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ENGINEERING DATA TRANSMITTAL

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Page 1 of 1
1. EDT 628523

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) Process Engineering		4. Related EDT No.: N/A		
5. Proj./Prog./Dept./Div.: Spent Nuclear Fuel Project		6. Design Authority/ Design Agent/Cog. Engr.: A. L. Pajunen		7. Purchase Order No.: N/A		
8. Originator Remarks: For Release USG SCREENING NUMBER: K-00-0287 <i>ALP</i> <i>2/28/2000</i>				9. Equip./Component No.: N/A		
				10. System/Bldg./Facility: N/A		
11. Receiver Remarks: 11A. Design Baseline Document? ☐ Yes ☒ No				12. Major Assem. Dwg. No.: N/A		
				13. Permit/Permit Application No.: N/A		
				14. Required Response Date: N/A		
15. DATA TRANSMITTED						
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Design- Nator	
1	HNF-4898	N/A	0	Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM)	E, S ^N , Q	
16. KEY						
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)		
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)		1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged		
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)						
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	
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21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments						

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A. Information Category ☐ Abstract ☐ Journal Article ☐ Summary ☐ Internet ☐ Visual Aid ☐ Software ☐ Full Paper ☒ Report ☐ Other _____	B. Document Number HNF-4898, Rev. 0 C. Title Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM) <div style="text-align: right; font-weight: bold;">61 TOTAL PAGES.</div> D. Internet Address
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F. Complete for a Journal Article 1. Title of Journal _____

G. Complete for a Presentation 1. Title for Conference or Meeting _____ 2. Group Sponsoring _____ 3. Date of Conference _____ 4. City/State _____ 5. Will Information be Published in Proceedings? ☐ No ☐ Yes 6. Will Material be Handed Out? ☐ No ☐ Yes

H. Author/Requestor A. L. Pitner <i>A. L. Pitner</i> (Print and Sign)	Responsible Manager J. R. Frederickson <i>J. R. Frederickson</i> (Print and Sign)
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RELEASE AUTHORIZATION

Document Number: HNF-4898 REV 0

Document Title: Phased Startup Initiative Phases 3 and 4 Test Plan
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Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM)

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM)

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Date Published
March 2000

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Available electronically at <http://www.doe.gov/bridge>. Available for a processing fee to the U.S. Department of Energy and its contractors, in paper, from:
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865-576-8401
fax: 865-576-5728
email: reports@adonis.osti.gov(423) 576-8401

Printed in the United States of America

**PHASED STARTUP INITIATIVE PHASES 3 AND 4
TEST PLAN AND TEST SPECIFICATIONS (OCRWM)**

TABLE OF CONTENTS

1.0 INTRODUCTION	1
2.0 OBJECTIVE	1
3.0 SCOPE	2
4.0 TEST DESCRIPTION	3
4.1 Fuel Retrieval System	3
4.1.1 Test Scope	3
4.1.2 Test Equipment	4
4.1.3 Data	12
4.1.4 Criteria	13
4.1.5 Test Prerequisites	14
4.2 Integrated Water Treatment System	14
4.2.1 Test Scope	14
4.2.2 Test Equipment	17
4.2.3 Data	18
4.2.4 Criteria	18
4.2.5 Test Prerequisites	18
4.3 Canister Selection	19
4.3.1 Phase 3 Fuel Canisters	19
4.3.2 Phase 4 Fuel Canisters	22
5.0 EXPECTED RESULTS	25
6.0 TEST PROCEDURE	31
7.0 SAFETY	31
8.0 QUALITY ASSURANCE	31
9.0 ORGANIZATION AND FUNCTION RESPONSIBILITIES	35
10.0 SCHEDULE	36
11.0 REPORTS	37
12.0 REFERENCES	37
13.0 DATA SHEETS	40
Appendix A. Fuel Retrieval System Process Description	A-1
Appendix B. Test Planning Form	B-1

LIST OF FIGURES

Figure 4-1. Simplified Fuel Retrieval and Integrated Water Systems Hot Testing Flow Diagram	5
Figure 4-2. Fuel Retrieval System Hot Test Block Flow Diagram.....	6
Figure 4-3. Simplified Integrated Water Treatment System Hot Test Block Flow Diagram	16
Figure 5-1. Hot Test Flow Diagram and Mass Balance.....	27

LIST OF TABLES

Table 4-1. Visual Data Available for KW Canisters Containing Mk IV Fuel.....	21
Table 4-2. Fuel Canisters Selected for Phase 1 of the FRS/IWTS Hot Test	22
Table 4-3. KW Fuel Cleaning Validation Test Canister Selection for Phase 2 of the FRS/IWTS Hot Test	24
Table 5-1. FRS/IWTS Hot Test Success Criteria and Design Basis.....	26

LIST OF ACRONYMS

ECN	Engineering Change Notice
EOC	Equipment Operating Center
FRS	Fuel Retrieval System
FTP	Functional Test Procedure
IWTS	Integrated Water Treatment System
IXM	Ion Exchange Modules
M&TE	Measuring and Test Equipment
MCO	Multi-Canister Overpack
NCR	Nonconformance Report
OCRWM	Office of Civilian Radioactive Waste Management
OP	Operating Procedure
PSI	Phased Startup Initiative
QARD	Quality Assurance Requirements and Description
QA	Quality Assurance
QC	Quality Control
SNF	Spent Nuclear Fuel

PHASED STARTUP INITIATIVE PHASES 3 AND 4 TEST PLAN AND TEST SPECIFICATIONS (OCRWM)

1.0 INTRODUCTION

Construction for the Spent Nuclear Fuel (SNF) Project facilities is continuing per the Level III Baseline Schedule, and installation of the Fuel Retrieval System (FRS) and Integrated Water Treatment System (IWTS) in K West Basin is now complete. In order to accelerate the project, a phased start up strategy to initiate testing of the FRS and IWTS early in the overall project schedule was proposed (Williams 1999). Wilkinson (1999) expands the definition of the original proposal into four functional testing phases of the Phased Startup Initiative (PSI). Phases 1 and 2 are based on performing functional tests using dummy fuel. These tests are described in separate planning documents. This test plan provides overall guidance for Phase 3 and 4 tests, which are performed using actual irradiated N fuel assemblies.

2.0 OBJECTIVE

The overall objective of the Phase 3 and 4 testing is to verify how the FRS and IWTS respond while processing actual fuel. Conducting these tests early in the project schedule will allow identification and resolution of equipment and process problems before they become activities on the start-up critical path.

The specific objectives of this test plan are to:

- Define the test scope for the FRS and IWTS;
- Provide detailed test requirements that can be used to write the specific test procedures;
- Define data required and measurements to be taken. Where existing methods to obtain these do not exist, enough detail will be provided to define required additional equipment; and
- Define specific test objectives and acceptance criteria.

The goals of this test are:

- To confirm equipment operability and establish the normal operating parameters;
- Following successful operability testing, complete the FRS Primary Cleaning Machine (PCM) performance validation;
- Demonstrate successful operation of the IWTS System; and
- Collect material balance data (including scrap quantities generated) that can be extrapolated to predict process performance during routine operation.

3.0 SCOPE

The scope of this test plan is limited to the PSI test Phases 3 and 4 using irradiated N fuel. It assumes that all construction of the FRS and IWTS is complete; PSI test Phases 1 and 2 are complete; and no open punch list items affect the conduct of tests using irradiated fuel. The Phase 3 and 4 tests have clearly defined limits and are not intended to involve the complete fuel retrieval process. In general, they begin with canister selection and proceed through fuel cleaning, sorting, and inspection. The fuel and scrap will be loaded back into fuel canisters and returned to storage. Appendix A describes the complete FRS process and highlights the specific steps that are a part of the Phase 3 and 4 tests. IWTS process systems will be activated to support the FRS steps tested. Testing will be done using only Mk IV fuel (pre-irradiated enrichment of 0.95 Wt% ^{235}U).

The Phase 3 and 4 tests are summarized below, and will follow completion of FRS/IWTS cold testing. Cold testing comprises Phases 1 and 2 of the PSI, while hot testing comprises Phases 3 and 4.

Phase 3

- FRS and IWTS operability verification
- A minimum of six canisters of fuel processed
- Objective is to set the PCM parameters and determine preliminary estimate of scrap generation/characteristics

Phase 4

- FRS PCM performance validation test
- IWTS operates to support FRS
- A minimum of 29 canisters of fuel processed
- Objective is to validate the PCM to ensure that safety base requirements for MCO loading are satisfied for fuel particulate loading and estimate scrap generation/characteristics

To address test result uncertainties, contingency canisters are identified as potentially processed during the hot test. A total of 16 canisters have been identified to support Phase 3 and 58 canisters to support Phase 4 testing. Both of these test phases will follow the requirements for process validation contained in Shen (1999).

The PCM is defined as equipment that ensures safety bases requirements are satisfied for fuel particulate loading (McCormack 1999). Therefore, validation of the PCM performance will be performed according to Office of Civilian Radioactive Waste Management (OCRWM) Quality Assurance Requirements and Description (QARD) requirements. This test plan satisfies the test planning requirements of OCRWM QARD testing specified in current procedures (AP-EN-6-031-00). A test planning form is attached as Appendix B.

The testing will be conducted using the SNF Project organizations that will be responsible for normal operations. Section 9.0 of this test plan describes these responsibilities and the interdependencies of the various organizations.

4.0 TEST DESCRIPTION

A simplified block flow diagram depicting the major components of the FRS/IWTS that are involved in the hot test is shown in Figure 4-1. In summary, for the FRS system they encompass the process from retrieval of a canister from the storage rack through examining fuel on the process table and return of the canister with cleaned fuel to the storage rack. The integral IWTS is also involved in the testing, which includes the pumping system that draws water through the decapping station, PCM and process table, the knockout pots, the settlers, the sand filters, and ion exchange modules (IXM).

This section will define the specific testing scope, test equipment required, data to be taken, criteria to measure test success with, and list specific canisters selected for each of the two hot test phases.

4.1 Fuel Retrieval System

The FRS retrieves fuel in canisters from the basin storage racks, removes canister lids, cleans the fuel of canister particulate, loads fuel into either fuel or scrap baskets, and queues the baskets for loading in a multi-canister overpack (MCO). The FRS equipment designs provide contamination control features linked to the IWTS. Appendix A provides a summary description of the process steps in the routine FRS process.

4.1.1 Test Scope

The FRS test scope is limited to operating tests of the canister decapping station, PCM, and process table work station. Fuel cleaned during the test will not be loaded into baskets. Instead, all material that would normally be loaded in fuel or scrap baskets during normal operations will be returned to canisters for storage in the existing basin racks.

Figure 4-2 provides a detailed listing of the FRS steps included in the hot test scope. Fuel canisters are retrieved and transferred to the canister decapping station. After decapping, fuel canisters are transferred to the PCM where the fuel is processed through a cleaning cycle. Cleaned fuel is transferred (in the canister) to the process table and dumped on the table in the manner planned for processing fuel during production operations. After inspection, the fuel is re-loaded into canisters. Any scrap generated by the cleaning process or recovered during clean out of the cleaning machine screens is loaded into a separate scrap canister. The canisters are then returned to the basin storage racks.

Data are collected at intermediate steps in the fuel retrieval activities during the hot test. These data include collecting extra visual observation records (photographs or video tapes), recording activity duration, and performing weight measurements that allow quantification of equipment reliability, unit operation performance, and development of a material balance around equipment pieces.

A number of visual observations and weight measurements characterizing the quantity and physical size of scrap are included in the test scope. Collection of these data is important because the test represent the first opportunity to compare actual scrap generation rates and packing density with design assumptions.

4.1.2 Test Equipment

4.1.2.1 Canister Retrieval

Canister retrieval will be accomplished using existing equipment and procedures for moving canisters in the basin. The overall start time for a canister will be recorded based on the time the canister is removed from the canister queuing station near the canister decapping station. This start time will be used as the basis for estimating the overall cycle time of each canister processed by the FRS. The canisters retrieved in each of the two hot test phases are described in Section 4.3.

Special Hot Test Equipment/Capabilities Required: none.

4.1.2.2 Canister Decapping Station

The canister decapping station reliability and performance will be evaluated during the hot test. The purpose of the canister decapping station is to remove canister lids in a controlled environment that minimizes the potential for contaminating the general basin water and aids in maintaining water clarity.

The equipment functions are confirmed in Phase 3 of the hot test by processing both Mk I and Mk II canister types through the decapping station. Reliability data are collected during both test phases by recording the cycle time when the canister lids are removed and the canister is ready to be moved to the cleaning machine. This cycle time is compared with the expected design decapping cycle time. In addition, any lost time attributed to a specific equipment malfunction is recorded. Time cycle data for canister decapping will continue to be collected during Phase 4 testing.

The performance of the canister decapping station is determined by monitoring ^{85}K concentration in the air and basin water radionuclide concentrations during the Phase 3 and 4 tests. The basin water radionuclide content will be monitored on a shift basis for correlation with the various fuel retrieval activities. More frequent monitoring may be determined to be required for short durations as the test data are evaluated. Trending analyses of these data will be performed to project anticipated radionuclide activity during full production FRS operations. The decapping station effectiveness at capturing canister off-gas will be measured by continuously monitoring the ^{85}Kr concentration in the ambient air near areas occupied by operators and recording any time lost due to airborne contamination alarms.

Figure 4-1. Simplified Fuel Retrieval and Integrated Water Systems Hot Testing Flow Diagram

Figure 4-2. Fuel Retrieval System Hot Testing Block Flow Diagram

Special Hot Test Equipment/Capabilities Required:

- Continuous air monitoring system recording ^{85}Kr concentrations in local area occupied by operators near decapping machine.

4.1.2.3 Primary Cleaning Station

After decapping, a canister is transferred to the PCM. The Phase 3 and 4 tests will be used to evaluate the PCM performance, reliability, time cycle, and material balances. Data to support these evaluations are obtained at the PCM, work table station, and during canister loading.

Pre-wash canister data will be collected to support the cleaning machine evaluation. These data consist of recording the time of transfer from the decapping station to the PCM (defines end of decapping and start of PCM cycles), the canister weight prior to cleaning (supports material balance evaluation) and a visual record (photograph) of the fuel damage as viewed from the top (pre-wash damage evaluated on the same basis as used for characterizing fuel in Pitner 1998). These pre-wash measurements are obtained on each canister in test Phase 3 and Phase 4. Note that per Figure 4-2, times recorded do not include time for special inspection steps like weighing.

There are four operating parameters on the PCM. These parameters include (nominal values from Shen 1999):

- flush nozzle pressure/flowrate (225 psig/20 gpm from each nozzle),
- fuel rotation rate (4 rpm),
- fuel rotation time (20 min), and
- discharge water flow rate (80 gpm).

Phase 3 cleaning machine tests will be performed to verify that the operating parameters are adequate to clean fuel in the range of damage categories. The range of actual flow rates for both flush nozzle and discharge water will be established during integrated cold testing. A flush nozzle flow rate will be selected once this range is known to initiate hot testing. Flush nozzle pressure at this flow rate will be noted. The actual discharge water flow rate will be established during cold testing because it is sensitive to the as-installed system and is not readily adjustable. The adequacy of the operating parameters will be evaluated by:

- a visual record of a top canister view during the transfer of fuel from the PCM to the work table station,
- a visual record of the fuel appearance after dumping on the work table, and
- the inspection procedure described in Shen (1999) (The inspection procedure takes assemblies and elements from the dump table to an inspection station. Assemblies are separated into elements for inspection.

A select panel of four or five individuals with expertise in process engineering, characterization, operations, modeling, and safety along with a qualified quality control (QC) inspector will be present during Phase 3 and Phase 4 test activities to assess the effective cleanliness of fuel after each cleaning operation. The panel will have completed training to satisfy basic process engineering requirements, and will be required to be familiar with technical basis documents and bounding assumptions associated with fuel cleanliness. The inspection will entail the visual examination of fuel elements after disassembly to detect any residual adherent canister sludge, including visual inspection of the inner bores of the fuel elements for any gross accumulations of sludge. The volume of sludge released (if any) upon separation of the fuel elements will also be assessed to determine whether it is within allowable limits. Details of the cleanliness inspection criteria are given in the Planning Document for this assessment (Pitner 2000).

The preferred location for performing the inspection would be the Equipment Operating Center (EOC). This would allow for direct communication between the inspection team and operations personnel. This communication will be necessary to direct the positioning of fuel elements to achieve optimum viewing orientations, and to coordinate the assessment of sludge volumes. If space limitations in the EOC or administrative controls won't permit this arrangement, the inspections could be conducted at a separate station receiving the same closed circuit television (CCTV) images as the EOC. However, verbal communication with the EOC operators will be required to coordinate the inspection activities. This could be established electronically, as with speakerphones or two-way radios.

If fuel in some damage categories is not adequately cleaned such that the subsequent process validation test would fail, then the PCM operating parameters are adjusted to improve cleaning. Shen (1999) describes a method for parameter adjustments if the nominal conditions prove to be inadequate. Parameter adjustments will be specified by the test engineer redlining the controlled copy of procedures used during Phase 3 tests. The test engineer will generally implement the following parameter modifications to improve cleaning parameter performance:

- Increase fuel rotation times in 5 min increments up to 30 min. If cleaning is still unsatisfactory, then:
- Reset the fuel rotation time to 20 min and increase the fuel rotation rate to 5 rpm. If cleaning is still unsatisfactory, decrease the fuel rotation rate to 3 rpm.
- If cleaning is still unsatisfactory, select the fuel rotation rate producing the best cleaning action and increase the flush nozzle flow rate. The pressure corresponding to a selected flowrate will be determined during Phase 2 testing.

After the cleaning parameters are set, two additional canisters will be processed (one Mk I and one Mk II canister) with nozzle flow rate decreased by an amount to be determined following Phase 2 testing and with the knowledge gained from the cleaning tests done up to this time. In addition, the fuel rotation rate will be decreased 1 rpm. Successful cleaning at these conditions will establish a range for operating parameters to be used in Phase 4 tests. Contingency canisters for the Phase 3 test are identified in Section 4.3 in case cleaning parameter variation is required.

The potential exists for the PCM to damage some fuel, generating scrap and fuel particulate (fuel particulate will be accumulated in the IWTS knockout pot). If excessive fuel damage is observed, it may be necessary to optimize cleaning and damage during Phase 3 tests. Recording the transient gamma radiation from fuel particulate in PCM discharge water will be used to monitor the progress of fuel cleaning. This measurement may be used to balance fuel rotation time with fuel damage if excessive scrap or fuel particulate generation is observed.

Phase 4 PCM tests are performed to demonstrate that the PCM performance satisfies the validation criteria described in Shen (1999). This is accomplished by processing a sequence of 29 canisters (identified in Section 4.3) and determining the cleaned assemblies satisfy the inspection criteria described above (the validation criteria allow for no more than one assembly in the 29 canister sequence to fail the inspection criteria before it would be concluded that the validation test failed). If the initial validation test fails, the test sequence will be terminated and PCM adjustments will be evaluated by returning to the Phase 3 activities. A new sequence of 29 canisters will then be processed after parameter adjustment. These activities are repeated until the validation test is successfully passed, or all canisters identified in Section 4.3 have been processed. If the PCM cannot be validated after processing the identified canisters (including contingency canisters), the test will be suspended and the process validation approach to PCM control re-evaluated.

The PCM reliability will be evaluated as part of the Phase 3 and 4 tests. The cleaning machine function will be demonstrated by successful operation of the machine during the Phase 3 tests. The PCM reliability will be evaluated by recording the cycle time of each canister processed during Phase 3 and Phase 4 tests after cleaning. Any lost processing time specific to a particular equipment piece failure will also be recorded.

Upon conclusion of the Phase 4 tests, the PCM bearings will be inspected for excessive wear. This inspection will be used to determine if additional development of bearing material must be initiated or the PCM modified to support a preventative maintenance program that periodically replaces bearings.

Post-wash top view photographs of each canister in the Phase 3 and Phase 4 tests will be obtained as input in the assessment of scrap generated by the FRS. A post-wash canister weight is obtained to support material balance evaluations.

The PCM will be cleaned out after processing each canister in the Phase 3 tests. This includes cleaning the PCM strainer. The mass of material accumulated on the PCM strainer will be evaluated by weighing the strainer before and after a canister is processed. Photographs of the material collected on the strainer and wash basket will be obtained to allow size estimates of this material. The Phase 3 results will be used to establish a frequency of clean out for the cleaning machine in the Phase 4 hot tests.

Special Hot Test Equipment/Capabilities Required:

- Calibrated scale and shortened canister hook for weighing canisters in the area of the process table (pre- and post-wash),

- Capability to obtain top view pictures of fuel in canisters (pre- and post-wash),
- Platform to set strainer on for grappling with shortened J hook and calibrated scale (pre- and post wash strainer weight),
- Gamma monitor with recorder on PCM discharge water line,
- Capability to photograph material collected on PCM strainer and wash basket, and
- Capability to inspect PCM bearings, including a baseline inspection taken at the start of cold testing (current cold test plans include a bearing inspection after approximately five operating cycles).

4.1.2.4 Process Table Work Station

Cleaned fuel is dumped at the process table work station to sort fuel from scrap and debris. The empty canister will be weighed to support material balance evaluations and inspected for damage with regard to any visual separation of welded joints. If undamaged, the canister will be used for re-loading fuel or scrap. If damaged, the canister will be stored as debris.

Fuel dumped on the work table will be sorted based on suitability for loading in a fuel basket. Outer elements are considered suitable for loading in a fuel basket if at least one end is in a condition that fits in a fuel basket socket. Inner elements are considered suitable for loading in a fuel basket if the element fits inside an outer element. Stackable element lengths are also suitable for loading in a fuel basket. The fuel gauging station will be used to support determining if fuel is suitable for loading in a fuel basket. The remaining material will be considered scrap.

Fuel considered suitable for loading in a fuel basket will be inspected based on the criteria described in Section 4.1.2.3. Photographs of the canister material after dumping will be used to assess the damage category of fuel after washing.

Special Hot Test Equipment/Capabilities Required:

- Capability to photograph dumped fuel on process table,
- Capability to photograph and video tape fuel separated at the element disassembly station, and
- Capability to assess total volume of any residual canister sludge on the fuel assemblies after cleaning.

4.1.2.5 Canister Loading/Return to Storage Rack

After inspection, the fuel processed in each test phase will be loaded in a tared canister, weighed in the canister, lids re-installed (optional based on revised Safety Analysis Report) and returned to the storage racks. Canisters determined to be in good condition will be reused. Damaged canisters will be disposed of as debris, and fuel from those canisters will be loaded into newly-fabricated Mk II canisters.

Scrap will be loaded into a separate canister after fuel has been separated and inspected. Scrap left on the process table, after removal of fuel suitable for loading in a fuel basket, will be collected on a plate containing 1 inch grid markings. The material will be spread out on the plate to approximate a single layer of scrap pieces and photographed. The scrap pieces are rearranged (stirred) on the plate, spread out, and photographed a second time. Using the grid as a guide, all scrap pieces with maximum dimension greater than 1 inch are transferred by manipulator to the scrap canister and weighed. A screen with 1 inch holes will be provided to assist with the sizing of scrap. This represents an estimate of the mass of coarse scrap pieces that would be loaded in coarse sectors of a scrap basket.

Scrap with maximum dimension less than 1 inch remaining on the grid will be processed using the vacuum wand to remove sludge (particles less than ¼ inch). The remaining fine scrap will be spread out to a single layer, photographed, rearranged, spread out and photographed a second time. This material will then be transferred to the scrap canister and weighed. Finally, scrap from cleanout of the PCM wash basket and PCM strainer is dumped on the grid and photographed/weighed as described previously for process table scrap with maximum dimension less than 1 inch. These materials represent an estimate of the mass of fine scrap that would be loaded in the fine sector of a scrap basket.

At the direction of the test engineer, the distance from the top of the scrap to the top of the canister will be measured. This measurement will support estimating the scrap packing density.

Current Basin criticality prevention specifications limit the wet weight of scrap loaded in a canister to 650 lb for Mk IV fuel (FDH 1999). A scrap canister will be established for each key of fuel processed during the hot tests (Section 4.3 identifies three keys such that there will be at least three scrap canisters generated by the hot test). The scrap canisters will be tared and weighed after each addition. The source of the scrap added will be identified to support the material balance evaluation of scrap generation rates. The scrap canisters are stored in the basin storage racks at the conclusion of the test.

Special Hot Test Equipment/Capabilities Required:

- Vertical canister unloading station used to hold canister during re-loading of fuel,
- A station must be made available for loading scrap in a canister (vertical canister unloading station may be suitable for this purpose also),
- Capability to load coarse and fine scrap into canisters,
- Plate with 1 inch grid markings and 1 inch screen to assist sizing, and
- Measuring device to estimate depth of scrap in canister.

4.1.2.6 Other Support

Debris, including unusable canisters and non-fuel material, may be generated during the hot tests and will need to be stored in the basin at the conclusion of the tests. New canisters will be required to allow repackaging of fuel and scrap during the hot test, assuming some canisters can not be re-used and scrap is packaged in separate canisters. Stuck fuel may be encountered during the hot test activity. There is no intent to process fuel that is found to be stuck in canisters. If

stuck fuel in encountered, processing of that canister will be terminated and not considered part of the validation process. The canister will be returned to storage, and tests will proceed to the next canister identified for testing.

Special Hot Test Equipment/Capabilities Required:

- Capability to examine canisters,
- Storage for damaged canisters and debris (may not be observed), and
- Following cleaning and examination, fuel will be loaded back into canisters and returned to the basin for storage. New Mk II canisters must be fabricated to replace any damaged canisters that cannot be reused and to provide for scrap storage.

4.1.3 Data

Data obtained during the FRS hot testing consist of:

- Cycle time data,
- Canister and cleaning machine screens weight data,
- Photographs of fuel condition,
- Video tape records of fuel element disassembly,
- Center basin water radionuclide measurements,
- ⁸⁵Kr ambient air concentration measurements near the canister decapping station,
- Transient gamma radiation levels in the PCM discharge water, and
- Photographs of the post-test condition of PCM bearings.

Cycle time data are obtained to support evaluation of equipment capacity and reliability. A process start time will be recorded for each canister, which will be used as the basis for evaluating cycle times for each equipment piece. Cycle times will be recorded for a particular canister at specified points in the process that allow differentiating between expected production operating time and time required to perform hot test specific activities. A single clock will be designated for use to obtain cycle times and cycle times will be recorded to the nearest minute. No calibration is required for the clock used.

Weight data are obtained from a calibrated scale attached to a shortened canister hook. Canister weight data are obtained after decapping (pre-wash), after washing (post-wash), after dumping (canister tare weight), after a canister is reloaded with clean fuel (clean fuel mass), and after each addition of scrap to the canister used for accumulating scrap (scrap mass). The mass of material captured by cleaning machine screens will be determined by weighing the screens before and after the screens are cleaned. These weight measurements will be used to develop a material balance for each canister processed during the hot test. Weight measurement will be recorded in pounds, with an accuracy of at least 0.2% of full scale (1000 lb) reading.

All major operational phases will be recorded using high-resolution cameras and SVHS video tape and video recorders with date/time indication. Photographs of fuel condition will be obtained from video recordings. Top view photographs will be obtained of fuel in canisters after decapping and cleaning by appropriate positioning of the canister or a video camera.

Photographs from video recordings will also be obtained of material accumulated on cleaning machine screens, fuel element disassembly and inspection, scrap on the process table that is loaded into the scrap canister, and any material separated as debris. Scrap photographs will be of suitable quality to support more advanced analysis of scrap piece sizes such as provided by a digitized vision system.

Scrap packing density will be estimated based on periodic measurement of the scrap depth in a canister barrel. Depth measurements will be recorded in inches with an accuracy of ± 1 inch.

Center basin water samples will be obtained to support evaluation of the canister decapping machine. This is a routine sample and sample analysis and no special analysis is required to support the hot test.

Ambient air ^{85}Kr measurements will be obtained by a continuous monitoring system specifically installed for the hot operations test. A continuous recording of gas compositions will be obtained so that any time delays between canister decapping and peak ^{85}Kr concentrations can be observed.

Gamma radiation levels in the PCM discharge water line will be obtained by positioning a gamma detector outside the discharge piping at a point that minimizes interference from the canister in the PCM and canisters in fuel storage racks. The transient gamma radiation level will be recorded, either electronically or by strip chart. This measurement will qualitatively monitor materials in the discharge line. The full-scale range for gamma radiation measurements will be established during the Phase 3 tests.

Photographs of the PCM bearings post-test condition will be obtained from video recordings. Current cold test plans include a bearing inspection after approximately five operating cycles that will be used for comparison purposes. These video recordings will be made using SVHS video tape and video recorders with date/time indication.

4.1.4 Criteria

Canister decapping functional testing will be considered complete during Phase 3 hot testing by demonstrating both Mk I and Mk II canisters can be opened without experiencing an equipment failure. During Phase 4 hot testing, the equipment reliability will be considered successful if the canister station availability supports an overall system availability of 70% (BNFL 1996). The canister decapping station contamination control performance will be demonstrated if the basin water radionuclide concentration, extrapolated to full production rates, are maintained within current operating control limits.

The PCM/Dump Table functional testing will be considered complete during Phase 3 hot testing by demonstrating the cleaning machine operates at the conditions specified as test parameters, manipulators support fuel and scrap sorting, fuel element disassembly is demonstrated, and fuel and scrap are re-loaded into canisters. During Phase 4 hot testing, the equipment reliability will be considered successful if the cleaning machine availability supports an overall system availability of 70% (BNFL 1996). The system capacity will be successfully demonstrated if the

average throughput, adjusted for process delays caused by test specific measurements, of seven canisters/day is achieved. The PCM cleaning performance is successfully completed by validating the cleaning system by processing 29 randomly selected canisters during the Phase 4 tests. Mass balances will be considered adequate if mass balance closure can be achieved within the weighing equipment accuracy.

Note that an effort is required to minimize the amount of added canisters required for reloading fuel after the final inspection process. This can be accomplished by reassembling the fuel elements as they are loaded back into canisters.

4.1.5 Test Prerequisites

The test prerequisites for starting the fuel retrieval system hot test are:

- Startup and cold tests are complete,
- Identified special test equipment and capabilities are installed and operable,
- Procedural steps and equipment for weighing canisters and screens are performed on a trial basis during cold testing,
- The IWTS is operating, and
- All instruments used to record data have current calibrations.

4.2 Integrated Water Treatment System

The IWTS is designed to remove particulate and dissolved impurities from K Basins water to maintain water quality specifications during fuel removal operations. Primary components include three submersible pumps, a knockout pot, particulate settlers, deep bed filters, ion exchangers, and water piping. A simplified block flow diagram is included here as Figure 4-3.

4.2.1 Test Scope

As noted on Figure 4-3, two components of the IWTS system, the knockout pot and the IXMs; will require specific data to be taken during the hot test. In addition, radiation levels will be measured at the end of Phase 4 testing. Also, water turbidity in the area of the process table will be routinely measured during Phase 3 and 4 testing.

4.2.1.1 Knockout Pot

Mass of the collected particulate will be measured and monitored during process validation to assess fuel damage during the washing operation and establish process control measures. Measurements will be taken frequently at the onset to establish process control requirements. During Phase 3, the weight of the knockout pot will be taken after washing each canister of fuel. During Phase 4, the weight of the knockout pot will be taken at intervals to be determined after reviewing data from Phase 3. All weights will be taken with no water flow through the knockout pot.

Should the measured mass of particulate collected in the knockout pot deviate substantially from expected levels (e.g., very high weights indicating metallic fuel loading), further assessment of the contents may be made. This could involve disassembly of the knockout pot and sampling its contents for composition, particle size, and other pertinent attributes.

The knockout pot pressure drop will be recorded to assess filter plugging. These readings will be recorded on the same interval as knockout pot weighing.

Figure 4-3. Simplified Integrated Water Treatment System Hot Test Block Flow Diagram

4.2.1.2 Ion Exchange Modules

The ability to maintain water quality requirements at the discharge of the IXMs is critical to operations in the basin and the cask loadout pit. In addition, quantification of IXM usage is desirable to confirm replacement schedules and waste disposal costs. Sampling of both the inlet and outlet streams will be done once during each operating shift that the hot test activities are performed to quantify IXM performance. Samples are to be taken while the cleaning machine is in operation. Water turbidity measurements will be taken at the same time.

4.2.1.3 Radiation Levels

Gamma radiation levels will be measured in the same manner as would be done during normal operations. The following locations need to be surveyed, as a minimum, before the start and at the completion of Phase 4 hot testing:

- IWTS piping,
- Sand filter, and
- Knockout pot and settlers.

The radiation levels found for the piping will provide early indications of the potential for sludge and/or fuel particulate deposits. Excessive deposits could lead to unacceptable operating levels during processing. The measurements of sand filter, knockout pot, and settlers will provide inputs for sludge removal project design.

4.2.2 Test Equipment

The planned knockout pot lifting fixture will contain a load cell. This will be used to determine knockout pot weight gains.

The normal sampling stations will be utilized for obtaining IXM inlet and outlet water samples. Radiation level measurements will be obtained using existing gamma and neutron dose detection equipment.

Water turbidity in the process area will be routinely monitored.

Special Hot Test Equipment/Capabilities Required: Measurement of water turbidity.

- Device for measuring the basin water turbidity.

4.2.3 Data

The knockout pot empty weight will be taken after completion of all cold testing and just before initiation of hot testing. This will provide the initial baseline. For Phase 3 hot testing, the knockout pot weight will be taken after every fuel canister completes the wash cycle. In addition, it will be taken at the end of Phase 3 hot testing to provide the baseline for starting Phase 4 testing. Before starting data collection in Phase 4, the results from Phase 3 will be reviewed to determine if a lower frequency of measurement can be justified. In addition, trending to estimate the total weight of particulate expected at the completion of hot testing will be done after each measurement.

Data on pressure drop will be taken at the same interval as weight. The routine IXM water sample analyses will be obtained to support hot test evaluations.

4.2.4 Criteria

There is no specific limit on the amount of particulate per wash batch that can be discharged to the knockout pot. It may be possible to qualitatively determine the amount of fuel damage by analyzing the rate of weight increase of the knockout pot compared to fuel processing rate. Also, these data can be used in conjunction with weights taken during fuel processing to complete a mass balance on the total amount of fuel/scrap/sludge created. If the pressure drop builds up too rapidly, testing will be stopped to assess what should be done.

For IXMs, normal discharge water quality criteria will apply. Other data taken will be for trending purposes, so no specific criteria apply. For radiation levels, the measurements will be used for dose projections and future project designs, so no specific criteria apply.

Measurements of basin water turbidity will be taken to assess the IWTS operational effectiveness. Water clarity will also be monitored and recorded by high-resolution cameras during all operational phases. Qualitative observations of sludge plume formation and persistence will be recorded.

4.2.5 Test Prerequisites

During IWTS cold testing, verification of the ability to weigh the knockout pot without removing the connecting piping must be done. At least 10 lifts are to be made with the knockout pot empty and no flow going through it. The weight indicated for each lift must not vary more than the repeatability specification for the load cell. In addition to verifying that this method of measurement is repeatable, the overall impact of the piping on the empty weight of the knockout pot will be determined. If this impact is too great, this method of obtaining the weight of collected particulate may not be acceptable and other means would have to be considered.

4.3 Canister Selection

The primary factor used to guide Phase 3 and 4 test canister selection is to support the FRS process validation procedure. Additional factors considered during the selection of fuel canisters for the hot test are:

- The keys used during test are composed of Mk IV fuel,
- The number of keys used during tests will be minimized to simplify accountability records, and
- Emphasizes fuel located in the west bay when possible to reduce the distance canisters must be moved.

The FRS process validation procedure describes three phases of operation: operational testing, process validation, and production (Shen 1999). FRS operational testing will be completed in Phase 3 of the hot test. The FRS process validation procedure will be completed by fuel selected in Phase 4 of the hot test.

4.3.1 Phase 3 Fuel Canisters

Operational testing is based on processing fuel through the fuel cleaning machine, observing results, and adjusting cleaning machine operating parameters until all fuel types satisfy cleaning criteria. This is expected to be based on processing approximately six canisters. Since the potential for encountering difficult to clean fuel is assumed to be related to fuel damage, fuel for this activity needs to cover a range of damage conditions (intact, breached, defected, and bad).

The ability to predict that selected canisters will contain a full range of fuel element damage categories is limited since the K West Basin canisters are capped. Table 4-1 summarizes visual data available for Mk IV fuel in the K West Basin from SNF Project characterization activities (lift and look observations) and past observations recorded during fuel encapsulation in the 1980's.

Fuel selection for Phase 3 tests was based on the following criteria:

- Fuel will be selected from both aluminum and stainless steel canisters. This provides cleaning tests on fuel from both canister types. In addition, the decapping station is tested using both Mk I and Mk II canister lid configurations;
- The initial fuel processed from a canister type will contain known element damage categories. This will ensure initial tests will cover the range of damage categories;
- At least one canister from the canister types will be processed that has not undergone a lift and look procedure. The lift and look activity generally resulted in separation of inner and outer elements, which may bias cleaning results. However, the damage categories in these canisters will be unknown until opened at the decapping station; and
- Known chip canisters will not be included in the Phase 3 test canisters selected, as this material is not representative of the general fuel population.

Application of the above criteria resulted in the canister sequence shown in Table 4-2. The Mk II canister located in position 1315 was selected as the first canister. This canister is known to contain only intact and breached fuel (no bad fuel). It was considered to be prudent to begin the hot operating test using a canister with primarily intact fuel. This is followed by a canister known to contain two bad outer elements (1316). A Mk II canister from the same key as the first two canisters, with unknown characteristics was selected as the third canister processed. This canister (6564) and five contingency Mk II canisters are located in the west bay, minimizing the length of fuel canister moves. An additional Mk I stainless steel canister containing unirradiated fuel is also identified as contingency material for the Phase 1 test.

A single Mk I aluminum canister of known condition (1243) was selected as the fourth canister. This canister contains all fuel damage categories. Two additional Mk I aluminum canisters of unknown condition, located in the west bay, were selected to complete the Phase 1 test canister selection. Table 4-2 also identifies four contingency Mk I aluminum canisters.

Table 4-1. Visual Data Available for KW Canisters Containing Mk IV Fuel

KW BASIN CANISTERS DESCRIPTIVE INFORMATION													
MBA 107 DATA (updated Oct 98)					JUNE 98 VIDEO DATA			CHARACTERIZATION VISUAL EXAM DATA – 1995/96 ⁽⁴⁾			Notes from encapsulation records ⁽²⁾		
Cube No.	Lid No.	Key No.	²⁴⁰ Pu%	Fuel Type	outers	inners	cubical	LID	can type ⁽¹⁾	Intact ⁽²⁾	Breached ⁽²⁾	Bad ⁽²⁾	
112	1568	13017	11.39	4	14	14	112	1568	IA				broken pieces
1214	315	12852	13.43	4	14	14	1214	315	IA	12i + 10o	2i + 4o	0i + 0o	
1243	309	12852	13.43	4	14	14	1243	309	IA	11i + 6o	1i + 5o	1i + 1o	
1305	5903	10001	13.59	4	6	4	1305	5903	II				chips
1315	91	13858	12.05	4	14	14	1315	91	II	8i + 6o	6i + 8o	0i + 0o	
1316	2246	13858	12.05	4	14	14	1316	2246	II	11i + 7o	3i + 5o	2o	
1604	1619	13017	11.39	4	14	14	1604	1619	IA				broken pieces
2073	8153	15244	13.58	4	0	1	2073	8153	II				chips??
3303	6768	10001	13.59	4	6	7	3303	4593	II				chips
3975	6009	10001	5.61	4	2	2	3975	6009	II				chips
4174	6087	10001	13.59	4	5	6	4174	6087	II				chips
4175	7362	10001	13.59	4	5	5	4175	7362	II				chips
4374	7536	10001	13.59	4	2	2	4374	7536	II				chips
4375	7587	10001	13.59	4	6	4	4375	7587	II				chips
4402	7578	10001	13.59	4	2	2	4402	7578	II				chips
4574	7476	10001	13.59	4	5	4	4574	7476	II				chips
4575	6082	10001	13.59	4	2	1	4575	6082	II				chips
6006 ⁽³⁾	2137	11540	16.49	4	13	14	6006	2137	II	13i + 6o	1i + 6o	1o	1 broken outer
6013	2008	12565	16.72	4	14	14	6014	6399	II	13i + 12o	1i + 2o		
0430	309	12852	13.43	4	13	14	6258	309	IA	12i + 7o	2i + 5o	1o	broken inners and outers
6259	1740	12852	13.43	4	14	14	6259	1740	IA				some broken fuel
6260	1862	12852	13.43	4	14	14	6260	1862	IA				1 broken piece
6262	943	12852	13.43	4	14	14	6262	943	IA				some broken fuel
6263	1884	12852	13.43	4	14	14	6263	1884	IA				some broken fuel
6265	1856	12852	13.43	4	14	14	6265	1856	IA				some broken fuel
6267	1741	12852	13.43	4	14	14	6267	1741	IA				some broken fuel

- (1) Canister Type: IA = Mk I aluminum canister, IS = Mk I stainless steel canister, II = Mk II stainless steel canister.
- (2) i = inner element, o = outer element.
- (3) Observations from encapsulation activities in the 1980's.
- (4) Visual examination data did not always rate all assemblies due to grappling problems during lift and look characterization.
- (5) Expected to be moved prior to start of hot operations.

Table 4-2. Fuel Canisters Selected for Phase 1 of the FRS/IWTS Hot Test
(includes contingency canisters)

MBA 107 DATA (updated Oct 98)											
Test Sequence	Cube No.	Lid No.	Key No.	²⁴⁰ Pu%	Fuel Type	Outers	Inners	Assy	Pu (g)	U (Kg)	Heat Load (Watts)
Stainless Steel Canisters for FRS Operational Testing											
1	1315*	91	13858	12.05	4	14	14	14	583	326.75	24.02
2	1316*	2246	13858	12.05	4	14	14	14	583	326.75	24.02
3	6564	986	13858	12.05	4	14	14	14	583	326.75	24.02
Aluminum Canisters for FRS Operational Testing											
4	0430*	309	12852	13.43	4	13	14	14	651	326.52	27.15
5	6263	1884	12852	13.43	4	14	14	14	651	326.52	27.15
6	6259	1740	12852	13.43	4	14	14	14	651	326.52	27.15
Contingency Stainless Steel Canisters											
	6563	980	13858	12.05	4	14	14	14	583	326.75	24.02
	6561	1056	13858	12.05	4	14	14	14	583	326.75	24.02
	6558	987	13858	12.05	4	14	14	14	583	326.75	24.02
	6557	1105	13858	12.05	4	14	14	14	583	326.75	24.02
	6556	918	13858	12.05	4	14	14	14	583	326.75	24.02
	3103 [‡]	2581	10764	-	4	13	13	13	0	304.27	0
Contingency Aluminum Canisters											
	1214*	315	12852	13.43	4	14	14	14	651	326.52	27.15
	6261	1895	12852	13.43	4	14	14	14	651	326.52	27.15
	6260	1862	12852	13.43	4	14	14	14	651	326.52	27.15
	6262	943	12852	13.43	4	14	14	14	651	326.52	27.15

* - Canisters with know visual characterization from 1995/96 shown in Table 4-1.

‡ - Unirradiated fuel in Mk I stainless steel canister.

4.3.2 Phase 4 Fuel Canisters

The FRS process validation phase described in Shen (1999) processes fuel to demonstrate that selected cleaning machine operating parameters provide acceptable confidence of satisfying the cleaning criteria. Once the process validation phase is complete, fuel cleaning during production operations can be performed without inspecting each fuel element (every tenth canister is inspected during production). The process validation phase must demonstrate, with 99% confidence, that no more than 15% of the canisters contain an assembly that fails the cleaning criteria. This is demonstrated by evaluating cleaning of a 29 canister sample from the basin population (Shen 1999).

Welsh and Pitner (1998) describe an analysis of visual examinations of approximately 250 assemblies from 20 K West basin canisters. The analysis indicates that, at the 0.05 level of significance, no relationship exists between outer element damage and storage parameters (canister type, fuel type, key date, years encapsulated, and ^{240}Pu content). A weak dependence of inner element damage on key number was observed, but the fraction of inner elements badly damaged is small compared to outer element damage. Therefore, based on the outer element observations, it is concluded that the damage characteristics of the basin canister population can be represented by a key.

Welsh and Pitner (1998) identify a statistically significant relationship between canister type and the presence of a heavy, white coating (subsequently identified as $\text{Al}(\text{OH})_3$). These heavy coatings may also interfere with the fuel cleaning process. Therefore, the 29 canister sample supporting FRS process validation test was randomly selected from two keys: one representing stainless steel canister storage and the other representing aluminum canister storage. Key numbers 12942 (163 aluminum canisters) and 13858 (167 stainless steel canisters) were selected as the keys representing the basin population. These keys contain Mk IV fuel and a relatively large number of canisters located in the west bay.

The actual sequence of canisters selected for processing during Phase 4 of the FRS/IWTS hot test is based on a random selection from the combined 330 canisters in the two keys. A random sequence of 58 canisters was developed for use in the FRS process validation phase of operations (58 canisters identified to provide canister selection contingency in case of cleaning validation failure on the first attempt). This canister selection sequence, shown in Table 4-3, must be maintained to ensure that the statistical foundation of the FRS process validation test is properly developed.

Table 4-3. KW Fuel Cleaning Validation Test Canister Selection for Phase 2 of the FRS/IWTS Hot Test (includes contingency canisters)

Sequence Number	MBA 107 DATA (updated Oct 98)										Heat (Watts)
	Cube No.	Lid No.	Key No.	²⁴⁰ Pu%	Type	outers	inners	Assby	Pu (g)	U (Kg)	
1	1071	4586	13858	12.05	4	14	14	14	583	326.75	24.02
2	6170	913	13858	12.05	4	14	14	14	583	326.75	24.02
3	826	4599	13858	12.05	4	14	14	14	583	326.75	24.02
4	1432	592	12942	12.83	4	14	14	14	621	326.64	25.25
5	836	4371	13858	12.05	4	14	14	14	499	279.45	20.54
6	4813	872	13858	12.05	4	14	14	14	583	326.75	24.02
7	854	4300	13858	12.05	4	14	14	14	440	246.53	18.12
8	1834	775	12942	12.83	4	14	14	14	621	326.64	25.25
9	811	4313	13858	12.05	4	14	14	14	499	279.45	20.54
10	818	4229	13858	12.05	4	14	14	14	583	326.75	24.02
11	869	4303	13858	12.05	4	14	14	14	513	287.34	21.12
12	6560	983	13858	12.05	4	14	14	14	583	326.75	24.02
13	861	4243	13858	12.05	4	14	14	14	386	216.39	15.90
14	4804	976	13858	12.05	4	14	14	14	583	326.75	24.02
15	850	4587	13858	12.05	4	14	14	14	574	321.17	23.61
16	4972	618	12942	12.83	4	14	14	14	411	216.27	16.72
17	6248	969	13858	12.05	4	14	14	14	583	326.75	24.02
18	4805	1051	13858	12.05	4	14	14	14	583	326.75	24.02
19	1841	690	12942	12.83	4	14	14	14	621	326.64	25.25
20	4815	1106	13858	12.05	4	14	14	14	583	326.75	24.02
21	1827	771	12942	12.83	4	14	14	14	621	326.64	25.25
22	1412	617	12942	12.83	4	14	14	14	621	326.64	25.25
23	6552	912	13858	12.05	4	14	14	14	583	326.75	24.02
24	1449	707	12942	12.83	4	14	14	14	621	326.64	25.25
25	1433	571	12942	12.83	4	14	14	14	621	326.64	25.25
26	1466	700	12942	12.83	4	14	14	14	621	326.64	25.25
27	1669	658	12942	12.83	4	14	14	14	621	326.64	25.25
28	6353	1132	13858	12.05	4	14	14	14	583	326.75	24.02
29	4968	622	12942	12.83	4	14	14	14	515	271.46	20.99
Contingency Canisters											
30	1421	613	12942	12.83	4	14	14	14	621	326.64	25.25
31	1840	725	12942	12.83	4	14	14	14	621	326.64	25.25
32	810	4772	13858	12.05	4	14	14	14	499	279.45	20.54
33	5916*	722	12942	12.83	4	14	14	14	621	326.64	25.25
34	6559	1034	13858	12.05	4	14	14	14	583	326.75	24.02
35	1837	724	12942	12.83	4	14	14	14	621	326.64	25.25
36	864	4335	13858	12.05	4	14	14	14	513	287.34	21.12
37	5059	684	12942	12.83	4	14	14	14	621	326.64	25.25
38	5908*	772	12942	12.83	4	14	14	14	621	326.64	25.25
39	1459	675	12942	12.83	4	14	14	14	621	326.64	25.25
40	4947	648	12942	12.1	4	14	14	14	587	327.20	23.09
41	6111	470	13858	12.05	4	14	14	14	583	326.75	24.02
42	1460	674	12942	12.83	4	14	14	14	618	325.23	25.14
43	1830	744	12942	12.83	4	14	14	14	621	326.64	25.25
44	1835	757	12942	12.83	4	14	14	14	621	326.64	25.25
45	4966	628	12942	12.83	4	14	14	14	486	255.69	19.77
46	6175	1035	13858	12.05	4	14	14	14	583	326.75	24.02
47	1419	610	12942	12.83	4	14	14	14	621	326.64	25.25
48	815	4523	13858	12.05	4	14	14	14	499	279.45	20.54
49	844	4432	13858	12.05	4	14	14	14	583	326.75	24.02
50	6562	1567	13858	12.05	4	14	14	14	583	326.75	24.02
51	6355	1193	13858	12.05	4	14	14	14	583	326.75	24.02
52	6173	1055	13858	12.05	4	14	14	14	583	326.75	24.02
53	1839	727	12942	12.83	4	14	14	14	621	326.64	25.25
54	838	4556	13858	12.05	4	14	14	14	583	326.75	24.02
55	1417	607	12942	12.83	4	14	14	14	621	326.64	25.25
56	1831	747	12942	12.83	4	14	14	14	621	326.64	25.25
57	859	4771	13858	12.05	4	14	14	14	583	326.75	24.02
58	5906*	716	12942	12.83	4	14	14	14	621	326.64	25.25

* - Expected to be moved prior to start of hot operations.

5.0 EXPECTED RESULTS

The success criteria, and source for the corresponding design basis document, for each of the four unit operations are listed in Table 5-1. The canister decapping must demonstrate control of contained gases and contaminated water to be successful. The PCM must demonstrate throughput rate, show achievement of the cleaning performance, and provide an overall material balance to be successful. The IWTS must demonstrate settling performance, waste generation rates, control of basin water radionuclide concentrations, and water clarity to be successful. All the processes must show general reliability and adequate capacity.

Figure 5-1 shows the material balance diagram that will be obtained from the hot test. It is a partial composite of the Process Flow Diagrams for FRS and IWTS (Drawings H-1-81161 and H-1-81164) and uses the same flow stream numbers from those drawings. The tabulations of Figure 5-1, (sheets 2 and 3) give the expected masses for the streams for the minimum and maximum number of canisters in Phase 3 and Phase 4 operations. Sheet 4 summarizes the materials accumulated for the two phases during normal or contingency situations. Confirmations of the quantities of sludge, broken fuel, etc. are needed to support planning for basin operations.

Table 5-1. FRS/IWTS Hot Test Success Criteria and Design Basis

Unit Operation	Objective	Success Criteria/Source
Canister Decapping	Equipment operational reliability	Demonstrate canister decapping functionality during Phase 3 tests. Support overall system availability > 70% during Phase 4 tests (Cleveland and Pajunen 1999).
	Control gases contained in canisters	Basin operating areas remain off mask during canister decapping and gaseous emissions, extrapolated to full production rate, within air permit (Groth 1999).
	Local control of basin water contamination	No significant increase in operating area dose fields or airborne contamination from canister decapping (Groth 1999).
	Equipment operational reliability	Demonstrate PCM/manipulator functionality during Phase 3 tests. Achieve overall system availability > 70% during Phase 4 tests when adjusted for differences between test and routine operations (Cleveland and Pajunen 1999).
PCM/Dump Table	System capacity	Cycle time through decapping and cleaning, extrapolated to production, compare with design estimates conditions approximately 7 canisters/day (Cleveland and Pajunen 1999).
	PCM performance	<ul style="list-style-type: none"> - Demonstrate inspection standards are feasible to support routine operation (Shen 1999) - Complete operational parameter testing of PCM in Phase 3 tests (Shen 1999) - Complete process validation of PCM in Phase 4 tests (Shen 1999)
	<ul style="list-style-type: none"> - Establish operating parameter range (~ 6 canisters) - Complete cleaning system validation (~ 29 canisters) 	
	Overall material balance	
	<ul style="list-style-type: none"> - Scrap generation rate/characteristics - PCM strainer performance - Stuck fuel 	<ul style="list-style-type: none"> - Quantify overall scrap generation rate and packing density observed and update total project MCO estimate (Pajunen 1997). Obtain scrap photographs to further characterize - Quantify potential for strainer to capture material smaller than 1/4 inch (Pajunen 2000, Groth 1999) - Record presence of stuck fuel (if found) and update predicted rate of using canister slitting equipment (Groth 1999)
	Quantify Knockout pot/Settler tank performance	Quantify sludge/metal particulate generated from cleaning (Pearce, et. al. 1998)
IWTS Water Treatment	Demonstrate treatment equipment performance	Treated water satisfies specification for water introduced to cask loadout pit and MCO (H-2-825868, Rev 4, IC-046)
	Demonstrate expected waste generation rate	Quantify ion exchange bed usage and update predicted waste generation during operation (H-2-825868, Rev 4, IC-146)
	Demonstrate general control of basin water	Water quality maintained such that visibility in operating areas does not hamper operations. Water clarity and radionuclide concentrations, extrapolated to full production, maintained within current operating limits.
	Collect additional data points characterizing KW fuel damage	Update damage category predictions KW basin fuel (Pimer 1998)
Other	Fuel selection	<ul style="list-style-type: none"> - Initial selection: Attempt to select fuel that includes fuel ranging from intact to bad condition from both AI and SS canisters (~ 6 canisters) (Shen 1999) - Process validation: Must use pre-selected random sample representative of the basin population (at least 29 canisters) (Shen 1999)

Figure 5-1. Hot Test Flow Diagram and Mass Balance (Sheet 1 of 4)

Figure 5-1. Hot Test Flow Diagram and Mass Balance (Sheet 2 of 4)

Phase I: Canisters for Operational Testing										
Components (kg)	FW-1: Retrieve Canister	FW-10: De-Capping Station	FW-29: PCM	FW-73: Process Table (scrap)	FW-63: Process Table (fuel)	IC-017: Sludge/Water	WW-11: Knockout Pot Effluent	WW-12: Settler Effluent	WW-14: Sand Filters Effluent	IC-189: Ion Exchange Module
Canister Quantity	6	6	6	2	6					
Fuel										
Uranium	2.0E+03	2.0E+03	2.0E+03	2.9E+02	1.7E+03	2.0E+00	1.1E+00	1.1E-03	1.1E-03	0.0E+00
Plutonium	3.7E+00	3.7E+00	3.7E+00	5.5E-01	3.1E+00	3.7E-03	2.2E-03	2.2E-06	2.2E-06	0.0E+00
Other	1.4E+02	1.4E+02	1.4E+02	2.1E+01	1.2E+02	1.4E-01	7.6E-02	7.6E-05	7.6E-05	0.0E+00
Total Fuel	2.1E+03	2.1E+03	2.1E+03	3.1E+02	1.8E+03	2.1E+00	1.2E+00	1.2E-03	1.2E-03	0.0E+00
Sludge										
Uranium	2.1E+00	2.1E+00	5.7E+00	0.0E+00	0.0E+00	5.7E+00	3.2E+00	3.2E-03	3.2E-03	0.0E+00
Plutonium	8.9E-03	8.9E-03	2.3E-02	0.0E+00	0.0E+00	2.3E-02	1.3E-02	1.3E-05	1.3E-05	0.0E+00
Other	2.1E+00	2.1E+00	2.3E+00	0.0E+00	0.0E+00	2.3E+00	1.3E+00	1.3E-03	1.3E-03	0.0E+00
Total Sludge	4.2E+00	4.2E+00	8.1E+00	0.0E+00	0.0E+00	8.1E+00	4.5E+00	4.5E-03	4.5E-03	0.0E+00

Phase I: Canisters for Operational Testing (including contingency canisters)										
Components (kg)	FW-1: Retrieve Canister	FW-10: De-Capping Station	FW-29: PCM	FW-73: Process Table (scrap)	FW-63: Process Table (fuel)	IC-017: Sludge/Water	WW-11: Knockout Pot Effluent	WW-12: Settler Effluent	WW-14: Sand Filters Effluent	IC-189: Ion Exchange Module
Canister Quantity	16	16	16	5	16					
Fuel										
Uranium	5.2E+03	5.2E+03	5.2E+03	7.8E+02	4.4E+03	2.1E+01	1.1E+01	1.1E-02	1.1E-02	0.0E+00
Plutonium	5.5E+00	5.5E+00	5.5E+00	8.3E-01	4.7E+00	6.6E-02	3.9E-02	3.9E-05	3.9E-05	0.0E+00
Other	3.7E+02	3.7E+02	3.7E+02	5.5E+01	3.1E+02	1.4E+00	8.0E-01	8.0E-04	8.0E-04	0.0E+00
Total Fuel	5.6E+03	5.6E+03	5.6E+03	8.4E+02	4.7E+03	2.2E+01	1.2E+01	1.2E-02	1.2E-02	0.0E+00
Sludge										
Uranium	5.5E+00	5.5E+00	1.5E+01	0.0E+00	0.0E+00	1.5E+01	8.5E+00	8.5E-03	8.5E-03	0.0E+00
Plutonium	2.4E-02	2.4E-02	6.0E-02	0.0E+00	0.0E+00	6.0E-02	3.6E-02	3.6E-05	3.6E-05	0.0E+00
Other	5.7E+00	5.7E+00	6.2E+00	0.0E+00	0.0E+00	6.2E+00	3.4E+00	3.4E-03	3.4E-03	0.0E+00
Total Sludge	1.1E+01	1.1E+01	2.2E+01	0.0E+00	0.0E+00	2.2E+01	1.2E+01	1.2E-02	1.2E-02	0.0E+00

Figure 5-1. Hot Test Flow Diagram and Mass Balance (Sheet 3 of 4)

Phase 2: Canisters for Validation										
Components (kg)	FW-1: Retrieve Canister	FW-10: De-Capping Station	FW-29: PCM	FW-73: Process Table (scrap)	FW-63: Process Table (fuel)	IC-017: Sludge/Water	WW-11: Knockout Pot Effluent	WW-12: Settler Effluent	WW-14: Sand Filters Effluent	IC-189: Ion Exchange Module
Canister Quantity	29	29	29	5	29					
Fuel										
Uranium	9.0E+03	9.0E+03	9.0E+03	1.3E+03	7.6E+03	3.7E+01	2.0E+01	2.0E+02	2.0E+02	0.0E+00
Plutonium	1.6E+01	1.6E+01	1.6E+01	2.5E+00	1.4E+01	1.3E+01	7.4E+02	7.4E+05	7.4E+05	0.0E+00
Other	6.3E+02	6.3E+02	6.3E+02	9.5E+01	5.4E+02	2.6E+00	1.4E+00	1.4E+03	1.4E+03	0.0E+00
Total Fuel	9.6E+03	9.6E+03	9.6E+03	1.4E+03	8.2E+03	4.0E+01	2.2E+01	2.2E+02	2.2E+02	0.0E+00
Sludge										
Uranium	1.0E+01	1.0E+01	2.8E+01	0.0E+00	0.0E+00	2.8E+01	1.5E+01	1.5E+02	1.5E+02	0.0E+00
Plutonium	4.3E-02	4.3E-02	1.1E-01	0.0E+00	0.0E+00	1.1E-01	6.5E-02	6.5E-05	6.5E-05	0.0E+00
Other	1.0E+01	1.0E+01	1.1E+01	0.0E+00	0.0E+00	1.1E+01	6.2E+00	6.2E+03	6.2E+03	0.0E+00
Total Sludge	2.0E+01	2.0E+01	3.9E+01	0.0E+00	0.0E+00	3.9E+01	2.2E+01	2.2E+02	2.2E+02	0.0E+00
Phase 2: Canisters for Validation (including contingency canisters)										
Components (kg)	FW-1: Retrieve Canister	FW-10: De-Capping Station	FW-29: PCM	FW-73: Process Table (scrap)	FW-63: Process Table (fuel)	IC-017: Sludge/Water	WW-11: Knockout Pot Effluent	WW-12: Settler Effluent	WW-14: Sand Filters Effluent	IC-189: Ion Exchange Module
Canister Quantity	58	58	58	10	58					
Fuel										
Uranium	1.8E+04	1.8E+04	1.8E+04	2.7E+03	1.5E+04	7.4E+01	4.1E+01	4.1E+02	4.1E+02	0.0E+00
Plutonium	1.7E+01	1.7E+01	1.7E+01	2.6E+00	1.5E+01	2.4E+01	1.4E+01	1.4E+04	1.4E+04	0.0E+00
Other	1.3E+03	1.3E+03	1.3E+03	1.9E+02	1.1E+03	5.2E+00	2.9E+00	2.9E+03	2.9E+03	0.0E+00
Total Fuel	2.0E+04	2.0E+04	2.0E+04	2.9E+03	1.7E+04	7.9E+01	4.4E+01	4.4E+02	4.4E+02	0.0E+00
Sludge										
Uranium	2.0E+01	2.0E+01	5.5E+01	0.0E+00	0.0E+00	5.5E+01	3.1E+01	3.1E+02	3.1E+02	0.0E+00
Plutonium	8.6E-02	8.6E-02	2.2E-01	0.0E+00	0.0E+00	2.2E-01	1.3E-01	1.3E-04	1.3E-04	0.0E+00
Other	2.1E+01	2.1E+01	2.2E+01	0.0E+00	0.0E+00	2.2E+01	1.2E+01	1.2E+02	1.2E+02	0.0E+00
Total Sludge	4.1E+01	4.1E+01	7.8E+01	0.0E+00	0.0E+00	7.8E+01	4.3E+01	4.3E+02	4.3E+02	0.0E+00

Figure 5-1. Hot Test Flow Diagram and Mass Balance (Sheet 4 of 4)

Phase 1: Accumulation Within Knockout Pot, Settler, and Ion Exchange Module (IXM)						
Components (kg)	Knockout Pot Accumulation (Phase 1)	Settler Accumulation (Phase 1)	IXM Accumulation (Phase 1)	Knockout Pot Accumulation 1-contingency (Phase)	Settler Accumulation (Phase 1-contingency)	IXM Accumulation (Phase 1-contingency)
Fuel						
Uranium	8.7E-01	1.1E+00	1.1E-03	9.2E+00	1.1E+01	1.1E-02
Plutonium	1.5E-03	2.2E-03	2.2E-06	2.7E-02	3.9E-02	3.9E-05
Other	6.1E-02	7.6E-02	7.6E-05	6.4E-01	8.0E-01	8.0E-04
Total Fuel	9.4E-01	1.2E+00	1.2E-03	9.8E+00	1.2E+01	1.2E-02
Sludge						
Uranium	2.6E+00	3.2E+00	3.2E-03	6.8E+00	8.5E+00	8.5E-03
Plutonium	9.2E-03	1.3E-02	1.3E-05	2.5E-02	3.6E-02	3.6E-05
Other	1.0E+00	1.3E+00	1.3E-03	2.8E+00	3.4E+00	3.4E-03
Total Sludge	3.6E+00	4.5E+00	4.5E-03	9.6E+00	1.2E+01	1.2E-02
Total	4.5E+00	5.6E+00	5.6E-03	1.9E+01	2.4E+01	2.4E-02

Phase 2: Accumulation Within Knockout Pot, Settler, and Ion Exchange Module (IXM)						
Components (kg)	Knockout Pot Accumulation (Phase 2)	Settler Accumulation (Phase 2)	IXM Accumulation (Phase 2)	Knockout Pot Accumulation 2-contingency (Phase)	Settler Accumulation (Phase 2-contingency)	IXM Accumulation (Phase 2-contingency)
Fuel						
Uranium	1.6E+01	2.0E+01	2.0E-02	3.3E+01	4.1E+01	4.1E-02
Plutonium	5.1E-02	7.4E-02	7.4E-05	9.6E-02	1.4E-01	1.4E-04
Other	1.2E+00	1.4E+00	1.4E-03	2.3E+00	2.9E+00	2.9E-03
Total Fuel	1.8E+01	2.2E+01	2.2E-02	3.5E+01	4.4E+01	4.4E-02
Sludge						
Uranium	1.2E+01	1.5E+01	1.5E-02	2.5E+01	3.1E+01	3.1E-02
Plutonium	4.5E-02	6.5E-02	6.5E-05	8.9E-02	1.3E-01	1.3E-04
Other	5.0E+00	6.2E+00	6.2E-03	1.0E+01	1.2E+01	1.2E-02
Total Sludge	1.7E+01	2.2E+01	2.2E-02	3.5E+01	4.3E+01	4.3E-02
Total	3.5E+01	4.4E+01	4.4E-02	7.0E+01	8.7E+01	8.7E-02

6.0 TEST PROCEDURE

Test procedures for the PSI Phase 3 and Phase 4 hot testing will be written as separate documents. Each test procedure will define the step-by-step processes involved in performing the hot testing, and direct the recording of the required data. The test procedures will make use of existing Functional Test Procedures (FTP) and Operating Procedures (OPs) for standard in-basin operations such as fuel canister transfers, decapping operations, fuel element separation, etc. After execution of each applicable FTP or OP, control will return to the primary Test Procedure to continue the testing process.

7.0 SAFETY

An Unreviewed Safety Question evaluation will be performed to assess this test activity against the current safety authorization basis. If necessary, an engineering change notice (ECN) will be prepared to modify the authorization basis, which will be transmitted to DOE for review and approval.

The size of scrap pieces generated by the PCM can be smaller than fuel chips currently stored in the basins. Therefore, the thermal stability of scrap stored in a canister will be evaluated to support the USQ evaluation. Plys (1999) concluded that a bed of 0.5 mm (~3/16 inch) fuel particles accumulated in the IWTS knockout pot (16 inch diameter, 12 inches high) will be thermally stable when covered by basin water. Since a canister barrel (~8 inch diameter, 25 inches high) will be loaded with coarse scrap, as well as small scrap pieces, it is anticipated that the knockout pot analysis represents a more reactive configuration than the scrap canister and scrap storage will be shown to be thermally stable.

A Job Hazard Analysis will be performed to assess safety concerns associated with all phases of the FRS/IWTS Hot Testing activities. Other safety related reviews to be performed include As-Low-As-Reasonably Achievable (ALARA) and ALARA Management Worksheet.

8.0 QUALITY ASSURANCE

FRS process validation has been identified as an activity that requires application of the OCRWM DOE/RW-0333P QARD. FRS and IWTS Hot Testing will be performed simultaneously. To provide for a consistent approach to quality, the more prescriptive requirements of the QARD will also be implemented for the non-OCRWM IWTS Hot Testing. Implementation of the QARD shall be in accordance with QAPP-OCRWM-001, Rev 4, *Quality Assurance Program Plan for Implementation of the OCRWM QARD* as identified in QA-OCRWM-1, *OCRWM QARD Requirements Matrix*.

The OCRWM QARD requirements matrix was reviewed and the functional elements that will be invoked on this work include, but are not limited to the following:

Section 1.0 Organization

The SNF Project organizational structure, functional responsibilities, and levels of authority are identified in HNF-3552 "Spent Nuclear Fuel Project Execution Plan". Organizational interfaces are identified in QAPP-OCRWM-001.

Quality shall be achieved and maintained by those who have been assigned to perform the testing. Persons or organizations not directly responsible for performing the tests shall perform verification of acceptability.

Section 2.0 Quality Assurance Program

The SNF Project Quality Assurance (QA) program for OCRWM related work is planned, implemented, and maintained in accordance with QAPP-OCRWM-001 and procedures listed in QA-OCRWM-1.

Planning shall be documented to ensure work is accomplished under suitably controlled conditions. Planning elements are identified in AP-EN-6-031 "Testing Process"

Personnel shall be indoctrinated and trained to achieve initial proficiency; maintain proficiency; and adapt to changes in technology, methods, or job responsibilities. Additionally, personnel who perform the testing or verify acceptability shall be in compliance with requirements specified in AP-TN-11-013 and qualified in accordance with QARD Section 10.2.9.

Section 3.0 Design Control

Changes to the design identified by this testing shall be subject to design control measures commensurate with those applied to the original design. Design change control for the SNF Project is described in AP-EN-6-030 "Engineering Process" and AP-EN-6-039 "Engineering Document Change Control".

Section 5.0 Implementing Documents

Implementing documents used to control and perform testing shall be reviewed, approved, and controlled. All testing shall be performed in accordance with approved test procedures. When work cannot be performed as described in the test procedure, or would result in an undesirable situation, the work shall be stopped. Work shall not resume until the procedure is changed to reflect the correct work practices.

Section 6.0 Document Control

Implementing documents and documents that specify technical or quality requirements shall be controlled. Controls shall be in place for the preparation, review, approval, distribution, use, and changes to documents.

Section 10 Inspection

Personnel qualified and certified in accordance with HNF-PRO-263 shall perform verifications for acceptance to technical or quality requirements. Inspection planning and performance shall be in accordance with AP-QA-11-002 "Quality Assurance Inprocess and Final Inspection".

Section 11 Test Control

Test planning shall be in accordance with Section 6.1 of AP-EN-031, "Testing Process". This plan and the Test Planning Form, attached as appendix B, conform to the test planning requirements. Additionally, required safety measures shall be identified.

Test results shall be documented and their conformance with acceptance criteria shall be evaluated by the Design Authority to ensure that test requirements have been satisfied.

Test documentation shall be in accordance with AP-EN-031 and as a minimum identify:

- Item or system tested,
- Date of test,
- Name of test personnel, including those recording data,
- Type of observation,
- Method of testing,
- Test criteria or reference documents used to determine acceptance,
- Results and acceptability of the test,
- Actions taken in connection with any nonconformances,
- Name and qualifications of the person evaluating the test results, and
- Identification of the measuring and test equipment (M&TE) used during the test, including the unique identifier, most recent calibration date, and calibration due date.

Section 12 Control of Measuring and Test Equipment

M&TE used to monitor the testing, collect data, or verify acceptability shall be calibrated, adjusted, and maintained as a unit at prescribed intervals, or prior to use, against reference calibration standards having traceability to nationally recognized standards. The M&TE used shall be documented, including its calibration schedule.

Calibration and control of M&TE shall be in accordance with HNF-PRO-490, "Control of Measuring and Test Equipment," AP-PM-3-002 "Controlling Tools, and Measuring and Test Equipment", and AP-PM-3-004 "Calibration of Instruments and M&TE".

Section 13 Handling, Storage, and Shipping

Handling of items shall be controlled to prevent damage in accordance with AP-MN-6-014, "Safety Class, Safety Significant, Handling, Storage, and Shipping." Special handling tools and equipment shall be utilized and controlled as necessary to ensure safe and adequate handling. Special handling tools and equipment shall be inspected and tested in accordance with procedures and at specified time intervals to verify that the tools and equipment are adequately maintained. Operators of special handling and lifting equipment shall be experienced or trained in use of the equipment.

Section 14 Inspection, Test and Operating Status

Items that have satisfactorily passed required testing shall be identified.

Test status shall be identified to prevent inadvertent bypassing of required tests. Test status shall be identified either on the items or in documents traceable to the items.

Status shall be maintained through the use of legible and easily recognizable status indicators (such as tags, markings, labels and stamps) or other means (such as travelers or test records).

Physical status indicators shall be applied and removed by QA personnel. QA personnel shall verify status identified in travelers or test records.

Implementation of test status shall be in accordance with AP-QA-11-003 "QA Inspection, Test, and Operating Status Indicators".

Section 15 Nonconformances

Items that do not conform to specified requirements shall be controlled to prevent inadvertent installation or use. Nonconforming items shall be documented on a Nonconformance Report (NCR). Identification of nonconforming items and processing of NCRs shall be in accordance with HNF-PRO-298 "Nonconforming Item Reporting and Control" as supplemented by AP-QA-11-004 "Nonconformance Reporting and Control".

Section 16 Corrective Action

A condition adverse to quality shall be identified when a QA program requirement or that of an implementing document is not met. Conditions adverse to quality shall be classified, documented and the documentation processed in accordance with HNF-PRO-1748 "OCRWM Corrective Action and Stop Work". Corrective action for conditions adverse to quality shall be managed in accordance with HNF-PRO-052 "Corrective Action Management".

Section 17 Quality Assurance Records

Test documentation is a Lifetime Quality Assurance Record. Test records shall be managed in accordance with AP-IR-1-029 "Records Management".

9.0 ORGANIZATION AND FUNCTION RESPONSIBILITIES

The on-duty Shift Manager has overall responsibility for activities within the 105 K West facility. The Operations Test Director (OTD) will have overall authority of the Phase 3 and Phase 4 testing and will report to the on-duty Shift Manager. The Cognizant and Process Engineer will report to the OTD. Facility Engineering is responsible for assigning Cognizant Engineers to the FRS and IWTS. The Cognizant Engineers will have overall technical authority of the respective systems during the hot test.

Process Engineering is responsible for developing the test plan and test specifications for this activity, developing the primary test procedures for conducting the hot testing, technical supervision of process related test activities, evaluating the data collected during testing, and issuing a report on the results obtained. Process Engineering also has lead responsibility for formulating the team of experts that will assess the effective cleanliness of the fuel following cleaning operations.

K West Basin Operations will perform the test operations and collect the prescribed data, including video recordings as required.

The SNF Project will perform the USQ screening for this activity.

QA Operations will conduct any quality assurance overviews required to support this test activity.

Procedures will write the OPs and FTPs to conduct the test operations in accordance with the requirements provided in this test plan.

Radiological Control will address radiological concerns associated with this test activity.

Operations Analysis and Waste Handling will generate the campaign letter required for moving fuel in the K West Basin.

K Basins Work Control will perform any planning and scheduling activities required to support this activity

K Basins Maintenance will provide any needed craft support for this activity.

10.0 SCHEDULE

Since there is no operating experience for the cleaning machine using actual fuel, this test initiates a first of a kind process. Therefore, schedule estimates for test completion are necessarily imprecise. Operating time contingency is included in each test phase to address this uncertainty. It is assumed that hot test operations will be performed one shift per day, five days per week. The schedule estimates for completing the hot test activities are described below.

Phase 3 Testing

- Estimate operating time at 1 canister/shift
- Minimum of 6 canisters = 6 shifts, or 6 days
- Maximum based on all contingency canisters (16) = 16 shifts or 16 days
- Time allowance to adjust cleaning machine parameters = 4 days
- Contingency for start-up operation = 10 days

- Total time estimate for Phase 3 testing = 4 to 6 weeks

Phase 4 Testing

- Estimate operating time at 2 canisters/shift
- Minimum of 29 canisters = 15 shifts, or 15 days
- Maximum based on all contingency canisters (58) = 29 shifts, or 29 days
- Allowance in maximum estimate to return to Phase 1 test = 10 days
- Contingency for start-up operation = 10 days

- Total time for Phase 4 testing = 5 to 10 weeks

Test Report Preparation

- Assemble, organize, evaluate data, and draft overall test report = 4 weeks
- Internal review of overall test report = 2 weeks
- Modify, approve and issue overall test report = 4 weeks
- Draft PCM performance report = 4 weeks
- Internal review PCM performance report = 2 weeks
- Issue Rev 0 PCM performance report = 2 weeks
- Peer review Rev 0 PCM performance report = 4 weeks
- Comment response, issue Rev 1 PCM performance report, compile QA package = 4 weeks

11.0 REPORTS

Following the completion of hot testing, two reports will be issued based on the test data. Process Engineering will issue a test report that documents the results of testing, tabulates the data, and makes specific recommendations on any changes and/or improvements that should be made before start-up. The overall test report will be an internally reviewed document.

A second report will be prepared specifically describing the PCM performance and validation testing. This report will form the basis for validating the PCM performance and will be peer reviewed to satisfy requirements for OCRWM documentation.

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13.0 DATA SHEETS

FRS Hot Testing Data Collection Sheet – Page 1

Date _____

Phase _____

Canister Lid No. _____

Step	Time	Data
Retrieve Canister		Cubicle Location _____
Start Decapping		CAM Alarm Down Time _____ Equipment Down Time _____ Basin Water Radionuclides _____
End Decapping		Top Photo _____ Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb
PCM Pre-Weights		Load Cell Tare _____ lb Wash Basket Pre-weight No. 1 _____ lb Wash Basket Pre-weight No. 2 _____ lb Wash Basket Pre-weight No. 3 _____ lb Load Cell Tare _____ lb Strainer Pre-weight No. 1 _____ lb Strainer Pre-weight No. 2 _____ lb Strainer Pre-weight No. 3 _____ lb
Load PCM and Wash		Radiation Monitor Activated _____ Start Wash Time _____ End Wash Time _____ Equipment Down Time _____
Remove Canister from PCM		Top Photo _____ Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb
Dump Fuel on Table		Stuck Fuel? Yes _____ No _____ Load Cell Tare _____ lb Empty Canister Weight No. 1 _____ lb Empty Canister Weight No. 2 _____ lb Empty Canister Weight No. 3 _____ lb Photo of Empty Canister _____ Turbidity _____ NTU Photo of Fuel on Table _____

FRS Hot Testing Data Collection Sheet – Page 2

Date _____

Phase _____

Canister Lid No. _____

Step	Time	Data
Clean Out PCM		Load Cell Tare _____ lb Wash Basket Weight No. 1 _____ lb Wash Basket Weight No. 2 _____ lb Wash Basket Weight No. 3 _____ lb Photo of Wash Basket _____ Load Cell Tare _____ lb Strainer Weight No. 1 _____ lb Strainer Weight No. 2 _____ lb Strainer Weight No. 3 _____ lb Photo of Strainer _____
Sort Fuel/Scrap/Debris		End Time _____ Photo of debris _____
Separate Fuel Assemblies and Inspect Fuel Elements		Video of Inspections _____ Total No. Inspected: Inners _____ Outers _____ No. Sludge Piles > 1" _____ No. Bore Obstructions Detected _____ End Time _____
Load Scrap > 1" into Scrap Canister		First photo of scrap _____ Second photo of scrap _____ Load Cell Tare _____ lb Canister Starting Weight No. 1 _____ lb Canister Starting Weight No. 2 _____ lb Canister Starting Weight No. 3 _____ lb Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb End Time _____
Load Table Fines into Scrap Canister		First photo of scrap _____ Second photo of scrap _____ Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb End Time _____

FRS Hot Testing Data Collection Sheet – Page 3

Date _____

Phase _____

Canister Lid No. _____

Step	Time	Data
Load Wash Basket Scrap into Scrap Canister		First photo of scrap _____ Second photo of scrap _____ Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb End Time _____
Load Strainer Scrap into Scrap Canister		First photo of scrap _____ Second photo of scrap _____ Load Cell Tare _____ lb Canister Weight No. 1 _____ lb Canister Weight No. 2 _____ lb Canister Weight No. 3 _____ lb Scrap depth _____ in. End Time _____
Load Fuel in Canister		Load Cell Tare _____ lb Empty Canister Weight No. 1 _____ lb Empty Canister Weight No. 2 _____ lb Empty Canister Weight No. 3 _____ lb Load Cell Tare _____ lb Loaded Canister Weight No. 1 _____ lb Loaded Canister Weight No. 2 _____ lb Loaded Canister Weight No. 3 _____ lb Top photo _____ End Time _____
Return Fuel Canister to Storage Rack		Cubicle Location _____ End Time _____

IWTS Hot Testing Knockout Pot Data Collection Sheet

[illegible]

IWTS Hot Testing Turbidity and IXM Data Collection Sheet

[illegible]

Appendix A. Fuel Retrieval System Process Description

The following sheets are derived from Jackson, 1999. Highlighted steps indicate the scope planned for hot testing.

Production Mode Operations

Inspection Operations

Loading Operations

Additional Hot Test Operations

Additional Cold Test Operations

Appendix B. Test Planning Form

TEST PLANNING FORM

Note: Complete all sections of this plan for all tests. In cases where the information is available in other documents, such as a test plan or procedure, reference the specific document by Number, Title, Revision, Date, and Section that defines that information.

1. Item or System to be tested: (QARD 11.2.1.B & HNF-PRO-1819, 2.9.2.1)

Fuel Retrieval System/Integrated Water Treatment system Hot Operation

2. Objective of the test: (e.g., prototype qualification, process or production qualification, equipment acceptance, pre-installation proof tests, construction tests, and pre-operational tests) (QARD 11.2.2.B)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 2.0

3. Name of Test Facility

K West Basin

4. List documents to be developed to perform and control the test. (QARD 11.2.1.A)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM)

Operating Procedures for FRS and IWTS Equipment Tested

5. List other types of documents used to perform and control the test:

(QARD 11.2.3 & HNF-PRO-1819, 2.9.2.2) If applicable include:

- Test facility specific requirements and procedures
- ASTM specs or other consensus standards
- Supplier manuals

Facility Operating Procedures

5a. To be evaluated when operating procedures complete

Print Name / Signature Test Director

Print Name / Design Authority Signature

Signatures indicate the test plan documentation was reviewed against, and is consistent with the test facility requirements.

6. Identify safety related information. (HNF-PRO-1819, 2.9.2.3f)

If non-routine job, prepare and include a hazard analysis by one of the following methods:

1. complete a Job Hazard Analysis (JHA)
2. a formal hazard analysis

Evaluated by USQ process and safety document modifications followed by readiness assessment

7. Identify testing requirements. (QARD 11.2.2.D & HNF-PRO-1819, 2.9.2.2)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 4.0

7a.

J. M. Kurta/G. E. Stegan

Print Name / Signature of design authority indicates the above testing requirements (Item 7) were provided or approved by the organization responsible for the design of the test item, unless otherwise indicated. (QARD 11.2.2.C & HNF-PRO-1819, 2.9.2.2)

8. Identify test acceptance criteria: (quantitative and qualitative, include precision levels, accuracy levels, and applicable units of measure)

(QARD 11.2.2.D & HNF-PRO-1819, 2.9.2.2, 2.9.2.3d)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 4.0

8a.

J. M. Kurta/G. E. Stegan

Print Name / Signature of design authority indicates the above acceptance criteria (Item 8) were provided or approved by the organization responsible for the design of the test item, unless otherwise indicated. (QARD 11.2.2.C)

9. Identify the test methods to be used, and the rationale for selection of this method:

(QARD 11.2.1.C & HNF-PRO-1819, 2.9.2.3c)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 4.0

10. Define the instructions for performing the test: (QARD 11.2.1.C & HNF-PRO-1819, 2.9.2.1)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 6.0

TEST PLANNING FORM

Note: Complete all sections of this plan for all tests. In cases where the information is available in other documents, such as a test plan or procedure, reference the specific document by Number, Title, Revision, Date, and Section that defines that information.

11. List all Test Prerequisites (be specific): (QARD 11.2.1.D & HNF-PRO-1819, 2.9.2.3e, 2.9.2.6)

Include the following:

- a. Required condition of the item or system to be tested including post-test conditions.
 - b. Equipment required to perform the test, include the type, range, accuracy, and tolerance to accomplish the intended function. (QARD 11.2.1.H)
 - c. Required condition of the test equipment.
 - d. Instrumentation required to perform the test, include the type, range, accuracy, and tolerance to accomplish the intended function. (QARD 11.2.1.H)
 - e. Calibration requirements of all instrumentation. (QARD 11.2.2.B)
 - f. Additional training, beyond the qualification levels, required for personnel performing the test, include associated safety requirements. (QARD 11.2.2.A)
 - g. Suitable environmental conditions for the test, for qualification testing consider the operating modes and environmental conditions where the item or system will be used.
 - h. Controls required to maintain suitable environmental conditions. (QARD 11.2.2.B)
- Provisions for data acquisition during the test.

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Sections 4.1.5 and 4.2.5

12. List all mandatory hold points including witness and verification points. (QARD 11.2.1.E & HNF-PRO-1819, 2.9.2.3g)

To be defined in future revision of HNF-4898

13. Identify the method to record data during the test. (QARD 11.2.1.F)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 13.0

14. Identify the method to record the test results. (QARD 11.2.1.F & HNF-PRO-1819, 2.9.2.4)

See HNF-4898, Rev. 0, Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM), Section 11.0

15. State how the provision for ensuring that prerequisites (ITEM 11) for the given test have been met. (QARD 11.2.1 G)

System readiness assessment completed prior to initiating test

16. Identify the functional qualification level of personnel performing the test. (QARD 11.2.1.I & HNF-PRO-1819, 2.9.2.3b)

To be defined in future revision of HNF-4898

17. Identify how any potential sources of uncertainty and error that may occur during testing will be identified and controlled. (QARD 11.2.2.E)

To be defined in future revision of HNF-4898

Person completing this form:

ALBIN PAJUNEN
Print name

signature

2/25/2000
date

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Process Engineering	Date 1/28/00
Project Title/Work Order		EDT No. 628523
Phased Startup Initiative Phases 3 and 4 Test Plan and Test Specifications (OCRWM)		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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Spent Nuclear Fuel Project

R. D. Crowe	R3-26	X
G. M. Davis	X3-80	X
J. A. Dent	X3-65	X
J. R. Frederickson	R3-86	X
S. D. Godfrey	X3-88	X
V. L. Hoefer	R3-86	X
J. J. Klos	X3-71	X
S. B. Lamson	X3-65	X
M. J. Langevin	X3-76	X
J. D. Mathews	X3-65	X
C. T. Miller	X3-79	X
W. C. Miller	R3-11	X
J. W. Neskas	R3-86	X
A. L. Pajunen	R3-86	X
R. D. Pedigo	S1-53	X
A. L. Pitner	R3-86	X
L. S. Semmens	X3-79	X
R. A. Sexton	R3-86	X
J. L. Shelor	X3-71	X
J. P. Sloughter	K9-46	X
D. W. Smith	S2-48	X
G. E. Stegen	X3-76	X
J. A. Swenson	R3-11	X
J. E. Truax	X3-71	X
D. J. Watson	X3-79	X
J. H. Wicks	X3-71	X
P. A. Young	X3-88	X
SNF Project	R3-11	X
SNF Training	S2-45	X
SNF Procedures	X3-86	X

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