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U. S. Nuclear Regulatory Commission
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SUSQUEHANNA STEAM ELECTRIC STATION
UNIT 1 FEEDWATER FLOW METER POWER
UPRATE STARTUP REPORT
PLA-5514 **Docket No. 50-387**

The purpose of this letter is to transmit the Susquehanna Steam Electric Station Unit 1 "Feedwater Flow Meter Power Uprate Startup Report" pursuant to Section 4.5.1 of the Susquehanna Steam Electric Station Technical Requirements Manual.

Please contact Mr. C. T. Coddington at (610) 774-4019, if there are any questions concerning this submittal.

Sincerely,

B. L. Shriver

Attachment

copy: NRC Region I
Mr. S. L. Hansell, NRC Sr. Resident Inspector
Mr. R. Janati, DEP/BRP
Mr. E. M. Thomas, NRC Project Manager

IE26

PPL Susquehanna, LLC

Susquehanna Steam Electric Station

Unit 1

Feedwater Flow Meter Power Uprate Startup Report

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Introduction

1.1 Report Abstract

This Feedwater Flow Meter Power Uprate Startup Report is written based on the requirements of the Susquehanna Technical Requirements Manual (TRM) Section 4.5.1. It is a summary report of power escalation testing that was performed following issuance of Amendment No. 194 to License No. NPF-14, which approved a 1.4 percent increase in the thermal power level on Unit 1.

This report addresses each of the startup tests conducted as part of this uprate, as required by TRM Section 4.5.1.2. This report includes a description of the measured values of the operating conditions or characteristics obtained during the test program and a comparison of these values with the design predictions and specifications. In addition, Section 3.2 states why other testing included in FSAR Chapter 14, Initial Test program, was not performed as part of this uprate.

This report is being submitted within 90 days following the completion of the Power Uprate Test Program, conducted on May 30, 2002, as specified by TRM Section 4.5.1.3.

1.2 Susquehanna Power Uprate Design Parameters

Susquehanna Unit 1 is a General Electric BWR/4. The original design power rating for the unit was 3439 MWt. It was originally licensed for operation at 3293 MWt. A previous 4.5% power uprate increased the licensed operating rated thermal power to 3441 MWt. This uprate was based on a designed maximum power of 3510 MWt and includes a 2% power margin required in 10 CFR Part 50, Appendix K.

The 2% margin is intended to allow a standard 95% confidence interval that the design rating of the plant (3510 MWt) will not be exceeded, and was based on evaluations of the existing instrumentation. A Leading Edge Flow Meter (LEFM✓™) supplied by Caldon, Inc. was installed on Unit 1 during the Spring 2002 outage as a more accurate means for measuring feedwater flow. Feedwater flow is used as an input to the core thermal power calculation. The increased accuracy of the LEFM✓™ instrument results in an increased accuracy of the calorimetric calculation (less than ± 0.6% of core thermal power, based on a standard 95% confidence interval evaluation) versus the previously installed venturi flow instrumentation

(± 2.0% of core thermal power). This improvement in uncertainty in the core thermal power calculation allows operation at 3489 MWt with no decrease in the confidence level that the actual operating power level is less than the power level (3510 MWt) required to be assumed in the ECCS accident analyses.

The improved core thermal power measurement accuracy obviates the need for the full 2% power margin required to be assumed in Appendix K analysis, thereby allowing an increase in the thermal power available for electrical generation. The LEFM✓™ instrumentation improves the confidence level that the actual reactor core thermal power remains at or below the value (3510 MWt) assumed in the Appendix K analyses.

All design parameters remain within the analyses previously conducted to increase the maximum design power to 3510 MWt. A design evaluation has concluded that the increased flow, temperatures and pressures are within the capacities of the supporting systems and components.

1.3 Power Uprate Test Program

The power uprate implementation commenced with Unit 1 operating at the previous 100% power level or 3441 MWt and culminated with Unit 1 operating in steady state at the new 100% power level of 3489 MWt. Compared to the Initial Startup Test Program and to the previous Power Uprate Test Program, this power uprate requires only a limited number of startup tests. The tests required are described in Section 10.7 "Summary of Start-Up Tests" of the SSES Power Uprate Topical Report NE-2000-001N Rev.1 previously submitted to the NRC in PLA-5276 (February 5, 2001) and as modified by PLA-5300 (May 22, 2001). These tests, which are described in FSAR Chapter 14.3 and Section 3.0 of this report, are listed below:

- Pressure Regulator Test
- Recirculation System Flow Calibration
- Steady State Data Collection
- Main Steam Line Radiation Monitor

In addition, other Unit 1 startup tests were performed as part of the normal SSES General Operating Procedures, Reactor Engineering Test Procedures and Surveillances.

No instruments required recalibration for operation at increased core thermal power, therefore, specific testing of recalibrated instruments was not required.

In accordance with the Susquehanna procedure program, a special test procedure was developed to conduct the power uprate startup testing. A detailed review by the SSES Plant Operations Review Committee (PORC) was performed on the governing test procedure, and on each of the specific test procedures. The Test Directors were from the Nuclear Systems Engineering (NSE) group and met the requirements for being a Test Director as established by the SSES procedure program.

The conduct of the startup test program for this power uprate was considered a "Special, Infrequent or Complex Test/Evolution (SICTE)." Consequently, the testing had additional management controls and oversight.

Testing of the LEFM✓™ device itself was previously completed, and therefore, is not within the scope of this report.

1.4 Power Uprate Test Program Scope

The Power Uprate Test Program was developed by reviewing the following documents:

- FSAR Chapter 14.2
- FSAR Chapter 14.3
- PLA-5276 dated February 5, 2001
- PLA-5300 dated May 22, 2001

The results of the Test Program were used to determine the acceptability of operating Unit 1 at the uprated power level.

Existing plant programs and procedures were used to control the startup test program.

2.0 Summary

The Susquehanna Unit 1 Power Uprate Test Program was performed to assure that the feedwater LEFM✓™ flow measurement modification was successful. The test program was implemented according to an established station schedule, with minor test exceptions. The test program established an overall increase in net electrical output that was slightly greater than anticipated. The plant equipment responded as expected to the increase in reactor power, and demonstrated that the unit can operate safely at the increased power conditions.

Key events related to the increase in rated thermal power include:

July 6, 2001	NRC issued Amendment 194 to License No. NPF-14.
March-April 2002	LEFM✓™ system installed during the Unit 1 outage and placed in an operating but not operable condition for monitoring, testing and adjustment.
May 23	LEFM✓™ placed in operable status, with reactor thermal power maintained at 3441 MWt.
May 29	Conducted pre-startup test program briefing with all parties involved in the testing.
May 30	Performed power uprate startup test program.

3.0 Power Uprate Test Procedure Abstracts and Test Results

3.1 Test Abstracts

The following tests were performed to assure adequate performance at the increased core thermal power conditions:

Pressure Regulator Test

Purpose:

The purpose of this test was to confirm that pressure regulation performance and margins are acceptable.

Results:

The following results were achieved by this test:

- The Electro-Hydraulic Control (EHC) System provided a fast and stable response to pressure and steam disturbances.

- The Main Turbine Control Valves (CV) 1, 2 and 3 were fully open with CV4 modulating system pressure at ~95 to 100% reactor power.

- It was confirmed from a review of the steam line flows that no limit cycles occurred that produced a steam line flow oscillation magnitude in excess of ± 0.5 % of rated steam flow.

- It was confirmed from extrapolated data that adequate margins to scram exist for peak neutron flux, peak vessel pressure, heat flux and peak steam line flows.

- The variation in incremental flow regulation was confirmed to be acceptable, in the range of 85-99% of steam flow obtained with control valves wide open (VWO.) The 85-99% (VWO) range variation was documented as acceptable during the SSES Unit 2 startup test program performed in July 2001.

- A review of feedwater flow test data accumulated during the entire testing period indicated that no 3rd harmonic frequencies exist in the EHC system that would cause pressure oscillations in the control valve hydraulic system. This also confirmed that a second steam line resonance compensator (SLRC) card did not need to be installed.

- The final load limit setting was returned to the as found condition, as it was determined that the present setting was acceptable.

- The control valve total position did not exceed the predicted value by more than 1.5% and met the acceptance criterion.

Recirculation System Flow Calibration

Purpose:

The purpose of this calibration was to perform a complete calibration of the installed recirculation system flow instrumentation. This includes specific signals to the plant process computer.

Results:

The core flow calibration was completed at 3486 MWt with core flow at 99.9 Mlb_m/hr. All of the following acceptance criteria were satisfied.

- The difference between indicated jet pump loop flows and calculated jet pump loop flows was not greater than 2%.
- The difference between calculated jet pump loop flows and indicated total core flow was not greater than 3%.
- The difference between indicated total core flow and calculated total core flow was not greater than 1%.

Steady State Data Collection

Purpose:

The purpose of this data collection effort was to obtain required data for evaluation of plant parameters at various power levels. This data was necessary:

- to identify if there are significant inconsistencies between actual and predicted parameters,
- to evaluate thermal performance monitoring activities and
- for fuel cycle specific benchmarking of the training simulator.

During the power ascension from 3097 MWt to 3489 MWt reactor power, data was collected to monitor the response of various systems and to calculate balance-of-plant performance parameters.

Results:

Plant data was acquired at power level plateaus of approximately 3097 MWt, 3441 MWt, 3465 MWt and 3489 MWt. Select performance parameters were evaluated at each plateau and extensive plant process computer (PICSY) data files were collected for use in future data analysis and SSES simulator use.

All evaluated plant parameters at all power levels fell within the expected tolerance bands.

Main Steam Line Radiation Monitor

Purpose:

The purpose of this data collection effort was to obtain data to determine if the setpoint of the main steam line radiation monitor needed to be adjusted after reactor power was increased to 3489 MWt.

Results:

Main steam line radiation data was collected and used to establish the main steam line high radiation setpoints, as part of normal startup procedures, at 3441 MWt. Based on Unit 2's performance and the operating experience gained from Unit 2's power uprate, main steam line radiation data was not collected at 3489 MWt, because it was expected that resetting the high radiation setpoints was unnecessary. Data collection following the Unit 2 power uprate confirmed that the main steam line (MSL) radiation levels did increase, but not to the extent that required changes to the MSL radiation monitors. Leaving the setpoint where it was set on April 15, 2002, during calibration of the monitors at a power level less than 3489 MWt is a conservative decision.

3.2 Initial Startup Tests Not Re-Performed

An engineering analysis (SSES Power Uprate Licensing Topical Report NE-2000-001N Rev.1) was performed for each system to determine the impact of the power uprate. As documented in the analysis, the system changes resulting from this uprate do not produce conditions that are significantly different from those in tests conducted as part of the initial test program, the previous power uprate test program, or surveillance test programs. Therefore, only those tests identified in Section 3.1 were conducted.