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Subject: Catawba Nuclear Station
Docket 50-414
Special Report
IIR C90-067-2; PIR 2-C90-0294

Gentlemen:

Attached is a report concerning UNIT COOLDOWN TO COLD SHUTDOWN DUE TO REACTOR COOLANT SYSTEM LEAKAGE. This report is submitted as a "Special" Report to ensure industry awareness of this event. The health and safety of the public were not affected by this incident.

Very truly yours,

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DUKE POWER COMPANY
CATAWBA NUCLEAR STATION
PROBLEM INVESTIGATION REPORT NO. 2-C90-0294

UNIT COOLDOWN TO COLD SHUTDOWN DUE TO REACTOR COOLANT SYSTEM LEAKAGE

ABSTRACT

On September 14, 1990 at approximately 0200 hours, with Unit 2 in Mode 3, Hot Standby, vendor personnel were in the process of performing a leak repair on a Core Exit Thermocouple Nozzle Assembly (CETNA) on the Reactor Vessel head. In order to perform the leak repair, it was necessary to drill through a modified blind hub (part of the Grayloc flange at the CETNA) into the Reactor Coolant (NC) System pressure boundary. A sealant injection valve was installed during this process to provide isolation at the pressure boundary. After the final drilling was completed, the sealant injection valve would not close. A second valve was threaded into the back of the first valve, but before it could be closed the entire assembly ejected from the hole. A conservative decision was made to consider the leakage as NC system pressure boundary leakage. Unit 2 commenced cooldown to Mode 5, Cold Shutdown, and an Unusual Event was declared. An analysis will be performed to determine the cause(s) of this failure. The original CETNA leaks are attributed to a Manufacturing Deficiency in that the modified blind hubs did not meet dimensional requirements during fabrication. The unacceptable hubs were identified and replaced. This report is being submitted as a Special Report.

BACKGROUND

The Reactor Coolant [EIIS:AB] (NC) System is designed to transport heat from the Reactor to the Steam Generators [EIIS:HX] (S/Gs), where heat is transferred to the Feedwater [EIIS:SJ] (CF) System and Main Steam [EIIS:SB] (SM) System of the secondary side. The NC System consists of four identical heat transfer loops connected in parallel to the Reactor Vessel [EIIS:VSL].

The Incore Instrumentation [EIIS:IG] (ENA) System provides information on the neutron flux distribution and fuel assembly outlet temperatures at selected core locations. Chromel-alumel thermocouples are threaded into guide tubes that penetrate the Reactor Vessel head through seal assemblies, and terminate at the exit flow end of the fuel assemblies.

Catawba Unit 2 utilizes a Core Exit Thermocouple Nozzle Assembly (CETNA) to provide the NC System pressure boundary seal where the thermocouple leads penetrate the Reactor Vessel head. There are five CETNAs on Unit 2 identified as connections #74 through 78. The CETNA, supplied by Combustion Engineering, Inc. (CE), consists of a nozzle assembly which is threaded and seal welded to the Reactor Vessel head nozzle, a Grayloc clamp set, a modified blind hub to form the second half of the flange and house Grafoil packing rings, drive sleeve and nut, thrust bearing and washers, and a hinged split collar to retain the assembly. Gray Tool Company manufactured the original Grayloc clamp sets, including the modified blind hubs. Gray Tool later gave up their N-stamp and turned over the manufacturing responsibility for these parts to CE. During the Catawba Unit 2 End-of-Cycle 2 (2EOC2) refueling outage, discoloration was found on three of the original modified blind hubs (manufactured by Gray Tool). As a conservative measure, these hubs were replaced with spare hubs manufactured by CE. Leakage inspections were conducted during startup, and no leakage was noted.

Technical Specification (T/S) 3.4.6.2 requires NC system leakage to be limited to no pressure boundary leakage during Mode 1, Power Operation, Mode 2, Startup, Mode 3, Hot Standby, and Mode 4, Hot Shutdown. Pressure boundary leakage is defined as leakage (other than S/G tube leakage) through a non-isolable fault in a NC system component body, pipe [EIIS:PSP] wall, or vessel wall. With any pressure boundary leakage present, the required action is to be in at least Hot Standby within 6 hours and in Mode 5, Cold Shutdown, within the following 30 hours. The T/S Bases states that pressure boundary leakage of any magnitude is unacceptable since it may be indicative of an impending gross failure of the pressure boundary.

EVENT DESCRIPTION

On June 10, 1990, Unit 2 was shutdown for the End-of-Cycle 3 (2EOC3) refueling outage. Following cooldown, it was noted that Core Exit Thermocouple Nozzle Assemblies (CETNAs) had been leaking at the Grayloc flange connection.

Maintenance Engineering Services (MES) contacted Design Engineering and the CETNA supplier, Combustion Engineering (CE), to evaluate the reason for the leaks so that corrective action could be taken prior to restart. During disassembly of the CETNAs, a breakaway torque check was performed on the Grayloc clamp nuts. The breakaway torque results indicated that the bolting material had relaxed during plant operation, therefore, CE recommended a new torque procedure for the Grayloc flange connection, which Design approved for use at Catawba.

On August 19, 1990 the CETNAs were reassembled using the new torque procedure per Work Request (W/R) 5312 SWR.

On September 4, 1990 with Unit 2 in Mode 4, Maintenance inspected the Reactor Vessel head and CETNAs for leakage. CETNA #74 had boron residue present, indicating leakage had occurred, but did not appear to be leaking at this time. CE was contacted and recommended that the CETNAs be rechecked in Mode 3, due to a design feature that provides better seating at higher pressures.

On September 5 at 2355 hours, Unit 2 entered Mode 3.

On September 6, the CETNAs were reinspected and no leakage was identified. On September 8, another inspection was performed and boron residue was found on CETNAs #74 and #76 in the area of the lower Grayloc clamp seal. On September 9, Maintenance cleaned the boron residue from both leaking CETNAs and observed a small steam leak at #76 (#74 did not appear to be leaking at this time). CE was contacted and recommended that a torque check pass be performed on the Grayloc flanges. Maintenance performed the torque check on #76 and did not note any nut movement, indicating the proper torque existed. On September 10, the CETNAs were inspected several times, and both #74 and #76 were leaking a small amount of steam. At the time, leak repair by injection of a sealant at the Grayloc connection was considered. This process is regularly used throughout the industry for repair of leaks under pressure. MES, Design, and CE conducted extensive evaluations to establish a sealant injection leak repair procedure for the CETNAs. During this evaluation process on September 12 at 0500 hours, Unit 2 entered Mode 2 for completion of Zero Power Physics Testing (ZPPT).

On September 13, Catawba Nuclear Station Modification (NSM) CN-20626 and the required 10CFR50.59 evaluation were approved to allow injection of a sealant into the CETNA seal ring areas on #74 and #76. The process consisted of partially drilling into the modified blind hub at the Grayloc flange, tapping the hole, inserting a threaded sealant injection valve [EIIS:V], and drilling through the remaining hub thickness to the NC system pressure boundary. The sealant injection valve would then be closed to isolate the pressure boundary, and reopened when the sealing process was to begin. Mock-up training sessions were conducted to familiarize workers with the repair procedure and the configuration of the involved components. W/R 3109 MES was originated to implement this modification.

On September 13 at 1200 hours, Unit 2 entered Mode 3 to allow CETNA repair work to begin. At approximately 2130 hours, a pre-job meeting was held between Radiation Protection (RP), MES, Maintenance, and Utilities Support Specialist, Inc. (USSI), who had been contracted by Duke Power to perform the repair work. RP requested that the area be cleaned prior to work beginning so that the initial part of the job could be performed without respirators and additional protective wear. The cleaning was completed at approximately 2300 hours. Also during pre-job preparations, each sealant injection valve was cycled several times to ensure proper operation.

On September 14 at approximately 0020 hours, USSI personnel entered the area to begin work on CETNA #76. The initial drilling was performed, the hole was tapped, and the sealant injection valve was inserted. At approximately 0200 hours the final drilling into the NC system pressure boundary was completed. As the drill bit was retracted from the hole, USSI personnel attempted to close the sealant injection valve, but the valve would not close. They then screwed a second sealant injection valve into the back of the first valve, while holding the first valve in place. When the first valve was released in order to close the second valve, the entire assembly ejected from the hole. Within minutes, a center punch was tapped into the hole to attempt to plug the opening. Leakage was reduced but did not stop completely. USSI personnel left the area at this time to locate another size center punch to better plug the hole. At approximately 0305 hours, USSI attempted to insert a center punch with a .187 inch diameter, but was unsuccessful. The original center punch was reinserted, again reducing the leak but not completely stopping it.

Soon after the problem occurred, the Shift Manager, Shift Supervisor, MES, and Maintenance met to evaluate the NC system leakage. A conservative decision was reached to consider the leakage as NC system pressure boundary leakage. The T/S 3.4.6.2 action statement was entered and preparations began for cooldown to Mode 5.

On September 14 at 0710 hours, Operations commenced cooldown to Mode 5. Also at this time, an Unusual Event was declared and proper notifications were made per Catawba Emergency Response Procedures. Even though leakage had been reduced by installation of the center punch, efforts continued to minimize the leakage to prevent contamination of other components in the area.

On September 14 at 1428 hours, Unit 2 entered Mode 4.

On September 14 at approximately 1530 hours, USSI personnel installed a modified C-clamp in place of the center punch at CETNA #76 in order to minimize leakage. This reduced leakage even further, but not completely.

On September 14 at 2338 hours, Unit 2 entered Mode 5 and the Unusual Event was terminated.

Following Unit 2 cooldown to Mode 5, CE and Gray Tool representatives were onsite to assist in the final CETNA repair work. While inspecting the spare modified blind hubs manufactured by CE, it was determined that the hubs did not meet the dimensional tolerances required for these parts. After evaluation, it was also determined that the dimensional error would have prevented proper seal seating contact when installed. The original hubs manufactured by Gray Tool were checked and no dimensional problems were found. All five CETNAs were subsequently checked to verify which hub (CE or Gray Tool) was currently installed. CETNAs #74, 76, and 78 had hubs manufactured by CE, and #75 and 77 had the original hubs manufactured by Gray Tool. The original Gray Tool hubs for connectors #74, 76, and 78 were located, cleaned, and inspected. No dimensional problems were found, and the hubs were approved for reuse.

On September 21, the original modified blind hubs manufactured by Gray Tool were installed at CETNAs #74, 76, and 78. After this replacement was complete, all five Unit 2 CETNAs had dimensionally acceptable hubs in place.

On September 25 at 2318 hours, Unit 2 entered Mode 4.

On September 26 at approximately 1530 hours, Maintenance inspected all five CETNAs for leakage. No leakage was noted.

On September 27 at 0449 hours, Unit 2 entered Mode 3. At approximately 2130 hours, Maintenance again inspected all five CETNAs. No leakage was noted.

CONCLUSION

While attempting to repair the leaking CETNAs, the sealant injection valve installed at the NC system pressure boundary would not close. A second valve was threaded into the back of the original valve, but before the second valve could be closed the entire assembly ejected from the hole. MES will perform a root cause analysis to determine the cause(s) of the failures associated with the sealant injection valve. This report will be revised upon completion of this analysis.

The original CETNA leaks are attributed to a Manufacturing Deficiency in that the modified blind hubs manufactured by CE did not meet required dimensional tolerances. The original hubs manufactured by Gray Tool were checked and met the dimensional requirements. Inspection of all five CETNAs revealed that #74, 76, and 78 had hubs supplied by CE. These CETNAs were identified as the ones that had experienced leakage. The original hubs manufactured by Gray Tool were located, cleaned, and inspected. No dimensional problems were noted and they were installed on Unit 2. All five Unit 2 CETNAs now have dimensionally acceptable modified blind hubs installed. During subsequent startup preparations, Maintenance inspected all five CETNAs in Mode 4, and again in Mode 3, for leakage. No leakage was noted.

After investigations concerning the improperly manufactured hubs, CE feels that the improper hubs are isolated to Catawba-2, Millstone-3, and CE Stock. All improper hubs at Catawba have been located. In addition, CE contacted Millstone-3 to advise them of the improper hubs. The Duke Power Quality Assurance Vendor Division has been contacted and advised of this problem.

The decision to consider the leakage as Reactor Coolant System pressure boundary leakage, and the resultant Unit cooldown and declaration of an Unusual Event, was a conservative action not strictly required by Catawba Technical Specifications. Pressure boundary leakage limits are established to preclude growth of defects to the point where coolant leak rates pose a threat to nuclear safety. Unit shutdown is required before crack propagation results in potentially limiting leak rates. The drilling of a 3/16 inch diameter hole is not considered to have posed a demonstrable potential for propagation. Leakage through the drilled hole was well within the capability of the normal charging system and posed no danger to unit safety. This event was conservatively reported to the NRC under the provisions of 10CFR50.72. This report is submitted as a Special Report and is not required under 10CFR50.73.

This event was considered for reportability under the requirements of 10CFR Part 21 with the conclusion that existence of a substantial safety hazard was not demonstrated. Leakage through the CETNA was of a magnitude that would have remained well within the capability of the normal charging system. The potential for a catastrophic failure of the CETNA, leading to a loss of coolant accident and safety system challenge, was not created as a result of the out-of-tolerance fittings. Further, the vendor concluded that only two plants, Catawba Unit 2 and Millstone Unit 3, could potentially have the out-of-tolerance parts. Thus, it was concluded that a Part 21 report was not required. This report is submitted as a Special Report to ensure industry awareness of this event.

A review of the OEP database for the past 24 months revealed one event in which an operating Unit was shutdown due to a Manufacturing Deficiency (LER 413/90-24). This incident involved a Nuclear Service Water [EIIS:BI] (RN) System pump [EIIS:P] motor [EIIS:MO] for which a stator had been manufactured approximately 0.1 inches shorter than required. Two other events in this time period were attributed to Manufacturing Deficiencies. LER 414/89-01 involved a Reactor Trip due to a fuse that failed on a feedwater control valve. LER 413/89-26 documented an unexpected Hydrogen Skimmer Fan [EIIS:BLO] breaker [EIIS:BRK] trip due to a defective Westinghouse breaker. These two incidents are different from the incident in this report in that they were not attributable to dimensional requirement inaccuracies. Per Nuclear Safety Assurance guidelines, this is not a recurring problem.

CORRECTIVE ACTION

SUBSEQUENT

1) After the sealant injection valve assembly ejected from the NC system pressure boundary, Unit 2 commenced cooldown to Mode 5 and an Unusual Event was declared.

2) During subsequent investigations, the spare modified blind hubs manufactured by CE were inspected and it was determined that they did not meet the dimensional requirements for these parts.

3) The original hubs manufactured by Gray Tool were inspected. No dimensional problems were noted.

4) All five Unit 2 CETNAs were inspected to determine whether CE or Gray Tool hubs were installed. CETNAs #74, 76, and 78 were identified as having CE hubs installed.

5) The original Gray Tool hubs for CETNAs #74, 76, and 78 were located, cleaned, and inspected. All were acceptable for installation on Unit 2, and were installed per W/R 5312 SWR.

6) Maintenance inspected all five CETNAs for leakage during Mode 4, and again in Mode 3. No leakage was noted.

7) The Duke Power Quality Assurance Vendor Division was contacted and advised of the problems concerning the hubs manufactured by CE.

PLANNED

1) An analysis will be performed to determine the cause(s) of the failures associated with the sealant injection valve.

2) This report will be revised upon completion of the sealant injection valve analysis.

SAFETY ANALYSIS

Following this incident, Performance conducted a review of Operator Aid Computer (OAC) data to establish the leakage rate at the repair location. An initial review indicated that NC system leakage at the CETNA was 6 to 9 gpm. After a detailed review of plant evolutions in progress during the incident, the actual leakage rate was determined to be less than 5 gpm. A leak of this magnitude is well within normal charging pump capability (approximately 150 gpm) and falls well below the limits of a small break Loss of Coolant Accident (LOCA). The actual hole diameter (.1875 inches) was less than the hole size of .375 inches considered in Section 15.6.5 of the Catawba Final Safety Analysis Report (FSAR) for which NC system inventory can be maintained by one charging pump.

The health and safety of the public were not affected by this incident.