November 1967

WANL-TNR-221
Preliminary
OPERATIONS MANUAL
PLUM BROOK REACTOR FACILITY
EXPERIMENT 62-16

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INFORMATION CATEGORY

unclassified

W.B. Morris 12/14/67

Authorized Classifier Date

MASTER

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PREFACE

The basic purpose of the water-cooled experimental system described in this document is to provide information which will assist in the selection of materials and components for incorporation in the NRX (NERVA Reactor Experiment) reactor currently being designed by Westinghouse Astronuclear Laboratory. The radiation levels in the PBRF HT-1 facility are considered the closest available to the actual NRX levels. An important factor is that many of the radiation effects which are of interest are those associated with dose rate rather than total integrated dose.

The basic purpose of the cryogenic inpile loop is to provide a high flux, low temperature environment in which proposed NRX (NERVA Reactor Experiment) materials and components can be performance tested. Neutron and Gamma Radiation effects testing has previously been conducted at high neutron and gamma fluxes but ambient temperature.

Typical items to be tested in each system would include materials tests, instrumentation components such as accelerometers, displacement transducers, and strain gages and small mechanical components such as control drum assemblies and dynamic bearings.

This manual contains procedures for the checkout, startup, operation and shutdown of the W-1 Cryogenic System and the W2-3 Water-Cooled System. Any revisions to the procedures contained in this manual shall be approved by PBRF.

Since the experiments performed in the W-1 and W2-3 systems will differ, and since each system will perform varied experiments, procedures for the conduct of experiments must be written for each test individually. These procedures will be prepared for each experiment by WANL-PBRF-TO and submitted to PBRF for review and approval prior to insertion of the experiment into HT-1. The procedures will include checkout, operation and disposition of each test in accordance with the provisions of this manual.

J. J. Quinn, Supervisor

Walter S. Wilgus, Manager

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SECTION 0

ADMINISTRATIVE PROCEDURES

0.1 OPERATIONS MANUAL - DISTRIBUTION AND MAINTENANCE

0.1.1 Distribution

0.1.1.1 Copies of this manual will be distributed as follows:

Copies 1-15	WANL-PBRF Test Operations
Copies 16-21	WANL-TSD&O
Copies 22-40	PBRF Project Engineer
Copy 41	WANL Library
Copies 42-23	WANL-PBRF File
Copies 44-45	Spare

0.1.1.2 New and revised spare procedures will be distributed in accordance with the list in 0.1.1.1 above.

0.1.1.3 A revised Table of Contents will accompany all revisions and/or new procedures as they are distributed.

0.1.2 Maintenance

0.1.2.1 All changes and revisions to this manual will be originated by Test Operations.

0.1.2.2 Maintenance of copies of this manual will be the responsibility of those receiving the manual.

0.2 OPERATING SCHEDULES

- 0.2.1 Test requirements vary with each individual test. Test Operations will provide the PBRF Project Engineer with an operating schedule at the beginning of the irradiation cycle.
- 0.2.2 The schedule will contain the following information:
 - 0.2.2.1 Test identification
 - 0.2.2.2 Operations shift organization
 - 0.2.2.3 Qualified operators
 - 0.2.2.4 PBRF services required
- 0.2.3 Whenever major repairs or maintenance items are to be performed, a schedule will be prepared and provided to the PBRF Project Engineer. The schedule will describe the work to be performed and show the proposed shift organization.

0.3 OPERATING RECORDS

0.3.1 General

0.3.1.1 All operating records will be maintained by Test Operation's personnel.

0.3.1.2 Completed logbooks and data sheets will be returned to the Test Operation's office for file.

0.3.1.3 Copies of the logbooks and/or data sheets will be provided by the Test Operation's office as requested.

0.3.2 Logbooks

0.3.2.1 The following logbooks operating records will be maintained by Test Operations:

0.3.2.1.1 W-1 System

0.3.2.1.1.1 W-1 System Log

0.3.2.1.1.2 W-1 Compressor Log

0.3.2.1.1.3 W-1 Expander Log

0.3.2.1.1.4 Cryogenic Experiment
Log

0.3.2.1.2 W2-3 System

0.3.2.1.2.1 W2-3 System Log

0.3.2.1.2.2 Water-Cooled Experiment
Log

0.3.2.2 Maintenance of the logbooks will be in accordance with Procedure 0.4.

0.3.3 Data Sheets

- 0.3.3.1 The following data sheet operating records will be maintained by Test Operations:
 - 0.3.3.1.1 W-1 System data sheets
 - 0.3.3.1.2 W2-3 System data sheets
 - 0.3.3.1.3 Experiment data sheets
- 0.3.3.2 Maintenance of data sheets will be in accordance with Procedures 4.3, 4.5 and 4.10.

0.4 LOGBOOKS

0.4.1 General

- 0.4.1.1 All entries will be written in ink or ball-point pen.
- 0.4.1.2 Erasures are prohibited. Errors will be corrected by striking through the error with a single line, entering the correct information and initialling the change.
- 0.4.1.3 Twenty-four hour time will be used. Each entry will be preceded by the time.
- 0.4.1.4 All events will be logged in sequential order.
- 0.4.1.5 Odd-numbered pages only will be used. Skipping of odd-numbered pages is prohibited. The even-numbered pages are reserved for late entries, comments and notes.
- 0.4.1.6 All lines on the odd-numbered pages will be used. Skipping of lines is prohibited.
- 0.4.1.7 At the completion of each shift, the recording technician shall place his initials on the line following the last entry.
- 0.4.1.8 At the completion of each shift, the shift leader will review and sign the logbook on the line following the recording technician's initials.

0.4.2 System Logbooks

- 0.4.2.1 The initial entry for each shift will include the following information:
 - 0.4.2.1.1 Date
 - 0.4.2.1.2 Time
 - 0.4.2.1.3 Shift personnel

- 0.4.2.1.4 Reactor condition
 - 0.4.2.1.5 Capsule positions
 - 0.4.2.1.6 Quadrant condition
 - 0.4.2.1.7 Experiment, operation and/or maintenance being performed
 - 0.4.2.2 The System Logbooks will record all manipulations, operations and conditions associated with the operation of the W-1 or W2-3 system.
- 0.4.3 Compressor Logbook
 - 0.4.3.1 The Compressor Logbook will record the running time, maintenance and adjustments made on the compressor.
 - 0.4.3.2 In the event of a malfunction, the Compressor Logbook will record in detail the events and correction.
- 0.4.4 Expander Logbook
 - 0.4.4.1 The Expander Logbook will record the same information for the expansion engine as for the compressor in Procedure 0.4.3 above.
- 0.4.5 Experiment Logbooks
 - 0.4.5.1 An Experiment Logbook will be received with each test fixture.
 - 0.4.5.2 The Experiment Logbook will record the test fixture inspection, bench checks, irradiation and post-irradiation operations.

0.5 IRRADIATION TESTS

0.5.1 General

0.5.1.1 Since irradiation tests will vary, it is not possible to provide procedures and analyses for all tests. Documents as listed below will be submitted to PBRF for approval for each irradiation test performed by Test Operations.

0.5.1.2 Irradiation tests will not be performed until the appropriate documents have been approved by PBRF.

0.5.2 Irradiation Test Documents

0.5.2.1 Preliminary Test Specification

0.5.2.2 Design Manual and Safety Analysis Supplement

0.5.2.3 Final Test Specification

0.5.2.4 Procedure 2.12 (Checkout of Experimental Readout Equipment) Supplement

0.5.2.5 Procedure 4.5 (Data Acquisition) Supplement

0.5.2.6 Procedure 5.4 (Experiment Parameters) Supplement

0.5.2.7 Procedure 7.4 (Unscheduled Shutdown - Experiment Requirements) Supplement

0.5.2.8 Procedure 8.11 (Experiment Abnormalities) Supplement

0.5.2.9 Procedure 9.2 (Hot Cell Examination) Supplement

0.5.2.10 Procedure 9.3 (Post-Irradiation Environmental Testing Facility Examination) Supplement

0.5.2.11 Procedure 9.4 (Disposition of Experiment Components) Supplement

0.5.3 Operations

0.5.3.1 Operations will be performed in accordance with
Procedure 4.5, Data Acquisition Supplement.

0.5.3.2 Qualified operators will be delineated in accordance
with Procedure 0.2, Operating Schedules.

0.5.4 Irradiation Test Listing

0.5.4.1 A listing of tests performed is included on the
following page.

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IRRADIATION TEST LIST

Number	Title	Cycle
*RE-4	Nuclear Heating Measurement	65S 65P 66S
*37/W407	Shield Materials	75P

*This experiment performed in accordance with 63-05R1 operating procedures.

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IRRADIATION TEST LIST

Number	Title	Cycle
*RE-4	Nuclear Heating Measurement	65S 65P 66S

*This experiment performed in accordance with 63-05R1 operating procedures.

0.6 SPECIAL OPERATIONS

0.6.1 General

- 0.6.1.1 On occasion special maintenance, testing or operational work will have to be performed by the Test Operation's staff. When this work includes operations not included in the Operations Manual, a special procedure will be prepared by Test Operations and submitted to the cognizant PBRF Project Engineer for approval prior to commencement of the work.
- 0.6.1.2 The special procedure will contain the following information:
 - 0.6.1.2.1 A brief description of the work to be accomplished.
 - 0.6.1.2.2 A listing of initial conditions to be met prior to commencement of any work. This will include any special permits required.
 - 0.6.1.2.3 A step-by-step account of the operation to be performed with sufficient detail to clarify each step.
- 0.6.1.3 Distribution of the special procedure will be in accordance with Procedure 0.1.
- 0.6.1.4 A listing of special operations procedures issued to date is included on the following page.

0.6.2 Special Operations Procedures Issued

0.6.2.1 HT-1 Insertion Machine - Quadrant C Installation

0.6.2.2 HT-1 Insertion Machine - ATS Pool Demonstration

0.6.2.3 HT-1 Seal, Flexible Joint, Spool and Gate Valve -
Quadrant C Installation

0.6.2.4 Quadrant C Operation Tests and Demonstration

0.7 EXPERIMENT OPERATOR QUALIFICATION

- 0.7.1 Since irradiation tests vary, operators assigned to perform the irradiation test will be qualified for operation.
- 0.7.2 The list of qualified operators shall be included with the operating schedule (Procedure 0.2) when submitted to PBRF.
- 0.7.3 Determination of qualification will be made by the Test Operation's Supervisor.
- 0.7.4 Qualification will be based on study of the documents listed on the following page and any additional requirements deemed necessary by the Test Operation's Supervisor.
- 0.7.5 A Qualification Sheet (see next page) will be completed by operators, as assigned, for each test.
- 0.7.6 The Qualification Sheet shall be signed by the Test Operation's Supervisor as evidence of qualification and retained in the Test Operation's office files.

EXPERIMENT OPERATOR QUALIFICATION SHEET

Document	Initial
Final Test Specification	_____
Procedure 2.12	_____
Procedure 4.5	_____
Procedure 5.4	_____
Procedure 7.4	_____
Procedure 8.10	_____
Procedure 9.2	_____
Procedure 9.3	_____
Procedure 9.4	_____

Completed by: _____

Date: _____

Qualified by: _____

Date: _____

Remarks:

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SECTION 1

EXPERIMENTAL EQUIPMENT AND OPERATING SUPPLIES

1.1 EXPERIMENTAL EQUIPMENT - RECEIPT, INSPECTION AND STORAGE

1.1.1 Receipt

- 1.1.1.1 Upon notification that a shipment of experimental equipment has arrived at the Plum Brook Station, notify the Experimental Equipment Supervisor.
- 1.1.1.2 Assist the carrier in delivering the equipment to the ATS receiving area.
- 1.1.1.3 Make the necessary acknowledgments on the carrier's paperwork. Obtain copies of all documents.

1.1.2 Inspection

- 1.1.2.1 Before removing the shipment from the carrier's vehicle, visually check the shipment for any signs of damage.
- 1.1.2.2 Note any damage on the carrier's paperwork.

1.1.3 Storage

- 1.1.3.1 Transfer the shipment to the WANL work area. If this is not possible, transfer the shipment to another area selected with the assistance of the Experimental Equipment Supervisor.
- 1.1.3.2 When equipment requiring special handling is shipped to PBRF from WANL, it will be adapted for rigging. PBRF will be given advance notice of special handling equipment needs as soon as practical. Any additional manpower, storage space, etc., will be requested from the PBRF Project Engineer by the Test Operation's Manager at least a week in advance.

1.2 TEST FIXTURE AND EXPERIMENTAL EQUIPMENT TESTING

1.2.1 Test Fixture

- 1.2.1.1 Check dimension shown on applicable WANL drawings against actual dimensions. Record any discrepancies.
- 1.2.1.2 Record the position and identification of each component, dosimeter and thermocouple in the Experiment Logbook.
- 1.2.1.3 Take resistance and insulation resistance measurements on the thermocouples.
- 1.2.1.3 Perform any other tests as required by the test specification.

1.2.2 Experimental Equipment

- 1.2.2.1 Perform any checkout and performance tests as required by the test specification.

1.2.3 Test Assembly

- 1.2.3.1 Connect all test leads to the readout instrumentation.
- 1.2.3.2 Obtain a set of data as required by the test specification.
- 1.2.3.3 Compare data to that taken prior to shipment as noted in the Experiment Logbook. Report any discrepancies to the Manager, Test Operations.

1.3 EXPERIMENTAL EQUIPMENT - TRANSFER TO CV

1.3.1 Experimental Readout Equipment

- 1.3.1.1 Obtain the Experimental Equipment Supervisor's permission to transfer readout equipment to the CV.
- 1.3.1.2 Using hand dollies or other handling equipment, transfer the readout equipment from the ATS building to the ROB.
- 1.3.1.3 Transfer to clean CV area.
 - 1.3.1.3.1 Place clean paper on the 0-0 floor level from the large door to the clean area.
 - 1.3.1.3.2 Using the handling equipment and the CV radial crane, if necessary, transfer the readout equipment to the clean area.
 - 1.3.1.3.3 Smear the handling equipment to insure freedom from contamination before returning it to the ATS building.
- 1.3.1.4 Transfer to contaminated CV area.
 - 1.3.1.4.1 Place clean paper on the 0-0 floor level inside the large door.
 - 1.3.1.4.2 Bring the readout equipment onto the papered area.
 - 1.3.1.4.3 Using the CV radial crane, transfer the equipment to the installation area.
 - 1.3.1.4.4 Smear any handling equipment used to insure freedom from contamination prior to returning it to a clean area.

1.3.2 Water-Cooled Test Fixture

- 1.3.2.1 Obtain the Experimental Equipment Supervisor's permission to transfer the test fixture to the CV.
- 1.3.2.2 Using handling equipment, if necessary, transfer the test fixture from the ATS building to the ROB.
- 1.3.2.3 Place the test fixture on the CV on 0-0 level inside the large door.
- 1.3.2.4 Transfer the test fixture to the WANL area using the CV radial crane, if necessary.

1.3.3 Cryogenic Test Fixture

1.3.3.1 Initial Conditions

- 1.3.3.1.1 The Hot Cave is prepared to accept the test fixture.
- 1.3.3.1.2 The test fixture is fitted with leads and necessary connectors to allow connection to the sample connector plate.
- 1.3.3.1.3 The closures for the transfer and removal tubes are closed and secured.
- 1.3.3.1.4 The Experimental Equipment Supervisor's permission has been obtained to carry out the test fixture transfer.

1.3.3.2 Transfer to Hot Cave

- 1.3.3.2.1 With continuous Health-Safety monitoring, open the Hot Cave doors. Acknowledge the door alarm.
- 1.3.3.2.2 Carry the test fixture into the Hot Cave and place it in a workable position on the work tray.

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- 1.3.3.2.3 Place all special tools necessary for
this experiment as described in the test
supplements, in the hot cave.
- 1.3.3.2.4 Close and secure the Hot Cave doors.

1.4 OPERATING SUPPLIES

- 1.4.1 Operating supplies are defined as gaseous nitrogen, liquid nitrogen and gaseous helium used for the operation of the W-1 System.
- 1.4.2 Operating supply requirements will be based on the projected operating schedule of the W-1 System, and a request for operating supplies will be submitted by the Manager, Test Operations to the PBRF Project Engineer one month in advance of the need.
- 1.4.3 Test Operations will be notified when the supplies are to be received, and receipt and handling will be in accordance with established PBRF procedures.
- 1.4.4 Storage of operating supplies will be in approved areas in accordance with established PBRF procedures.

1.5 GASES AND CRYOGENIC LIQUIDS - TRAILER INSTALLATION

1.5.1 Liquid Nitrogen Trailer

- 1.5.1.1 Insure that the instrument air regulator is set at 80 psig.
- 1.5.1.2 Connect the trailer hose upstream of X-132-N at the connection point.
- 1.5.1.3 Follow the instructions posted on the trailer door.
- 1.5.1.4 Open valve X-132-N.

CAUTION: Always wear protective face shield and gloves while performing operations with the LN₂ trailer.

1.5.2 Helium Make-up Trailer

- 1.5.2.1 Insure that the instrument air regulator is set at 80 psig.
- 1.5.2.2 Connect the trailer hose upstream of X-118-HH at the connection point.
- 1.5.2.3 Follow the instructions posted on the trailer door.
- 1.5.2.4 Open valve X-118-HH.

1.5.3 Helium Manifold L-101

- 1.5.3.1 Connect the GHe bottles upstream of X-120-HH1 and X-120-HH-2.
- 1.5.3.2 Open the GHe bottle valves.
- 1.5.3.3 Open valves X-120-HH1 and X-120-HH2.

1.6 SPARE PARTS CONTROL

1.6.1 Ordering

1.6.1.1 The initial ordering of spares will be in accordance with the recommended spare parts list supplied by the vendors of equipment. If a recommended spare parts list is not available from the respective vendors, or if the vendor's recommendations are not considered adequate, WANL will determine the number and parts required as spares.

1.6.1.2 Spares will be reordered when the inventory card for a particular part reflects the minimum inventory.

1.6.2 Receiving

1.6.2.1 Upon receipt of spares, each part will be identified and tagged in accordance with 1.6.3.1 below.

1.6.2.2 Upon initial receipt, an inventory card will be filled out to reflect part number, name, maximum and minimum inventory, category and designated storage area. The inventory card will be maintained in a card file in the Test Operation's office.

1.6.2.3 The inventory card will be updated as spares are received as a result of reordering.

1.6.3 Identifying

1.6.3.1 Parts will be identified primarily by part number and part name and tagged accordingly. Each part will be identified with the corresponding system and the identifying tag will also show the designated storage area.

1.6.4 Storing

1.6.4.1 The majority of spares, which are relatively small, will be stored in upright cabinets in the ATS Building.

1.6.4.2 Larger spares, which will not fit in the storage cabinets, will be stored in Building 2018.

1.6.5 Issuing

1.6.5.1 Draw a part from storage and remove the tag.

1.6.5.2 Fill out the reverse side of the tag to reflect the user's name, date, and where part is to be used.

1.6.5.3 Use the tag to update the card file.

1.6.5.4 If a minimum inventory is reflected on the inventory card after updating, the part will be reordered.

SECTION 2

PRE-START PROCEDURES

2.1 W2-3 SYSTEM PROCEDURE'S CHECKLIST

- 2.1.1 The procedures listed on the following page are to be completed in the order listed during the 24-hour period prior to reactor startup to insure that all phases of the water-cooled experiment are in readiness for operation.
- 2.1.2 The date and time are to be recorded with the initials of the technician completing each procedure in the list.
- 2.1.3 If a procedure is not applicable to the experiment, it will be so stated in the blank alongside the procedure.
- 2.1.4 When the checklist has been completed, it will be signed by the Test Operation's Supervisor and submitted to the Test Operation's Manager for review and file.
- 2.1.5 All checklists requiring signature will be included with this procedure when it is returned to the Test Operation's office.

W2-3 PROCEDURE CHECKLIST

Order	Number	Title	Date	Time	Initials
1	2.2	W2-3 System Valve Checklist	_____	_____	_____
2	2.3	Gas Pressurization System - HT-1 Insertion Machine Lower Dry Box	_____	_____	_____
3	2.4	Gas Pressurization System - HT-1 Insertion Machine Hardstop	_____	_____	_____
4	2.5	Pressurization System - HT-1 Insertion Machine Hydraulic Cylinders	_____	_____	_____
5	2.6	Gas Pressurization System - HT-1 Gate Valve Operator	_____	_____	_____
6	2.7	Gas Actuation System Pressure Test	_____	_____	_____
7	2.8	Equipment Continuity and Insulation Resistance Checks	_____	_____	_____
8	2.9	Checkout of HT-1 Insertion Machine Instrumentation and Control Systems	_____	_____	_____
9	2.10	Test Fixture Insertion into W2-3 Capsule	_____	_____	_____
10	2.11	W2-3 System Purge and Hydrostatic Test	_____	_____	_____
11	3.1	W2-3 Experiment Cooling System Startup	_____	_____	_____
12	2.12	Checkout of Experimental Readout Equipment	_____	_____	_____

W2-3 PROCEDURE CHECKLIST

Order	Number	Title	Date	Time	Initials
13	2.13	Checkout of W2-3 System Instrumentation	_____	_____	_____
14	3.6	Reactor Startup	_____	_____	_____

Approved by: _____

Date: _____ Time: _____

2.2 W2-3 SYSTEM VALVE CHECKLIST

2.2.1 Notify Experimental Equipment Supervisor that check is to be made and obtain his permission to perform valve manipulations.

2.2.2 Quadrant A Valves

PB29V01 open _____ PB15V31 open _____

PB15V33 closed _____ PB29V97 open _____

2.2.3 Quadrant C Valves

PC-V1 closed _____ PC-1V13 open _____

PC-V2 closed _____ PC-1V14 closed _____

PC-V4 open _____ PB15V40 open _____

EC-V2 closed _____ PV-4 closed _____

VD-V1 closed _____ PV-2 closed _____

VD-V3 closed _____ PB15V37 open _____

VD-V4 closed _____ PB20V67 closed _____

VD-V5 open _____ PB20V68 open _____

PV-1 closed _____ SP-V5 open _____

PV-3 closed _____ SP-V7 closed _____

PC-1V11 closed _____ SP-V4 closed _____

PC-1V12 open _____ 10-inch gate
valve closed _____

2.2.4 Test Corridor Valves

SP-V1 open	_____	SP-V10 open	_____
SP-V2 open	_____	SP-V11 closed	_____
SP-V9 closed	_____	SP-V12 open	_____

2.2.5 Sample Actuation Valves

SA-V1 closed	_____	SA-V2 closed	_____
SA-V3 closed	_____	SA-V9 closed	_____
SA-V5 closed to experiment	_____	SA-V101 open (if applicable)	_____
SA-V6 closed	_____	SA-V102 closed (if applicable)	_____

2.2.6 When completed this procedure will be signed by the technician completing the checklist and it will be submitted to the Test Operation's Supervisor.

Completed by: _____

Date: _____ Time: _____

2.3 GAS PRESSURIZATION SYSTEM - HT-1 INSERTION MACHINE LOWER DRY BOX

- 2.3.1 Adjust manifold regulator M2-REG-1 for a 150 psig setting.
- 2.3.2 Insure that one of the manifold valves M2-V-1, M2-V-2 or M2-V-3 is open.
- 2.3.3 Adjust regulator DB-REG-1 to 11 psig.
- 2.3.4 Insure that valves DB-V-1 and DB-V-2 are open.
- 2.3.5 Pressure indicator DB-PI-2 should indicate 11 psig.
- 2.3.6 Check that the float is visible on the flow indicator gage glass DB-GG-1.

2.4 GAS PRESSURIZATION SYSTEM - HT-1 INSERTION MACHINE HARDSTOPS

- 2.4.1 Adjust manifold regulator M2-REG-1 for a 150 psig setting.
- 2.4.2 Insure that one of the manifold valves, M2-V-1, M2-V-2 or M2-V-3, is open.
- 2.4.3 Adjust regulator HS-REG-1 to 150 psig.
- 2.4.4 Insure that bypass valves HS-V-2 and HS-VD-1 are closed and that valve HS-V-1 is open.
- 2.4.5 Pressure indicator HS-PI-2 should indicate 150 psig.

NOTE: When the hardstops are in the "up" position, solenoid valve HS-SOL-1 has the vent path direction closed. When the hardstops are in the "down" position, the solenoid valve HS-SOL-1 has the vent path direction opened.

2.5 PRESSURIZATION SYSTEM - HT-1 INSERTION MACHINE HYDRAULIC CYLINDERS

- 2.5.1 Check auxiliary reservoir gage glass HC-GG-1 to verify water supply. Also, verify that vent drain valve HC-VD-1 is closed.
- 2.5.2 Check that auxiliary reservoir valve HC-V-1 is open.
- 2.5.3 Verify that the main shutoff valve HC-V-3 and the hydraulic cylinder valves HC-V-4 and HC-V-5 are opened.
- 2.5.4 Close the pump control valve HC-V-2 and pump the hand pump until the desired pressure is indicated on HC-PI-1.

2.6 GAS PRESSURIZATION SYSTEM - HT-1 GATE VALVE OPERATOR

- 2.6.1 Adjust gas bottle regulator M1-REG-1 for a 50 psig setting.
- 2.6.2 Insure that either of the manifold valves M1-V-1 or M1-V-2 is open.
- 2.6.3 Adjust regulator EIM-REG-1 to 10 psig.
- 2.6.4 Insure that valve EIM-V-1 is in the open position.
- 2.6.5 Pressure indicator EIM-PI-2 should indicate 10 psig.

2.7 GAS ACTUATION SYSTEM PRESSURE TEST

2.7.1 Locate the test fixture on the 0-0 level adjacent to Quadrant C and connect the flexible gas hose between it and the gas supply system.

2.7.2 Establish the valving indicated below in the gas system.

SA-V1 open SA-V5 "Actuate"

SA-V2 closed SA-V6 closed

SA-V3 open SA-V7 closed

SA-V4 closed (relief 400 psig) SA-V101 closed (if used)

SA-V8 set at 150 psig SA-V102 open (if used)

SA-V9 closed SA-V11 closed

SA-V10 open SA-V12 closed

Gas bottle supply valve
closed SA-V13 closed

Gas bottle regulating valve
closed

NOTE: Evacuate only if the test specification permits; if evacuation not permitted, purge by using Procedures 2.7.4 and 2.7.5.

2.7.3 Close SA-V101, open SA-V2, and evacuate system to 28 inches Hg. through SA-V2. Close SA-V2.

2.7.4 Pressurize accumulator by turning SA-V5 to "Fill", opening bottle supply valve and adjusting bottle regulating valve to give a pressure which will be determined in 4.5, Data Acquisition. Close SA-V1 and turn SA-V5 to "Actuate".

2.7.5 Slowly open SA-V1. Open SA-V9, SA-V7 and SA-V101 and pressurize system to a pressure which will be determined in 4.5 by continual manipulation of SA-V5 and SA-V1.

- 2.7.6 Observe pressure changes for five (5) minutes and make certain it is less than 8 psi. If the drop exceeds 8 psi, find and repair leaks.
- 2.7.7 Open SA-V6, close SA-V3 and SA-V102.

2.8 EQUIPMENT CONTINUITY AND INSULATION RESISTANCE CHECKS

2.8.1 Initial Conditions

- 2.8.1.1 Breaker No. 2, No. 4 and No. 6 on power panel CV-E1 open.
- 2.8.1.2 Valve drive motor line switch S11 open.
- 2.8.1.3 Seal pump drive motor line switch S18 open.
- 2.8.1.4 Insertion machine drive motor line switch S10 open.
- 2.8.1.5 Console power supply switch SCB3 open.
- 2.8.1.6 Console power motor heater supply switch SCB6 open.

2.8.2 Valve Drive Motor

- 2.8.2.1 Motor leads of K-9 contacts T1, T2 and T3. ____ Meg.
- 2.8.2.2 Line leads of K-9 contacts. ____ Meg.
- 2.8.2.3 Motor controller wire No. 50. ____ Meg.
- 2.8.2.4 Motor controller wire No. 51. ____ Meg.

2.8.3 Seal Pump Drive Motor

- 2.8.3.1 Motor leads of K-14 contacts T1, T2 and T3. ____ Meg.
- 2.8.3.2 Line leads of K-14 contacts. ____ Meg.
- 2.8.3.3 Motor Controller wire No. 73. ____ Meg.
- 2.8.3.4 Motor Controller wire No. 74. ____ Meg.

2.8.4 Insertion Machine Drive Motor

- 2.8.4.1 Motor side of K-1 contacts T1, T2 and T3. ____ Meg.

2.8.4.2 Line side of K-1 contacts. ____ Meg.

2.8.4.3 Relay panel wire No. 2 on TB1-1. ____ Meg.

2.8.5 Final Conditions

2.8.5.1 Breakers No. 2, No. 4 and No. 6 on power panel
CV-E1 closed.

2.8.5.2 Valve drive motor line switch S11 closed.

2.8.5.3 Seal pump drive motor line switch S18 closed.

2.8.5.4 Insertion machine drive motor line switch S10 closed.

2.8.5.5 Console power supply switch SCB3 closed.

2.8.5.6 Console power motor heater supply switch SCB6 closed.

2.8.6 When completed, this procedure will be signed by the technician
completing the checklist and it will be submitted to the Test Operation's
Supervisor.

Completed by: _____

Date: _____ Time: _____

2.9 CHECKOUT OF HT-1 INSERTION MACHINE INSTRUMENTATION AND CONTROL SYSTEMS

2.9.1 Instrumentation and Safety Systems Checkout

2.9.1.1 Logic Chassis

- 2.9.1.1.1 Energize the instrumentation racks by placing the main power switch in the On position.
- 2.9.1.1.2 Energize the logic chassis by depressing the Power On pushbutton.
- 2.9.1.1.3 Depress the Oper-Cal pushbutton to Calibrate position.
- 2.9.1.1.4 Observe that the Oper-Cal pushbutton indicates Cal, that the Insert-W/draw pushbutton is energized, and the nixie displays read as follows:
 - a. Δ RPM reads -62
 - b. RPM reads 0062
- 2.9.1.1.5 Set the Δ RPM trip thumbwheels to 64 and note that the Clutch Slip indicator is de-energized.
- 2.9.1.1.6 Set the Δ RPM trip thumbwheels to 63 and note that the Clutch Slip indicator energizes.
- 2.9.1.1.7 Depress the Insert-W/draw pushbutton to the Insert position. Observe that the Insert-W/draw pushbutton indicates Insert.

NOTE: The Insert-W/draw pushbutton does not supply control to the insertion machine. It supplies a false insert or withdraw signal to the logic chassis in Cal position and therefore will not cause the carriage to move.

- 2.9.1.1.8 Turn the Var. Output pot of Channel A of the thrust demodulator in the clock-wise direction and observe that the low and high trip lights for Channel A energize.

NOTE: The thrust demodulator is used as a signal generator to check the operation of the trips in the logic chassis.

- 2.9.1.1.9 Turn the Var. Output pot of Channel B of the thrust demodulator in the clock-wise direction and observe that the low and high trip lights for Channel B energize.

- 2.9.1.1.10 Depress the Insert-W/draw pushbutton to the W/draw position. Observe that the Insert-W/draw pushbutton indicates W/draw.

- 2.9.1.1.11 Repeat 2.9.1.1.8 and 2.9.1.1.9 above, but turning the Var. Output in the counterclockwise direction.

- 2.9.1.1.12 Depress the Oper-Cal pushbutton to Oper position. Observe that the Oper-Cal pushbutton indicates Oper, that the Insert-W/draw pushbutton is de-energized, and that all numerical nixie displays on the logic chassis indicate zero.

2.9.2 Thrust Demodulator

- 2.9.2.1 Depress the Oper-Cal pushbutton to the Cal position.
- 2.9.2.2 Observe that the Oper-Cal pushbutton indicates Cal.
- 2.9.2.3 Place the Cal Level switch to the zero position.
- 2.9.2.4 Observe zero position on Channel A and Channel B meters.
- 2.9.2.5 Rotate the Cal Level switch in the plus direction, steps 1 to 5, and observe that Channel A and Channel B meters deflect to the right progressively with each step.
- 2.9.2.6 Rotate the Cal Level switch in the minus direction, steps 1 to 5, and observe that Channel A and Channel B meters deflect to the left progressively with each step.
- 2.9.2.7 Return the Cal Level switch to zero.
- 2.9.2.8 Depress the Oper-Cal pushbutton to the Oper position.
- 2.9.2.9 Observe that the Oper-Cal pushbutton indicates Oper.

2.9.3 Skew Demodulator

- 2.9.3.1 Repeat 2.9.2 above.

2.9.4 Capsule Alignment Calibration

- 2.9.4.1 Place the Oper-Cal pushbutton to the Cal position. Observe that the Oper-Cal pushbutton indicates Cal and that the V Adj-Zero pushbutton energizes.
- 2.9.4.2 Place the V Adj-Zero pushbutton to the zero position.
- 2.9.4.3 Observe zero deflection (X and Y) on the oscilloscope. If any deflection is noted, set dot to center by varying the horizontal and vertical adjustments on the oscilloscope.

- 2.9.4.4 Place the V Adj-Zero pushbutton to the V Adj position.
- 2.9.4.5 Place the DVM Select switch to the $X^2 + Y^2$ position.
- 2.9.4.6 Turn the V Adj pot clockwise and observe that the Align Error indicator energizes.
- 2.9.4.7 Observe trip voltage (5.96 ± 50 mv.) on the DVM.
- 2.9.4.8 Place the DVM Select switch to the X position.
- 2.9.4.9 Remove the Y input from the oscilloscope.
- 2.9.4.10 Place the Skew Demodulator in the Cal position.
- 2.9.4.11 Place the Capsule Alignment Calibration Chassis in the Oper position.
- 2.9.4.12 Turn the Cal Level switch of the Skew Demodulator clockwise until the DVM reads 2.95 volts $\pm$ 50 mv. Observe X deflection of the dot to the right (oscilloscope horizontal deflection should be adjusted to correspond to 2 volts/circule).
- 2.9.4.13 Return the Cal Level switch to zero position.
- 2.9.4.14 Replace the Y input to the oscilloscope.
- 2.9.4.15 Place the DVM Select switch to the Y position.
- 2.9.4.16 Remove the X input from the oscilloscope.
- 2.9.4.17 Turn the Cal Level switch of the Skew Demodulator clockwise until the DVM reads 3.54 volts $\pm$ 50 mv.
- 2.9.4.18 Observe Y deflection of the dot upwards (oscilloscope vertical deflection should be adjusted to correspond to 2 volts/circle).
- 2.9.4.19 Return the Cal Level switch to zero position.

2.9.4.20 Replace the X input to the oscilloscope.

2.9.4.21 Place the Oper-Cal pushbutton of the Skew Demodulator to the Oper position. Observe that the Oper-Cal pushbutton indicates Oper.

2.9.5 Thrust Limiting System Calibration

2.9.5.1 Initial Conditions

2.9.5.1.1 Turn the Control Power keylock switch on the console to the On position.

2.9.5.1.2 Verify that the Mechanical Stop switch is in the Down position.

2.9.5.1.3 Set the clutch current at the values specified in Procedure 5.3.

2.9.5.1.4 Depress the Capsule Insert button.

2.9.5.1.5 When the Capsule Position Indicator reads 136 inches, depress the Capsule Stop button.

2.9.5.1.6 Verify that HC-V-3, HC-V-4 and HC-V-5 on the Calibrating System panel are open.

2.9.5.1.7 De-energize the Insertion Machine drive motor 440 VAC power.

2.9.5.2 Pressure Insert Low Trip

2.9.5.2.1 Depress the Capsule Insert button.

2.9.5.2.2 Using the hand pump, pressurize the Calibration System to approximately 360 psig.

2.9.5.2.3 Verify the thrust trip at 2800 to 3200 pounds.

2.9.5.2.4 Depress the Capsule Stop button.

2.9.5.3 Pressure Insert High Trip

2.9.5.3.1 Install a jumper between wire 139 (K12-4) and wire 35 (TB1-7) on the relay rack. This will simulate normal HT-1 pressure.

2.9.5.3.2 Install a jumper between wire 139 (K12-4) and wire 78 (TB6-10) on the relay rack. This will simulate gate valve open.

2.9.5.3.3 Depress the Capsule Insert button.

2.9.5.3.4 Using the hand pump, increase the Calibration System pressure to approximately 1355 psig.

2.9.5.3.5 Verify thrust trip at 11,800 to 12,300 pounds.

2.9.5.3.6 Depress the Capsule Stop button.

2.9.5.4 Pressure Withdrawal Trip

2.9.5.4.1 Depress the Capsule Withdraw button.

2.9.5.4.2 Gradually relieve the Calibration System pressure until the Thrust Limiting System trips.

2.9.5.4.3 Verify thrust trip at 5800 to 6200 pounds.

2.9.5.4.4 Depress the Capsule Stop button.

2.9.5.5

Final Conditions

- 2.9.5.5.1 Remove the jumpers installed in 2.9.5.3 above.
- 2.9.5.5.2 Energize the Insertion Machine drive motor 440 VAC power.
- 2.9.5.5.3 Relieve the Calibration System pressure.
- 2.9.5.5.4 Depress the Capsule Withdraw button.
- 2.9.5.5.5 Verify that the carriage has stopped when it reaches the fully withdrawn position.

2.10 TEST FIXTURE INSERTION INTO W2-3 CAPSULE

2.10.1 Initial Conditions

- 2.10.1.1 Notify Experimental Equipment Supervisor and obtain his permission to initiate installation.
- 2.10.1.2 Procedures 2.8 and 2.9 complete.

2.10.2 Capsule Insertion

- 2.10.2.1 Turn hardstop switch to Down position (Full Down light will energize and Full Up light will de-energize).
- 2.10.2.2 Open PV-3.
- 2.10.2.3 Depress Insert button (Insert light will energize and Fully Withdrawn light will de-energize). Capsule will drive forward to Seal Position and stop automatically (Seal Position light will energize and Insert light will de-energize).
- 2.10.2.4 Open PV-2 for approximately one (1) minute.
- 2.10.2.5 Close PV-2 and PV-3.
- 2.10.2.6 Open PV-4.
- 2.10.2.7 Start seal pump by depressing pump start button. Check that seal pump light is On.
- 2.10.2.8 Open SP-V4.
- 2.10.2.9 Monitor leakage for one (1) minute and close SP-V4.
- 2.10.2.10 Stop seal pump by depressing pump stop button.
- 2.10.2.11 Turn hardstop switch to Up position (Full Up light will energize and Full Down light will de-energize).

- 2.10.2.12 Maintain contact with RCR while performing steps 2.10.2.13 through 2.10.2.15.
- 2.10.2.13 Depress Valve Open button (Valve Not Fully Open light will energize and Valve Closed light will de-energize). Valve Open light will energize and Valve Not Fully Open light will de-energize when valve is fully open.
- 2.10.2.14 Depress Insert button (Insert light will energize and Seal Position light will de-energize).
- 2.10.2.15 Depress Stop button when the capsule position indicates 60 inches (Insert light will de-energize).
- 2.10.2.16 Start seal pump by depressing pump stop button. Check that seal pump light is On.
- 2.10.2.17 Open SP-V4.
- 2.10.3 Test Fixture Insertion
 - 2.10.3.1 Lower sample fixture into quadrant.
 - 2.10.3.2 Slowly slide sample fixture into capsule by using the rope and pulley system.
 - 2.10.3.3 Close the Marman clamp to the test fixture.
- 2.10.4 Capsule Withdrawal
 - 2.10.4.1 Close SP-V4.
 - 2.10.4.2 Stop seal pump by depressing pump stop button.
 - 2.10.4.3 Maintain contact with RCR while performing steps 2.10.4.4 through 2.10.4.5.
 - 2.10.4.4 Depress Withdraw button (Withdraw light will energize).

- 2.10.4.5 Withdraw capsule to Seal Position (Seal Position light will energize and Withdraw light will de-energize). The capsule will stop automatically.
- 2.10.4.6 Depress Valve Close button (Valve Open light will de-energize and Valve Not Fully Closed light will energize). Valve Closed light will energize and Valve Not Fully Closed light will de-energize when 10-inch gate valve is fully closed.
- 2.10.4.7 Close PV-4.

NOTE: If experiment is not to be irradiated immediately, complete this procedure. If experiment is to be irradiated immediately, refer to Procedure 2.1 and continue the checklist.
- 2.10.4.8 Open PV-2 and PV-3 for approximately one (1) minute.
- 2.10.4.9 Close PV-3.
- 2.10.4.10 Turn hardstop switch to Down position (Full Down light will energize).
- 2.10.4.11 Retract the capsule by depressing the Withdraw button (Withdraw light will energize and Seal Position light will de-energize).
- 2.10.4.12 Close PV-2 when the capsule nose is out of seal but not fully withdrawn. When capsule reaches the fully withdrawn position, it stops automatically. Withdraw light will de-energize and the Fully Withdrawn light will energize.

2.11 W2-3 SYSTEM PURGE AND HYDROSTATIC TEST

- 2.11.1 Open VD-V1.
- 2.11.2 Open PV-1, VD-V3 and VD-V4 for approximately six (6) minutes.
- 2.11.3 After approximately six (6) minutes, close VD-V3 and VD-V4.
- 2.11.4 Vent pressure gage by opening PC-1V14. Close PC-1V14.
- 2.11.5 Close VD-V1 and PV-1.
- 2.11.6 Start seal pump by pressing start button. Check seal pump light is On.
- 2.11.7 Open SP-V7 momentarily.
- 2.11.8 Close SP-V7 and monitor pressure drop at PI-1 for fifteen (15) minutes and make certain it is less than 10 psi. If the drop exceeds 10 psi, find and repair the leaks if possible. Report results to Experimental Equipment Supervisor and record in system log book.
- 2.11.9 Open VD-V1 to vent pressure from capsule and then close.
- 2.11.10 Secure seal pump by pressing the pump stop button. Check that the seal pump Off light is On and the seal pump On light is Off.

2.12 CHECKOUT OF EXPERIMENTAL READOUT EQUIPMENT

- 2.12.1 Experimental readout equipment will be checked in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for checkout procedure.

2.13 CHECKOUT OF W2-3 SYSTEM INSTRUMENTATION

2.13.1 Initial Conditions

2.13.1.1 Notify the Experimental Equipment Supervisor and obtain his permission to initiate the checks.

2.13.1.2 Instruments and control panels in XCR and CV energized, including multipoint recorder amplifier and chart drive.

2.13.2 Fuse and Lamp Test Check

2.13.2.1 Check that fuse panel Power Available lights are On in XCR and CV.

2.13.2.2 Check Scam Annunciator in XCR and CV by pressing test button and making certain that lights on all channels are energized.

2.13.3 Meter Relay Alarm Check

2.13.3.1 Establish contact with Westinghouse operator and PBRF XO, move setpoints to existing meter readings, and verify that an alarm signal is produced and subsequently cleared, both on the local Scam unit and in the CV.

2.13.3.2 Following the test, return the pointers to the correct values.

2.13.4 Multipoint Recorder Alarm Check

2.13.4.1 Manually turn the pen drive linkage to drive indicator upscale to 250°F. Make certain that alarm (TA-1) is produced at 250°F $\pm$ 5°F and subsequently cleared, both locally and in CV.

2.13.5 Flow Alarm Check

2.13.5.1 Verify that PBRF has performed this check.

2.14 W-1 SYSTEM PROCEDURES CHECKLIST

- 2.14.1 The procedures listed on the following page are to be completed in the order listed during the 24-hour period prior to reactor startup to insure that all phases of the cryogenic experiment are in readiness for operation.
- 2.14.2 The date and time are to be recorded with the initials of the technician completing each procedure in the list.
- 2.14.3 The checklist will be used to startup the cryogenic system. If the system is to be operated independently from the experiment, and if a procedure is not applicable to an experiment, those procedures which are not applicable will be marked as such in the blank alongside the procedure.
- 2.14.4 When the checklist has been completed, it will be signed by the Test Operation's Supervisor and submitted to the Test Operation's Manager for review and file.
- 2.14.5 All checklists requiring signature will be included with the checklist when it is returned to the Test Operation's office.

W-1 PROCEDURE CHECKLIST

Order	Number	Title	Date	Time	Initials
1	2.15	W-1 System Valve Checklist	_____	_____	_____
2	2.16	Checkout of W-1 System Instru- mentation and Controls	_____	_____	_____
3	1.5	Gases and Cryogenic Liquids - Trailer Installation	_____	_____	_____
4	2.17	W-1 System Helium Purity Check	_____	_____	_____
5	4.6	Gel Trap Regeneration	_____	_____	_____
6	3.2	W-1 System Compressor Startup	_____	_____	_____
7	3.3	W-1 System Liquid Nitrogen Startup	_____	_____	_____
8	3.4	W-1 System Gas Flow Initiation	_____	_____	_____
9	3.5	W-1 System Expander Startup	_____	_____	_____
10	4.7	W-1 System Cooldown	_____	_____	_____
11	2.18	Test Fixture Insertion Into W-1 Capsule	_____	_____	_____
12	2.19	W-1 Capsule Evacuation and Helium Fill	_____	_____	_____
13	4.9	W-1 Capsule Cooldown	_____	_____	_____
14	2.20	W-1 Capsule Transfer from Hot Cave to HT-1 Insertion Machine	_____	_____	_____

W-1 PROCEDURE CHECKLIST

Order	Number	Title	Date	Time	Initials
15	2.3	Gas Pressurization System - HT-1 Insertion Machine Lower Dry Box	_____	_____	_____
16	2.4	Gas Pressurization System - HT-1 Insertion Machine Hardstop	_____	_____	_____
17	2.5	Gas Pressurization System - HT-1 Insertion Machine Hydraulic Cylinders	_____	_____	_____
18	2.6	Gas Pressurization System - HT-1 Gate Valve Operator	_____	_____	_____
19	2.7	Gas Actuation System Pressure Test	_____	_____	_____
20	2.8	Equipment Continuity and Insulation Resistance Checks	_____	_____	_____
21	2.9	Checkout of HT-1 Insertion Machine Instrumentation and Control Systems	_____	_____	_____
22	2.12	Checkout of Experimental Readout Equipment	_____	_____	_____
23	3.6	Reactor Startup	_____	_____	_____

Approved by: _____

Date: _____ Time: _____

2.15 W-1 SYSTEM VALVE CHECKLIST

2.15.1 All manual valves will be in the closed position except those instrument isolation valves which are asterisked. These valves will be opened.

2.15.2 Compressor J-101

2.15.2.1 Manual Valves

* 1.	P-101-HH-3	_____	* 14.	SV-101-HH-6	_____	
* 2.	P-101-HH-1	_____	* 15.	SV-101-HH-7	_____	
	3.	B-101-HH-1	_____	* 16.	SV-101-HH-8	_____
	4.	B-101-HH-2	_____	* 17.	P-101-HH-5	_____
* 5.	P-113-HL-2	_____	* 18.	P-101-LU-5	_____	
	6.	B-101-HH-3	_____	* 19.	P-101-LU-6	_____
* 7.	P-101-HH-2	_____	* 20.	P-101-LU-4	_____	
	8.	X-113-HL-2	_____	* 21.	P-101-HH-9	_____
	9.	V-113-HL	_____	* 22.	P-101-HH-10	_____
* 10.	P-113-HL-1	_____	* 23.	P-101-HH-11	_____	
* 11.	L-113-HL	_____	* 24.	P-101-HH-12	_____	
* 12.	H-113-HL	_____	* 25.	P-101-HH-13	_____	
* 13.	SV-113-HL-3	_____	* 26.	P-101-HH-14	_____	
		_____	* 27.	C-101-LU-5	_____	

2.15.2.2 Drain Valves

1.	D-101-HH-1	_____
2.	D-101-HH-2	_____
3.	D-101-HH-3	_____
4.	D-101-LU-6	_____

2.15.3 Compressor Cooling Water

2.15.3.1 Manual Valves

* 1.	P-100-WS	_____	10.	X-100-WS-6	_____
* 2.	L-101-WS	_____	11.	X-100-WS-2	_____
* 3.	H-101-WS	_____	12.	X-100-WR-2	_____
4.	X-100-WR-3	_____	13.	X-100-WS-1	_____

- 5. X-100-WR-4 _____
- 6. X-100-WR-6 _____
- 7. X-100-WS-3 _____
- 8. X-100-WS-4 _____
- 9. X-100-WS-7 _____

- 14. X-100-WR-1 _____
- 15. D-100-WS _____
- 16. D-100-WR _____
- 17. X-100-WR-5 _____
- 18. X-100-WS-5 _____

2.15.4 Oil Trap G-101

2.15.4.1 Drain Valve

- 1. D-101-HH-4 _____

2.15.5 Filter G-106

2.15.5.1 Manual Valve

- 1. X-102-HH-1 _____

2.15.6 Surge Drum F-101

2.15.6.1 Manual Valves

- * 1. P-101-HH-4 _____
- * 2. P-103-HH _____
- * 3. P-121-HL _____
- 4. X-117-HH _____

- * 5. P-119-HH _____
- 6. X-121-HL _____
- * 7. P-116-HL _____

2.15.6.2 Drain Valve

- 1. D-101-HH-5 _____

2.15.7 Emergency Manifold L-101 and Helium-Nitrogen Supply

2.15.7.1 Check Safety Chains in Place

2.15.7.2 Manual Valves

1. X-120-HH-1	_____	* 6. P-118-HH-1	_____
2. X-120-HH-2	_____	* 7. P-118-HH-2	_____
* 3. P-120-HH-1	_____	8. X-118-HH	_____
* 4. P-120-HH-2	_____	9. X-132-N	_____
* 5. P-120-HH-3	_____	* 10. P-117-HH	_____

2.15.8 Cold Box L-102

2.15.8.1 Check to Insure Rupture Disc Is Not Bolted Down

2.15.8.2 Check Vacuum Level of Insulation Space Is Less Than 500 Microns

2.15.8.3 Manual Valves

1. X-102-HH-2	_____	12. C-122-T	_____
* 2. P-102-HH	_____	13. C-123-T	_____
3. B-115-HL	_____	14. B-124-HH	_____
4. C-102-HH	_____	15. V-128-T	_____
5. C-106-HH	_____	16. C-128-T	_____
6. C-107-HH	_____	17. C-129-T	_____
* 7. P-111-HL	_____	18. D-112-HL	_____
8. X-113-HL-1	_____	19. D-114-HH	_____
9. NL-102-L	_____	20. C-102-2-HD	_____
10. NL-102-H	_____	21. C-102-2-LD	_____
11. D-107-HH	_____	22. C-102-4D	_____
		23. C-102-4D-1	_____

2.15.9 Filter G-107

2.15.9.1 Manual Valves

1. X-107-VAC _____

2.15.10 Expander J-102

2.15.10.1 Manual Valves

* 1.	P-108-HH	_____	* 6.	L-131-HL	_____
2.	C-130-T	_____	7.	X-99-WS	_____
3.	C-131-HL	_____	8.	X-99-WR	_____
* 4.	P-130-HL	_____	* 9.	P-102-LU-1	_____
* 5.	H-131-HL	_____	10.	X-102-VAC	_____

2.15.11 Filter G-103

2.15.11.1 Manual Valves

1.	X-103-VAC	_____
* 2.	L-109-HL	_____
3.	P-103-HL	_____
* 4.	H-109-HL	_____

2.15.12 Thaw Blower J-103

2.15.12.1 Manual Valves

1.	B-126-T	_____	5.	C-131-T	_____
2.	C-126-T-1	_____	6.	C-124-T-1	_____
* 3.	P-126-T	_____	7.	C-126-T-2	_____
* 4.	P-123-T	_____	8.	C-127-T	_____

Check Belt Tension

2.15.13 Thaw Heater C-103

2.15.13.1 Manual Valves

1.	C-124-T-2	_____

2.15.14 Hot Cave

2.15.14.1 Manual Valves

1. X-139-VAC	_____	* 5. H-105-XA	_____
2. X-137-VAC	_____	* 6. L-105-XA	_____
3. D-142-W	_____	* 7. L-104-XA	_____
4. D-141-W	_____	8. D-143-W	_____

2.15.14.2 Vent Valves

1. P-137-VAC	_____
2. P-139-VAC	_____

2.15.15 Cold Box Vacuum Pump J-104

2.15.15.1 Manual Valves

1. P-138-VAC	_____
2. X-138-VAC	_____

Check Belt Tension

2.15.16 Capsule Vacuum Pump J-105

2.15.16.1 Manual Valves

1. P-140-VAC	_____
2. X-140-VAC	_____

Check Belt Tension

2.15.17 Air Dryer L-103

2.15.17.1 Manual Valves

1. IA-2	_____

2.15.18 Miscellaneous Valves

2.15.18.1 Manual Valves

1.	X-105-XA	_____	6.	X-109-VAC-2	_____
* 2.	H-110-HL	_____	7.	X-110-VAC-1	_____
* 3.	L-110-HL	_____	8.	X-110-VAC-2	_____
4.	X-140-VAC-1	_____	9.	X-201-VAC	_____
5.	X-109-VAC-1	_____	10.	X-202-VAC	_____

2.15.19 Vacuum Jacketed Piping

NOTE: Vacuum level in insulation space should be less than 1000 microns at ambient conditions and less than 10 microns after cooldown.

MK	No.	Ambient	After Cooldown
	3.		
	4.		
	5.		
	6.		
	7.		
	8.		
	11.		
	12.		
	13.		
	14.		
	15.		
	17.		
	18.		
	19.		
	20.		
	21.		
	22.		
	23.		
	24.		
	25.		
	26.		
	27.

NOTE: Those MK pipe numbers listed on the preceding page are those equipped with vacuum probes. Pipe numbers 1, 2, 9 and 10 are located in the reactor pool area and can be checked for vacuum level only when the pool is dry using the 1/8 inch P.S. probe shutoff valves.

- 2.15.20 When completed, this procedure will be signed by the technician completing the checklist and it will be submitted to the Test Operation's Supervisor.

Completed by: _____

Date: _____ Time: _____

2.16 CHECKOUT OF W-1 SYSTEM INSTRUMENTATION AND CONTROLS

2.16.1 Initial Conditions

2.16.1.1 All starting controls must be positioned as follows so that energizing a control circuit will not start a device:

1. MS-101-1 Compressor Motor STOP
2. MS-101 Compressor Oil Pump STOP
3. MLA Compressor MG STOP
4. MS-102-2 Expander Motor STOP
5. MS-102 Expander Lube Oil Pump STOP
6. MS-103 Thaw Blower Motor STOP
7. MS-105 Capsule Vacuum Pump Motor STOP
8. MS-104 Cold Box Vacuum Pump Motor STOP
9. MS-106 Hot Cave Exhaust Fan Motor STOP
10. MS-120 Emergency Flow OFF

2.16.2 4,160 Volt Feeder Cubicle

2.16.2.1 Energize disconnect circuit breaker to apply power to 225 KVA power unit and compressor motor controller.

2.16.3 Compressor Motor Starter

2.16.3.1 Move draw out mechanism handle to UP position which energizes the 104 amp fused disconnect for power to the motor control circuit and main line contactor.

2.16.4 225 KVA Power Unit

- 2.16.4.1 Energize 45 amp fused disconnect to power 4160/480
volt transformer.
- 2.16.4.2 Energize 250 amp circuit breaker to power the
Reactor Building MCC.
- 2.16.4.3 Energize 125 amp circuit breaker to power the
Compressor Building MCC.

2.16.5 Reactor Building MCC

- 2.16.5.1 Energize 40 amp circuit breaker to power 30 KVA
transformer to power Panel P-1.
- 2.16.5.2 Energize 5 amp circuit breaker for the expander
lube oil pump.
- 2.16.5.3 Energize 50 amp circuit breaker to power 25 KW
heater circuit (see Procedure 4.7.4).
- 2.16.5.4 Energize 50 amp circuit breaker for thaw blower
(J-103) circuit.
- 2.16.5.5 Energize 30 amp circuit breaker for thaw heater
(C-103) circuit.
- 2.16.5.6 Energize 100 amp circuit breaker to power the
expander starting circuit.

2.16.6 Compressor Building MCC

- 2.16.6.1 Energize 5 amp circuit breaker for compressor seal
oil pump.
- 2.16.6.2 Energize 50 amp circuit breaker for compressor
exciter.

2.16.6.3 Energize 30 amp circuit breaker to energize (480/280V 10 KVA) transformer for lighting panel.

2.16.7 Power Panel GP-1

2.16.7.1 Turn handwheels on valves AV-109, AV-110, AV-124, AV-126 and AV-137 full clockwise.

2.16.7.2 Set MC-148 to 15 psig.

2.16.7.3 Energize circuit breaker 6 to power the emergency helium supply system, and the containment isolation circuits AV-120 and AV-149 will close.

NOTE: Check that containment alarm clears (RCR panel). Open contacts will close capsule isolation valves AV-109, AV-124, AV-126, AV-137, AV-110, and open FCV-148 preventing flow through the capsule. Open contacts will open valves AV-120 and AV-149.

2.16.8 Power Panel P-1

2.16.8.1 If temperature conditions require, energize circuit breakers 1, 3, 5, 7 and 9 to start water pipe tracing heaters.

2.16.8.2 Set MC-130 at 0 psig. PCV-130 is now on automatic control. When the expander is started and downstream pressure begins to increase, PC-130 will begin to close PCV-130. Energize circuit breaker 4 to power the expander bypass valve (PCV-130) circuit.

2.16.8.3 Check that circuit breaker 6 is energized to power instrument air dryer circuit.

2.16.8.4 Check that circuit breakers 13 and 11 are energized, if required, to check the cold box vacuum pump (J-104) circuit and capsule vacuum pump (J-105) circuit.

- 2.16.8.5 Energize circuit breaker 17 to power the HT-1 panel service power.
- 2.16.8.6 Energize circuit breaker 19 to power the HT-1 panel lighting circuit.
- 2.16.8.7 Energize circuit breaker 2 for panel Y-3 service power.
- 2.16.8.8 Energize circuit breaker 8 for panel Y-3 heater monitors.
- 2.16.9 Lighting Panel L-1
 - 2.16.9.1 Energize as desired Compressor Building lighting, breakers 1, 2 and 3 receptacles, breaker 4 and heater circuit and breakers 9 and 10.
 - 2.16.9.2 Energize circuit breakers 6, 7 and 8 to power Compressor Building rooftop ventilating fans.
 - 2.16.9.3 Energize circuit breakers 11 and 12 to provide instrument power and service power to the Y-4 panel.
- 2.16.10 Distribution Panel MCC-E2
 - 2.16.10.1 Energize circuit breakers 7A and 7C to power process instruments and instrument power strips in HT-1 panel.
 - 2.16.10.2 Energize circuit breaker 8C to power Y-2 panel instruments.
 - 2.16.10.3 Energize circuit breaker 7B to power the HT-1 panel alarm modules.

NOTE: Energizing circuit breaker 7B at the distribution panel will actuate HT-1 panel annunciator system. Each abnormal condition is indicated by a flashing bright white light and a steady red light at the panel. The alarm horn will also sound.

Press Acknowledge pushbutton PB-2A and PB-2C to acknowledge alarms. Horn will be silenced, red light will go out, white light will stop flashing but remain brightly lighted until the abnormal condition is corrected. The white light will then be dimly lighted, indicating normal condition.

If the abnormal condition is corrected before an Acknowledge pushbutton is pressed, the white light will be dim but the red light horn will be on.

Press Acknowledge pushbutton to return the annunciator to its normal indicating condition (white light dimly lighted, red light and horn off).

2.16.11 Instrumentation Valves

2.16.11.1 Check all instrumentation valves and set them to provide the necessary signals to the instruments in accordance with the sketches in Section 11.6.

2.16.12 Instrumentation Set Points

2.16.12.1 Verify that the instrumentation set points are set in accordance with the valves delineated in Section 11.7.

2.16.13 Alarm Checkout

To be written at a later date.

2.17 W-1 SYSTEM HELIUM PURITY CHECKS

2.17.1 The purity of the system helium must be checked before each startup to avoid serious operating problems which may require premature loop shutdown.

2.17.2 The loop must be pressurized to obtain a good H_e sample.

2.17.3 Take samples at the following places:

CAUTION: Use caution when taking samples as gas may be high pressure or cold. Use appropriate safety equipment.

2.17.3.1 V-113-HL - H_e return line to compressor.

2.17.3.2 P-140-VAC - at capsule vacuum pump.

2.17.3.3 V-128-T - near gel trap.

2.17.3.4 C-102-2HD - at cold box.

2.17.4 If the contaminant level at each place is less than 100 ppm the loop may be started.

2.17.5 If the level is above 100 ppm refer to Procedure 4.15 (W-1 System Purge).

2.18 TEST FIXTURE INSERTION INTO W-1 CAPSULE

2.18.1 Initial Conditions

2.18.1.1 New sample section in cave.

2.18.1.2 Tools required for installation in cave.

2.18.1.3 Capsule void of a sample test fixture and related hardware.

2.18.2 Insert the nose of the new sample section into the capsule.

2.18.3 Transfer the shield section of the test fixture from the storage position to the support cradles of the conveyor.

2.18.4 Engage and lock the bayonet fitting connecting the sample and shield sections.

2.18.5 Connect the two fluid power lines.

2.18.6 Engage the bayonet tool into the shield section and drive the test fixture into the capsule with the conveyor. During this operation the instrumentation lead must be positioned along the fixture.

2.18.7 Disengage the bayonet tool. Do not permit counterclockwise rotation of the fixture already in the capsule.

2.18.8 Transfer the middle section of the test fixture from storage position to the support cradles of the conveyor.

2.18.9 Engage and lock the bayonet fitting connecting the shield section to the middle section of the test fixture.

2.18.10 Connect the two fluid power lines.

2.18.11 Drive the test fixture into the capsule with conveyor. During this operation all instrumentation lead must be positioned along the fixture.

2.18.12 Repeat Procedure 2.17.

- 2.18.13 Remove the bayonet tool from the tool holder and place in storage position.
- 2.18.14 Convey the insulation section (ball-lock tool attached) from the storage position to the support cradles of the conveyor.

NOTE: Ball-lock tool must be positioned simultaneously into the tool holder.
- 2.18.15 Drive insulation section forward and engage and lock the bayonet fittings.
- 2.18.16 Connect the two fluid power lines.
- 2.18.17 Connect the instrumentation leads.
- 2.18.18 Drive the test fixture into the capsule until one (1) foot of the insulation section is still out of the capsule.
- 2.18.19 Disengage the ball-lock tool and retract it to its farthest point along the rails.
- 2.18.20 Remove the cradles from the rail and place in storage position.
- 2.18.21 Reengage the ball-lock tool and drive the test fixture into the capsule. Insure that the three 1/4-inch diameter dowels engage the mating holes in the connector pressure plate.
- 2.18.22 Disengage the ball-lock tool and retract from capsule.
- 2.18.23 Reconnect the two fluid power lines.
- 2.18.24 Complete a continuity check. Enter results in the Experiment Log.
- 2.18.25 Position the seal follower plate on the ball-lock tool and drive it into position with the conveyor.
- 2.18.26 Retract the ball-lock tool and remove it to storage position.

- 2.18.27 Position the back cover removal tool into the tool holder of the conveyor with the crane.

NOTE: Closure cover is still attached to removal tool.

- 2.18.28 Remove the protective cover from the closure cover.
- 2.18.29 Carefully drive the closure cover to the capsule with the conveyor.
- 2.18.30 Engage the threads of the closure cover and the capsule with the manipulators.
- 2.18.31 Activate the back cover removal tool and drive the closure cover to its limit.
- 2.18.32 Evacuate and pressure test the capsule in accordance with Procedure 2.19.
- 2.18.33 Repeat Procedure 2.18.24.
- 2.18.34 Retract the back cover removal tool from the closure cover.
- 2.18.35 Close the in-cave door of the removal tube.
- 2.18.36 Engage the top square drive of the in-cave Marman clamp of the removal tool with the ratchet wrench.
- 2.18.37 Drive the Marman clamp closed as indicated by the position indicating lights, until fully closed.

2.19 W-1 CAPSULE EVACUATION AND HELIUM FILL

2.19.1 Install a vacuum probe at L-109-HL.

2.19.2 Check the following valve lineup and position as indicated:

Close

AV-109
AV-110
AV-126
AV-137
C-124-T1
X-140-VAC
P-140-VAC
H-109-HL
P-103-HL

Open

AV-124
X-140-VAC-1
D-141W

2.19.3 Start capsule vacuum pump.

2.19.4 After ten (10) minutes, open X-140-VAC.

2.19.5 Evacuate capsule to less than 500 μ at L-109-HL.

2.19.6 Close X-140-VAC.

2.19.7 Monitor vacuum rise at L-109-HL for thirty (30) minutes. If vacuum rises to 7500 μ , repeat 2.19.5 to 2.19.7 until vacuum is satisfactory.

2.19.8 Slowly open AV-110 and pressurize capsule.

2.19.9 Remove vacuum probe from L-109-HL.

2.19.10 Open H-109-HL, L-109-HL and P-103-HL.

2.19.11 Close AV-110 and monitor pressure at PdR-109. If pressure leakage is detected, repair as necessary.

2.19.12 Stop capsule vacuum pump.

2.19.13 Close AV-124, X-140-VAC-1 and D-141W.

Astronuclear
Laboratory

SECTION 3

STARTUP PROCEDURES

3.1 W2-3 EXPERIMENT COOLING SYSTEM STARTUP

- 3.1.1 Slowly open PC-V1 and PC-V2.
- 3.1.2 Slowly close PC-V4.
- 3.1.3 Vent pressure transmitter impulse lines.
- 3.1.4 Adjust PC-V2 to give 65 gpm flow if PCW system is in operation. If not, open PC-V2 three (3) turns.
- 3.1.5 Record time and date of completion of Experiment Installation in log book.
- 3.1.6 Record set of data as per Procedure 6.4, if required.

3.2 W-1 SYSTEM COMPRESSOR STARTUP

3.2.1 General

- 3.2.1.1 This procedure will start the compressor at no-load conditions by recirculating gas through the compressor stage bypass lines. The compressor will then be loaded to full operating capacity and compressor output circulated through the surge drum until compressor operation is checked.

3.2.2 Initial Operations

- 3.2.2.1 Check for proper lubrication level in compressor sump and build a few pounds oil pressure with the hand oil pump after forcing air from the oil lines (refer to I-R Manual for additional instructions).
- 3.2.2.2 Open valves X-100-WS-1 and X-100-WR-1.
- 3.2.2.3 Open compressor cooling water supply valve X-100-WS-2 and return valve X-100-WR-2. Check the supply pressure PI-100 and the supply temperature TI-100-8.
- 3.2.2.4 Open fully the water valves listed below:
Stage 1 Cylinder	X-100-WS-3
Intercooler No. 1	X-100-WR-3
Stage 2 Cylinder	X-100-WS-4
Intercooler No. 2	X-100-WR-4
Stage 3 Cylinder	X-100-WS-7
Aftercooler	X-100-WR-6
Lube Oil Cooler	X-100-WS-6
- 3.2.2.5 Check that compressor cooling water low flow alarm (A-12, HT-1 panel) clears after flow has been established.
- 3.2.2.6 Check that compressor discharge valve X-102-HH-1 is closed.

- 3.2.2.7 Open compressor suction valve X-113-HL-2.
- 3.2.2.8 Open the three compressor stage bypass valves; B-101-HH-1, B-101-HH-2 and B-101-HH-3 on the compressor to allow the compressor to be started without load.
- 3.2.2.9 Set MC-116 (Y-4 panel) at 65 psig. Compressor suction pressure will be maintained at setting of MC-116.
- 3.2.2.10 Check that PIC-103 (HT-1 panel) is set at 1000 psig with selector in automatic control mode.
- 3.2.2.11 Check that PV-117-1 in the helium trailer makeup line is set at 100 psig, then open valve X-117-HH.
- 3.2.2.12 Slowly open X-118-HH and monitor PIX-101 while filling surge drum with helium to 100 psig minimum pressure. This step should be performed even if surge drum is already filled with helium at a higher pressure from a previous shutdown since makeup helium may be required at system startup.
- 3.2.2.13 Start compressor seal oil pump at Compressor Building MCC after checking reservoir seal oil level.
- 3.2.2.14 Start compressor MG set (compressor exciter). Adjust the D. C. output voltage to full voltage by turning the rheostat on the compressor motor controller full clockwise.
- 3.2.3 Compressor Startup
 - 3.2.3.1 Depress field loss reset button.
 - 3.2.3.2 Start compressor at Compressor Motor Controller MS-101-1.

- 3.2.4.5 Throttle cylinder and cooler cooling water valves to obtain proper helium and oil temperatures throughout compressor.
- 3.2.4.6 Recheck compressor operation thoroughly at this point to assure that it is operating at the manufacturer's rated conditions.
- 3.2.4.7 When proper operation has been verified, set PIC-103 to 300 psig.

- 3.2.3.3 After the motor has started and synchronized (synchronizing contactor can be heard energizing approximately three (3) seconds after start button is pressed), adjust the field amperage to 69 amps (as indicated on the field amperage meter) by readjusting the rheostat as necessary.
- 3.2.3.4 Check that low lube oil pressure alarm (A-1, HT-1 panel) clears.
- 3.2.3.5 Allow the compressor to run at no-load conditions for at least five (5) minutes, during which proper operation must be verified according to the manufacturer's specifications (refer to I-R Manual).
- 3.2.3.6 Recheck settings on the following controls:
Valve X-113-HL-2	Open
Valve X-102-HH-1	Closed
Controller PIC-103	Set at 1000 psig
Controller MC-116	Set at 65 psig
- 3.2.4 Compressor Loading
- 3.2.4.1 Close first stage bypass valve B-101-HH-1.
- 3.2.4.2 When compressor gauge PI-101-1 indicates normal first stage discharge pressure (about 172 psig), close second stage bypass valve B-101-HH-2.
- 3.2.4.3 When compressor gauge PI-101-3 indicates normal second stage discharge pressure (about 419 psig), close third stage bypass valve B-101-HH-3.
- 3.2.4.4 Check that compressor discharge gauge PI-101-2 indicates normal discharge pressure of 1000 psig. When this pressure is reached, PCV-103 will open allowing compressor discharge to the surge drum at 1000 psig and recirculation to compressor suction through PV-116.

3.3 W-1 SYSTEM LIQUID NITROGEN STARTUP

3.3.1 Slowly open X-132-N.

3.3.2 Set LIC-102 at 90% to open valve LCV-132 and admit liquid nitrogen to the forecooler. The gel trap coil will fill with liquid nitrogen, and the forecooler will be filled 90% full (its normal operating level).

3.3.3 After allowing time for these two components to cool, check that forecooler low level alarm light (LA-102, HT-1 panel) has gone out indicating that the forecooler (N₂ Pot) has filled.

3.4 W-1 SYSTEM GAS FLOW INITIATION

3.4.1 This procedure will start gas flow through the system at low pressure and a low flow rate. The compressor will continue operating at full output flow but will circulate a portion of its output through the surge drum.

3.4.2 Initial Conditions

3.4.2.1 Check that valves have been positioned as follows to provide a flow loop through the cold box, expander bypass, the capsule bypass and back through the cold box to the compressor inlet:

Open	Close
X-102-HH-2	AV-109
C-102-HH	AV-110
C-106-HH	B-124-HH
C-107-HH	
FCV-148	
X-113-HL-1	

3.4.2.2 Procedure 3.3 completed (Liquid Nitrogen Startup).

3.4.3 Gas Flow

3.4.3.1 Gradually open compressor discharge valve X-102-HH-1 partially to establish gas flow through the system. Gas will now be withdrawn from the surge drum and makeup trailer to pressurize the system and flow gas through the loop.

3.4.3.2 Monitor LCV-132 and TE-102-11 to insure that LCV-132 can adjust for the additional warm gas flow and keep the gel trap at 144°R (monitor TE-102-11).

3.4.3.3 Adjust X-102-HH-1 as needed.

3.4.3.4 Allow operation to become stabilized, then check pressures and flows carefully before proceeding with expander starting procedure.

3.5 W-1 SYSTEM EXPANDER STARTUP

3.5.1 Initial Conditions

3.5.1.1 Compressor startup, Procedure 3.2 completed.

3.5.1.2 Gas flow initiation, Procedure 3.4 completed.

3.5.2 Start expander lube oil pump and check crankcase oil level.

3.5.3 Check that oil pressure is above 15 psig at panel board, and that the low lube oil alarm light (A-6, HT-1 panel) goes out.

3.5.4 Energize expander bypass valve control by depressing MS-130.

NOTE: Insure MC-130 is set at 0 psig output.

3.5.5 Open expander blowby valve C-131-HL to return blowby gas to the system after expander is started. Blowby flow can be monitored at FI-131 on the Y-3 panel.

CAUTION: Do not make speed adjustments while expander is stopped.

3.5.6 Start expander by depressing MS-102 on the Y-3 panel and adjust the variable speed drive control on the expander for 150 rpm.

3.5.7 Insure that AV-108 opens upon expander start.

3.6 REACTOR STARTUP

- 3.6.1 Insure that all applicable procedures have been completed in accordance with Procedures 2.1 or 2.14, as appropriate.
- 3.6.2 Qualified operators are assigned to stations on the Operating Schedule. Verify your position.
- 3.6.3 Operations, data accumulation and manipulations will be performed in accordance with the procedural supplements issued for each individual test.
- 3.6.4 Refer to Procedure 4.5, Data Acquisition, for experimental operation and special conditions.
- 3.6.5 Continuous monitoring of the experiment is required during reactor startup and power level changes. Periodic monitoring is required after experiment parameters stabilize.

SECTION 4

OPERATING PROCEDURES

4.1 CAPSULE INSERTION

4.1.1 Initial Conditions

- 4.1.1.1 Notify the Experimental Equipment Supervisor and obtain his permission to perform the insertion.
- 4.1.1.2 If the insertion is for an experimental run, Procedure 2.1 or 2.14, as appropriate, must be completed.
- 4.1.1.3 If the insertion is for purposes other than experiment, Procedures 2.8 and 2.9 must be completed.

4.1.2 Insertion

- 4.1.2.1 Turn hardstop switch to Down position (Full Down light will energize and Full Up light will de-energize).
- 4.1.2.2 Open PV-3.
- 4.1.2.3 Depress Insert button (Insert light will energize and Fully Withdrawn light will de-energize). Capsule will drive forward to Seal Position and stop automatically (Seal Position light will energize and Insert light will de-energize).
- 4.1.2.4 Open PV-2 for approximately one (1) minute.
- 4.1.2.5 Close PV-2 and PV-3.
- 4.1.2.6 Open PV-4.
- 4.1.2.7 Start the seal pump by depressing the pump start button. Check that pump seal light is On.
- 4.1.2.8 Open SP-V4.
- 4.1.2.9 Monitor leakage for one (1) minute and close SP-V4.
- 4.1.2.10 Stop seal pump by depressing the pump stop button.

- 4.1.2.11 If the insertion is for an experimental run, obtain and record a set of data in accordance with Procedure 4.5.
- 4.1.2.12 Turn the hardstop switch to the Up position (Full Up light will energize and Full Down light will de-energize).
- 4.1.2.13 Contact RCR operator. Maintain constant communication with RCR during insertion.
- 4.1.2.14 Depress Valve Open button (Valve Closed light will de-energize and Valve Not Fully Open light will energize). Valve Open light will energize and the Valve Not Fully Open light will de-energize when 10-inch gate valve is fully open.
- 4.1.2.15 Depress the Insert button and insert capsule into HT-1.
- 4.1.2.16 Stop the insertion by depressing the Stop button at the first data position in accordance with Procedure 4.5.
- 4.1.2.17 Continue the insertion in accordance with Procedure 4.5.
- 4.1.2.18 If the first stopping position is full in, complete the following steps.
- 4.1.2.19 Stop the insertion by depressing the Stop button at 14 inches.
- 4.1.2.20 Using the winch, manually raise LVDT arm.
- 4.1.2.21 Depress Insert button (Insert light will energize). Drive capsule forward to Jog position (Jog light will energize and Insert light will de-energize). Capsule will stop automatically at the Jog position.
- 4.1.2.22 Depress Jog Insert button until Fully Inserted light energizes. Each time the Jog Insert button is depressed, the capsule moves and the Insert light will energize.

- 4.1.2.23 Start the seal pump by depressing the pump start button. Check that seal pump light is On.
- 4.1.2.24 Open SP-V4.

4.2 CAPSULE WITHDRAWAL

- 4.2.1 Notify the Experiment Equipment Supervisor and obtain his permission to perform capsule withdrawal.
- 4.2.2 Contact RCR operator. Maintain constant communication with RCR during withdrawal.
- 4.2.3 Close SP-V4.
- 4.2.4 Stop seal pump by depressing the pump stop button.
- 4.2.5 Depress the Withdraw button (Withdraw light will energize and Fully Inserted light will de-energize).
- 4.2.6 When the capsule reaches the 14-inch position, depress the Stop button.
- 4.2.7 Using the winch, lower the LVDT arm onto the capsule.
- 4.2.8 Depress the Withdraw button. The capsule will withdraw to the Seal Position and automatically stop (Seal Position light will energize and Withdraw light will de-energize).
- 4.2.9 Depress Valve Close button (Valve Open light will de-energize and Valve Not Fully Closed light will energize). Valve Closed light will energize and Valve Not Fully Closed light will de-energize when 10-inch gate valve is fully closed.
- 4.2.10 Close PV-4.
- 4.2.11 Open PV-2 and PV-3 for approximately one (1) minute.
- 4.2.12 Close PV-3.
- 4.2.13 Turn hardstop switch to Down position (Full Down light will energize and Full Up light will de-energize).
- 4.2.14 Retract the capsule by depressing the Withdraw button (Withdraw light will energize and Seal Position light will de-energize). Close PV-2 when capsule nose exits the seal. When capsule reaches the full withdrawn position it stops automatically (Withdraw light will de-energize and Fully Withdrawn light will energize).

4.3 W2-3 SYSTEM MONITORING

- 4.3.1 The W2-3 system will be monitored from the XCR. Additional monitoring will be initiated at the instrument console if any parameters behave irregularly.
- 4.3.2 Parameters will be continuously monitored during capsule insertion and withdrawal and during reactor startup and power level changes if the capsule is in HT-1. Refer to Section 8 if abnormal conditions arise.
- 4.3.3 A qualified operator will be within the page area at all times during an irradiation.
- 4.3.4 All instrument charts will be clearly marked to show the position of the pen or print wheel and the time and date at beginning of each shift.
- 4.3.5 The time and date of any sudden change in system or experiment parameters will be shown on instrument charts.
- 4.3.6 System data sheets will be completed once every hour on the half hour.
- 4.3.7 Experiment data sheets will be completed in accordance with Procedure 4.5.
- 4.3.8 System data will be recorded on data sheets as shown on the sample sheet attached to this procedure.

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REMARKS

4.4 GAS ACTUATION SYSTEM OPERATION

4.4.1 At times the experimental equipment will include a system for applying gas pressure to test fixtures to actuate transducers and other devices. The pressure will be used merely to pulse the fixture from one position to another. Figure 10.4 is a diagram of the system.

4.4.2 Application of Pressure

- 4.4.2.1 Adjust gas bottle regulator to give pressure as required in Procedure 4.5.
- 4.4.2.2 Turn SA-V5 to Actuate position to pressurize experiment. SA-V1 may be used to assist in fine adjustment of pressure.
- 4.4.2.3 To achieve the desired pressure it may be necessary to transfer more gas by turning SA-V5 to Fill and back to Actuate.

4.4.3 Reduction of Pressure

- 4.4.3.1 SA-V3 should be opened and closed as required to reduce pressure.

CAUTION: This operation will not be performed while the reactor tank is being filled and pressurized.

4.4.4 Reference Pressure Control (when applicable)

- 4.4.4.1 In some experiments it is necessary to establish an 0 psig reference pressure in the test fixture. This is accomplished by a 1/4 - inch line connected to the reactor tank vent system between SA-V3 and SA-V6, through SA-V102. A pressure gage with isolation valve SA-V101 is connected to measure this reference pressure. SA-V102 is normally closed.

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- 4.4.4.2 During startup, some buildup of pressure may be observed in the reference line until experiment temperatures stabilize. This buildup should be relieved using SA-V102. During operation, further slight changes in pressure are possible. During data taking operations, SA-V102 should be used to maintain 0 psig in the reference line.
- 4.4.4.3 If leakage develops across the differential pressure device as indicated by a continual pressure buildup in the reference line, close SA-V1 (and SA-V102 if open). Notify the Experimental Equipment Supervisor and the cognizant sponsor engineer. If the leakage is isolated, operation may be resumed by closing SA-V102.

4.5 DATA ACQUISITION

- 4.5.1 Data acquisition will be in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for the acquisition procedure.

4.6 GEL TRAP REGENERATION

4.6.1 Initial Conditions

- 4.6.1.1 Compressor shutdown.
- 4.6.1.2 Expander shutdown.
- 4.6.1.3 Liquid Nitrogen shutdown.
- 4.6.1.4 Gel Trap isolated.

4.6.2 Gel Trap Vent

- 4.6.2.1 Check gel trap pressure at D-107 and vent gel trap to 50 psig through valve V-128-T.
- 4.6.2.2 Close valve D-107-HH.
- 4.6.2.3 Replace 0-1000 psig pressure gage with 0-60 psig gage.
- 4.6.2.4 Open valve D-107-HH.
- 4.6.2.5 Vent gel trap to 26 psig through V-128-T.

CAUTION: Gel trap venting must be done at a slow rate so as not to damage silica gel within gel trap.

4.6.3 Gel Trap Thaw

- 4.6.3.1 Open each of the following valves:
 - C-124-T-2
 - C-126-T-1
 - C-128-T
 - C-123-T
 - X-121-HL
- 4.6.3.2 Fully open blower bypass valve B-126-T.

- 4.6.3.3 Energize the thaw heater and thaw blower circuit breakers.
- 4.6.3.4 Check oil level of blower.
- 4.6.3.5 Set TIS-103 $\leq$ 859°F.
- 4.6.3.6 Set TIS-125 at 175°F (150°F - 200°F range).
- 4.6.3.7 Start thaw blower by depressing MS-103.
- 4.6.3.8 Throttle B-126-T to maintain a 2 psig difference between PI-123 and gage at D-107-HH.
- 4.6.3.9 Vent excess pressure at V-123-T as silica gel desorbs gases.
- 4.6.3.10 Monitor thaw gas temperature at point TE-102-8 on TI-102 at the HT-1 panel. Continue circulating thaw gas until temperature at TE-102-8 rises to 559°R for operational thaw, or to 675°R for moisture removal.
- 4.6.3.11 Adjust TIS-125 to maintain temperature at TE-102-8 for about 10 hours at 559°R, or for 19 hours at 675°R.
- 4.6.3.12 Stop the thaw blower and heater.
- 4.6.3.13 Monitor TE-102-8 and note any appreciable drop over a 15-minute interval. If the trap was adequately thawed, temperature will remain nearly constant. However, a sharp temperature drop (over 20°R) indicates that thawing is incomplete and that thawing should be continued until a constant thaw gas temperature is maintained after allowing the gel bed to reach equilibrium temperature.
- 4.6.4 Gel Trap Purge
 - 4.6.4.1 Set PV-121 to supply 15 psig helium from the surge drum.

- 4.6.4.2 Set TIS-125 on Y-3 panel at lowest set point to insure heater remains off.
- 4.6.4.3 Start the thaw blower.
- 4.6.4.4 Throttle B-126-T to maintain a 2 psig differential on gages PI-123 and D-107-HH.
- 4.6.4.5 Partially open valve V-128-T to vent desorbed gases. Pure helium will be automatically supplied as needed from the surge drum.
- 4.6.4.6 Continue this purge until the total contaminant level at V-128-T drops to 100 ppm.
- 4.6.4.7 Stop thaw blower.
- 4.6.4.8 Open thaw blower.
- 4.6.4.9 Close Valve C-128-T.
- 4.6.4.10 Fully open V-128-T.
- 4.6.4.11 Flow gas through the gel trap in normal flow direction for several minutes to complete gel trap purge (less than 100 ppm contaminant level at V-128-T).
- 4.6.4.12 Close V-128-T.
- 4.6.4.13 Close each of the following valves:
 - C-124-T-2 B-126-T
 - C-126-T-1 C-123-T
 - D-107-HH X-121-HL
- 4.6.4.14 Remove 0-60 psig gage installed at D-107-HH and replace it with the 0-1000 psig gage.

4.7 W-1 SYSTEM COOLDOWN

- 4.7.1 Fully open X-102-HH-1 to connect full compressor output to system.
- 4.7.2 Gradually increase compressor discharge pressure (PIC-103) to 1000 psig and expander speed (SI-102) to 300 rpm.
- 4.7.3 Energize MS-111-1.
- 4.7.4 Insure switch M-111-3 (HT-1 panel) is Off to remove 25 KW heater bypass around expander-compressor shutdown interlock. Check that bypass light is extinguished. Heater will now be automatically shut down if compressor or expander stops.
- 4.7.5 Set PC-130 at 100 psig and MC-130 at 0 psig output. This will place PCV-130 on automatic pressure control.
- 4.7.6 Throttle FCV-148 using MC-148 to establish 100 psig expander outlet pressure at PI-130.
- 4.7.7 With TRC-111 manual control mode, maintain the following conditions and start cooling of the cold end by reducing the heat load supplied by the 25 KW heater.

CAUTION: The cooling rate as indicated by temperature drop at TI-102-5 between each increment should be controlled at about 2°R per minute.

Compressor Suction Pressure	65 psig
Compressor Discharge Pressure	1000 psig
Expander Inlet Pressure	975 psig
(throttle C-102-HH if required)	
Expander Speed	300 rpm
Expander Discharge Pressure	100 psig

- 4.7.8 Record the following data at start of cold end system cooldown and at each increment of cooldown after loop conditions stabilize:

****Increment**

		Start	1st	2nd	3rd	4th	5th
Expander Inlet Temperature	*TI-102-5	540°R	450°R	360°R	270°R	180°R	90°R
Expander Inlet Pressure	PI-108						
Expander Exhaust Pressure	PI-130						
Expander Outlet Temperature	TI-109						
Expander Blowby Flow	FI-131						
Compressor Flow	FI-113						

* Use TI-102-5 for 540°R to 186°R readings. Use TI-108 (inlet) and TI-109 (outlet) for readings below 186°R.

* * Stabilized with ± 15°R for temperature indicated.

- 4.7.9 Continue cooling until temperature reaches 50°R at expander outlet (TI-109).

NOTE: Check that gel trap is at operating temperature (144°R at TI-102-11).

- 4.7.10 Place TRC-111 in automatic control mode. In this mode of operation TRC-111 will control the 25 KW heater to maintain temperature.

- 4.7.11 Allow the system to operate until the total contaminant level (sampled at C-102-2-HD and at V-128-T) is below 15 ppm indicating that the gel trap has removed residual contaminants from the helium.

NOTE: Use Procedure 2.17 to obtain H_e samples.

- 4.7.12 Monitor temperatures and flows. Throttle valve C-102-HH as required to maintain cold box helium outlet temperature (TI-102-6 to within 14°F of cold box helium inlet temperature (TI-102-1).

4.8 W-1 CAPSULE COOLDOWN

4.8.1 Initial Conditions

4.8.1.1 Procedure 2.18 complete.

4.8.2 Capsule Cooldown

4.8.2.1 Slowly open AV-109.

4.8.2.2 When pressure stabilizes at PdR-109, slowly open AV-110.

4.8.2.3 Slowly close FCV-148 by decreasing air signal from MC-148 to 0 psig.

NOTE: As FCV-148 closes, FI-110 should start to indicate flow, TRC-111 will automatically reduce the 25 KW heat input to the loop. Sample TC's should begin to indicate as the capsule cools off and approaches test temperature. TRC-111 will automatically control the 25 KW heater, adding heat as necessary to stabilize and control the loop temperatures.

4.8.2.4 Record set of experimental data if required by Procedure 4.5.

4.9 W-1 SYSTEM MONITORING

- 4.9.1 The W-1 System will be monitored from the XCR. Additional monitoring will be initiated at the local panels if any parameters behave irregularly.
- 4.9.2 Parameters will be monitored continuously under the following conditions:
- 4.9.2.1 System startup
 - 4.9.2.2 System cooldown
 - 4.9.2.3 Capsule insertion
 - 4.9.2.4 Capsule withdrawal
 - 4.9.2.5 Reactor startup (if capsule is in HT-1)
 - 4.9.2.6 Reactor power level changes (if capsule is in HT-1)
 - 4.9.2.7 Abnormal conditions (refer to Section 8)
- 4.9.3 A qualified operator will be within the page area at all times during an irradiation.
- 4.9.4 All instrument charts will be clearly marked to show the position of the pen or print wheel and the time and date at the beginning of each shift.
- 4.9.5 The time and date of any sudden change in system or experiment parameters will be shown on the instrument charts.
- 4.9.6 System data sheets will be completed once every hour on the half hour while the system is operating.
- 4.9.7 System data will be recorded on data sheets as shown on the sample sheets attached to this procedure.
- 4.9.8 Experiment data sheets will be completed in accordance with Procedure 4.5.

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4.10 POST IRRADIATION ENVIRONMENTAL TESTING SYSTEM OPERATION

To be written at a later date.

4.11 EXPANDER THAW

4.11.1 Initial Conditions

4.11.1.1 Loop shutdown

4.11.1.2 Cold box and capsule isolation valves closed to prevent contamination.

4.11.2 Provide a thaw loop through the thaw heater, thaw blower and expander by opening:

C-124T-2	C-130T
C-126T-1	C-131T

4.11.3 De-energize expander 100 amp CB and tag "Off".

4.11.4 Mechanically release the expander brake and bar the expander over so that the piston will be at full out position to expose maximum cylinder area and volume.

4.11.5 Open expander inlet and outlet valves in accordance with the manufacturer's instructions.

4.11.6 Start the thaw blower (J-103) at MS-103 at the Reactor Building MCC. Thaw heater will start automatically.

4.11.7 Set TIS-125 to supply 100°F to 150°F temperature gas to the expander.

4.11.8 Complete expander thaw will require at least two hours after thaw gas reaches ambient temperature at expander discharge thaw piping.

CAUTION: Expander packing may be damaged if packing is heated above 150°F.

4.11.9 After thawing is complete, shut down blower.

4.11.10 Close the following valves:

C-124T-1	C-130T
C-126T-1	C-131T

CAUTION: Be sure to remove expander valve lifting levers before the expander is returned to service.

4.12 CAPSULE THAW

4.12.1 Initial Conditions

4.12.1.1 Procedure 6.15 complete (W-1 Capsule Bypass Operation).

4.12.2 Open the following valves:

AV-126	C-124-T-1
C-126-T-2	X-120-VAC
AV-124	X-140-VAC-1

4.12.3 Open P-120-VAC until PdR 109 reads 15 psig.

4.12.4 Open valves C-124-T-2, B-126-T and C-126-T-1.

4.12.5 Check set point at TIS-125 is 250°F.

4.12.6 Start thaw blower with MS-103.

4.12.7 Adjust B-126-T as required to maintain temperature.

4.12.8 As system begins to warm up and the pressure increases at PI-126, vent excess pressure through P-140-VAC.

4.12.9 Secure thaw blower when capsule and sample temperatures TIS-103 at ≤ 850 read ambient.

4.12.10 Close valves C-124-T1 and C-126-T2.

4.12.11 Vent all pressure through P-140 and monitor pressure on PdR-109 to read "Zero".

4.12.12 Close the following valves:

AV-126	X-140-VAC
AV-124	X-140-VAC-1
P-140-VAC	C-124-T-2
B-126-T	C-126-T-1

SECTION 5

OPERATING PARAMETERS

5.1 W2-3 SYSTEM OPERATING PARAMETERS

5.1.1 The W2-3 System will be operated within the range of the parameters as listed below:

HT-1 Gate Valve Continuity and Insulation Resistance	≥ 2 Meg for motor and line leads
---	--

	≥ 1 Meg for controller and relay panel wires
--	--

HT-1 Gate Valve Operative Pressure	9.5 - 10.5 psig
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HT-1 Flow	60 - 70 GPM
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HT-1 Pressure	145 - 155 psig
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HT-1 Temperature

HT-1 Inlet	132 - 142°F
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Capsule Inlet	136 - 146°F
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Capsule Outlet	140 - 150°F
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Seal Leakage	0
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Seal Pressure	160 - 180 psig
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Seal Pump Continuity and Insulation Resistance	≥ 2 Meg for motor and line leads
---	--

	≥ 1 Meg for controller and relay panel wires
--	--

5.2 W-1 SYSTEM OPERATING PARAMETERS

To be written at a later date.

5.3 HT-1 INSERTION MACHINE OPERATING PARAMETERS

5.3.1 The HT-1 Insertion Machine will be operated within the range of the operating parameters listed below:

Capsule Alignment	Fully Withdrawn	X, 0 - + 20 Y, 0 - + 40
	Seal	X, 0 - + 10 Y, -5 - + 10
	14 inch	X, 0 - + 10 Y, -5 - + 10
Capsule Position	Fully Withdrawn	139.5 - 140
	Seal (Insert)	122.3 - 122.9
	Seal (Withdraw)	120.5 - 121.0
	Fully Inserted	0 - 0.2
Clutch Current	Start 68%	
	Insert 50%	
	Withdrawn 50%	
Clutch Slippage (Δ RPM)		-62 - + 62
Drive Motor Continuity and Insulation Resistance		$\geq$ 2 Meg for motor and line leads
		$\geq$ 1 Meg for controller and relay panel wires
Dry Box Pressure		10.5 - 11.5 psig
Hardstop Pressure		145 - 155 psig
Thrust	HT-1 Pressurized	
	Insert	9K - 10K
	Withdraw	7.5 - 8.5K
	HT-1 Not Pressurized	
	Insert	.5 - 1K
	Withdraw	-.5 - - 1K

5.4 EXPERIMENT OPERATING PARAMETERS

- 5.4.1 Experiment parameters will be in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for parameters.

SECTION 6

SCHEDULED SHUTDOWN

6.1 W2-3 SYSTEM DATA REQUIREMENTS

- 6.1.1 If the W2-3 System is in operation at the time of reactor shutdown, a complete set of system data will be recorded on the data sheet.
- 6.1.2 Subsequent to reactor shutdown, system data will be taken in accordance with Procedure 4.3 for a period of two hours unless otherwise specified.

6.2 W2-3 SYSTEM SHUTDOWN

- 6.2.1 Notify the Experimental Equipment Supervisor and the RCR that the system will be shutdown.
- 6.2.2 Slowly open PC-V4.
- 6.2.3 Slowly close PC-V1 and PC-V2.
- 6.2.4 Record the shutdown of the system in the logbook.

6.3 W2-3 TEST FIXTURE REMOVAL

6.3.1 Notify the Experimental Equipment Supervisor and obtain his permission to carry out the removal of experiment.

6.3.2 Venting and Purging of Helium System

6.3.2.1 If the gas actuation system has been used, establish valving as indicated below:

SA-V1	open	SA-V6	closed
SA-V2	closed	SA-V7	open
SA-V3	open	SA-V101	open (if applicable)
SA-V4	closed	SA-V102	open (if applicable)
SA-V5	"Actuate"		
Gas bottle supply valve closed			
Gas bottle regulating valve closed			

6.3.2.2 Open SA-V6 to relieve any pressure in system.
Close SA-V6.

6.3.2.3 Pressurize accumulator by turning SA-V5 to "Fill", opening bottle supply valve and adjusting bottle regulating valve to the pressure specified in Procedure 4.5.

6.3.2.4 Close SA-V1 and turn SA-V5 to "Actuate".

6.3.2.5 Slowly open SA-V1 and pressurize system to the pressure specified in Procedure 4.5 by manipulation of SA-V5.

6.3.2.6 Open SA-V6 to relieve pressure. Close SA-V6.

6.3.2.7 Repeat steps 6.3.2.3 to 6.3.2.6.

6.3.3 Bypass Flow and Capsule Purge

6.3.3.1 Shut down W2-3 System in accordance with Procedure 6.2.

6.3.3.2 Open VD-V1 and PV-1 for approximately five (5) minutes.

- 6.3.3.3 After five (5) minutes, close VD-V1 and PV-1.
- 6.3.4 Positioning the Capsule
 - 6.3.4.1 Insert the capsule in accordance with Section 2.10.2 of Procedure 2.10.
- 6.3.5 Test Fixture Removal
 - 6.3.5.1 Open the Marman clamp holding the test fixture.
 - 6.3.5.2 Slowly remove the fixture from the capsule using the rope and pulley system.
 - 6.3.5.3 Lay the test fixture on the quadrant floor.
- 6.3.6 Withdrawing the Capsule
 - 6.3.6.1 Close SP-V4.
 - 6.3.6.2 Stop Seal Pump by depressing pump stop button.
 - 6.3.6.3 Establish and maintain contact with RCR while performing steps 6.3.6.4 to 6.3.6.6.
 - 6.3.6.4 Depress Withdraw button (Withdraw light will energize).
 - 6.3.6.5 Withdraw capsule to seal position. The capsule will stop automatically (Seal Position light will energize and Withdraw light will de-energize).
 - 6.3.6.6 Depress Valve Close button (Valve Open light will de-energize and Valve Not Fully Closed light will energize). Valve Closed light will energize and Valve Not Fully Closed light will de-energize when 10-inch gate valve is fully closed.
 - 6.3.6.7 Close PV-4.
 - 6.3.6.8 Open PV-2 and PV-3 for approximately one (1) minute.

- 6.3.6.9 Close PV-3.
- 6.3.6.10 Turn hardstop switch to Down position (Full Down light will energize and Full Up light will de-energize).
- 6.3.6.11 Retract the capsule by depressing the Withdraw button (Withdraw light will energize and Seal Position light will de-energize).
- 6.3.6.12 Close PV-2 when capsule nosw is out of seal but not fully withdrawn. When capsule reaches the fully withdrawn position, it stops automatically. Withdraw light de-energizes and Fully Withdrawn light will energize.

6.4 W2-3 TEST FIXTURE IN-QUADRANT DISASSEMBLY

- 6.4.1 Submerge the WANL cutting fixture at a convenient level in Quadrant C.
- 6.4.2 With continuous Health Safety monitoring, position incore end of the test fixture in the cutting fixture.
- 6.4.3 Secure the test fixture to the quadrant or the quadrant bridge rail.
- 6.4.4 Attach shipping cask with lid removed to crane. Replace drain plug with a valve and attach approximately six (6) feet of the flexible hose to the valve. Shut valve.
- 6.4.5 Position the cask adjacent to the test fixture for receiving test items.
- 6.4.6 Disassemble the test fixture using the cutting fixture or other tools as may be provided.
- 6.4.7 Transfer test items into cask and position lid on cask.
- 6.4.8 With continuous Health Safety monitoring, remove cask from quadrant.
- 6.4.9 Lower water level in cask by draining to the quadrant through the valve and flexible tubing. Replace drain plug.
- 6.4.10 Decontaminate cask to the level required by Health Safety for transfer to the intended destination.
- 6.4.11 Complete necessary documents for transfer.
- 6.4.12 Transfer cask out of the CV.
- 6.4.13 Following removal from the CV, the cask should be moved to either of the areas specified below:
 - 6.4.13.1 To the rear of the facility hot laboratories for on-site post-irradiation study.
 - 6.4.13.2 To the facility shipping area for off-site post-irradiation study.

6.5 UNDERWATER TRANSFER TO CANAL J

- 6.5.1 Notify the Experimental Equipment Supervisor and obtain his permission to commence the transfer.
- 6.5.2 Make certain underwater doors between Quadrant C and Canal J are open.
- 6.5.3 Attach nylon lines to the item as needed to control its movement. These lines should have floats attached to the upper end to allow retrieval after being passed through underwater doors.
- 6.5.4 Waterproof the ends of any instrument leads or gas lines attached to item, and attach to floats.
- 6.5.5 Move item to Quadrant C floor in front of door to Canal E and pass floats through door.
- 6.5.6 Retrieve the floats and move item to a point in front of door to Canal F.
- 6.5.7 Pass the floats through underwater door to Canal F.
- 6.5.8 Retrieve floats and move item to a point in front of door to Canal J.
- 6.5.9 With the permission of the Hot Laboratory Supervisor, pass floats through door into Canal J.
- 6.5.10 Retrieve the floats and move item to desired point in Canal J.

6.6 EXPERIMENT TRANSFER FROM CANAL J TO PBRF HOT CELL

6.6.1 Initial Conditions

- 6.6.1.1 Transfer of fixture to Canal J complete.
- 6.6.1.2 Experiment leads fitted with necessary connectors to allow connection to in-cell wiring system as required.
- 6.6.1.3 The electrical system as required for test fixture operation and output measurements assembled, connected to in-cell connector panel and tested.
- 6.6.1.4 Actuation gas control system assembled and tested as required. This includes the control station located outside of Cell No. 1 and tubing from there to interior of the cell. If a differential pressure connection to the sample holder exists, leave the end of the associated flexible metal hose open to the atmosphere by removing the plug.
- 6.6.1.5 Hot cell work table covered with clean blotter paper.
- 6.6.1.6 Necessary tools placed in-cell, within reach of manipulators.
- 6.6.1.7 Vise attached to work table to allow positioning of fixture in front of north window.
- 6.6.1.8 Photographic equipment set up outside of window (if needed).
- 6.6.1.9 Experiment log book available.

6.6.2 Transfer to Cell

- 6.6.2.1 Attach lifting bar to the 20-ton hook of the Hot Handling Room crane.

- 6.6.2.2 Make underwater hookup of the lifting bar and sample holder.
- 6.6.2.3 Remotely lift fixture from Canal J and place on floor behind Cell No. 1.
- 6.6.2.4 Remove 20-ton crane hook and attach the 5-ton crane hook.
- 6.6.2.5 By remotely operating crane, raise lifting bar and sample holder from floor behind Cell No. 1 and position on hot cell door lift tray.
- 6.6.2.6 Lower crane until it disengages lifting bar and move crane out of way.
- 6.6.2.7 Close hot cell door.
- 6.6.2.8 Grasp fixture with General Mills manipulator and position on table in a north-south direction with experiment end of fixture in front of north window.

6.7 W2-3 CAPSULE IN-QUADRANT STORAGE

6.7.1 Initial Conditions

6.7.1.1 The capsule is in the fully withdrawn position.

6.7.1.2 The Experimental Equipment Supervisor has been notified of the capsule transfer and his permission has been obtained.

6.7.2 Using the long-handled tool, open the aft swing clamp on the Capsule Storage Stand.

6.7.3 Attach the Capsule Handling Tool to the CV radial crane.

6.7.4 Using the CV radial crane, position the Capsule Handling Tool over the capsule.

6.7.5 Lower the Capsule Handling Tool onto the capsule and secure the clamps.

6.7.6 Using the winch, raise the Alignment Indicator LVDT arm.

6.7.7 Open the fore and aft swing clamps on the HT-1 Insertion Machine with the long-handled tool.

6.7.8 Slowly raise the capsule from the HT-1 Insertion Machine and transfer it to the Capsule Storage Stand.

6.7.9 Lower the capsule onto the Capsule Storage Stand.

6.7.10 Using the long-handled tool, close the aft swing clamp on the Capsule Storage Stand.

6.7.11 Open the Capsule Handling Tool clamps and return the tool to storage.

6.7.12 Using a long-handled hook tool, place the Insertion Machine rail covers in place.

6.7.13 If the quadrant is to be drained, place the lead vault upper section on the Capsule Storage Stand using the CV radial crane.

6.8 W-1 SYSTEM DATA REQUIREMENTS

- 6.8.1 If the W-1 System is in operation with flow through the capsule and the capsule is inserted in HT-1, a complete set of system data will be taken in accordance with Procedure 4.9 at the time of reactor shutdown.
- 6.8.2 Since the W-1 System can operate independently, system data will be taken in accordance with Procedure 4.9 for the duration of the run as delineated in the operating schedule.

6.9 W-1 SYSTEM SHUTDOWN CHECKLIST

- 6.9.1 Termination of W-1 System operations will be delineated in the operating schedule.
- 6.9.2 Shutdown of the W-1 System will be accomplished by use of the procedures listed on the following page in the order listed.
- 6.9.3 The date and time are to be recorded with the initials of the technician completing each procedure in the list.
- 6.9.4 When the checklist has been completed, it will be signed by the Test Operations Supervisor and submitted to the Test Operations Manager for review and file.
- 6.9.5 Any procedures requiring signature will be included with the checklist when it is returned to the Test Operations Office.

W-1 SHUTDOWN CHECKLIST

Order	Number	Title	Date	Time	Initial
1	6.10	Gel Trap Isolation	_____	_____	_____
2	6.11	Liquid Nitrogen System Shutdown and Drain	_____	_____	_____
3	6.12	Expander Shutdown	_____	_____	_____
4	6.13	Compressor Shutdown	_____	_____	_____

6.10 GEL TRAP ISOLATION

- 6.10.1 Open B-124-HH.
- 6.10.2 Close C-107-HH.
- 6.10.3 Close C-106-HH.
- 6.10.4 Connect a 0-1000 psig pressure gage at valve D-107-HH.
- 6.10.5 Open D-107-HH.
- 6.10.6 Slowly open V-128-T and vent gel trap to 100 psig.

CAUTION: Gel trap venting must be accomplished slowly so that the gel does not get damaged.

- 6.10.7 Maintain gel trap pressure at 100 psig.

6.11 LIQUID NITROGEN SYSTEM SHUTDOWN AND DRAIN

6.11.1 Close valve X-132-N.

6.11.2 Set LIC 102 to 100% setting.

CAUTION: When draining the system, full protective clothing must be worn.

6.11.3 Open valve C-102-4D.

6.11.4 Slowly open valve C-102-5D and allow liquid nitrogen to drain.

6.11.5 After liquid nitrogen has been completely drained, leave C-102-5D cracked open to vent boil off in line between LCV-132 and X-132-N.

6.12 EXPANDER SHUTDOWN

- 6.12.1 Gradually reduce expander speed to 125 rpm using the variable speed drive control on the expander.
- 6.12.2 Insure that PCV-130 opens and maintains a downstream pressure of 100 psig (PI-130).
- 6.12.3 Place MS-111-3 in the Off position. The 25 KW heater will automatically shut down when the expander is stopped.
- 6.12.4 Stop the expander by depressing MS-102-2 (Y-3 panel).
- 6.12.5 Verify that valve AU-108 closes.
- 6.12.6 Stop the expander lube oil pump by depressing MS-102.
- 6.12.7 Close C-131-HL.
- 6.12.8 Close PG-108.
- 6.12.9 Adjust FCV-148 (MC-148) to maintain compressor suction pressure at 65 psig.

6.13 COMPRESSOR SHUTDOWN

- 6.13.1 Adjust setting of PIC-103 to lowest pressure possible (approximately 200 to 300 psig).
 - 6.13.2 Slowly close compressor discharge valve X-102-HH-1.
 - 6.13.3 Monitor pressures throughout system and continue compressing helium into the surge drum until the third stage discharge pressure (PI-101-2) is the same as surge drum pressure (PI-101).
 - 6.13.4 Slowly reduce the setting on MC-116 until PI-113-1 indicates 56 psig.
 - 6.13.5 Monitor flow on FI-113 as MC-116 is reduced. Reduction of flow indicates a reduction in pressure.
 - 6.13.6 When the system pressure has been reduced to a minimum, unload the compressor as follows and monitor pressure at PI-113-1.
 - 6.13.6.1 Slowly open B-101-HH-3.
 - 6.13.6.2 Slowly open B-101-HH-2.
 - 6.13.6.3 Slowly open B-101-HH-1.
- NOTE: System pressure will rise slightly when compressor is unloaded as high pressure helium in the compressor discharge backflows into the system.
- 6.13.7 Reset PIC-103 to 1200 psig and switch to manual control.
 - 6.13.8 Stop the compressor at the compressor motor controller (MS-101-1).
 - 6.13.9 Stop compressor seal oil pump (MS-101-3).
 - 6.13.10 Close the cooling water inlet valve (X-100-WS-2).

6.14 W-1 CAPSULE BY-PASS OPERATION

6.14.1 Initial Conditions

6.14.1.1 Capsule in seal position in hot cave or on hot cave charging machine.

6.14.1.2 W-1 System in operation.

6.14.2 Using MC-148, slowly increase the output air signal to open FCV-148.

6.14.3 Adjust FCV-148 to maintain compressor suction pressure at 65 psig.

6.14.4 Monitor TRC-111 to confirm that the 25 KW heater compensates for the change in heat load.

6.14.5 Slowly close AV-109 by using the handwheel.

6.14.6 Slowly close AV-110 by using the handwheel.

6.15 W-1 CAPSULE TRANSFER FROM HT-1 INSERTION MACHINE TO THE HOT CAVE

6.15.1 Initial Conditions

6.15.1.1 Experimental Equipment Supervisor notified of the transfer.

6.15.1.2 Hot Cave Charging Machine carriage at fully withdrawn position.

6.15.1.3 W-1 Capsule at fully withdrawn position.

6.15.1.4 Procedure 6.14 completed.

6.15.2 With the long-handled tool, open the fore and aft swing clamps on the Hot Cave Charging Machine.

6.15.3 Attach the Capsule Handling Tool to the CV radial crane.

6.15.4 Position the Capsule Handling Tool over the capsule on the HT-1 Insertion Machine.

6.15.5 Lower the Capsule Handling Tool onto the capsule and secure the clamps.

6.15.6 Using the winch, raise the Alignment Indicator LVDT arm.

6.15.7 With the long-handled tool, open the fore and aft swing clamps on the HT-1 Insertion Machine.

6.15.8 Using the CV radial crane, raise the capsule, position it over the Hot Cave Charging Machine and lower it into place on the carriage.

6.15.9 With the long-handled tool, close the fore and aft swing clamps on the Hot Cave Charging Machine.

6.15.10 Release the Capsule Handling Tool clamps and return the tool to the storage area.

- 6.15.11 Verify that the inner door on the removal tube is closed.
- 6.15.12 Fully open Hot Cave Valve No. 1.
- 6.15.13 Using the drive handwheel, drive the Hot Cave
Charging Machine carriage to its fully inserted position.
- 6.15.14 Fully close the Marman clamp using the long-handled
tool.

6.16 W-1 TEST FIXTURE REMOVAL IN HOT CAVE

6.16.1 Initial Conditions

- 6.16.1.1 Procedure 6.15 completed.
- 6.16.1.2 Procedure 4.12 completed.
- 6.16.1.3 Experiment removal tools previously placed in hot cave.

6.16.2 Evacuation and Purge of Gas Actuation System

- 6.16.2.1 If the Gas Actuation System has been used, establish valving as indicated below:

SA-V1	Open	SA-V6	Closed
SA-V2	Closed	SA-V7	Open
SA-V3	Open	SA-V9	Open
SA-V4	Closed	SA-V101	Open (if installed)
SA-V5	"Actuate"	SA-V102	Open (if installed)

Gas bottle supply valve closed
Gas bottle regulating valve closed

- 6.16.2.2 Open SA-V6 to relieve any pressure in system.
Close SA-V6.
- 6.16.2.3 Pressurize accumulator by turning SA-V5 to "Fill", opening bottle supply valve and adjusting bottle regulating valve to the pressure specified in Procedure 4.5.
- 6.16.2.4 Close SA-V1 and turn SA-V5 to "Actuate".
- 6.16.2.5 Slowly open to SA-V1 and pressurize system to the pressure specified in Procedure 4.5 by manipulation of SA-V5.

6.16.2.6 Open SA-V6 to relieve pressure; close SA-V6.

6.16.2.7 Repeat steps 6.16.2.3 to 6.16.2.6.

6.16.3 Draining Removal Tube

6.16.3.1 Open valves D-141-W and P-137-VAC for five (5) minutes.

6.16.3.2 Close D-141-W and P-137-VAC.

6.16.4 Disassembly Operations

6.16.4.1 Engage the ratchet wrench in the top square drive of the in-cave Marman clamp of the removal tube.

6.16.4.2 Open the Marman clamp as shown by the position indicating lights until fully open.

6.16.4.3 Open the in-cave door.

6.16.4.4 Position the tool holder onto the rails.

6.16.4.5 Position the back cover removal tool into the tool holder.

6.16.4.6 Drive the conveyor and back cover removal tool forward, engage and secure it to the back cover of the capsule.

6.16.4.7 Activate the back cover removal tool in reverse and unscrew the back cover from capsule.

6.16.4.8 Drive conveyor and back cover removal tool to a position in front of window.

6.16.4.9 Place protective cover over threads of cover.

6.16.4.10 Convey both the back cover and removal tool to storage position.

- 6.16.4.11 Position the ball lock tool onto the tool holder
(assure that tool is in extended position).
- 6.16.4.12 Drive conveyor forward until the ball lock tool
engages the seal follower plate.
- 6.16.4.13 Remove seal follower plate by driving conveyor in
reverse. Remove the plate from the ball lock tool
and place it on the tray.
- 6.16.4.14 Disconnect the two fluid power lines.
- 6.16.4.15 Drive the ball lock tool forward and engage the
insulation section of capsule.
- 6.16.4.16 Drive conveyor reverse approximately one foot and
disengage the tool.
- 6.16.4.17 Drive the ball lock tool reverse as far as possible
(change tool to retracted position).
- 6.16.4.18 Place the support cradle onto the rails and position it
as far forward as possible.
- 6.16.4.19 Reengage the ball lock tool to the insulation section.
- 6.16.4.20 Reverse the conveyor and retract the test fixture as
far possible. Adjust support cradle as required during
this operation.
- 6.16.4.21 Disconnect the two fluid power lines.
- 6.16.4.22 Disconnect the electrical connectors.
- 6.16.4.23 Disconnect the first bayonet fitting.

NOTE: Do not permit counterclockwise rotation of the
fixture still in the capsule.

- 6.16.4.24 Transfer the insulation section to Storage Pad No. 1.
Do not disengage the ball lock tool.
- 6.16.4.25 Place the bayonet tool in the tool holder of the
conveyor system.
- 6.16.4.26 Engage the bayonet tool with the female fitting of
the middle section of the test fixture and lock in place.
- 6.16.4.27 Retract the middle section of the test fixture by
reversing the conveyor. Withdraw the instrumentation
leads during this operation.
- 6.16.4.28 Disconnect the two fluid power lines.
- 6.16.4.29 Disconnect the bayonet fitting and the bayonet tool.
- 6.16.4.30 Transfer the middle section of the test fixture to the
storage pad.
- 6.16.4.31 Repeat Procedures 6.16.4.26 through 6.16.4.30 for
removing the shield section of the test fixture.
- 6.16.4.32 Repeat Procedures 6.16.4.26 through 6.16.4.30 for
removing the sample section.
- 6.16.4.33 Place the sample section and instrumentation leads of
the test fixture on the work tray.

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**6.17 W-1 CAPSULE TRANSFER FROM HT-1 INSERTION MACHINE TO POST
IRRADIATION ENVIRONMENTAL TESTING FACILITY**

To be written at a later date.

6.18 W-1 TEST FIXTURE REMOVAL IN POST IRRADIATION ENVIRONMENTAL TESTING FACILITY

To be written at a later date.

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**6.19 W-1 CAPSULE TRANSFER FROM POST IRRADIATION ENVIRONMENTAL
TESTING FACILITY TO HOT CAVE**

To be written at a later date.

6.20 SAMPLE TRANSFER FROM HOT CAVE TO PBRF HOT CELL

6.20.1 Sample Loading into Transfer Tube

6.20.1.1 Place the sample section and instrumentation leads into the transfer can.

6.20.1.2 Place the seal cap on the transfer can.

6.20.2 Drain Transfer Tube

6.20.2.1 Insure that transfer tube gate valve is closed by checking indicating lights.

6.20.2.2 Open valve D-142-W and P-139-VAC for five (5) minutes.

6.20.2.3 Close D-142-W and P-139-VAC.

6.20.3 Load Transfer Tube

6.20.3.1 Engage the top square drive of the in-cave Marman clamp of the transfer tube with the ratchet wrench.

6.20.3.2 Open the Marman clamp as shown by the position indicating lights until fully open.

6.20.3.3 Open the in-cave door.

6.20.3.4 Convey the transfer can from the work tray to the rollers leading into the transfer tube with the crane.

6.20.3.5 Disengage the crane from transfer can.

6.20.3.6 Roll the transfer can into the transfer tube until completely inserted.

6.20.3.7 Close the in-cave door.

6.20.3.8 Engage the top square drive of the in-cave Marman clamp of the transfer tube with the ratchet wrench.

6.20.3.9 Close the Marman clamp as shown by the position
 indicating lights until fully closed.

6.20.4 Transfer of Transfer Can

6.20.4.1 Open Hot Cave Valve No. 2.

6.20.4.2 Attach special hook tool to CV radial crane, engage
 the hook tool into eyelet of transfer can and extract
 the transfer can from the transfer tube.

6.20.4.3 Set the transfer can on its base, upright on the floor
 of Quadrant C.

6.20.4.4 Close Hot Cave Valve No. 2.

6.20.4.5 Remove the hook tool from the transfer can.

6.20.4.6 Transfer the transfer can to Canal J in accordance
 with Procedure 6.5.

6.20.4.7 Transfer the transfer can to the Hot Cell in accordance
 with Procedure 6.6.

6.20.5 If the sample is to be transferred via a cask, complete the following
 steps:

6.20.5.1 Attach the cask with lid removed to the CV radial
 crane.

6.20.5.2 Replace the drain plug with a valve and attach
 approximately 6 feet of flexible hose to the valve.
 Close the valve.

6.20.5.3 Position the cask adjacent to the transfer can.

6.20.5.4 Place the transfer can in the lead cask.

6.20.5.5 Remove the hook tool from the transfer can.

- 6.20.5.6 Replace lid on lead cask.
- 6.20.5.7 With Health Safety monitoring, raise the lead cask to the 0'0" elevation using the CV radial crane.
- 6.20.5.8 Drain the water from the cask cavity and secure the lid.
- 6.20.5.9 Clean and decontaminate the lead cask to conform with PBRF Health Safety specifications.
- 6.20.5.10 Transfer the cask to the area adjacent to the CV truck door.
- 6.20.5.11 When the truck door is opened, transfer the lead cask from the truck door to the rear of the Hot Laboratory.
- 6.20.5.12 Attach lead cask to the 20-ton hook of the Hot Handling Room crane.
- 6.20.5.13 Lift the cask and position it on the door tray of Cell No. 1.
- 6.20.5.14 Disengage the crane and move it out of the way.
- 6.20.5.15 Close hot cell door.
- 6.20.5.16 Remotely remove the lid from cask.
- 6.20.5.17 Remotely remove the transfer can from the cask.
- 6.20.5.18 Position the transfer can in a workable location in front of south window.

6.21 QUADRANT DRAINAGE

6.21.1 Prior to drainage of Quadrant C, WANL equipment will be placed in the following conditions pursuant to the provisions of this manual:

6.21.1.1 W 2-3 System - (if operating) in by-pass flow.

6.21.1.2 W-1 System - (if operating) in capsule by-pass.

6.21.1.3 W2-3 Capsule - on Capsule Storage Stand with lead vault in place.

6.21.1.4 W-1 Capsule - on HT-1 Insertion Machine fully inserted into HT-1.

6.21.1.5 HT-1 Insertion Machine - 440 VAC to the HT-1 drive motor secured and tagged out to prevent table abort.

6.21.2 If the situation at the time of quadrant drainage will not permit the above conditions to be met, special instructions will be issued with the maintenance schedule in accordance with Procedure 0.2.

SECTION 7

UNSCHEDULED SHUTDOWN

7.1 UNSCHEDULED REACTOR SHUTDOWN - W2-3 SYSTEM REQUIREMENTS

- 7.1.1 An unscheduled reactor shutdown will not significantly effect the operation of the W2-3 System.
- 7.1.2 As soon as possible after the unscheduled shutdown, a complete set of W2-3 System data will be taken.
- 7.1.3 Subsequent to the shutdown, system data will be taken in accordance with Procedure 4.3 for a period of 2 hours.
- 7.1.4 Any abnormalities noted during this time will be immediately reported to WANL Supervision and to the Experimental Equipment Supervisor.
- 7.1.5 Refer to Procedure 7.4 of the experiment package for the experiment requirements.

7.2 UNSCHEDULED REACTOR SHUTDOWN - W-1 SYSTEM REQUIREMENTS

- 7.2.1 An unscheduled reactor shutdown will momentarily change the heat load on the system until it is corrected by the action of the C-101 heater.
- 7.2.2 The system will be continuously monitored for a period of 1 hour after the unscheduled shutdown.
- 7.2.3 System data shall be taken in accordance with Procedure 4.9 while the system remains in operation.
- 7.2.4 Any abnormalities will be immediately reported to WANL Supervision and to the Experimental Equipment Supervisor.
- 7.2.5 Refer to Procedure 7.4 of the experiment package for experiment requirements.

7.3 UNSCHEDULED W-1 SYSTEM SHUTDOWN

- 7.3.1 In the event of an unscheduled W-1 System shutdown the operator's prime responsibility will be to insure that all system components are in a safe condition.
- 7.3.2 No attempt at restarting the system shall be made until the cause of the shutdown has been definitely established, corrective action completed, experiment requirements ascertained and satisfied and permission received from WANL Supervision and the Experimental Equipment Supervisor.
- 7.3.3 Refer to Procedure 7.4 of the experiment package for experiment requirements.

7.4 UNSCHEDULED SHUTDOWN - EXPERIMENT REQUIREMENTS

- 7.4.1** Experiment requirements will be in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for specific actions required.

SECTION 8

ABNORMAL OPERATING PROCEDURES

8.1 W2-3 SYSTEM GENERAL PRECAUTIONS

- 8.1.1 Any evidence of abnormal operation will be reported as quickly as possible to WANL supervision, to the Experimental Equipment Supervisor or the Shift Supervisor.
- 8.1.2 Following corrective actions, the over-all situation will be recorded in detail in the log and notations made (including date and time) on the appropriate charts.
- 8.1.3 While specific instructions are given in Procedure 8.2 for correcting certain abnormal conditions, in no case should operation be continued indefinitely unless the abnormality can be explained and approval from WANL supervision and the Experimental Equipment Supervisor has been obtained.

8.2 W2-3 SYSTEM ALARM TABULATION AND CORRECTIVE ACTION

8.2.1 Inlet Coolant Flow - Lo Flow alarm on FA-1

- 8.2.1.1 Insure PC-V2 is full open. If flow cannot be increased notify the Experimental Equipment Supervisor or the Shift Supervisor and WANL supervision.

8.2.2 Outlet Coolant Flow - Lo Flow alarm on FA-2

- 8.2.2.1 If inlet flow has also decreased with PC-V2 full open and flow cannot be increased notify the Experimental Equipment Supervisor or the Shift Supervisor and WANL supervision.
- 8.2.2.2 If inlet flow is normal, outlet normal flow cannot be established and system temperatures approach 250°F, remove the capsule from HT-1.

8.2.3 Inlet Coolant Flow - Lo Lo Flow alarm on FA-3

- 8.2.3.1 Verify that the reactor has scrammed.
- 8.2.3.2 Verify that the Insertion Machine automatic table abort has initiated.
- 8.2.3.3 Attempt to re-establish normal flow by opening PC-V2.
- 8.2.3.4 Monitor system temperatures and initiate Procedure 8.3 if they approach 250°F.

8.2.4 Outlet Coolant Flow - Lo Lo Flow alarm on FA-4

- 8.2.4.1 Verify that the reactor has scrammed.
- 8.2.4.2 Verify that the Insertion Machine automatic table abort has initiated.

- 8.2.4.3 Attempt to re-establish normal flow by opening PC-V2 if inlet flow has also decreased.
- 8.2.4.4 Monitor system temperatures and initiate Procedure 8.3 if they approach 250°F.
- 8.2.4.5 If inlet flow is normal, initiate Procedure 8.3 to prevent quadrant contamination.
- 8.2.5 Primary Coolant Pressure - Lo Pressure alarm on PA-1
 - 8.2.5.1 Proceed with corrective action for coolant flow alarm that will accompany the pressure alarm.
- 8.2.6 System Temperature - High Temperature alarm on TR1-A
 - 8.2.6.1 If two or more temperatures are over 250°F, withdraw the capsule from HT-1 and initiate Procedure 8.3 if temperatures do not decrease.
 - 8.2.6.2 If a single thermocouple is over the alarm point and the other thermocouple indications are normal, thermocouple failure is indicated. Jumper the failed point.
- 8.2.7 PC-V4 not fully closed
 - 8.2.7.1 Close valve PC-V4. Verify that temperatures have returned to normal. Initiate Procedure 8.3 if temperatures rise to 250°F.

8.3 W2-3 SYSTEM EMERGENCY COOLING PROCEDURE

- 8.3.1 Open PV-1, VD-V1 and PC-V4, in that order.
- 8.3.2 Close PC-V1 and PC-V2, in that order.
- 8.3.3 Adjust VD-V1 to maintain temperatures below 250°F. If cooling is inadequate, open EC-V2, close VD-V1 and close PV-1.
- 8.3.4 Initiate capsule retraction if conditions warrant. Refer to Procedure 4.2 for Capsule Withdrawal.

8.4 W-1 SYSTEM GENERAL PRECAUTIONS

- 8.4.1 Any evidence of abnormal operation will be reported as quickly as possible to WANL supervision, the Experimental Equipment Supervisor or the Shift Supervisor.
- 8.4.2 Following corrective actions, the over-all situation will be recorded in detail in the log and notations made (including date and time) on appropriate charts.
- 8.4.3 While specific instructions are given in Procedure 8.5 for correcting certain abnormal conditions, in no case should operation be continued indefinitely unless abnormality can be explained and approval from WANL supervision and the Experimental Equipment Supervisor has been obtained.
- 8.4.4 Certain abnormal conditions may necessitate shutdown of only a portion of the loop while corrective action is taken to remedy abnormality. Partial shutdown would be initiated after concurrence with Experimental Equipment Supervisor and WANL supervision. Shutdown of the remainder of the loop will be dependent upon time involved and nature of abnormal condition.

8.5 W-1 SYSTEM ALARM TABULATION AND CORRECTIVE ACTION

8.5.1 Annunciator "A"

8.5.1.1 PA-101-1 Compressor low lube oil pressure (alarm at 18 psig; shutdown at 15 psig).

8.5.1.1.1 Compressor low lube oil pressure will be indicated by a low reading on gage PI-101-4 (I.R. Panel).

8.5.1.1.2 Check pressure differential across filter on gage PI-101-4, using valve P-101-LU-4.

8.5.1.1.3 Check oil sump level and add if necessary.

8.5.1.1.4 Inspect all lines for leaks and repair if possible. Mark all leak areas.

8.5.1.1.5 If abnormality cannot be explained, initiate a planned shutdown as per Procedure 6.9.

8.5.1.2 PA-101-2 High Compressor Discharge Pressure (alarm at 1100 psig).

8.5.1.2.1 High compressor discharge pressure will be indicated on PI-101-2 (I.R. Panel), PIC-103 (HT-1 Panel) and PIX-103 (Y-4 Panel).

8.5.1.2.2 Check TI's on water system.

8.5.1.2.3 Adjust PIC-103 to reduce high pressure.

8.5.1.2.4 Throttle B-101-HH-3 to maintain 1000 psi discharge.

- 8.5.1.2.5 Check pressure reading at PI-101-2 and PIX-103.
- 8.5.1.2.6 Check for adequate air supply to PCV-103 and associated instrumentation.
- 8.5.1.2.7 If abnormality cannot be explained, initiate a planned shutdown per Procedure 6.9.
- 8.5.1.3 PA-102 Expander Low Lube Oil (alarm at 12 psig; shutdown at 10 psig).
 - 8.5.1.3.1 Expander low lube oil pressure alarm will be indicated on gage PI-102-1 (Expander Panel).
 - 8.5.1.3.2 Check oil pressure on gages PI-102-2 and PI-102-3. If PI-102-2 is significantly greater than PI-102-3, a clogged filter is indicated.
 - 8.5.1.3.3 Check oil sump level and add if necessary.
 - 8.5.1.3.4 Inspect and repair leaks if possible.
 - 8.5.1.3.5 If abnormality cannot be explained, initiate a planned cold end shutdown as per Procedure 6.10, 6.11 and 6.12.
- 8.5.1.4 PS-113 Compressor Low Suction Pressure (alarm at 55 psig; shutdown at 50 psig).
 - 8.5.1.4.1 Compressor low suction pressure will be indicated on PI-113 (HT-1 Panel), PIX-113 (Y-4 Panel) and PI-113-1 (I. R. Panel).

- 8.5.1.4.2 Insure MS-120 (XCR) in "Off" position.
- 8.5.1.4.3 Check for adequate air supply to MC-116 and associated instrumentation.
- 8.5.1.4.4 Check MC-116 set at 65 psig.
- 8.5.1.4.5 Check PI-101 is at least 100 psig.
- 8.5.1.4.6 Check the helium trailer to insure an adequate supply of helium is available.
- 8.5.1.4.7 Open valve X-118-HH full.
- 8.5.1.4.8 Adjust PV-117-1 to 100 psig.
- 8.5.1.4.9 Inspect associated lines for leaks and repair if possible; mark all leak areas.
- 8.5.1.4.10 If abnormality cannot be explained, initiate a planned shutdown as per Procedure 6.9.
- 8.5.1.5 PA-YA Air Supply Low Pressure (alarm at 60 psig).
 - 8.5.1.5.1 Air supply low pressure will be indicated by low readings on both PG-1 and PG-2.
 - 8.5.1.5.2 Insure valves 25V132 and 25V133 open.
 - 8.5.1.5.3 Contact S.E.B. operator and confirm that PBRF air supply system is normal.
 - 8.5.1.5.4 If abnormality cannot be explained, initiate a planned shutdown as per Procedure 6.9.
- 8.5.1.6 TA-108 Expander Low Suction Temperature (alarm at 88°R).

- 8.5.1.6.1 Expander low suction temperature will be indicated at TI-108 (Y-3 Panel).
- 8.5.1.6.2 Adjust TRC-111 (HT-1 Panel) to proper operating setpoint.
- 8.5.1.6.3 Check TIS-101 and TI-111.
- 8.5.1.6.4 If abnormality cannot be explained, initiate a planned cold end shutdown as per Procedure 6.10, 6.11 and 6.12.
- 8.5.1.7 TA-111 Heater Outlet Low Temperature (alarm at 50°R).
 - 8.5.1.7.1 A heater outlet low temperature will be indicated at TI-102-10 and TI-111.
 - 8.5.1.7.2 Check for adequate air supply to TX-111-1 and associated instrumentation.
 - 8.5.1.7.3 Adjust TRC-111 to proper operating setpoint.
 - 8.5.1.7.4 Check TIS-101.
 - 8.5.1.7.5 If abnormality cannot be explained, initiate a planned cold end shutdown as per Procedure 6.10, 6.11 and 6.12.
- 8.5.1.8 TA-113 Compressor Low Suction Temperature (alarm at 42°F; shutdown at 40°F).
 - 8.5.1.8.1 Compressor low suction temperature will be indicated at TI-102-6 (HT-1 Panel) and TI-113 (I. R. Panel).
 - 8.5.1.8.2 Decrease flow through C-102-HH.

- 8.5.1.8.3 Check PI-111, PI-102 and PI-108.
- 8.5.1.8.4 Check expander speed.
- 8.5.1.8.5 Check PCV-103 position.
- 8.5.1.8.6 If abnormality cannot be explained,
initiate a planned cold end shutdown
as per Procedure 6.10, 6.11 and 6.12.
- 8.5.1.9 SA-102-1 Expander High Speed (alarm at 300 rpm).
 - 8.5.1.9.1 Expander high speed will be indicated
at SI-102 (Expander Panel).
 - 8.5.1.9.2 Adjust vari-drive to reduce speed.
 - 8.5.1.9.3 If abnormality cannot be explained,
initiate a planned shutdown as per
Procedure 6.12.
- 8.5.1.10 SA-102-2 Expander Low Speed (alarm at 112 rpm).
 - 8.5.1.10.1 Expander low speed will be indicated
at SI-102 (Expander Panel).
 - 8.5.1.10.2 Adjust vari-drive to increase speed.
 - 8.5.1.10.3 If abnormality cannot be explained,
initiate a planned shutdown as per
Procedure 6.12.
- 8.5.1.11 FA-101 Compressor Cooling Water Flow (alarm at
100 gpm).
 - 8.5.1.11.1 Compressor cooling water low flow will
be indicated by a higher than normal
temperature.

- 8.5.1.11.2 Check a possible low reading on gage PI-100.
- 8.5.1.11.3 Check channel 101 instrument valves.
- 8.5.1.11.4 Monitor temperature indicators to insure that temperature does not exceed 350°F while adjusting cooling water valves, if necessary, if temperature exceeds 350°F, initiate a planned shutdown as per Procedure 6.9.
- 8.5.1.12 LA-102 Liquid Nitrogen Low Level (alarm at 12 psig or 30 inches).
 - 8.5.1.12.1 Liquid nitrogen low level will be indicated at LIC-102 (Cold Box).
 - 8.5.1.12.2 Check LCV-132 open.
 - 8.5.1.12.3 Check for adequate air supply at valve and associated instrumentation.
 - 8.5.1.12.4 Check LN₂ trailer to insure an adequate supply of LN₂ is available.
 - 8.5.1.12.5 Open X-132-N full.
 - 8.5.1.12.6 Check valve Y-132 open.
 - 8.5.1.12.7 Check TI-102-2 and TI-102-3 for high temperature.
 - 8.5.1.12.8 Adjust C-102-HH to restore normal temperature.
 - 8.5.1.12.9 Monitor TI-102-4; if temperature rises above 150°R, initiate a planned cold end shutdown as per Procedure 6.10, 6.11 and 6.12.

- 8.5.1.13 ETA-102 Expander Trip
 - 8.5.1.13.1 Confirm that expander has stopped and brake applied.
 - 8.5.1.13.2 Check PCV-130 open.
 - 8.5.1.13.3 Insure AV-108 is closed.
- 8.5.2 Annunciator "C"
 - 8.5.2.1 FA-110-2
 - 8.5.2.1.1 If loss of flow is caused by a rupture within the CV, immediately close AV-109 and AV-110.
 - 8.5.2.1.2 A low flow will be indicated on TR-110.
 - 8.5.2.1.3 Check for adequate air supply to FX-110 and associated valves.
 - 8.5.2.1.4 Check the following valve positions:

FCV-148	closed	AV-109	open
B-115-HL	closed	AV-110	open
C-123-T	closed		
C-128-T	closed		
C-129-T	closed		
 - 8.5.2.1.5 Check PIC-103 set correctly.
 - 8.5.2.1.6 Check expander speed.
 - 8.5.2.1.7 Check PCV-130 position.
 - 8.5.2.1.8 Check expander bloy-by, FI-131.
 - 8.5.2.1.9 If abnormality cannot be explained, initiate a planned shutdown as per Procedure 6.9.

- 8.5.2.2 FA-110-1 Helium Flow (Lo Lo).
- 8.5.2.3 PA-109 Capsule Inlet Pressure (Hi).
- 8.5.2.4 RA-103 Hot Cave Filter (Hi Rad).
- 8.5.2.5 RA-104 Hot Cave Vent (Hi Rad).
- 8.5.2.6 RA-110 H_e Return Line (Hi Rad).
- 8.5.2.7 TA-1C-1 Sample Temperature Hi Hi.
- 8.5.2.8 TA-1C-2 Sample Temperature Hi Hi.
- 8.5.2.9 Compressor Shutdown (Lo Lo Lube, Lo Lo Suction Pressure, Lo Lo Suction Temperature).
- 8.5.2.10 Emergency Retraction - Compressor Shutdown (Hi Hi Sample Temperature Lo Lo Helium Flow).
- 8.5.2.11 Scram Compressor Shutdown (Hi Hi Sample Temperature Lo Lo Hi Flow).

8.6 W-1 SYSTEM ABNORMALITIES

8.6.1 Loss of Cold Box Vacuum

- 8.6.1.1 A loss of cold box vacuum will be indicated by slowly rising cold end system temperatures and higher than normal vacuum readings in cold box area.
- 8.6.1.2 Check that vacuum pump is operating properly. If inoperative, replace with another vacuum pump.
- 8.6.1.3 Check that valve X-138 VAC is open and P-138 if closed.
- 8.6.1.4 Check pressure vacuum gage on cold box. If pressure exceeds atmospheric pressure, initiate a planned shutdown as per Procedure 6.9.

NOTE: Upon a loss of cold box vacuum pump, system can normally be operated for several days without any abnormalities. Close X-138 VAC.

8.6.2 TA-102-10 (Alarm at °F)

- 8.6.2.1 Cold box inlet high temperature will be indicated by slowly rising temperatures within cold box.
- 8.6.2.2 Check TI-109.
- 8.6.2.3 Check 25 KW heater operating properly.
- 8.6.2.4 Check flow rate at FR-110.
- 8.6.2.5 Check TI-102-5.
- 8.6.2.6 If abnormality cannot be explained, initiate a cold end shutdown as per Procedure 6.9.

8.6.3 Compressor Seal Oil

**8.6.3.1 Loss of seal oil pressure will be indicated at
PI-101-5 and PI-101-6.**

**8.6.3.2 Check oil level, check for leaks and repair if
possible.**

8.6.4 Thaw Blower High Discharge Temperature

8.6.5 Thaw Blower Low Suction Temperature

8.6.6 Thaw Heater High Element Temperature

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8.7 W-1 SYSTEM EMERGENCY FLOW

To be written at a later date.

8.8 HT-1 INSERTION MACHINE ABNORMALITIES

8.8.1 Thrust - High Thrust Alarm on Channels A and B

8.8.1.1 Insure Insertion Machine has stopped.

8.8.1.2 Check alignment indicator to verify alignment.

8.8.1.3 Verify high thrust readings and Channels A and B.

8.8.1.4 Notify the Experimental Equipment Supervisor and WANL supervision.

8.8.1.5 Do not attempt to restart the machine until the cause of the trip-out has been determined; and then only with the permission of the Experimental Equipment Supervisor and WANL supervision.

8.8.1.6 If permission is given for restart, obtain the thrust lockout key from the XO. The key is located in Key Cabinet No. 1 in the XCR; Key No. 27.

8.8.1.7 Insert the key into the lock switch. Momentarily turn the key to "Close" and then to "Open".

8.8.2 Torque - High Δ RPM on Logic Panel

8.8.2.1 Insure Insertion Machine has stopped.

8.8.2.2 Manually operate the gear box and obtain torque values for the direction in which the machine is being used.

8.8.2.3 If the torque values do not exceed 120 inch-pounds for insertion or 60 inch-pounds for withdrawal, a restart may be attempted.

- 8.8.2.4 With the permission of WANL supervision and the concurrence of the Experimental Equipment Supervisor, the insert and/or withdraw potentiometer settings for the clutch may be increased to a maximum dial setting of 55.
- 8.8.2.5 Restart the machine.
- 8.8.3 Alignment - Alignment Alarm on Skew Demodulator
 - 8.8.3.1 Stop the Insertion Machine.
 - 8.8.3.2 Insure LVDT arm is in position.
 - 8.8.3.3 Insure capsule is properly secured in the Insertion Machine carriage clamp.
 - 8.8.3.4 Continuously monitor thrust. If thrust is normal, continue operation.
 - 8.8.3.5 If thrust approaches trip value, stop the machine and notify the Experimental Equipment Supervisor and WANL supervision.
- 8.8.4 Sump Level - High Level in Motor Sump
 - 8.8.4.1 De-energize the drive motor by tripping breaker S1 and breaker No. 4.
 - 8.8.4.2 Open the motor starter cover and take meggar readings on T1, T2 and T3.
 - 8.8.4.3 If meggar values are satisfactory, continue operation taking meggar readings every half hour.
 - 8.8.4.4 If meggar values are below acceptable limits, remove the capsule if it is inserted. If not inserted, do not attempt insertion. Notify the Experimental Equipment Supervisor and WANL supervision.

8.8.5 Seal Pressure - Lo Pressure Alarm on PI-3.

8.8.5.1 Check de-ionized water supply pressure on PI-2.

8.8.5.2 Check that the seal system valve lineup is in the following condition and the seal pump is running:

SP-V1	open	SP-V7	closed
SP-V2	open	SP-V9	closed
SP-V4	open	SP-V11	closed
SP-V5	open	SP-V10	open
		SP-V12	open

8.8.5.3 Visually check for piping leaks.

8.8.5.4 Monitor seal leakage flow on FI-1.

8.8.5.5 If leakage is excessive, notify the Experimental Equipment Supervisor and WANL supervision.

8.8.5.6 Do not withdraw the capsule. With the permission of WANL supervision and concurrence of the Experimental Equipment Supervisor, the capsule may remain in HT-1.

8.9 BELLOWS RUPTURE

- 8.9.1 A rupture of the bellows would be indicated by the pressure gage downstream of the accumulator. If the gage is reading less than the primary cooling water system pressure and suddenly increases to that pressure, or if the gage is reading greater than the primary cooling water pressure and suddenly decreases to that pressure, then a bellows rupture is indicated.
- 8.9.2 If a rupture occurs, close SA-V1.
- 8.9.3 Do not make any further attempts to pressurize the bellows.
- 8.9.4 Refer to Procedure 8.10 of the Experimental Test Package for experiment requirements.

8.10 EXPERIMENT ABNORMALITIES

- 8.10.1 Corrective actions for experiment abnormalities will be in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for specific actions.

8.11 POWER FAILURE

- 8.11.1 In the event of a complete site power failure, the reactor will scram and all operating equipment will stop. If the capsule is inserted, it must be withdrawn as quickly as is reasonably possible.
 - 8.11.1.1 Obtain the Experimental Equipment Supervisor's or Shift Supervisor's permission to enter the CV.
 - 8.11.1.2 Using battery power lights, attach a sample thermocouple to a portable potentiometer and monitor the temperature.
 - 8.11.1.3 Manually withdraw the capsule until the temperatures stabilize at a safe level.
 - 8.11.1.4 As soon as practical, notify the WANL supervision.
- 8.11.2 Other system or equipment power failures will result in alarms. Follow the corrective actions for the actuated alarms.

8.12 CONTAINMENT VESSEL EVACUATION

- 8.12.1 The experiment operator must evacuate the containment vessel immediately through the nearest exit when evacuation is ordered.
- 8.12.2 After evacuating the containment vessel and before leaving area, remove protective clothing and proceed immediately to the XCR.
- 8.12.3 Monitor the alarm and shutdown panel in XCR.
- 8.12.4 Notify WANL supervision.
- 8.12.5 Alert the Experimental Equipment Supervisor that if an experiment off-normal condition is indicated, permission for special re-entry to the containment vessel may be requested.
- 8.12.6 Request Health Safety to provide a complete set of protective clothing and air breathing equipment if re-entry is possible.
- 8.12.7 Change into clean protective clothing and air breathing equipment and stand by should containment vessel re-entry be required.
- 8.12.8 If an off-normal condition occurs as indicated by a summation alarm, request permission from the Experimental Equipment Supervisor to enter the containment vessel immediately. If permission is granted, carry out the appropriate abnormal operating procedure. If special re-entry permission cannot be obtained, take whatever actions are possible to place the equipment in a non-hazardous condition.
- 8.12.9 If a scram condition occurs as indicated by the experiment shutdown panel, verify with the Experimental Equipment Supervisor that the reactor has scrammed.
- 8.12.10 If site evacuation is ordered, the experiment operator must evacuate the containment vessel immediately and follow the prescribed PBRF site evacuation procedures.

SECTION 9

POST IRRADIATION TESTING

9.1 DOSIMETER DISASSEMBLY

9.1.1 Initial Conditions

- 9.1.1.1 Dosimeters in-cell, either attached to an experiment or unattached as a result of prior removal.
- 9.1.1.2 Clean blotter paper on table.
- 9.1.1.3 Tools and accessories in-cell.

9.1.2 Dosimeter Removal

- 9.1.2.1 Cut any holddown or safety wiring with wire cutters.
- 9.1.2.2 Cut any welds securing dosimeter with either a hack saw or grinder.

9.1.3 Dosimeter Disassembly

- 9.1.3.1 Secure dosimeter tube in jaws of circumferential slitter.
- 9.1.3.2 Cut 1/4 inch from one end to remove crimped section of tube.
- 9.1.3.3 Slide contents out of tube and place each item in one of the numbered vials.
- 9.1.3.4 If difficulty is encountered in removing contents, remove 1/4 inch from the other end of the tube, and gently push contents out using a small rod.
- 9.1.3.5 Put all waste material into 1-gallon cans for disposal.
- 9.1.3.6 Monitor radiation level of vials and depending on results, store either in a 1-gallon can or a shielded container pending further disposition.

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9.2 HOT CELL EXAMINATION

- 9.2.1 Hot Cell examination will be in accordance with sponsor's test specifications. Refer to Experimental Test Package for specific operations.**

9.3 POST IRRADIATION ENVIRONMENTAL TESTING FACILITY EXAMINATION

- 9.3.1 Examination in the Post Irradiation Environmental Testing Facility will be in accordance with the sponsor's test specifications. Refer to the Experimental Test Package for specific operations.

9.4 DISPOSITION OF EXPERIMENT COMPONENTS

- 9.4.1** Disposition of components will be in accordance with sponsor's test specifications. Refer to Experimental Test Package for specific details.

SECTION 10

W2-3 SYSTEM DRAWINGS

10.1

10.2

SK-110
HOT CELL GAS SYSTEM

NOTE: Dotted line applied to differential pressure transducer tests only.

SK 111
CV GAS SYSTEM

SECTION 11

W-1 SYSTEM DRAWINGS

INSTRUMENTATION SYMBOLS	
SYMBOL	2 ND OR 3 RD POSITION
A	PROCESS VARIABLE
C	ALARM
D	CONTROLLER
E	DIFFERENTIAL
F	ELEMENT
I	FLOW
L	AMPERAGE
N	LEVEL
M	MANUAL
P	INDICATOR
R	PRESSURE
S	RECORDING
T	TEMPERATURE
U	SPEED
V	SWITCH
X	VOLTAGE
Z	POSITION
	TRANSMITTER
	RELAY

PUMPING LEGEND & MATERIAL SPECIFICATION CODE			
SIMBOL	SERVICE	SPEC.	MATERIAL
HN	GASEOUS HELIUM HIGH PRESS: 100 PSIG	M3	CARBON STEEL
		M3	INVAR W/IN. JAQUET SCHEM
HL	GASEOUS HELIUM LOW PRESS: 100 PSIG	M3	CARBON STEEL
		M3	INVAR W/IN. JAQUET SCHEM
N	NITROGEN LIQUID LOW PRESS: 100 PSIG	M3	CARBON STEEL
		M3	INVAR W/IN. JAQUET SCHEM
T	THANK LINES	M3	STAINLESS STL. SCH 40S
		M3	STAINLESS STL. SCH 10S
W	VACUUM LINES	M3	STAINLESS STL. SCH 40S
		M3	STAINLESS STL. SCH 10S
W	WATER/COOLING WATER SUPPLY TIE	M3	CARBON STEEL
W	WATER/COOLING WATER RETURN	M3	CARBON STEEL
TA	INSTRUMENTATION AIR 100 PSIG	M3	CARBON STEEL

LOCAL PANEL DESIGNATIONS	
R.B. MCC	REACTOR BUILDING MOTOR CONTROL CENTER
C.B. MCC	COMPRESSOR BUILDING MOTOR CONTROL CENTER
IR	LOCAL PANEL AT COMPRESSOR
E	LOCAL PANEL AT EXPANDER
COLD BOX	LOCAL PANEL AT COLD BOX
RCR	REACTOR CONTROL ROOM
Y1A	LOCAL PANEL INSIDE CONTAINMENT-EL -0'-0"
Y2	LOCAL PANEL AT HOT VESSEL
Y3	LOCAL PANEL IN REACTOR BUILDING BASEMENT
Y4	LOCAL PANEL IN COMPRESSOR BUILDING

LEGEND

GATE VALVE
GLOBE VALVE
BUTTERFLY VALVE
CHECK VALVE
AIR OPERATED CONTROL VALVE
MANUALLY OPERATED VALVE WITH PNEUMATIC OVERRIDE
3 WAY SOLENOID VALVE
REDUCER
RELIEF VALVE
BALL VALVE
NEEDLE VALVE
— F — FLOW ORIFICE
— R — RESTRICTION ORIFICE
— C — HOSE CONNECTION
— S — SIGHT FLOW INDICATOR
VACUUM JACKETED FLEXIBLE HOSE
PLASTIC BENDA TURNING
— E — ELECTRICAL CONTROL
GEOGRAPHIC BOUNDARY
— P — PIPED PIPE
BLIND FLANGE OR NUTPIPE END
FLOW FROM DE-SUBMERGED
PIPE INTO FLOW LINE
CAPPED PIPE (UNLOADED)
— D — DRYER COUPLING

1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
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LOOP SHUTDOWN BLOCK DIAGRAM

SK 154

11.4

11.5

11.6

PS-YA
V.E. Type H-5
Model 270
0-200 psi
Set at 60 psi

INSTRUMENT AIR TUBING SCHEMATIC

SK 143

COLD BOX WARM END HELIUM OUTLET FLOW

SK 148

THAW BLOWER SUCTION TEMPERATURE MONITOR

SK 133

COOLING WATER FLOW DIAGRAM

SK 134

COMPRESSOR DISCHARGE PRESSURE MONITOR

PIX-II3

Foxboro 45
0-100 psi range & scale
3-15 psi out

PS-II3

Barksdale D2T-A150
6.7-150 psi range
300 psi proof
Set pole 1 at 55 psi ↓ (alarm)
Set pole 2 at 50 psi ↓ (shutdown)

PI-II3

Robertshaw 3-15 range
0-100 scale

COMPRESSOR INLET PRESSURE MONITOR

TS-113-1, 2

UE Type E-5, Model 84

-50 to +150°F

Set TS-113-1 at 42°F↓(alarm)

Set TS-113-2 at 40°F↓(shutdown)

SK 145

COMPRESSOR INLET TEMPERATURE MONITOR

SK 146
COMPRESSOR INLET PRESSURE CONTROL

SK 138

EXPANDER INLET TEMPERATURE MONITOR

SK 156
12.6.26
EXPANDER INLET TRIP VALVE

FI-131

Barton 227
500 psi SWP
0-30" WC ΔP
0-100 sq ft scale
Reading x 30 (in SCFH)

FE-131

0-30" WC

SK 150
EXPANDER BLOWBY INDICATOR

Moore Hl selector

11.22

SK 140
EXPANDER DISCHARGE TEMPERATURE MONITOR

All Valves 6-30 psi
SK 131

CAPSULE ISOLATION PILOT VALVE PANEL

11.25

PdI-103

Barton 227
150 psi SWP
0-50" H₂O
Range & scale

PdX-109

Honeywell
2500 psi SWP
0-400" H₂O in
4-20 MA out

PX-109

Honeywell
0-120 psi in
4-20 MA out

PS-109

Barksdale DZT-A150
300 psi proof
0-150 range
Set at 110 psi ↑

PdR-109

Honeywell 4-20 MA
Recorder, 0-100
linear scale
PX reading x 1.2 (in psi)
PdX reading x 4 (in H₂O)

SK 139

CAPSULE ΔP MONITOR

FX-110

Foxboro Series I3
0-50" WC in
3-15 psi out

FR-110

Honeywell
3-15 psi in
0-10 sq rt scale
Reading x 180 (in lb/hr)

FS-110-1, 2

Barksdale D2T HI5
3-15 psi range

FS-110-1

Set Pole 1 at 8.34 psi ↓
Set Pole 2 at 8.34 psi ↓

FS-110-2

Set Pole 1 at 12.7 psi ↓ (alarm)
Pole 2 not used

SK 141

CAPSULE OUTLET FLOW MONITOR

HOT CAVE ΔP MONITOR

PdI-I04, I05

Dwyer Model 2005
0-5" H₂O ΔP

SK I37

HOT CAVE EXHAUST ΔP MONITOR

SK 147
EMERGENCY FLOW CONTROL

FE-149

Critical Flow Orifice
D-605425

SK 152

EMERGENCY FLOW COLD BOX HELIUM VENT

<u>Valve</u>	<u>Setting (psig)</u>
117-1	100
118	120
119	80
120-1	110
121	15

Above Detail Typical for the Following:

<u>Pressure Tap</u>	<u>Valve</u>	<u>Line</u>	<u>Function</u>
P-117-HH	PV-117-1	HH-117-1 1/2"-M10	Trailer He to Surge Drum
P-118-HH-2	PV-118	HH-118-1 1/2"-M10	Trailer He to Cold Box
P-119	PV-119	HH-119-1 1/2"-M1	Surge Drum He to Cold Box
P-120-HH-3	PV-120-1	HH-120-1 1/2"-M10	Bottle He to Cold Box
P-121-HL	PV-121	HL-121-1"-M1	Surge Drum He to Thaw System (Normal Make-Up)

SK 153

EMERGENCY FLOW & BACKUP SYSTEM

<u>Instrument</u>	<u>Set Point</u>
PIC-103	1000 psig
PC-130	100 psig
MC-148	0 psig
MC-116	65 psig
PC-117-1	100 psig
PC-118	120 psig
PC-119	80 psig
PC-120-1	110 psig
PC-121	15 psig
LIC-102	90% (36 in.)
PS-101-1	Pole 1, 18 psig; Pole 2, 15 psig
PS-101-2	1100 psig
LS-102	12 psig
PS-102	Pole 1, 12 psig; Pole 2, 10 psig
PS-109	110 psig
PS-113	Pole 1, 55 psig; Pole 2, 50 psig
PS YA	60 psig
TIS-101	850°F
TIS-103	850°F
TIS-125	250°F
TRS-IC-2	No. 1 & No. 2, 260°R, No. 3 & No. 4, 200°R, No. 5 & No. 6, 100°R
TRC-111	25% (87°R)
TS-108	7.16 psig (88°R)
TS-111	3.00 psig (50°R)
TS-113-1	42°F
TS-113-2	40°F
TS-125-1	275°F
TS-125-2	-25°F
TS-1C-1	160°R
TS-2C-1	160°R
FS-101	6.25 psig
TS-110-1	Pole 1, 8.34 psig; Pole 2, 8.34 psig
FS-110-2	Pole 1, 12.75 psig; Pole 2 not used
RIS-103	100 mr
RIS-104	1 mr
RIS-110	1 mr
SS-102-1	315 rpm
SS-102-2	100 rpm

INSTRUMENTATION SET POINTS