development activities involve using the facility as an engineering testbed. Typical retrieval testbed activities that would be considered for this facility include the following.

- Develop in-tank obstacle work around techniques
- Hose management technique development
- Optimization and evaluation of in-tank viewing systems
- Control system response evaluation
- Advanced control system development.

These future/privatization training and engineering development needs impose the additional requirement for the facility to include sufficient space for future expansion to include training and engineering development facilities. Allowing for vehicle parking, equipment staging, crane maneuvering, training facility, and an engineering development facility, the potential space required for a future test facility is for about 2.8 hectares (7 acres) of ground and the associated utilities required to operate the facilities.

# 5.0 SCHEDULE AND COST

## 5.1 SCHEDULE

Scheduling considerations are a major factor in determining if an existing facility can be used for HTI testing, or if a new facility can be constructed. One of the drawbacks for using an existing facility is that it is difficult to dedicate that facility to HTI testing for the required time period, since the facilities are not "owned" by HTI, and other programs are also competing for their use. The 337 Highbay may not be available until 1999 due to the removal of sodium piping in the facility. Use of the GDF vaults would require extensive rework, the cost of which may be shared by a project which is converting the vaults to a low-level waste disposal facility. That project, however, is just entering the conceptual design stage phase and actual conversion of the vaults will occur beyond the November 1998 need date for HTI testing. MASF has also been used for testing of a mixer pump retrieval system (two 300 hp mixer pumps) for the W-151 project and will be used for testing of ten additional systems for the W-211 project that will continue intermittently until the year 2018. The FMEF is currently being used to test the Light-Duty Utility Arm; however, that testing is scheduled to be completed by the end of this year.

## 5.2 COST

Cost considerations also play a major role in deciding whether to use an existing facility or to construct a new facility. There is a cost trade-off between modifying an existing facility and construction of a new facility. A 1990 study (Croskrey 1990) performed rough order of magnitude estimates, for various test facility configurations whose requirements were more extensive but similar to the HTI test facility requirements, including the following:

| Test Facility Configuration | Cost Estimate (in 1990 $) |
|---|---|
| 1. Rectangular steel test tank | $ 4,300,000 |
| 2. Rectangular concrete test tank | $ 4,600,000 |
| 3. Cylindrical steel test tank | $ 5,160,000 |

The final decision based on cost should include consideration of the future use of the test facility after HTI testing has been completed.

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# 6.0 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

Existing facilities for testing of the HTI retrieval equipment at the Hanford Site do not entirely meet the minimum requirements. The facility that most meets all the requirements for testing, without major renovation, is the MASF. The major drawback of the facility is that the cell size is quite a bit smaller than what is required for testing of the equipment at full extension and through 90° radial movement. The FMEF may warrant future evaluation as a test facility after design details have been completed. Consideration might also be given to the possibility of using multiple facilities, such as using the cold test facility for equipment set up and installation and another facility to demonstrate operation.

If cost and schedule analysis warrant the building of a new test facility, the preferred site location is in the 600 Area, between the 200 East and West Areas. The decision is based on the close location of the site to the east and west tank farms, the adjacent location of the cold test facility that may be used in conjunction with the new facility, and adequate space and expansion requirements.

## 6.2 RECOMMENDATIONS

The following recommendations are made based on the reviews and investigation performed for this report:

- Perform a detailed cost/benefit analysis for remodeling the MASF for use for HTI equipment testing, versus construction of a new testing facility.
- Re-evaluate testing requirements to determine if any requirements can be relaxed or dropped in lieu of the cost/benefit analysis, and investigate if a temporary test facility could be constructed to evaluate specific requirements.
- Re-evaluate test facility site/location after HTI equipment preliminary design is complete.

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