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FUEL RETRIEVAL SUB-PROJECT DECAPPING STATION PERFORMANCE TEST DATA REPORT

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Abstract This document is to provide the test data report for Decapping Station Performance Testing. These performance tests were full scale and viewed as a continuation of development testing performed earlier (SNF-2710). A prototype decapping station confinement box was tested, along with some special tools required for the process, providing assurance that the fuel handling equipment will operate as designed, allowing for release of the FRS equipment for installation.

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FUEL RETRIEVAL SUB-PROJECT DECAPPING STATION PERFORMANCE TEST DATA REPORT

Spent Nuclear Fuel Project

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October 1999

Hanford Operations and Engineering Contractor for the
U S Department of Energy under Contract DE-96RL13200

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1 0 INTRODUCTION

This report details the equipment used for the Decapping Station testing activities, discusses equipment performance, and presents results from the tests. The tests described herein were conducted in accordance with SNF-3813, *Fuel Retrieval Sub-Project Decapping Station Performance Test Procedure*

1 1 Background

The Fuel Retrieval System (FRS) Sub-Project is providing development testing, factory acceptance testing (FAT), cold validation testing, and construction acceptance testing (CAT) for the FRS equipment. Pre-operational testing, hot process validation and system operations will be performed by the SNF Operations organization. The primary goal of the FRS test program is to validate the system design prior to deployment of equipment in the basins. This approach will minimize the potential need for system modification once the equipment is installed in a radioactive environment. The FRS test program provides an integrated transition from design to fabrication to installation and on into pre-operational testing.

The decapping station is designed to provide a means of removing the lids from both friction sealed (MK-0, MK-I) canisters and mechanically sealed (MK-II) canisters while minimizing the release of canister liquor, sludge, and/or trapped gas into the basin water. The station allows for the positioning of a canister so that lid removal tools may be attached. Once the tools are attached, the station confinement box is closed around the canisters and the lid removal operation is performed. During this operation, the lids are loosened and raised up above the canister barrels, the barrels are flushed with water to dilute the canister liquor, and any released gases are controlled by the gas handling system.

A prototype decapping station confinement box was provided for testing by the FRS project. Mock-ups of the Canister Liquid Extraction System, the Off-Gas Handling System, and the High Pressure System were assembled and used to complete the system (Figure 1). Some special tools required for the process, such as the MK-I Canister Lid Removal Tool and the MK-II Canister Lid Removal Tool, were also tested. Each system identified above was tested together, as a complete operational system, to demonstrate that material handling needs were met. Drawings for the configuration testes are listed in Table 1. These drawings were red-lined as modifications were made to the decapping station equipment and the drawings were updated by the design agent after testing was complete.

Figure 1. Decapping Station System

Testing was performed to validate and verify that the FRS decapping station, based on the Test Specification for the Fuel Retrieval Sub-Project Decapper Station, SNF-FRS, SPC.011, Rev. 1, can perform its intended function as designed. This testing verified the process design features of the decapping station, with emphasis on the confinement box and decapping tool performance, off-gas behavior, and confinement and removal of simulated canister liquor. The testing also verified specific remote operations features of the decapping station. Testing proved the capabilities of the process equipment as a system.

Table 1 Decapping Station Drawings

Drawing No	Revision	Title
DW-209	2	FRS In Pool Equipment Decapping Station
DW-260	2	FRS Canister Off-Gas Handling System
DW-264	0	Decapping Station Hydraulic Manifold
DW-266	0	Decapping Station Pump Suction Hose
DW-273	0	Stuck Fuel and Decapping Station Hydraulic System
DW-274	0	Stuck Fuel and Decapping Station Control Panels
DW-362	1	FRS Canister Lid Removal Tool
DW-369	2	Canister Lid Removal Tool Deployment System
DW-263	0	Canister Lid Removal Tool Installation
DW-367	0	Decapping and Stuck Fuel Station Support Table
DW-373	0	Stuck Fuel & Decapping Station Hydraulic Schematic
DW-378	0	FRS In-Pool Equipment Flex Extension Socket

1.2 Objective

To meet the primary goal of FRS decapping station performance testing, which was to verify that the FRS decapping station can perform its intended function, several specific objectives had to be met. These objectives were as follows:

- Verify the overall operability of the decapping station equipment, including the canister lid removal tool that requires an operator interface
- Verify that the MK-I canister lid removal tooling system design, including hydraulic control, is functional
- Establish and verify the corresponding MK-I canister lid removal hydraulic (water) flow rate and pressure
- Verify the MK-II canister lid removal tooling system design, including hydraulic control, is functional
- Verify that the decapping tooling deployment system design is functional, including grating interfaces and operator access
- Determine the canister flushing flow rate, pressure, and confirm the nozzle placement established in the current design
- Confirm the confinement and transfer of simulated canister-contaminated liquid
- Establish the operating process parameters for the decapping station that ensure that the release of cesium spans a minimum of 2-min, but not to exceed 10-min, time period
- Demonstrate collection/confinement of canister entrapped gases while decapping
- Demonstrate transfer of canister gases through the off-gas system piping
- Verify the functionality of the remote features provided for installation and maintenance of the decapping station and canister lid removal tool
- Verify the rigging features and tools for the decapping station support table and the decapping station confinement box and lid assembly

1.3 Acceptance Criteria

The decapping station performance tests were devised to provide verification of the final process design of the decapping station. To meet this, the testing needed to meet the acceptance criteria described below:

The decapping station must capture at least 95% of the cesium contained within the canister liquid and direct it to the discharge line. The release of cesium to the discharge line shall span a 2 minute to 10 minute period to ensure removal with the required efficiency in the current IWTS ion exchange system. The total quantity of cesium discharged from the decapping station during a test via the discharge line shall be greater than or equal to 95% of the initial cesium content of the canister.

The gas collection system must capture and transfer nominally 50% of the gas in a MK-I canister and 95% of the gas released from the MK-II canister.

During decapping processing testing, two decapping tools are deployed into the confinement box to allow the decapping station lid to remain closed during the removal of both canister lids. Adequate clearance must be demonstrated so there is no interference between the tools during the lid removal and transfer process. Both tools must allow closure of the decapping station lid without fouling on either half of the lid. Specific requirements for MK-I and MK-II lid removal are provided as follows.

MK-I Lid Removal –

- The decapping tool must align with and locate onto the MK-I canister lid gas vent valve body.
- The valve removal plunger must locate on the valve and unscrew the valve by unthreading the valve from the valve body.
- The decapping tool must lock onto the valve body by shifting the control lever to the lid lock position, hold the lid during canister barrel sparging, remove the lid from the barrel, and transfer the lid to the debris bin after both lids have been removed.
- The decapping tool must allow attachment of the decapping pump hose without releasing the valve body. The water feed line must have adequate pressure and flow to pop the lid from the canister barrel.

MK-II Lid Removal -

- The decapping tool must align with and locate onto the MK-II canister lid lock nut.
- The tools must close onto the lock nut by shifting the control lever to the lock position and remain in a locked position without slipping/breaking loose during subsequent decapping operating steps.
- The decapping tool handle must facilitate application of adequate torque to break the lock nut loose by turning of the decapping tool steering wheel.
- The decapping tool must completely back off the lock nut and twist the locking bar out from under the locking tabs by continued turning of the decapping tool steering wheel.
- The decapping tools must remain attached to the lids during water sparging of each of the canister barrels, opening of the confinement box lid, lifting the lids from the barrels, and transferring the lids to the debris bin, after both lids have been removed.
- The decapping tools must release the lids in a controlled manner over the debris bin by shifting the control lever to the release position.

The acceptance criteria for the remote features tests is that all equipment can be rigged into position and all connections made remotely from grating level using the recommended tools and procedures. All items requiring replacement or maintenance should be able to be remotely removed and replaced using the tools provided.

2.0 DECAPPING STATION SYSTEM TEST SET-UP

2.1 Confinement Box

The confinement box tested in the K-Basin Mock-Up (KBMU) will be used in the K-West Basin to decap the fuel canisters. The confinement box, shown in Figure 2, is constructed of carbon steel plates and reinforcing steel members. The confinement box is sized to hold one spent nuclear fuel canister orientated in an upright position. The confinement box has a 2-in. liquid extraction port at the bottom end of the one side and a 2-in. off-gas port on the upper end of the other side. The liquid extraction port connects to the canister liquid extraction system and the off-gas port connects to the decapping station off-gas system.

Figure 2. Decapper Confinement Box Deployed in 305 Pool

The confinement box lid is comprised of two opposing doors, which are operated by hydraulic actuated cylinders mounted on the decapping station base. Both the doors and the cylinders include design features that allow remote maintenance. The decapping station lid includes two penetrations to permit deployment and operation of the decapping tools into the confinement box. These tools attach to the canister lids and are used to remove the lids from the canister barrels. The decapping station doors are open during attachment of the decapping tools to the canisters and flushing of the canister barrels. The decapping station doors are closed during all flushing operations. The decapping station doors are re-opened to transfer the canister lids to a debris bin.

The ports in the decapping station lid are sized to allow for the following:

- Provide adequate in-leakage flow to prevent liquor release to the pool.
- Minimize the escape of gas that is released from the canister during lid removal.

The doors are sloped toward the north end of the decapping station confinement box to allow the canister gas to migrate to the off-gas line.

The confinement box includes two water-sparging nozzles (Figure 3) to flush contaminated liquid from the opened canister barrels. The nozzles are not intended to perform a vigorous mixing of the canister contents. Instead, the design intent is to flush enough contaminated liquor from the canisters into the liquid extraction system to capture greater than 95% of the cesium released from a canister and transport it to the IWTS to prevent the release of more than a 5% concentration of cesium liquor into the basin pool.

Figure 3. Top of Decapper with Lids Open Showing Spray Nozzles

2.2 Canister Liquid Extraction System

Canister liquid will be extracted from the decapping station confinement box through the 2-in. water suction line. The water line from the confinement box can be seen in Figure 4. This system was mocked-up in the KBMU using a Tri-Nuk submersible pump, which provided liquid flow out of the containment box at the rate of 70-80 gallons per minute. Flow was measured by a turbine flow meter mounted 20 pipe diameters downstream of the pump. Flow was controlled by a two-inch valve on the outlet of the pump. Flow from the containment box to the pump was carried by a two-inch PVC flex hose. Flow out of the pump was returned to the bulk pool water in the KBMU.

In the basin, suction is drawn on the confinement box by the Integrated Water Treatment System (IWTS) suction pump, which is mounted on the decapping station pump stand. The water suction line includes remote connectors to allow connection of the decapping station confinement box to the IWTS suction pump using 2-in. flexible hose.

Figure 4. Decapping Station Showing Confinement Box Water Flow Piping

The decapping station suction pump is designed to draw approximately 80 gpm from the confinement box. This flow was found to be adequate to remove the cesium flushed from the canisters during the lid removal process.

2.3 Off-Gas Handling System

The decapping station off-gas handling system consists of an 8-in. diameter duct located in the basin superstructure, approximately 11 ft above grating level. The 8-in. duct drops down close to grating level in a U-shape and the 2-in. diameter off-gas line from the decapping station tees into the duct at approximately 1-ft above the grating level.

For testing purposes, the off-gas handling system was mocked up using 2" diameter PVC pipe sloped at approximately 25° to the horizontal coming off at the confinement box. The sloped line extended 15-ft away from the decapping station before turning vertically up to tee into the simulated 8" diameter duct running at 3 inches of water vacuum. The off-gas line included a water inlet port located approximately 6-in. below the basin water surface and connected to a pump, to allow approximately 1 to 3 gpm of water to flow down into the confinement box. This flow of water was designed to provide some scrubbing of the released gas and prevent build-up of cesium contamination in the line. Figure 5 shows the mocked-up off-gas line for the test.

Figure 5. Off-Gas Handling System Mock-up Schematic

2.4 Decapping Tools

Several tools are required to support the decapping of MK-I and MK-II canisters including two canister lid removal tools with their deployment system, a MK-I canister gas trap removal tool, and a MK-I canister lid removal pump.

2.4.1 Canister Lid Removal Tools and Deployment System

The canister lid removal tools (see Figure 6) support removal of lids from both MK-I and MK-II canisters. Lid removal from MK-I canisters is achieved by using water pressure applied internally to the canister to force off the lid. Lid removal from the MK-II canisters is achieved using mechanical means to release the lid-locking bar. The decapping tool will allow the removal of lids from either MK-I or MK-II canisters using a single tool. The tool includes an end-effector that will locate on the hex head on the MK-I lid valve body, or on the locking nut on the MK-II lid. The specific process steps for the MK-I and MK-II lid removal are as follows:

The decapping tools are positioned over the canister barrels, and each tool is located over and seals against the vent valve body on the lid of a canister barrel. A spring-loaded plunger engages the valve stem in the MK-I vent valve. A handle is used to turn the tool and open the MK-I vent valve. After the valve is opened, the tool grab fingers are positioned around the hex head on the vent valve, firmly locking the tool to the canister lid. The decapping tool high pressure water pump system is attached to the tool and activated to pressurize the canister with process water and push the lid off the canister. After the lid is raised to the top of the canister barrel, the decapping tool lifts the lid further up into the space between the canister top and the under side of the closed lid to allow the canister gas to escape and to allow the canister to be flushed by using the water jets.

For the MK-II lids, the decapping tool grab fingers are positioned around the lid locking nut and locked. Once engaged, the handle is turned to fully open the

Figure 6. Canister Lid Removal Tool

locking nut, and then swing the locking bar from under the locking tabs. The lid is lifted to allow the canister gas to escape and to flush the canister liquid.

2.4.2 MK-I Canister Gas Trap Removal Tool

The MK-I fuel canisters have gas traps suspended from the canister lids by a stainless steel tube. The MK-I canister gas trap line must be crimped and sealed, and the gas trap must be removed before placement of the canister into the confinement box. A gas trap tube crimping/cutting tool will be used to perform this function while the canisters are temporarily stored in the FRS process staging area.

The gas trap removal tool was not available during the testing window and may be performed at a later date.

2.4.3 MK-I Canister Lid Removal Pump

The MK-I canister lid is lifted using internal water pressure following opening of the canister lid vent valve. A multi-stage centrifugal pump provides treated basin pool water at moderate pressure through the decapping tool to the vent valve. The lid removal pump outlet hose is connected through a quick-disconnect fitting at the top of the decapping tool. The hose is connected following attachment of the decapping tool to the canister lid and opening of the vent valve plug. The lid removal pump outlet hose is disconnected from the decapping tool following removal of the lid from the canister before transfer of the lids to the debris bin.

3.0 TEST RESULTS

This section provides a general test procedure description, test results, and discussion of test results for the decapping station tests. For these tests, a custom canister was made by welding together a single barrel from both a MK-I and MK-II canister, making a single fuel canister with two different lid types.

3.1 Canister Liquor Control Tests

3.1.1 Preliminary Dye Test

The purpose of the preliminary test was to obtain visual data on the ability of the decapping station to capture canister liquor and control gas releases. A total of three test runs were made using the decapping station set up in the 305 facility K-Basin Mock-up (KBMU) pool. Completed data sheets for each test are found in Appendix A of this report.

Each barrel of the custom canister was doped with two grams of 4×10^{-4} molar potassium permanganate (KMnO_4). The potassium permanganate was used to

dye the canister liquor a bright violet color. As this solution is released from the canister and mixed with the KBMU pool water, the potassium permanganate reacts with the hydrogen peroxide in the KBMU water and is reduced to manganese dioxide precipitate. After about three minutes of reaction time, the resulting solution will be visually clear. The KBMU pool must have a hydrogen peroxide concentration of greater than 50 ppm for this test to work properly.

For this test to be successful, none of the dye solution should be visible outside the confinement box during the canister decapping operation or during the opening of the decapping station doors. This test was performed in two parts, Test A and Test B. In Test A, the flush flow was turned on after the canister lids were removed. In Test B, the flush flow was turned on prior to canister lid removal.

Test 1 - Test 1A was performed with the canister flush flow turned on after the lids were raised. Three full weight lead filled dummy fuel elements and three carbon steel dummy fuel elements were loaded into each canister barrel. The canister barrels were each filled with 3.2 gallons of building tap water at pool water temperature, allowing for a 2" air space in each barrel. Each barrel was then doped with two grams of 4×10^{-4} molar potassium permanganate.

The canister was loaded into the confinement box, the decapping tools attached, and the box lids closed. The discharge pump was started (70 gpm) as was the off-gas water in-flow (1-3 gpm). The MK-II lid was loosened and raised using the mechanical fingers to turn the nut. The nut was only tightened to 50 ft-lbs because preliminary attempts to loosen the nut at the specified torque of 110 ft-lbs failed, necessitating a design change for the nut loosening feature. The MK-I lid was loosened and raised using the Myers PB51-8 booster feed pump set for a flow of 7 gpm at 110 psig. Once both lids were raised, the canister flush flow was initiated. Flush flow was adjusted to 17 gpm @ 35 psig. Flow meter and pressure gauge calibration data is found in Appendix B.

After flushing for 3 minutes and waiting one minute, the confinement box lids were opened. No dye was released from the confinement box during decapping operations or when the confinement box lids were opened. No gas was observed in the off-gas lines (clear sections). All the gas was released when the confinement box lids were opened.

During this test, there were numerous difficulties with the control system operating the decapping tools. The tools would not go to their prescribed set point positions under certain operating conditions. The vendor was notified and called in to correct the programming deficiencies.

Test 1B was a repeat of Test 1A except that the canister flush flow was turned on prior to opening the canister barrel lids. After flushing for 3 minutes after lid removal and waiting one minute, the confinement box lids were opened. No dye

was released from the confinement box during decapping operations. A small amount of dye was released when the confinement box lids were opened. The time between first lid opening and opening the confinement box lids was ~ 5 minutes. This was quicker than for the first test. No gas was observed in the off-gas lines (clear sections). All the gas was released when the confinement box lids were opened.

See Appendix A, pages A-2 through A-4, for applicable data sheets.

Test 2 - Following the first preliminary dye tests, the lid removal tools were modified to change the MK-II nut engagement so that a fully torqued lid could be loosened and removed. Test 2A was set up like the previous tests except that one instrumented PVC dummy fuel element was added to each canister barrel as a place holder, no sensor data was recorded. The test was performed with the canister flush flow turned on after the lids were raised, as in test 1A.

The MK-II lid was raised using the new tool to turn the nut (torqued to 115 ft-lbs). The new tool engaged the nut more easily and functioned flawlessly in this mode. A pump change was made for lifting the MK-I lid because performance had been poor for lifting the lids off with the flow set at 7 gpm @ 110 psig. The new pump was a TEEL 2PC39 multi-stage booster feed pump. Flow was 9-10 gpm at 195-200 psig. Once both lids were raised, the canister flush flow was initiated. Flush flow was adjusted to 17 gpm @ 35 psig.

After flushing for 3 minutes and waiting one minute, the confinement box lids were opened. No dye was released from the confinement box during decapping operations or when the confinement box lids were opened. No gas was observed in the off-gas lines (clear sections) during operations. All the gas was released when the confinement box lids were opened.

Test 2B was a repeat of Test 2A except that the canister flush flow was turned on prior to opening the canister barrel lids. After flushing for 3 minutes after lifting the canister barrel lids and waiting one minute, the confinement box lids were opened. It was observed that the MK-I lid had not been lifted off its canister barrel. No dye was released from the confinement box during decapping operations or when the MK-II lid was lifted. No gas was observed in the off-gas lines (clear sections) during operations. All the gas was released when the confinement box lids were opened.

As stated above, after opening the decapper box lids it was observed that the MK-I lid had not been raised. It was determined that the vent valve had not been opened to allow the water pressure to lift the lid.

See Appendix A, pages A-5 through A-7, for applicable data sheets.

Test 3 - Following the second set of preliminary dye tests, the decapper box was modified in an attempt to improve gas bubble capture. Because of these changes to the box, the preliminary dye tests were re-run. Test 3A was set up like the previous tests and was performed with the canister flush flow turned on after the lids were raised, as in Tests 1A and 2A.

Once both lids were raised to the intermediate position, the canister flush flow was initiated. Flush flow was adjusted to 17 gpm @ 35 psig. After flushing for 3 minutes and waiting one minute, the confinement box lids were opened. No dye was released from the confinement box during decapping operations or when the confinement box lids were opened.

Test 3B was a repeat of Test 3A except that the canister flush flow was turned on prior to opening the canister barrel lids. After flushing for 3 minutes after lid removal and waiting one minute, the confinement box lids were opened. A small amount of dye was released from the top crack between the lids when the MK-II lid was raised to the intermediate position.

Eight small, dime size bubbles of gas were released when the decapper lids were opened, indicating most of the gas was channeled into the off-gas handling system or came out through the cracks during this test. After the canister was removed from the pool, it was noted that a small amount of dyed water remained in the very bottom of the can.

See Appendix A, pages A-8 through A-10, for applicable data sheets.

3.1.2 Quantitative Tests

The purpose of the quantitative test was to obtain measurable data on the ability of the decapping station to capture canister liquor. To simulate the canister liquor during these tests, a small amount of cesium nitrate was mixed with pool water loaded into the canister barrels. The canisters and confinement box were instrumented with probes that recorded the concentration of this solution based on the conductivity of the fluid (see Figure 7).

Figure 7 Instrumented PVC Dummy Fuel Pin

Per requirements in the test specification, the decapping station must capture at least 95% of the cesium contained within the canister liquid and direct it to the discharge line. This means that the canister liquor concentration is at acceptable levels (less than 5%) for general dispersion into the K-Basin pool if the conductivity values found inside the confinement box and the canister are above the 5% solution values from the calibration curve.

Discussion relating the test data to the calibration data is found in Appendix C, along with single sensor plots comparing the test data to the 5% calibration value.

This test was performed in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal. Test data plots and data tables are found in Appendix A.

Test Q1A (test A) was performed with the canister flush flow turned on after the lids were raised. Three full weight lead filled dummy fuel elements and three carbon steel dummy fuel elements were loaded into each canister barrel. One instrumented PVC dummy fuel element (Figure 8) was also loaded into each barrel. Calibration data for these instrumented PVC dummy fuel elements is found in Appendix C. Instrumentation wires were routed through the sides of the canister barrels and out the top of the decapper box between the lids. Both canister barrels were filled with water at pool water temperature, allowing for a 2" air space in each barrel. About 2.5 gallons of water was used in each barrel. Cesium nitrate was added to each barrel at a concentration of 2 grams per 5 gallons of water.

Figure 8 Instrumented PVC Dummy Fuel in Canisters

The canister was loaded into the confinement box, the decapping tools attached, and the box lids closed. The discharge pump was started (70 gpm) as was the off-gas in-flow. The attempt to raise the MK-I lid failed. Follow-on examination of the tool showed that the bleeder bar, that engages the vent valve, was cocked in the tool and could not engage the valve.

The MK-II lid was loosened and raised to the intermediate position. After flushing for 3 minutes and waiting one minute, the confinement box lids were opened. During this time, about 3" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. A few ~1" diameter bubbles escaped the box while flushing the canister. About 10 to 15 one inch diameter bubbles were released when the box lids were opened.

See Appendix A, pages A-11 through A-12, for applicable data sheets.

Figure 9 plots the data taken from the instrumented dummy fuel element in the MK-II barrel (the MK-I barrel plot is also present but the lid did not lift off). The plot shows the water conductivity changing rapidly over the three minute flush period, indicating that the canister liquor is being diluted and flushed out. It took less than a minute to meet the clean acceptance criteria of greater than or equal to 95% of the initial cesium content of the canister. The wall sensor, located just above the canister barrel inside the confinement box, appeared to be periodically shorting out against the canister barrel lid as it laid on the lid during the test. Attempts were made to eliminate this short during subsequent tests.

Figure 9. QTest 1A Sensor Probe Data

For this test (and each test to follow), two underwater cameras and one above water camera were used to take video of the decapping operation. The video tapes showed some gas bubble release out the confinement box lid both during decapping and box lid opening, as well as gas bubble travel through the off-gas piping. Gas bubbles were released through the crack between the confinement box lids and the holes where the lid removal tools go through the box lids during decapping and flushing. It is estimated that about 40% to 60% of the gas was successfully taken away by the off-gas handling system. These video tapes will be transmitted to the FRS project files upon issue of this report. A list of video tapes is presented in Appendix D.

Test Q2 (test B) was a repeat of test Q1 except that the canister flush flow was turned on prior to opening the canister barrel lids. The attempt to raise the MK-I lid was not successful in this test. After the flush jets were turned on, the MK-II lid was loosened, raised to the intermediate position, and flushed for three minutes. During this time, about 4" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 3 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Ten to fifteen small ~1" diameter bubbles were released to the pool upon opening the lids.

Figure 10 plots the data taken from the instrumented dummy fuel element in the MK-II barrel. MK-I barrel plot is also present but the lid did not lift off as discussed above. The plot shows the water conductivity changing rapidly over the three minute flush period, indicating that the canister liquor is being diluted and flushed out. It took less than a minute to meet the clean acceptance criteria of greater than or equal to 95% of the initial cesium content of the canister. The wall

sensor, located just above the canister barrel lid inside the confinement box, again appeared to be periodically shorting out against the canister lid during the test.

See Appendix A, pages A-12 through A-14, for applicable data sheets.

Figure 10. QTest 2 Sensor Probe Data

The video tapes for this test showed some gas bubble release out the confinement box lid both during decapping and box lid opening, as well as gas bubble travel through the off-gas piping. Gas bubbles were released through the crack between the confinement box lids and the holes where the lid removal tools go through the box lids during decapping and flushing. It is estimated that about 40% to 60% of the gas was successfully taken away by the off-gas handling system. These video tapes will be transmitted to the FRS project files upon issue of this report.

Test Q2A - Starting with test Q2A (test A), the decapping operation through canister flushing was performed one barrel at a time, starting with the MK-I barrel. For test Q2A, the flush flow was turned on after the lids were lifted. The MK-I lid was loosened in 30 seconds using 9gpm water at 190 to 195 psi. The lid was raised to the intermediate position and the barrel was flushed for three minutes. The flush water was turned off. After completing the MK-I barrel flush, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for three minutes. During this time, about 3" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 3 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Ten to fifteen 1/2" to 1" diameter bubbles were released upon opening the decapper lids.

Figure 11 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the

three minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-I barrel, the water generally met the clean criteria in less than a minute and definitely met the criteria at two minutes. For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The MK-I sensors seemed to clean up a little more when the MK-II lid was opened and the flush jets turned back on. No explanation is given other than the mixing action from the flush jets is different with both lids raised. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for the majority of this test. It appears to have again shorted out when the flush jets were turned off at the end of the test and it settled down against the canister barrel lid.

See Appendix A, pages A-15 through A-16 for applicable data sheets.

Figure 11. QTest 2A Sensor Probe Data

The video tapes for this test show that gas bubble release behavior was the same as for test Q2. These video tapes will be transmitted to the FRS project files upon issue of this report.

After reviewing the conductivity data from the first three tests, it was determined that the water conductivity reached the clean acceptance criteria, of greater than or equal to 95% of the initial cesium content flushed out of the canister, in two minutes or less. Based on this, the flush time was reduced to two minutes for the remainder of the testing. Also, it was decided to eliminate testing with the flush flow starting before lid removal (test B's), only testing with the flush flow starting after lid removal. This was agreed to by the FRS test engineer and the NHC test director.

Test Q3 was the first test with the two minute flush flow after lid removal. The test was set up and the MK-I lid was loosened in 15 seconds using 10gpm water at 190 to 195 psi. The lid was raised to the intermediate position and the barrel was flushed for two minutes followed by flush jet shut off. After completing the MK-I barrel flush, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for two minutes. During the MK-I flush, about 4" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. During the MK-II flush, about 6" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Eight to twelve 1/2" to 1" diameter bubbles were released upon opening the decapper lids.

Figure 12 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-I barrel, the water generally met the clean criteria in less than a minute and definitely met the criteria at two minutes. For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. Again, the MK-I sensors seemed to clean up a little more when the MK-II lid was opened and the flush jets turned back on. No explanation is given other than the mixing action from the flush jets is different with both lids raised. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for this test and did not short out at all. See Appendix A, pages A-16 through A-18 for applicable data sheets.

Figure 12. QTest 3 Sensor Probe Data

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These video tapes will be transmitted to the FRS project files upon issue of this report.

Test Q4 - No changes were made for test Q4. The test was set up and an attempt was made to loosen the MK-I lid. The lid did not raise after using water at 190 to 195 psi. Only about 6 to 7 gpm flow could be established, indicating only by-pass flow between the tool head and the valve housing. Post-test examination revealed that the valve end was broken off so the tool could not engage the vent valve to open it. After failing to open the MK-I lid, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for two minutes. During the MK-II flush, about 12.5" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Twenty 1-1/2" to 2" diameter bubbles were released upon opening the decapper lids.

Figure 13 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The MK-I lid did not open so the sensors do not change value. The MK-II plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The wall sensor was shorting out prior to opening the MK-II lid but appeared to maintain a good reading during the decapping and flushing activity.

See Appendix A, pages A-19 through A-20, for applicable data sheets.

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These video tapes will be transmitted to the FRS project files upon issue of this report.

Test Q5 was aborted with no data taken. A computer malfunction occurred prior to initiating lid removal and the test was stopped without attempting to open canister barrel lids.

Test Q6 - No changes were made to the test set-up for test Q6. The test was set up and the MK-I lid was loosened in 30 seconds using 10-gpm water at 195 to 200 psi. The lid was raised to the intermediate position. There was about a three to four minute delay in turning on the flush jets due to a miscommunication between the test director and the pump operator. Once the flush jets were turned on, the barrel was flushed for two minutes, then the flush jets were shut off. After completing the MK-I barrel flush, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for several minutes. The time was extended to observe the effect of added flushing. After about three minutes, the sensors indicate that the water cleaned up an additional amount. During the flushing of both barrels, about 6" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Five to ten 1" to 1-1/2" diameter bubbles were released upon opening the decapper lids.

Figure 14 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. As stated above, there was a delay in turning on the flush water after the MK-I barrel lid was lifted off. Once the jets were turned on, the water cleaned up and generally met the clean criteria in less than a minute and definitely met the criteria at two minutes. For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for this test and no short was indicated.

See Appendix A, pages A-20 through A-22, for applicable data sheets.

Figure 14. QTest 6 Sensor Probe Data

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These video tapes will be transmitted to the FRS project files upon issue of this report.

Test Q7 - No changes were made to the test set-up for test Q7. The test was set up and the MK-I lid was loosened in about 15 seconds using 10 gpm water at 195 psi. The lid was raised to the intermediate position and the barrel was flushed for two minutes, followed by flush jet shut off. After completing the MK-I barrel flush, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for two minutes. During the flushing of both barrels, about 4" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Ten to fifteen 1" to 1-1/2" diameter bubbles were released upon opening the decapper lids.

Figure 15 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-I barrel, the water cleaned up and generally met the clean criteria in less than a minute and definitely met the criteria at two minutes. The sensor located at the bottom of the canister barrel is sporadic, indicating that the sensor is probably shorting out during the flushing operation. Because this sensor is at the bottom of the barrel, loss of its data does compromise the test. For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for this test and no short was indicated.

See Appendix A, pages A-23 through A-24, for applicable data sheets.

Figure 15. QTest 7 Sensor Probe Data

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These video tapes will be transmitted to the FRS project files upon issue of this report.

Test Q8 - No changes were made to the test set-up for test Q8. The test was set up and the MK-I lid was loosened. There was some binding of the tool that occurred while opening the vent valve, and the decapper lids had to be opened and re-closed twice during this activity to relieve the binding. After the vent valve was completely opened it took about 20 seconds to lift the lid using 10 gpm water at 195 psi. The lid was raised to the intermediate position and the barrel was flushed for about six minutes to see what, if anything, extending the flushing time did. The sensor readings remained flat after about four minutes. After completing the MK-I barrel flush, the MK-II lid was loosened, raised to the intermediate position and the barrel was flushed for two minutes. Trapped air was not measured for this test. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. A few 1" diameter bubbles were released upon opening the decapper lids.

Figure 16 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-I barrel, the water cleaned up and generally met the clean criteria in less than a minute and definitely met the criteria at two minutes. The sensor located at the bottom of the MK-I barrel lagged behind in cleaning up.

The bottom of the barrel finally met the clean criteria after about four minutes. The MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for this test and no short was indicated.

See Appendix A, pages A-24 through A-26, for applicable data sheets.

Figure. 16 QTest 8 Sensor Probe Data

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These videotapes will be transmitted to the FRS project files upon issue of this report.

Test Q9 - No changes were made to the test set-up for test Q9. The test was set up and the MK-I lid was loosened in 15 seconds using 10 gpm water at 195 psi. The lid was raised to the intermediate position and the barrel was flushed for several minutes. After completing the MK-I barrel flush, the MK-II lid was loosened and raised to the intermediate position and the barrel was flushed for several minutes. During the flushing of both barrels, about 5" of air was trapped in the clear trap of the 2-1/4" ID off-gas line. After completing the 2 minute flush and waiting one minute after turning the flush water off, the confinement box lids were opened. Ten to twenty 1" to 1-1/2" diameter bubbles were released upon opening the decapper lids.

Figure 17 plots the data taken from the instrumented dummy fuel elements in both canister barrels. The plot shows the water conductivity changing rapidly over the two minute flush period, indicating that the canister liquor is being diluted and flushed out. For the MK-I barrel, the water cleaned up and generally met the clean criteria in less than a minute and definitely met the criteria at two minutes.

For the MK-II barrel, it took less than a minute to meet the clean acceptance criteria. The wall sensor, located just above the canister barrel inside the confinement box, appeared to work well for this test and no short was indicated.

See Appendix A, pages A-27 through A-28, for applicable data sheets.

The video tapes for this test show that gas bubble release behavior was the same as for the previous tests. These video tapes will be transmitted to the FRS project files upon issue of this report.

3.2 Gas Collection System Tests

The purpose of the gas collection system testing was to evaluate the ability of the decapper confinement lid design to channel the gas released during the decapping operations into the off-gas handling system. The off-gas handling system setup is discussed in Section 2.3. Ideally, data collected would include off-gas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of off-gas line water counter flow rates. As testing progressed, it became apparent that some of this data either could not be collected, or was not useful. Ultimately, no timed data was collected. Only gas bubble characteristics and release data were recorded. Since the design was set at a 25° incline for the off-gas line, the 15°, 35° and 45° tests were not performed. Also, only the 1 gpm off-gas counter-flow tests were run. No separate tests were performed; data for this assessment was taken during the liquor control tests.

Clear sections of pipe and a gas trap were added as part of the off-gas collection system mocked up in the 305 pool. Gas bubbles were observed during liquor control testing

activities and the observations are reported in this section. Location of these devices is shown in Figures 5 and 18.

Figure 18. Decapping Station System Showing Off-Gas Piping

Review of the videotapes taken during the qualitative tests shows that an estimated 40% to 60% of the released bubbles were captured during lid removal and flushing activities. Review notes are in Appendix D. Small, 0.5" to 2" diameter bubbles equaling between ~ 260 and 390 ml were captured from the canisters during lid removal, while large slugs of gas, equaling between ~ 652 to 900 ml were captured when the lid removal tools were used to lift the MK-I lids and when the flush jets were turned on. It is estimated that a maximum of a ~5500 ml of air was introduced into the decapping station confinement box during the decapping of one canister barrel.

It is virtually impossible to determine the exact amounts of air coming from the canisters versus air introduced from the lid removal tools and water lines (tools and flush jets). Tools and water lines totally filled with air could introduce an order of magnitude more gas than was seen during testing activities; up to ~65 liters of air. However, this is not the case since the estimated maximum volume introduced during any one test is 5.5 liters.

3 3 Remote Features Testing

The remote features tests were conducted using long handled tools to remove the hydraulic cylinders and nozzle assemblies from the decapping station. The ability to perform this function and ease of performance was evaluated. All the WEPD tools were not available for this testing activity and only the flex head and standard socket tools were evaluated.

3 3 1 Remove and Replace Decapping Station Hydraulic Cylinders

K-Basin operators performed the operations to remove and replace the hydraulic cylinders for actuating the confinement box lids. The WEPD socket head tool was used to remove the nuts and a stiffback suspended from the overhead crane was used to lift the cylinders. A "Peter's" tool was used to assist the stiffback operation for lifting the cylinders. The first attempt to remove the cylinders met with limited success. After much difficulty, the cylinder was lifted off its mounting bolts. Attempts to re-mount the cylinder were unsuccessful. It was suggested that the bolt holes in the cylinder mounts be either widened or slotted. The decapping station was sent back to the 400 area shop for modifications. The bolt holes for the cylinder mounts and the spray nozzle mounts were widened and the decapping station was returned for re-testing.

After the decapping station was returned from the 400 area shop, the hydraulic cylinder removal operation was repeated by K-Basin operators. The hydraulic pressure in the cylinders was bled off prior to performing the operation. The cylinders were removed and replaced with minimal difficulty. This time, a "J-hook" tool was used instead of the "Peter's" tool, otherwise the same tools were used as were used before. Some difficulty was encountered with the lid falling open and getting in the way of replacing the nuts. A clamp may need to be designed to slide over the lid to keep them together during this operation or another operator will be required to hold the lids in place with a long pole tool.

Video was taken of the removal and replacement operation and will be transmitted to the FRS project files upon completion of this report and transmittal of all data.

3 3 2 Remove and Replace Decapping Station Nozzle Assembly

K-Basin operators performed the operations to remove and replace the nozzle assemblies for flushing the canister barrels. The WEPD socket head tool was used to remove the nuts and the "J-hook" tool, suspended from the overhead crane, was used to lift the spray nozzle assemblies. The nozzle assemblies were removed and replaced with relative ease. Video was taken of the operations and will be transmitted to the FRS project files upon completion of this report and transmittal of all data.

3 3 3 Remove and Replace Decapping Station Lid Assembly

Removal of the lids was not performed. Instead, this operation was discussed in a meeting format by K-Basin operators and project testing staff. The operators and testing staff were confident that the lids could be removed and replaced with little difficulty. The nuts are easy to reach and there is direct overhead access to the lids for removal and re-installation.

3 3 4 Installation

This operation only involved connecting the decapping station to the table and connecting the piping mock-ups. The decapping station was easily placed on the table. The piping was installed with ease. However, the exact method of attachment was not the same as that which will be used in the field. The actual tools and hoses were not available to conduct this operation in a purely prototypical fashion.

3 4 MK-II Lid Locking Nut Removal Torque

The purpose of the MK-II lid locking nut removal test was to find the torque required to remove a MK-II locking nut. For this test, a lid was placed on a MK-II canister and torqued to 115 ft-lbs. The nut was removed using a torque wrench and the removal torque was recorded. Table 2 shows the results of this test. The maximum torqued required to loosen the nut was 110 ft-lbs.

Table 2 MK-II Locking Nut Removal Torque

Test Number	Locking Nut Removal Torque, Ft-Lbs
1	80
2	100
3	90
4	100
5	110
6	95
7	100
8	100
9	100
10	95

3 5 Tool Modification Verification Tests

After the lid removal tools were modified to capture the bleeder bar so it would not jam (as seen in tests Q1A and Q2), a series of tests were performed to ensure that the

modification was effective and did not otherwise effect tool operation. A total of eleven tests, using MK-I canisters, were performed to verify that the tool modification did not affect tool operation. Both canister barrels lids were lifted off during each test. Since the modification dealt with the MK-I function of the tool, only one MK-II test was performed to verify that the MK-II function of the tool was not affected by the tool modification. Table 3 shows the results of this test series. The modification was successful in eliminating the jamming problem. No other problems were encountered.

Table 3 Tool Modification Test Results

Test Number	Tool Type	Observations
1	MK-II	No Issues. The tools operated as before the modification.
2	MK-I	One barrel came off as before modification. Second barrel did not lift off. Examination showed that the canister plug valve was damaged so that the tool could not engage.
3	MK-I	The plug valves were replaced in both barrels before starting the test. Both barrels came off with ease. No problems were encountered.
4	MK-I	Tool 1 opened the lid with no problems. The plug valve sheared off for the second barrel and the lid did not open.
5	MK-I	Both lids came off with ease. No problems were encountered.
6	MK-I	Both lids raised up when pressurized with water. One lid did not come off when the tool was raised. Examination showed the lid was very loose and could be removed by hand. It is suspected that there was insufficient latch.
7	MK-I	Both lids came off with ease. No problems were encountered.
8	MK-I	Both lids came off with ease. No problems were encountered.
9	MK-I	Both lids came off with ease. No problems were encountered.
10	MK-I	Both lids came off with ease. No problems were encountered.
11	MK-I	Both lids came off with ease. No problems were encountered.
12	MK-I	Both lids came off with ease. No problems were encountered.

4 0 SUMMARY AND CONCLUSIONS

4 1 Testing

Decapping Station performance testing provided valuable input to the final system design, as well as establishing the operability of the equipment and refining the operating procedure. Testing confirmed that the confinement box captures the canister liquor and carries it away. Testing showed that the gas collection system was only partially successful in capturing the gas and carrying it out of the basin water. A meeting was held with the Design Engineer, Design Authority, FRS Test Engineer, and the Test Director to discuss the adequacy of the gas collection system performance. The system was determined to meet the needs the project. The group consensus was that further modifications to the decapper confinement box would not significantly improve gas capture performance.

4 1 1 Canister Liquor Control Tests

A total of ten canister liquor control tests were performed for this activity with the final decapping station configuration. One preliminary dye test was performed and nine quantitative tests were performed with this configuration. The canister liquor control tests verified that the decapping station adequately captures the canister liquor such that the canister liquor concentration will be at acceptable levels for general dispersion into the K-Basin pool when the confinement box is opened.

Several test objectives were satisfied and several operating parameters were established during the liquor control tests. These are as follows:

- The barrel lid removal sequence was established. The decapping should be performed one barrel at a time through the flushing activity. For the MK-I canister, both lids need to be pressurized before the first lid is raised to the intermediate position for flushing. For the MK-II canister, the first lid can be removed, raised to the intermediate position, and flushed before the second lid is removed.
- The lid decapping tool and tool deployment system functionality was validated during testing. In the MK-I position, the tool engaged the barrel lid valve, unscrewed the valve, and pressurized the barrel to raise the lid. The water flow and pressure necessary to raise the lid was increased from the original 7 gpm at 110 psig to 10 gpm at 195 psig. In the MK-II position, the tool, as modified based on preliminary testing activities, engaged the lid nut and successfully turned the nut to loosen the lid. See table 3 for testing results after final tool modification.
- Results of the preliminary dye tests and review of the conductivity probe data showed that the canister liquor was adequately flushed from the

canister barrels, contained within the confinement box, and carried away by the confinement box water flow, confirming the canister flushing flow rate, pressure, and nozzle placement. The flush time necessary to meet the acceptable liquor concentration level was generally between one and two minutes. It is recommended that this time be set at three minutes to ensure that a liquor concentration equilibrium has been met.

4.1.2 Gas Collection System Tests

Data was taken during the Quantitative Tests to establish the validity of the off-gas collection system.

As reported in Section 3.2, review of the video tapes taken by the two underwater cameras and the one above water camera during the qualitative tests shows that bubbles were captured during lid removal and flushing activities. Small bubbles were captured from the canisters during lid removal, while large slugs of gas were captured when the lid removal tools were used to lift the MK-I lids and when the flush jets were turned on. These video tapes show some gas bubble release out the confinement box lid both during decapping and box lid opening, as well as gas bubble travel through the off-gas piping. Gas bubbles were released through the crack between the confinement box lids and the holes where the lid removal tools go through the box lids during decapping and flushing. It is estimated that about 40% to 60% of the gas was successfully taken away by the off-gas handling system. If the lid removal tools and the flush jet water supply can be kept free of air while operating at K-Basins, the amount of gas getting into the off-gas system and the K-Basin water will be greatly reduced.

4.1.3 Remote Features Testing

The remote features tests were conducted using long handled tools to remove the nuts and handle the removed equipment. The ability to perform the function and ease of performance was evaluated.

K-Basin operators performed the operations to remove and replace the hydraulic cylinders for actuating the confinement box lids and the nozzle assemblies for flushing the canister barrels. The cylinders were removed and replaced with minimal difficulty after final tool modifications. Some difficulty was encountered with the lid falling back and getting in the way of replacing the nuts. A clamp may need to be designed to slide over the lid or a second operator needs to hold them closed with a long pole tool, keeping them together during this operation. A suggestion to strengthen the hydraulic cylinder lifting bale was not incorporated. However, the modifications that were made were adequate to perform the operation with minimal difficulty. The nozzle assemblies were removed and replaced with relative ease after final modifications.

Removal of the lids was not performed. Instead, this operation was discussed in a meeting format by K-Basin operators and project testing staff. The operators and testing staff were confident that the lids could be removed and replaced with little difficulty. The nuts are easy to reach and there is direct overhead access to the lids for removal and re-installation.

4.2 Issues

Decapping Station testing activities identified some issues that require attention prior to decapping operations. These are explained in the following sections regarding tool modifications, tool deployment system, hydraulic control system, and installation.

The following decapping tool modifications are suggested:

- Replace the bar handles with hand wheels
- Provide hand wheel cheater bars, 3' and 5' to reduce maximum force required to loosen nut to 30 lbs
- Repair water leak in Tool 1 quick connect
- Provide a step stool/step up
- Shim tool stand to hang tools plumb or slightly back toward the tool deployment system
- Add tool identification, i.e. "Tool 1", "Tool 2"
- Add MK-I/MK-II position indicator on tool locking plate

The tool deployment system has numerous pinch points. Care should be taken when sliding the tools along the rail, raising and lowering the tools, operating the hand wheels, swinging the tools over the canisters and back again, and actuating the tool latches.

The distance between the top of the grating to the top of the table where the decapper sits should be 17' 5". The table legs need to be adjusted to achieve this distance.

4.3 Facility Operation Recommendations

The recommended operating procedure developed from these testing activities is presented in Appendix E. By following these general steps, successful decapping of both MK-I and MK-II canisters should be achieved.

Appendix E also contains procedures for recovering from hydraulic control system malfunctions or faults. PLC faults occur whenever the tool can not move to its specified elevation.

Recommended changes to the Hydraulic Control System are:

- Add a default light for the PLC on the outside of the cabinet so the cabinet does not need to be opened up to check for a PLC default condition.
- Replace keyed switches with non-keyed switches
- Locate the PLC control panel immediately adjacent to the deployment tool station

50 REFERENCES

SNF-FRS, SPC 011, Rev 1, *Test Specification for the Fuel Retrieval Sub-Project Decapper Station*, M A Knight, BNFL, Inc , 1998

SNF-3813, *Fuel Retrieval Sub-Project Decapping Station Performance Test Procedure*, J R Thielges, P V Meeuwsen, Numatec Hanford Corporation, Richland, WA, 1999

APPENDIX A
TEST DATA SHEETS AND DATA PLOTS

APPENDIX A

TEST DATA SHEETS AND DATA PLOTS

Test Data Sheets

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color As this solution is released from the canister and mixed with the KBMU pool water the potassium permanganate will react with the hydrogen peroxide in the KBMU water and be reduced to manganese dioxide precipitate After about three minutes of reaction time the resulting solution will be visually clear The KBMU pool must have a hydrogen peroxide concentration of greater than 50 ppm

For this test to be successful none of the dye solution should be visible outside the containment box during the canister decapping operation or during the opening of the decapping station doors

This test will be done in two parts Test A and Test B In Test A the flush flow is turned on after the lids are removed In Test B the flush flow is turned on prior to canister lid removal If either portion of this test is unsuccessful the FRS Test Engineer will be notified and testing will be put on hold waiting for resolution

PRELIMINARY DYE TEST INSTRUCTIONS

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Install the lid removal deployment system
- 2 Place the decapper station on the bottom of the KBMU pool
- 3 Place one inch layer of washed sand in each canister barrel
- 4 Place seven carbon steel dummy fuel inners and outers in each barrel
- 5 Fill each barrel of the canister with 12.2 liters (3.2 gallons) of water (building tap water or deionized water) of the same temperature as the pool 12.2 liters will allow for a two inch air space in each barrel NOTE Do not use pool water or allow pool water to mix with the water in the canister
- 6 Place the appropriate MK I and MK II caps on each barrel Torque MK I lid to 45 foot/pounds and MK II to 115 foot/pounds
- 7 Start the working level and underwater cameras
- 8 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 9 Place a decapping tool on each canister lid Close the decapper station lids
- 10 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas in flow is 1.3 gpm
- 11 Remove MK II canister lid Remove the MK I lid using Myers PB51-8 booster pump fed by 35 psi water Record elapsed time pressure and flow used

15 sec	<u>110</u>	psi	<u>7</u>	gpm
30 sec	<u>110</u>	psi	<u>7</u>	gpm

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45 sec	<u>110</u>	psi	<u>7</u>	gpm
60 sec	<u>110</u>	psi	<u>7</u>	gpm
3 min	<u>110</u>		<u>7</u>	
Total time	<u>3 min</u>			

- 12 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 13 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 14 Watch for any dye or gas that may be released from the decapper containment Record findings

NO DYE WAS RELEASED FROM CONTAINMENT BOX DURING DECAPPER
OR WHILE OPENING THE CONTAINMENT BOX LID. ALL GAS WAS
RELEASED FROM CONTAINMENT BOX NO GAS WAS SEEN IN OFF GAS PIPE

- 15 Turn off the discharge pump
- 16 Comment and evaluate on the effectiveness and ease of use of the decapping tool

PROBLEMS WITH PLS, MK II LID TORQUED TO 50 LBS,
MANY PINCH POINTS ON TOOL

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed

- 1 Place one inch layer of washed sand in each barrel
- 2 Place seven carbon steel dummy fuel inner and outer in each canister barrel
- 3 Fill each barrel of the canister with 12.2 liters (3.2 gallons) of water of the same temperature as the pool NOTE Do not use pool water or allow pool water to mix with the water in the canister
- 4 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
50 foot/lbs DUM 5/18/94
- 5 Start working level and underwater cameras
- 6 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 7 Place a decapping tool on each canister lid Close the decapper station lids
- 8 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas inflow is 1-3 gpm

- 9 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 10 Remove MK-~~N~~^I canister lid Remove the MK-~~I~~^{II} lid using Meyers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

15 sec 20 psi 2 gpm
30 sec 100 psi 7 gpm
45 sec 100 psi 7 gpm
60 sec 100 psi 7 gpm

Total time 2 min

- 11 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 12 Watch for any dye or gas that may be released from the decapper containment Record findings

NO DYE RELEASED FROM CONTAINMENT DURING DECAPPING OF SMALL
AMOUNT RELEASED WHEN CONTAINMENT BOX OPENED. TIME FROM
FIRST LID OPEN TO CONTAINMENT BOX OPEN QUICKER (3-5 MIN) THAN

- 13 Turn off the discharge pump TEST 1 GAS RELEASE WAS SAME AS TEST 1
- 14 Comment and evaluate on the effectiveness and ease of use of the decapping tool

SAME AS TEST A

- 15 Remove decapping station from the KBMU pool, drain, and place on grating

9.1.2 Quantitative Tests

The purpose of the quantitative test is to obtain measurable data on the ability of the decapping station to capture canister liquor

During this test, a small amount of cesium nitrate will be added to the water used to simulate the canister liquor The canisters and containment box have been instrumented with probes that will record the concentration of this solution based on the conductivity of the fluid

If the conductivity values found inside the containment box and the canister are below the 5% solution values from the calibration curve, the determination has been made that the canister liquor concentration is at acceptable levels for general dispersion into the K-Basin pool

color As this solution is released from the canister and mixed with the KBMU pool water, the potassium permanganate will react with the hydrogen peroxide in the KBMU water and be reduced to manganese dioxide precipitate After about three minutes of reaction time, the resulting solution will be visually clear The KBMU pool must have a hydrogen peroxide concentration of greater than 50 ppm

For this test to be successful, none of the dye solution should be visible outside the containment box during the canister decapping operation or during the opening of the decapping station doors

This test will be done in two parts, Test A and Test B In Test A the flush flow is turned on after the lids are removed In Test B the flush flow is turned on prior to canister lid removal If either portion of this test is unsuccessful, the FRS Test Engineer will be notified and testing will be put on hold waiting for resolution

PRELIMINARY DYE TEST INSTRUCTIONS

REDUE TEST
WITH NEW MK II
TOOL

Test A For this test the flush flow is turned on after the lids are removed

- 1 Install the lid removal deployment system
- 2 Place the decapper station on the bottom of the KBMU pool
- 3 Place one inch layer of washed sand in each canister barrel
- 4 ^{1 PK, 3 FULL WT LEAD & 3 CARBON E/7/99 PM} Place seven carbon steel dummy fuel inners and outers in each barrel
- 5 Fill each barrel of the canister with 12.2 liters (3.2 gallons) of water (building tap water or deionized water) of the same temperature as the pool 12.2 liters will allow for a two inch air space in each barrel NOTE Do not use pool water or allow pool water to mix with the water in the canister
- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lid to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Start the working level and underwater cameras
- 8 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 9 Place a decapping tool on each canister lid Close the decapper station lids
- 10 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas in-flow is 1-3 gpm
- 11 Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed by 35 psi water Record elapsed time, pressure and flow used

15 sec	200	psi	10	gpm
30 sec	195	psi	10	gpm

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45 sec 200 psi 9 gpm
60 sec _____ psi _____ gpm

Total time 45 SEC

- 12 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 13 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 14 Watch for any dye or gas that may be released from the decapper containment Record findings

NO DYE OUTSIDED CONTAINMENT BOX

ALL GAS RELEASED FROM CONTAINMENT BOX

- 15 NO GAS IN OFF GAS LINE
Turn off the discharge pump

- 16 Comment and evaluate on the effectiveness, and ease of use of the decapping tool

BOTH TOOLS WORKED, TOOK TWO ~~THREE~~ SHOTS
TO LOCK TOOL TO MK I LID

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

- 1 Place one inch layer of washed sand in each barrel
1 PVC, 3 RUL W/ LEAD & 3 CARBON 6/7/99
- 2 Place seven carbon steel dummy fuel inners and outers in each canister barrel
- 3 Fill each barrel of the canister with 12 2 liters (3 2 gallons) of water of the same temperature as the pool NOTE Do not use pool water or allow pool water to mix with the water in the canister
- 4 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 5 Start working level and underwater cameras
- 6 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 7 Place a decapping tool on each canister lid Close the decapper station lids
- 8 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas inflow is 1-3 gpm

- 9 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 10 Remove MK-II canister lid Remove the MK-I lid using Meyers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

15 sec	<u>50</u>	psi	<u>5</u>	gpm
30 sec	<u>195</u>	psi	<u>7</u>	gpm
45 sec	<u>200</u>	psi	<u>8</u>	gpm
60 sec	<u>200</u>	psi	<u>10</u>	gpm

Total time 145 SEC

- 11 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 12 Watch for any dye or gas that may be released from the decapper containment Record findings

NO DYE OUTSIDE BOX NO GAS IN
OFF GAS SYSTEM ALL GAS RELEASED FROM
BOX

- 13 Turn off the discharge pump
- 14 Comment and evaluate on the effectiveness and ease of use of the decapping tool

MK I LID NOT REMOVED, MK-II
TOOL WORKED GOOD

- 15 Remove decapping station from the KBMU pool, drain, and place on grating

9 1 2 Quantitative Tests

The purpose of the quantitative test is to obtain measurable data on the ability of the decapping station to capture canister liquor

During this test, a small amount of cesium nitrate will be added to the water used to simulate the canister liquor The canisters and containment box have been instrumented with probes that will record the concentration of this solution based on the conductivity of the fluid

If the conductivity values found inside the containment box and the canister are below the 5% solution values from the calibration curve, the determination has been made that the canister liquor concentration is at acceptable levels for general dispersion into the K-Basin pool

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color As this solution is released from the canister and mixed with the KBMU pool water, the potassium permanganate will react with the hydrogen peroxide in the KBMU water and be reduced to manganese dioxide precipitate After about three minutes of reaction time, the resulting solution will be visually clear The KBMU pool must have a hydrogen peroxide concentration of greater than 50 ppm

For this test to be successful, none of the dye solution should be visible outside the containment box during the canister decapping operation or during the opening of the decapping station doors

This test will be done in two parts, Test A and Test B In Test A the flush flow is turned on after the lids are removed In Test B the flush flow is turned on prior to canister lid removal If either portion of this test is unsuccessful, the FRS Test Engineer will be notified and testing will be put on hold waiting for resolution

PRELIMINARY DYE TEST INSTRUCTIONS

JUNE 29, 1999

Test A For this test the flush flow is turned on after the lids are removed

- 1 Install the lid removal deployment system
- 2 Place the decapper station on the bottom of the KBMU pool
- 3 Place one inch layer of washed sand in each canister barrel
- 4 Place seven carbon steel dummy fuel inners and outers in each barrel
- 5 Fill each barrel of the canister with 12.2 liters (3.2 gallons) of water (building tap water or deionized water) of the same temperature as the pool 12.2 liters will allow for a two inch air space in each barrel NOTE Do not use pool water or allow pool water to mix with the water in the canister
- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lid to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Start the working level and underwater cameras
- 8 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 9 Place a decapping tool on each canister lid Close the decapper station lids
- 10 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas in-flow is 1-3 gpm
- 11 Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed by 35 psi water Record elapsed time, pressure and flow used

15 sec	110	psi	11	gpm
30 sec	95	psi	9	gpm

45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm

Total time 30 SEC

- 12 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 13 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 14 Watch for any dye or gas that may be released from the decapper containment Record findings

NO DYE RELEASED

- 15 Turn off the discharge pump
- 16 Comment and evaluate on the effectiveness, and ease of use of the decapping tool

PLC VERY DIFF, VERY HARD TIME GETTING MK II
TOOL ON NJT,

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed JULY 1, 1999

- 1 Place one inch layer of washed sand in each barrel
- 2 Place seven carbon steel dummy fuel inners and outers in each canister barrel
- 3 Fill each barrel of the canister with 12.2 liters (3.2 gallons) of water of the same temperature as the pool NOTE Do not use pool water or allow pool water to mix with the water in the canister
25 GALLONS OK 7-1-99
- 4 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 5 Start working level and underwater cameras
- 6 Place loaded canister into the decapping station and lower to bottom of KBMU pool
- 7 Place a decapping tool on each canister lid Close the decapper station lids
- 8 Start the discharge pump Adjust flow rate to 70 gpm Verify offgas inflow is 1-3 gpm

- 9 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments

- 10 Remove MK-II canister lid Remove the MK-I lid using ~~Moyers PB51-8 booster pump fed with 35 psi water~~ Record elapsed time, pressure and flow used

15 sec 90 psi 8 gpm
30 sec 140 psi 10 gpm
45 sec 195 psi 10 gpm
60 sec _____ psi _____ gpm

Total time 45

- 11 Remove the lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid
- 12 Watch for any dye or gas that may be released from the decapper containment Record findings

SMALL AMOUNT OF DYE RELEASE FROM TOP CRACK

- 13 Turn off the discharge pump
- IN DECAPPER LID, SMALL (8 DIME SIZE BUBBLES RELEASED FROM LID AS OPENED, SMALL AMOUNT OF DYED WATER IN BOTTOM OF CAN

- 14 Comment and evaluate on the effectiveness and ease of use of the decapping tool

GR 17-1-99
PLC PROBLEMS TOOL WORK O.K.

- 15 Remove decapping station from the KBMU pool, drain, and place on grating

9 1 2 Quantitative Tests

The purpose of the quantitative test is to obtain measurable data on the ability of the decapping station to capture canister liquor

During this test, a small amount of cesium nitrate will be added to the water used to simulate the canister liquor The canisters and containment box have been instrumented with probes that will record the concentration of this solution based on the conductivity of the fluid

If the conductivity values found inside the containment box and the canister are below the 5% solution values from the calibration curve, the determination has been made that the canister liquor concentration is at acceptable levels for general dispersion into the K-Basin pool

This test will be done in two parts Test A and Test B In Test A, the flush flow is turned on after the lids are removed In Test B, the flush flow is turned on prior to canister lid removal

QUANTITATIVE TEST INSTRUCTIONS

The gas volume trap will be installed for all quantitative testing

Q IATest

Test A For this test, the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
- 2 Place ~~six~~ washed carbon steel dummy fuel inners and outers in each barrel The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use
- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used
- 4 Fill both canister barrels with water of the same temperature as the pool For this test, pool water may be used Leave about a two-inch air space in each barrel
Volume of water used 2.5 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 *7-1-99* Verify back flow in offgas line is 1-3 gpm
- 13 *7-1-99* Open decapper lid Attach lid removal tools and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

GRJ 7-1-99
3 LEAD FILLED

** For Steps 13 through 17 to be performed one barrel at a time, starting with MK side.*
GRJ Thuley 7-1-99

15 sec 180 psi 8 gpm
30 sec 195 psi 9 gpm

MK II 21:30 SE

45 sec 195 psi 9 gpm
60 sec 195 psi 9 gpm

Total time 2 1/2 min DID NOT OPEN * Probable tool capture slot failure

14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments

15 Flush for 3 minutes Turn off flush flow, wait one minute

16 Open containment box lid

17 Watch for any gas that may be released from the decapper containment
Record findings

FEW 1" DIA BUBBLES WHILE JETTING, 10-15 1" DIA
WHEN CONTAINMENT LID OPENED

18 Remove decapping station from the KBMU pool, drain, and place on grating

19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

MK I LID NOT REMOVED, MK II WORKED OK

20 Print conductivity probe plots

21 Record volume of gas in gas trap 3 in 3

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed

Q 2 Test

1 Place one inch layer of washed sand in each barrel

2 Place 3 9/1/99 and 3 lead filled carbon steel dummy fuel inners and outers in each barrel

3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used

4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 2.5 gal

5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm

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- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1-3 gpm
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid ~~Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water. Record elapsed time, pressure and flow used~~ JRJ 7-1-99

15 sec	<u>120</u>	psi	<u>10</u>	gpm
30 sec	<u>195</u>	psi	<u>10</u>	gpm
45 sec	_____	psi	_____	gpm
60 sec	_____	psi	_____	gpm

Total time 30 sec

MKI 3:18.30
MKII 3:28.00

- 15 Flush for 3 minutes Turn off flush flow and wait one minute
- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

TRAPPED 4" GAS 10-15 SMALL TO 1" BUBBLES

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

LOCKS NOT LOCKED MK I FEW PLC PROBLEMS

20 Print conductivity probe plots

21 Record volume of gas in gas trap 41⁴

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 <u>80</u> ft-lb	Torque 6 <u>95</u> ft-lb
Torque 2 <u>100</u> ft-lb	Torque 7 <u>100</u> ft-lb
Torque 3 <u>90</u> ft-lb	Torque 8 <u>100</u> ft-lb
Torque 4 <u>100</u> ft-lb	Torque 9 <u>100</u> ft-lb
Torque 5 <u>110</u> ft-lb	Torque 10 <u>95</u> ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

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This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

Test ^{2A} ~~Q3~~ 7/1/99

The gas volume trap will be installed for all quantitative testing.

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
- 2 Place ~~six~~ washed carbon steel dummy fuel inners and outers in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used 2 1/2 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds.
- 7 Place loaded canister into the decapping station.
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool.
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes).
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.
- 12 Verify back flow in offgas line is 1-1/2 gpm.
- 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. ~~Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water.~~ Record elapsed time, pressure and flow used.

15 sec 190 psi 9 gpm
30 sec 195 psi 9 gpm

3 LEAD FILLED
gr 7-1-99

starting with MK I side
GR Thelge
7-1-99
7/1/99

CONFIDENTIAL

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45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm

Total time 30 SEC

MCI 4:08:00 LID OFF
4:10:00 JETS START

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments

- 15 Flush for 3 minutes Turn off flush flow, wait one minute

MCI II 4:18:00
JET 4:20:30

- 16 Open containment box lid

- 17 Watch for any gas that may be released from the decapper containment
Record findings

10-15 1/2-1" GAS BALLS

- 18 Remove decapping station from the KBMU pool, drain, and place on grating

- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap 3 in

GR 3 7/1/99

Test B This test is a repeat of the Test A (above) ~~with the flush flow on prior to the canister lids being removed.~~

TEST 3 7/1/99 2 minutes flush

- 1 Place one inch layer of washed sand in each barrel

3 LEAD FILLED - 3 CARBON GR 3 7/1/99

- 2 Place ~~six~~ carbon steel dummy fuel inners and outers in each barrel

- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used

- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 2 1/2 gal

- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm

- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is ~~1-3 gpm~~ 6 gpm PVM 7/1/99
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used PVM 7/1/99

15 sec	<u>190</u>	psi	<u>10</u>	gpm
30 sec		psi		gpm
45 sec		psi		gpm
60 sec		psi		gpm

MKL { 5 23 00 OPEN
2 min JET

Total time 15 SEC

- 15 Flush for 2 min 7/1/99 Turn off flush flow and wait one minute

MKL { 528:30 OPEN
5:29:30

- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

8-12 1/2" to 1" gas balls

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

Worked well throughout decapping both barrels

20 Print conductivity probe plots

21 Record volume of gas in gas trap 4" MK I 6" MK II

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK- I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

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This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

TEST 4
7/1/99 2 minute
Flush

The gas volume trap will be installed for all quantitative testing

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
JK 7/1/99
- 2 Place ~~six~~ ³ washed carbon steel dummy fuel inners and outers, in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
3 LEAD FILLED JK 7/1/99
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used 2 1/2 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds.
- 7 Place loaded canister into the decapping station.
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool.
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes).
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.
- 12 Verify back flow in offgas line is 1-3 gpm.
- * Steps 13 through 17 to be performed one barrel at a time, starting with MK I side.
- 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. Remove the ~~MK-I lid using Myers PB51-8 booster pump fed with 35 psi water~~. Record elapsed time, pressure and flow used.
JK 7/1/99
JK Jhodge 7-1-99

15 sec 190 psi 7 gpm
30 sec 195 psi 6 gpm

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45 sec 195 psi 7 gpm
60 sec 195 psi 6 gpm

Total time DID NOT OPEN

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments

- 15 Flush for 2 minutes GRJ 7/1/99 Turn off flush flow, wait one minute

- 16 Open containment box lid

MKII

6:08:30 LID
6:10:00 JET

- 17 Watch for any gas that may be released from the decapper containment Record findings

20 1 1/2 to 2" GAS BALLS

- 18 Remove decapping station from the KBMU pool, drain, and place on grating

- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

MKII LID DID NOT OPEN

Broke off valve and

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap 12 1/2 in

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

Test # 6
7/1/99 GRJ

- 1 Place one inch layer of washed sand in each barrel

- 2 Place 3 carbon steel dummy fuel inners and outers in each barrel 3 LEAD FILLED

- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used

- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 2 1/2 gal

- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm

- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1- $\frac{1}{2}$ gpm ^{7/1/99}
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid ~~Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used~~ ^{7/1/99}

15 sec	195	psi	6	gpm
30 sec	200	psi	10	gpm
45 sec		psi		gpm
60 sec		psi		gpm

MK1 6:51.00
MK2 6:59:10

Total time 30 sec

- 15 Flush for 2 minutes Turn off flush flow and wait one minute
- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

5-10 1-1/2

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

Tools worked well for both barrels

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- 20 Print conductivity probe plots
- 21 Record volume of gas in gas trap 6

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

The gas volume trap will be installed for all quantitative testing.

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
- 2 Place six washed carbon steel dummy fuel inners and outers in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used 2.5 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds.
- 7 Place loaded canister into the decapping station.
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool.
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes).
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.

- 12 Verify back flow in offgas line is 1-3 gpm.
- * *Steps 13 through 17 to be performed one barrel at a time, starting with MK I side.*
- 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. ~~Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water. Record elapsed time, pressure and flow used.~~

15 sec 195 psi 10 gpm
30 sec psi gpm

7 gr
Test to
7/1/99

GR Thelge
7-1-99

DR 7-1-99

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45 sec _____ psi _____ gpm

60 sec _____ psi _____ gpm

Total time 15 Sec

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments

- 15 Flush for 3 minutes Turn off flush flow, wait one minute

- 16 Open containment box lid

- 17 Watch for any gas that may be released from the decapper containment
Record findings

10-15 1 to 1 1/2

- 18 Remove decapping station from the KBMU pool, drain, and place on grating

- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

Worked well for both barrels

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap 4 in

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

Test B

- 1 Place one inch layer of washed sand in each barrel
- 2 Place six carbon steel dummy fuel inners and outers in each barrel
- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used
- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 2 1/2 gal
- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A _____ gm, barrel B 1 gm

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- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1-^{two} gpm
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid ~~Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water~~ Record elapsed time, pressure and flow used

15 sec 195 psi 10 gpm
 30 sec _____ psi _____ gpm
 45 sec _____ psi _____ gpm
 60 sec _____ psi _____ gpm

826 LID OFF
834

Total time 205 RC

M

- 15 Flush for 5 minutes Turn off flush flow and wait one minute
- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

Few 1"

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

MK-II lid was not removed

20 Print conductivity probe plots

21 Record volume of gas in gas trap -NA-

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

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This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

TEST 9

The gas volume trap will be installed for all quantitative testing.

Test A For this test, the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
- 2 Place six washed carbon steel dummy fuel inners and outers in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used 2 1/2 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds.
- 7 Place loaded canister into the decapping station.
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool.
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes).
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.
- 12 Verify back flow in offgas line is 1-3 gpm.
- * Steps 13 through 17 to be performed one barrel at a time, starting with MK I side.
- 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water. Record elapsed time, pressure and flow used.

15 sec 195 psi 10 gpm
30 sec _____ psi _____ gpm

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45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm

Total time 15 SEC

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments

- 15 Flush for GRJ 7/2/99 minutes Turn off flush flow, wait one minute

MK I LID OFF 9:07:30

- 16 Open containment box lid

MK II

9:14:18

- 17 Watch for any gas that may be released from the decapper containment
Record findings

10-20 1" to 1 1/2" DIA

- 18 Remove decapping station from the KBMU pool, drain, and place on grating

- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

SKB TEST 2

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap 5" in

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

- 1 Place one inch layer of washed sand in each barrel

- 2 Place six carbon steel dummy fuel inners and outers in each barrel

- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used

- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 2 1/4 gal

- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm

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- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1-3 gpm
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

15 sec 195 psi 10 gpm
 30 sec _____ psi _____ gpm
 45 sec _____ psi _____ gpm
 60 sec _____ psi _____ gpm

Total time 16545

- 15 Flush for 2.9KJ 7/2/99 minutes Turn off flush flow and wait one minute

- 16 Open confinement box lid

- 17 Watch for any gas that may be released from the decapper containment
Record findings

FRW 8-10 2" DIA

- 18 Turn off data acquisition system

- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

BOTH SIDES WORKED

CONFIDENTIAL

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20 Print conductivity probe plots

21 Record volume of gas in gas trap 5 1/2

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

The gas volume trap will be installed for all quantitative testing.

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
- 2 Place six washed carbon steel dummy fuel inners and outers in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used _____ gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A _____ gm, barrel B _____ gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds.
- 7 Place loaded canister into the decapping station.
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool.
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes).
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.
- 12 Verify back flow in offgas line is 1-3 gpm.
- * *Steps 13 through 17 to be performed one barrel at a time, starting with MK I side*
- 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water. Record elapsed time, pressure and flow used.

15 sec _____ psi _____ gpm
30 sec _____ psi _____ gpm

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45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm

Total time _____

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments,

- 15 Flush for ^{2 gals 7/2/99} minutes Turn off flush flow, wait one minute

- 16 Open containment box lid

- 17 Watch for any gas that may be released from the decapper containment
Record findings

- 18 Remove decapping station from the KBMU pool, drain, and place on grating

- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap _____ in

Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

- 1 Place one inch layer of washed sand in each barrel

- 2 Place six carbon steel dummy fuel inners and outers in each barrel

- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used

- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used _____ gal

- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A _____ gm, barrel B _____ gm

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- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 7 Place loaded canister into the decapping station
- 8 Close the decapper station lids and lower to the bottom of the KBMU pool
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1-3 gpm
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

15 sec _____ psi _____ gpm
 30 sec _____ psi _____ gpm
 45 sec _____ psi _____ gpm
 60 sec _____ psi _____ gpm

Total time _____

- 15 Flush for ^{2 GRJ 7/2/99} 3 minutes Turn off flush flow and wait one minute

- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

- 20 Print conductivity probe plots
- 21 Record volume of gas in gas trap _____

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F), identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters.

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut.

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

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This test will be done in two parts, Test A and Test B. In Test A, the flush flow is turned on after the lids are removed. In Test B, the flush flow is turned on prior to canister lid removal.

QUANTITATIVE TEST INSTRUCTIONS

TEST 1

The gas volume trap will be installed for all quantitative testing.

Test A For this test the flush flow is turned on after the lids are removed.

- 1 Place one inch layer of washed sand in each barrel
3 WASHED CARBON / 3 LEAD FILLED
- 2 Place ~~six~~ washed carbon steel dummy fuel inners and outers in each barrel. The dummy fuel used for this testing must be stored in the KBMU pool for a minimum of 24 hours prior to use.
- 3 Place one instrumented PVC dummy fuel element in each barrel. Route instrumentation wires through port in the side of the containment box. Penetration must be watertight. A rubber wire grommet or a sealed connector may be used.
- 4 Fill both canister barrels with water of the same temperature as the pool. For this test, pool water may be used. Leave about a two-inch air space in each barrel.
Volume of water used 5 gal
- 5 Add two grams cesium nitrate per five gallons of water to each barrel. Mix well.
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm
- 6 Place the appropriate MK-I and MK-II caps on each barrel. Torque MK-I lids to 45 foot/pounds and MK-II to 15 foot/pounds
50 foot / p
- 7 Place loaded canister into the decapping station.
- 8 ~~Close the decapper station lids and lower to the bottom of the KBMU pool.~~ P/M 5/2/99
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes). P/M 5/2/99
- 10 Start the underwater camera.
- 11 Start the discharge pump. Adjust flow rate to 70 gpm.
- 12 Verify back flow in offgas line is 1-3 gpm.
- * 13 Open decapper lid. Attach lid removal tools and close decapper lid. Remove MK-II canister lid. Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water. Record elapsed time, pressure and flow used.

15 sec 110 psi 7 gpm
30 sec 120 psi 7 gpm

45 sec 115 psi 7 gpm
 60 sec _____ psi _____ gpm

Total time 50 sec

- 14 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 15 Flush for 3 minutes Turn off flush flow, wait one minute
- 16 Open containment box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

GAS FROM TOOL HOLES, & SUT - Medium bubbles when each lid came off Small volume of bubbles came out when the decapper lids were opened.

- 18 Remove decapping station from the KBMU pool, drain, and place on grating
- 19 Comment on and evaluate the effectiveness and ease of use of the decapping tool

NOT BAD NOT TORQUE 50 LB. Easy to engage each can lid Can selector switch can not be changed or will not fault. Went to raise to intermediate until both lids are ~~lifted~~ removed

- 20 Print conductivity probe plots

- 21 Record volume of gas in gas trap Ø in

✓ Test B This test is a repeat of the Test A (above) with the flush flow on prior to the canister lids being removed.

TEST 2 (TEST 2 KEAN AS TEST 2A)

- 1 Place one inch layer of washed sand in each barrel
- 2 Place six carbon steel dummy fuel inners and outers in each barrel
- 3 Place one instrumented PVC dummy fuel element in each barrel Route instrumentation wires through port in the side of the of containment box Penetration must be watertight A rubber wire grommet or a sealed connector may be used
- 4 Fill both canister barrels with water of the same temperature as the pool For this test pool water may be used Leave about a two inch air space in each barrel
Volume of water used 5 gal
- 5 Add two grams of cesium nitrate per five gallons of water to each barrel Mix well
Total cesium nitrate used barrel A 1 gm, barrel B 1 gm

- 6 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to ~~15~~ ⁵⁰ foot/pounds
- 7 Place loaded canister into the decapping station
- 8 ~~Close the decapper station lids and lower to the bottom of the KBMU pool~~ pvn 5/21/99
- 9 Start the data acquisition system and allow readings to stabilize (about two minutes)
- 10 Start the underwater camera
- 11 Start the discharge pump Adjust flow rate to 70 gpm
- 12 Verify back flow in offgas line is 1-3 gpm
- 13 Start the flush jet supply pump Adjust water flow to 17 gpm NOTE The discharge pump flow may need adjustments
- 14 Open decapper lid Attach lid removal tools, and close decapper lid Remove canister Mark II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time pressure and flow used

15 sec	<u>115</u>	psi	<u>7</u>	gpm
30 sec	<u>117</u>	psi	<u>7</u>	gpm
45 sec	<u>117</u>	psi	<u>7</u>	gpm
60 sec	<u>117</u>	psi	<u>7</u>	gpm

Total time 3

- 15 Flush for 3 minutes Turn off flush flow and wait one minute
- 16 Open confinement box lid
- 17 Watch for any gas that may be released from the decapper containment
Record findings

SAME AS TEST 1

- 18 Turn off data acquisition system
- 19 Comment and evaluate the effectiveness, and ease of use of the decapping tool

HAD TO REINSTALL MK II TOOL ON CANISTER LID

* MK I LID NOT REMOVED

20 Print conductivity probe plots

21 Record volume of gas in gas trap Ø

9 1 3 Quantitative Data Evaluation

Using the conductivity probe calibration data (Appendix F) identify the value associated with a 5% cesium nitrate solution. Compare this value to the values found in the canister and containment box. Find the flush jet run time that both of these values are less than the 5% cesium nitrate values. If the decapping conductivity value does not reach 5%, rerun Test 9 1 2 with flush times of five minutes. If the 5% value was reached, note the run time and rerun Test 9 1 2 with flush time slightly longer than the noted run time. When satisfactory results are achieved, rerun the test three times without changing any test parameters. *6/23/99 JRT 5/21/99*

9 1 4 MK-I Lid Locking Nut Removal Torque

The purpose of the MK-I lid locking nut removal test is to find the torque required to remove a MK-I locking nut. *JRT 5/21/99 JRT 5/21/99*

Place a lid on a MK-I canister. Torque to 115 foot/pounds. Remove nut, record torque required. Perform ten times.

Torque 1 _____ ft-lb	Torque 6 _____ ft-lb
Torque 2 _____ ft-lb	Torque 7 _____ ft-lb
Torque 3 _____ ft-lb	Torque 8 _____ ft-lb
Torque 4 _____ ft-lb	Torque 9 _____ ft-lb
Torque 5 _____ ft-lb	Torque 10 _____ ft-lb

9 2 GAS COLLECTION SYSTEM TESTS

The purpose of the gas collection system testing is to evaluate the decapper confinement lid design, offgas transport time, gas volume collected, gas collection locations, gas bubble characteristics, and effects of offgas line water counter flow rates.

For this test to be successful, no uncontrolled gasses should be released to the water surface.

Clear sections of pipe and a gas trap will be added to the offgas collection system. Location of these devices is shown in Appendix F.

Where reasonable, the gas collection test will be run concurrent with the liquor control tests found in Section 9 1 of this procedure.

OFF GAS HANDLING SYSTEM TEST INSTRUCTIONS

Test A For this test the lower portion of the offgas line will be 15 degrees and the offgas in-flow will be 1 GPM

- 1 Fill each barrel of the canister with 12 2 liters/3 2 gallons of water of the same temperature as the pool (pool water may be used)
- 2 Place seven carbon steel dummy fuel inners and outers in each canister barrel
- 3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 4 Place loaded canister into the decapping station
- 5 Adjust the lower portion of the offgas line to 15°
- 6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 1 GPM
- 7 Start the underwater camera
- 8 Start the discharge pump Adjust flow rate to 70 gpm Verify off gas back flow is 1-3 gpm
- 9 Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Meyers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used

15 sec	_____ psi	_____ gpm
30 sec	_____ psi	_____ gpm
45 sec	_____ psi	_____ gpm
60 sec	_____ psi	_____ gpm

Total time _____

- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open containment box lid Evaluation of containment box effectiveness

- GRJ*
6/23/99
28/6/23/99
- 12 Watch the clear section of offgas piping
 Record time required from lid removal to initial bubble(s) pass(ing) marks on clear sections of pipe
 TIME Point 1 _____ Point 2 _____
 Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe
 TIME Point 1 _____ Point 2 _____
 Record time required for gas bubbles to exit offgas line
 TIME _____
 - 13 Record evidence of gas released through tool ports _____
 - 14 Calculate approximate bubble velocity in horizontal and vertical sections of offgas line
 HORIZONTAL _____ feet/minute
 VERTICAL _____ feet/minute
 - 15 Record general bubble characteristics (size, coalescence, slug flow, etc)

 - 16 Record evidence of gas in the discharge suction line Evidence may come from visual data or signs of pump cavitation _____
 - 17 Turn off the discharge pump
 - 18 Open Confinement box lid Estimate gas volume released, if any

 - 19 Move removal tool deployment system and drop lids to bottom of pool
 - 20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool
 MK-I canister lid _____
 MK-II canister lid _____

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6/23/99

Test B For this test the lower portion of the offgas line will be 15° and the offgas in-flow will be 2 GPM

- 1 Fill each barrel of the canister with 12.2 liters/3.2 gallons of water of the same temperature as the pool (pool water may be used)
- 2 Place seven carbon steel dummy fuel inners and outers in each canister barrel
- 3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 4 Place loaded canister into the decapping station
- 5 Adjust the lower portion of the offgas line to 15°
- 6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 2 GPM
- 7 Start the underwater camera
- 8 Start the discharge pump Adjust flow rate to 70 gpm
- 9 Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Meyers PB51-8 booster pump fed with 35 psi water Record elapsed time pressure and flow used

15 sec	_____ psi	_____ gpm
30 sec	_____ psi	_____ gpm
45 sec	_____ psi	_____ gpm
60 sec	_____ psi	_____ gpm

Total time _____

- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open containment box lid Evaluation of containment box effectiveness

- 12 Watch the clear section of offgas piping

Record time required from lid removal to initial bubble(s) pass(ing) marks on clear sections of pipe

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GRJ 6/23/99
Df 6/23/99

TIME Point 1 _____ Point 2 _____

Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe

TIME Point 1 _____ Point 2 _____

Record time required for gas bubbles to exit offgas line

TIME _____

13 Record evidence of gas released through tool ports _____

14 Calculate approximate bubble velocity in horizontal and vertical sections of offgas line

HORIZONTAL _____ feet/minute

VERTICAL _____ feet/minute

15 Record general bubble characteristics (size, coalescence, slug flow, etc)

16 Record evidence of gas in the discharge suction line Evidence may be from visual data or pump cavitation _____

17 Turn off the discharge pump

18 Open the confinement box lid Estimate gas volume released, if any _____

19 Move removal tool deployment system and drop lids to bottom of pool

20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool

MK-I canister lid _____

MK-II canister lid _____

Test C For this test the lower portion of the offgas line will be 15° and the offgas in-flow will be 3 GPM

1 Fill each barrel of the canister with 12 2 liters/3 2 gallons of water of the same temperature as the pool (pool water may be used)

2 Place seven carbon steel dummy fuel inners and outers in each canister barrel

- 3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 4 Place loaded canister into the decapping station
- 5 Adjust the lower portion of the offgas line to 15°
- 6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 3 GPM
- 7 Start the underwater camera
- 8 Start the discharge pump Adjust flow rate to 70 gpm
- 9 Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed with 35 psi water Record elapsed time, pressure and flow used
15 sec	_____ psi	_____ gpm
30 sec	_____ psi	_____ gpm
45 sec	_____ psi	_____ gpm
60 sec	_____ psi	_____ gpm
- Total time _____
- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments
- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open containment box lid Evaluation of containment box effectiveness
- _____
- _____
- 12 Watch the clear section of offgas piping
- Record time required from lid removal to bubble(s) pass(ing) marks on clear sections of pipe
- TIME Point 1 _____ Point 2 _____
- Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe
- TIME Point 1 _____ Point 2 _____

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Record time required for gas bubbles to exit offgas line

TIME _____

13 Record evidence of gas released through tool ports _____

14 Calculate approximate bubble velocity in horizontal and vertical sections of offgas line

HORIZONTAL _____ feet/minute

VERTICAL _____ feet/minute

15 Record general bubble characteristics (size, coalescence slug flow, etc)

16 Record evidence of gas in the discharge suction line Evidence may come from visual data or pump cavitation _____

17 Turn off the discharge pump

18 Open the containment box lid Estimate gas volume released, if any

19 Move removal tool deployment system and drop lids to bottom of pool

20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool

MK-I canister lid _____

MK-II canister lid _____

Test D For this test the lower portion of the offgas line will be 25° and the offgas in-flow metering pump set to 2 GPM

1 Fill each barrel of the canister with 12.2 liters/3.2 gallons of water of the same temperature as the pool (pool water may be used)

2 Place seven carbon steel dummy fuel inners and outers in each canister barrel

3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds

4 Place loaded canister into the decapping station

5 Adjust the lower portion of the offgas line to 25°

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- 6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 2 GPM

- 7 Start the underwater camera

- 8 Start the discharge pump Adjust flow rate to 70 gpm

- 9 ~~Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed by 35 psi water~~ Record elapsed time, pressure and flow used
- Steps 9 through 17 to be performed one barrel at a time starting with MK-I side JRS 7/2/99*

15 sec _____ psi _____ gpm
30 sec _____ psi _____ gpm
45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm

Total time _____

- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
NOTE The discharge pump flow may need adjustments

- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid Evaluation of containment box effectiveness

- 12 Watch the clear section of offgas piping

Record time required from lid removal to bubble(s) pass(ing) marks on clear sections of pipe

TIME Point 1 _____ Point 2 _____

Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe

TIME Point 1 _____ Point 2 _____

Record time required for gas bubbles to exit offgas line

TIME _____

- 13 Record evidence of gas released through tool ports _____

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14 Calculate approximate velocity in horizontal and vertical sections of offgas line

HORIZONTAL	_____	feet/minute
VERTICAL	_____	feet/minute

GRJ
7/2/99

15 Record general bubble characteristics (size, coalescence, slug flow, etc)

16 Record evidence of gas in the discharge suction line Evidence may come from visual data, or pump cavitation

17 Turn off the discharge pump

18 Open Confinement box lid Estimate gas volume release, if any

19 Move removal tool deployment system and drop lids to bottom of pool

20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool

MK-I canister lid _____

MK-II canister lid _____

Diff 6/23/99
GRJ
6/23/99

Test E For this test the lower portion of the offgas line will be 35° and the offgas in-flow metering pump set to 2 GPM

1 Fill each barrel of the canister with 12 2 liters/3 2 gallons of water of the same temperature as the pool (pool water may be used)

2 Place seven carbon steel dummy fuel inners and outers in each canister barrel

3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds

4 Place loaded canister into the decapping station

5 Adjust the lower portion of the offgas line to 35°

6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 2 GPM

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- 7 Start the underwater camera *GR 1 6-23-99 DJ 6/23/99*
- 8 Start the discharge pump Adjust flow rate to 70 gpm
- 9 Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster pump fed by 35 psi water Record elapsed time pressure and flow used
- 15 sec _____ psi _____ gpm
30 sec _____ psi _____ gpm
45 sec _____ psi _____ gpm
60 sec _____ psi _____ gpm
- Total time _____
- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi NOTE The discharge pump flow may need adjustments
- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid Evaluation of containment box effectiveness
- _____
- _____
- 12 Watch the clear section of offgas piping
- Record time required from lid removal to bubble(s) pass(ing) marks on clear sections of pipe
- TIME Point 1 _____ Point 2 _____
- Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe
- TIME Point 1 _____ Point 2 _____
- Record time required for gas bubbles to exit offgas line
- TIME _____
- 13 Record evidence of gas released through tool ports _____
- 14 Estimate general bubble velocity in horizontal and vertical sections of offgas line
- HORIZONTAL _____ feet/minute
VERTICAL _____ feet/minute

- ② 6/23/99
JRC 6/23/99
- 15 Record bubble characteristics (size, coalescence, slug flow, etc)

 - 16 Record evidence of gas in the discharge suction line Evidence may come from visual data or pump cavitation _____
 - 17 Turn off the discharge pump
 - 18 Open Confinement box lid Estimate gas volume release, if any

 - 19 Move removal tool deployment system and drop lids to bottom of pool
 - 20 Estimate the amount of gas released to surface when lids are dropped from decapping tool to bottom of pool
MK-I canister lid _____
MK-II canister lid _____

Test F For this test the lower portion of the offgas line will be 45° and the offgas in-flow metering pump set to 2 GPM

- 1 Fill each barrel of the canister with 12 2 liters/3 2 gallons of water of the same temperature as the pool (pool water may be used)
- 2 Place seven carbon steel dummy fuel inners and outers in each canister barrel
- 3 Place the appropriate MK-I and MK-II caps on each barrel Torque MK-I lids to 45 foot/pounds and MK-II to 115 foot/pounds
- 4 Place loaded canister into the decapping station
- 5 Adjust the lower portion of the offgas line to 45°
- 6 Close the decapper station lids and lower to the bottom of the KBMU pool Adjust the offgas in-flow to 2 GPM
- 7 Start the underwater camera
- 8 Start the discharge pump Adjust flow rate to 70 gpm

- 9 Open decapper lid Attach lid removal tools, and close decapper lid Remove MK-II canister lid Remove the MK-I lid using Myers PB51-8 booster Pump fed by 35 psi water Record elapsed time, pressure and flow used

15 sec _____ psi _____ gpm
 30 sec _____ psi _____ gpm
 45 sec _____ psi _____ gpm
 60 sec _____ psi _____ gpm

Total time _____

- 10 Start the flush jet supply pump Adjust flow to 17 gpm @ 35 psi
 NOTE The discharge pump flow may need adjustments

- 11 Raise the canister lid using the deployment system Flush for 3 minutes Wait one minute and open confinement box lid Evaluation of containment box effectiveness

- 12 Watch the clear section of offgas piping

Record time required from lid removal to bubble(s) pass(ing) marks on clear sections of pipe

TIME Point 1 _____ Point 2 _____

Record time required from lid removal to end of bubble(s) pass(ing) marks on clear sections of pipe

TIME Point 1 _____ Point 2 _____

Record time required for gas bubbles to exit offgas line

TIME _____

- 13 Record evidence of gas released through tool ports _____

- 14 Calculate approximate bubble velocity in horizontal and vertical sections of offgas line

HORIZONTAL _____ feet/minute

VERTICAL _____ feet/minute

- 15 Record general bubble characteristics (size, coalescence, slug flow, etc)

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- 16 Record evidence of gas in the discharge suction line Evidence may come from visual data or pump cavitation _____
- 17 Turn off the discharge pump
- 18 Open Confinement box lid Estimate gas volume release, if any

- 19 Move removal tool deployment system and drop lids to bottom of pool
- 20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool
MK-I canister lid _____
MK-II canister lid _____

9 3 REMOTE FEATURES TESTING

The remote features testing will be conducted using the production equipment and maintenance instruction Where possible, testing will be conducted using the 305 high bay monorail Key point of each feature test will be video recorded

REMOTE FEATURES TEST INSTRUCTIONS

9 3 1 Remove and Replace Decapping Station Hydraulic Cylinders

Using the WEPD developed long handled tools remove and replace the decapper station hydraulic cylinders All work will be done from the grating level Record all difficulties and comments Also note and record any hydraulic fluid releases into the pool Estimate quantity
360, 80
The hydraulic cylinders were removed and replaced from the grating level. The cylinders came off with ease and went back on successfully. The hydraulic pressure was bled off prior to the operation. Some difficulty was encountered with the lid falling back and getting in the way of replacing the nuts

9 3 2 Remove and Replace Decapping Station Nozzle Assembly

Using the WEPD developed long handled tools remove and replace the decapper station nozzle assembly All work will be done from the grating level Note any visible hydraulic fluid leaks Record all difficulties and comments

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- DR 6/23/99*
GR 3 6/23/99
- 16 Record evidence of gas in the discharge suction line Evidence may come from visual data or pump cavitation _____
 - 17 Turn off the discharge pump
 - 18 Open Confinement box lid Estimate gas volume release, if any

 - 19 Move removal tool deployment system and drop lids to bottom of pool
 - 20 Estimate the amount of gas released to surface when lids are dropped from tool to bottom of pool
- MK-I canister lid _____
MK-II canister lid _____

9 3 REMOTE FEATURES TESTING

The remote features testing will be conducted using the production equipment and maintenance instruction. Where possible, testing will be conducted using the 305 high bay monorail. *or 300 or mobile crane*
Key point of each feature test will be video recorded
GR 3/30/99

REMOTE FEATURES TEST INSTRUCTIONS

9 3 1 Remove and Replace Decapping Station Hydraulic Cylinders

GR 7-27-99
Using the ~~WEPD~~ developed long handled tools remove and replace the decapper station hydraulic cylinders. All work will be done from the grating level. Record all difficulties and comments. Also note and record any hydraulic fluid releases into the pool. Estimate quantity.

~~UNABLE TO REMOVE CYLINDERS - NUTS WERE REMOVED STAY~~

~~CRANE BENT LIFTING BAIL, CYLINDER MOUNTS HOOKED ON STUD & WERE NOT REMOVED~~ - See data sheets after mods

9 3 2 Remove and Replace Decapping Station Nozzle Assembly

GR 7/22/99
Using the ~~WEPD~~ developed long handled tools remove and replace the decapper station nozzle assembly. All work will be done from the grating level. Note any visible hydraulic fluid leaks. Record all difficulties and comments.

The nozzle assembly was removed and re-installed with relative ease using a 'hook'. No difficulties were encountered.

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9 3 3 Remove and Replace Decapping Station Lid Assembly

GR 3 7 22-99
Using the WEPD developed long handled tools remove and replace the decapping station lid assembly All work will be done from the grating level Record all difficulties and comments
Removal of the lids was not performed. Lid removal was evaluated by
K Basin operators, who were confident the lids removal operation could
be performed

9 3 4 Remove and Replace Canister Lid Removal Tool "O" Ring

GR 16-23-99 Jul 03
Using the WEPD developed long reach tools and McMaster Carr item no 9451K65 Remove and replace canister lid removal tool "O" ring Record all difficulties and comments

9 3 5 Installation/Rigging

GR Thelges 3/30/99
~~Using FDNW developed procedures to rig the support table, decapping station, and pump stand into the KMBU~~ Remotely connect the decapping station to the table Remotely connect all piping including the hydraulics, to the decapping station Record all difficulties and comments
GR 3 6 23/99
DECAPPING STATION MOUNTS ON TABLE WITH EASE, REMOTE
PIPING WAS NOT DONE (NO TOOLS/NO PROPER HOSES)

9 3 6 Canister Gas Trap Removal and Line Crimping Tool

GR 16/23/99 @ 6/23/99
Deferred to start alone test
The purpose gas trap removal and line crimping tool testing is to verify that the tool is functional Remove and crimp a MK-I gas trap using the long handled crimping tool Comment on ease of use, interference points, and effectiveness of seal

TEST DATA PLOTS

NOTE The plot data tables are too large to insert into this report and will be transmitted along with the rest of the test data to the FRS project file upon completion of this data report

Test Data Plots

QTEST1A

QTEST2

QTEST2A

QTEST3

QTEST4

QTEST6

QTest 7

QTest 8

QTest 9

APPENDIX B
CALIBRATION RECORDS

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Item No	Component Tag #	Component Description	Units	Decapping Station (Records in Appendix E)			QC Signature
				NIST/ HSL	305 CAL/ QC VERIFY	Manufacturer	
		DECAPPER INSTRUMENTATION					
1	SN 120582	Torque Wrench	ft lbf	X			<i>[Signature]</i> 4/27/99
2	SN 54532	Torque Wrench	ft lbf	X			<i>[Signature]</i> 4/27/99
3	SN 20873	Water Flow Meter 80 gpm	gpm	X	X		<i>[Signature]</i> 5/6/99
4	OMEGA FLD842	Water Flow Meter 13 gpm	gpm	X	X		<i>[Signature]</i> 5/6/99
5	OMEGA 0-200 G2	Water Pressure gauge, 155psi	psi	X	X		<i>[Signature]</i> 5/6/99
6	OMEGA FLD841	Water Flow Meter 17 gpm	gpm	X	X		<i>[Signature]</i> 5/6/99
7	OMEGA 0-60 G1	Water Pressure gauge 35 psi	psi	X	X		<i>[Signature]</i> 5/6/99
8		Digital Level	degrees	X			
8	H624-004	Water Flow Meter 1/2" x 1/2"	gpm		X		<i>[Signature]</i> 5/6/99

[Signature]
4-15-99

41

4/19/98

HANFORD STANDARDS LABORATORY CALIBRATION REPORT

[illegible]

JJ Electronics, Inc
7007 S E Lake Road
Portland Oregon 97267
(503)786 3005 FAX 786 2994

954-88-01 001

419125
CERTIFICATE OF CALIBRATION

Certificate #

151404

#723 01

COMPANY DYNACORP C/O FLUOR DANIEL HANFORD		1298	DEPT ITEM#1																																					
INSTRUMENT IDENTIFICATION																																								
MAKE PROTO	MODEL 6134A		SERIAL 03010																																					
PROP# 954-88-01-021	DESCRIPTION TORQUE WRENCH																																							
INSTRUMENT PROBLEM			INSTRUCTIONS																																					
RQ#16436			WORK AUTH ORDER DATE 05-Mar-1999 CUST PO 3249/16436 TERMS COD ☐ CONTRACT ☒ CALIBRATE ☐ ESTIMATE ☒ NON CONTRACT ☒ TEST DATA ☐ FUNCTION TEST ☐ WARRANTY ☒ REPAIR ☐																																					
USER			PHONE 509 376-7865																																					
SERVICE INFORMATION																																								
RECEIVED TOLERANCE	SEALS	ADJUSTMENT	CLEANING	REPAIRS																																				
Within Tolerance	Intact	None	Minor	None																																				
RETURNED TOLERANCE	TOLERANCE																																							
Within Tolerance	±4% CW / ±6% CCW																																							
REMARKS																																								
VERIFICATION TESTED TUR 24 1 DATA IN FOOT/POUNDS <table border="1"> <thead> <tr> <th>STD</th> <th>CW</th> <th>UUT</th> <th>STD</th> <th>CCW</th> <th>UUT</th> </tr> </thead> <tbody> <tr> <td>50 63</td> <td></td> <td>50</td> <td>49 91</td> <td></td> <td>50</td> </tr> <tr> <td>100 8</td> <td></td> <td>100</td> <td>100 4</td> <td></td> <td>100</td> </tr> <tr> <td>201 1</td> <td></td> <td>200</td> <td>197 5</td> <td></td> <td>200</td> </tr> <tr> <td>302 5</td> <td></td> <td>300</td> <td>296 3</td> <td></td> <td>300</td> </tr> <tr> <td>352 1</td> <td></td> <td>350</td> <td>343 1</td> <td></td> <td>350</td> </tr> </tbody> </table>					STD	CW	UUT	STD	CCW	UUT	50 63		50	49 91		50	100 8		100	100 4		100	201 1		200	197 5		200	302 5		300	296 3		300	352 1		350	343 1		350
STD	CW	UUT	STD	CCW	UUT																																			
50 63		50	49 91		50																																			
100 8		100	100 4		100																																			
201 1		200	197 5		200																																			
302 5		300	296 3		300																																			
352 1		350	343 1		350																																			
TECH	PROCEDURE	CAL INT	CALIBRATION DATE	NEXT DUE DATE																																				
# 54	CP 6	12 MO	19-Mar-1999	19-Mar-2000																																				
TEMP 20 °C HUMID 42 %																																								
STANDARDS USED																																								
ID#	MANUFACTURER	MODEL NUMBER	NOMENCLATURE	DUE DATE																																				
282	CDI	950 DT	TORQUE CALIBRATION	21-Apr-1999																																				
NIST TEST # TRQ MMAP 822/CA																																								
JJ Electronics Inc certifies that the equipment noted hereon has been compared to standards in accordance with the reference procedure of specification and has been found In Tolerance unless noted otherwise in remarks above Standards used to establish the basis for this calibration are certified as being traceable to the National Institute of Standards and Technology or derived from accepted values of natural constants or by the ratio type of self calibration The calibration system and records are in compliance with MIL STD 45662A ANSI Z540.1 ISO Guide 25 ISO 10012.1 and ISO 9000 series Stated uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level coverage factor (k=2) TUR > 4.1 unless otherwise noted This Certificate shall not be reproduced except in full without the written approval of JJ Electronics Inc																																								
AUTHORIZED BY Tom Moody			MAR 31 1999 QA INSP																																					

REV 9 (8/97) EPZC

Original

Date March 31, 1999
TO HSL Customers File
From J R Emery Mgr HSL
Subject HSL Calibration Reports

On June 18 1998 the performance of M&TE calibrations by the HSL was suspended. On that same date off-site calibration facilities began the calibration of HSL customer M&TE via Purchase Order or Contract Requisition.

When returned to the site after calibration the M&TE is accompanied by a vendor calibration certification. The vendor certification includes pertinent information relating to each respective calibration. This includes the following: traceability, compliance to ANSI/NCSL Z540-1-1994 or other national calibration or quality standards, calibration ratio, as-found and as-left data (as applicable), range(s), tolerance(s), date calibrated, calibration frequency, date due for recalibration, person performing the calibration, out-of-tolerance data and limiting conditions of use (as applicable), and any other information relative to the calibration.

When the vendor certification is received, the HSL attaches an HSL Calibration Report to the vendor documentation. The HSL Calibration Report primarily serves as the device for updating the HSL SLIC Database for future recall of the M&TE for calibration.

As of this date the following information will be annotated on the HSL Calibration Report: vendor compliance to 4.1 calibration ratio, M&TE status (Active, Suspended, Rejected, etc.), date of the calibration, date M&TE is due for recalibration, tolerance as received, calibration history (up to the last four calibrations), and the signature, date and stamp of the HSL engineer who performed the review. All other information relative to the calibration is contained in the vendor's certification. All pages of the completed report will be paginated.

A copy of this letter will be incorporated into each HSL Calibration Report.

2122 4/22/99

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Rev. 0

B-7

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION

Hedland H624 004 FLOW METER

Cog Engineer PAUL MEYERSON Date 4/28/99

Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Hedland H624 004 flow meter will be used to measure the Water flow into the backflow port. The purpose of this procedure is to verify that the flow meter purchased from Hedland is within the expected accuracy range. The range of this instrument is 1/2 to 4 gallons.

1 Adjust flow to one gallon per minute

2 Fill empty one gallon container for one minute

3 Record actual volume 1 gallons

4 Perform calculation to find percent error

(found volume/expected volume)x100 Record value 0

If volume found is not within 5% of expected volume perform specific gravity correction calculation
The formula for this calculation is found in appendix A. Rerun one gallon per minute flow test

5 Adjust flow to two gallons per minute

6 Fill empty one gallon container tank for 1 minute

7 Record actual volume 2 gallon(s)

8 Perform calculation to find percent error

(found volume /expected volume)x100 Record value 0

9 Adjust flow to 4 gallons per minute

10 Fill empty container for 1 minute

11 Record actual volume 4 gallons

12 Perform calculation to find percent error

(found volume/expected volume) x 100 Record value 0

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION

OMEGA 0 200 Pressure gauge G2

Cog Engineer PAUL MEEUWSEN Date 4/5/99Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Omega pressure gauge will be used to measure water pressure in the canister lid blow off line. The purpose of this procedure is to verify that the pressure gauge purchased from Omega is within the expected accuracy range. The range of this instrument is 0 200 psi.

- 1 Plum Penwalt 150 psi (absolute) 584 31 04 004 (expiration date 10/16/99) pressure gauge in a tee configuration with Omega gauge to be verified
- 2 Adjust pressure to ^{65 Absolute PM 5/6/99} 50 psi on Penwalt gauge
- 3 Record pressure reading on Omega gauge 50 1/2 psi
- 4 Perform calculation to find percent error
(found pressure/expected pressure)100 Record value 1%
- 5 Adjust pressure to ^{115 Absolute PM 5/6/99} 100 psi on Penwalt gauge
- 6 Record pressure reading on Omega gauge 100 psi
- 7 Perform calculation to find percent error
(found pressure/expected pressure)100 Record value 0
- 8 Adjust pressure to ^{140 Absolute PM 5/6/99} 125 psi on Penwalt gauge
- 9 Record pressure reading on Omega gauge 126 psi
- 10 Perform calculation to find percent error
(found pressure / expected pressure) 100 Record value 8%

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION

OMEGA 0 60 Pressure gauge G1

Cog Engineer PAUL MEKUNSEN Date 4/6/99

Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Omega pressure gauge will be used to measure water pressure in the canister cleaning jets line. The purpose of this procedure is to verify that the pressure gauge purchased from Omega is within the expected accuracy range. The range of this instrument is 0 60 psi.

- 1 Plum Penwalt 0 150 psi (absolute) 584 31 04 004 (expiration date 10/16/99) in a tee configuration with Omega gauge to be verified

- 2 Adjust pressure to ^{35 ABSOLUTE PM 5/4/99} 20 psi on Penwalt gauge

- 3 Record pressure reading on Omega gauge 20 psi

- 4 Perform calculation to find percent error

(found pressure/expected pressure)100 Record value 0

- 5 Adjust pressure to ^{45 ABSOLUTE PM 5/4/99} 30 psi on Penwalt gauge

- 6 Record pressure reading on Omega gauge 30 psi

- 7 Perform calculation to find percent error

(found pressure/expected pressure)100 Record value 0

- 8 Adjust pressure to ^{55 ABSOLUTE PM 5/4/99} 40 psi on Penwalt gauge

- 9 Record pressure reading on Omega gauge 40 1/4 psi

- 10 Perform calculation to find percent error

(found pressure / expected pressure) 100 Record value .6 %

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION

Halliburton MCII FLOW METER S/N 202673

Cog Engineer PAUL MEEUWSEN Date 4/28/99
Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Halliburton MCII flow meter will be used to measure the water flow out of the decapper confinement box. The purpose of this procedure is to verify that the flow meter purchased from Omega is within the expected accuracy range. The range of this instrument is 10 to 100 gallons per minute.

- 1 Mark 305 buildings 22.5 diameter clear plastic tank 17.4 from bottom. This mark identifies 30 gallons
- 2 Adjust flow to 15 gallons per minute
- 3 Fill empty tank for two minutes
- 4 Record actual water depth 17.1 inches
- 5 Perform calculation to find percent error
(found dimension (inches)/17.4) x 100 Record value 1.7%
- 6 Adjust flow to 30 gallons per minute
- 7 Fill empty tank for one minute
- 8 Record actual water depth 17.1 inches
- 9 Perform calculation to find percent error
(found dimension (inches)/17.4) x 100 Record value 1.7%
- 10 Adjust flow to 60 gallons per minute
- 11 Fill empty tank for 1/2 minute
- 12 Record actual water depth 17.1 inches
- 13 Perform calculation to find percent error
(found dimension (inches)/17.4) x 100 Record value 1.7%

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION

OMEGA FL 7325 FLOW METER #1

Cog Engineer PAUL M. BEUWSEN Date 4/28/99
Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Omega Fl 7325 flow meter will be used to measure the water flow into the decapper confinement box through the flush nozzles. The purpose of this procedure is to verify that the flow meter purchased from Omega is within the expected accuracy range. The range of this instrument is 2.25 gallons

1 Mark 305 buildings 22.5 diameter clear plastic tank 17.4 from bottom. This mark identifies 30 gallons

2 Adjust flow to 10 gallons per minute

3 Fill empty tank for three minutes

4 Record actual water depth 16 1/4 inches

5 Perform calculation to find percent error

(found dimension (inches)/17.4)x100 Record value 66%

6 Adjust flow to 15 gallons per minute

7 Fill empty tank for two minute

8 Record actual water depth 18 1/4 inches

9 Perform calculation to find percent error

(found dimension (inches)/17.4)x100 Record value 1.9%

10 Adjust flow to 20 gallons per minute

11 Fill empty tank for 1 1/2 minutes

12 Record actual water depth 16 7/8 inches

13 Perform calculation to find percent error

(found dimension (inches)/17.4) x 100 Record value 30%

K BASIN FUEL RETRIEVAL DECAPPER AND CANISTER SLITTER FIELD CALIBRATION
OMEGA FL-7325 FLOW METER #2

Cog Engineer PAUL MERUWSEN Date 4/28/99
Quality Assurance [Signature] Date 5/6/99

INTRODUCTION

The Omega Fl 7325 flow meter will be used to measure the water flow into the decapper confinement box through the flush nozzles. The purpose of this procedure is to verify that the flow meter purchased from Omega is within the expected accuracy range. The range of this instrument is 2.25 gallons

1 Mark 305 buildings 22.5 diameter clear plastic tank 17.4 from bottom. This mark identifies 30 gallons

2 Adjust flow to 10 gallons per minute

3 Fill empty tank for three minutes

4 Record actual water depth 15.2 inches

5 Perform calculation to find percent error

(found dimension (inches)/17.4)x100 Record value 12.7%

6 Adjust flow to 15 gallons per minute

7 Fill empty tank for two minutes

8 Record actual water depth 16 1/2 inches

9 Perform calculation to find percent error

(found dimension (inches)/17.4)x100 Record value ~~12.7~~ 52%

10 Adjust flow to 20 gallons per minute

11 Fill empty tank for 1 1/2 minutes

12 Record actual water depth 17 inches

13 Perform calculation to find percent error

(found dimension (inches)/17.4) x 100 Record value 2.3%

APPENDIX E (Cont)
PRE-TEST INSTRUMENTATION CALIBRATION REPORT

INSTRUMENT TAG NO _____ DESCRIPTION _____					CALIBRATION NUMBER _____
MANUFACTURER _____ MODEL _____ SERIAL NO _____					
NIST TRACEABLE M&TE CALIBRATION NUMBER _____		M&TE EXPIRATION DATE _____		EQUIPMENT TYPE _____	
REMARKS _____					AMBIENT TEMP* _____
					PROCEDURE NUMBER (IF APPLICABLE) _____
STANDARD READING	INPUT SIGNAL	AS FOUND READING	AS LEFT READING	TOLERANCE	
CALIBRATION REMARKS _____					
CALIBRATED BY _____			DATE CALIBRATED _____		PAGE _____ OF _____

Belhaven Calibration Data Sheet

418730
Report Number
BEL98-679

Tag No 584 88 01-002
Instrument Type Torque Wrench
Manufacturer CDI
Serial No
Model 3504LDFN - Dial Torque
Cal Due Date 1/26/2000
System
Special Instructions

			Cal Point	As Found	As Left	% Full Scale Accuracy
Units	ft-lbs		70	68 (CW)	68 (CW)	-0 5714
F S Accuracy	2 0	%	140	137 (CW)	137 (CW)	-0 8571
F S Accuracy		%	210	207 (CW)	207 (CW)	-0 8571
Full Scale	350		280	279 (CW)	279 (CW)	-0 2857
Permitted Variation	7		350	351 (CW)	351 (CW)	0 2857
Cal Temp	68F		70	75 (CCW)	75 (CCW)	1 4286
			140	141 (CCW)	141 (CCW)	0 2857
			210	209 (CCW)	209 (CCW)	-0 2857
			280	280 (CCW)	280 (CCW)	0 0000
			350	351 (CCW)	351 (CCW)	0 2857

Test Equipment Omegadyne Load Cell, S/N 450 (TC)

Calibration Performed By S. S. 771

Date 1 26 99

ORIGINAL

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2/18/99
1/21/11

Rept 42111

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APPENDIX C

SENSOR DATA PLOT/CALIBRATION DATA INTERPRETATION

APPENDIX C

SENSOR DATA PLOT/CALIBRATION DATA INTERPRETATION

Both the MK-I and MK-II canister barrels were instrumented with probes that recorded the concentration of the cesium nitrate solution during confinement box flushing and lid removal. Figure C 1 shows a schematic of the instrument probe, showing the location of the individual sensors relative to the bottom of the canister barrel.

A calibration of the sensors was performed at a cesium nitrate concentration of 5% (Figure C 2). This data was used to show when the cesium nitrate concentration in each barrel reached acceptable levels. As the cesium nitrate concentration in the box and canister barrels decreases, the probe sensor values increase. Therefore, the acceptance criteria stated in the Design Specification is met when the probe sensor values for the box and canisters meet or exceed the 5% concentration calibration values. For example, if the probe sensor value from sensor A1, located at the top of the MK-II barrel, exceeded ~2, the barrel solution concentration was within the acceptance criteria for that location. Figures C 3 through C 12 separately show the sensor 5% calibration data superimposed on the Qtest 2A data for each sensor. This is representative of how each test behaved.

Figure C-1 Probe Sensor Locations

APPENDIX C

SENSOR CALIBRATION DATA

Test System Conductivity Probes

Data File caldata1

#####

Seconds	A1	A2	A3	A4	A5	B1	B2	B3
0	1 925659	1 952667	1 948242	1 86554	1 904221	2 391357	1 991806	2 012024
5	1 929245	1 955566	1 949387	1 86554	1 904984	2 389297	1 993408	2 017136
10	1 927109	1 955032	1 949005	1 865005	1 905136	2 392349	1 993713	2 016754
15	1 925735	1 956406	1 948929	1 864548	1 904068	2 391586	1 993866	2 016678
20	1 921921	1 954956	1 946793	1 86348	1 901474	2 38678	1 991425	2 015305
25	1 922684	1 956177	1 948395	1 865082	1 903076	2 388687	1 992798	2 014771
30	1 925507	1 9561	1 947098	1 864166	1 901932	2 388229	1 991196	2 014618
35	1 928482	1 957397	1 947784	1 864243	1 90239	2 386246	1 992569	2 016296
40	1 930008	1 958466	1 948471	1 86554	1 903992	2 387848	1 991425	2 015915
45	1 929855	1 956787	1 948013	1 864853	1 903839	2 38739	1 991653	2 015915
50	1 930847	1 958008	1 949615	1 866302	1 903915	2 388856	1 990814	2 015457
55	1 93573	1 96167	1 952667	1 867447	1 904526	2 389069	1 991653	2 016983
60	1 932831	1 958237	1 950684	1 865692	1 903	2 387466	1 988525	2 01416
65	1 933212	1 958847	1 951218	1 864624	1 901627	2 386932	1 989059	2 015305
70	1 929245	1 95694	1 951752	1 864777	1 902084	2 386551	1 987457	2 013397
75	1 932373	1 958694	1 952896	1 865387	1 902161	2 386627	1 989365	2 014771
80	1 931915	1 958694	1 953201	1 86554	1 903915	2 390366	1 98822	2 013931
85	1 930237	1 957855	1 951752	1 863937	1 901474	2 385941	1 987	2 011795
90	1 928482	1 956177	1 951523	1 8647	1 902542	2 38678	1 98555	2 011337
95	1 926498	1 957703	1 951981	1 864471	1 902161	2 387314	1 984634	2 011414
100	1 924667	1 95694	1 951752	1 864243	1 90361	2 388611	1 984329	2 010574
105	1 920929	1 954269	1 948853	1 86058	1 899261	2 386932	1 981506	2 010117
110	1 9207	1 956253	1 949387	1 862183	1 90239	2 389145	1 981659	2 010193
115	1 919098	1 955948	1 949234	1 860886	1 902466	2 390823	1 980362	2 00882
120	1 919708	1 959152	1 950912	1 863327	1 904831	2 392502	1 98288	2 012253
125	1 914444	1 957626	1 948395	1 859283	1 901779	2 390137	1 980438	2 01004
130	1 912384	1 958084	1 947937	1 858597	1 90239	2 391739	1 982269	2 011719
135	1 911392	1 958389	1 946259	1 857529	1 903	2 392044	1 983261	2 010574
140	1 908493	1 957779	1 945038	1 855316	1 901398	2 389679	1 981277	2 009277
145	1 909866	1 96022	1 946335	1 855087	1 901093	2 388153	1 98143	2 008286
150	1 909027	1 960449	1 945496	1 853867	1 901245	2 389603	1 982651	2 009201
155	1 909485	1 960983	1 946335	1 854706	1 902084	2 390366	1 9841	2 009964
160	1 907272	1 959152	1 945572	1 852493	1 901703	2 392426	1 985779	2 011414
165	1 906204	1 958008	1 944504	1 852112	1 901474	2 392197	1 983643	2 009201
170	1 904755	1 957321	1 945801	1 852112	1 902313	2 391815	1 983109	2 009583
175	1 905518	1 955948	1 944351	1 84967	1 900558	2 390289	1 981125	2 007446
180	1 906967	1 955032	1 943512	1 849213	1 899643	2 390518	1 981583	2 008667
185 001	1 906509	1 954269	1 943054	1 847763	1 90094	2 392349	1 981659	2 007904
190 001	1 905899	1 955566	1 942444	1 845169	1 900864	2 393951	1 982651	2 010651
195 001	1 904755	1 955872	1 943436	1 845093	1 899796	2 396545	1 983719	2 011032
200 001	1 901245	1 955872	1 942596	1 845322	1 899872	2 391891	1 984024	2 011337

APPENDIX C **SENSOR CALIBRATION DATA** **(continued)**

B4	B5	wall	outlet
2 105255	1 606903	1 193008	1 212158
2 108536	1 609192	1 194153	1 212616
2 106857	1 606216	1 192169	1 212921
2 1064	1 607666	1 189651	1 21254
2 105179	1 605072	1 190186	1 211243
2 105942	1 60614	1 192703	1 212692
2 105942	1 605759	1 192398	1 211319
2 10556	1 606979	1 193466	1 21048
2 105408	1 606979	1 194153	1 209869
2 10434	1 606064	1 195755	1 210785
2 103653	1 606522	1 196213	1 211014
2 106705	1 608658	1 197205	1 209946
2 104187	1 606598	1 197281	1 209946
2 105026	1 607208	1 196594	1 20842
2 103348	1 605072	1 196671	1 207809
2 106476	1 607208	1 197891	1 208878
2 105713	1 607361	1 192245	1 209412
2 104645	1 606903	1 186676	1 207275
2 104645	1 605606	1 190491	1 207886
2 10434	1 608582	1 195831	1 208496
2 103882	1 60759	1 196976	1 20842
2 103424	1 605606	1 195831	1 205673
2 105255	1 609879	1 197586	1 207581
2 102356	1 606979	1 195908	1 20575
2 10556	1 609955	1 198654	1 207809
2 103043	1 608429	1 197128	1 20575
2 104568	1 609421	1 195679	1 206436
2 102509	1 607056	1 197281	1 207199
2 100906	1 60553	1 198196	1 206512
2 102051	1 607971	1 198502	1 205902
2 101517	1 608505	1 197205	1 205978
2 102127	1 608582	1 198425	1 206436
2 102814	1 60759	1 199188	1 20636
2 101059	1 608353	1 200333	1 208038
2 10083	1 608429	1 202011	1 208115
2 101059	1 60881	1 201172	1 207275
2 102203	1 607666	1 201248	1 207581
2 100296	1 606522	1 195755	1 207123
2 101746	1 608047	1 197433	1 205521
2 102203	1 608734	1 198044	1 206055
2 103424	1 608582	1 198959	1 206055

Figure C-2. Sensor Calibration Data, 5% Solution Concentration

Figure C-3. Calibration Test vs QTest 2A Sensor A1 Data

Figure C-4. Calibration Test vs QTest 2A Sensor A2 Data

Figure C-5. Calibration Test vs QTest 2A Sensor A3 Data

Figure C-6. Calibration Test vs QTest 2A Sensor A4 Data

Figure C-7. Calibration Test vs QTest 2A Sensor A5 Data

Figure C-8. Calibration Test vs QTest 2A Sensor B1 Data

Figure C-9. Calibration Test vs Test 2A Sensor B2 Data

Figure C-10. Calibration Test vs QTest 2A Sensor B3 Data

Figure C-11. Calibration Test vs QTest 2A Sensor B4 Data

Figure C-12. Calibration Test vs QTest 2A Sensor B5 Data

APPENDIX D
VIDEO TAPE LIST AND NOTES

APPENDIX D**VIDEO TAPE LIST AND NOTES**

Tape Number	Description
1	Dye tests and Qualitative Tests 1-4 - Handicam
2	Dye tests and Qualitative Tests 6-9 - Handicam
3	Dye tests and Qualitative Tests 1-4 - Underwater Camera
4	Dye tests and Qualitative Tests 6-9 - Underwater Camera
5	Dye tests and Qualitative Tests 1-4 - Bubble Collection
6	Dye tests and Qualitative Tests 6-9 - Bubble Collection
7	Remote Features Tests

Notes -**Underwater Camera Tape 7/1/99, Tape #3:**

Dye Test 3 - Two puffs of dye seen right after MK-II lid raised. Dye came out of the confinement box near the tool hole openings. No dye was released when the lids were opened.

HandiCam above water camera, Tapes 1 & 2:

Test 1A - MK-I lid was not removed

Test 2 - MK-I lid was not removed

Test 2A - Both lids were successfully removed

Test 3 - Both lids were successfully removed

Test 4 - No video available

Test 6 - Both lids were successfully removed

Test 7 - Both lids were successfully removed

Test 8 - Some binding occurred while turning the tool to open the MK-I lid. Opened and closed the decapper lid twice to relieve the binding. Tool was apparently pushed against the away wall of the hole in the decapper lid.

Test 9 - Both lids were successfully removed

Bubble Camera Tape 7/1/99, Tape #5:

Dye Test 3 - Initial bubbles ~ 7 one-inch, second set ~ 7 one-inch, third set ~5 one-inch, fourth set two large bubbles ~ 2" and four small ~ .5", fifth set 2 ~ 1/2", a total of ~ 4" to 6" captured.

Emptied bubbles.

1/2" to 1" OD bubbles slowly released

Large slug of bubbles ~ 6" worth - probably blowing a lid

Large slug of bubbles ~ 12" worth - probably starting flush

Emptied bubbles

APPENDIX D

VIDEO TAPE LIST AND NOTES

Large slug of bubbles - cleared tools of air

Emptied bubbles

Several 1/2" to 1" OD bubbles - total ~3"

Several 1/2" to 1" OD bubbles and 1 small slug - 4" more, total ~ 7"

Emptied bubbles

Several bubbles - ~3" worth

Emptied bubbles

Several bubbles - ~3" worth

Additional bubbles over time - ~1" to 2" more; 4" to 5" total

Emptied bubbles

Large slug - ~12" worth

Emptied bubbles

Small slug - ~6" worth

2nd slug - ~10" worth

Emptied bubbles

Small slug - ~6" worth

Large slug - ~12" worth; total 18" to 20"

End of Tape #5

Bubble Camera Tape 7/2/99, Tape #6

Started with emptied tube

A stream of bubbles - ~8" to 10" worth

Slug of bubbles - ~8" worth

Several large slugs filled the catch tube and beyond

Emptied bubbles

APPENDIX D**VIDEO TAPE LIST AND NOTES**

Large slug - total ~5" worth
Small slug - ~4" worth; total ~9"

Emptied bubbles

Several 2" OD bubbles - ~4" worth
Small slug - ~4" worth; ~8" total
Several small bubbles - ~4" to 5" worth: ~12" to 13" total

Emptied bubbles

Steady stream of 1" to 1.5" bubbles - ~5" total
Large slug - ~13" worth; ~18" total
Small slugs - filled tube and beyond

Emptied bubbles

Small slugs ~1" to 2" OD - ~5" worth
Large slug - ~13" to 15" worth; 18" to 20" total
Large slugs - flow filled tube and beyond, several large slugs
Several large bubbles flowing through the tube

APPENDIX E

**OPERATING PROCEDURE AND HYDRAULIC SYSTEM
MALFUNCTION/FAULT RECOVERY PROCEDURE**

APPENDIX E

OPERATING PROCEDURE AND HYDRAULIC SYSTEM MALFUNCTION/FAULT RECOVERY

The BNFL Operating Manual contains the latest operating procedure. Comments to the procedure have been provided to the BNFL design engineer and forwarded to the FRS design authority.

Hydraulic System Malfunction/Fault Recovery

There are several instances where the PLC that controls the lid removal tools may fault, malfunction, or just plain not cooperate. In these instances, some steps of recovery are necessary to continue operating the system. Known instances include the following situations:

- Going from jog mode to run mode after setting the tool lower limit
- Missing the lid/tool alignment causing the tool to stop and fault
- Whenever the tool is stopped before it gets to its desired position

Whenever any of the above situations occur, the system must be completely turned off using the EHC key switch. After waiting one minute (I found that you only need to wait a few seconds), the system can be turned back on and any fault should be cleared.

Before decapping operations can start, the lower limits for each tool must be set for each type of canister. This is done with the hydraulic control system set in the jog mode. Once these positions have been set, the system needs to be turned off and back on before it can be operated in the run mode.

If the tool did not successfully engage the lid in the run mode and a fault occurred, the system must be reset as described above. There are two choices for continuing from this point. The operator can either raise the tool and again attempt to engage the lid in the run mode, or use the jog mode to engage the lid. If the jog mode is used for either barrel, the system will not be in the necessary float mode when it comes to opening the lids. Even though both lids are now completely lowered, the operator must place the system in the run mode and push the lower button in each tool position in order for the system to go into the float mode.