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May 22, 1985

Dr. J. Nelson Grace, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Re: Catawba Nuclear Station, Unit 2
Docket No. 50-414
Significant Deficiency No. 414/85-06

Dear Dr. Grace:

Pursuant to 10 CFR 50.55(e)(1)(iii), please find attached Significant Deficiency Report No. 414/85-06.

Very truly yours,

H.B. Tucker/lsb

Hal B. Tucker

LTP:slb

Attachment

cc: Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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CATAWBA NUCLEAR STATION

Significant Deficiency 414/85-06

Overpressurizing and Rupture of Volume Control Tank During Cold Hydrostatic Testing

Identification: On April 20, 1985, the Unit 2 Volume Control Tank (VCT) ruptured after being overpressurized during the Unit2 Cold Hydrostatic Test. Damage occurred to various piping and other components in the tank room. This event is similar in nature to the overpressurization of portions of the Residual Heat Removal System which occurred on April 19, 1985 and will be described in a forthcoming Significant Deficiency Report 414/85-08.

Initial Report: On April 22, Virgil Brownlee and Hugh Dance of NRC Region II, Atlanta, Georgia were notified of the incident by L. M. Coggins, T. B. Bright and T. L. Utterback of Duke Power Company, 422 South Church Street, Charlotte, North Carolina 28242.

Summary: The VCT is a 2,992 gallon capacity stainless steel tank, designed for an internal pressure of 75 psig. As part of the Chemical and Volume Control System (NV), it was being used to accept letdown and as a suction source for the centrifugal charging pumps in the filling and venting of the Reactor Coolant System (NC) for Cold Hydro testing. Enclosure 1 describes the NV system and flow paths used during the test.

The VCT had two inlet sources: the normal NC letdown, and the mini-flow line from the centrifugal charging pump. Prior to the incident, leakage of the NC pump seal return flow at valve 2NV125B had been causing the VCT level to drop, so the Refueling Water Storage Tank (FWST) was swapped alternately with the VCT in order to bring the VCT level back up. This manual re-filling of the VCT was in progress at the time of the incident. Added to this, the VCT relief path isolation valve had been locked closed prior to Unit 1 operation because the relief path is through a Unit 1/ Unit 2 boundary into a common relief header to the recycle holdup tanks.

The VCT was allowed to overfill during this swap-over to the FWST, causing the flow to cease from the letdown orifice, therefore putting it under the NC pressure of 700 psig. Additional pressure was applied from the centrifugal charging pump 2B through the mini-flow line. Having no relief protection, the tank ruptured.

Background: The Reactor Coolant (NC) System Cold Hydrostatic test is performed in accordance with the following two controlling procedures:

> Temporary Operating Instruction - TOI/2/A/6150/01 - Initial Filling and Venting the Reactor Coolant System and Control of NC System for NC Hydro
>
> Construction Procedure CP-1072 - Hydrostatic Test of the Unit 2 Reactor Coolant System and Portions of Associated Piping (Cold Hydro)

TOI/2/A/6150/01 provides written instructions to bring the NC System up to 2200 psig. CP-1072 provides instructions to take the NC System from 2200 psig to between 3107 and 3292 psig. After the required checks are made,

CP-1072 brings the NC System pressure back down to between 2200 and 2300 psig. TOI/2/A/6150/01 is used to decrease the NC System pressure further for the completion of the test. The NC System is filled, vented, and heated by using the Chemical and Volume Control (NV) System, the Residual Heat Removal (ND) System, and the Reactor Coolant Pumps.

The NV System is a support system to the NC System used to maintain the NC System water inventory. The NV System performs this function by continuously charging to and accepting letdown from the NC System. The letdown flow passes through letdown orifices to drop the pressure. This flow then passes through demineralizer filters, and finally into the VCT which acts as a surge tank. On a high VCT level, letdown flow is diverted to the Recycle Holdup Tanks (RHT) by valve 2NV172A when the valve controller is selected to AUTO.

Charging into the NC System is provided by the charging pumps. The NV System contains a reciprocating charging pump and two centrifugal charging pumps (CCP). These pumps can take suction from the VCT or FWST. The charging pumps feed the charging line and also supply water to the NC Pump seals.

An alternate letdown path is available from loop C of the NC System. This excess letdown is diverted to one of two locations by divert valve 2NV125B. Excess letdown may be diverted to the Reactor Coolant Drain Tank, or combine with the NC Pump seal leakoff flow and return to the VCT.

The VCT level is monitored by four channels of level instrumentation. Two channels feed indication on the Auxiliary Shutdown Panels. A third channel feeds an indicator near the tank. The fourth channel feeds a Control Room level indicator, as well as an analog computer point. A High/Low VCT Level Annunciator alarms at approximately 98% for the High level and 16% for the low level. At the time of the incident, the analog computer point was providing an input to a trend recorder in the Control Room to record the VCT level changes.

The VCT pressure instrumentation feeds a Control Room indicator, as well as an analog computer point. A high pressure annunciator was set to alarm at 65 psig. Both level and pressure channels that feed the Control Room indicators had been calibrated prior to the incident.

Relief Valve 2NV223 relieves excess VCT pressure to the RHT. The setting for 2NV223 is 75 psig. The relief flow path is through Unit 1/Unit 2 Boundary Valve 1NB287 and into a common relief header to the Recycle Holdup Tanks (located on Unit 1 side of the Security Interim Boundary). Both Recycle Holdup Tanks are being used to support Unit 1 operation. Valve 1NB287 had been locked closed prior to Unit 1 fuel load for two reasons:

1. To prevent Unit 1 contamination from reaching Unit 2 areas; and

2. To prevent non-contaminated water on Unit 2 from entering the Unit 1 radwaste processing systems.

The flow diagram containing this valve includes a note which states, "This valve remains closed until Unit 2 is ready for operation. It is then locked open." There was no clear identification of the functional requirements for this valve.

Description: The process of filling and venting the NC System began on April 8, 1985, at approximately 1400 hours per TOI/2/A/6150/01. During the fill and vent process, valve 2NV172A was found to be installed backwards. This valve is controlled by a three position selector switch located on the Main Control Board. The three positions are VCT, AUTO, and RHT. Since the valve was installed incorrectly, the RHT position on the switch aligns the valve to the VCT. The switch remained in this position throughout the incident to allow letdown to flow to the VCT. The switch template was changed to reflect the true valve status. In this position, the valve would not attempt to divert to the RHT.

The NC System filling process was completed on April 12, at 1900 hours. The water level in the VCT began to drop on April 13, at 0600 hours. The VCT was acting as a suction source to the CCP 2B. As the level continued to drop, the Refueling Water Storage Tank (FWST) was aligned as the pump suction source by opening valve 2NV253B. The VCT was then isolated by closing valve 2NV188A to allow letdown to refill the tank.

It was later discovered that valve 2NV125B was causing the VCT level to drop. The NC Pump seal return flow was leaking through this valve and into the Reactor Coolant Drain Tank (Excess Letdown was isolated at the time). Since the leak was considered controllable by isolating the VCT at a certain decreasing level, and aligning the VCT to the CCP suction on a certain increasing level, the decision was made to proceed with TOI/2/A/6150/01. As the VCT level dropped to approximately 40%, the tank was isolated by closing either valve 2NV188A or 2NV189B. Letdown then refilled the tank. As the level approached 70% to 80%, the appropriate valve was opened by the Operator to allow the tank to supply suction for the CCP. A procedure change was not made to TOI/2/A/6150, because the evolution of refilling the tank was simple in nature.

The process of swapping from the VCT to the FWST continued through April 20. The VCT level decrease was calculated to be approximately 1% per minute. As the VCT was isolated, letdown filled the tank at a rate of approximately 5% per minute. The continual process of isolating the tank added an extra workload on the Operator. It took approximately 30 minutes for the VCT level to drop from 80% to 40%. It took approximately 8 minutes for the isolated tank to increase from 40% to 80%.

On April 20, at 1059:25 hours, the FWST was aligned for charging, and the VCT was isolated. The VCT level then began to increase at the rate of 5% per minute. At 1107:20 hours, VCT pressure instrumentation overranged at 90 psig. The indication printed on the alarm typer, but the Operator could not recall receiving a VCT High Pressure Annunciator Alarm. At 1109:36 hours, the VCT level channel overranged at 100% indicated level. Again, the Operator did not recall receiving the VCT High/Low Level Annunciator Alarm. At the time, the High Level Annunciator was set to alarm at 98%.

The Operator recalled seeing the Control Board Indicators at 80% VCT level and 62 psig VCT pressure. At this point, he terminated the VCT filling operation by opening 2NV188A and closing 2NV253B, at 1117:05 hours. Forty-five seconds later, the charging pump flow rapidly dropped to approximately 5 gallons per minute. At approximately 1118 hours, the VCT ruptured.

Once the tank ruptured, the Control Room received a VCT Low Level Annunciator Alarm. The Operator responded and noticed VCT Level at 0%, VCT pressure at 0 psig, and NC System pressure at 500 psig and decreasing rapidly. He immediately secured CCP 2B at 1119:25 hours. Letdown flow and charging flow were isolated at 1122:01, and 1124:27 hours, respectively.

Analysis: A trend recorder was set up in the Control Room to trace VCT level. Once the tank reached 100% level, as indicated on the recorder print-out, it remained at 100% for approximately 10 minutes. This agrees with the alarm typer which indicates an overranged level condition approximately 10 minutes before the tank ruptured.

At the time of the incident, the VCT was receiving inlet flow from two sources; the normal NC letdown flowpath, and the Centrifugal Charging Pump mini-flow line which passes through the Seal Water Heat Exchanger and into the VCT. The tank contents were leaking through 2NV125B and feeding the CCP suction just before the incident (2NV188A had just been opened).

It is postulated that the VCT ruptured from two combined pressure sources. One source was from the NC System. The NC System was at 700 psig at the time. As the tank approached a water solid condition, the flow through the Letdown Orifice ceased, thereby applying NC System pressure to the VCT. The second source was from the CCP 2B discharge pressure, which was applied through the pump mini-flow line. The centrifugal charging pump shutoff head is 2670 psig. Since the tank is only designed for 75 psig, these two sources combined to rupture the tank.

The tank split from top to bottom. The rupture force was great enough to cause the tank to fold back in two halves, exposing the inner wall. Piping and other components in the room were damaged.

Prior to the incident, the Operator had diverted his attention to aid two Operators on a procedure. He occasionally monitored the VCT level and pressure indicators on the Control Board. After helping the two Operators, he recalled seeing the control board indicators at 80% VCT level, and 62 psig VCT pressure. At this point, he performed the tank swapover as mentioned earlier. He then began to aid two construction personnel on a work request. Approximately one minute later, he received the VCT Low Level Alarm. VCT level and pressure indicators are in a row with two other indicators. It is possible that the Operator did not view the correct gauges prior to the swapover.

The level indicator that the Operator used receives input from the same transmitter that feeds the analog computer point. The analog computer point was set up to provide input to the trend recorder at the time. The

calibration of the level and pressure instrumentation were checked after the rupture had occurred. No problems were discovered. The trend recorder, analog computer point, and the Control Board indicator were in calibration.

Several other causes contributed to the event. The VCT did not have any relief protection during the performance of TOI/2/A/6150/01. When the relief path isolation valve was originally closed prior to Unit 1 Operation, the responsible personnel were not fully aware of the consequences on Unit 2. Also, the isolated relief paths were not identified by the procedure preparer or reviewers, or associated test personnel. The malfunction of the valve which caused the VCT level to drop and thus require manual refilling was also a contributing factor.

Safety Implications: At the time of this incident, Unit 2 was in the construction testing phase prior to initial fuel loading. Therefore, the NC System was not required to provide core cooling at the time.

The overpressurization and subsequent rupture of the Volume Control Tank did not result in any recordable personnel injuries. The three employees who were in the vicinity received bruises and lacerations, but did not require hospitalization.

Corrective Action:

Non-conforming Item (NCI) reports have been issued to:

1. Identify and evaluate areas of overpressurization and affected Chemical and Volume Control System piping and equipment.

2. Evaluate two instruments that were overpressurized during this incident.

3. Identify electrical cables that may have been water damaged.

4. Evaluate damage to the 6-inch Liquid Waste Drain Line.

5. Evaluate damage to the hangers.

6. Reinstall valve 2NV172A correctly. This NCI was issued on April 9, 1985.

Shutdown Requests have been issued to:

1. Install a temporary relief header for all Unit 2 relief valves which go to the Recycle Holdup Tank on Unit 1. This header relieves into a barrel sump on the 543 ft. elevation.

2. Remove the damaged VCT and install the replacement tank.

3. Replace the damaged NV System piping and remove and replace the VCT level and pressure instrumentation tubing.

4. Bypass the damaged VCT and use the FWST as a surge tank throughout the remainder of Cold Hydro.

The following corrective actions have been completed:

1. The leaking valve 2NV125B has been repaired.

2. Calibration checks have been performed on portions of instrument loops 2NV5760, 2NV5761, and 2NV5500. No problems were found.

3. The test procedure TOI/2/A/6150/01 (Initial Filling and Venting the Reactor Coolant System and Control of NC System for NC Hydro) was reviewed and several improvements made.

4. A review was performed of all isolated relief paths due to Unit 1/Unit 2 separation, and for any additional protective measures required prior to restart of the test.

5. A Technical Memorandum was issued to Operations Personnel on operating the NV System while the VCT is being repaired.

The final resolution of the NCI's will assure that any areas of overpressurization are identified, evaluated and repaired. A follow-up report will be submitted by July 15, 1985 describing the status of all corrective actions and a schedule for completion of remaining work.

ENCLOSURE 1

NV SYSTEM - UNIT 2

CATAWBA NUCLEAR STATION