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ENGINEERING DATA TRANSMITTAL

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7. Abstract This document provides guidance to perform Light Duty Utility Arm (LDUA) development work and documentation required to validate the design of the LDUA System.		

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LDUA ENGINEERING DEVELOPMENT PLAN

J. W. Engstrom

September 15, 1994

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LDUA ENGINEERING DEVELOPMENT PLAN

1.0 INTRODUCTION

This engineering development plan summarizes the effort required to acquire a Light Duty Utility Arm (LDUA) to design and build the associated subsystems to support the LDUA System. The LDUA System will be used to deploy various types of sensors and devices to demonstrate the technology and qualify the integrated system for operational use in the Hanford single shell tanks to characterize the waste inside single shell tanks on the Hanford site and assess tank integrity. The work undertaken to accomplish this activity is jointly sponsored by the EM-50 Office of Technology Development (OTD), EM-30 Office of Waste Programs and responsible organizations within Westinghouse Hanford Company (WHC). The EM-50 OTD programs and multiple U.S. Department of Energy (DOE) labs will contribute to the development of the LDUA System.

1.1 SCOPE

The scope of this plan is for development of the LDUA System for use in the Hanford site tank farms. Continued application development activities beyond the initial LDUA development will also be under the scope of this plan. Generally this plan will apply to LDUA Systems being developed for use at other DOE sites. Activities described in this plan beyond the test program may not directly apply to LDUA systems that will be used at other DOE sites.

This plan also defines the program requirements and expectations for the LDUA participants that will be supplying equipment for the LDUA System.

1.2 OBJECTIVES

The objectives of this Development Plan are to provide the information and guidance necessary to perform LDUA development work identified in the LDUA Work Breakdown Structure (WBS) element descriptions. It also describes the work and documentation required to validate the design of LDUA System.

The Work Breakdown Structure (WBS) elements are summarized into the following categories. The full definition of the WBS is found in the WBS dictionary, Appendix A.

1) Project Management.

This includes system administration, technical coordination, DOE's OTD program activities, project documentation control and reporting.

2) System Engineering

This category including equipment design, procurement and fabrication. This involves the procurement of the LDUA subsystem from a robotics vendor and the development of associated subsystems by various DOE contractor organizations. The subsystems include confinement over the tank opening, instrumentation and control, and the end effectors carried by the LDUA.

3) LDUA System Documentation.

The documentation to fully define the LDUA system will be in the form of studies, design baseline and analysis documents. Documentation required to qualify the LDUA system for operation in the underground storage tanks will include safety, environmental compliance, testing and operations documents.

4) Validation of the LDUA system.

Validation of the system includes the formal design reviews at various stages of the system design activities, testing and the operational readiness review (ORR). The basis for this validation will be the LDUA system documentation developed during the third activity, the LDUA system documentation.

5) LDUA system turnover to tank farm operations.

These activities will involve producing a turnover plan and supporting documents, operations and maintenance documents, operational training on the system and transfer of the ownership of the LDUA system to the tank farm operations personnel.

A program file has been developed to store and track all LDUA program documents. An example of the LDUA program file is found in Appendix B. This file index will be update periodically to add or delete file categories as required.

2.0 DESIGN REQUIREMENTS

The coordination and integration of engineering and development work of the LDUA subsystems will be performed at the Hanford site by WHC. This work will entail developing the functions and requirements for each of the LDUA subsystems, definition and control of system interfaces. From this, specifications and design documents of the subsystems will be developed by LDUA Program Participants at various DOE laboratories and commercial vendors. This information will be used to form the basis of the system verifications in the form of design reviews. Procurement documents for the equipment will be in the form of arrangement drawings, specifications and procurement requisitions for design and build contracts and purchase of commercial equipment. Cognizant engineers shall be responsible for the coordination and oversight of subsystem engineering activity by all supporting contributors and monitoring and assisting in the design and fabrication of the equipment.

Typical Documents that will be generated during the LDUA development program are as follows:

- Functions and Requirements
- Specifications
- Design Documents
 - Drawings
 - Design Analysis
- Design Descriptions
- Development Testing Documents
- Technology Research Documents

- Value Engineering Study Reports
- Technical Reports
- Test Plans
- Test Procedures
- Test Reports

Other DOE laboratories (LDUA program participants) will be contributing to the LDUA program. This will include the LDUA decontamination system, contributions to the LDUA control and data acquisition systems and many of the end effectors which will be developed and supplied to the LDUA program at Hanford from the other DOE laboratories. LDUA program contributors shall support the verifications of the system through design reviews and testing. The roles of the other laboratories in the LDUA development are described in the following sections.

3.0 DESIGN CONTROL AND VERIFICATION

Formal design reviews will be conducted on the integrated LDUA system design. These reviews will include design and other engineering documents prepared and submitted by all contributing DOE laboratories as well as commercial vendors under contract to the contributing DOE laboratories to deliver major subsystems or components.

There are three points during the engineering design process at which formal design reviews will be held. These reviews are the conceptual design review (CDR), the preliminary design review (PDR - 25% detail design) and the detail design (DDR - 80% detail design) reviews. The design reviews are intended to verify that the designs meet all the functional and operational requirements and are adequate to perform the intended function before fabrication of the equipment begins. A graded approach consistent with the requirements established by the safety classification of individual subsystem and components will be applied in establishing the level of review and timing for release to fabrication.

Prior to each design review, a design review package shall be assembled and submitted to the design review board at least one month before the design review board meets. The design review package shall include drawings, analysis, functions and requirements, and/or other appropriate documents. Then the design review board is to submit their comments before the design review session for inclusion into a Comment Data Base. During the design review session, each comment will be reviewed and appropriate action taken to resolve the comment. The design reviews will be performed in accordance with WHC document, WHC-CM-6-1 *Standard Engineering Practices*, EP-4.1, Rev 4, "Design Verification Requirements." For the LDUA program, the following verification methods, as a minimum, will be used: formal design reviews and qualification testing of the LDUA System.

The Comment Data Base that will be used is an electronic data base. The database will be used for the purpose of recording and storing comments, open action items, and assigned responsibility for resolution, and status of the action items. It is a management tool to assure the responsiveness and closure of the comments. This database provides a vehicle to identify actions which may

significantly affect the system schedule and cost. This data base will be utilized the entire time of the project until all comments are closed out. Final version of the database that shows the resolved status will be maintained in the project file until turnover of the LDUA System to TWRS operations.

Informal design or peer reviews may be performed as required before or after the formal design reviews to work out the design details. These informal reviews shall be documented in meeting minutes, correspondence or other types of documents and entered in the LDUA program files. Any action items from these informal reviews shall be entered into the comment database for tracking and for conformation of resolution.

4.0 INTERFACE CONTROL

Interface Control Documents (ICD) shall be developed to control the design features for co-functioning LDUA subsystems, equipment, facilities and computer software.

The ICD shall be used to document and control the data and information that define the interface boundaries between systems, subsystems and equipment. Also, the interface boundaries shall define the areas of responsibility for systems and subsystems. The documents shall delineate and identify all the physical and functional interfaces that require coordination to establish and maintain compatibility between the co-functioning equipment, computer software, and the tank farm facilities. The overall LDUA System shall be organized into systems and subsystems. Each of the systems and subsystems shall identified by a numbering scheme. A cognizant engineer shall be assigned responsibility of the system.

An interface control database shall be developed to track the interface information that will be found on the interface documents. Each interface shall be assigned an Interface Control Number (ICN). Data for each ICN shall be included or referenced on the interface database.

The ICN documents shall be developed in accordance the interface control requirements in WHC-CM-6-1, *Standard Engineering Practices*, EP 1.5. The interface documents will generally be in the form of interface control drawings, in text documents and a database. An interface control document plan has been implemented to comply with the above requirements and is found in Reference 5.

Each of the LDUA participants shall contribute interface information for the interface of responsibility. Each participant on either side of the interface shall periodically review the interface information of their responsibility and keep that information current. Updating of the interfaces shall be through the system cognizant engineer. The interface control database shall be periodically distributed to those responsible for the interfaces between subsystems.

5.0 SAFETY REQUIREMENTS

The safety interface with this program is described by *LDUA Safety Program Plan*, WHC-SD-WM-231. This plan ensures that all the design and fabricated equipment will meet all safety requirements for installation and operation in the tank farm at the Hanford site. The objectives of Safety program plan will be to:

- Provide direction for identifying all required safety analyses, testing and hardware safety features for the LDUA design phase.
 - Provide a plan for identifying hazards, evaluating them and incorporating features that address them in the system design.
- Identify organizational interfaces and responsibilities for safety issues.
- Identify the WHC Safety organization involvement in LDUA design, construction and operation.

The LDUA safety program will strive to address all safety and environmental issues in a timely manner and assure compliance with DOE policies regarding nuclear safety, radiation safety, industrial safety, fire protection, and environmental protection for the LDUA system. Each of the LDUA participants shall provide safety analysis and information, as required, for the equipment that will be supplied.

The safety classifications at the system level for the LDUA System are described in the *Preliminary Safety Equipment List for the Light Duty Utility Arm System*, WHC-SD-WM-SEL-034.

6.0 PROCUREMENT

The LDUA cognizant program administrator provides guidance and oversight of all WHC procurement activities and acts as the liaison with WHC procurement and the primary LDUA System point of contact with the LDUA vendor. Procurement activities by other LDUA participants shall include, as a minimum, the following.

- Preparation of specifications
- Approval of vendor designs
- Approval of inspection plans
- Approval of acceptance testing
- Approval of documents as required by specification/purchase order
- Approval of all documents to be delivered to WHC
- Approval of Shipping instructions for equipment that will be delivered to WHC
- LDUA Program participants shall interface with WHC during procurement phase. This includes the review of specifications, purchase order requirements, etc.

Typical Procurement Documents (To be submitted to WHC with delivery of equipment to WHC).

- Purchase orders, including changes/alterations
- Specifications, including revisions
- Correspondence - Seller and Buyer
- Submittal by Seller as required by purchase order. The following are submittal examples:
 - Drawings
 - Design documentation
 - Welding procedures
 - Welder qualification
 - Inspections documents
 - Acceptance Test Plans
 - Acceptance Test Procedures
 - Acceptance Test Reports
- Acceptance by Buyer. This may include receipt/inspection reports, acceptance of supplier documentation by Buyer.
- Progress reports
- Schedule

7.0 OPERATIONAL AND MAINTENANCE MANUALS

Operational and Maintenance Manuals (OMM) shall be prepared for the LDUA System equipment. The responsibility for preparation for these manuals shall be the providers, WHC and the LDUA participants, of the LDUA equipment. The Operational portion of the OMM shall contain all the information required to operate and control the LDUA System equipment. The maintenance portion of the OMM shall contain the procedures to service, replace components, tools, spare parts, trouble shooting and any other information to maintain the equipment. A software manual shall be prepared that provides user's instructions, test and installation procedures, and any other information use fully use the capabilities of the software.

8.0 QUALITY ASSURANCE REQUIREMENTS

Quality Assurance (QA) is an integral part of any successful design and fabrication program. It provides independent oversight at the design, construction and validation stages to assure appropriate management so that the stated objectives and goals are achieved.

Westinghouse Hanford Company directs compliance with DOE quality requirements in WHC-CM-4-2, *Quality Assurance*. This document imposes selective and judicious application of criteria from the national consensus standard, ASME NQA-1, on all quality affecting activities.

The WHC QA interface with this program shall be specified by a QA Program Plan prepared to comply with WHC-CM-4-2. This plan will ensure that appropriate program activities will be defined, controlled and documented in accordance with approved procedure.

LDUA participants at other DOE sites shall use their own QA program to implement QA requirements for the equipment that will be supplied to the LDUA System. These programs shall conform to applicable DOE orders and standards for QA Programs.

9.0 TESTING

9.1 COLD TESTING

WHC, with assistance from the LDUA vendor and LDUA participants, shall qualify the integrated operation of the LDUA subsystems by perform a Cold Test Program. Cold Test means that the equipment shall not be subject to radiological or extreme environments during the cold test program.

Cold Tests shall include a period of Calibration, Grooming and Alignment (CG&A) and full test of the subsystems and integrated system functions and operations. CG&A is performed to provide functional checkouts of instruments and equipment after installation. This activity ensures adequate preparation of the equipment before actual operation. It also provides early identification of equipment problems. The tests shall include a battery of tests for each subsystem adequate to verify its performance and establish its safety features required to support qualification for installation into the Hanford single shell tanks.

The tests will be conducted in the Cold Test facility located in the Fuels and Materials Examination Facility building which is in the 400 area on the Hanford site. A Cold Test plan and procedures shall be prepared to perform these tests. During the tests, a test log shall be maintained and a test report issued at the conclusion of the Cold testing. Guidance for preparing the Cold Test documents shall be in accordance with WHC-CM-6-1, *Standard Engineering Practices*, EP 4.2, Testing Requirements. The testing documentation shall be provided for inclusion in the ORR package where required to receive approval for operational testing. As part of this pre-operational test program, a special operational demonstration may be conducted for viewing by DOE-RL & HQ, user organizations, industry representatives and stakeholders from Hanford and other DOE sites, state and public organizations.

9.2 HOT TESTING

The Hot test will be conducted in a selected waste tank in the Hanford 200 area tank farms. This test program will be under the direction of TWRS (EM-30) with support from LDUA development team (EM-50).

10.0 OPERATIONAL READINESS REVIEW

Prior to conducting the Hot test, an Operational Readiness Review (ORR) is required to assure that the entire LDUA system is ready to be deployed in the tank. This ORR process will be coordinated by TWRS (EM-30) and conducted in accordance with WHC-CM-1-5, *Standard Operating Practices*, ORR 1.2. Approval of the ORR will be required prior to initiating the operational test (hot) activities. The ORR package will require that all the design verification comments are resolved, all safety and QA documents are complete, an operation and maintenance document is in place and a readiness review package has been prepared. A readiness review team will review all the documents to be assured that the LDUA system and all the subsystem meet all the requirements to allow operation of the LDUA inside the waste tanks.

11.0 TURNOVER

Turnover of the LDUA System is a process of transferring ownership of the LDUA System from the WHC EM-50 developers to WHC EM-30 TWRS operations organizations. The turnover process includes a turnover plan that shall be prepared by the customer EM-30 TWRS organization. Then a turnover package shall be prepared jointly by the EM-50 and EM-30 organizations and this will form the basis for transferring ownership the LDUA System from EM-50 to EM-30.

12.0 DELIVERABLES

The LDUA documents to be generated during the development activities are listed below and those responsible for generating the documents.

- a) LDUA Development Plan (This document) (WHC)
- b) Tank Selection and Deployment Strategy Report (WHC)
- c) Tank Farm Studies (WHC)
- d) Environmental Compliance Documentation (WHC)
- e) Functions and Requirements (PNL/WHC)
- f) Engineering Documentation (WHC and LDUA participants)
- g) Software Development Plan (WHC)
- h) Software Documentation (WHC and LDUA participants)
- i) Interface Control Document (WHC)
- j) Engineering Analysis Documentation (WHC and LDUA participants)
- k) Safety Program Plan (WHC)
- l) Safety Documentation (WHC)
- m) Quality Assurance Documentation (WHC and LDUA participants)
- n) Procurement Documentation (WHC and LDUA participants)
- o) Test Documentation - Acceptance Testing (WHC and LDUA participants)
- p) Test Documentation - Cold Test Program (WHC and LDUA participants input)

- q) Training Records (WHC)
- r) Operations and Maintenance Documentation (WHC and LDUA participants)
- s) Project Management and Control Documentation (WHC)
- v) System Turnover Documentation (WHC EM-30/EM-50)

The equipment and/or facilities to be provided during the above activities are listed below.

- a) The LDUA subsystem which includes the robotic arm and deployment truck (WHC/Vendor)
- b) The tank riser interface confinement subsystem which will include the enclosure, the end effector changeout mechanism, the riser adaptor module. (WHC/Vendor)
- c) Decontamination and ventilation equipment. (INEL/Vendor/WHC)
- d) LDUA and data acquisition equipment and software and a trailer to house and transport this equipment. (SNL/Vendor)
- e) Equipment to provide utility services to run the LDUA system. This will included equipment such as electrical generators, instrument enclosures, etc. (WHC/Vendor)
- f) Pre-operational test (cold test) facility and equipment. (WHC)
- g) End Effectors, both arm mounted and stand alone. These will include the Topographical Mapping System, overview Video Camera Systems and future End Effectors. (ORNL/vendor, WSRC/INEL/WHC)

A check list of all deliverables to be transferred to WHC shall be generated by the LDUA participants and submitted to a LDUA system cognizant engineer for review and approval. The WHC Engineering Data Transmittal (EDT) form shall be used for formal approval and retention of the deliverables at WHC. All documents for the LDUA System will be required for the ORR and turnover activities that will occur at WHC.

Documents generated by the LDUA participants shall be submitted to WHC on a periodic basis as directed by WHC. The final submittal of the above document deliverables shall be submitted to WHC in a notebook form prior to the LDUA Operational Readiness Review (ORR) that will conducted for the LDUA Hot test program.

13.0 REFERENCES

1. WHC-CM-6-1, *Standard Engineering Practices*
2. WHC-CM-4-2, *Quality Assurance*
3. WHC-SD-WM-231, *LDUA Safety Program Plan*
4. WHC-SD-WM-SEL-034, *Preliminary Safety Equipment List for the Light Duty Utility Arm System*
5. WHC-SD-TD-ICD-001, *LDUA Interface Control Document Plan*
6. WHC-CM-1-5, *Standard Operating Practices*

14.0 ACRONYM LIST

CG&A Calibration, Grooming and Alignment
ICD Interface Control Document or Drawing
ICN Interface Control Number
INEL Idaho National Engineer Laboratory
LDUA Light Duty Utility Arm
OMM Operation and Maintenance Manual
ORNL Oak Ridge National Laboratory
ORR Operational Readiness Review
SNL Sandia National Laboratory
TWRS Tank Waste Remediation System
WHC Westinghouse Hanford Company
WSRC Westinghouse Savannah River Company

APPENDIX A

LDUA WORK BREAKDOWN STRUCTURE DICTIONARY

LIGHT DUTY UTILITY ARM SYSTEM WORK BREAKDOWN STRUCTURE (WBS) DICTIONARY

Revision 4
February 7, 1994

1.0 UST-ID Characterization and Retrieval Program Coordination (WHC)
(WBS in separate document)

2.0 Early Deployment System (PNL)
(WBS in separate document)

3.0 Light Duty Utility Arm System (WHC)

3.1 Project Management (WHC)

3.1.1 System Administration

3.1.1.1 UST-ID Technology Development Integration (WHC)

Organize, plan, and manage LDUA System¹ activities and provide system management documentation, including Technical Task Plan, functional requirements, work plans, schedule, work breakdown structure, and budget. Provide reporting on status of activities in accordance with the requirements of the Characterization and Retrieval Program. Provide direction to and coordination of work performed in support of LDUA System at multiple DOE laboratories funded through both the UST-ID and RDTP Programs. Organize and execute system reviews, manage tasks specific to the Technical Task Plan (TTP). Work with LDUA System Technical Lead and Control System Integrator to review system engineering activities and oversee progress toward meeting established milestones.

3.1.1.2 TWRS Operations Integration (WHC)

Organize, plan, and manage TWRS-LDUA System operations activities and provide operations management documentation, including schedule, budget, Transition Plan, Operations Strategy, Operational Readiness Review (ORR) Strategy, Operations Procedures, and Operation Training Plan. Provide direction to and coordination of work performed in support of Hot Deployment of the LDUA System at the Hanford Site. Support and participate in system design reviews. Work with LDUA System Technical Lead to review system development status and oversee progress toward meeting established milestones.

3.1.2 Technical Coordination (WHC/PNL)

Perform technical direction and oversight of engineering work in support of LDUA System development², procurement, design, fabrication, and testing.

¹ Light Duty Utility Arm (LDUA) as used in this text refers to the arm and its deployment system to be purchased for use in the tanks. The term LDUA System refers to the LDUA plus related system equipment, including the Tank Riser Interface and Confinement (TRIC) enclosure, maintenance system, decontamination system, Operations Control Trailer and end-effectors.

Develop system functions and requirements for the entire LDUA System. Work with LDUA System Controls System Integrator (SCSI) to incorporate control system specific requirements into System Functions and Requirements document and to ensure system instrumentation and controls work not directed by the SCSI is properly integrated and reviewed. Work with Hanford Site EM-30 and other DOE Sites to ensure compatibility of system designs with waste tank requirements. Participation in mid-year and other required technical and program reviews.

3.1.3 UST-ID Program Activities (WHC)

Provide transfer of technological information developed under the scope of work of the LDUA System to other DOE laboratories, industry and the technical community. This activity shall cover participation in technical conferences, industry demonstrations, and DOE programs to disseminate technical information related to the LDUA System. Input to the ProTech Information System shall be provided to satisfy a DOE/HQ deliverable requirements. Additionally transfer technology from other DOE Laboratories and industry to the LDUA, including the Remote Tank Inspection System through Idaho National Engineering Laboratory (INEL). Work with INEL to provide a LDUA System for use in their underground storage tanks.

3.1.4 Project Documentation Control (WHC)

Establish LDUA Project File to be used for system qualification and eventual turnover to TWRS operations of required records to operate and maintain the system. Establish a file index which is updated and distributed to project personnel and supporting individuals to centrally collect and store copies of all project records. The LDUA System Lead shall be responsible for establishing and maintaining the project file. Guidelines for submitting information to the project file shall be established and form the basis for identifying responsibilities for documentation submittal and approvals.

3.1.5 UST-ID Reporting (WHC)

Weekly and monthly reporting shall be provided as required by the UST-ID and internal WHC guidelines. In addition requirements for reporting by subsystem providers and other system contributors shall be provided by the LDUA System Lead. Progress of work by system contributors shall be reported and tracked at the system level. Monthly input to the Progress Tracking System (PTS) shall be submitted as required by the WHC Technical Program Manager. Monthly status meetings will be held to report status of work, track performance, and exchange information.

3.2 Equipment Design, Procurement and Fabrication (WHC/PNL/INEL/SNL/WSRC/ORNL)

3.2.1 Arm and Deployment System Procurement

3.2.1.1 Proposal Review and Contract Award (WHC/PNL/INEL)

Support to WHC Procurement to answer vendor questions during preparation of bid packages shall be provided. Receipt of vendor proposals shall be reported to DOE/RL to satisfy milestones. Vendor proposals shall be reviewed by a Bid Evaluation Board using the evaluation criteria established in the Request for Proposal package. A successful bidder shall be selected and a contract for the design, fabrication and acceptance testing of the arm and deployment system shall be awarded. Selection of the successful bidder will be reported to DOE/RL to satisfy milestones.

3.2.1.2 Conceptual Design (WHC/PNL/INEL/Vendor)

Following initiation of the procurement contract, a conceptual design review (CDR) package shall be prepared by the vendor based on the requirements of the performance specification and contract documents. This package shall be forwarded to the Buyer for incorporation into the system design review package, that will be forwarded to the design review committee and meeting participants.

3.2.1.3 Detailed Design (WHC/PNL/INEL/Vendor)

Following successful completion of the CDR, the vendor shall receive formal notification to proceed with a preliminary detail design to 25% completion. A 25% Preliminary Design Review (PDR) package shall be prepared and a formal review conducted at the buyer's site. Notification to proceed with design to 80% completion shall be issued following agreement on comment resolution. An 80% Detailed Design Review (DDR) package shall be prepared and a formal review conducted at the buyer's site.

3.2.1.4 Fabrication and Testing (WHC/PNL/INEL/Vendor)

Following agreement on resolution of comments on the 80% DDR package, the vendor shall be notified of approval to proceed with fabrication. Approval to proceed with selected long lead procurement may precede after this notification at the discretion of the buyer. Following completion of fabrication an acceptance test shall be performed for buyer's witness. Upon successful completion and acceptance by the buyer, a completed test report and all documentation shall be issued to the buyer at time of shipment. Completion of this will satisfy key milestones.

3.2.1.5 System Delivery and On-site Support (WHC/Vendor)

Deliver completed system and required documentation to WHC for testing in a cold test facility. Participate in setup and integration of the LDUA System in the test facility. Provide on-site support for integration of the LDUA subsystem with other subsystems and provide required training on system to WHC personnel. Provide ongoing level of effort support for troubleshooting and maintenance of the system as established in the contract.

3.2.1.6 TWRS Field Deployment Unit - Arm and Deployment System (WHC)

TWRS shall procure an additional LDUA System for in-tank use based on design and development work completed by the UST-ID. The UST-ID shall provide support in developing procurement documentation for procurement of an additional arm and deployment systems for TWRS.

3.2.2 Control and Data Acquisition Systems

3.2.2.1 LDUA Control System Integration and Coordination (WHC)

The LDUA System Control System Integrator (SCSI) shall oversee and direct work on development of the instrumentation and control systems for the LDUA System. This task includes participating in value engineering evaluation(s) of control system needs, and to communicate with the UST-ID Program Control System Integrator (PCSI) to develop a report(s) documenting results of the evaluation(s). Following the evaluation(s), the SCSI shall oversee the development of system controls design baseline documents for the system. In addition, the SCSI shall direct the development of validation and verification requirements, plans and documentation for controls software,

and work with Sandia National Laboratory (SNL) and the LDUA vendor to ensure software is developed in accordance with established requirements. The SCSI shall review and direct work on the data acquisition system and controls trailer, as required to ensure compatibility with overall system functional requirements. The SCSI shall work with the LDUA Technical Coordinator to establish system functions and requirements and to integrate controls information and designs with the balance of mechanical and electrical hardware. The SCSI shall act as technical point of contact for all instrumentation and controls work and reviews supporting the LDUA System. Work with the PCSI to ensure the LDUA control system meets established program requirements and goals.

3.2.2.2 Supervisory Control System (SNL/Vendor)

Participate in value engineering evaluation of control system needs for the LDUA System. Provide information on GISC and MiniLab systems and other control system related work ongoing at SNL to support evaluation of potential usage on LDUA. Participate in review of LDUA vendor controls design to ensure compatibility with the overall control system requirements. Develop detail design of control system as defined by the LDUA functional requirements and strategy developed in the controls value engineering study. Provide hardware for development, testing and final delivery to WHC for integration with the other subsystems at the cold test facility. Participate in equipment integration and validation during system cold and hot testing. Provide required software and hardware documentation to support design validation and verification processes.

3.2.2.3 I&C and Electrical Equipment (WHC)

Provide electrical, instrumentation, and control design for LDUA subsystems not provided by the LDUA vendor or other subsystem providers. This activity includes the following activities as a minimum. Provide electrical and I&C engineering support for the Tank Riser Interface and Confinement subsystem, any required maintenance equipment, test facility design and equipment, system testing and other tasks to be defined as the system engineering progresses. Activities shall be performed in accordance with the direction and guidelines established by the SCSI for the LDUA System. Provide support in qualification of subsystem software systems in accordance with the requirements of the software development plan (SDP).

3.2.2.4 Data Acquisition System Coordination (WHC)

Establish functional requirements for the LDUA data acquisition system, considering sensors and any identified needs for integration of data with the controls for positioning of the LDUA. Work shall conform with guidelines and functional requirements established by the LDUA SCSI and Characterization and Retrieval PCSI. Provide block diagrams of system architecture and interfaces with control systems for the LDUA and related system equipment (e.g. Tank Riser Interface and Confinement Enclosure, End-Effector Exchange System).

3.2.2.5 Supervisory Data Acquisition System (SNL)

Provide a data acquisition system design and obtain and test system hardware. Work with LDUA SCSI to ensure design of the data acquisition system is compatible with the overall control system design for LDUA. Ensure compatibility of system hardware with Operations Control Trailer design. Evaluate commercially available software to determine compatibility

with LDUA System functional requirements. Provide required documentation for system operation and validation.

3.2.2.6 Operations Control Trailer (WHC/SNL)

Design and fabricate an Operations Control Trailer to house the data acquisition system equipment, LDUA manipulative controls equipment, high level control system equipment, and other monitors for viewing system support and recording. The Operations Control Trailer shall provide a workstation for system test engineers, operators and observers, and shall provide the necessary ergonomics and environmental systems required for extended duration occupancy and for protection of system equipment.

3.2.2.7 Control System Requirements and Interfaces (WHC)

Provide definition of requirements for LDUA control system to support development of overall system level Functions and Requirements Document. Define control system interfaces and integrate into LDUA System Interface Control Document.

3.2.2.8 Software Development Plan and Validation Records (WHC)

Provide a baseline document defining the requirements and methods to be used to test and validate software systems for the LDUA System. Software quality assurance records shall reflect the applicable requirements depending on the safety and quality assurance classifications of the subsystem. Software code, test documents and other records required to qualify the system for hot operation shall be specified in the Software Development Plan. Copies of all software quality assurance records shall be maintained in the project file.

3.2.3 Tank Riser Interface and Confinement (TRIC) (WHC/Vendor)

3.2.3.1 TRIC Enclosure (WHC/INEL/Vendor)

Design a structure to form the interface between the underground storage tank riser and the LDUA subsystem provided by a commercial vendor. Conduct a value engineering study to identify the best engineering solution, considering cost, functional requirements, and regulatory impacts. This interface structure shall form the confinement boundary for any airborne or smearable contamination resulting from operation of the LDUA subsystem in the tank. Provide required engineering specifications, drawings and other documents required to build and test this subsystem. Required interfaces for the LDUA subsystem, End-Effector Exchange System, decontamination system, and other equipment shall be identified and controlled.

3.2.3.2 End-Effector Exchange System (WHC/Vendor)

Design and fabricate an automated end-effector exchange system mechanism to be installed in the Tank Riser Interface and Confinement (TRIC) enclosure. This component shall provide for storage and changeout of end effectors on the LDUA subsystem within the confinement boundary. Required interfaces with the TRIC structure and LDUA tool interface plate and arm shall be identified and controlled.

3.2.3.3 Decontamination System (INEL/Vendor)

Design and provide hardware for a decontamination system to be integrated into the Tank Riser Interface and Confinement (TRIC) enclosure. Perform a

trade study to select a decontamination method and media which is best suited for the LDUA System application. Provide detail design and/or specification of this system for procurement of the required equipment. Participate in integration and testing of the decontamination system as part of the LDUA cold and hot testing.

3.2.3.4 Ventilation System (INEL/Vendor)

Design and provide hardware for a ventilation system to be integrated into the Tank Riser Interface and Confinement (TRIC) enclosure. Perform necessary analyses to determine a ventilation method that is best suited for the LDUA System application. Provide detail design and/or specification of this system for procurement of the required equipment. Participate in the integration and testing of the ventilation system as part of the LDUA cold and hot testing.

3.2.3.5 TRIC Field Deployment Unit (WHC/Vendor)

TWRS shall procure an additional TRIC subsystem for in-tank use based on design and development work completed by the UST-ID. The UST-ID shall provide support in developing procurement documentation for procurement of an additional TRIC Field Deployment Unit for TWRS.

3.2.4 Maintenance Facility and Equipment (WHC)

Provide required equipment for maintenance of the LDUA subsystem. Facility location and equipment requirements shall be as defined in the Operations and Maintenance Study (WBS 3.3.2.3). (Subtier WBS elements to be determined following completion of this study.)

3.2.5 Tool Interface Plate (WHC/Vendor)

Develop and fabricate a tool interface plate (TIP) to be placed on the end of the LDUA and on each LDUA deployable end-effector. Integrate utility/actuation devices required to accommodate remote changeout of end effectors in the Tank Riser Interface and Confinement (TRIC) enclosure and End-Effector Exchange System (EEES). Provide necessary utilities for currently identified and anticipated future end effectors.

3.2.6 End Effectors

3.2.6.1 Surveillance and Inspection Systems Development

3.2.6.1.1 Needs Assessment (WHC)

A needs assessment study will be performed to determine priorities at the Hanford site for surveillance and inspection technologies to support tank integrity assessments. A report with a prioritized list of the needs and strategy for obtaining or developing the appropriate technologies to satisfy these needs shall be prepared.

3.2.6.1.2 Technology Review (WHC)

An engineering study shall be performed to locate and review appropriate technologies to satisfy particular surveillance and inspection needs identified in the above assessment report. A search of industry, other DOE sites and government agencies, and literature shall be performed to assess the state of the art with respect to remote surveillance and inspection and select appropriate devices to be deployed by the LDUA System.

3.2.6.1.3 Design and Procurement (WHC)

Engineering design and/or procurement of recommended surveillance and inspection technologies shall be performed to deliver selected systems for testing at the LDUA cold test facility.

3.2.6.1.4 Technology Transfer (WHC/INEL/WSRC)

Where appropriate findings of the above studies and engineering activities shall be published or transferred for application at other DOE sites. In particular, work shall be closely coordinated with activities underway to test the Remote Tank Inspection (RTI) System at INEL. Information on development of remote inspection devices for this system shall be transferred for possible application to the LDUA System. Specifically, INEL is evaluating using a non-destructive weld examination device and a high resolution laser range-finder inspection system. INEL shall provide recommendations on the use of these systems on the LDUA. Visual surveillance technologies developed for applications at Savannah River will also be evaluated for application to LDUA.

3.2.6.2 Video and Photographic Systems (WSRC)

This activity shall provide video and photographic riser mounted and end-effector systems necessary for obtaining visual data of the interior of underground waste storage tanks. The activity shall include the design and fabrication of several different end-effectors that include; overview camera system, overview stereo camera system, close-up stereo video system, and close-up stereo photography system. These end-effector systems shall be available for use in cold testing of the LDUA.

3.2.6.3 Topographical Mapping Systems (WHC/PNL/ORNL)

Evaluate joint deployment of laser range-finder (LRF) and structured light mapping systems (SLMS) to investigate the potential for enhanced mapping capabilities using both systems together. If feasible, develop a testing strategy for deployment of the systems in conjunction with LDUA testing. Provide letter reports detailing requirements for testing the dual mapping system for incorporation into the LDUA system Test Plan.

3.2.6.3.1 Laser Range-finder (PNL)

Identify and adapt, as necessary, Laser Range-finder (LRF) system technology for use and deployment on LDUA. Perform necessary packaging, radiation hardening, and ruggedness enhancement modifications to allow LRF system deployment on LDUA. The LRF system shall be available for use in cold testing of the LDUA.

3.2.6.3.2 Structured Light (ORNL)

Identify and adapt, as necessary, Structured Light Mapping System (SLMS) technology for use with the LDUA. Perform necessary packaging, radiation hardening, and ruggedness enhancement modifications to allow SLMS system deployment in support of the LDUA. The SLMS shall be available for use in cold testing of the LDUA.

3.2.6.3.3 Mapping Systems Integration and Data Fusion (PNL/ORNL/SNL)

Techniques to integrate (fuse) data from different types of mapping systems shall be developed and demonstrated. Fused data shall be used for developing an enhanced tank mapping capability and world model generation.

3.2.6.4 Non-Destructive Examination End-Effector (INEL)

This activity shall identify and adapt as necessary, Non-Destructive Examination (NDE) technologies for use with the LDUA. The activity shall focus on the utilization of existing, "off-the-shelf" technologies. Partnerships with commercial companies, colleges and universities shall be established as necessary.

3.2.6.5 Characterization End-Effectors (WHC)

This activity shall provide end-effectors to demonstrate appropriate technologies for in-situ chemical, rheological, radiological characterization of waste. Devices shall be provided for demonstration and evaluation during LDUA System cold testing. Results of hot cell development and/or other testing shall be provided to support system documentation development.

3.2.6.6 Retrieval End-Effectors (WHC)

To date no specific requirements for retrieval or sampling functions have been identified for the LDUA System. Details shall be added as specific tasks are identified. Potential activities involve demonstration of scaled retrieval devices and collection of samples for characterization or process verification.

3.2.6.6.1 Scaled Retrieval End Effector Testing - TBD**3.2.6.6.2 Sampling - TBD****3.2.6.6.3 Process Verification - TBD****3.3 System Documentation****3.3.1 Tank Selection and Deployment Strategy (WHC/PNL)**

Develop selection criteria and evaluate potential candidate tanks for deployment of the LDUA System for hot testing and demonstration and for follow-on operational use after system turnover. Provide letter documenting selection process and recommended candidate tanks. Deployment strategy shall form basis for pursuing development of required safety and environmental compliance documentation.

3.3.2 Tank Farm Studies (WHC)

Perform engineering studies as required to define requirements and operating parameters for the LDUA System. Evaluate site conditions and develop input to system functional requirements. Define system qualification requirements for testing and operational use.

3.3.2.1 Riser Study (WHC/KEH)

Perform review of available documentation on 12" and 4" tank risers in the Hanford single shell tanks to determine availability and condition of these risers. Prepare a report on the findings of this review and recommend further actions for field verification or examination of risers that are selected for use by the LDUA System.

3.3.2.2 Tank Farm Access & Layout Study (WHC/KEH)

Perform a review of available documentation on tank farm site layout and

access conditions and recommend best configurations for deployment of the LDUA System. Provide a report and any required layout drawings documenting system deployment scenarios and equipment placement. Define requirements for tank farm access and any limitations or restrictions which must be considered in the testing or operation of the system within the various single shell tank farms.

3.3.2.3 Operations and Maintenance Study (WHC)

Perform an assessment of the operating and maintenance requirements for the LDUA System for hot operations in the single shell tank farms. Assess availability of existing hot maintenance facilities/areas which may be suitable for performing maintenance operations on the various LDUA subsystem equipment. Determine additional equipment design requirements and provide a detailed description of the operating and maintenance scenarios for the system.

3.3.2.4 Field Verification Measurements (WHC/KEH)

Perform field verification measurements of selected risers designated for use by the LDUA system. Field Verification shall include the measurement of inside of selected risers using plug gauges and other devices to determine riser clearance, orientation, and general suitability.

3.3.3 Functions and Requirements (F&Rs)(WHC/PNL)

Develop a Functions and Requirements document to guide design of the LDUA System. This document shall incorporate information from the LDUA procurement specification and subsystem functional requirements. Define the operating parameters and design requirements against which the subsystems shall be reviewed. Update document as required to incorporate new information determined from various engineering studies.

3.3.4 Interface Control Document (ICD) (WHC/PNL)

Develop an Interface Control Document that shall record the interfaces between equipment within the LDUA System and between the LDUA System and the tank farm or maintenance facility. Maintain and update this document as detail designs of equipment are developed. The ICD shall establish interface configuration and ownership of the corresponding components, to control system design and ensure proper performance in testing and operation.

3.3.5 Test Documentation

3.3.5.1 Test Facility Engineering Study (WHC)

An engineering study of the requirements and available options for performing cold testing of the LDUA System shall be performed. A test facility site shall be selected based on an evaluation of available sites against selection criteria. A conceptual design of the test facility layout and cost estimate for fabrication and setup of the facility shall be developed. A report documenting the above information shall be provided.

3.3.5.2 Test Facility Design Documentation (WHC)

Detail design engineering drawings and analyses shall be provided as appropriate to construct and setup the cold test facility for the LDUA System. Facility modifications and equipment installation and setup shall be accomplished to provide a simulated tank farm environment for cold testing and demonstration.

3.3.5.3 Pre-operational (Cold) Test Plan (WHC/PNL)

A test plan shall be prepared to establish the requirements and methods for pre-operational testing of the LDUA System in a cold test facility. This document shall be released and form the basis for preparation of subsequent testing documents.

3.3.5.4 Pre-operational (Cold) Test Procedures (WHC/PNL)

Approved test procedures shall be provided against which the testing of the LDUA System shall be conducted and controlled. Procedures for operating equipment, gathering test data and documenting test results shall be specified in these procedures. Appropriate safety and operational requirements shall be incorporated into the test procedures.

3.3.5.5 Pre-operational (Cold) Test Report (WHC/PNL)

Following completion of pre-operational testing of the LDUA System, a test report documenting the results of pre-operational testing of the LDUA System shall be provided. This report shall document how the requirements of the test plan were met and shall include records of testing such as test logs and procedures used. This report shall become part of the Operational Readiness Review (ORR) package.

3.3.5.6 Operational (Hot) Test Plan (WHC)

A test plan shall be prepared to establish the requirements and methods for operational testing of the LDUA System in a Hanford single shell tank. This document shall be released and form the basis for preparation of subsequent testing documents. This test plan shall become part of the ORR package.

3.3.5.7 Operational (Hot) Test Procedures (WHC)

Approved test procedures shall be provided against which the testing of the LDUA System shall be conducted and controlled. Procedures for operating equipment, gathering test data and documenting test results shall be specified in these procedures. Appropriate safety and operational requirements shall be incorporated into the test procedures. These test procedures shall become part of the ORR package.

3.3.5.8 Operational (Hot) Test Report (WHC)

Following completion of operational hot testing of the LDUA System, a test report documenting the results of operational testing of the LDUA System shall be provided. This report shall document how the requirements of the test plan were met and shall include records of testing such as test logs and procedures used.

3.3.6 Operational Readiness Review (ORR) Documentation

3.3.6.1 Operational Readiness Review Strategy (WHC)

A strategy paper or report shall be developed outlining the best information available on requirements for development of an ORR package for hot testing and subsequent operation of the system in Hanford single shell tanks. This document shall be developed for review as part of the detailed design review package to ensure appropriate activities are identified and scheduled, and system planning reflects the requirements for developing the ORR package. This strategy shall form the baseline for ORR planning and new requirements and policies shall be reflected in addenda to this document.

3.3.6.2 Operational Readiness Review (ORR) Package (WHC)

An operational Readiness Review Package shall be prepared containing the required documentation to establish readiness of the system for operation in a single shell tank. Requirements for the package shall be as established in the Operational Readiness Review Strategy and subsequent requirements, as dictated by tank farm operating requirements.

3.3.6.3 Operational Readiness Review Report (WHC)

Following completion of operational readiness review of the LDUA System a test report documenting the results and disposition of operational testing plans shall be provided. This document shall provide the basis for obtaining approval to proceed with operational testing of the LDUA System in a Hanford underground waste storage tank.

3.3.7 Safety Documentation (WHC)

3.3.7.1 Safety Plan (WHC)

A Safety Plan shall be provided outlining the activities and documents required for safety validation of the LDUA System. This document shall identify the sequence of activities and responsibilities for actions or documents.

3.3.7.2 Preliminary Safety Equipment List (PSEL) (WHC)

A Preliminary Safety Equipment List (PSEL) shall be prepared identifying the safety classification of the LDUA subsystems and components. This information shall be provided prior to and incorporated into the Conceptual Design Review package and shall be reflected in system engineering and validation requirements. Requirements for safety classification activities shall be defined in the Safety Plan.

3.3.7.3 Preliminary Hazards Analysis (PHA) (WHC)

A preliminary Hazards Analysis (PHA) shall be performed following the system Conceptual Design Review. The conceptual design shall be evaluated to determine potential hazards that should be addressed in the detail design. Requirements for the PHA shall be defined in the Safety Plan. As much as practical existing documentation shall be referenced in performing this analysis.

3.3.7.4 Hazards and Operations Analysis (HAZOPS) (WHC)

A Hazards and Operations Analysis (HAZOPS) shall be performed following the system Preliminary Design Review. The preliminary design shall be evaluated to determine potential hazards associated with the operation of the LDUA system. Requirements for the HAZOPS analysis shall be specified in the Safety Plan.

3.3.7.5 Safety Assessment (WHC)

A Safety Assessment (SA) and or other safety assessment documentation shall be provided as required by the Safety Plan and DOE guidelines and orders. Existing SA documentation for tank farm operations shall be reviewed to determine if LDUA System operations are covered or similar to those already analyzed.

3.3.8 Environmental Compliance Documentation (WHC)

3.3.8.1 NEPA Strategy (WHC)

A strategy for meeting the requirements for NEPA documentation for testing and operation of the LDUA System shall be prepared. This strategy shall be presented for review and comment to the DOE-RL NEPA Compliance Officer prior to proceeding with preparation of the required documentation.

3.3.8.2 NEPA Documentation (WHC)

3.3.8.2.1 NEPA Documentation - Testing (WHC)

NEPA documents necessary for testing the LDUA System, as described in the NEPA Strategy Report, shall be prepared and forwarded for review and approval to DOE as required. The NEPA documentation for testing shall be referenced as part of the ORR package.

3.3.8.2.2 NEPA Documentation - Operations (WHC)

NEPA documents necessary for operations of the LDUA System in the underground waste storage tanks at the Hanford site, as described in the NEPA Strategy Report, shall be prepared and forwarded for review and approval to DOE as required. The NEPA documentation for operations shall be referenced as part of the ORR package.

3.3.8.3 Regulatory Analysis (WHC)

Following the Conceptual Design Review the LDUA system design information, functions and requirements and other available operating information shall be provided to WHC Regulatory Analysis to perform an assessment of applicable federal, state and local environmental regulations that could impact the LDUA System design or operation. The report of this regulatory analysis shall become part of the ORR package.

3.3.8.4 Other Environmental Compliance Documentation (WHC)

Any environmental compliance documents (e.g. Clean Air Act Permit) that are identified in the Regulatory Analysis Report as being required for the LDUA System shall be obtained through the appropriate governmental agency. These documents shall become part of the ORR package.

3.3.9 Operations Documentation (WHC)

Requirements for additional operations documentation shall be defined in the Operations and Maintenance Study (WBS 3.3.2.3).

3.3.10 Engineering Analysis Documentation (WHC)

Documentation of engineering calculations and analyses shall be provided as appropriate to support system design and validation. This documentation shall be review as part of the system design review process.

3.3.11 Quality Assurance Documentation (WHC)

A Quality Assurance Plan shall be provided to direct and define the requirements for quality assurance activities and documents supporting the LDUA System. Additional quality assurance reviews and documentation shall be provided as specified in this plan.

3.3.12 Engineering Documentation (WHC)

Engineering documentation shall be prepared, reviewed and approved in

accordance with established contractor requirements. Engineering documents shall reflect the applicable requirements for safety and quality assurance (e.g. safety class, impact level) as established in the applicable plans and guidance. These engineering documents shall include items such as drawings, diagrams, reports, specifications, trade studies and other documents appropriate to support and record the system design and its basis.

3.3.13 Project Documentation (WHC)

Project documentation shall be prepared as required to establish the administrative and program baseline for the LDU System development, procurement/fabrication, testing and eventual turnover. As the activities to develop and demonstrate the LDU System are not classified as an official project under the definition of DOE 4700, these documents shall be as agreed to by the UST-ID system providers and tank farm customer organizations. An engineering workplan shall be prepared outline the planning for direction and control of the project, and establishing priorities and responsibilities for participants. Additional project documentation shall be provided as required by the Office of Technology Development (EM-50) and tank farm customer organizations (EM-30).

3.3.14 Vendor Documentation (WHC)

Vendor documentation shall be controlled and stored for turnover with the system to tank farm customers in accordance with WHC procedures. Certified Vendor Information files shall be maintained as part of the Project File until such time that this documentation is turned over to Tank Farm Operations.

3.3.15 Procurement Records (WHC)

Procurement records (e.g. Purchase Orders, Contract, Inspection Reports etc.) shall be maintained in the project file until turnover of the system to Tank Farm Operations.

3.3.16 Training Records (WHC)

Records of training for participants in various activities on the LDU project shall be maintained as part of the LDU project file.

3.4 System Validation

3.4.1 Conceptual Design Review (CDR) (WHC)

A design review committee shall be convened to review CDR packages supplied by the LDU Vendor and other subsystem providers. A formal review shall be held at Hanford, and following completion of the review and compilation of comments and questions, a design review report shall be issued forwarding meeting notes and comments for resolution to participants. WHC shall provide interface requirements for related system equipment at the time of the conceptual design review.

3.4.2 Preliminary (25%) Design Review (PDR) (WHC)

A design review committee shall be convened to review 25% complete preliminary design packages supplied by the LDU Vendor and other subsystem providers. A Preliminary Design Review shall be conducted at Hanford after completion of 25% of the system design. Following completion of the review meeting and compilation of comments and questions a report on the PDR shall be issued.

3.4.3 Detailed (80%) Design Review (DDR) (WHC)

A design review committee shall be convened to review 80% complete detail design packages supplied by the LDUA Vendor and other subsystem providers. A Detail Design Review shall be conducted at Hanford after completion of 80% of the system design. Following completion of the review meeting and compilation of comments and questions a report on the DDR shall be issued.

3.4.4 Training (System Testing) (WHC)

Training for participation in all testing of the LDUA System shall be performed in accordance with the requirements established in the applicable test plans and procedures. Specific requirements for this training shall satisfy all WHC requirements for safety and conduct of operations.

3.4.5 System Pre-operational Test (Cold Test) (WHC)

Pre-operational testing of the LDUA System shall be conducted in a cold test facility in accordance with requirements of the test plan and procedures.

3.4.5.1 System Cold Demonstration (WHC)

An official demonstration of the system shall be performed for DOE, State Regulators, and customer organizations as part of the cold test activity.

3.4.6 Operational Readiness Review (ORR) (WHC)

An ORR shall be conducted to review the ORR package prepared for the LDUA System and to determine system readiness for hot operations in a single shell tank. An ORR committee shall be selected to perform this review in accordance with WHC procedures for conducting such reviews. This activity shall be required prior to receiving authorization to proceed with operational (hot) testing of the LDUA System.

3.4.7 System Operational Test (Hot Test) (WHC)

Operational testing of the system shall be conducted in a single shell tank in accordance with requirements of the test plan, test procedures, and tank farm operating procedures.

3.4.7.1 System Hot Demonstration (WHC)

An official demonstration of the system shall be performed for DOE, State Regulators, and customer organizations as part of the hot test activity.

3.4.8 Development Testing (WHC/PNL/SNL/ORNL/WSRC/INEL)

Development testing and demonstration of LDUA End Effectors and associated support subsystems shall be conducted in the LDUA Cold Test Facility. Development tests and demonstrations performed shall be conducted in accordance with the requirements and procedures described in the Test/Demonstration Plan and Test/Demonstration Procedures.

3.4.8.1 End Effector & Data Acquisition System Demonstration (PNL/WHC/SNL)

Development testing of selected surveillance and inspection end effectors and the data acquisition system shall be conducted prior to full incorporation into the LDUA System. Testing shall be conducted at the LDUA Cold Test Facility, Building 4706, Fuels and Materials Examination Facility (FMEF). The demonstration shall be performed for DOE, State Regulators, and customer organizations as part of the LDUA End Effector Development activity.

3.5 System Turnover

3.5.1 Turnover Plan (WHC)

A plan for transition of ownership from EM-50 UST-ID LDUA System developers to EM-30 TWRS customer organizations shall be developed. This plan shall outline the procedures and responsibilities for turning over ownership of the system to the operations customer. This plan shall be prepared, reviewed and approved in accordance with WHC procedures and requirements.

3.5.2 Turnover Package (WHC)

A turnover package shall be prepared including the elements defined in the turnover plan. This package shall be prepared jointly by EM-50 and EM-30 organizations and upon approval shall form the basis for transitioning ownership of the system.

3.5.3 Transition Team (WHC)

3.5.3.1 Transition Team (WHC)

An EM-30 staffed transition team shall be named to work with EM-50 system developers to facilitate eventual transition of ownership of the system to Tank Farm Operations customers. The number of representatives on this team shall develop through the life of the project to a maximum number of participants during the hot testing and system turnover phases. Members of the transition team shall participate in reviews of the system design, testing of the system.

3.5.3.2 Operations Crew Assignments (WHC)

Operations Crew(s) shall be assembled and assigned by EM-30 TWRS and shall become fully trained in the operation and maintenance of the system to ensure Tank Farms Operations is ready to assume full operating responsibility for the system after turnover.

3.5.3.3 Operations Support Staff Assignments (WHC)

Adequate operations support staff (e.g. planner/scheduler, cost analyst) shall be assembled and assigned by EM-30 TWRS to support operation of the LDUA.

3.5.4 Operations Training (WHC)

Training shall be provided to members of the EM-30 transition team on testing, operations and maintenance of the LDUA System equipment. Requirements for this training shall be established in various documents, including the Operations and Maintenance Study, Test Plans, and Turnover Plan. Part of the training shall consist of participation on functional operation of the equipment during system operational testing. Records of training shall be prepared and maintained as established in the system test plans and Turnover Plan.

3.5.5 Operating Procedures (WHC)

System Operating Procedures shall be developed by EM-30 TWRS following completion of hot testing of the LDUA System. Results of testing and recommendations from the Operational Test Report shall be reflected in the preparation of these documents. EM-50 UST-ID system developers shall support development of these procedures as required to provide technical assistance and reviews.

3.5.6 Operations and Maintenance Manuals (WHC)

Operations and Maintenance Manuals (OMMs) shall be prepared and turned over to Tank Farm Operations TWRS as part of the system turnover package.

3.5.7 Open Item Resolution (WHC)

Open items identified in the Operational Test Report and Turnover Plan shall be tracked and maintained in a controlled database to ensure completion of outstanding actions and corrective measures. Details on resolution and closeout of open items shall be specified in the Turnover Plan.

3.5.8 Ownership Transfer (WHC)

Following completion of activities specified in the Turnover Plan and agreement of all parties to resolution or continuance of open items, ownership of the LDUA System shall be transferred from the EM-50 UST-ID system developers to the EM-30 TWRS Tank Farm customer organization. Some members of the EM-50 development team shall continue to support the system after turnover and as defined in the Turnover Plan.

3.6 Continued Applications Development Support (WHC)

The UST-ID LDUA system development team shall continue to develop enhanced capabilities for use with the LDUA. Development of new End-Effectors and adaptation of new technologies to the LDUA shall be pursued.

3.7 Technology Transfer (WHC)

The LDUA System technology shall be actively transferred and applied to other DOE sites.

4.0 Characterization Systems (WHC)

(WBS in separate document)

5.0 Tank Retrieval Manipulator System (WHC)

(WBS in separate document)

6.0 Waste Dislodging & Conveyance Systems (WHC)

(WBS in separate document)

APPENDIX B

LDUA PROGRAM DOCUMENT FILING INDEX

LIGHT DUTY UTILITY ARM (LDUA) FILE INDEX

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- 1.18 Points of Contact
- 1.19 CRADA Information
- 1.20 ECCEL
- 1.21 ANS RRSD
- 1.22 Systems Engineering
- 1.23 Technical Services Contracts
- 1.24 Equipment Loan Agreements
- 1.25 Performance Indicators
- 1.26 Self Assessments
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- 2.1 Outgoing
 - 2.1.1 INEL
 - 2.1.2 SNL
 - 2.1.3 PNL
 - 2.1.4 USTID/ROBOTICS
 - 2.1.5 WHC
 - 2.1.6 TWRS Customers
 - 2.1.7 DOE/HQ LDUA
 - 2.1.8 DOE/HQ OTHER
 - 2.1.9 MISC
 - 2.1.10 WSRC
 - 2.1.11 ORNL
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- 2.2 Incoming
 - 2.2.1 INEL
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 - 2.2.6 TWRS Customers
 - 2.2.7 DOE/LDUA
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 - 2.2.9 Miscellaneous

2.2.10 ANS Corresp.

- 2.2.11 SPAR
- 2.2.12 WSRC Incoming Corresp.
- 2.2.13 ORNL
- 2.2.14 KEH
- 2.2.15 Robotics Vendors
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- 2.3 Telecons
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- 2.4 Meeting Minutes
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 - 2.4.3 Cog. Engineer Meetings
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 - 2.4.6 FY94 Kickoff
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- 2.5 Trip Reports
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 - 2.6.1 Progress Tracking System (PTS)
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 - 2.7.10 LDUA PIS
- 2.8 Presentations
- 2.9 Graphics, Photos, Videos
- 2.10 References
 - 2.10.1 TWRS Reports
- 2.11 Logbooks
- 2.12 Publications
 - 2.12.1 ANS Publications
 - 2.12.2 Hanford Reach Articles
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 - 2.12.4 UST-ID Publications
- 2.13 DOE Tank Integrity Panel
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- 2.15 LDUA Technology Transfer, ORNL
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- 2.17 ACTION ITEMS
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- 3.1 Cost Estimates
 - 3.1.1 EDS Cost Est.
 - 3.1.2 LDUA Equipment Cost Estimate
 - 3.1.3 LDUA Test Facility Cost Estimate
 - 3.1.4 Estimate at Completion
- 3.2 Cost Account Authorization
- 3.3 Cost Account Plans
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 - 3.3.2 TPCNs
 - 3.3.3 FY 93 Cost Reports
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- 3.4 WBS Dictionary & Index
 - 3.4.1 EDS WBS
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- 3.5 Financial Plans
 - 3.5.1 FY Work Plans
 - 3.5.2 Acquisition Plans
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- 3.6 Milestones
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 - 3.6.3 WHC Key Milestone Schedules
 - 3.6.4 Milestone Description Sheets
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 - 3.6.6 Baseline Change Request
- 3.7 Budget Guidance Correspondence
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 - 3.7.2 Budget Info Gen.
 - 3.7.3 FY 1993 Guidance
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- 3.8 Project Planning
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 - 3.9.5 TWRS Top Level
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- 3.10 Principle Investigator Work Plans
 - 3.10.1 WHC
 - 3.10.1.1 LDUA ENGR. Work Plan
 - 3.10.2 PNL
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- 3.10.4 INEL
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- 3.10.6 Tank Farms Projects
- 3.10.7 Other
- 3.10.8 WSRC
- 3.11 Process Tracking System (PTS) Reports

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- 4.1 Program Plan
- 4.2 QA/Safety Plans
- 4.3 System Lead
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- 4.4 TTPs - General Information
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 - 4.4.4.1 TTP RL 332002
 - 4.4.5 TPM Guidance
 - 4.4.6 ORNL TTPS
 - 4.4.7 TTP Listings
- 4.5 TWRS Plans
 - 4.5.1 Retrieval Plan
 - 4.5.2 Characterization Plan
 - 4.5.2.1 Characterization Needs
 - 4.5.3 Tank Safety Applied Tech. Plan
- 4.6 LDUA
 - 4.6.1 Technical Task Plan RL401203
 - 4.6.1.1 FY'94 TTP RL401203
 - 4.6.1.2 FY'95 TTP
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 - 4.6.2 Protect
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 - 4.6.5 LDUA TTP Correspondence
- 4.7 Early Deployment System
 - 4.7.1 TTP
 - 4.7.2 EDS Information (General)
 - 4.7.3 EDS Prelim Des. Rev.
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- 4.8 Characterization
 - 4.8.1 TTP
- 4.9 Long Reach Arm (Retrieval)
 - 4.9.1 TTP
 - 4.9.2 Robotics TWRS Program
- 4.10 National Working Groups
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 - 4.10.2 Technical Program Managers
 - 4.10.3 Integ Demo (ID) & Integ Prog (IP)
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 - 4.12.2.1 1993 Mid Year
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- 4.12.2.3 FY94 Mid-Year Tech. Review
 - 4.12.2.4 FY 94 Qtrly Review
 - 4.12.3 TTP Reviews
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 - 4.12.4.2 FY 1994 Recommendations
 - 4.12.4.3 FY 94 DOE TTP Comments
 - 4.12.5 Strategic Plans
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 - 4.12.7 Standard EM-50 OD. PROC.
 - 5.0 LDUA System Requirements
 - 5.1 General System Requirements
 - 5.1.1 System Functions & Req. Doc.
 - 5.1.2 LDUA
 - 5.1.2.1 Equipment Numbering
 - 5.1.2.2 Interface Control System
 - 5.1.3 Tank Riser Interface & Confinement
 - 5.1.3.1 Decon System
 - 5.1.3.1.1 DECON F&R
 - 5.1.3.1.2 Decon System General
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 - 5.1.3.2 Tool Changeout Sys.
 - 5.1.3.3 Ventilation
 - 5.1.3.4 VE Session
 - 5.1.3.5 General Info
 - 5.1.4 Maintenance Subsystem
 - 5.1.4.1 O&M Study
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 - 5.1.4.3 Operations Info
 - 5.1.5 Control Systems
 - 5.1.5.1 Control Systems Evaluation
 - 5.1.5.2 Data Acquisition
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 - 5.1.5.5 Controls Trailer
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 - 5.1.5.8 SNL Activities
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 - 5.1.6.1 Explosive Atmosphere Req.
 - 5.1.7 Support Utilities
 - 5.1.8 Miscellaneous
 - 5.1.9 Test Facility
 - 5.1.9.1 Test Facilities, Engineer Study
 - 5.1.10 DOE Orders
 - 5.2 Tank Farms Operating Requirements
 - 5.2.1 Tank Information
 - 5.2.2 LDUA Tank Information
 - 5.2.2.1 Tank Selection Letters
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 - 5.2.2.3 Tank 241-A-105
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 - 5.3.3 Tool Interface Plate
 - 5.3.4 Waste Sampling System
 - 5.3.5 Raman Spectrometer
 - 5.3.6 Remote Sensor Head
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 - 5.3.8 Data Fusion
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 - 5.3.11 Riser Alignment Device
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 - 5.4 Surveillance and Inspection
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 - 5.4.2 NDE Requirements
 - 5.5 TWRS Reports
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- 6.0 System Design Deliverables
 - 6.1 LDUA System
 - 6.1.1 System Design Description
 - 6.1.2 Specifications
 - 6.1.3 Conceptual Design Review
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 - 6.1.3.2 CDR Package
 - 6.1.3.3 CDR Report
 - 6.1.4 20% Design Review/Report
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 - 6.1.5.1 Comment Resolution Records
 - 6.1.6 Final Design Documentation
 - 6.1.7 Tank Riser Interface and Confinement
 - 6.1.7.1 Decon System Design
 - 6.1.7.2 Tool Changeout System
 - 6.1.7.3 Ventilation
 - 6.1.8 Maintenance Glovebox Design
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 - 6.1.11 I&C Design
 - 6.1.11.1 Data Acquisition
 - 6.1.11.2 Manipulative Control
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 - 6.2 End Effector & Instrument Designs
 - 6.2.1 Laser Range Finder
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 - 8.1 Safety Guidance
 - 8.2 Safety Classifications
 - 8.3 Hazards & Operability Study
 - 8.3.1 Preliminary Hazards Analysis (PHA)
 - 8.4 USQ Evaluation Form
 - 8.5 Fault Tree/FMECA
 - 8.6 Safety Assessment/SAR
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 - 8.9 Safety Evaluation - General
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- 10.0 Procurement
 - 10.1 LDUA
 - 10.1.1 RFP & SPEC
 - 10.1.1.1 RFP Corresp.
 - 10.1.2 Vendor Proposals
 - 10.1.3 Technical Evaluation
 - 10.1.3.1 Business Evaluation
 - 10.1.4 Contract
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 - 10.2 Gloveboxes/Enclosures
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 - 10.4 Vendor Data
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 - 10.6 Purchase Requisitions/Orders/Changes
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 - 10.8 NCRs/Waivers
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- 12.0 Testing
 - 12.1 Cold Demonstration Test
 - 12.1.1 Test Plan
 - 12.1.2 Test Procedures
 - 12.1.3 Test Bed Preparations & Setup
 - 12.1.4 Pre-Test Review
 - 12.1.5 Testing Documentation (Logs, etc.)
 - 12.1.6 Test Reports
 - 12.1.7 Miscellaneous
 - 12.1.8 Test Facility Study
 - 12.2 Hot Deployment Test
 - 12.2.1 Test Plan
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 - 12.2.3 Tank Selection
 - 12.2.3.1 Tank Description/Information
 - 12.2.4 Tank Farms Setup
 - 12.2.5 Readiness Review
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 - 12.3 Development Testing
 - 12.3.1 Dev. Test Plan
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 - 13.2.1 Operating and Maintenance Manual
 - 13.2.2 Maintenance Schedule
- 13.3 Operator Training
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- 13.5 System Turnover Documentation
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