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DUKE POWER

September 27, 1990

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Catawba Nuclear Station
Docket No. 50-414
LER 414/90-12

Gentlemen:

Attached is Licensee Event Report 414/90-12, concerning TECHNICAL SPECIFICATION VIOLATION DUE TO PRESSURIZER HEAT-UP LIMIT EXCEEDED DURING RESIDUAL HEAT REMOVAL PUMP TEST.

This event was considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Tony B. Owen

Tony B. Owen
Station Manager

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U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

# LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| Catawba Nuclear Station, Unit 2 | 0 5 0 0 0 4 1 4 | 1 OF 1 0 |

TITLE (4) Technical Specification Violation Due to Pressurizer Heatup Limit Exceeded Following Residual Heat Removal Pump Test

| EVENT DATE (5) | | | LER NUMBER (6) | | | REPORT DATE (7) | | | OTHER FACILITIES INVOLVED (8) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | MONTH | DAY | YEAR | FACILITY NAMES | DOCKET NUMBER(S) |
| 0 9 | 0 1 | 9 0 | 9 0 | 0 1 2 | 0 0 | 0 9 | 2 7 | 9 0 | N/A | 0 5 0 0 0 |
| | | | | | | | | | | 0 5 0 0 0 |

OPERATING MODE (9): 5

POWER LEVEL (10): 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

| | | | |
|---|---|---|---|
| 20.402(b) | 20.405(c) | 50.73(a)(2)(iv) | 73.71(b) |
| 20.405(a)(1)(i) | 50.36(c)(1) | 50.73(a)(2)(v) | 73.71(c) |
| 20.405(a)(1)(ii) | 50.36(c)(2) | 50.73(a)(2)(vii) | OTHER (Specify in Abstract below and in Text, NRC Form 366A) |
| 20.405(a)(1)(iii) | X 50.73(a)(2)(i) | 50.73(a)(2)(viii)(A) | |
| 20.405(a)(1)(iv) | 50.73(a)(2)(ii) | 50.73(a)(2)(viii)(B) | |
| 20.405(a)(1)(v) | 50.73(a)(2)(iii) | 50.73(a)(2)(x) | |

LICENSEE CONTACT FOR THIS LER (12)

| NAME | TELEPHONE NUMBER |
|---|---|
| C. L. Hartzell, Compliance Manager | AREA CODE 8 0 3 8 3 1 - 3 6 6 5 |

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

| CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO NPRDS | CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO NPRDS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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SUPPLEMENTAL REPORT EXPECTED (14)

| YES (If yes, complete EXPECTED SUBMISSION DATE) | X NO | EXPECTED SUBMISSION DATE (15) | MONTH | DAY | YEAR |
|---|---|---|---|---|---|
| | | | | | |

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On September 1, 1990, with Unit 2 in Mode 5, Cold Shutdown, following performance of an IWP test on Residual Heat Removal (ND) System Pump 2B, a temperature transient of the Reactor Coolant (NC) System Pressurizer (PZR) occurred which resulted in the Technical Specification (T/S) heatup limit being exceeded at approximately 0740 hours. With ND Train A operating to provide decay heat removal capability, and Chemical and Volume Control (NV) System Train A operating to provide NC System charging capability, ND Train B was aligned per the Performance ND Pump 2B Test procedure valve lineup. Control Room Operators (CROs) then isolated both ND Trains letdown to NV and started the ND pump in mini-flow to perform the test. CROs were closely monitoring PZR level indications and noticed a PZR cooldown which approached but did not exceed the T/S PZR cooldown rate limit. CROs reestablished ND letdown to secure the cooldown transient and aborted the test. Subsequently, while attempting to recover from the cooldown, a heatup of the PZR occurred which exceeded the T/S heatup rate limit due to temperature stratification within the PZR. This incident is attributed to an Inadvertent Action and a Defective Procedure. Corrective actions taken included securing a PZR heatup and recovering temperature. Additional corrective actions included a PZR operability determination, a revision to the test procedure, and development of enhanced training.

BACKGROUND

The primary purpose of the Residual Heat Removal [EIIS:BP] (ND) System is to remove heat from the Reactor core and Reactor Coolant [EIIS:AB] (NC) System during plant cooldown and refueling operations. In addition, the ND System secondary functions include transfer of refueling water between the Refueling Water Storage Tank and the Refueling Cavity for refueling operations, providing overpressure protection to the NC System, and providing NC letdown flow for pressure control and purification during plant shutdown and refueling.

The ND System provides two parallel cooling trains for the NC System. It consists of two residual heat removal heat exchangers [EIIS:HX], two residual heat removal pumps [EIIS:P], and the associated piping [EIIS:PSP], valves [EIIS:V], and instrumentation necessary for operational control. During ND System operation, reactor coolant passes through the respective pump and heat exchanger and is returned to the NC System cold legs. The ND Train A suction source is from NC Loop B hot leg and the flow returns to NC Loops C and D cold legs. The ND Train B suction source is from NC System Loop C hot leg and returns to the NC Loops A and B cold legs. The ND System also provides an alternative means of letdown flow from the NC System. When the NC System pressure and temperature have been reduced sufficiently to place the ND System in operation, the system supplies low pressure reactor coolant to the letdown flowpath downstream of the NV pressure reducing orifices. This letdown flow is diverted from the ND Heat Exchanger to the Chemical and Volume Control [EIIS:CB] (NV) System. By regulating the letdown flow rate with the ND to NV letdown control valve, NV-135, NC System inventory can be controlled.

The purpose of the NC System is to transport heat from the Reactor core to the Steam Generators (S/Gs), where heat is transferred to the Main Feedwater [EIIS:SJ] (CF) and Main Steam [EIIS:SB] (SM) Systems of the secondary side.

The NC System consists of four identical heat transfer loops connected in parallel to the Reactor vessel [EIIS:VSL]. Each loop contains an NC pump and a S/G. In addition, the system includes a pressurizer, a pressurizer relief tank, interconnecting piping, valves, and instrumentation necessary for operational control.

The Pressurizer provides a point in the NC System where liquid and vapor can be maintained in equilibrium under saturated conditions for pressure control purposes. Pressure is controlled by the use of electrical heaters [EIIS:EHTR] and water sprays. Steam is formed (by the heaters) or condensed (by the pressurizer spray) to minimize pressure variations. Thermocouples are provided for temperature indication in the PZR steam and water regions.

During startup and shutdown, NC System pressure is controlled by the use of the pressurizer heaters and the pressurizer spray. The rate of temperature change in the NC System is controlled by the Control Room Operator. Heatup rate is controlled by pump energy and by the pressurizer electrical heating capacity. This heatup rate takes into account the continuous spray flow provided to the pressurizer.

A pressurizer surge line connects the bottom of the pressurizer to one Reactor hot leg and enables continuous reactor coolant volume pressure adjustments between the NC System and the Pressurizer.

NC System pressure is controlled by using either the electrical heaters (in the water region) or the spray (in the steam region) of the pressurizer plus steam relief for large transients. The electrical heaters are located near the bottom of the pressurizer. A portion of the heater group is proportionally controlled to correct small pressure variations. These variations are due to heat losses, including heat losses due to a small continuous spray. The remaining (backup) heaters are turned on when the pressurizer pressure controlled signal demands approximately 100% proportional heater power.

The spray nozzles are located on the top of the Pressurizer. Spray flow is initiated when the pressure controller spray demand signal is above a given setpoint. Steam condensed by the spray reduces the pressurizer pressure. A small continuous spray is normally maintained to help maintain uniform water chemistry and temperature in the Pressurizer.

Technical Specification (T/S) 3.4.9.2 requires the pressurizer temperature to be limited to:

a. a maximum heatup of 100 degrees F in any 1-hour period, and
b. a maximum cooldown of 200 degrees F in any 1-hour period.

T/S 3.4.9.2 is applicable at all times. When these limits are exceeded, the following actions are required:

a. restore the temperature to within the limits within 30 minutes,
b. perform an engineering evaluation to determine the effects of the out-of-limit condition on the structural integrity of the pressurizer,
c. determine that the pressurizer remains acceptable for continued operation or be in at least Hot Standby within the next 6 hours, and
d. reduce the pressurizer pressure to less than 500 psig within the following 30 hours.

PT/2/A/4200/10B, Residual Heat Removal Pump 2B Performance Test, is performed to verify the operational readiness of the ND Pump 2B. The test consists of isolating the pump from the NC Loops per a procedure line up and operating the pump in minimum flow for at least five minutes. The operating parameters for the pump are measured, recorded, and compared to previously determined reference values which are known to represent acceptable pump performance. Deviations from the reference values are used to determine the operational readiness of the pump or to initiate corrective action as needed in order to restore the pump to operational readiness. Finally, ND Pump 2B is then realigned by a valve checklist to ensure that each valve manipulated during the test is returned to its original "As Found" position.

EVENT DESCRIPTION

On September 1, 1990, with Unit 2 in Mode 5, Cold Shutdown, Operations (OPS) personnel were in the process of completing the Performance (PRF) valve lineup for Residual Heat Removal ND System Pump 2B per PT/2/A/4200/10B, Residual Heat Removal Pump 2B Operability Test. NC Pump 2B was inservice along with a NV System Centrifugal Charging Pump operating to provide charging to the NC System. The ND Train A was aligned to the NC System to provide core decay heat removal and letdown to the NV System.

The PRF test lineup, which requires the ND Pump 2B suction to be aligned to the Refueling Water Storage Tank (FWST) with the pump discharge isolated from the NC System loops, was complete to the point of closing 2ND-24A (ND HX A Outlet to Letdown HX). Earlier in the shift, a meeting was held between OPS and PRF personnel and the Shift Manager to discuss performance of the test with both trains of ND letdown isolated. Their discussion focused on the effect which ND letdown isolation would have on PZR level. Guidelines for test termination were discussed based on PZR level response. Since this test did not inject water into the NC System, and since the test was expected to last approximately 30 minutes, an impact on PZR temperature was not expected to result from the slow increase in PZR level following isolation of letdown flow. In addition, as a result of this meeting, OPS decided to halt the test valve lineup just prior to Step 13.6.3.2.12 (closing 2ND-24A) until PRF technicians were in place for the pump run in order to minimize the time letdown was isolated.

At approximately 0415 hours, PRF technicians notified the Control Room Operators (CROs) that they were ready for the pump to be started. CROs then isolated ND letdown to the NV System by closing 2NV-135 (ND Flow to Letdown HX) and reduced NV charging flow to the 30 gpm minimum required for NC pump seals. In addition, they closed 2NV-24A and opened 2FW-55 (ND Pump 2B Suction from FWST) to complete the PRF valve lineup. At this time the initial Pressurizer (PZR) level and water temperatures were 35% and 425 degrees F, respectively. NC System temperature was approximately 185 degrees F.

At approximately 0420 hours, CROs started ND Pump 2B in minimum flow at the request of PRF.

During the time frame from 0435 to 0450 hours, indicated PZR water temperature steadily decreased from approximately 422 degrees F to 282 degrees F while PZR level steadily increased from 35% to approximately 54%. PZR vapor temperature decreased slightly from approximately 425 degrees F to 422 degrees F.

At approximately 0455 hours CROs noted a large difference between the PZR vapor and water temperatures (421 degrees F versus 258 degrees F) on the Control Room gauges. They immediately notified their supervision. Computer alarms were recieved indicating a Low PZR Water Temperature Rate.

At approximately 0500 hours, CROs were in contact with the PRF technicians performing the pump test. The technicians informed the CROs that they could only verify 450 of the required 500 gpm on the installed test gauge (CNPRF 20426).

At approximately 0503 hours, at the request of the Unit Supervisor, CROs reestablished ND letdown flow by opening 2NV-24A and 135 in order to match the 35 gpm charging flow. In addition, the PZR cooldown was secured as indicated PZR water temperature was stabilized at approximately 238 degrees F. However, PZR level continued to gradually increase. This increase was due to the water in the bottom of the PZR expanding as it was heated up.

At approximately 0505 hours, CROs secured ND Pump 2B and aborted the pump test. Subsequently, C/R personnel discussed how to recover from the PZR cooldown transient and heatup the PZR without exceeding the T/S heatup limit. Based on training on a previous event, the CROs recognized the need to maintain balanced charging and letdown flows and constant NC inventory. At approximately 0510 hours, CROs began to gradually increase ND letdown flow to approximately 40 gpm while maintaining charging flow at 35 gpm to achieve the desired heatup of PZR water temperature using the PZR heaters.

From approximately 0510 to 0630 hours, CROs maintained ND letdown flow slightly greater than charging flow. During this time frame, PZR water temperature continued to constantly increase (from approximately 238 degrees F to 288 degrees F) while PZR vapor temperature slightly decreased from approximately 420 degrees F to 413 degrees F. In addition, PZR level continued to increase from 60% to 65% while PZR pressure continued to decrease from approximately 332 to 310 psig.

At approximately 0630 hours, CRO slightly reduced ND letdown flow from 37 to 30 gpm while maintaining charging at 35 gpm.

Between 0630 and 0645 hours, OPS shift turnover occurred. During this time frame, PZR water temperature increased from 288 to 300 degrees F while PZR vapor temperature remained at approximately 412 degrees F. PZR level was approximately 65% and increasing slightly.

At approximately 0645 hours, shift turnover was completed and the primary concerns of the on-coming CROs were securing the PZR level increase and controlling PZR temperature. At this time, charging flow was approximately 35 gpm while ND letdown flow was 30 gpm.

At approximately 0650 hours, CRO began increasing ND letdown flow to approximately 37 gpm in an attempt to secure the PZR level increase and preclude the filling the PZR to the high level alarm setpoint (70%).

At approximately 0700 hours, the PZR level increase was secured and stabilized at approximately 68%. With PZR level stable, the CROs roticed that the High PZR Water Temperature Rate alarms were received. At this time, PZR water and vapor temperature were approximately 300 and 411 degrees F, respectively.

Between 0715 and 0730 hours, the CROs increased ND letdown flow from approximately 37 to 47 gpm while maintaining charging flow constant at 35 gpm. During this time frame, PZR level decreased from 68 to 66%. PZR water temperature sharply increased from approximately 316 to 340 degrees F as a result of the stratified layers of hotter water being lowered to the elevation of the PZR water RTD. PZR pressure began to stabilize at approximately 313 psig. In addition, the "High PZR Water Temperature Rate" alarm was received.

At approximately 0730 hours, with PZR water temperature increasing, the CROs increased PZR spray flow and reduced PZR "C" heater group output in an attempt to stop or reduce the temperature increase. In addition, the CRO decreased ND letdown flow to approximately 37 gpm. Charging flow remained constant at 35 gpm.

At approximately 0740 hours, while the CRO were attempting to stop the PZR temperature increases, the T/S PZR heatup rate limit of 100 degrees F per hour was exceeded by 18 degrees F. At this time, ND letdown and charging flows were constant at approximately 37 and 35 gpm, respectively. PZR water and vapor temperatures were stabilizing at approximately 402 and 409 degrees F, respectively. PZR level was stable at 66%.

At approximately 0800, CROs were able to stabilize PZR water and vapor temperatures at approximately 410 and 412 degrees F, respectively; thus stopping the heatup transient.

At approximately 0900 hours, the CROs were able to equalize the PZR water and vapor temperatures at approximately 416 degrees F.

CONCLUSION

During this incident, the PZR experienced two separate temperature transients. The first transient, a cooldown, resulted in the T/S cooldown rate limit being approached but not exceeded. The second, a heatup, resulted in the T/S heatup rate limit being exceeded.

Violation of the PZR heatup limit occurred following the CRO's attempt to adjust NC letdown flow rate so as to stop the PZR level increase. Letdown flow rate was increased from 30 gpm to 37 gpm and subsequently to 47 gpm. The end result was a decrease in PZR level from 68% to 66%. This slight drop in level was sufficient to bring relatively hotter water down to the location of the thermocouple and an increase in indicated PZR water temperature from 300 degrees F to 340 degrees F, exceeding the 100 degrees F/hr heatup limit (minimum PZR water temperature had been 238 degrees F). The CRO's compensation of letdown flow rate was exacerbated by the extreme sensitivity of PZR temperature response to small changes in PZR level (a 40 degree temperature change resulting from a 2% change in level) was a compounding factor. The violation of the PZR heatup rate limit is attributed to an Inadvertent Action in that the action chosen was proper but execution failed because a human factor deficiency existed (the extreme sensitivity of PZR temperature response to level changes).

The preceding cooldown transient occurred as a result of the inflow of colder NC system water to the PZR as NC inventory was increased with letdown isolated. The cooldown transient created the situation in which the heatup limit violation occurred. Once the cooldown transient was recognized, CROs anticipated the approaching temperature limit and acted properly to terminate the test before the PZR cooldown limit was exceeded.

Once the cooldown transient was recognized and stopped, the CROs properly discussed and anticipated the need to avoid violation of the heatup limit during recovery. They had significant difficulty, and ultimately were not successful in balancing makeup and letdown flow rates so as to maintain constant NC inventory. It is now recognized that even small (i.e. 2%) changes in PZR level can cause significant change in temperature indications in the PZR.

Prior to performing the test, the possibility of changing the test procedure to maintain one train of letdown was discussed during the pre-test meetings between OPS and PRF. Operations decided that the expected slow level change could be accomodated without undue operational impact. The operators were aware of the potential impact on PZR temperature of rapid, large increases in PZR level, based on lessons learned from a previous event. The sensitivity of PZR temperature due to slow or small level changes was not known at the time. Nevertheless, a contributing cause of this incident is identified as a Defective Procedure which required isolation of both trains of letdown.

A review of the Operating Experience Program database for the past 24 months indicates that one previous event involved testing with a root cause of management deficiency due to deficient procedure preparation and issuance which led to a T/S violation. LER 413/90-22 involved a T/S violation due to the injection of approximate 5000 gallons of water into the NC System during an Engineered Safety Features Actuation periodic test. As a result, a rapid insurge of cooler water in the PZR resulted in an excessive cooldown and a subsequent excessive heatup. These two events differed in the rate at which cold water entered the PZR. The current event emphasizes the PZR temperature sensitivity to even small flow rates. Nevertheless, controlling PZR temperature with respect to cooldown and heatup rate limits is considered a recurring problem per the Nuclear Safety Assurance guidelines.

This incident has been explained and discussed with Operations shift personnel. Additional, in-depth training will be provided to licensed Operations shift personnel on PZR cooldown and heatup rate limits and the required actions to be taken to avoid exceeding them under startup/shutdown conditions with larger temperature differentials between the PZR and NC system. Information will be sought from Westinghouse as to how other plants address this concern.

This event, along with the event described in LER 413/90-022, will be reviewed with appropriate Performance and Operations personnel with emphasis on the need to incorporate into test procedures the special measures/actions needed to control plant conditions, including test termination criteria and actions.

As described in LER 413/90-022, other procedures for tests involving the potential for water injection and/or PZR in/outsurges will be reviewed to ensure adequate precautions and guidance are given to control plant conditions and in particular, PZR temperature.

Westinghouse initiated an evaluation based on the recorded PZR temperature data and concluded that the design life and the PZR structural integrity were not compromised. Design Engineering concurred that continued operation was acceptable.

Westinghouse will complete and send to Duke Power a more detailed engineering evaluation including fatigue and fracture analysis to determine the specific effect of the transients (cooldown and heatup) on the design life of the PZR. This LER will be revised if significantly different results are determined.

Appropriate Performance and Integrated Scheduling personnel will review this incident with emphasis on scheduling tests which involve water inflow to the PZR at times when the PZR steam bubble has not been drawn.

Design Engineering will review and evaluate this incident to recommend the best recovery method which minimizes PZR stress effects.

CORRECTIVE ACTION

SUBSEQUENT

1) CROs reestablished ND letdown by opening 2ND-24A and 135 to secure the PZR cooldown.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

2) CROs took the necessary actions to secure the PZR heatup and recover PZR temperature.

3) PIR 2-C90-0281 was initiated to request Design Engineering evaluation of the recorded PZR temperature data.

4) Westinghouse initiated an evaluation based on the recorded PZR temperature data and concluded that the design life and the PZR structural integrity were not compromised. Design Engineering concurred that continued operation was acceptable.

5) PT/2/A/4200/10B, ND Pump 2B Performance Test, was revised to allow one train of ND letdown to be available during the test.

6) The incident was explained and discussed with Operations Shift Supervisors in the Shift Supervisor meeting held on September 14, 1990.

7) This incident was explained to Operations shift personnel via an Update.

PLANNED

1) Westinghouse will complete and send to Duke Power a more detailed engineering evaluation including fatigue and fracture analysis to determine the specific effect of the transients (cooldown and heatup) on the design life of the PZR. This LER will be revised if significantly different results are determined.

2) Appropriate Performance and Integrated Scheduling personnel will review this incident with emphasis on scheduling tests which involve water inflow to the PZR at times when the PZR steam bubble has not been drawn.

3) In-depth training on PZR temperature control, with respect to cooldown and heatup rate, will be provided to licensed Operations shift personnel.

4) Appropriate Performance and Operations personnel will review this event with emphasis on the need to incorporate into test procedures the special measures/actions needed to control plant conditions, including test termination criteria and actions.

5) Other procedures for tests involving the potential for water inflow to (outflow from) the PZR will be reviewed to ensure adequate precautions and guidance are given to control plant conditions and modes.

6) Design Engineering will review and evaluate this incident to recommend the best recovery method which minimizes PZR stress effects.


*U.S. GPO: 1988-520-589 00070

SAFETY ANALYSIS

A preliminary engineering evaluation performed by Westinghouse provides the basis for the following conclusion:

On September 1, performance of ND Pump 2B Performance Test resulted in a cooldown transient of the PZR within the T/S limit of 200 degrees F per hour. While attempting to recover from the cooldown, the PZR experienced a heatup transient beyond the limits specified in T/S 3.4.9.2. The transient histories and relevant parameter data describing the transients were compiled and provided to Westinghouse. The data showed that the plant experienced a cooldown of approximately 188 degrees F during the first transient and a heatup of 112 degrees F during subsequent transient.

Over the past three years, Westinghouse has performed evaluations of off-normal heatup and cooldown transients at over ten plants. The scenarios are similar, with a large insurge of water in the lower regions of the PZR causing a rapid cooldown, with a possible subsequent heatup when recovering temperature. The temperatures involved, as well as plant conditions and operating status, are also similar.

Relevant data for the Catawba Unit 2 transients were reviewed and compared with similar events at other plants, as well as with evaluations of historical operating records performed as part of transients and fatigue cycle monitoring programs performed by Westinghouse for several other plants. Based on this review, Westinghouse has determined that the structural integrity of the PZR has not been compromised.

A detailed engineering evaluation, including fatigue and fracture analysis, to determine the specific effect of the transients or the design life of the PZR (if any effect) will be performed. A report containing the results of the engineering evaluation will be provided at a later date.

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