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

Report Nos.: 50-338/88-15 and 50-339/88-15

Licensee: Virginia Electric and Power Company
Richmond, VA 23261

Docket Nos.: 50-338 and 50-339 License Nos.: NPF-4 and NPF-7

Facility Name: North Anna 1 and 2

Inspection Conducted: May 24 - 27, 1988

Inspector: _____ 6/23/88
M. Thomas Date Signed

Approved by: _____ 6/23/88
G. A. Belisle, Chief Date Signed
Quality Assurance Programs Section
Operations Branch
Division of Reactor Safety

SUMMARY

Scope: This routine, announced inspection was conducted in the areas of reviewing licensee actions taken due to service water system fouling in the recirculation spray heat exchangers.

Results: In the areas inspected, violations or deviations were not identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

J. Bailey, Nuclear Engineering
*M. Bowling, Assistant Station Manager, North Anna Power Station (NAPS)
R. Calder, Manager, Nuclear Engineering
*R. Clark, Engineer, Plant Engineering, NAPS
*R. Driscoll, Manager, Quality Assurance, NAPS
*R. Enfinger, Assistant Station Manager, NAPS
J. Erb, Nuclear Analysis and Fuel
S. Harvey, Supervisor of Advisory Operations, NAPS
*D. Heacock, Superintendent of Technical Services, NAPS
*G. Kane, Station Manager, NAPS
P. Kemp, Licensing Coordinator, NAPS
L. Lee, Assistant Supervisor, Chemistry, NAPS
M. Matras, Nuclear Analyis and Fuel
*T. Porter, Supervisor, Nuclear Safety Engineering, NAPS
D. Quarz, Licensing Engineer, NAPS
R. Rasnic, Supervisor, Mechanical Engineering
*J. Smith, Supervisor, Nuclear Safety Engineering, NAPS
T. Snow, Supervisor, Chemistry, NAPS
*J. Stall, Superintendent of Operations, NAPS

Other licensee employees contacted during this inspection included engineers, operators, security force members, technicians, and administrative personnel.

Other Organizations

Calgon Corporation
A. Smith, Corporate Biologist
C. Szymke, Account Supervisor

NRC Resident Inspectors

*J. Caldwell, Senior Resident Inspector

*Attended exit interview

2. Heat Exchanger Fouling Problems At North Anna

This inspection reviewed actions taken by Virginia Power in response to recirculation spray heat exchanger (RSHXs) fouling. This inspection also included reviewing system design requirements for the recirculation spray (RS) system and the service water system. The review results are discussed in the following paragraphs.

a. System Design Review

(1) Recirculation Spray System

The RS system and the Quench Spray (QS) system are the subsystems which comprise the containment depressurization system. Two major functions of the RS system are: a) combines with the QS system to depressurize containment to subatmospheric pressure within 60 minutes during a loss of coolant accident (LOCA) or a main steamline break accident inside containment and to maintain subatmospheric pressure following the accident; and b) to provide the emergency core cooling system (ECCS) with water for effective core cooling on a long term basis after a LOCA. There are four RSHXs per unit. The RSHXs were designed with a zero fouling factor (hour-foot^2 °F/BTU) for both inside and outside heat exchanger tube surfaces. The RSHXs have to be clean and maintained in dry lay-up to meet this design requirement.

(2) Service Water System

The service water system is a common system. Service water sources at North Anna Units 1 and 2 are the service water reservoir and the North Anna reservoir and these two independent water sources form the ultimate heat sink. The service water reservoir is the primary water source for the service water system and the North Anna reservoir is the alternate source.

The accident design basis for service water system pumping requirements is a simultaneous LOCA for one unit and loss of offsite power for both units. Under these conditions, the service water system has to supply the four RSHXs on the unit with a LOCA: three charging pump lube oil, gear box, and seal coolers per unit; one air compressor per unit; one main control room air conditioning condenser per unit; and one component cooling heat exchanger for the unit without the LOCA.

b. Recirculation Spray Heat Exchanger Fouling

The licensee determined that leaving the RSHXs in wet lay-up resulted in unacceptable heat exchanger tube walls (inside surface) fouling. The heat exchangers were placed in wet lay-up using service water, which flows through the RSHXs tube side. As a result of the fouling the licensee implemented the following actions.

(1) The licensee reviewed the RSHXs ability to perform their design basis function. An engineering evaluation was performed for steady state conditions assuming a 0.002 fouling factor for the service water side of the RSHXs.

The evaluation's purpose was to determine the required service water temperature at which the fouled RSHXs could perform their design function.

The inspector asked licensee personnel how long had the RSHXs been in wet lay-up and whether the 0.002 fouling factor provided enough conservatism. Licensee personnel stated that they had not completed their review to determine how long the RSHXs had either been maintained in wet lay-up or had service water in them during dry lay-up conditions due to leakage from service water system valves which isolate service water from the RSHXs. Licensee personnel further stated that the 0.002 fouling factor was considered to be conservative. The fouling factor stated in standard industry tables for water conditions like North Anna's service water reservoir with the RSHXs in wet lay-up (i.e. artificial spray pond with treated makeup and water velocity less than 3 feet/sec) is 0.001. The fouling factor was doubled from 0.001 to 0.002 in order to provide additional conservatism. Licensee personnel also stated that photographs taken of the RSHXs lower tubesheet area during a previous outage were reviewed and the pictures showed no indications of heat exchanger fouling.

In addition to determining the required service water temperature for the 0.002 fouling factor, the licensee also determined the required service water temperatures for the RSHXs for various inside tube fouling factors ranging from approximately 0.0004 to 0.003. The licensee also requested the architect engineer (Stone and Webster) for NAPS to perform a transient analysis of the effect of the increased fouling factor on the design basis accident analysis. The licensee compared their steady state calculations to the architect engineer's transient calculations and found that the two were in close agreement. Assuming a 0.002 fouling factor for the RSHXs inside tube wall, the maximum service water temperature permitted to meet the containment response requirements in the accident analysis was approximately 84°F. The licensee placed an administrative limit on the maximum service water temperature of 83°F in lieu of the Technical Specifications (TS) limit of 95°F.

(2) RSHXs Chemical Cleaning

The licensee developed a chemical cleaning program to remove biological fouling from the RSHXs. The process included using chemicals for cleaning the heat exchangers, a biocide for killing the biological growth, and a molybdate corrosion inhibitor for corrosion control. Water samples were being taken at various cleaning process stages for analysis. Licensee personnel stated that sample analysis would assist in determining the cleaning process effectiveness. The inspector reviewed procedure 1-TOP-49.42, Chemically Cleaning 1-RS-E-1C

There was a separate procedure for each of the eight RSHXs. The instructions in this procedure were typical for the other RSHXs. Since this procedure was developed to clean and remove biological fouling, the inspector asked licensee personnel if there was a

concern with inorganic fouling on the heat exchanger tubes. Licensee personnel stated that they had determined that biological fouling was the only type of fouling likely to be present. This determination was made based on the RSHXs design and lay-up conditions and discussions with various industry experts experienced in heat exchanger fouling and biological fouling. Included in these discussions were representatives from Calgon Corporation. They developed the chemical treatment program currently being used for the service water system at NAPS and are familiar with types of biological fouling that might occur. Calgon also helped develop the chemical cleaning program for the RSHXs and is providing the chemicals for the cleaning.

The inspector observed portions of the chemical cleaning process for RSHXs 1-RS-E-1C and 2-RS-E-1C. Activities were being performed in accordance with applicable procedures. The licensee had cleaned RSHXs 1A, 1B, and 1C for each unit. The 1D RSHX for each unit remained to be cleaned.

The inspector asked licensee personnel if additional measures (such RSHX inspection or heat balance testing) were planned in order to return the service water temperature to the TS limit of 95 °F. Licensee personnel stated that they believed the chemical cleaning process was adequate to restore the RSHXs to their design condition. The licensee further stated that conservative fouling factors would be used to determine the administrative limits for the service water temperature until the cleaning process effectiveness could be verified. The licensee stated that measures for returning to the TS limit for service water temperature were described in a justification for continued operation (JCO) for the RSHXs for Units 1 and 2 dated May 25, 1988. Measures described in the JCO included the following:

- After cleaning, the RSHXs will be maintained in wet lay-up using primary grade water. A service water temperature administrative limit of 90°F would be applicable assuming a fouling factor of 0.001 for the heat exchangers in wet lay-up.

- Once the RSHXs are placed in dry lay-up and a surveillance program established to ensure that they remain in dry lay-up, a service water temperature administrative limit of 92°F would be applicable assuming a 0.00075 dry fouling factor.

- The service water temperature limit would not be re-established at the TS limit of 95°F until confirming that the fouling factor was less than 0.0004. Confirmation would be by means such as a cleaning process sampling program, RSHX inspection, or a laboratory test.

Licensee personnel stated that they were unable to perform heat balance testing on the RSHXs because of the design of the RS system. The licensee further stated that they would review what actions were necessary to develop the capability to perform RSHX heat balance testing.

Another question discussed with licensee personnel was whether there was adequate service water flow through the RSHXs. This question arose during the cleaning process when RSHX flow instrumentation indicated that the service water flow was less than the design requirement of 4500 gpm. Licensee personnel stated that the low flows were due to instrumentation problems because during attempts to resolve the problem, flow instrumentation in the main service water return header indicated a flow change of approximately 4500 gpm when the RSHX was isolated. The low flows were attributed to debris partially blocking the RSHX flow instrument lines. It was stated that after the instrument lines were back flushed, service water flow through the RSHXs returned to normal.

After reviewing actions already taken and those planned by the licensee, the inspector concluded that implementation of all the actions would provide reasonable assurance that the RSHXs were operable and capable of performing their design functions during accident conditions.

During the exit meeting, the inspector stated that followup items would not be identified in this report concerning this issue. An unresolved item was identified by the resident inspectors and is documented in NRC Inspection Report Nos. 50-338, 50-339/88-11. This issue is also discussed by the resident inspectors in NRC Inspection Report Nos. 50-338, 50-339/88-16.

3. Exit Interview

The inspection scope and results were summarized on May 27, 1988, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee.