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April 26, 1990

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

Subject: Catawba Nuclear Station
Special Report - Unit 1
Technical Specification 3.4.9.3.c.

Gentlemen:

Pursuant to Technical Specification 3.4.9.3 Action Statement c., a Special Report is to be submitted within 30 days of an event in which the "PORVs or the Reactor Coolant System Vents are used to mitigate a Reactor Coolant System pressure transient". An event occurred on Unit 1 on March 20, 1990 in which the PORVs controls were unable to respond but the Residual Heat Removal System's pump suction relief valves mitigated the transient.

As described in the Station FSAR and the NRC's Safety Evaluation Report, the suction relief valves are a part of the LTOP protection when that system is aligned to the primary coolant system as it was that day.

Therefore, we are submitting this Special Report to describe the circumstances of the event, the effect of the relief valves on the transient and corrective actions taken to prevent recurrence. The contents of this report were described in an Enforcement Conference held in Atlanta on April 25, 1990.

Very truly yours,

Tony B. Owen

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Station Manager

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DUKE POWER COMPANY
CATAWBA NUCLEAR STATION
PROBLEM INVESTIGATION REPORT NO. 1-C90-0094

REACTOR COOLANT AND RESIDUAL HEAT REMOVAL SYSTEMS
UNEXPECTED PRESSURIZATION TRANSIENT DURING FILL AND VENT

ABSTRACT

On March 20, 1990, with Unit 1 in Mode 5, Cold Shutdown, while in the process of filling and venting the Reactor Coolant (NC) System, an unexpected pressurization transient of the NC System occurred at approximately 0940 hours. Control Room Operators (CROs) had closed the Pressurizer Power Operated Relief Valves (PORVs) and were increasing NC System pressure to 100 psig by adjusting the Chemical and Volume Control (NV) System charging and Residual Heat Removal (ND) letdown. CROs were closely monitoring the NC System pressure indications in the Control Room when they noticed that the Pressurizer Relief Tank (PRT) level was increasing and that the ND Pump 1A discharge pressure was abnormally high. CROs then realized that the NC System was pressurized above 100 psig; but NC System pressure indications all read zero. Investigation confirmed that the ND Pump 1B suction relief valve lifted, NC System was pressurized to greater than 100 psig, and root valves were isolated to all the Control Room NC pressure instrumentation. This incident is attributed to a Management Deficiency due to an incomplete review of equipment status indicators prior to a condition change. A walkdown of affected piping on the ND System, testing of the ND suction relief valve, an engineering safety evaluation, and an operability determination of ND and NC were performed before the NC System fill and vent activities were resumed. This report is submitted as a Special Report.

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 pl^nt 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 is used as a part of the Emergency Core Cooling System (ECCS) and 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. The inlet lines to the ND System are connected to the hot legs of two Reactor coolant loops, while the return lines are connected to the cold legs of each of the Reactor coolant loops. These return lines are also the Emergency Core Cooling System (ECCS) low head injection lines.

In its capacity as the low head portion of the ECCS, the ND System provides long term recirculation capability for core cooling following the injection phase of the loss of coolant accident (LOCA).

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.

NC System pressure is controlled by the use of the pressurizer where water and steam are maintained in equilibrium by electrical heaters [EIIS:EHTR] and water sprays. Steam can be formed (by the heaters) or condensed (by the pressurizer spray) to minimize pressure variations due to contraction and expansion of the Reactor coolant spring-loaded safety valves and Power Operated Relief Valves (PORVs) from the pressurizer provide for steam discharge to the pressurizer relief tank, where the steam is condensed and cooled by mixing with water.

Overpressure protection for the NC System is afforded by a combination of procedural controls as well as design features of several components. The Low Temperature Overpressure Protection (LTOP) System is placed into operation when NC temperature is reduced below a setpoint (285 degrees F) value. This provides protection against nonductile fracture (10CFR50, App. G) by reducing the setpoints of PORVs NC32B and NC34A, per Technical Specification requirements. In addition, the ND System is unisolated from the NC System at pressures less than approximately 400 psig until heat removal via the ND System is no longer required. In this unisolated state, the ND System is a natural extension of the basic function to control NC System temperature and pressure. In this state, ND suction line relief valves ND3 and ND38 provide NC overpressure protection.

Overpressure protection for the ND System is assured by a combination of relief valves and auto-isolating suction valves. The inlet isolation valves (ND1B, ND2A, ND36B, and ND37A) have interlocks to prevent opening until NC pressure is below a setpoint (approximately 400 psig) and to auto-isolate at a higher setpoint (approximately 600 psig). This higher setpoint serves to protect against the potential for an intersystem LOCA. With these valves open, the above mentioned relief valves, ND3 and ND38, provide not only NC but ND overpressure protection as well. These are 4 inches by 6 inches Dresser type 1910 safety relief valves. These valves have a nominal set relief pressure of 450 psig at operating temperatures and a corresponding cold set pressure of 463 psig. At temperatures below 250 degrees F, these valves would ideally relieve at the cold set pressure. They also have an accumulation pressure of 45 psig which means that the valves would not achieve full lift until a pressure of 45 psig greater than the relief pressure is reached. At full lift, each relief valve has the capacity to relieve at a flowrate of 1040 gpm. These valves would ideally reseat at approximately 22.5 psig below the set pressure. This flow is in excess of the combined flow of the charging pumps at that pressure. Only one charging pump is allowed operable in Mode 5, Cold Shutdown, per Technical Specifications. Also, relief valves (ND31, ND35, and ND64) in the ND discharge lines provide overpressure protection against back leakage from the NC System through the discharge flowpath check valves.

Technical Specification (T/S) 3.4.9.3 requires at least one of the following overpressure protection systems shall be OPERABLE:

a. Two PORVs with a lift setting of less than or equal to 450 psig, or

b. The NC System depressurized with an NC vent of greater than or equal to 4.5 square inches.

T/S 3.4.9.3 is applicable in Mode 4, Hot Shutdown, when the temperature of any NC System cold leg is less than or equal to 285 degrees F, Mode 5, Cold Shutdown, and Mode 6, Refueling, with the Reactor vessel head on. When these conditions cannot be met, the following actions are required.

a. With one PORV inoperable, restore the inoperable PORV to OPERABLE status within 7 days or depressurize and vent the NC System through at least a 4.5 square inch vent within the next 8 hours.

b. With both PORVs inoperable, depressurize and vent the NC System through at least a 4.5 square inch vent within 8 hours.

c. In the event either the PORVs or the NC System vent(s) are used to mitigate an NC System pressure transient, a Special Report shall be prepared and submitted to the Commission pursuant to Specification 6.9.2 within 30 days. The report shall describe the circumstances initiating the transient, the effect of the PORVs or NC System vent(s) on the transient, and any corrective action necessary to prevent recurrence.

The Integrated Scheduling (I/S) group is responsible for scheduling and tracking all outage related work and activities. To perform this function, I/S receives blocks of work from each station group and integrates the work into a schedule to be used by station groups involved in an outage. Project 2, the outage scheduling computer program, is the mechanism used to develop the schedule. I/S depends on the Operations (OPS) group to identify scheduling logic based on operability and Technical Specification requirements for specific plant condition and mode changes.

Operations is responsible for performing reviews which ensure that all required work and activities are completed, all systems and components are operable, and Technical specification requirements have been met prior to allowing a plant condition or mode change to occur. To perform this review, OPS uses the following tools: Nuclear Maintenance Data Base (NMDB), Project 2, Removal and Restoration (R&Rs, i.e. tagouts), Periodic Tests (PTs), and System Alignment Procedures. OPS Support personnel are expected to utilize all the above tools necessary to assure appropriate plant configuration control.

EVENT DESCRIPTION

On March 20, 1990, with Unit 1 in Mode 5, Operations (OPS) was conducting the NC System Fill and Vent per procedure OP/1/A/6150/01, Filling and Venting the Reactor Coolant System. A Chemical and Volume Control [EIIS:CB] (NV) System centrifugal charging pump was operating to pressurize the NC System to approximately 100 psig while letdown was being accomplished to the NV System by means of the Residual Heat Removal (ND) System. The ND System was aligned to the NC System with Train A operating to remove core residual heat. Refer to Attachment 1 for incident sequence of events and Attachment 2 for fill and vent sequence.

The initial fill of the NC System was complete and preparation for increasing NC pressure was being performed per the fill and vent procedure. With the PORVs closed, Control Room Operators (CROs) noticed the Pressurizer Relief Tank (PRT) level was still increasing. Per their training and procedural guidance, they recognized the PRT increasing level as abnormal (a noticeable level increase in the PRT is an indication that the Pressurizer (PRZ) and NC System piping are water solid). Because the Operators believed that PORV leakage was the cause for the increasing level in the PRT, they reduced charging flow and isolated the PORVs one at a time. However, PRT level continued to increase. At approximately 0957 hours, CROs discovered that ND Pump 1A discharge pressure was indicating approximately 375 psig. Again, they recognized that this was also abnormal since normal ND pump discharge pressure should have been approximately 200 psig when NC pressure is zero psig. After subsequent discussion with their supervision, it was concluded that the NC System was pressurized to approximately 175 psig, although NC System pressure indications in the Control Room read zero and the ND suction relief valves may have lifted. A decision was made to dispatch a Non-licensed Operator (NLO) in Containment to visually inspect the ND suction relief valves while depressurizing to approximately 200 psig ND pump discharge pressure.

While in Containment, at approximately 1008 hours, the NLO found the Train B ND suction relief valve passing flow. The ND suction relief valves are routed to the PRT and provide overpressurization protection. At 1030 hours, CROs then isolated the Train B ND suction relief valve from the NC System by closing the ND loop suction isolation valves to reseat the ND suction relief valve. At approximately 1030 hours, the PZR PORVs were declared inoperable per T/S 3.4.9.3, placing Unit 1 in an 8 hour action statement (the T/S inoperability time was moved back to 0708 hours to reflect when the PORVs were originally closed).

The ND suction relief was reseated, and Train B of ND realigned to the loops at 1205 hours.

Operations Engineer A notified Instrument and Electrical (IAE) Supervisor A and requested an investigation of the NC System pressure indications problem (all indication reading zero). After subsequent investigation, IAE Supervisor A confirmed that the root valves to NC System pressure instruments were valved out for previously scheduled maintenance compression fittings outage work (wide range pressure loops 1NC5120, 5121, and 1NC 5140, 5141 per Work Requests 5491 IAE-2 and 1493 MES-1, respectively) .

At approximately 1345 hours, NC pressure had been reduced to atmospheric and the NC PORVs reopened to establish the 4.5 square inch vent space required by Technical Specifications in the absence of operable PORVs. At approximately 1420 hours, IAE completed unisolating and restoring the Control Room NC pressure instrumentation. Operations then realigned Train B ND to the NC System and declared the PORVs operable, exiting T/S 3.4.9.3 and the 8 hour action statement.

CONCLUSION

This incident is attributed to a Management Deficiency due to an inadequate review of equipment status indicators by Operations to assure that all required work was completed prior to a plant condition change during the outage. During this outage and in the past, Operations had reviewed the following documents to ensure equipment operability prior to changing modes or conditions within a mode:

1) Nuclear Maintenance Data Base (NMDB)
2) Project 2
3) Removal and Restoration (R&Rs, i.e. tagouts)
4) Periodic Tests
5) Procedure System Alignments
6) Detailed knowledge of work status by Unit Manager's Group Engineers
7) Technical Specifications Action Item Log

Operations had been successful in entering conditions such as loops drained, initiation of refueling, and mid loop operations through these specific reviews. In this event, the Operations Unit 1 Manager's Group did not review the Nuclear Maintenance Data Base for setting the head and PORV related items. Had this database been reviewed, the incomplete status of the original work request for welding the fittings on these instrument loops and of the supplemental would have been noted. The relationship of the NC pressure instruments to PORV operability was understood by Operations. The review of NMDB for outstanding work requests prior to condition change was not a formalized process.

The program that had been used in the past was not a formal written program requiring review of the above noted components. As a corrective action, this program that Operations follows to assure equipment operability during mode and condition changes will be formalized and established within the Operations Management Procedures. The program will be written and a review session conducted prior to the Unit 2 EOC3 outage.

A contributing cause is assigned to the scheduling mechanism that permitted setting the Reactor Vessel Head with the pressure instruments isolated. The work requests to replace compression tube fitting with socket welds on NC System Wide Range Pressure instrumentation were scheduled to be worked and completed prior to setting the Reactor Vessel Head. Integrated Scheduling scheduled these (primary) work requests as an activity in the outage schedule, which was required to be complete prior to fill and vent. These primary work requests had, as a prerequisite for closeout, a functional verification involving a visual inspection while the NC System was pressurized. The supplemental work requests to isolate and restore the NC System pressure instrument loops were identified only as notes associated with the primary work request and were not identified as stand alone items within the outage schedule. Per the supplemental work request, the restoration of the instrumentation was to be performed and then documented on a Standing Work Request (SWR), 6114 SWR, which is used to assure that the NC pressure instrumentation is properly aligned and in service prior to Mode 4. When the welding work identified by the primary work request was reported as completed, the primary and supplemental work requests were dropped from the Project 2 (outage scheduling computer program) schedule. These supplemental work requests were obtained by an IAE Planner who recognized that their remaining work scope (restoration of instrumentation) paralleled that of the SWRs used to assure NC pressure instrumentation alignment prior to Mode 4. Lacking an indication on the supplemental work requests that restoration was required prior to setting the Reactor Vessel Head, the IAE Planner filed the SWR with the supplemental work requests so that they could be scheduled and performed at the same time. This work would have been scheduled to be performed prior to Mode 4 (expected for March 24).

6114 SWR is used to perform a valve checklist assuring certain NC System instrumentation, required in Mode 4 and for plant operation, is properly aligned prior to Mode 4.

Immediate corrective actions included stopping all activities associated with plant heat-up isolation of the PORVs to determine leakage into the PRT, visual inspection of ND suction relief valves in Containment, and isolation of the ND suction relief valve from the NC System to reseat the relief valve. In addition, IAE unisolated and restored NC System wide range pressure instruments in order to restore PORV operability.

Additional, subsequent corrective actions included a walkdown of the ND System, review of NC and ND System instrumentation, relief valve pressure testing, and initiation of a 10CFR50.59 Evaluation, an Operability Evaluation, and PIR 1-C90-0094.

As corrective actions to the scheduling and planning of outage work the following actions are being taken:

1) The outage schedule will be coded such that conditon changes will be handled similar to mode changes.

2) Operations will develop the list of conditions and equipment required operable for each conditon.

3) The IAE group will revise their administrative controls for root valve status in condition changes to be similar to their present approach to mode changes.

4) IAE and OPS will develop a program to clearly identify instruments out of service or calibration that will require a sticker to be placed on Control Room instruments.

5) The Planning group will consider establishing a program on supplemental work requests that will tie them to the original as -1 or -2 rather than as separate group work requests.

CORRECTIVE ACTION

SUBSEQUENT

1) Control Room Operators isolated the PORVs one at a time to determine the leak path into the PRT. PORVs were not leaking by to the PRT.

2) NLO in Containment inspected the ND Pumps suction relief valves to determine if valves were passing flow. The NLO found ND Pump 1B suction relief valve passing flow to the PRT.

3) CROs depressurized the NC System and isolated ND Pump 1B suction relief valve from the NC System in order to reseat the valve.

4) IAE determined that NC System pressure instrumentation root valves were isolated. Using Work Requests 5491 IAE-1, 1491 MES-1, 1492 MES-1, and 1493 MES-1, IAE opened the root valves and returned the NC System pressure instrumentation to service.

5) IAE performed a calibration on 1NDPT5090 Loop (ND Pump 1A discharge pressure) and discovered that the instrument was out of calibration (65 psig high) thus indicating an erroneous ND and NC pressure.

6) CROs realigned ND Pump 1B suction relief to the NC System and verified that the relief valve had reseated.

7) Plant Startup was held at this point until Management understood the event and necessary follow-up actions.

8) Operations performed a walkdown of both trains of the ND System to inspect for leaks.

9) Operations reviewed the fill and vent procedure and developed a list of instruments required to fulfill the procedure. Operations identified instruments which were indicating correctly, needed maintenance, and needed functional verification.

10) IAE reviewed and determined the status of each instrument identified by Operations as being essential to the fill and vent procedure.

11) Operations reviewed work requests to ensure equipment operability before proceeding with fill and vent. Surveillances were reviewed to ensure all necessary equipment tests were up-to-date.

12) MES replaced the ND Pump 1B suction relief valve with a valve previously pressure tested to 625 psig.

13) CNS initiated a 10CFR50.59 Safety Evaluation to ensure that an unreviewed safety question did not exist.

14) PIR 1-C90-0094 was initiated to request from Design Engineering an operability evaluation for the NC and ND System.

PLANNED

1) Operations will formalize the program to assure equipment operability during mode and condition changes; this program will be established within the Operations Management Procedure.

2) Operations will make changes to the controlling procedure for Unit shutdown that prior to installing the Reactor Vessel Head, IAE signoffs must be obtained.

3) Operations will assume the lead in identifying Unit condition changes within Modes 1 through 6. A final list that includes equipment requirements for each condition will be provided to the responsible station group. The station sections will use this list to determine when signoffs for condition changes need to be provided in the Operations procedure. The Operations procedures group will incorporate these signoffs in their procedures.

4) Integrated Scheduling will provide logic in the outage schedule for the scheduling of Technical Specification plant conditions as addressed in item #2 above. Codes will be provided for these plant conditions similar to the Mode codes presently in use. This will allow lists of identified work, required to be completed prior to a specific plant condition change, to be generated for review by the outage management team.

5) Instrument and Electrical will revise the existing adminsitrative controls for instrument root valve position verification prior to a Mode change. The revision will address those instrument root valves required to be verified prior to a Technical Specification plant condition change.

6) IAE and OPS will develop a program that will clearly identify instruments within the Control Room that are either out of service (i.e, root valves isolated) or known to be out of calibration.

7) Maintenance Engineering Services will change Standing Work Requests for instrument realignment and ensure they match Unit condition and mode change requirements.

8) Planning will consider a program to ensure that a work request written as a supplemental or in support of another work request will be a -1, -2, etc. rather than one of an initiating group.

9) Planning will review the work request pre-review process and procedure to ensure that they comply with the outage scheduling mechanism changes.

10) To correct the Human Performance deficiencies identified in this and other recent events, additional corrective actions are to be taken to limit the opportunities for error.

SAFETY ANALYSIS

While charging to pressurize the NC System, the CROs had been monitoring PRT level and NC System wide range pressure instrumentation per the NC Fill and Vent procedure. The NC System wide range pressure instrumentation had been isolated for previously scheduled outage work and never restored. Therefore, Operators were unaware that NC pressure eventually reached approximately 460 psig. The NC System wide range pressure instrumentation also provides input to PZR PORV logic. Because this instrumentation was isolated, the ND loop suction valves would not have been capable of auto isolation and Low Temperature Overpressure Protection (LTOP) was not functional; leaving the ND suction relief valves as the only pressure relief path. (Refer to Attachment 3, Operability Determination.)

On March 20, Catawba performed a 10CFR50.59 Safety Evaluation of this incident to ensure that an unreviewed safety question did not exist. The results of the evaluation showed that the peak pressure experienced by NC and ND Systems did not exceed the pipe ratings, Technical Specifications, or past system hydrotesting. In addition, neither the probability nor the consequences of an accident or malfunction of equipment important to safety evaluated or not in the Final Safety Analysis Report (FSAR), was increased by this incident. Therefore, no unreviewed safety question exists. It is concluded that the margin of safety as defined by Technical Specifications has not been reduced by this incident.

On March 21, Design Engineering responded to PIR 1-C90-0094, with an operability evaluation for the NC and ND Systems. It was determined that the ND safety relief valves responded properly to the pressurization transient event caused by the NV pumps. After a review of ND piping, valves, instrumentation, and components, there were no adverse impact on the ND System resulting from the peak pressure created during the incident. Design Engineering concluded that the peak pressure reached was within the normal response range for a relief valve, with a maximum design setting of 600 psig plus 10% accumulation.

In addition, the NC System Nil Ductility Transition Temperature (NDTT) limit for Reactor startup was reviewed. At no time did the NC System exceed the pressure allowed for its corresponding temperature. Therefore, it was concluded that the NC and ND Systems were operable following this incident.

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

ATTACHMENT 1

SEQUENCE OF EVENTS

DATE	TIME	EVENT
3//20/90	0700	Fill of the Reactor Coolant System (NC) in progress.
	0708	Pressurizer is full as identicated by Pressurizer Relief Tank (PRT) level increase. Closed Pressurizer PORVs. Charging flow was adjusted to approximately 100 gpm and letdown flow to approximately 30 gpm to begin pressurizing the NC System to 100 psig. (This evolution normally takes 4 to 6 hours.) Operators are closely observing the 3 NC System pressure indications in the Control Room.
	0945	Control Room Operator notices PRT level increasing. Recognized this as abnormal and reduced the charging rate towards the letdown rate. Supervision notified.
	0950	Operators felt pressurizer PORVs may be leaking into the PRT. Began isolating them one at a time. PRT level still increasing.
	~0957	Operators noticed RHR Pump (ND) discharge pressure indicating 375 psig (normal pressure with zero NC pressure would be approximately 200 psig). They then realized NC System was pressurized to approximately 175 psig at this time, but NC System pressure indications all read zero. Notified Operator in Containment to look at ND suction reliefs and continued depressurizing to 200 psig ND Pump discharge pressure.
	1008	Operator in Containment reported B ND suction relief passing flow.
	1030	With ND Pump Discharge reduced toward normal, Operators isolated B ND suction from the NC System to reseat the relief valve. Also entered action statement for inoperable pressurizer PORVs (8 hour action statement). Clock was started at 0708 hours. Notified IAE to investigate NC System pressure indication problems.

DATE	TIME	EVENT
3/20/90	~1100	Obtained printout from All Points Data Base (APD) that showed that NC pressure had reached approximately 520 psig. Notified Management and Design. Note: Later on that evening, IAE performed a calibration on the 1NDPT5090 loop. The "As Found" calibration of this instrument (Analog Operator Aid Computer Channel) was 65 psig high. The actual NC pressure, therefore was 455 psig.
	~1112	Operators attempt to restore "B" Train ND suction relief but valve would not open due to interlock with 1FW-55B. Dispatched Operator per procedure to manually open 1ND-36B.
	1205	Realigned B ND suction to the NC System and verified relief had reseated.
	1345	PORVs reopened and established Technical Specification required 4.5 square inch vent space.
	~1420	NC Pressure instruments were unisolated and pressurizer PORVs were declared operable.

ATTACHMENT 2

The following is a sequence of events which must be accomplished to properly fill and vent the NC System.

a. NC System Fill (OP/1/A/6150/01, Enclosure 4.1)
   1) Review limits and precautions
   2) Establish initial conditions
   3) Verify breaker and valve positions per Enclosure 4.1
   4) Vent PRT to Containment
   5) Pzr spray control manual and open
   6) Open RV head and Pzr vents to PRT
   7) Establish fill source
   8) Fill NC System
   9) Isolate individual components vents as a solid stream of water issue
   10) Purge NC pumps seal bypass lines
   11) Fill NC cold leg injection lines
   12) At ~22% Pzr level isolate other NC level instrumentation (tygon tubing)
   13) Reduce flow when PRT level increases noticeably (Pzr full)
   14) Close Pzr PORVs and place in "low press" position
   15) Maintain 50 psig NC system press
   16) Isolate fill water source
   17) Establish normal makeup alignment (if applicable)
   18) Close RV head vents to PRT

b. NC System Venting (Enclosure 4.2)
   1) Establish 325 psig (minimum) NC System press
   2) Open NC pump seal returns
   3) Run one NC pump 20-30 seconds, then stop pump and wait 10 minutes
   4) Vent RV head to PRT
   5) Start one pump 20-30 seconds, then stop pump
   6) Reduce NC press to 100 psig and wait 15 minutes
   7) Vent RV heat to PRT
   8) Vent Pzr to PRT
   9) Repeat steps 1) through 8) for each NC pump
   10) Vent system instrumentation
   11) Run each NC pump one minute, reduce NV press to 100 psig and wait 15 minutes
   12) Vent RV head to PRT
   13) Vent Pzr to PRT
   14) NC system press to 325 psig
   15) Run all four NC pumps for 5-10 minutes
   16) Stop NCPs

17) Reduce NC press to 100 psig
18) Vent RV head to PRT
19) Vent Pzr to PRT
20) Add hydrazine (if required)
21) Start NCP A or B when press 325 psig
22) Stop NCP when hydrazine added
23) NC System press to 100 psig
24) Pzr spray valves to close
25) PRT to normal lineup
26) NC System press to 0 psig
27) N2 blanket in Pzr from PRT
28) Drain Pzr to 95% level
29) Vent RVLIS
30) Heat-up Pzr if desired

ATTACHMENT 3

OPERABILITY EVALUATION

Residual Heat Removal (ND) and Reactor Coolant (NC) Systems
Revision 1

Statement of Problem

During NC fill and vent operations, the ND pump 1A discharge pressure reached an apparent pressure of 690 psig. The ND loop suction relief valves appeared to lift and relieve. The wide range NC pressure loops 5120, 5121, 5140, and 5141 were isolated for maintenance work, thus preventing any pressure indication or LTOP protection with 1NC32B or 1NC34A. This also would have prevented ND loop suction valves automatic closure.

System Description

Overpressure protection for the NC (Reactor Coolant) System is afforded by a combination of procedural controls as well as design features of several components. The Low Temperature Overpressure Protection (LTOP) System is placed into operation when NC temperature is reduced below a setpoint value. This provides protection against nonductile fracture (10CFR50, App. G) by reducing the setpoints of two pressurizer power operated relief valves (PORVs NC32B and NC34A) from 2335 psig to 400 psig. In addition, the ND (Residual Heat Removal) System, which borders the NC System, is unisolated from the NC System at pressures less than approximately 400 psig until heat removal via the ND System is no longer required. In this unisolated state, the ND System is a natural extension of the basic function to control NC System temperature and pressure. In this state, relief valves ND3 and ND38 on Train A and B respectively provide NC overpressure protection.

Overpressure protection for the ND System is assured by a combination of relief valves and auto-isolating suction valves actuated by an Auto-Closure Interlock (ACI). The inlet isolation valves (ND1B, ND2A, ND36B, and ND37A) have interlocks to prevent opening until NC pressure is below a setpoint (approximately 400 psig) and to auto-isolate at a higher setpoint (approximately 600 psig). This higher setpoint serves to protect against the potential for an intersystem LOCA. With these valves open, the above mentioned relief valves, ND3 and ND38, provide not only NC but ND overpressure protection as well. These are 4" x 6" Dresser type 1910 safety relief valves. These valves have a nominal set relief pressure of 450 psig and an accumulation pressure of 45 psig which means that the valves would not achieve full lift until a pressure 45 psig greater than the relief pressure is reached. At full lift, each relief valve has the capacity to relieve at a flowrate of at least 900 gpm. These valves would ideally reseat at approximately 22.5 psig below the set pressure (blowdown of 22.5 psig). This flow is in excess of the combined flow of the charging pumps at that pressure, not all of which should be operable during ND operation. Also, relief valves (ND31, ND35, and ND64) in the ND discharge lines provide overpressure protection against backleakage from the NC System through the discharge flowpath check valves.

Operability Evaluation

In preparation for the NRC telephone conference on 3-21-90, the ND pump 1A discharge pressure instrument previously reading 690 psig was found to be in error by 65 psig. As a result, the ND pump discharge pressure never exceeded 625 psig. This is still a conservative estimate due to the extrapolation of values between 5 minute readings. Because of the conservative uncertainty associated with this extrapolation, it is concluded that the ND relief valves performed as expected and that ND pump suction pressure was approximately 460 psig, not 520 as originally interpreted. Suction safety relief valve 1ND3 apparently opened and had reseated by the time operators were able to investigate. Additionally, ND pump discharge pressure of 625 psig was not in excess of normal expected system response pressure. This is because even when ND pump discharge relief valve 1ND31 relieves at 600 psig, full lift and hence full flow is not achieved until 10% accumulation pressure (660 psig) is reached. This response is acceptable under ASME Section III.

Although ND Train B was out of service, it was determined that ND suction relief valve on Train B (ND38) was passing flow, thus suction to ND Train B was isolated in order to reseat the valve. The flow passing Train B relief valve was calculated to be approximately 155 gpm which is well below the rated capacity of the valve (at least 900 gpm). Full capacity of the relief valve was never challenged so the corresponding system suction pressure never exceeded the set pressure plus 10% accumulation (450 psig + 45 psig = 495 psig). Since this is the normally expected system response, and the design pressure of 540 psig was never exceeded, no question of operability exists for either Train A or B suction side of ND System.

Because ND pump 1B was not operating, no pressure increase existed across the pump; therefore, its discharge piping and components were not challenged.

NC System Pressure Evaluation

When the Unit 1 NC System was being filled and vented, the NC pressure sensing lines serving both the LTOP and ACI functions were blocked, forcing reliance on the ND suction line safety relief valves 1ND3 and 1ND38. These valves responded as designed when incoming ND pressure exceeded their set pressure; however, with the ND pump in operation, a maximum pressure of 625 psig was reached in the ND pump discharge piping on Train A. Using a discharge pressure of 625 psig, and subtracting 165 psig for ND pump head at 3100 gpm (Ref CNM-1201.05-318), the maximum NC System pressure was approximately 460 psig. This is a conservative estimate since vessel pressure would be approximately 10 psig lower due to its higher static elevation. Therefore, the actual NC System conditions of 460 psig at 114˜F do not exceed the "Heatup Curve" from Tech Spec 3.4.9.1, Figure 3.4-2 and Tech Spec limits were not exceeded. This provides approximately a 70 psi margin (530-460) at 114˜F.

ND System Pressure Review

Pipe, fittings, equipment, and instrumentation located within the area pressurized have been evaluated for the acceptability of being pressurized to 625 psig. (It should be noted that the discharge portion of the ND System was hydrotested to 900 psig except for a portion hydrotested to 803 psig since the ND heat exchanger was a limiting component). A detailed review was conducted for the following items:

1) Piping materials from ND pump 1A discharge through valves 1ND26, 1ND27, 1ND28A, 1NV135 and all normally closed vent, drain, and isolation valves were considered. This pressure event did not affect piping stress analysis or hanger designs.

2) Valves which are located within the piping boundaries mentioned above

3) Instrumentation located within the piping boundaries mentioned above

4) Mechanical Equipment

Results of these reviews, as well as the methodology followed, are described below.

1) Piping Materials

Piping materials (pipe, fittings, and flanges) subjected to this pressure event are qualified for at least a design pressure of 792 psig at 120˜F which is greater than the actual pressure of 625 psig (114˜F) during the pressure event. Pipe spec. PS-601.2, which applies to all of this piping, permits a maximum pressure of 792 psig at 120˜F.

Code calculations per Section III paragraph NC3640 are performed for the design conditions listed by the pipe spec subtable. Pipe spec. subtables are not system specific and a single subtable is used for many applications in the plant. Maximum design conditions listed by the pipe spec. subtable are always greater than or equal to the design conditions listed by the flow diagram. Also design conditions for the pipe spec. subtables are based on the limiting pipe size and schedule for all sizes covered by the subtable. Smaller pipe sizes such as the sizes affected by this pressure event have a higher code allowable pressure than listed by the subtable design conditions. This conservatism qualifies these piping materials for higher design conditions than are listed by the flow diagram and even the pipe spec. subtable. Stress analysis and hanger design are not affected by this pressure event.

2) Valves

The valves in the 1A ND pump discharge line have been reviewed in light of the actual (extrapolated) maximum pressure of 625 psig reached during the event. This pressure was not in excess of normal expected system response pressure of 600 psig set pressure plus 10% accumulation (660 psig) for this discharge line's relief valve 1ND31. Such a pressure response is acceptable per ASME Code Section III, and is not considered an overpressure event. Therefore, no further analysis is required. No adverse impact on valves occurred as a result of this event.

However all valves affected have been reviewed to determine the maximum conditions that each valve is designed for. These conditions are as follows:

TAG NUMBER	VALVE DESIGN CONDITION	
	PSIG	˜F
1ND008	2485	650
1ND010	680	200
1ND012	2485	650
1ND014	2485	650
1ND019	680	200
1ND020	2485	650
1ND021	2485	650
1ND024A	2485	650
1ND025A	2485	650
1ND026	710	150
1ND027	710	150
1ND028A	1420	150
1ND029	2485	650
1ND058B	2485	650
1ND067	680	200
1ND069	2485	650
1ND070	2485	650
1ND071	2485	650
1ND073	2485	650

1ND074	2485	650
1ND077	2485	650
1ND090	2485	650
1ND100	2485	650
1ND101	2485	650
1ND102	2485	650
1NM039	2485	680
1NS043A	1365	200
1NV135	945	150

3) Instruments

The ECPE and ECLD groups have reviewed the instruments subjected to the recent inadvertent ND System overpressurization. Below is a list of the instruments that were reviewed.

Review of Instruments Requiring Replacement

The instruments reviewed would not have been damaged. The one exception to the above statement is 1NDPG5201; however, this instrument's root valve was closed. This instrument is used for testing only and was isolated at the time of the event. None of these instruments require replacement.

Review of Instruments Requiring Calibration Check

It is recommended that a two or three point check to verify the calibration of instruments 1NDPG5040 and 1NDPG5041. The purpose of this check is to determine if a zero or span shift has occurred. The results of this check will determine if a full calibration is required. These are the only instruments that actually were pressurized above normal conditions.

INSTRUMENTS REVIEWED

1NDTW5000	1NDFE5190
1NDTW5020	1NDFT5190
1NDFE5040	1NDFT5191
1NDPG5040	1NDPT5090
1NDPG5041	1NDPG5200
1NDTW5060	1NDPG5201
1NDPS5200	

4) Mechanical Equipment

The vendor manuals provide both design conditions and hydrotest pressures to which this equipment was tested. This information is presented below:

	Ref	Design (psig)	Hydrotest (psig)
ND Pump	CNM-1201.05-318 DCD 11-9-88		
Casing only		600	936
Mechanical Seal unit only		600	1200
ND Heat Exchanger	CNM-1201.06-83 DCD 2-18-88		
Shell Side (KC System)		150	225
Tube Side (ND System)		600	803

By inspection, the peak pressure of 625 psig reached during this pressure event is enveloped by allowable hydrotest pressures. Therefore, there was no adverse impact on mechanical components.

Impact on Technical Specifications:

- Technical Specifications 3.4.1.4.1 and 3.4.1.4.2, which specify the conditions required for the Residual Heat Removal (ND) System to perform a core cooling function, was not adversely impacted.

- Technical Specification 3.4.9.1, which specifies Reactor Coolant (NC) System (except the pressurizer) temperature and pressure limitations during heatup, cooldown, criticality, and inservice leak and hydrostatic testing, was not violated since actual conditions reached (460 psig at 114°F) were within the limits established by Tech. Spec.

- Although Technical Specifications 3.4.4 which specifies the conditions required for operability of the Power Operated Relief Valves (PORVs) and 3.4.9.3 which specifies the conditions required for operability of the Overpressure Protection System were not observed leading to the incident (described in PIR 1-C90-0094), the future ability of the PORVs to relieve in other modes or to provide Low Temperature Overpressure Protection (LTOP) was not adversely affected by this event

- Technical Specifications 3.5.2 and 3.5.3 which specify the limiting conditions for operation of the Emergency Core Cooling System (ECCS) Subsystems were not violated since the Centrifugal Charging (NV) Pump was unaffected, and the ability of ND to perform a core cooling function was not adversely impacted.

Conclusion

Based on Design Engineering's review of PIR 1-C90-0094, it was determined that ND safety relief valves responded properly to a potential overpressure event caused by Centrifugal Charging (NV) pumps. Resulting pressures created during this event in the ND pump suction and discharge lines have been evaluated. This review of ND piping, valves, instrumentation, and equipment has identified that there was no adverse impact on ND System. In fact, the conservately extrapolated peak pressure of 625 psig reached during the event was within normal response range for a relief valve set at 600 psig plus 10% accumulation. This response is acceptable under ASME Section III.

In addition, the Reactor Coolant (NC) System NDT limit for startup was reviewed. At no time did the NC System exceed the pressure allowed for its corresponding temperature.

In conclusion, NC and ND Systems are considered operable following this event.

References

1. Flow Diagrams

   CN-1561-1.0 Rev 6
   CN-1561-1.1 Rev 3
   CN-1554-1.7 Rev 5

2. Telephone conversations R. C. Bucy with P. W. Barrett, Dennis Robinson, Bill Hallman, Ron Jones on 3-20-90 -- 3-21-90

3. Duke Power Company conference call with NRC Site Inspectors, Region, and NRR

4. Vendor Drawings

   CNM-1201.05-318 DCD 11-9-88
   CNM-1201.06-83 DCD 2-18-88

5. Calc. by W. B. Hallman, Determination of ND Suction Pressure (Peak) and Max Flow through 1ND3 and 1ND38 During Potential Overpressure Event of 3-20-90

6. Duke calculation CNC-1223.11-00-0003, 9-4-86

7. Letter from R. S. Bondurant to R. C. Bucy concerning ND System overpressurization, 3-21-90

8. Memo from B. J. Barbee to R. C. Bucy and S. S. Lefler concerning PIR 1-C90-0094, 3-22-90

9. Telephone conference, 3-21-90, S. S. Lefler and R. C. Bucy to M. S. Purser and D. L. Caldwell regarding pipe stress and hangers