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DUKE POWER

March 30, 1990

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

Subject: Catawba Nuclear Station
Docket No. 50-414
LER 414/90-03

Gentlemen:

Attached is Licensee Event Report 414/90-03, concerning ANNULUS VENTILATION SYSTEM FAILURE TO MEET VACUUM DECAY TIME TEST CRITERIA WITH INTERFACING VENTILATION SYSTEMS IN POST LOCA ALIGNMENT.

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/TEL

Tony B. Owen
Station Manager

keb\LER-NRC.TBO

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NRC Form 366
(9-83)

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

LICENSEE EVENT REPORT (LER)

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TITLE (4) Annulus Ventilation System Failure To Meet Vacuum Decay Time Test Acceptance Criterion With Interacting Ventilation Systems In Post LOCA Alignment

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)
									N/A	0 5 0 0 0
0 3	0 1	9 0	9 0	— 0 0 3	— 0 0	0 3	3 0	9 0		0 5 0 0 0

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 9 7	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)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv) X	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
	AREA CODE
R.M. Glover, Compliance Manager	8 0 3 — 8 3 1 1 - 3 2 3 6

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	

SUPPLEMENTAL REPORT EXPECTED (14)

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

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

On March 1, 1990, with Unit 2 in Mode 1, Power Operation, at 97% power, Performance performed PT/2/A/4450/03C Section 12.9, VE Vacuum Decay Time Test, on the Unit 2 Annulus Ventilation System (VE) in response to NRC Information Notice No. 90-02, Potential Degradation of Secondary Containment, to correct error adjustment in the test acceptance criteria, and to evaluate the effect of interacting ventilation systems. The VE System was immediately declared inoperable and Technical Specification (T/S) 3.0.3 was entered when the test acceptance criterion was not met. Subsequent repair work and testing were performed to declare operability and exit T/S 3.0.3. This incident is attributed to interaction between ventilation systems that was not fully understood, leading to testing in a less than conservative alignment. Enhanced visual inspection of the Annulus pressure boundary will be evaluated to better ensure its integrity.

BACKGROUND

The Annulus Ventilation [EIIS:VD] (VE) System is designed to: 1) achieve and maintain a negative pressure in the Annulus following a loss-of-coolant accident (LOCA); 2) minimize the release of radioisotopes following a LOCA by filtering and recirculating a large volume of Annulus air relative to the volume discharged to maintain a negative pressure; and 3) provide long term fission product removal by filtration.

The VE System is an engineered safety feature and consists of redundant (100 percent capacity) subsystems. Each subsystem consists of a filter [EIIS:FLT] train, fan [EIIS:BLO], dampers, associated duct work, and control systems. The VE System does not operate during normal plant operation. Upon receipt of a Safety Injection signal (SS), the recirculation and discharge dampers are aligned to exhaust air to the Unit Vent until the Annulus negative pressure is greater than -0.5 inwg. These dampers then modulate to exhaust air to maintain the Annulus negative pressure.

The CANVENT computer [EIIS:IMOD] program was developed by Duke Power Company to analyze the thermal effects of a LOCA on the Containment [EIIS:NH] Annulus. This program takes several factors into account, such as pre-LOCA Annulus temperature and pressure, and the capability of the VE fans to achieve and maintain a vacuum in the Annulus following a LOCA. Other factors included in this program are heat transfer from upper and lower Containment into the Annulus, effects of swelling of Containment, and changes in Annulus air density during a LOCA. This computer model is used to establish various design parameters of the VE System.

Technical Specification 3.6.1.8 requires both trains of VE to be operable in Mode 1, Power Operation, Mode 2, Startup, Mode 3, Hot Standby, and Mode 4, Hot Shutdown. The Action Requirement is that with one train of VE inoperable, the train must be restored to operability within seven days or the Unit must be in at least Mode 3 within the next 6 hours, and in Mode 5, Cold Shutdown, within the following 30 hours. Surveillance Requirement 4.6.1.8 states that at least once per 18 months, the VE System shall be demonstrated operable. This requirement is periodically met by the Annulus Ventilation System Performance Test, PT/1,2/A/4450/03C.

The Fuel Handling Area Ventilation [EIIS:VG] (VF) System is designed to: 1) maintain a suitable environment for the operation, maintenance, and testing of equipment; 2) maintain a suitable environment for personnel access; and 3) maintain the fuel handling and storage building at a negative pressure relative to the atmosphere to minimize out-leakage.

The VF System consists of the following components (per Unit basis):

1) One 100 percent capacity ventilation supply air handling unit and associated dampers and duct work.

2) Two 100 percent capacity exhaust systems.

The VF Exhaust System is an engineered safety feature. Each redundant set of filter [EIIS:FLT] trains (two 50 percent capacity) fans, and motor [EIIS:MO] operated dampers which is served from separate trains of emergency class IE standby power. This assures the integrity and availability of the exhaust system in the event of any single active failure.

The Auxiliary Building Ventilation [EIIS:VF] (VA) System is designed to provide a suitable environment for equipment operation and personnel access during both normal and accident conditions.

The VA System serves areas of the Auxiliary Building [EIIS:NF] with the exception of the Control Room Area and the Fuel Handling Area. It consists of the following subsystems: 1) Auxiliary Building Ventilation Supply (ABSU) Subsystem; 2) Auxiliary Building Unfiltered Exhaust (ABUX) Subsystem; 3) Auxiliary Building Filtered Exhaust (ABFX) Subsystem; 4) Auxiliary Shutdown Panel Rooms Air-Conditioning Subsystem; 5) Radwaste Area Ventilation Subsystem; and 6) Supplementary Ventilation Subsystem.

The ABFX Subsystem consists of two filter trains with fans, two preheater [EIIS:EHTR]/demister sections and associated duct work per unit (four trains for the station). The subsystem serves areas of the Auxiliary Building which are subject to potential contamination. The subsystem serves both a non-safety and a safety related function. During normal plant operation, the two filter trains and fans operate as two 50 percent capacity components of the exhaust system. Each filter train is equipped with a bypass section with the normal mode of operation being the bypass position. Upon indication of a high radiation level in the Auxiliary Building, the bypass dampers automatically close and the filter train inlet dampers automatically open to direct air flow through the filter train. Upon high radiation in the Unit Vent, the filter fans shut down. The filter fans are also prohibited from operating during the activation of the Tornado Isolation Controls.

During a Loss of Coolant Accident (LOCA) condition, the two unit related ABFX filters, fans, and preheater/demister sections operate as two 100 percent capacity components of the exhaust system. Upon receipt of a Sequencer signal, minimum leakage dampers close, shutting off air flow from all areas of the Auxiliary Building except for the rooms which contain safety related pumps [EIIS:P] which are part of the Emergency Core Cooling System (ECCS). Each of the two 100 percent capacity exhaust ducts will exhaust air from the pump rooms through the associated preheater/demister sections, filter trains, and fans to the Unit Vent until one train from each unit has been shut off administratively. This subsystem is Nuclear Safety Related.

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

The VE Vacuum Decay Time Test (PT/2/A/4450/03C Section 12.9) measures the time it takes the Annulus pressure to decay from -3.5 to -0.5 inches of water with the VE System secured. The test consists of drawing greater than 4 inches water vacuum in the Annulus, securing the VF System, and recording the vacuum decay time. The purpose of the test is to ensure that a proper Annulus decay time can be attained in greater than 85 seconds, as specified in the test acceptance criterion. Attaining the proper vacuum decay time in the required time frame verifies the Annulus pressure boundary integrity by ensuring that less than 2,000 scfm air in-leakage into the Annulus. Per the Catawba Final Safety Analysis Report (FSAR), this 2,000 scfm is the assumed value used to analyze the thermal effects of a LOCA and to calculate the on-site and off-site dose during a Post LOCA condition. Catawba Technical Specifications do not require a surveillance to ensure less than 2,000 scfm air in-leakage.

On February 28, 1990, Section 12.9 of PT/2/A/4450/03C was revised to allow repeating the Vacuum Decay Time Test under different VA and VF systems alignments in order to determine effects of VA/VF on the vacuum decay time. Additional changes to the test were made to include independent verification for installing, removing, and modifying instrumentation.

EVENT DESCRIPTION

On March 1, 1990, with Unit 2 in Mode 1, Power Operation, at 97% Reactor power, Performance Engineer A performed five test runs of PT/2/A/4450/03C Section 12.9, VE Vacuum Decay Time Test, to evaluate the effect of interacting ventilation systems on the VE System.

Test run #1 was performed with the Unit 1 and 2 Auxiliary Building Ventilation Systems (VA) and the Unit 2 Fuel Handling Ventilation System (VF) operating in the normal alignment. In this alignment the Unit 2 VE System vacuum decay time was 115.5 seconds; well above the 85 seconds required per the test acceptance criterion.

Test run #2 was performed with the Unit 1 and 2 VA Systems operating in the normal alignment and the Unit 2 VF System secured. In this alignment, the VE System vacuum decay time was 78 seconds; below the required 85 seconds specified in the test acceptance criterion.

At 1145 hours, Performance Engineer A notified the Control Room personnel that the VE System was inoperable due to its inability to meet the Vacuum Decay Time Test acceptance criterion. Control Room personnel immediately entered Technical Specification 3.0.3 for the VE System. Nuclear Operations Technicians (NOT) A de-energized and tagged the power supply breaker [EIIS:BRK] for each B Train VA Filtered Exhaust Fan (1B and 2B) per a VC/VA compensatory action sheet (reference LER 413/90-011). Subsequently, Performance and Maintenance personnel

immediately began sealing with tape potential air in-leakage paths in the Annulus and adjacent areas per Work Request 7403 PRF. Performance Engineer A then performed test run #3 with the VA and VF Systems in the post LOCA alignment (i.e., Train B of VA on Units 1 and 2 secured, Train A of VA on Units 1 and 2 operating in the Post LOCA Exhaust Mode, and Unit 2 VF secured). In this alignment, the VE System vacuum decay time was 114 seconds. This test was performed and passed within one hour after the previous test failed.

At 1255 hours, Performance notified Control Room personnel that the VE System was operable and had met the test acceptance criterion. Control Room personnel immediately declared the VE System operable and exited Technical Specification 3.0.3.

At 1330 hours, Operations issued a compensatory action sheet for the VE System to ensure operability. The compensatory action required Operation shift personnel to verify tape in the following areas once per shift: door AX715A (Upper Airlock); door AX714B (Fuel Pool to Upper Airlock); door AX416 (lower Annulus); and the floor area behind Motor Control Center PHP2D (560 elevation Electrical Penetration Room).

Subsequently, a cork seal located between the upper Annulus door and the CAD door to the upper personnel airlock was sealed and tape removed from door AX715A and door AX721, test run #4 was performed with VA and VF in the post LOCA alignment. In this alignment, the VE vacuum decay time was 105 seconds. Tape was then removed from door AX416 and test run #5 was performed. The VE System vacuum decay time was 94 seconds.

Performance Engineer A instructed Performance and Maintenance personnel to retape the following areas: door AX714B (on door seal); door AX715A (on door frame); door AX416 (on door frame); the floor area behind MCC PHP2D; and a cork seal along the wall located between the upper Annulus door and the CAD door to the upper personnel airlock. At 1650 hours, Performance updated the compensatory action sheet to reflect the taped areas.

From March 1 through 15, Maintenance personnel, using Work Requests 4862 SWR, 4865 SWR, and 4868 SWR, removed tape and repaired by caulking all the defective areas of the Annulus pressure boundary except door AX714B which could not be sealed further.

On March 16, 1990, Performance Engineer A performed seven test runs (Test Run #6 - #12)of the Vacuum Decay Time Test. Test run #6 was performed with the Unit 1 and 2 VA Systems and the Unit 2 VF System operating in the normal alignment. In this alignment, the VE vacuum decay time was 192 seconds; above the required 85 seconds.

Test run #7 was performed with the Units 1 and 2 VA Systems operating in the normal alignment and the Unit 2 VF System secured. In this alignment, the VE vacuum decay time was 135 seconds.

Test run #8 was performed with the VA and VF Systems in the post LOCA alignment. In this alignment, the VE vacuum decay time was 114 seconds. This vacuum decay time was above the time recorded during test run #3 performed on March 1.

Test run #9 was performed with the Units 1 and 2 VA Systems and the Unit 2 VF System secured. In this alignment, the VE vacuum decay time was 120 seconds.

Test run #10 was performed with the Unit 1 and Unit 2 VA Systems and the Unit 2 VF System in the post LOCA alignment. This test run was performed to verify the results of test run #8. The VE vacuum decay time was 116 seconds; two seconds more than the 114 seconds recorded per test run #8.

Performance personnel removed tape from door AX714B. With the VA and VF Systems still aligned in the post LOCA alignment, test run #11 was performed. In this alignment, the VE vacuum decay time was 113 seconds.

The final test (test run #12) was performed to verify the results obtained during test run #11 (VA and VF Systems in the post LOCA alignment). The VE vacuum decay time was again 113 seconds.

The VE compensatory action sheet, issued on March 1 to verify tape in the Annulus pressure boundary area, was removed.

CONCLUSION

This incident is attributed to not fully understanding the interaction between VE and VA/VF. This allowed the Annulus Vacuum Decay Time Test to be performed in an alignment that was not the most conservative; the test failed on March 1, 1990 when performed with VA and VF in their accident alignment. Testing on March 16, 1990, after boundary repairs, confirmed acceptable air in-leakage and yielded decay times greater than 85 seconds, including tests run with VA and VF in their accident alignment.

A thorough understanding of the VE design bases, including the effects of different system alignments and environmental factors, would have led to more conservative test conditions.

Corrective actions included using Work Requests 7403 PRF, 4862 SWR, 4865 SWR, and 4868 SWR to repair and seal by caulking the defective areas of the Annulus pressure boundary to reduce air in-leakage. These efforts were successful to the point where test results obtained after the Annulus pressure boundary was sealed indicated that the vacuum decay time increased substantially.

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Another subsequent corrective action involved the PIR evaluation of the 78 and 57 second vacuum decay times as possible unanalyzed conditions. Design Engineering evaluation used the 78 and 57 seconds to calculate on-site and off-site dose values and determined that FSAR dose values changed but regulatory limits were not exceeded.

A review of past Vacuum Decay Time Tests for Units 1 and 2 revealed the following:

1) On May 17, 1989, a vacuum decay time of 71 seconds resulted in inoperability of the Unit 2 VE System. Unit 2 was in Mode 5 and no T/S action statement was applicable. Subsequent action was taken to seal the Annulus boundary by adjusting dampers, repairing a breach in the Equipment Hatch boot seal and replacing several door seals. On May 19, the test was performed again with acceptable results (104 seconds).

2) Unit 1 VE Vacuum Decay Time Test results were reviewed and all exceeced 92 seconds, ranging from 96 to 140 seconds..

A review of the OEP database for the past 24 months identified two previous incidents where unanticipated system interaction affected a ventilation system (LER 414/89-020 and 413/90-011). LER 414/89-020 involved the inoperability of the VA System due to the induction of lint from the Radiation Protection clothes dryers into the VA Filtered Exhaust Subsystem; causing an air flow monitor to clog. A Technical Specification violation occurred due to not recognizing the condition and taking appropriate action within the Technical Specification action statement requirements. Lint induction into the VA System is being controlled by increased preventive maintenance and inspections. A permanent solution is being developed by Design Engineering. LER 413/90-011 involved the inoperability of the VC System due to its inability to maintain a positive Control Room pressure with the VA System in an abnormal alignment. Compensatory actions are taken to ensure VC System operability whenever the VA System is placed in an abnormal alignment.

Technical Specification violations involving ventilation systems are a recurring problem, and to deal with this, an extensive review is currently in progress at Catawba to verify that ventilation system testing is meeting the intent of Technical Specifications, the Final Safety Analysis Report (FSAR), and Regulatory Guides dealing with ventilation systems. In LER 414/89-020, a comprehensive response was described to deal with ventilation system problems involving design deficiencies. Parts of the comprehensive response will ensure that ventilation testing is meeting design requirements (i.e., Performance,

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Operations and Design Engineering will review available plant parameters for addition to the Performance Monitoring Database System to enhance the analysis and trending of ventilation systems performance data). Also, Design Engineering will perform a thorough and systematic review of ventilation system design requirements and compare them against nominal operating data to ensure consistency with the FSAR and Technical Specification parameters.

CORRECTIVE ACTION

SUBSEQUENT

1) On March 1, 1990, Work Request 7403 PRF was used to allow Performance and Maintenance personnel to tape the following defective areas of the Annulus pressure boundary: door AX714B (Fuel Pool to Upper Personnel Airlock) on door seal; door AX715A (CAD door to Upper Personnel Airlock) on door frame and seal; door AX721 (Upper Annulus) on door seal; door AX416 (Lower Annulus) on door frame and seal; floor area behind MCC PHP2D (560 elevation electrical penetration room); and cork seal located between the upper Annulus door and the CAD door to the Upper Personnel Airlock.

2) On March 1, PIR 2-C90-0072 was written to request Design Engineering evaluation of the 78 seconds VE vacuum decay time recorded in test run #2 on 3/1/90. Design Engineering evaluation will determine if on-site and off-site dose limits as specified in the FSAR would have been exceeded.

3) On March 1, a compensatory action sheet generated to verify, once per shift, the taped areas of the Annulus pressure boundary to ensure VE System operability.

4) From March 1 through 15, per Work Requests 4862 SWR, 4865 SWR, and 4868 SWR, Maintenance performed the necessary caulking repair work to seal the defective areas of the Annulus pressure boundary.

5) On March 16, 1990, Performance retested the Unit 2 VE System by performing the VE Vacuum Decay Time Test after known defective areas of the Annulus pressure boundary were repaired.

PLANNED

1) The need to perform visual inspections and testing of the Annulus pressure boundary to identify and repair defective areas will be evaluated.

2) The necessary procedural changes to the VE Vacuum Decay Time Test to ensure the VE System is tested in the most conservative VA/VF alignment will be implemented.

3) An extensive review of ventilation systems and associated procedures is currently in progress at CNS which will verify that ventilation system testing is meeting the intent of Technical Specifications, the FSAR, and Regulatory Guides. This item will be complete when all necessary systems have been reviewed.

4) Performance, Operations, and Design Engineering will review available plant parameters for addition to the Performance Monitoring Database system to enhance the analysis and trending of ventilation systems (as well as other systems) performance data (from Planned Corrective Action 13, LER 414/89-020).

5) Design Engineering has initiated a thorough and systematic review of ventilation system design requirements and compare them against nominal operating data to ensure consistency with the FSAR and Technical Specification parameters (from Planned Corrective Action 14, LER 414/89-020).

SAFETY ANALYSIS

The VE System is an engineered safety feature and is activated by the Safety Injection signal (Ss). Upon receipt of this signal, the recirculation and discharge dampers are aligned to exhaust a large volume of air to the Unit Vent until the Annulus pressure is negative. The dampers then modulate to exhaust air as required to maintain the Annulus negative pressure.

Performance tests the VE System per PT/2/A/4450/03C (VE Performance Test) at least every 18 months to ensure the operability of the system. Section 12.9 (Vacuum Decay Time Test) is used to ensure the system is capable of attaining a proper vacuum decay time in greater than 85 seconds; thus ensuring less than 2,000 scfm air in-leakage into the Annulus. The 2,000 scfm air in-leakage is the assumed value used to calculate dose for the post LOCA conditions.

During test run #2 on March 1, 1990, a 78 second vacuum decay time was recorded. This may have presented an unanalyzed condition. PIR 2-C90-0072 was written for Design Engineering evaluation. Design Engineering calculated the dose impact associated with the 78 seconds Annulus pressure decay time as opposed to the 85 seconds. Their assessment calculation focused on thyroid dose since it tends to be the controlling dose in accident analyses. The results indicated that FSAR dose values would be exceeded but are well within the regulatory limits, as shown below:

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Dose Assessment Using 78 Seconds Vacuum Decay Time

Parameter	1989 FSAR Dose Values	Calculated Dose	NRC Dose Limits
Control Room Thyroid	20 rem	20 rem	30 rem
Off-Site Thyroid (Exclusion Area Boundary)	150 rem	152 rem	300 rem

Performance evaluated the 21 seconds difference in vacuum decay times obtained during test run #7 (VA operating in normal alignment and VF secured) and #8 (VA and VF in the Post LOCA alignment) on March 16. Because Performance Engineers did not test in the Post LOCA alignment prior to taping defective areas of the Annulus boundary on March 1, a decision was made to subtract 21 seconds from the 78 seconds vacuum decay time and request a Design Engineering evaluation. Design Engineering calculated the dose impact associated with the 57 seconds vacuum decay time as opposed to the 78 seconds. Again the results indicated the FSAR dose values would be exceeded but are within the the regulatory limits, as shown below:

Dose Assessment Using the 57 Seconds Vacuum Decay Time

Parameter	1989 FSAR Dose Values	Calculated Dose	NRC Dose Limits
Control Room	20 rem	21 rem	30 rem
Offsite	150 rem	182 rem	300 rem

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

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