APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-285/90-42 Operating License: DPR-40

Docket: 50-285

Licensee: Omaha Public Power District (OPPD)
444 South 16th Street Mall
Omaha, Nebraska 68102-2247

Facility Name: Fort Calhoun Station (FCS)

Inspection At: FCS, Blair, Nebraska

Inspection Conducted: October 15-19, 1990

Inspector: for T. F. Johnson, Reactor Inspector, Plant Systems Section, Division of Reactor Safety — Date 11/9/90

Approved: For T. F. Stetka, Chief, Plant Systems Section, Division of Reactor Safety — Date 11/7/90

Inspection Summary

Inspection Conducted October 15-19, 1990 (Report 50-285/90-42)

Areas Inspected: Routine, announced onsite inspection of events relating to the OPPD engineering ongoing Design Basis Reconstitution effort, where the licensee discovered that the FCS could be outside the containment cooling design bases for the component cooling water (CCW), raw water (RW), and containment spray (CS) systems following a worst-case design basis accident (DBA).

Results: Within the areas inspected, no violations or deviations were identified. It appears that as the result of the licensee's review of the containment cooling design basis, the previous configurations of CCW, RW, and CS systems, were adequate in controlling containment peak pressure below 60 psig following a worst-case DBA. It is apparent that licensee management initiated appropriate and immediate actions to resolve the design concerns.

DETAILS

1. PERSONS CONTACTED

*R. Andrews, Division Manager, Nuclear Services
*J. Biggs, Radiochemistry
*A. Bilau, Acting Supervisor, Radwaste Operations
*J. Chare, Manager, Nuclear Licensing
*V. Frahm, Jr., Supervisor, Radiochemistry
*F. Franco, Manager, Radiological Services
*A. Friebe, Radiochemistry Technician
*J. Gasper, Acting Division Manager, Nuclear Operation
*J. Glantz, Chemist
K. Henry, Lead Systems Engineer
*R. Jaworski, Manager, Station Engineering
*J. Krist, Environmental Scientist, Radiation Services
*L. Kusek, Manager, Nuclear Safety Review
*M. Lazar, Supervisor, Operations Training
*D. Lovett, Acting Supervisor, Radiation Program
R. Mehaffey, Supervisor, Electrical/Instrumentation and Control
*T. Patterson, Manager, Fort Calhoun Station
*W. Pence, System Engineer, HVAC
*R. Phelps, Manager, Design Engineering
*R. Sexton, Supervisor, Radiation Health and Engineering
*B. Schmidt, Supervisor, Secondary Chemistry
*R. Short, Supervisor, Special Services Engineering
*L. Sills, Operations QA Auditor
*C. Simmons, Station Licensing Engineer
*F. Smith, Supervisor, Chemistry
*D. Spires, QA Auditor
*T. Therkildsen, Supervisor, Nuclear Licensing
B. VanSant, Lead Mechanical Engineer
*B. Weber, Supervisor, Reactor Performance
*S. Willrett, Manager, Nuclear Materials/Administration

Stone & Webster Engineering Corporation (SWEC)

C. Morrell, Acting Mechanical Manager, Design Engineering, Nuclear

NRC

*J. Jang, Senior Radiation Specialist, RI
*J. Nicholas, Senior Radiation Specialist, RIV
*T. Reis, Resident Inspector

*Denotes attendance at the exit interview.

The inspector also interviewed other licensee personnel during the inspection.

2. GENERAL

2.1 BACKGROUND

During the reconciliation of design basis information and subsequent development of the Fort Calhoun Station (FCS) Design Basis Documents (DBDs) by OPPD, it was determined that information required to support values or statements made in the DBDs were sometimes missing or inconsistent. As the result of this determination, OPPD established a program to identify, evaluate, and resolve these discrepant and open issues within the DBDs. During this review and evaluation, the raw water (RW), component cooling water (CCW) and containment spray (CS) systems as built flow calculations could not be retrieved from available original documents and were then identified as open items. OPPD categorized these open items in categories numbered from 1 to 6 with Category 1 having the most safety significance and Category 6 the least safety significance. These open items indicated that the potential existed that the three containment cooling systems (RW, CCW, and CS) would be unable to prevent the containment peak pressure from exceeding its maximum design pressure during a Design Basis Accident (DBA).

Based upon this preliminary information, on September 28, the licensee shutdown the plant to Hot Shutdown, pending final resolution on this issue.

OPPD had become aware of these concerns through preliminary calculations performed by their contractors, Stone & Webster (SWEC) and Combustion Engineering (CE).

The worst-case DBA postulated was a large break loss of coolant accident (LOCA), concurrent loss of offsite power and instrument air, and failure of Emergency Diesel Generator (EDG) No. 2. These accident conditions would have the following effects:

° Upon loss of instrument air, the RW and CCW interface valves fail open thus rendering the CCW system inoperable as the result of a loss of CCW inventory. These interface valves do have backup air accumulators; however, since these accumulators are nonsafety-related, no credit (from a design basis standpoint) can be taken for their availability. The RW system provides the backup cooling for the CCW system.

° Upon loss of EDG No. 2, the RW system would be reduced from three to two RW pumps. Because of the elevation difference between the RW pumps and the containment fan cooler coils, these two pumps would not provide sufficient head and flow to prevent the water in the cooling coils from flashing to steam. This would significantly degrade the heat removal performance of the containment coolers.

° Upon loss of EDG No. 2, only one (SI-3A) of the three CS pumps would be available to cool the containment during postulated accident conditions. The one CS pump would be aligned to both CS headers. In this configuration, the reduced system resistance and low initial containment pressure would allow the pump horsepower (HP) requirements to exceed the motor's 300 HP rated capacity.

On September 29, 1990, the licensee received additional information that confirmed the preliminary information regarding equipment vulnerability in the postulated scenarios. The licensee issued a 4-hour report to the NRC pursuant to 10 CFR 50.72(b)(2)(i).

2.2 INSPECTION TASK

On October 3, 1990, a conference call was held between the NRC and OPPD to discuss these events. OPPD was informed that an inspector would be dispatched to the site to review the issue. The inspector was directed to conduct:

- A thorough review of the sequence of events leading to the event;
- A review of the postulated design deficiencies; and,
- A review of the licensee's planned corrective actions.

The inspector reviewed the event, inspected the affected equipment, reviewed design calculations, and interviewed managers, operators and design engineers. Documents reviewed by the inspector are listed in the Attachment to this report.

3. INSPECTION ACTIVITIES

3.1 Sequence of Events

The following sequence of events was developed by the inspector as the result of a conference call with engineering personnel on October 16, 1990, a memorandum from SWEC to OPPD, and interviews with managers.

- October 1989 — OPPD requested SWEC to propose a complete analysis of the RW and CCW systems to document the basis of the design and licensing requirement, and to determine the design margin available.
- October 6, 1989 — SWEC letter DB-527 provides the first proposal to perform an RW system design evaluation.
- October 26, 1989 — Memorandum PED-FC-89-2360 from OPPD Engineering written recommending SWEC perform a RW system design evaluation.
- November 1, 1989 — Draft revision of RW DBD received.
- November 1989 — SWEC verbally authorized to start RW system design analysis.
- February 1990 — Fort Calhoun begins refueling outage.
- May 1990 — Fort Calhoun ends refueling outage. The RW and CCW system valves were rebuilt during this outage.

- June 1990 — OPPD system engineering began collection of RW system temperature and flow data for use by SWEC in the system design analysis.
- September 1990 — OPPD system engineering provided RW system temperature and flow data to SWEC to be used to validate the system models.
- September 21, 1990 — SWEC upgraded this open item (No. 59) from Category 2 to Category 1 based on the preliminary results of their RW/CCW evaluations.
- September 24, 1990 — OPPD received letter DB-763 from SWEC which documented the SWEC preliminary results of the RW/CCW evaluation.
- September 26, 1990 — FCS plant manager informed of the preliminary results from SWEC.
- September 24-28, 1990 — SWEC and OPPD engineering work concurrently to evaluate this issue. SWEC on site September 27-28, 1990.
- September 28, 1990 — Plant manager makes decision to proceed with a plant shutdown based on preliminary results of the engineering evaluation.
- September 29, 1990 — Plant in Hot Shutdown at approximately 3:40 a.m.
- September 29, 1990 — Formal letter issued to Station Engineering per Procedure PED-QP-19 notifying OPPD of a potential reportable condition relating to CCW/RW and CS systems.
- September 29, 1990 — OPPD notifies the NRC of this event.

3.2 Review of the DBA Event

To determine whether the licensee was outside the design basis for maximum containment pressure following a postulated accident, the inspector reviewed the following issues:

1. The potential for loss of CCW inventory through the failed open RW/CCW interface valves upon loss of instrument air.

2. Availability of adequate CCW flow to provide cooling for the CS system via the shutdown heat exchangers during spray recirculation operation.

3. Accuracy of Technical Specification Basis 2.4 concerning the redundancy of the CS system and containment cooling systems.

4. The potential for CS pump SI-3A to exceed its motor horsepower rating when providing flow to both spray headers.

3.2.1 CCW/RW Interface Valves

The inspector's review indicated that upon the onset of a DBA concurrent with a loss of instrument air, the interface valves would fail open. Since the CCW system is at a higher pressure than the RW system, CCW inventory would be lost through the RW system into the Missouri River. Discussions with OPPD engineering indicated that it would take 3-5 minutes for the CCW system pressure to become low enough to allow a reverse flow back to the CCW system from the RW system. This would restore both the CCW and RW systems. This would however, also reduce the efficiency of the containment fan coolers (CFCs) which are required to reduce pressure in containment.

The licensee initiated a temporary modification to hand-jack the RW/CCW interface valves closed. This modification would prevent a potential loss of CCW inventory through these interface valves. Operator actions would be required to use RW backup cooling for the shutdown cooling heat exchangers following a Recirculation Actuation Signal (RAS). The licensee has updated the Emergency Operating Procedures (EOPs) by incorporating instructions for completing these operator actions. Hand-jack closure of these interface valves has not been finalized as a permanent resolution. The licensee is also considering upgrading the nonsafety-related air accumulators on the interface valves to safety-related accumulators. This also has not been finalized. The inspector verified that this modification was complete by random selection of several CCW/RW interface valves to determine that they were hand-jacked closed and that caution tags were applied. The inspector also verified that changes were made to the EOPs that provide the operator actions to be taken.

Subsequent calculations performed by CE indicate that the CS system is sufficient to maintain containment pressure below maximum design pressure without the CFCs.

3.2.2 Adequacy of CCW Flow

Another concern regarding the CCW system was whether there was adequate flow distribution to provide cooling for the CS via the shutdown cooling heat exchangers following a Recirculation Actuation Signal (RAS). CE verified through calculations and assumptions using the CONTRANS computer code for containment pressure analyses that flow to the shutdown cooling heat exchangers is sufficient.

The inspector reviewed the preliminary hand calculations in calculation No. 002-NT90-C-012 but did not review the CONTRANS computer code. The inspector concluded that CCW flow would apparently be sufficient for cooling the shutdown heat exchangers.

3.2.3 Basis of Technical Specification 2.4

The original design provided RW backup cooling to the CFCs by remote manual action. This design, which formed the basis for TS 2.4, assumed that the CFCs were redundant to the CS system for controlling containment peak pressure in

the short-term. CE's analyses indicates that the function of the CFCs could be degraded or lost upon loss of instrument air. The system modeling analysis showed that if RW was used to supply cooling water to the CFCs, the elevation difference between the CFCs and RW pumps would theoretically create vacuum conditions and allow water inside the coolers to flash to steam. In the licensee's latest analysis, it is assumed that the CFCs are lost and do not contribute in containment pressure reduction. The licensee has decided to take no credit for the CFCs as a redundant system. This is based on calculations indicating that the CS can control containment pressure without the CFCs. The inspector reviewed the proposed changes to the TS and USAR. These changes will be submitted to the NRC for formal review.

3.2.4 Containment Spray Pump SI-3A

During a worst-case DBA (prior to the modification), CS pump SI-3A would be aligned to feed both CS headers. In this configuration, low system resistance and low initial containment pressure would allow the pump to operate in a runout mode, thereby causing the pump horsepower requirements to exceed the motor's 300 HP rated capacity and its 1.15 service factor (which equates to 345 HP).

Discussions with OPPD engineering indicated that even with only pump SI-3A providing flow through both CS headers, there would be sufficient cooling to reduce pressure inside containment. Review of the LOCA long-term cooling containment response curve indicated that when containment pressure is about 45 psig, the SI-3A pump motor will be operating in the 300 to 345 HP range delivering minimum required flow. The curve also indicated that containment pressure would peak at 59.816 psig with the pump motor running at approximately its rated 300 HP capacity. When containment pressure is reduced to about 30 psig, pump SI-3A would be operating at 345 HP. The response curve indicates that it takes approximately 48 minutes for pressure to decay from a peak pressure of 59.815 psig to 30 psig. At 30 psig, pump SI-3A would continue to run at approximately 345 HP.

OPPD engineering informed the inspector that CE and the pump motor vendor (General Electric) held a conference call on September 28, 1990. During that conference call General Electric stated that the pump motor can run continuously for 60 days at 345 HP.

To assure a conservative approach to this issue, the licensee expanded their evaluation to assume that pump SI-3A has failed. The licensee's calculation/ assumptions indicate that with no operator actions taken to realign the CFCs or to realign the power supply for the other CS pump (SI-3C), the peak containment pressure of 59.816 psig would not be reached until 3.84 hours into the accident. The licensee considers this to be ample time to compensate for the event with operator action.

To assure that these design reviews and assumptions were consistent with operator activities, the inspector interviewed two shift supervisors to determine if the operators would have any control room indication that pump SI-3A was failing. Discussions with the operators and review of the Emergency Operating

Procedures (EOPs), indicate that in an accident scenario, the EOPs require the operators to perform safety function status checks which include the monitoring of containment integrity and CS operation. The operation of CS pump SI-3A motor would be monitored using CS flow indications and CS pump motor current. Based upon this review, it was apparent to the inspector that the design of the CS system and operator guidance would have been sufficient to mitigate the potential for a breach of containment integrity during a DBA.

To prevent a runout of CS pump SI-3A from occurring, the licensee initiated a modification which would change the control circuit logic of CS header isolation valve HCV-344. A Containment Spray Actuation Signal (CSAS) would normally open both CS header isolation valves HCV-344 and HCV-345. This modification provides an interlock that will keep HCV-344 closed if the two pumps powered from DG-2 (SI-3B and SI-3C) are not operating. This modification was completed prior to plant restart.

3.2.5 Conclusion

As the result of the inspector's review, it was conncluded that the CS, RW, and CCW systems would have been adequate to maintain containment peak pressure below 59.816 psig during this accident scenario. Even though operator actions would be required to restore the CCW system function, it appears that there was ample time for operators to initiate manual actions to mitigate an increasing containment pressure. The modification installed on valve HCV-344 will assure that the CS system will be available. In addition, the licensee will be pursuing changes to the TS and USAR.

The inspector concluded that the licensee's design basis reconstitution program is functioning to identify and resolve issues as they are identified.

4. EXIT MEETING

An exit meeting was held October 19, 1990, with the personnel indicated in paragraph 1 of this report. At this meeting, the scope of the inspection and the findings were summarized. The licensee did identify the calculations developed by SWEC as proprietary information.

ATTACHMENT

EOPs Reviewed

EOP-00, "Standard Post Trip Action," Revision 2, June 30, 1990

EOP-02, "Loss of Off-Site Power/Loss of Forced Circulation," Revision 4, May 19, 1990

EOP-03, "Loss of Coolant Accident," Revision 10, May 19, 1990

EOP-05, "Uncontrolled Heat Extraction," Revision 7, May 19, 1990

EOP-20, "Functional Recovery Procedure," Revision 9, June 30, 1990

Technical Specifications

Section 2.4 (Basis)

Section 4.2.3

Calculation

002-NT90-C-012, Revision 0

Modifications

MR-FC-90-053, "Containment Spray Header Valve Interlock," September 29, 1990

TM-90-022, "Handjack Closure of the CCW/RW Interface Valves," October 1, 1990 (Temporary Modification)

Memorandum

PED-FC-90-2925, dated September 29, 1990

Letters

LIC-90-0776, dated October 12, 1990

LIC-90-0738, dated October 1, 1990

DB-763, dated September 21, 1990

O-MPS-90-078, dated September 29, 1990

Procedures

PED-QP-19.1, "Evaluation of Potentially Reportable Conditions," Revision 0, November 17, 1989