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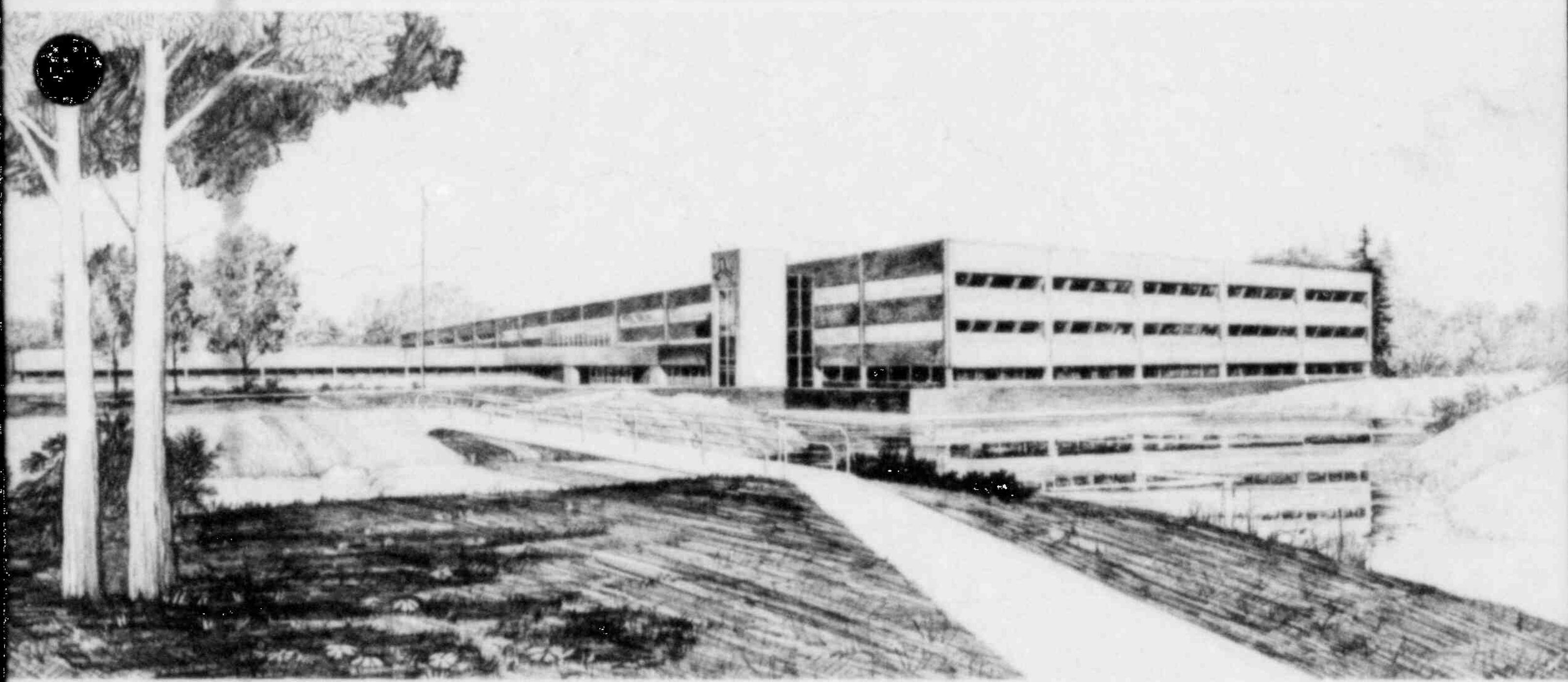
EGG-LOFT-5731
NE L9 Series
EOS L9-3
March 11, 1982

# LOFT EXPERIMENT OPERATING SPECIFICATION
# ANTICIPATED TRANSIENT TEST SERIES L9
# TEST L9-3

NRC Research and/or Technical Assistance Report

M. D. Peters

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



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# INTERIM REPORT

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Idaho Falls, Idaho 83415

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**INTERIM REPORT**

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# LOFT EXPERIMENT OPERATING SPECIFICATION ANTICIPATED TRANSIENTS WITH MULTIPLE FAILURES NUCLEAR TEST L9-3

M. D. Peters
J. E. Koske

March 11, 1982

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LOFT EXPERIMENT OPERATING SPECIFICATION

ANTICIPATED TRANSIENTS WITH MULTIPLE FAILURES

NUCLEAR TEST L9-3

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# FOREWORD

This document provides the programmatic information required by the LOFT Facility Division (LFD) to develop the Experiment Operating Procedure (EOP) for Test L9-3.

Paramete- specifications throughout this Experiment Operating Specification (EOS) are based upon actual process instrumentation indications, those which would directly influence operator action. References to technical specification limits include no correction for error margin or instrument error.

Specifications are subject to revision according to constraints of the Experiment Safety Analysis (ESA).

## ABBREVIATIONS

| | |
|---|---|
| ATWS | Anticipated Transient Without Scram |
| BWST | Borated Water Storage Tank |
| BST | Blowdown Suppression Tank |
| CHF | Critical Heat Flux |
| DAVDS | Data Acquisition and Visual Display System |
| DBR | LOFT Design Basis Report |
| DOE | Department of Energy |
| ECC(S) | Emergency Core Cooling (System) |
| EOP | Experiment Operating Procedure |
| EOS | Experiment Operating Specification |
| ESA | Experiment Safety Analysis |
| ESF | Engineered Safety Feature |
| HEM | Homogeneous Equilibrium Model |
| HPIS | High-Pressure Injection System |
| JEG | Joint Experiment Group |
| LECS | LOFT Experiment Control System |
| LEPD | LOFT Experimental Program Document |
| LFD | LOFT Facility Division |
| LOCA | Loss-of-Coolant Acc ent |
| LOCE | Loss-of-Coolant Experiment |
| LOFA | Loss-of-Feedwater Accident |
| LOFT | Loss-of-Fluid Test (Facility) |
| LOFW-LOCA | Loss-of-Feedwater Induced Loss-of-Coolant Accident |
| LPIS | Low Pressure Injection System |
| MFP | Main Feedwater Pump |

| | |
|---|---|
| MLHGR | Maximum Linear Heat Generation Rate |
| MTA | Mobile Test Assembly |
| NE | Nuclear Experiment |
| NRC | Nuclear Regulatory Commission |
| ODDS | Operational Diagnostic and Display System |
| P&ID | Piping and Instrument Diagram |
| PCCS | Primary Component Cooling System |
| PCP | Primary Coolant Pump |
| PCS | Primary Coolant System |
| PLSS | Plant Log and Surveillance System |
| PNA | Pulsed Neutron Activation |
| POM | Plant Operating Manual |
| PORV | Power Operated Relief Valve |
| PPS | Plant Protection System |
| PSMG | Primary System Motor-Generator (Sets) |
| PWR | Pressurized Water Reactor |
| PZR | Pressurizer |
| QOBV | Quick-Opening Blowdown Valve |
| SCS | Secondary Coolant System |
| SDD | System Design Description |
| SG | Steam Generator |
| SPGR | Specific Gravity |
| $T_{av}$ | Average of $T_h$ and $T_c$ |
| $T_h$ | Hot leg primary coolant bulk temperature, reactor vessel exit bulk temperature |
| $T_c$ | Cold leg primary coolant bulk temperature, reactor vessel inlet bulk temperature |

| | |
|---|---|
| TBS | To Be Supplied |
| TIP | Traversing In-core Probe |
| W | Westinghouse |
| ASME | American Society of Mechanical Engineers |
| CFR | Code of Federal Regulations |
| EFPH | Effective Full Power Hours |
| EP | Experiment Prediction |
| IDAR | Instrument and Date Acquisition Requirement |
| $K_{eff}$ | Effective Neutron Multiplication factor |
| MPa | $10^6$ Pascals |
| MTC | Moderator Temperature Coefficient |
| psia | Pounds per Square Inch, Absolute |

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FIGURES

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LOFT EXPERIMENT OPERATION SPECIFICATION NUCLEAR TEST L9-3

## 1. INTRODUCTION

Anticipated Transients Without Scram (ATWS) for light water reactors have been a long-standing unresolved safety issue of the U.S. Nuclear Regulatory Commission (NRC). The significance of ATWS in reactor safety is that some ATWS events can result in high system pressures which can potentially lead to fuel damage and the release of a large amount of radioactivity into the environment. To address the ATWS issue, the NRC in September 1980 published a proposed ATWS rule to amend the Code of Federal Regulations (10CFR50). Now, after more than a year of public meetings and comments, the NRC is about to issue a revised ATWS rule (November 1981). When the Code of Federal Regulations is amended, it is expected that the regulation will include measures both to reduce the likelihood of ATWS events and to mitigate the consequences of an ATWS once it has occurred. The planning of the L9-3 experiment is based on NRC's regulatory position contained in SECY-80-409[1] and prior publications of the NRC. The L9-3 experiment is intended to simulate the important physical conditions following a loss of feedwater without scram transient hypothesized for future commercial PWRs conforming to the acceptance criteria proposed by the NRC.[1]

Upon loss of feedwater to the steam generators in a PWR power plant, the heat transfer from the primary to the secondary system is degraded as the water inventory in the steam generators decreases. Normally the reactor will trip (insert control rods to shutdown the reactor, or scram) on a signal of low feedwater flow or low steam generator level. In the absence of a scram the steam generators will soon boil dry and most of the heat produced by the reactor core will be dissipated in the primary fluid, raising its temperature. The expansion of the primary fluid associated with its temperature rise at first compresses the vapor space of the pressurizer, causing the spray valve to open. If the pressure continues to increase, the relief and safety valves open. Subsequently the pressurizer will be filled with liquid water and the system pressure will continue to rise to a maximum when the volumetric relief flow rate equals the volumetric expansion rate of the primary fluid. It is this maximum pressure that constitutes one of the primary safety concerns of ATWS events. The LOFT L9-3 experiment is designed to achieve a peak primary pressure that will result in stress levels above the "Level B Service Limit" yet below the Level C limit in commercial PWRs.

Another major concern of a loss of feedwater without scram accident is the long-term shutdown capabilities of PWR systems after the initial peak pressure has passed. The L9-3 experiment will explore a way to depressurize the primary system by latching open the PORV and by using the auxiliary feedwater system to reduce temperature such that high concentration boron solution can be injected into the system to permanently shut down the reactor. This will be at least a first step in bringing the reactor to a stable shutdown condition after a loss-of-feedwater ATWS.

# II. EXPERIMENT OBJECTIVES

To address issues relating to system response and plant recovery procedures following a loss-of-feedwater ATWS in a commercial nuclear power plant, the following programmatic objectives have been established for the L9-3 experiment:

1. Provide experimental data for benchmarking PWR vendors' ATWS computer codes as required by the NRC proposed ATWS rule (USNRC SECY-80-409).

2. Evaluate alternate methods of achieving long term shutdown (without the insertion of control rods) following an ATWS event, to address concerns defined in the proposed NRC staff rul (Federal Register Vol. 46, No. 226).

To support the above programmatic objectives, several specific test objectives for the L9-3 experiment have been defined. In establishing these test objectives, it is realized that resluts from the LOFT experiment will not be directly applicable to the larger commercial plants. However, by application of the codes to LOFT results, it is expected that an assessment of the capabilities of the codes to predict important system response characteristics during and ATWS event in a commercial pressurized water reactor can be obtained. Therefore, the test specific objectives for L9-3 are:

1. To achieve a maximum primary system pressure that is several measuring standard errors above the code safety valve opening pressure setpoint but below 110% of the setpoint pressure.

2. To determine the transient reactor power by using available neutron flux instrumentation and measured core thermal-hydraulic parameters to assess the applicability of the point kinetics model used in predicting transient reactor power.

3. To determine the steam generator secondary dryout behavior and its effect on the primary system response characteristics.

4. To determine the two-phase and subcooled flow characteristics of the experimental pressurizer PORV and safety valve at high pressures [$\geq$17 MPa (2500 psia)].

## III. PREREQUISITES

The following prerequisites must be completed prior to initiating Test L9-3.

1. Complete the Experiment Safety Analysis (ESA) and incorporate all required EOS changes into the Experiment Operating Procedure (EOP).

2. Issue the Experiment Prediction Document.

3. Check out the Data Acquisition and Visual Display System (DAVDS) software using predefined functional and configuration tests.

4. Perform a one point end-to-end check of the process instruments identified in Table 1 within 60 days of the tests. If a problem is indicated, recalibrate the instrument.

5. Verify the location and orientation of accessible experimental instruments and piping.

6. Complete an accumulator blowdown through the test PORV piping assembly to checkout the operation of the instrumentation.

7. Verify that the actuation and reset setpoints are within tolerance for the test PORV (CV-P139-87) and spray valve (CV-P139-5-1).

8. Early in the pre-initiation power run, compare a DAVDS data listing with the control room instrument readings and resolve any discrepancies. As a minimum, compare those instruments identified in Table 1.

9. In addition to the normal PCS leak rate measurement taken each shift, measure PCS leak rate within 3 hours of test initiation.

10. Determine the system steady state heat losses to the environment at normal operating temperature and pressure conditions prior to reactor startup.

11. Complete the pre-test calibration requirements specified in Section V, and DOP 87-005 "DAVDS Experimental Measurements Test Procedure."

12. Assure that a source of 7,000 $\pm$ 200 PPM boron is ready for operation.

13. Inhibit RSS (Reactor Shutdown System) scram signals to prevent reactor scram during the test.

14. The test PORV value shall have been calibrated in the LOFT Test Support Facility loop per the requirements specified in Reference 4.

15. The pressurizer spray valve flow control shall be adjusted to provide a spray flow rate of 12 $\pm$ 2 gpm.

## IV. TEST DESCRIPTION AND REQUIREMENTS

This section is intended for facility and operating personnel use. It provides the system configuration and the initial conditions that must be established prior to initiating the transient, as well as the operator actions required during the transient. All parameters given in this section are "as indicated" by the appropriate process instrumentation.

Experiment L9-3 will utilize the test PORV piping configuration to provide for a small break in the pressurizer. The test PORV relief capacity is 5250 lbm/hr saturated vapor@2350 psia and the simulated safety valve flow will be 6850 lbm/hr saturated vapor at 2500 psia.

The initial conditions for Test L9-3 will be as specified in Table 3.

All operations will be in compliance with the Technical Specifications. Deviations from the Plant Operating Manual (POM) may occur and will be noted in this EOS.

No modifications or alterations should be made to the LOFT systems or data acquisition and instrumentation systems during or after an experiment until approval of the Joint Experiment Group (JEG) is obtained. This is to allow evaluation of a system or component should unexpected experimental results be obtained.

### 4.1 Test Sequence

The following items will be completed prior to test initiation but have no requirement to be done in order.

1. Complete prerequisites established in section III.

2. Complete DAVDS instrument calibrations as set forth in section V.

3. Program and checkout the LOFT Experiment Control System (LECS).

4. Establish the initial conditions required in Table 3.

5. Disable the plant PORV (CV-P139-5-4) by placing handswitch in "CLOSED" position.

6. Operate at power to establish the required decay heat level of Section 4.3.1.

7. Take the water samples required in Section 4.4.

8. Initiate BST recirculation.

9. Isolate purification system.

10. Secure steam generator continuous blowdown.

The following actions should be performed in sequence.

1. Start DAVDS.

2. Trip the main feed pump.

3. Shut steam valve CV-P4-10 when the conditions of section 4.5.1 are achieved.

4. When the conditions of sections 4.5.5 are met, initiate the plant recovery procedure described in section 4.5.5.

## 4.2 System Configuration

The system configuration for the L9-3 experiment is shown in Figure 2. Specific explanation of the system configuration is given in the following subsections.

### 4.2.1 Primary Coolant System

The experimental PORV and safety valves will be simulated by a single valve, CV-P-139-87, with a double actuator such that the first position corresponds to the PORV flow capacity and the second position corresponds to the PORV and the safety valve combined flow capacities. The PORV setpoints are given in Table 2.

The plant safety valves RV-200 and RV-201 will be replaced by power actuated relief vaves CV-P139-200 and -201 and their setpoint will be reset to a value of 19.3 MPa (2800 psia).

The pressurizer spray control valve CV-P139-5-1 will open and close in response to normal pressurizer pressure control signals; however, the flow will be throttled to give 12 $\pm$ 2 gpm. The pressurizer cycling and backup heaters will be operative.

The primary coolant pumps PC-P-1 and PC-P-2 will be operated during the transient.

The plant PORV isolation valve CV-P-139-18 will be open and the plant PORV CV-P139-5-4 will be disabled (in "CLOSED" position) when the test is initiated.

The purification system will be isolated during the test.

The primary pump injection pump discharge relief RV-232 will be gagged.

### 4.2.2 Blowdown System

The steam generator and primary coolant pump simulators in the broken loop will be isolated; the broken loop hot leg will terminate at flange FL-19 and the broken loop cold leg will terminate at isolation valve CV-P-138-2.

The reflood assist bypass valves CV-P-138-70 and CV-P-138-71 will be closed during the test.

### 4.2.3 Emergency Core Cooling System

There are no programmatic specifications for the ECC accumulators or the LPIS pumps. Low hot leg pressure signals to ECC should be inhibited when initiating the plant recovery procedure.

HPIS flow will be initiated when the conditions specified in Section 4.5.5 are met. HPIS-B will pump 260 ± 10 gallons of 7,000 ppm borated water from the mix tank, followed by 3000 ppm borated water from the BWST, at 6 ± 1 gpm to the downcomer. HPIS-A pump will be inhibited. The HPIS pump discharge relief RV-147 and RV-148 will be gagged.

## 4.3 Initial Conditions

A summary of the initial conditions for Test L9-3 is given in Table 3. Prior to tripping the MFP, the initial conditions set forth below will be established. Systems or controllable parameters not identified in the table or set forth below may be operated per POM requirements.

### 4.3.1 Power History

The reactor shall be operated at a nominal 50 MW for a duration sufficient to establish a decay heat level not less than 800 kW at 1000 seconds after shutdown. Decay powers larger than this are acceptable.

Should a reactor trip occur during the power run to establish decay heat, the down time must be considered when computing required reactor operating time after reactor startup to achieve the specified minimum decay power.

### 4.3.2 System Conditions

4.3.2.1 Pressurizer Heaters and Spray. The pressurizer heater control switch (backup and cycling) shall be placed in automatic. The spray control switch shall be placed in automatic.

4.3.2.2 Purification System. The purification system shall be isolated.

4.3.2.3 Blowdown loop Warmup Recirculation. CV-P139-36 shall be checked open.

4.3.2.4 Broken Loop Hot Leg Heaters. Power to the nozzle portion of the broken loop hot leg (BLHL) heat tracing shall be energized to maintain a BLHL temperature not greater than 575°F (575 K).

4.3.2.5 PORVs. The plant PORV control switch shall be positioned to "CLOSED". CV-P139-18, CV-P139-57 and CV-P139-58 shall be open. The test PORV control switch shall be in "AUTO".

4.3.2.6 BST Recirculation. BST recirculation shall be established at full spray pump capacity by taking suction at the BST bottom and discharging through the spray headers.

4.3.2.7 RSS. All appropriate signals to the RSS matrix shall be inhibited to prevent reactor scram.

4.3.2.8 Secondary Coolant System (SCS). Stop continuous steam generator blowdown flow. Drain condensate receiver level sufficiently to maintain steady state MFP operation while making allowance to receive full SG steaming inventory without overflow.

4.3.2.9 Test PORV Heat Tracing. The heat tracing installed on the test PORV line shall be energized to control temperature at 500 $\pm$ 25°F.

## 4.4 Water Sampling Requirements

Within 24 hours prior to test initiation, a liquid sample will be obtained from the primary coolant system, the secondary coolant system, and the blowdown suppression tank. None of the analyses have to be completed prior to initiating the test.

The primary coolant system sample will be analyzed for lithium concentration in addition to the normal daily samples. The secondary coolant system sample will be analyzed per the Plant Operating Manual (POM) requirements for a steaming steam generator.

Prior to recirculating the liquid in the blowdown suppression tank after the test, a liquid sample will be obtained and analyzed as specified above. Additionally, the sample will be analyzed for I-131, I-133 and total gas, and a gamma spectrometric analysis will be performed.

## 4.5 Actions Required During the Test

After manually tripping the MFP several operator actions are required to control the test.

### 4.5.1 Steam Flow Control Valve

The steam flow control valve CV-P4-10 will be manually closed when there is indication of steam generator dryout (at about 600 psig steam generator pressure). Subsequently, operate the main steam or bypass steam valve to maintain steam generator pressure above the tube sheet differential pressure limit but below high pressure open signal to CV-P4-10.

### 4.5.2 Data Recording Termination

Data recording may be terminated (except PLSS) upon verification by the JEG that the plant temperature and pressure are being controlled by the recovery actions, approximately 15 minutes after initiating the recovery procedure.

#### 4.5.4 Test PORV Operation

Allow the test PORV to cycle automatically until the conditions of Section 4.5.5 are met at which point the test PORV shall be latched open.

#### 4.5.5 Plant Recovery and Test Termination

At $T_o$ + 10 minutes the following actions shall be taken to initiate plant recovery. These actions are not necessarily to be performed in sequence, and may be performed concurrently:

4.5.5.1 Place the test PORV in the "PARTIAL OPEN" position. Subsequently assist plant depressurization by using the test PORV in the "PARTIAL OPEN" position, as required. Shut the test PORV when pressure has dropped to 2160 psig.

4.5.5.2 Control plant cooldown by using auxilliary and/or makeup feedwater flow, as required. The primary temperature should be reduced to 590°F and subsequently controlled to within 10° of 590°F until test termination, if possible.

4.5.5.3 Initiate HPIS-B flow at 6 $\pm$ 1 gpm from the mixtank to the downcomer injection line.

The test will be terminated ten (10) minutes after the primary temperature first dropsto 590°F following initiation of the recovery procedure.

### 4.6 Abnormal Conditions

This section covers system failures and unplanned events that could occur prior to and during the test. This document defers to the ESA concerning abnormal conditions from which the alternate actions irrecoverably impact the test programmatically.

4.6.1 Unplanned Events Prior to Test Initiation

4.6.1.1 DAVDS Recording Failure. IF a DAVDS recording system or tape deck fails prior to initiating the experiment, the test should be placed on "Hold" until the system is repaired or until a coordinated decision is reached to proceed with the experiment.

4.6.1.2 Reactor and Associated Systems Abnormalities

There are no LOFT Program requirements for operator actions taken to mitigate any casualty condition occurring prior to initiating the test. Should a casualty and recovery take place, the initial conditions of this EOS shall be reestablished prior to initiating the test.

4.6.2 Unplanned Events After Test Initiation

4.6.2.1 DAVDS Recording Failure. The experiment should continue until it is determined that the DAVDS cannot be repaired. Data recording should be continued until the JEG recommends that the recording be terminated or until the recording media is filled to capacity in the event of an emergency termination.

4.6.2.2 Reactor and Associated System Abnormalities. The test should be terminated if any condition occurs that causes loss of control of the experiment; e.g., loss of off site power, loss of instrument air. Loss of control will also be considered to include loss of instrument channels required to ascertain test status relative to ESA bounds, or uncontrollable heat up/repressurization approaching PCS design limitations.

4.6.2.3 Test PORV Fails Shut. If the test PORV fails in the shut position the test will be aborted and the plant will be recovered in accordance with the EOP.

4.6.2.4 Test PORV Fails Open. If the test PORV fails in the open position after the peak pressure has been achieved and the valve is subsequently cycling, the test is terminated. Recover the plant per the EOP.

# V. MEASUREMENT AND CALIBRATION REQUIREMENTS

## 5.1 Measurement Requirements

Measurements required for the L9-3 experiment are identified on the Data Acquisition Requirements List (DARL) to be published prior to the test.

DDAPS, analog, and DDAS recording will be required from $T_0$ - 1 minute until the plant is stable at the conditions identified in Section 4.5.2. PLSS will be required to test termination.

Measurements that fail prior to test initiation should be repaired if possible. If a failed instrument(s) cannot be repaired, the JEG shall determine the course of action.

To assist the JEG with determining their course of action the critical measurements list is provided in Table 4. The list identifies measurements which are considered important for the experiment.

## 5.2 DAVDS Calibration Requirements

Prior to initiating the test, the measurement calibrations specified in DOP-87-008, "Pre-LOCE Data Verification," shall be completed.

## 5.3 Post-Test Calibration Requirements

After a test has been completed (within 2 weeks) calibrate the blowdown suppression tank liquid level detectors. Perform an accumulator blowdown through the test PORV piping assembly to recheck the instrumentation.

REFERENCES

1. "Proposed Rulemaking to Amend 10CFR Part 50 Concerning Anticipated Transients Without Scram (ATWS) Events", USNRC SECY-80-409, September 4, 1980.

2. P. Kuan, LOFT Experiment Definition Document, Nuclear Test L9-3, EGG-LOFT-5732 (January 1982).

3. "Anticipated Transients Without Scram for Light Water Reactors", NUREG 0460, Vol. 4, March 1980.

4. W. A. Owca, Experiment Operation Specification for LOFT L9-3 Experimental Pressure Relief Valve Calibration, EGG-SEMI-5773, February 1982.

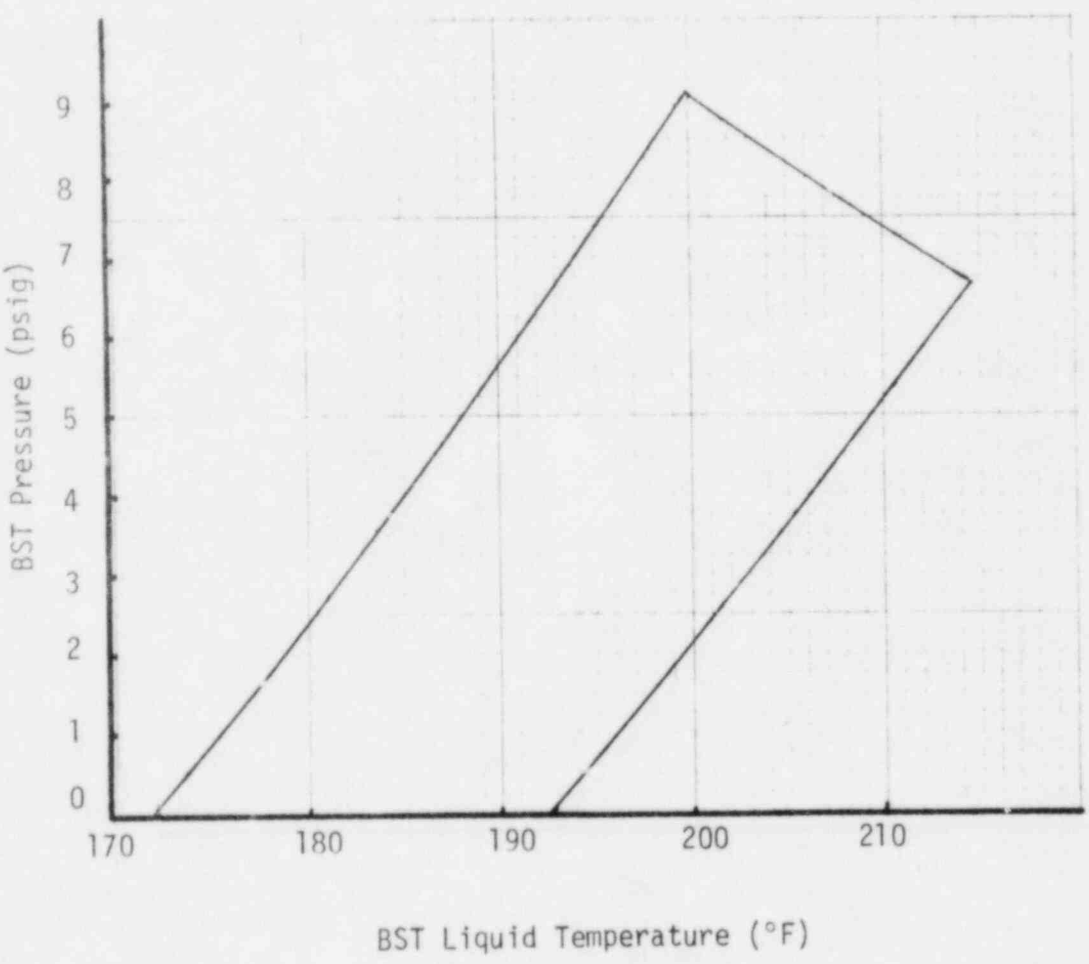


Figure 1. BST Initial Conditions

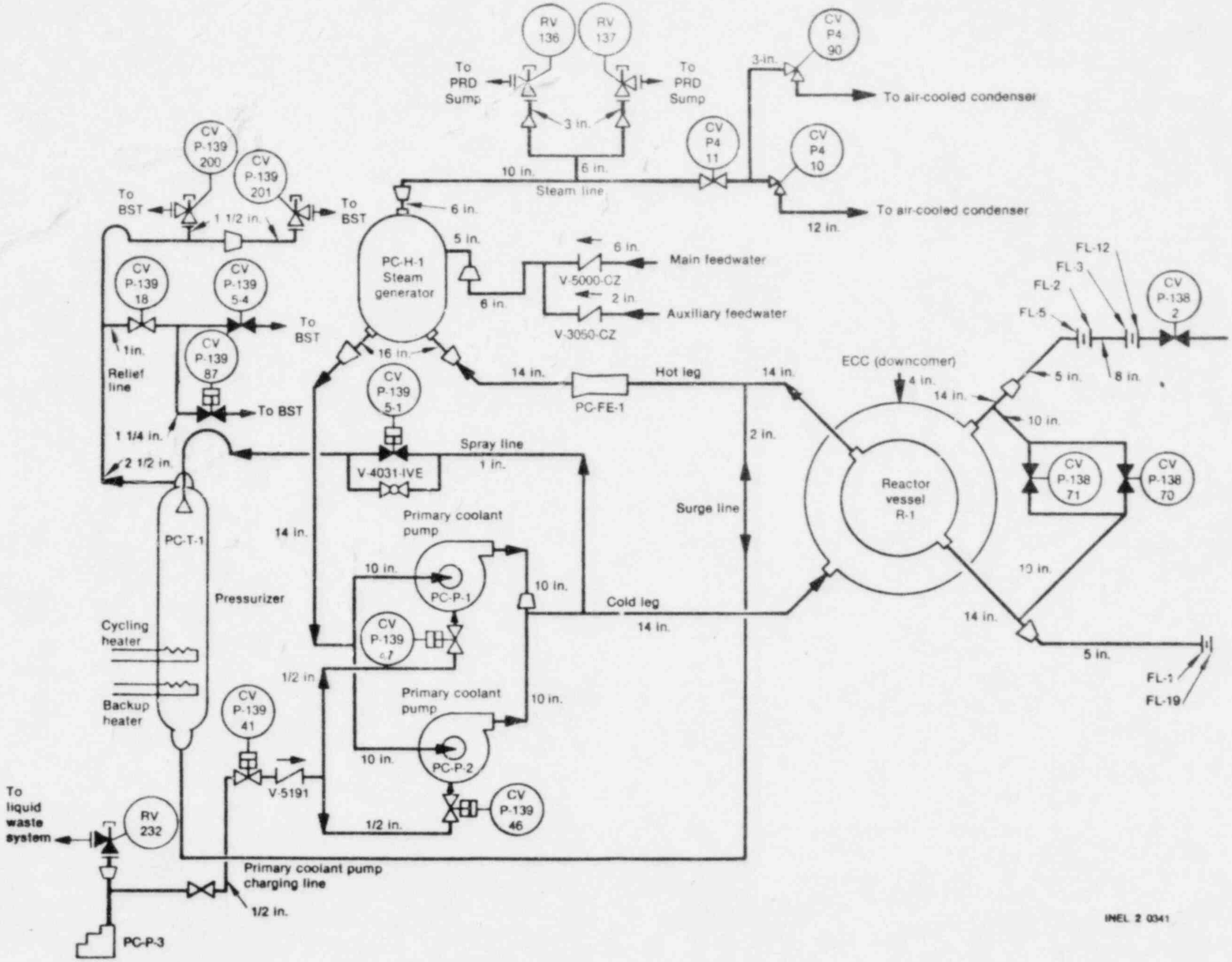


FIGURE 2. LOFT TEST L9-3 SYSTEM CONFIGURATION

TABLE 1. PROCESS INSTRUMENTS REQUIREING CALIBRATION PRIOR TO TEST

| Instrument | Parameter Measured |
|---|---|
| FT-P4-72-2 | Feedwater Flow |
| FT-P4-62A | Auxiliary Feedwater Flow |
| FT-P4-62B | Secondary Makeup Flow |
| FT-P4-12 | Steam Flow |
| FT-P4-72A | Feedwater Flow ΔP |
| FT-P128-104 | HPIS A Flow |
| FT-P128-85 | HPIS B flow |
| FT-P139-27-1 | PCS Flow |
| FT-P139-27-2 | PCS Flow |
| FT-P139-27-3 | PCS Flow |
| FT-P141-22 | Primary Component Cooling System Flow |
| LT-P138-33 | BST Liquid Level |
| LT-P138-58 | BST Liqiud Level |
| LT-P139-7 | Pressurizer Liquid Level |
| PT-P4-10A | Steam Generator Pressure |
| PT-P139-2 | Primary Hot Leg Pressure |
| TE-P138-170 | Broken Loop Cold Leg Warmup Line Temperature |
| TE-P141-94 | PCC Temperature - Downstream |
| TE-P141-95 | PCC Temperature - Upstream |
| TT-P4-4 | Feedwater Temperature |
| TE-P139-32-1 | Hot Leg Temperature - Wide Range |
| TE-P139-29 | Cold Leg Temperature - Wide Range |
| TE-P139-19 | Pressurizer Vapor Temperature |
| TE-P139-20 | Pressurizer Liquid Temperature |

TABLE 1. (continued)

| Instrument | Parameter Measured |
|---|---|
| LT-P4-42 | Condensate Receive Temperature Level |
| PT-P4-22 | Condensate Receiver Pressure |
| TE-P4-54 | Condensate Receiver Temperature |

TABLE 2. REACTOR TRIP, ECC INITIATION AND TEST PORV SETPOINTS

| Signal | Setpoint |
|---|---|
| Reactor Trip - High Hot Leg Pressure<br>- Low Hot Leg Pressure | Inhibited<br>Inhibited |
| Reactor Trip - High Hot Leg Temperature<br>- Low Primary Flow | Inhibited<br>Inhibited |
| Test PORV Actuation - PORV Setpoint | 2338 psig (16.20 MPA) |
| Test PORV Actuation - Safety Relief Setpoint | 2488 psig (17.24 MPA) |
| Test PORV Reset - PORV Setpoint | 2308 psig (16.00 MPa) |
| Test PORV Reset - Safety Relief Setpoint | 2375 psig (17.03 MPa) |
| Plant PORV | Disabled |
| Plant Safety Relief Valves | 2788 psig (19.3 MPa) |

TABLE 3. INITIAL CONDITIONS

| Primary Coolant System | Operating Band[a] Value | Tolerance |
|---|---|---|
| Decay heat level (Kw @ 1000 s) | ≥800 | -- |
| Power level (MW) | 49.5 | ±0.5 |
| Pressurizer pressure (psig) | 2156 | ±15 |
| Pressurizer level (in.) | 46 | ±1 |
| Control rod posn. (in.) | 54 | ±0.5 |
| $T_{ave}$ (°F) | 565 | ±2 |
| Core ΔT (°F) | 38 | ±2 |
| BST | | |
| Liquid level (in.) | 50 | ±2 |
| Liquid temperature (°F) | See Figure 1 | -- |
| Pressure (psig) | See Figure 1 | -- |
| BST recirculation (GPM) | Full Pump Capacity | -- |
| Broken Legs | | |
| Cold leg temperature (°F) | | |
| Indicated by TE-P138-170 | 565 | ±30 |
| Secondary Coolant System | | |
| SG Liquid level (in.) | 10 | ±2 |

a. Values shown are indicated values.

TABLE 4. CRITICAL MEASUREMENTS LIST

---

(1) Liquid properties intact loop, cold leg

PE-PC-005 or PE-PC-006
TE-PC-006 or 10

(2) Liquid properties intact loop, hot leg

FE-PC-002A, B, or C
TE-PC-002A, B, or C
ME-PC-002A, B, or C

(3) Liquid properties at break (PORV line)

DE-PC-S03 A, or B
TE-PC-S05 or -S06
TE-PC-S03 or -S04
PdE-PC-S03
PdE-PC-S02
PE-PC-S05 or 6
FE-PC-S02
ME-PC-S02

(4) Upper end box temperature

TE-1UP-001 or TE-3UP-001
TE-2UP-001 or -3
TE-4UP-001 or -3
TE-5UP-010 thru -015 (any one)
TE-6UP-001 or 3

(5) Lower plenum fluid temperature

TE-1LP-001 or TE-3LP-001
TE-2LP-001 or 3
TE-4LP-001 or 3
TE-5LP-001 or 4
TE-6LP-001 or 3

(6) Steam generator conditions

TE-SG-001A or -001B
TE-SG-002A or -002B
TE-SG-003
TE-SG-004
TE-SG-005
PE-SGS-001

(7) Liquid properties in suppression tank

PdE-SV-001 or -002
PE-SV-055 or -060
TE-SV-006, 11 or 12

(8) Process instruments listed in Table 1.

(9) Cladding thermocouples will be required to monitor core temperatures. The determination that sufficient cladding thermocouples are operable to ensure test safety will be made by the JEG and the Reactor Systems Branch.

(10) At least one of the three average power range channels. At least one of the two source range channels.