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Cold Pump Test, Training, and Mock-Up Facility Functions and Requirements

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U.S. Department of Energy Contract DE-AC06-99RL14047

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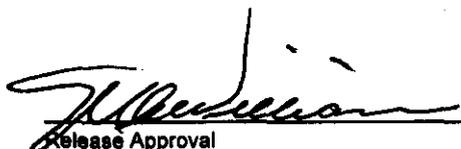
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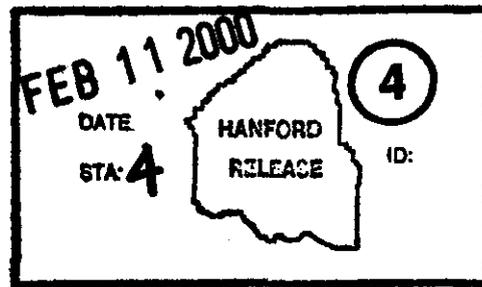
Abstract:

This document defines the functions and requirements (F&R) for a test facility to provide for pre-deployment, checkout, testing, and training for the underground storage tank retrieval equipment, systems, and crews that will be developed or deployed as part of Waste Feed Delivery. The F&R for a River Protection Project retrieval test facility, one that supports a production mode tank farm system, are identified.

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COLD PUMP TEST, TRAINING, AND MOCK-UP FACILITY FUNCTIONS AND REQUIREMENTS

January 2000

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Prepared for:
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APPENDIX A - COLD PUMP TESTING, TRAINING, AND MOCK-UP

FACILITY FUNCTIONS AND REQUIREMENTS VALUE

ENGINEERING SESSIONA-1

TERMS

BNFL Inc.	British Nuclear Fuels Limited Inc.
CPTTM	Cold Pump Test, Training, and Mock-Up
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy-Richland Operations
F&R	Functions and requirements
FY	Fiscal year
HAMMER	Hazardous Materials Management and Emergency Response
HVAC	Heating, ventilating, and air conditioning
MASF	Maintenance and Storage Facility
NPSH	Net positive suction head
ORP	Office of River Protection
RPP	River Protection Project
SST	Single-shell tank
VE	Value Engineering
WFD	Waste Feed Delivery

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COLD PUMP TEST, TRAINING, AND MOCK-UP FACILITY FUNCTIONS AND REQUIREMENTS

1.0 INTRODUCTION

The Waste Feed Delivery (WFD) Program will develop the strategies, tank sequencing, structures, systems, and components that will collect, prepare, and deliver high- and low-level waste feed to the privatization contractor, British Nuclear Fuels Limited Inc. (BNFL Inc.), on-time and within specification.

WFD will install and test waste retrieval systems in the 241-AN, AY, AZ, AP, AW, C, S, and SY tank farms. The system chosen for deployment in the tanks must undergo testing to demonstrate system operability and verify processes and procedures. A facility for testing the waste retrieval system setup, operation, deployment, and dismantling before installation of the system in the tank farm is required. Additionally, with the transition of the Hanford Tank farms from a mission of "safe storage" to one of "production mode" with severe penalties for insufficient or out of specification feed, the need to have spare mixer and transfer pumps tested over the full-range of operations is imperative. The test facility should demonstrate the functionality and operability of the integrated waste retrieval systems in a physical environment approximating that of the tanks and allow testing of the retrieval system under both normal and off-normal conditions before hot operations.

The initial user of the facility will be WFD; however, the facility is also expected to be useful for testing future retrieval systems and concepts including Privatization Phase 2.

2.0 SCOPE

This document defines the functions and requirements (F&R) for a test facility to provide for pre-deployment, checkout, testing, and training for the underground storage tank retrieval equipment, systems, and crews that will be developed or deployed as part of WFD. Additionally, the F&R for a TWRS retrieval test facility, one that supports a production mode tank farm system, are identified. The goals of the facility are listed below.

- Test pumps before installation.
- Prove pump configuration functionality.
- Provide training.
- Replicate field conditions.
- Provide system and field condition mock-up capabilities.

- Study configuration, deployment, and operation concepts for retrieval and transfer of wastes.
- Test static and dynamic leak detection systems.
- Explore alternative retrieval concepts.
- Test new techniques to reduce costs.
- Provide testing/ training facility for economic diversification.

3.0 ASSUMPTIONS

There are a number of assumptions that were adopted to prepare the F&R for the test facility. The primary assumptions are listed below.

- The test facility will be used to conduct pre-operational testing activities in a non-contaminated environment. These pre-operational testing activities include deployment and setup of the system(s), insertion of the equipment into the simulated tank through the appropriate "risers," operational demonstration, and removal of the system/equipment from the test facility.
- The test facility will be constructed around the WFD testing needs although the F&Rs will reflect the additional testing (e.g., tank stabilization, miscellaneous underground storage tank retrieval) needs to the extent possible.
- Radioactive or contaminated waste simulants will not be used in the facility.
- Some waste simulants, preferably non-hazardous materials, may be used in the test facility and will be provided, and disposed of, by the organization performing the test.
- The test facility physical environment will not duplicate all of the tank environmental conditions including air flow (heating, ventilating, and air conditioning), radiation, corrosive vapors, mists, fog, steam, humidity, chemicals, etc.
- The test facility is needed by the end of fiscal year (FY) 2002 to accommodate testing of the retrieval systems planned for near term use and production mode delivery of feed to the privatization vendor.
- Limited testing of retrieval equipment can be accomplished at a vendor's facility or at a number of existing Hanford facilities, e.g. the cold test facility. Deployment, installation, and operation of this type of equipment in a full-scale, full-power simulation is not possible at any currently identified location or facility.

4.0 TESTING REQUIREMENTS

The WFD requirements for testing of tank waste retrieval equipment are for a facility where the retrieval system setup, deployment, operation, and dismantling can be demonstrated before installation in the field. Verification of procedures and demonstration of operator proficiency are also needed. There are longer term testing needs associated with production mode support and qualification of retrieval equipment for the duration of the WFD program. Additionally, the facility will support single-shell tank (SST) retrieval and Phase 2 testing.

There are six categories of testing to be considered in building a testing program.

- **Development Testing.** Development testing is performed to develop design information, concepts, or criteria. It may also be performed to develop performance characteristics.
- **Acceptance Testing.** Acceptance testing is performed to demonstrate that fabrication, assembly, installation, and construction requirements have been met as required in the design documents.
- **Qualification Testing.** Qualification testing is performed to verify adequacy of design and verify adequacy of performance under conditions that simulate the most adverse design conditions.
- **Preoperational Testing.** Preoperational testing is performed in preparation for operational testing. During preoperational testing, systems and components are operated at defined parameters to ensure that they are ready for full operational testing. Preoperational testing may be performed at the test facility, at the tank farm, or both.
- **Operational Testing.** Operational testing is performed by the operator with items in their final in-service configuration (including interfaces) to verify that functional, operational, and design requirements have been met.
- **Production/Process Testing.** Production/process testing is performed to develop and maintain a backlog of pre-qualified spares for replacement during recovery operations. Additionally, production testing is performed at operating facilities to evaluate potential improvements, develop optimum process parameters, or establish new criteria.

The WFD testing will consist of a demonstration of the functionality and operability of the integrated waste retrieval system in a physical environment approximating that of a Hanford waste tank as well as validation and verification of retrieval equipment, processes, and procedures and their effectiveness. Production testing will be used to allow smooth and efficient operations of the WFD systems. Typical tests that will be performed at the test facility are listed below.

- Performance, functional, F&R compliance
- Mixing/transport model verification
- Operational sequences and responses
- Integrated systems operation
- Interfaces
- Off-normal recovery operations

- Operational readiness demonstrations
- Spare equipment qualification.

4.1 WASTE FEED DELIVERY COLD PUMP TEST, TRAINING, AND MOCK-UP FACILITY FUNDAMENTAL FUNCTIONS AND REQUIREMENTS IDENTIFICATION

The F&R were developed from two sources. The first was from a review of previous Hanford Tanks Initiative (HTI) test facility F&R (the HTI program was cancelled before document release), and the second was from those identified in a Cold Pump Test, Training, and Mock-Up (CPTTM) Facility F&R workshop conducted November 17 and 18, 1999 (see Appendix A). Workshop results and the list of attendees are included in Appendix A. The functions and requirements from both the previous studies and the workshop were revised and updated to reflect the testing needs of the WFD program and future retrieval projects as currently understood.

There are some fundamental functions that must be accommodated in the test facility design in order for the facility to (1) provide the minimum testing capability to the develop and verify the current and future retrieval and transfer concepts, and (2) support a production mode tank farm delivery system (see requirement ranking matrix in Appendix A).

The common functions to support both missions are listed below.

4.1.1 Contain Liquids

The test facility is required to contain liquids both for testing to develop and maintain a backlog of pre-qualified spares during operation and during construction/start-up to perform acceptance testing, qualification testing, and pre-operational testing.

4.1.2 Provide Access for Pump Tests

The test facility will provide access for testing, including access to the pump systems, support and control systems, test media, etc., to perform, monitor, and control test execution. 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. Confined space conditions such as the potential for oxygen deficient atmosphere should be avoided from both the safety and productivity standpoints.

4.1.3 Provide 25T (70-ft) Crane

The facility is to provide a test space of adequate size. The facility must accommodate testing of full length waste retrieval and transport systems. This dictates the use of a cranes system of sufficient height and rating to assemble, insert, and remove the retrieval systems. The operating clearance below the crane hook needs to be a minimum of 70 ft to allow insertion and removal of the equipment in and out of the risers.

4.1.4 Provide 480V Power

Power requirements are dictated by the need to provide power for pump operation (as much as 700 hp).

4.1.5 Provide Instrumentation for pump testing

Pump control and pump and test monitoring instrumentation will be required during pump testing.

4.1.6 Provide Equipment/Pump Storage Area

Sufficient storage is required for test equipment, consumables, analysis equipment, pumps and support systems.

4.1.7 Provide Space To Mock-Up Pumps, Jumpers

The facility shall permit mock-up to simulate the physical conditions in the tank farm. This mock-up includes pits, risers, and other features in the tank farms. Since every tank is different in this aspect, the facility needs to provide the versatility for the user to be able to install simulated pits, risers, and other features as necessary for testing

4.1.8 Provide Lay Down Space for Pump Deliveries

The minimum acreage required for the test site includes space for equipment staging, crane maneuvering, and aboveground facilities (estimated at 7 to 10 acres).

4.1.9 Provide Diagnostic Capabilities

The ability to monitor and evaluate vibration, power requirements, and system performance during operation is required for system evaluation. Additionally, the ability to disassemble equipment after completion of the testing to evaluate component performance and durability is required.

4.1.10 Supply Air and Water

The waste retrieval systems will use the utilities supplied to the tank farms. The test facility needs to provide comparable water, service air, instrument air, etc., necessary to operate the waste retrieval systems.

4.1.11 Be Available Quickly (3 Years)

The current WFD integrated schedule shows the initial WFD projects initiating construction in FY 2004. If the facility is not available early enough prior to construction, it becomes more difficult to integrate test results into system baselines. Additionally, insufficient time to establish and maintain a qualified spares system could prevent the implementation of a successful spares system prior to initiation of operations.

4.1.12 Provide Control Station, Communication, and Data Acquisition Systems

The test facility must enable testing and equipment performance information to be gathered and communicated to the test engineers during and after test execution, including pump performance, vibration, temperature, flow in/out, spatial distribution, liquid levels in tank and associated holding tanks, etc. Programmable logic controllers shall be used for instrumentation and control of tank systems to the extent possible and the test facility system shall be able to duplicate the tank farm systems as closely as possible.

4.2 SYSTEM AND METHODOLOGY VERIFICATION FUNCTIONS AND REQUIREMENTS

The fundamental functions that must be accommodated in the test facility design in order to develop and verify the current and future retrieval and transfer concepts and leak detection systems are identified below.

4.2.1 Provide Simulated Waste

Simulant use requires a facility that does not preclude the user from importing and using simulants in the tests.

4.2.2 Provide Alternative Holding Tanks

Holding tanks will be required to prove dynamic leak detection systems, provide storage for transfer pump discharge, inflow holding capacity, and storage volume for test down time and tank pumpout.

4.2.3 Capability To Test On Water or Simulant

Fully integrated testing of the retrieval systems may require the use of waste simulants. Simulants may need to be prepared and placed in the test to demonstrate retrieval system capability and performance during the tests.

4.2.4 Provide Inspection Access (In-Tank Viewing)

Engineers, operators, visitors, and guests will want to observe the test activities. These observations will include the "in-tank" portions of the equipment being tested. Windows/observation galleries should include sufficient space for at least 10 viewers to simultaneously view the test activities.

4.2.5 Tank Full Depth Below Grade

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 is essential to demonstrate system readiness and spare replacement.

4.2.6 Provide Simulant Holding

Accommodation of simulant use will require providing means to store, and remove the simulants and ingredients prior to, and after, use in the test activities.

4.2.7 Provide Tank Temperature Control System

The ability to heat test media to anticipated actual waste temperatures or control tank temperatures is required to test system effectiveness, durability, and reliability in simulated tank waste environments.

4.2.8 Provide Remote Monitoring

Monitoring by off-site individuals is required for data evaluation, trouble shooting, data synthesis etc. Remote monitoring may be required by pump vendors, design engineers, offsite experts, etc.

4.2.9 Provide Routine Access To Tank Bottom

Routine access to the tank bottom is required to simulate various tank configurations (e.g., air lift circulators), provide in-place equipment inspection, allow simulate removal, and for evaluation of alternative retrieval technologies (e.g., in-tank vehicles).

4.2.10 Chemical Storage

Chemical storage is required for equipment cleaning/lubricating materials, and other chemicals used before, during, or after the testing activities on the in-tank equipment, test equipment, information acquisition, equipment storage, or material handling equipment.

4.2.11 Provide Training Rooms/Offices

The facility needs to provide adequate conditioned office/conference room space to allow for test team pre-test briefing, post-test de-briefing, and operator and craft training.

4.2.12 Provide Multiple Risers In Tank (75-ft Diameter)

Proofing of the current retrieval strategies requires the demonstration of mixer pump operation in a tank inclusive with a transfer pump. Additionally, mock-up of in-filling, decant, and mixing scenarios will require the simultaneous use of multiple risers.

4.2.13 Provide Artificial Leak Path

Development and proofing of static and dynamic leak detection systems require the ability to remove test fluids from the bottom of the tank during transfers in and out of the tank to simulate fluid loss from the bottom of a leaking tank.

4.3 PRODUCTION MODE FUNCTIONS AND REQUIREMENTS

The fundamental functions that must be accommodated in the test facility design in order for the facility to support a production mode waste feed system are identified below.

4.3.1 Provide Systems/Storage/Qualified Spares/Training for Rapid Pump Replacement

The craft personnel that will be responsible for installing the system in the tank farms require practice/training on the installation and removal procedures including safety precautions. The test facility will provide the location for this installation practice/training with the total integrated waste retrieval system for support of a production mode tank farm system. The ability to install, test, and safely and efficiently control and operate the equipment is the key to waste retrieval productivity.

4.3.2 Allow 24-Hour Facility Access

Facility access any time with little or no prior notice is required for rapid spare replacement.

4.3.3 Provide Shop Facilities (Minor Repairs/Modifications)

The test facility design needs to accommodate maintenance, trouble-shooting, debugging, or diagnosis activities that may be performed on the waste retrieval system by providing a protected/heated maintenance work area and storage space near the test area.

4.4 ADDITIONAL POTENTIAL FUNCTIONS AND REQUIREMENTS

There are additional functions that customers will consider highly desirable in order to accomplish the complete range of test activities that they envision.

Secondary F&R have been identified by the maintenance and reliability engineering organization . These F&R are associated with testing and evaluation of tank monitoring instrumentation and are needed to support start-up and full-scale testing that currently have to be performed at less suitable locations or after installation in the tank. Examples of this testing include the following:

- ENRAF densitometers
- Mass flowmeters
- Camera systems
- Ultrasonic interface level analyzers (URSILLA)
- Strain gauges
- Suspended solids profilers (gamma profilers)
- ENRAF liquid level detectors
- Immersible pump/winch systems, etc.
- Vertical pump storage for up to 15 pumps.

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.
- Develop hose management technique (SSTs)
- Optimize and evaluate in-tank viewing systems
- Evaluate control system response
- Develop advanced control system.

Secondary Functions and Requirements require evaluation against available funding and other constraints to determine if they should be included or accommodated in the test facility design. The secondary functions and requirements are listed below.

- Provide vacuum to dome space.
- Allow truck access on dome.
- Provide suppression tank (net positive suction head [NPSH] determination).
- Provide a sheltered environment (roof).
- Provide parking.
- Provide loading dock.
- Allow on-site simulated waste preparation.
- Allow for expansion.

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 7 to 10 acres of ground and the associated utilities required to operate the facilities.

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APPENDIX A

**COLD PUMP TESTING, TRAINING, AND MOCK-UP FACILITY
FUNCTIONS AND REQUIREMENTS VALUE ENGINEERING SESSION**

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APPENDIX A

**COLD PUMP TESTING, TRAINING, AND MOCK-UP FACILITY
FUNCTIONS AND REQUIREMENTS VALUE ENGINEERING SESSION**

A Value Engineering (VE) session was conducted November 17, 1999, at Parsons Engineering in Richland Washington, to develop the functions and requirements for a Cold Pump Test, Training, and Mock-Up (CPTTM) Facility to support the waste feed delivery mission. Below is a list of attendees and the results of the session.

Attendees:

Nick Presecan	Parsons Eng.	Facilitator
Will Pickett	WFD	Project Eng.
Greg Leshikar	Cogema	Pump Testing Eng.
Marshall Hauck	FDNW	Design Eng. W-211
Craig Shaw	WFD (Cogema)	Pump Specification
Vincent Fitzpatrick	WFD (Mactec)	SST Retrieval
John VanBeek	LMHC	W-211 Project Manager
Michael McKinney	NHC	W-211 Project Engineer
Roger Davey	Sulzer Pump	Chief Hydraulic Engineer
Al Vickery	WFD (Parsons)	Program Engineer
Al Erhart	LMHC	Retrieval Operations
Todd Erickson	LMHC	Tank Farm Maintenance
Det Wegener	FDH-HAMMER	Training
Doug Holbrook	FDNW	Construction

Mission: To reduce risk to the WFD Program through, (1) the development and verification of current and future retrieval and transfer concepts, and (2) support of a production mode tank farm system.

Goals to support mission:

Test pumps before installation

Prove pump configuration functionality

Training

Replicate field conditions

Proved system and field condition mock-up capabilities

Study configuration, deployment, and operation concepts for retrieval and transfer of wastes

Explore alternative retrieval concepts

Test new techniques to reduce costs

Provide testing/ training facility for economic diversification

Justification for CPTTM Facility:

Return on investment

Failure/penalty prevention

Risk mitigation (through realistic simulation)

Operations and maintenance simulation

Expedient pump replacement

Operator qualification/training
Engineering expertise development
Optimization of pump storage & handling
Phase 2 development

Questions not addressed by CPTTM Facility:

Determination of current waste properties
Impacts to current projects

Counter Considerations for Facility Justification:

Project W-211 staff is not supportive of developing a test facility. Their rationale is as follows:

- Testing to specifications should be provided by the vendor
- Operability testing can be accomplished at the Hanford's 400 area Maintenance and Storage Facility (MASF)
- Installation and removal simulation, crew training, and procedure development can be accomplished at the cold test facility caisson located in the 600 area
- Testing inside a building will not simulate a tank farm environment
- Any test facility proposed will not be available soon enough to benefit project W-211
- Funds to support a new test facility will divert funding from other projects or activities
- Project W-211 testing is planned and scheduled using existing facilities
- The ability of simulants to match real waste properties is questionable.

The above opinion was predominantly supported by the W-211 project manager and project engineer. However, Project W-211 conceded that if such a test facility were currently available the project would use it. The points made are valid in light of project W-211 specifically. Care

should be taken in considering these points in light of a production mode support of tank farm operations and maintenance, follow-on projects, and single-shell tank (SST) retrieval.

Stakeholders:

Tank Farm Operations

WFD Program

Tank Farm Maintenance

Life-Cycle Projects

Engineering

Hazardous Materials Management and Emergency Response (HAMMER)

U.S. Department of Energy Office of River Protection (DOE ORP)

U.S. Department of Energy Richland Operations (DOE RL)

Pacific Northwest National Laboratory (PNNL)

BNFL Inc.

Washington State Department of Ecology

Defense Nuclear Facilities Safety Board (DNFSB)

Tribes

Facility Requirements:

The facility requirements were reviewed and grouped by importance in supporting the WFD program's two mission support aspects, (1) the development and verification of current and future retrieval and transfer concepts, and (2) support of a production mode tank farm system with pumps already proven for application. The groups were ranked (3) High importance, (2) medium importance, and (1) low importance.

To support both mission aspects, the ranking of functions is as follows:

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Requirement	Importance to development & verification	Importance to production mode	Function currently met at other facilities
Contain liquids	3	3	
Provide access for pump tests	3	3	
Provide 25T (70-ft) crane	3	3	
Provide 480V power	3	3	
Provide Instrumentation for pump testing	3	3	
Provide storage area	3	3	
Provide space to mock-up pumps, jumpers,	3	3	600 Area cold test in conjunction with 200W fab shops
Provide lay down space for pump deliveries	3	3	200E has horizontal storage/lay down area
Provide diagnostic capabilities	3	3	
Supply air and water	3	3	
Be available quickly (3years)	3	3	
Provide communication and data acquisition system	3	3	
Provide control station	2	2	
Provide simulated waste	3	1	
Provide alternative holding tanks	3	1	
Capability to test on water or simulant	3	1	
Provide inspection access (in-tank viewing)	3	1	

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Requirement	Importance to development & verification	Importance to production mode	Function currently met at other facilities
Tank full depth below grade	3	1	
Provide simulant holding	3	1	
Provide tank heating system	3	1	
Provide remote monitoring	3	1	
Provide routine access to tank bottom	3	1	
Chemical storage	3	1	
Provide 60-ft deep tank	2	1	
Provide training rooms/offices	2	1	HAMMER
Provide multiple risers in tank (75-ft dia)	2	1	
Provide systems/storage/qualified spares/training for rapid pump replacement	1	3	
Allow 24-hr facility access	1	3	
Provide shop facilities (minor repairs/mods)	1	3	200W and 300 Area
Provide vertical pump storage	1	3	
Provide vacuum to dome space	1	1	
Allow truck access on dome	1	1	
Provide suppression tank (NPSH determination)	1	1	Vendor facilities
Provide a sheltered environment (roof)	1	1	
Provide parking	1	1	
Provide loading dock	1	1	

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Requirement	Importance to development & verification	Importance to production mode	Function currently met at other facilities
Allow on-site simulated waste preparation	1	1	PNNL
Allow for expansion	1	1	

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