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Subcontract NP-1

WANL-TME-1343

20 December 1965

Westinghouse Astronuclear Laboratory

ACTIVATION PLAN FOR THE W-1 LOOP

MASTER

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PBRF Test System Design

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SECTION 1

INTRODUCTION

This report defines the work program and schedule required to activate the W-1 loop to a point where an irradiation could be accomplished in December 1966.

Instead of presenting every step-by-step detail, this report outlines the scope of the work to be accomplished and the schedule for same.

All schedules presented herein are predicated upon a final completion date of the SNPC-20 work prior to 30 April 1966. It is also assumed that the W-2 loop test program is to be completed during February 1966.

Elements of the proposed work program are outlined below:

- 1) Surveillance of SNPC-20 Contractor.
- 2) Preparation of procedures and performance of a system test and checkout program.
- 3) Preparation of designs and modifications of the facility.
- 4) Preparation of an Operation Manual.
- 5) Preparation of a Maintenance Manual.
- 6) Preparation of procedures to control operating supplies.
- 7) Maintenance of up-to-date drawings and manuals to reflect "as-built" conditions.
- 8) Preparation and direction of an operator training and qualification program.

SECTION 2

SNPC-20 CONTRACTOR SURVEILLANCE PROGRAM

General

This program consists of rendering engineering support to SNPO-C as outlined below to assure:

- 1) Completion of the W-1 loop facility by the SNPC-20 Contractor in accordance with the contract documents.
- 2) Satisfactory performance of the various systems and components within the scope of the SNPC-20 contract.

Description

To accomplish the above stated aims, WANL will perform the following functions.

- 1) Review contractor and vendor drawings and specifications to assure conformance requirements of the facility.
- 2) Review requests by the contractor for changes and amendments to the contract requirements.
- 3) Review as-built drawings to assure agreement with the actual facility and with the contract documents. These drawings then form the basic description on the W-1 loop.
- 4) Inspect equipment in vendors' shops and installation at the site to assure quality of materials and workmanship and conformance with the contract documents. This includes the review of procedures, the surveillance of equipment and system pressure tests, helium leak tests, radiographic and other non-destructive tests, cleaning routines, etc.

5) Monitor construction at PBRF to assure adherence to the contract requirements as to installation details from an engineering standpoint, and recommend resolution of technical questions.

6) Review the Contractor's operating manual for correctness, completeness, and suitability for the as-built facility. The manual will be incorporated into the overall facility operations manual to be prepared by WANL.

7) Review the contractor's checkout, performance, and acceptance test procedures. Assure that these procedures are correct and sufficiently complete and detailed to demonstrate conformity of each item of equipment and the overall system with the design, performance and functional requirements of the contract.

8) Prepare surveillance procedures for implementing contract requirements as to checkout, performance and acceptance tests.

9) Witness checkout, performance, and acceptance tests, assuring conformance with approved Contractor procedures. Observe and record all operations, inspections, data recordings, actual rates of helium makeup to system (leakage), system and mechanical operating or control anomalies and potential problem areas. Review and evaluate test results in accordance with the contract documents. Recommend acceptance, retest, and modifications as required.

SECTION 3

WANL TEST AND ACCEPTANCE

This section describes system and equipment operational tests to be performed by WANL after acceptance of the W-1 loop by the Government. These tests will determine the range of operating characteristics of the loop. The suitability of the various components to perform as required in conducting actual in-pile experiments will be investigated in accordance with specific procedures prepared by WANL. Operation of the system during this test program will be an integral part of the operator training program.

Refrigeration Systems Tests

Test Procedures

WANL will prepare test procedures defining the following tests.

- 1) Determination of the range of capability of the compressor, expander, and cold box.
- 2) Mapping of loop characteristics by varying appropriate parameters (i.e., expander discharge pressure and temperature, compressor suction and discharge pressures). Maximum refrigeration capacity and the effect of operation at reduced capacity will be determined.
- 3) Operation of the loop for the anticipated maximum test duration to demonstrate system reliability and determine if any modifications to the system or operating procedures are necessary to assure continuous operation. Gel trap capacity for this duration will be verified.

- 4) Thaw of the capsule, gel trap, cold box, and expander using the thaw system to verify its operation and determine thaw cycle time.
- 5) Introduction of normal and emergency system perturbations during system operation to verify response and function of control and safety circuits and equipment.
- 6) A buoyancy test to determine the shift, if any, between the capsule in air and submerged in water.

Performance of Test

WANL will perform the checkout and test program in accordance with the test procedures outlined in the above paragraph.

In-Reactor Tests

Test Procedures

To ensure the compatibility of the W-1 cryogenic capsule with Plum Brook Reactors horizontal through-tube (HT-1) procedures will be written for the following tests and operations.

- 1) An alignment test to ensure that an annulus is maintained during insertion of the capsule into HT-1.
- 2) A reactivity worth test with the capsule at operating conditions and using a dummy sample.

Performance of Test

WANL will perform the checkout and test program in accordance with the test procedures outlined in the above paragraph.

SECTION 4

FACILITY MODIFICATIONS AND ADDITIONS

This section describes the known modifications and additions which must be made to the system by WANL. These modifications are divided into two groups to distinguish between work that must be done before the Contractor is finished, and work that cannot be done until after the contract is complete.

WANL will perform the following functions for the modifications listed below.

- 1) Prepare design and installation drawings, including quality assurance requirements.
- 2) Procure, fabricate, and install the required equipment and systems.
- 3) Prepare performance test procedures.
- 4) Accomplish performance testing.

Modifications Required Prior to Completion of the Contractor's SNPC-20 Work

- 1) New HT-1 Gate Valve - The present gate valve has excessive leakage and must be replaced with a new body and disc. The components are on order and will be installed during the first prolonged shutdown of the reactor after January 1966.
- 2) Dummy Capsule - To allow completion of the acceptance tests before the real capsule is delivered, a dummy capsule is being fabricated. This dummy capsule is made of vacuum-jacketed piping held by a charging flange suitable for mounting on the Hot Cave Charging Machine.

- 3) Y1A Panel - This terminal panel is being installed in the base of the present W-2 loop control console to allow the Contractor to complete the wiring.
- 4) In-Quadrant Tube Grabber - To allow maneuvering of the capsule in the quadrant, a tool must be designed and fabricated to firmly grasp the capsule with no resulting damage to the surface finish.
- 5) Air Dryer - Filters - The PBRF process air supply is known to be very dirty. To prevent this dirt from contaminating the W-1 loop lines, air dryer filters should be installed prior to operation.
- 6) Hot Cave 'C' Charging Machine - To allow the insertion of the capsule into the hot cave for disassembly, a charging machine will be installed in Quadrant C.

The time required to install the machine will be reduced by conducting a component compatibility test program at WANL prior to shipment.

The alignment of the machine with the hot cave transfer sleeve will be accomplished so that it will be suitable for both the W-1 capsule and the Lewis Lab capsule.

Final Loop Modifications

- 1) Hot Cave 'C' Sleeve Sight Glass - To alert the hot cave operator as to when it is safe to open the sleeve doors, the addition of a sight glass is required to indicate the water level.
- 2) Arming of Scram System from HT-1 Gate Valve - An electrical interlock is required to prevent inadvertent scrambling of the reactor if the HT-1 gate valve is closed.
- 3) Automatic Emergency Capsule Withdrawal - An electrical interlock system is required to withdraw the capsule from the reactor in the event of the following emergencies:

High Experiment Temperatures

Low Helium Flow

Low Water Flow

4) Miscellaneous HT-1 Charging Machine Modifications - To adapt the HT-1 charging machine for use with the W-1 capsule, the following modifications are required.

- a) Extension of the rear manual drive.
- b) Installation of a load cell system to measure thrust imparted to the clamp and stop the machine if excessive thrust is reached.
- c) Relocation of the rear alignment jack.
- d) Installation of a capsule position indicator system
- e) Install rollers to limit sideways movement of the clamp.
- f) Install a wiper on the main drive shaft.
- g) Provide wear strips on the top of HT-1.
- h) Modify the rear main shaft bearing.
- i) Improve the clamp opening mechanism.
- j) Modify the alarm annunciator system.

5) Scram to Cutback - In accordance with the approved design manual and hazards analysis, change the requirements for scrambling the reactor to a cutback.

6) Automatic Initiation System for Emergency Helium - The present emergency helium system required manual initiation. This will be changed to an automatic initiation system in the event of low helium flow.

7) Summation Alarm to the Reactor Control Room - To provide the Reactor Control Room with a "loop trouble" indication alarm.

8) Hot Cave 'C' Alarm - To provide an alarm when the rear hot cave door is opened.

9) Re-align HT-1 Charging Machine - Due to the change in buoyancy between the W-2 and the W-1 capsules the HT-1 charging machine will require re-alignment.

10) W-2 Loop Operation to XCR - To allow for the monitoring of both the helium and water parameters from outside the reactor containment vessel together with associated alarms, the present W-2 loop controls must be relocated to the Experiment Control Room.

11) Auxiliary Helium Cooling System - In the event of a call for reactor containment, both the normal and emergency helium supplies are cut off. To provide cooling while the capsule is being withdrawn from the reactor, a separate helium supply must be provided. This system may take bottled helium to the capsule and exhaust it into the CV or it may be a recirculating system.

12) Radiation Monitors - System No. 1 is required to ensure that no hazardous conditions will develop due to the leaking of radioactive helium. It will consist of an in-stream gas radiation monitor. System No. 2 is required in the event of a call for emergency helium flow. The quantity of radioactive material released must be recorded. It will consist of a radiation monitor and recorder at the emergency helium release point.

13) Absolute Gas Filter - To prevent any radioactive particulate from circulating in the system, the installation of a 0.3 micron filter is required to replace the one previously provided by the SNPC-20 Contractor.

14) Experiment Transfer Equipment - At present there is no provision for transferring a radioactive experiment from the hot cave to the hot cells. To keep the experiments dry, the design of a water-proof container together with the necessary handling equipment will be required.

15) Hot Cave 'C' Tools - To allow efficient operation in the hot cave, the design of special tools will be required to allow the intricate disassembly operations to be performed.

16) Hot Cave 'C' Source Test - To ensure that the shielding of the hot cave is adequate, a source test will be made by PBRF. WANL will review the results and install any additional shielding required.

17) Capsule Installation - To enable the completion of the SNPC-20 contract on schedule, it will be necessary for WANL to connect the capsule and associated instrumentation to the W-1 system.

This work will be done in accordance with the SNPC-20 specification in all aspects including final inspection.

- 18) Miscellaneous - These items include:
- a) Installation of an emergency exit from the compressor building.
 - b) Addition of control lights on the 225 KVA-MCC.
 - c) Placement of the emergency helium exit line to allow discharge in a safe manner from the top of the cold box.

SECTION 5

MANUALS

Operations Manual

An Operations Manual will be prepared in accordance with PB XSP-1003-R1 and will follow the outline given below. The Operations Manual will be revised as necessary to operate the W-1 loop in the safest and most efficient manner.

- 1) Receiving Experimental Equipment - This section will include instruction steps on handling, unpacking and storage of experimental equipment.
- 2) Experiment Insertion and Handling - Step-by-step procedures covering the insertion and withdrawal of the W-1 capsule in HT-1 and the hot cave insertion tube and the special handling that is required to complete these operations will be detailed in this section.
- 3) Pre-Loop Startup Procedures - This section will contain a check list of items which must be completed before starting the cryogenic system or auxiliary equipment.
- 4) Reactor Startup Procedures - This section will contain a check list of items which must be completed before reactor startup to assure that the system and experiment are ready for reactor operation.
- 5) Startup Procedures - This section will contain instruction steps to startup the loop and its auxiliary systems. Special experiment monitoring to be done during a reactor startup together with the actions that will be taken if the parameters are other than the expected values will be included.

- 6) Operating Procedures - This section will contain normal operating instructions together with the frequency and type of data to be recorded.
- 7) Loop Shutdown - This section will contain instruction steps to shutdown the loop and its auxiliary systems. Data to be recorded from the time shutdown is initiated until the experiment is removed will be included.
- 8) Abnormal and/or Emergency Procedures - Procedures for all alarms including the following events will be detailed in this section:
 - a) Loss of primary pumps.
 - b) Loss of coolant flow.
 - c) Loss of power to experiment.
 - d) Power failure at PBRF.
 - e) Evacuation of containment vessel.
 - f) Experiment equipment failure or malfunction.
 - g) Unplanned reactor power cutback
- 9) Removal of Experiment After Shutdown - This procedure will detail such items as temporary storage requirements, radiation surveys, disassembly procedures, and underwater transfer from hot cave 'C'.
- 10) Hot Cave 'C' Procedures - This procedure will outline all manipulations and tests to be done in the hot cave including disassembly tests and reassembly routines.
- 11) Experiment Disposition - This procedure will detail packaging and shipment of experiment components.
- 12) Loop Securing - This procedure will detail the required steps to secure the loop and associated systems for a long term shutdown.

Maintenance Manual

WANL will prepare a complete Maintenance Manual for the guidance of operating personnel in the proper maintenance and service of equipment to ensure dependable and safe operation, increase loop utilization, and minimize failures leading to possible reactor cutbacks

or scrams. This manual will include the individual component maintenance manuals supplied as part of the SNPC-20 Contract to form a composite manual for the entire system. It will also include data listed below.

- 1) Lubrication Schedule, indicating recommended oil specifications and quantities, and frequency for all equipment.
- 2) Preventive Maintenance Schedule, indicating inspection and replacement requirements, procedures, and frequency for all applicable equipment.
- 3) Major Equipment Overhaul Schedule, including major overhaul requirements, procedures, and schedules for applicable equipment.
- 4) Maintenance Control Forms, including check lists and log sheets for each category of maintenance.
- 5) Tools and Equipment Tabulation, listing tools and equipment for performing all maintenance and checkout of equipment.

Final Design Manual and Hazards Analysis

The Design Manual and Hazards Analysis will be revised to include all changes made to the system prior to the end of June 1966. Changes made after June 1966 will be issued as revision sheets to the final Design Manual and Hazards Analysis.

SECTION 6

OPERATOR TRAINING AND QUALIFICATION PROGRAM

Training Program

To qualify operators for the W-1 cryogenic loop, an extensive, formal training program will be conducted. The basic goal of this program is to insure that all operators possess the knowledge, ability and experience for the safe and efficient operation of this loop and associated equipment.

To achieve this goal an Operator Qualification Guide will be prepared which will delineate the requirements for operator qualification. This guide will cover the major sub-systems of the W-1 loop in sections. Each section will specify the requirements for system qualification and will include a procedure for obtaining signatures on the check-off sheet. Appropriate check-off sheets will be contained at the end of each section.

The training program to accomplish the above requirements will consist of a two-phase endeavor comprising (1) technical orientation (theory), and (2) practical on-the-job training.

The technical orientation phase will include classroom lectures given by responsible WANL-NASA personnel. During this period, the Design Manual and Hazard Analysis, WANL-TNR-110* the operator qualification guide and vendors technical manuals will be

*WANL-TNR-110, Interim Report, Plum Brook Reactor Facility Cryogenic Loop Design Manual and Hazards Analysis, PBRF Experiment No. 62-16, Volume 1, S. Stein, May 1963, Unclassified

studied. Each formal lecture will be "tailored" to a specific section of the Operator Qualification Manual. At the conclusion of each lecture, classroom discussions will be held followed by a written or oral quiz.

In conjunction with the classroom instruction, practical on-the-job training will be conducted. This phase of the program allows each trainee to familiarize himself with the physical location of all components in the system. During this phase the trainee will "learn by doing" in order to obtain maximum training on qualification and study. Included in this phase of the training program will be the requirement that each trainee demonstrate a knowledge of all hot cave equipment.

Qualification Procedure

Qualification will be demonstrated by ability to operate the various W-1 subsystems based on a sound indoctrination in the theory of operation.

Each trainee will satisfactorily complete the items listed in the Operator Qualification Guide and will be tested by written and oral examination to demonstrate the completeness of his knowledge. The trainee must obtain the signature prescribed on each check-off sheet. The signatures denote agreement that the trainee has fulfilled qualification requirements.

Upon completion of the qualification requirements, each trainee's record will be examined by a 5-man qualification board. Membership of the board will include:

- 1) WANL-PBRF Supervisor - (Chairman)
- 2) Responsible WANL Cryogenics Specialist
- 3) Responsible WANL Instrumentation and Control Specialist
- 4) Responsible WANL Mechanical Equipment Specialist
- 5) PBRF Project Engineer

The board will interview the applicant and may elect to conduct further oral and written examinations if he has weak areas in his qualification program. When qualified the candidate will be issued a Certification of Qualification.

SECTION 7

ADMINISTRATION

Spare Parts

Specific procedures will be compiled for ordering, receiving, identifying, storing and checking out spare parts for the W-1 cryogenic inpile loop. To ensure a minimum system shutdown, an adequate supply of spare parts will be maintained.

Operating Supplies

Gaseous helium, liquid nitrogen and gaseous nitrogen will be government furnished and will be ordered by the PBRF Project Engineer. The Project Engineer will be notified one month in advance of WANL requirements.

Nomenclature Change

All of the drawings and manuals associated with the system will be revised to reflect a new numbering system.

Drawing Revisions

All WANL drawings will be revised to reflect the as-built condition of the loop and associated systems.

APPENDIX A

W-1 LOOP ACTIVATION SCHEDULE