UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-280/90-29 and 50-281/90-29

Licensee: Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Docket Nos.: 50-280 and 50-281 License Nos.: DPR-32 and DPR-37

Facility Name: Surry 1 and 2

Inspection Conducted: October 15-19, 1990

Inspector: P. T. Burnett November 1990
Date Signed

Approved by: G. A. Belisle, Chief 10/15/90
Date Signed
Test Programs Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This routine, unannounced inspection addressed the areas of surveillance of core power distribution and hot channel factors, surveillance and calibration of nuclear instruments, and thermal power monitoring.

Results:

Hot channel factors were controlled within limits for all cases reviewed, but in one instance the interval between surveillances exceeded 44 effective full power days, which may be a violation of the Technical Specifications, but is currently listed as a unresolved item pending an interpretation of the language of the specifications. (Paragraph 2.b)

All other surveillance activities reviewed were conducted at the required frequencies and with acceptable results.

End-of-cycle operations at reduced power and temperature appear to have been well controlled. (Paragraph 3.c)

Procedures used for routine surveillance of thermal power have not been compared with the beginning-of-cycle precision heat balance, which is a common industry practice. (Paragraph 4.a)

No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*W. R. Benthall, Supervisor, Licensing
R. M. Berryman, Manager of Nuclear Analysis and Fuel
*R. E. Bilyeu, Licensing Engineer
D. D. Dziadosz, Supervisor of Core Design
*D. S. Hart, Supervisor, Quality Assurance
*J. W. Henderson, Lead Reactor Engineer
*M. R. Kansler, Station Manager
*R. W. Orga, Quality Assurance
*J. A. Price, Assistant Station Manager
*E. R. Smith, Site Quality Assurance Manager
T. B. Sowers, Superintendent of Engineering

Other licensee employees contacted included engineers, technicians, security force members, and office personnel.

NRC Resident Inspectors

W. E. Holland, Senior Resident Inspector
S. G. Tingen, Resident Inspector
*J. W. York, Resident Inspector

*Attended exit interview on October 19, 1990.

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2. Surveillance of Core Power Distribution Limits (61702, 61707)

a. Procedures and Other Licensee Documents

1/2-PT-28.2 (Approved February 1, 1990), Reactor Core Flux Maps, is used to checkout the movable incore detectors, collect axial flux distribution data in specified incore thimbles, record PRNI chamber currents and AFD meter readings during the flux mapping process, and to submit the raw data for analysis.

The procedure was basically sound, but it was noted that the checkout of the MDs prior to mapping was somewhat superficial. Each MD was, in turn, placed at midcore; excitation voltage was decreased until a reduction in output was noted; then, excitation was increased until an increased signal, beyond the original, was observed. Finally the excitation voltage was set at the midpoint of the two observations. More common practice is to obtain and plot the relationship between

voltage and current at regular intervals and to confirm that a reasonable plateau exists where current is not strongly dependent on voltage. The operating voltage is determined by inspection of the plateau. The plotted plateaus are retained for trending MD performance. The licensee appeared receptive to the inspector's comments on this subject.

The flux map analysis is performed at an off site computer using the INCORE computer program. A summary of the INCORE results is provided in a POWER DISTRIBUTION SUMMARY SHEET, which is prepared from the INCORE output. Heat flux and enthalpy rise hot channel factors are compared with TS limits.

The NUCLEAR CORE DESIGN MANUAL, USER'S COPY, PART VII, CHAPTER I, FLUX MAP ANALYSIS (Revision 0, May 1990) (written by the Nuclear Analysis and Fuel Group of Virginia Power) provides methods for both manual and computer based checks of the validity of the input data and for review of the output of the INCORE code prior to issuance of the POWER DISTRIBUTION SUMMARY SHEET.

Other documents reviewed to evaluate the licensee's performance in this area included:

(1) TECHNICAL REPORT NE-657 (Revision 1), SURRY UNIT 2, CYCLE 10, DESIGN REPORT.

(2) TECHNICAL REPORT NE-757 (Revision 0), SURRY UNIT 2, CYCLE 10, STARTUP PHYSICS TESTS REPORT.

(3) MEMORANDUM (Dated October 10, 1990) SURRY POWER STATION, CORE PERFORMANCE CHARACTERISTICS FOR SEPTEMBER 1990, which applied to both units.

b. Surveillance Activities

Review of surveillance records for both units confirmed that acceptable surveillance intervals and results were maintained throughout cycle 10A for Unit 1.

However, the Unit 2, cycle 10, records revealed that the interval between surveillances was apparently too long in one instance. The surveillance on July 18, 1990 was conducted at a core burnup of 8016 MWd/MTU, and the succeeding surveillance was conducted on September 4, 1990 at a burnup of 9525 MWd/MTU. With 33.8 MWd/MTU equivalent to 1.0 EFPD, this interval is 44.8 EFPD or 1.44 EFPM. TS 4.10B requires that the hot channel factors of TS 3.12 shall be determined every EFPM. TS 4.02 allows a 25% tolerance on surveillance intervals, or a maximum of 1.25 EFPM, in this case. The licensee's position is that the language of the specification requires the surveillance in each full-power month, but does not limit the interval, which might then be nearly 60 EFPD. They further

claim that the NRC has found this interpretation and implementation of the surveillance requirement satisfactory in the past, but provided no documentation of that claim.

This class of power reactor has no capability for continuous monitoring of the incore power distribution, unlike all other classes. Only gross power distribution parameters, such as QPTR and AFD, can be monitored continuously by the excore PRNIs. This extension of the surveillance interval does not appear to be prudent.

Nevertheless, pending an NRC management determination of the interpretation of the TS surveillance interval, this item will be treated as unresolved. (UNR 50-281/90-29-01: The interval between surveillances of hot channel factors exceeded 1.25 EFPM.) This item is similar to UNR 50-280 and 281/90-14-02, which will be addressed by NRC management.

The inspector also noted that all 50 flux mapping thimbles were rarely, if ever, used (or available) in performing the flux maps in either unit. Typically, 38 to 41 thimbles were used in the full core flux maps. Thirty-eight is the minimum number allowed by TS.

Document (3) contained a summary of all of the reactivity anomaly calculations performed for both units for their current cycles. The surveillance frequencies were satisfied, and the observed anomalies were well within the limits of TS.

c. Future Activities

Discussions with plant personnel revealed that, starting with cycle 12 on both units, core loadings will be designed to reduce the fast flux exposure of both the beltline and the longitudinal welds. This added complexity in the number of fuel material regions will necessitate a change in the computer program used to analyze flux maps. The INCORE program will be replaced by the CE-COR program, and efforts to qualify the program for use at Surry are currently underway.

No violations or deviations were identified.

3. Calibration of Nuclear Instrumentation Systems (61705)

a. Procedures and Other Licensee Documents

NUCLEAR CORE DESIGN MANUAL, USER'S COPY, PART VII, CHAPTER E, Power Range Detector Calibration Versus Burnup, (Revision 0, May 1990) (written by the Nuclear Analysis and Fuel Group of Virginia Power) describes the method used for incore-excore nuclear instrument correlation. The internally generated computer program INEXC is used for data analysis and determining instrument setpoints. It is described in TECHNICAL REPORT NE-764, VIRGINIA POWER INCORE/EXCORE INSTRUMENTATION CALIBRATION CODE MANUAL.

1/2-PT-28.8 (Approved September 5, 1989), Power Range Nuclear Instrumentation Calibration, is performed to collect data for the incore-excore correlation and to recalibrate the F(delta I) function and PRNI channels as defined in TS 4.1. The procedure requires that a minimum of three flux maps (quarter core or full core) be obtained over a range of 5 to 10% in AFD units. These specifications are truly the minimum to accomplish the correlation. Better and more consistent results could be obtained by increasing both the number of flux maps and the span in AFD. This observation was discussed with the licensee.

b. Surveillance Activities

Completed incore-excore nuclear instrument calibrations were reviewed for Unit 1, cycle 10A, and Unit 2, cycle 10. In all cases, the frequency of test performance was satisfactory and test results satisfied the acceptance criteria established by the licensee.

The inspector independently analyzed some of the incore-excore correlations of PRNI chamber current with incore axial offset using a least-squares analysis spreadsheet with the SUPERCALC3 microcomputer program. Zero-offset currents and the slopes of current versus offset agreed with those obtained by the licensee. In the inspector's analyses, the quality of the correlation was determined from the calculation of a correlation coefficient. Correlation coefficients equal to 0.98 or greater, the maximum value is 1.0, were accepted as indicating that no unaccounted for variables were influencing the results. A limit of 0.98 on the correlation coefficient is consistent with standard statistical practice.

The licensee's computer program, INEXC, calculates a SEE, rather than a correlation coefficient, and places an upper limit on the SEE of 0.8. By perturbing data used in both analyses, the inspector was able to demonstrate that the SEE was not nearly as rigorous a determinant of the quality of the fit as the correlation coefficient. The perturbed value of the correlation coefficient dropped to 0.90, but the SEE increased only to 0.74. Thus, in the case where the correlation coefficient would identify the results as suspect, the SEE would accept the results without question. This observation was discussed with licensee personnel during the inspection.

c. Unit 1, Cycle 10A, End-of-Cycle Power Coastdown

For cycle 10A, Unit 1 reached the end of full-power capability (zero boron and ARO) at about 14,000 MWd/MTU. To extend cycle burnup to the design value of 15,900 MWd/MTU, the licensee elected to operate at reduced average coolant temperature and reduced power. To evaluate and support the change in operating characteristics, EWR-90-251, RC COASTDOWN SETPOINTS/SURRY/1&2, was initiated and completed. The EWR identified and evaluated four setpoints that would require changing:

(1) Pressurizer control
(2) Steam Dumps
(3) Coolant Average Temperature
(4) High T-average Alarm.

No special procedures were issued for the transition. According to engineering personnel, the control room manipulations were considered the skill of the craft and the operators received refresher training on the simulator in controlling the xenon transient that would result from shifting the axial power distribution by reducing coolant temperature.

The planned 8°F reduction in T-average was introduced over about a day of operation, by a slow and intermittent boration process. The colder water in the downcomer reduced the leakage flux to the PRNIs, and several interruptions of the process occurred to perform recalibrations of the PRNIs against the reactor heat balance, which is discussed in paragraph 4. During the process, AFD changed from -2% to +9%.

The cited instrument setpoints were changed once after the completion of the temperature reduction.

In the view of the reactor engineers, who supported the transition, the entire evolution and the subsequent coastdown went smoothly. The inspector did not interview the operators to obtain their perspectives on the evolution.

No violations or deviations were identified.

4. Core Thermal Power Evaluation (61706)

a. Procedures

1/2-PT-35.0 (Revision 1), Reactor Power Calibration Using Feed Flow, is used when the unit computer is in service for data logging, and a hand calculation of reactor heat balance based upon feedwater flow is to be performed.

1/2-PT-35.1 (Revision 1), Reactor Power Calibration Using Feed Flow, is used when the unit computer is not available for data logging, and a hand calculation of reactor heat balance based upon feedwater flow is to be performed.

1/2-PT-35.2 (Revision 1), Reactor Power Calibration Using Steam Flow, is used when the unit computer is in service for data logging, and a hand calculation of reactor heat balance based upon steam flow is to be performed. Unlike most facilities, the Surry units have calibrated steam flow venturis. That feature is discussed in more detail in Inspection Report 50-280 and 281/88-29.

In reviewing the reference copies of the Unit 2 versions of the above procedures, the inspector noted numerous typographical and fixed data errors. For each steam generator loop, in each calculation, there is a constant datum for line loss and conversion of gauge pressure to absolute pressure. Although a variation from loop-to-loop is expected, there was also a variation from procedure-to-procedure for loop C, which was not present in the other two loops. By reference to plant calculational files, the licensee was able to establish which of the three values was correct, but could not explain or justify the errors in the procedures. One of the errors listed as typographical included a failure to include all of a precautionary statement in one procedure. It appears that better effort at proof reading and peer review is required when procedures are first issued or changed.

1/2-PT-35.3 (Revision 1), Reactor Power Calibration Using CALCALC Computer Program, is the most commonly used of the thermal power surveillance procedures. Other than to initiate the program, no human interaction is required to enter data into the program or to perform the analysis. It performs power calculations based upon steam flow, feedwater flow, and primary flow and differential temperature.

ENG-35.0, Calculating Reactor Power, Delta-T Setpoints, and Reactor Coolant System Flow, is used at the start of an operating cycle, in conjunction with temporarily installed precision instruments. It has three purposes:

(1) To calculate reactor power using steam flow.
(2) To calculate 100%-power, delta-temperature protection and control values.
(3) To calculate reactor coolant flow by equating primary and secondary side heat balances.

However, this procedure does not require any comparison of results with the procedures used to perform routine heat balances or set limits on how much those procedures may differ in results from the precision calculation. This observation was discussed with licensee personnel during the inspection.

b. Surveillances Activities

Selected surveillances of PRNI indication versus heat balance were reviewed for Unit 2 for the month of October 1990. In all cases, the procedure used was 2-PT-35.3; so there were neither data entries nor hand calculations to review. The surveillance frequency exceeded the TS requirements, and it was clear that the operators performed this convenient surveillance whenever they had any question about power level or the PRNI calibration. Hence, for every surveillance reviewed, the agreement between thermal power and PRNI indications was well within TS limits.

ENG-35.0 was last performed on October 6, 1989, for Unit 2. All of the test objectives were met, but there were no records of routine heat balances in the test package for comparison of those results with the precision results. The licensee does not have a TS requirement to measure primary side flow, but has been measuring it, with this procedure, since the steam generators were replaced. Licensee engineers stated that the results were being trended and that two of the loops were unchanged, but that loop A had exhibited a slight downward trend, which might still be within experimental uncertainty. The experiences of other facilities, at which hot leg streaming had complicated or invalidated the measurement of primary flow, were discussed with licensee engineers.

No violations or deviations were identified.

5. Exit Interview (30703)

The inspection scope and findings were summarized on October 19, 1990, with those persons indicated in paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee. Proprietary material was reviewed in the course of this inspection, but is not included in this report.

UNR 50-281/90-29-01: The interval between surveillances of hot channel factors exceeded 1.25 EFPM - paragraph 2b.

6. Acronyms and Initialisms Used throughout This Report

AFD	axial flux difference
ARO	all rods out
dP	differential pressure
EFPD	effective full power days
EFPM	effective full power months
ENG	engineering procedure
EOL	end of (core) life
EWR	engineering work request
MD	movable detector
MWd/MTU	megawatt-days per metric tonne of uranium
NE	nuclear engineering
pcm	percent millirho, a reactivity unit
ppmB	parts per million boron
PRNI	power range nuclear instruments
PT	periodic test procedure
QPTR	quadrant power tilt ratio
RC	reactor coolant
RCS	reactor coolant system
SEE	standard error of the estimate
TS	Technical Specifications
UNR	unresolved