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LOFT EXPERIMENT OPERATING SPECIFICATION

ANTICIPATED TRANSIENT WITHOUT SCRAM EXPERIMENT

NUCLEAR TEST L9-4

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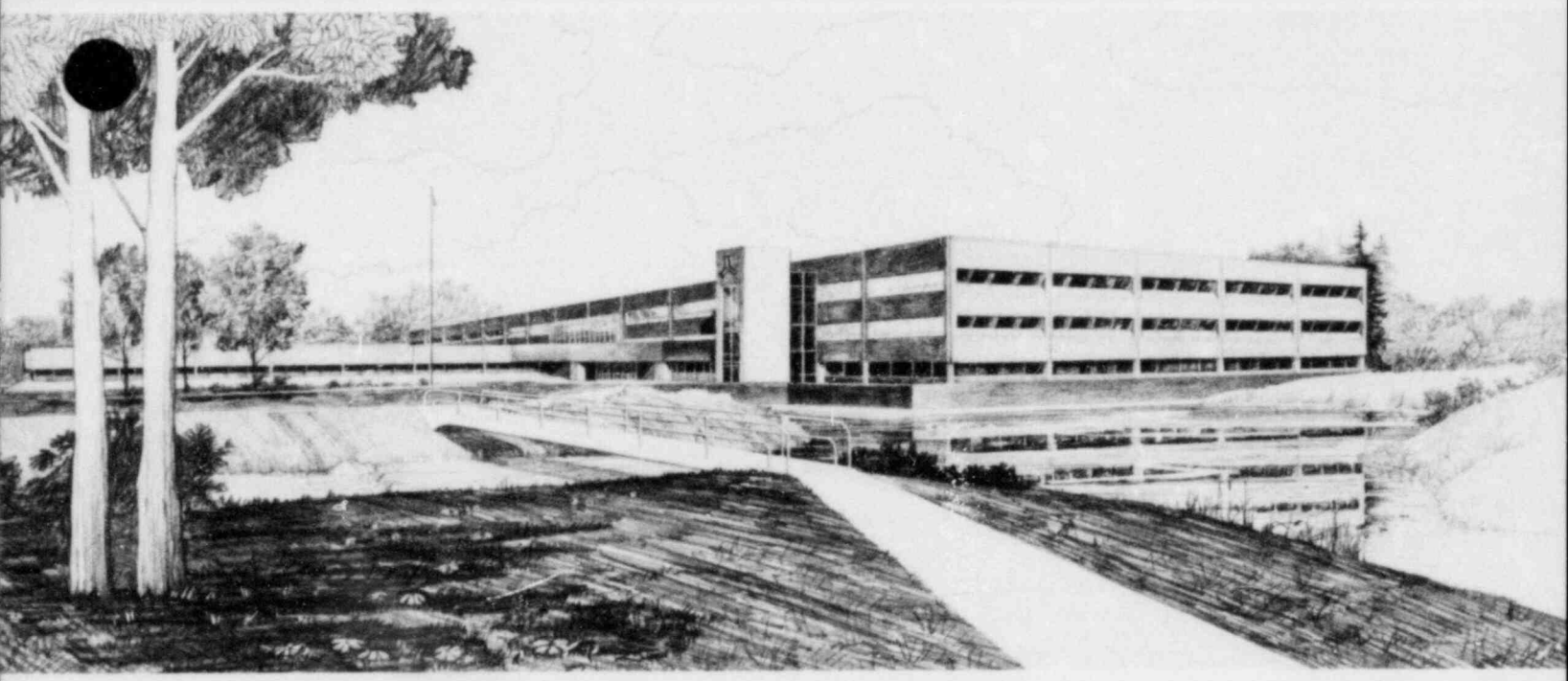

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NUCLEAR TEST L9-4

by

S. Silverman

September 15, 1982

LOFT EXPERIMENT OPERATING SPECIFICATION
L9-4 ATWS EXPERIMENT

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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 L9-4.

Parameter 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).

CONTENTS

FIGURE

TABLES

ABBREVIATIONS

ATWS	Anticipated Transient Without Scram (see definition at end of list)
BLHL	Broken Loop Hot Leg
BST	Blowdown Suppression Tank
DAVDS	Data Acquisition and Visual Display System
ECC	Emergency Core Cooling
EOP	Experiment Operating Procedure
EOS	Experiment Operating Specification
ESA	Experiment Safety Analysis
JEG	Joint Experimental Group
HPIS	High-Pressure Injection System
LFD	LOFT Facility Division
LOFT	Loss-of-Fluid Test (Facility)
LPIS	Low Pressure Injection System
MFP	Main Feedwater Pump
MSV	Main Steam Valve
NRC	Nuclear Regulatory Commission
PCP	Primary Coolant Pump
PCS	Primary Coolant System
PLSS	Plant Log and Surveillance System
POM	Plant Operating Manual
PPS	Plant Protection System
PORV	Power Operated Relief Valve
PWR	Pressurized Water Reactor
RSS	Reactor Shutdown System
SCS	Secondary Coolant System

LOFT EXPERIMENT OPERATING SPECIFICATION
ANTICIPATED TRANSIENT WITHOUT SCRAM EXPERIMENT
NUCLEAR TEST L9-4

I. INTRODUCTION

Anticipated transients without scram (ATWS) have been the subject of discussions and analyses within the nuclear industry since early 1969, and have been designated an unresolved safety issue by the Nuclear Regulatory Commission. The significance of ATWS in the evaluation of reactor safety is that some ATWS events could result in melting of the reactor fuel and the release of a large amount of radioactive fission products. Therefore, LOFT Test L9-4 has been developed to gain a better understanding of integral system response for a loss-of-offsite power ATWS and to determine the ability of existing analytical techniques to predict the system response.

The loss-of-offsite power portion of the experiment will approximate the behavior of a large pressurized water reactor to this transient. The scaling is discussed in detail in The Experimental Definition Document. Prior to test initiation, the reactor and all support systems will be in a normal configuration. The reactor will be operating at 100% of rated power. All control systems will be in the automatic mode of operation except rod control. The experiment will start by tripping the primary coolant and feedwater pumps and main steam valve. The valve will take 13 s to fully close. The flow through the primary coolant system will decrease quickly and natural circulation will be temporarily established until the steam generator inventory has depleted. The energy in the reactor core will increase the primary system pressure and temperature until the relief valve setpoint is reached. Code calculations predict that the test relief valve will cycle until the negative reactivity insertion (primarily due to doppler and moderator feedback) causes the power to decrease to approximately 3% of full power at 500 s. The steam generator boils completely dry at 650 s. The primary coolant system will stabilize after the test relief valve stops cycling and at 1500 sec the test is terminated.

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2. EXPERIMENT OBJECTIVES

To address issues relating to the consequences of a postulated ATWS, the following major programmatic objective has been defined for the LOFT ATWS experiments. This objective is:

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

To support the above programmatic objective, the following specific test objectives have been identified:

1. To determine the effect of primary coolant pump operation on initial system response and peak pressure by comparing results from L9-4 (pumps tripped) with results from L9-3 (pumps running).

2. To provide data for analysis of the effect of natural circulation cooling capability under high power conditions.

3. To provide data to evaluate the capabilities of the computer codes to predict the fluid conditions (temperature, pressure, and quality) in both the primary and the secondary systems and to evaluate the adequacy of point kinetics assumptions used in prediction of reactor power levels.

3. PREREQUISITES

The following prerequisites must be completed prior to initiating Test L9-4.

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 90 days of the tests. If a problem is indicated, recalibrate the instrument.

5. Verify that the actuation and reset setpoints are within tolerance for the test PORV/safety at the relief valve position (CV-P139-87):

Open	2488 ± 25 psig
Close	2413 ± 25 psig

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

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

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

9. Inhibit scram signals to prevent automatic reactor scram during the test.

10. The plant safety relief valves CV-P139-200 and -201 shall be set at 2788 psig. The plant PORV, CV-P139-5-4, shall be disabled.

4. 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 L9-4 will utilize the test PORV piping configuration to simulate the flow through the PORV plus Relief Valve of a large pressurized water reactor.

The initial conditions for the experiment will be as specified in Section 4.3.

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 3.

2. Complete DAVDS instrument calibrations as set forth in Section 5.

3. The plant PORV isolation valve CP-P139-18 shall be open.

4. Isolate the purification system.

5. Initiate BST recirculation.

6. Secure the pressurizer cycling and backup heaters.

The following actions should be performed in sequence:

1. Establish the initial conditions specified in Table 2.

2. Start DAVDS.

3. Trip the primary coolant PSMG motor breakers and main feedwater pump; this is t_o.

4. Initiate closing of the main steam control valve at time t_o.

5. Initiate auxiliary feedwater flow of 8 gpm at t_o + 10 s.

6. From t_o to 1500 s, maintain the secondary side pressure at $950 \begin{smallmatrix} + 50 \\ - 0 \end{smallmatrix}$ psig.

7. At t_o + 1500 sec the test is terminated. Insert the control rods and begin plant recovery in accordance with the Experiment Operating Procedure.

4.2 System Configuration

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 setpoints are given in Section 3. For the present test, the second position will be used.

The primary coolant pumps PC-P-1 and PC-P-2 will not be operated during the transient.

The heat tracing installed on the test PORV line shall be energized to control temperature (metal) as near 500°F as possible.

The primary coolant pump injection pump discharge relief RV-232 will be gagged. The HPIS A and B pump discharge relief valves RV-147 and RV-148 shall be gagged also.

4.2.2 Blowdown System

The broken loop hot leg will terminate at flange FL-1 and the broken loop cold leg will terminate at isolation valve CV-P138-2.

The blowdown loop cold leg warmup recirculation valve CV-P139-36 shall be checked open.

BST recirculation shall be established at full spray pump capacity.

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

The ECC shall be inhibited above 1800 psig from t_o to 1500 sec.

4.3 Initial Conditions

A summary of the initial conditions is given in Table 2. Prior to initiating the test, the initial conditions shall be established. Systems

or controllable parameters not identified in the table or set forth below may be operated as specified in the POM.

The reactor shall be operated at a nominal 50 MW for a duration sufficient to establish a decay heat level not less than 850 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.

4.4 Water Sampling Requirements

Water sampling requirements are as specified in the POM.

4.5 Actions Required During the Test

4.5.1 Operator Actions

1. At t_o trip the primary coolant PSMG motorbreakers and main feedwater pump and close main steam control valve CV-P4-10

2. Initiate auxiliary feedwater flow of 8.0 gpm at t_o + 10 s

3. Maintain secondary side pressure of $950 \begin{smallmatrix} + 50 \\ - 0 \end{smallmatrix}$ psig until t_o + 1500 sec.

4. The remainder of plant recovery is not programmatic and will be specified in the Experiment Operating Procedure.

4.5.2 Data Recording Termination

Data recording may be terminated (except PLSS) 2 minutes after test termination.

4.6 Abnormal Conditions

This section covers system failures and unplanned events that could occur prior to and during the test.

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 heatup/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 the test is terminated. Recover the plant per the EOP.

5. MEASUREMENT AND CALIBRATION REQUIREMENTS

5.1 Measurement Requirements

Measurements required for the L9-4 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_o - 1) min until the conditions identified in Section 4.5.2. PLSS will be required to test termination.

Measurements listed in Tables 1 and 3 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 3. 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 Posttest 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.

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TABLE 1. PROCESS INSTRUMENTS REQUIRING CALIBRATION PRIOR TO TEST L9-4

Instrument	Parameter Measured
FT-P139-27-1, -2, -3	PCS Flow
PT-P139-2, 3, 4	PCS pressure, hot leg
PT-P139-5-1	Pressurizer pressure
TE-P139-19	Pressurizer vapor temperature
TE-P139-20, -20-1	Pressurizer liquid temperature
LT-P004-008A, -8B	Steam generator, feedwater liquid level
FT-P004-72-2, -72A	Feedwater flow
FT-P4-12	Steam flow
PT-P4-34	Feedwater pressure
TT-P4-4	Feedwater temperature
PT-P4-10A	Steam generator pressure
PdT-P139-30	Reactor vessel Δ pressure
TE-P-139-32, 33, 34	PCS hot leg, fluid temperature
TE-P139-29	PCS cold leg, fluid temperature
LD-P139-6, 7, 8	Pressurizer, liquid level
FT-P128-104	HPIS A flow
FT-P128-85	HPIS B flow

TABLE 2. INITIAL CONDITIONS FOR L9-4

	Operating Band[a]	
Primary Coolant System	Value	Tolerance
Decay heat level (kW @ 1000 s)	>850	--
Power level (MW)	50	+0 -1
Pressurizer pressure (psig)	2157	±15
Pressurizer level (in.)	46	+0 -2
Control rod position (in.)	54	±0.5
Cold leg temperature	544	±2
Core ΔT (°F)	38	±2
Boron Concentration	As required	--
BST		
Liquid level (in.)	50	+5 -0
Liquid temperature (°F)	See Figure 1	--
Pressure (psig)	See Figure 1	--
BST recirculation (GPM)	Full pump capacity	--
Broken Legs		
Cold leg temperature (°F)		
Indicate by TE-P138-170	544	±30
Secondary Coolant System		
SG Liquid level (in.)	10	±2

a. Values shown are indicated values.

TABLE 3. CRITICAL MEASUREMENTS LIST FOR L9-4

1. Liquid properties intact loop, cold leg

   DE-PC-1A, B, C (two of three)
   FE-PC-1A, B, C (two of three)
   TE-PC-1A, B, C (one of three)
   PE-PC-5, -6, -1 (one of three)
   DE-PC-1D (for background)
   TE-PC-006, 10

2. Liquid properties intact loop, hot leg

   DE-PC-2A, B, C (two of three)
   FE-PC-2A, B, C (two of three)
   TE-PC-2A, B, C (two of three)
   DE-PC-2D (for background)
   ME-PC-2A, B, C (two of three)
   PE-PC-2, or PT-P139-2 or -3 or -4

3. Test PORV

   DE-PC-SO3A or B
   TE-PC-SO5 or 6
   TE-PC-SO3 or 4
   PdE-PC-SO2
   PdE-PC-SO3
   PE-PC-SO5 or 6
   FE-PC-SO2
   ME-PC-SO2

4. Reactor vessel, liquid and nuclear properties

   PdE-RV-5
   LE-3UP-1-1 thru -1-9
   LE-1ST-1
   LE-1ST-2
   PE-1UP-1A
   PE-1UP-1A1
   TE-1ST-1 thru -6
   TE-3UP-3, 4 (one of two)
   TE-1UP-3, 4 (one of two)

5. Pressurizer, liquid properties

   PE-PC-4 or PT-P139-5-1
   LD-P139-6, 7, 8 (one of three)
   TE-P139-19
   TE-P139-20 or -20-1

TABLE 3. (continued)

6.	Steam generator and secondary side
	FT-P4-12
	PE-SGS-1
	TE-SG-3
	TE-SG-4
	TE-SG-5
	TE-SG-1 or 1A
	TE-SG-2 or 2A
7.	Liquid properties in suppression tank
	PdE-SV-001 or -002
	PdE-SV-055 or -060
	TE-SV-006 or 11 or 12
8.	Miscellaneous
	PdE-PC-1, 2, 3, 5 (all)
	PdT-P139-30
	FT-P128-104 or -85
10.	Cladding thermocouples will be required to monitor core temperatures. The determination that sufficient cladding thermocouples are operable to insure test safety will be made by the JEG and the Research Reactor Safety Assurance Branch.

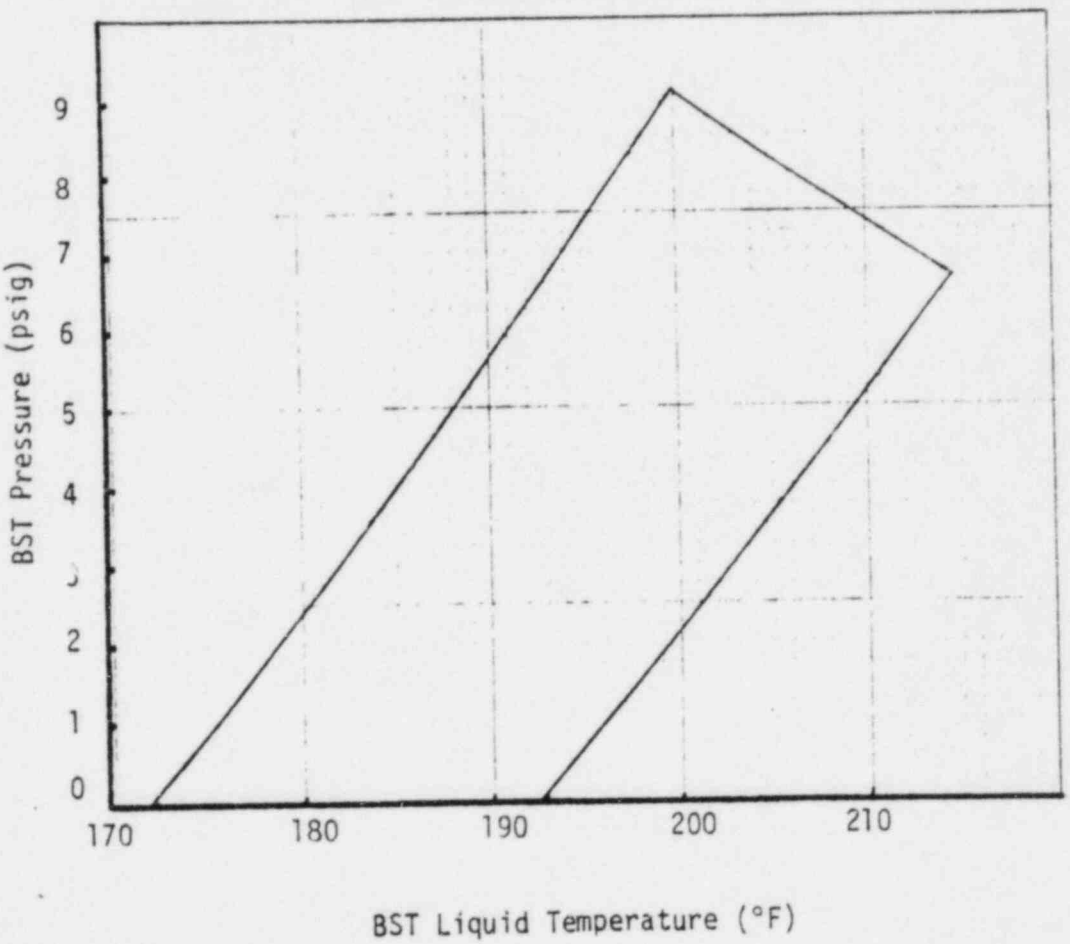

Figure 1. BST Initial Conditions