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SUBJECT: Forwards addl info re effect of DC power supply failure on ECCS performance,per J Stefano 881128 request.

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December 19, 1988

10 CFR Part 50
Appendix K

Director of Nuclear Reactor Regulation
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MONTICELLO NUCLEAR GENERATING PLANT
DOCKET NO. 50-263 LICENSE NO. DPR-22

Evaluation of Probability of DC Power Supply
Failure Affecting ECCS Performance (TAC No. 71092)

References: (1) Letter dated November 28, 1988 from John Stefano (NRC) to D M Musolf (NSP) concerning: "Effect of DC Power Supply Failure on Monticello ECCS Performance (TAC No. 71092)

(2) Letter dated October 4, 1988 from David Musolf (NSP) to the Director of NRR titled: "Effect of a DC Supply Failure on ECCS Performance"

(3) Letter dated October 20, 1988 from David Musolf (NSP) to the Director of NRR titled: "Additional Information concerning the Effect of a DC Supply Failure on ECCS Performance"

The purpose of this letter is to provide additional information related to the effect of a DC power supply failure on ECCS performance as requested in Reference (1). The attached report provides the analysis supporting our statement in References (2) and (3) that a coincident Loss of Coolant Accident, Loss of Offsite Power, and DC power supply failure is a low probability event. The report concludes that the total probability is approximately 7×10^{-11} per year for this event.

The following related actions will also be completed:

1) Submit proposed DC power supply design modification for NRC approval prior to February 15, 1989.

2) Install the NRC approved modification during the next refueling outage.

A001

3) Perform a review of other passive electrical failures effect on LOCA analysis. This will be done as part of the Monticello Probabilistic Risk Assessment.

Please contact us if you have any questions related to this issue.

David Musolf

David Musolf
Manager Nuclear Support Services

c: Regional Administrator-III, NRC
NRR Project Manager, NRC
Sr Resident Inspector, NRC
G Charnoff

Attachment

MONTICELLO NUCLEAR GENERATING PLANT

A PROBABILITY ANALYSIS OF THE LOSS OF DC POWER SUPPLY FAILURE ON ECCS ANALYSIS

Large Break LOCA

Scenarios involving a loss of offsite power and additional failures are shown on Table 1 for the Large Break LOCA. Failures other than loss of 125 VDC are shown for comparison. Table 2 identifies the ECCS equipment available for each of the scenarios listed in Table 1.

Our current ECCS analysis assumed the worst single failure to be the failure of the selected injection valve to open with a loss of offsite power (Table 1 Case 3). Case Nos 9 and 12 would only have one core spray pump available. These two cases are further described below.

Case No 9 and 12 involve a large break LOCA with the loss of one division of 125 VDC bus, a loss of offsite power and Low Pressure Coolant Injection (LPCI) Loop Selection Logic selecting the loop without 125 VDC control power. In these cases, the plant would have only one low pressure pump injecting until manual action could be taken. The loss of a division's 125 VDC bus causes a loss of breaker control power to all equipment associated with that division including ability to automatically transfer the supply for that division's LPCI injection valves. If the LPCI Loop Selection logic selects the LPCI injection valve powered from the division without 125 VDC power, only one low pressure pump will be available for injection, i.e., the core spray pump powered from the division with 125 VDC power. Two RHR pumps would be available if the injection valve can be supplied with 480 V power. If the LPCI Loop Selection logic selects the LPCI injection valve powered from the division with 125 VDC power, two RHR pumps and one core spray pump will inject.

Probability of a Loss of Offsite Power

This analysis will consider a loss of offsite power anytime during the 24 hours following the LOCA to be of concern:

Probability of a Loss of Offsite Power per day	x	1 day	=	Probability of a Loss of Offsite Power during the event
(2.2×10^{-4})	x	1	=	(2.2×10^{-4})

Probability of a Loss of 125 VDC Power

This analysis will consider a loss of 125 VDC power anytime during the 24 hours following the LOCA to be of concern:

Probability of a Loss of 125 VDC per	x	1 day	=	Probability of a Loss of 125 VDC Power during the event
(9×10^{-4})	x	1 day	=	(9×10^{-4})

Case No. 9

Probability of a Large Break LOCA per year	x	Probability of a Loss of Offsite Power	x	Probability of a Loss of 125 VDC	x	Probability of Loss of Division I 125 VDC	x	Probability of LPCI loop selection logic select Division I Valve		
(7×10^{-4})	x	(2.2×10^{-4})	x	(9×10^{-4})	x	(0.5)	x	(0.5)	=	

3.5×10^{-11} per year

Case No. 12

Probability of a Large Break LOCA per year	x	Probability of a Loss of Offsite Power	x	Probability of a Loss of 125 VDC	x	Probability of Loss of Division II 125 VDC	x	Probability of LPCI loop selection logic select Division II Valve		
(7×10^{-4})	x	(2.2×10^{-4})	x	(9×10^{-4})	x	(0.5)	x	(0.5)	=	

3.5×10^{-11} per year

If the break occurs in one of the recirculation loops, the LPCI loop selection logic will select the intact recirculation loop for the RHR pumps to inject into. If the break occurs outside the Recirculation System, the

LPCI loop selection logic could select either loop. The factor of 0.5 accounts for the probability of the LPCI loop selection logic selecting the LPCI injection valve in the division with the loss of 125 VDC control power.

If the loss of one division's 125 VDC power occurs after the loss of offsite power, no problem will exist as the Diesel Generator supply breakers, powered from 125 VDC, will have closed and both divisions injection valves will have power. The above probability calculation does not specify the order of loss of one division's DC power and offsite power. The above calculation accounts for the possibility of loosing one division's 125 VDC power in a 24 hour period following the LOCA or having lost that division's 125 VDC power prior to the LOCA. The offsite power could have been lost anytime within the 24 hours following the LOCA. The probability calculation is conservative in this respect.

Core Spray Line Break

The core spray line inside the drywell is a special case as the break prevents one core spray pump from injecting into the vessel.

Scenarios of interest are shown on Table 3 for the Core Spray Line Break LOCA. Table 4 identifies the ECCS equipment available for each of the scenarios listed in Table 3. The core spray line break depressurizes the reactor in roughly 5 minutes. High Pressure Coolant Injection (HPCI) and Automatic Depressurization System (ADS) do play a role in this transient. ADS is available in all scenarios shown on Table 3, but is not listed as equipment available in Table 4 since it is available in all situations.

The availability of HPCI depends upon the availability of Division II 125 VDC.

Past LOCA sensitivities studies have shown that if 2 RHR pumps and one train of ADS are operable for a core spray line break, the peak clad temperature will not exceed 700°F. The case where one core spray pump, HPCI and one train of ADS are operable was not run by General Electric as it was considered to be bounded by the case with 2 RHR pumps and ADS available. The following cases are not bounded by past LOCA analysis: 22, 41 and 44. The probability of these cases occurring will be discussed below.

If the break occurs inside containment in core spray line of the opposite division as the loss of 125 VDC supply power, neither core spray pump would be available for low pressure injection. One core spray pump would pump to the break and the other's breaker would have no control power. If the LPCI Loop Selection logic selects the LPCI injection valve powered from the division without 125 VDC power, the RHR pumps would not be available until the swing bus could be manually transferred.

Probability of a Pipe Rupture per 10 foot section per hour	x	Number of Hours per year	=	Probability of a Pipe Rupture per 10 foot section per year
(8.6×10^{-10})	x	(6.57×10^{3})	=	5.7×10^{-6}

Simultaneous Core Spray Line Break and Loss of Offsite Power:

Probability of a Pipe Rupture per 10 foot section per year x Number of 10 foot Sections of Core Spray Pipe between The Reactor Vessel and the injection check valve in one division x Probability of a Loss of Offsite Power

$(5.7 \times 10^{-6}) \times (2) \times (2.2 \times 10^{-4}) =$

$2.5 \times 10^{-9} = P_a$

Case No. 22

Probability of a Loss of 125 VDC x Probability of Loss Division II 125 VDC x Probability of LPCI loop selection logic selecting Division II valve x P_a =

$(9 \times 10^{-4}) \times (0.5) \times (0.5) \times (2.5 \times 10^{-9}) =$

5.6×10^{-13} per year = P_{22}

Case No. 41

Probability of a Loss of 125 VDC x Probability of Loss Division I 125 VDC x Probability of LPCI loop selection logic selecting Division I valve x P_a =

$(9 \times 10^{-4}) \times (0.5) \times (0.5) \times (2.5 \times 10^{-9}) =$

5.6×10^{-13} per year = P_{41}

Case No. 44

Probability of a Loss of 125 VDC x Probability of Loss Division II 125 VDC x Probability of LPCI loop selection logic selecting Division II valve x P_a =

$(9 \times 10^{-4}) \times (0.5) \times (0.5) \times (2.5 \times 10^{-9}) =$

5.6×10^{-13} per year = P_{42}

Total Probability:

$$P_9 + P_{12} + P_{22} + P_{41} + P_{44} = \text{Total Probability}$$

$$3.5 \times 10^{-11} + 3.5 \times 10^{-11} + 5.6 \times 10^{-13} + 5.6 \times 10^{-13} + 5.6 \times 10^{-13} =$$

$$7.2 + 10^{-11} \text{ per year} \simeq 7 \times 10^{-11} \text{ per year}$$

This analysis was done using probabilities from the Monticello Individual Plant Evaluation (IPE) which is based on the Industry Degraded Core Rulemaking Group (IDCOR) IPE methodology. Plant specific data is used from the IPE when available. The Monticello IPE assumes one RHR pump or one core spray pump is sufficient to prevent core damage after a LOCA. This is based on General Electric Topical Report NEDO-24708.

The Monticello IPE concluded the overall core damage frequency to be 1.5E-5/year. Generally, sequences with a frequency less than 1E-7/year will not have a significant impact on the IPE results. Therefore, operation of Monticello for the next 9 months, when the plant will be modified to eliminate these scenarios, will not have a significant effect on safety.

However, in the unlikely event one of these scenarios did occur, plant procedures have been issued to restore power to the de-energized bus that supplies the LPCI injection valve. Operators have been trained in the use of these procedures.

TABLE 1

LARGE BREAK LOCA RECIRCULATION SUCTION PIPE

FAILURE COMBINATIONS CONSIDERED

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
1										

NOTE: THE FOLLOWING CASES ASSUME A LOSS OF OFFSITE POWER

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
2										
3			X							
4				X						
5					X				X	
6					X					X
7						X			X	
8						X				X
9							X		X	
10							X			X
11								X	X	
12								X		X

NOTE: CS = Core Spray, LPCI = Low Pressure Coolant Injection
LSL = Loop Selection Logic, D/G = Emergency Diesel Generator

TABLE 2

LARGE BREAK LOCA RECIRCULATION SUCTION PIPE
EQUIPMENT AVAILABLE FOR SPECIFIC FAILURE COMBINATIONS

Case No	Additional Failures	Low Pressure ECCS Equipment Available
1	None	2 CS + 4 RHR
2	Loss of Offsite Power	2 CS + 4 RHR
3	Loss of Offsite Power and Loss of Div I D/G	1 CS + 2 RHR
4	Loss of Offsite Power and Loss of Div II D/G	1 CS + 2 RHR
	Loss of Offsite Power and Loss of Div I LPCI Injection valve and:	
5	LPCI Loop selection logic selects Div I injection valve	2 CS
6	LPCI Loop selection logic selects Div II injection valve	2 CS + 4 RHR
	Loss of Offsite Power and Loss of Div II LPCI Injection valve and:	
7	LPCI Loop selection logic selects Div I injection valve	2 CS + 4 RHR
8	LPCI Loop selection logic selects Div II injection valve	2 CS
	Loss of Offsite Power and Loss of Div I 125 DC Power and:	
9	LPCI Loop selection logic selects Div I injection valve	1 CS
10	LPCI Loop selection logic selects Div II injection valve	1 CS + 2 RHR
	Loss of Offsite Power and Loss of Div II 125 DC Power and:	
11	LPCI Loop selection logic selects Div I injection valve	1 CS + 2 RHR
12	LPCI Loop selection logic selects Div II injection valve	1 CS

Note: CS = Core Spray Pump, RHR = Residual Heat Removal Pumps or LPCI pumps
LPCI = Low Pressure Coolant Injection, D/G = Emergency Diesel Generator

TABLE 3

CORE SPRAY LINE BREAK INSIDE THE DRYWELL

FAILURE COMBINATIONS CONSIDERED

NOTE: THE FOLLOWING CASES ASSUME A DIVISION I CORE SPRAY LINE BREAK

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
1										
2		X								
3					X				X	
4					X					X
5						X			X	
6						X				X
7							X		X	
8							X			X
9								X	X	
10								X		X

NOTE: THE FOLLOWING CASES ASSUME A DIVISION I CORE SPRAY LINE BREAK AND A LOSS OF OFFSITE POWER

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
11										
12		X								
13			X							
14				X						
15					X				X	
16					X					X
17						X			X	
18						X				X
19							X		X	
20							X			X
21								X	X	
22								X		X

NOTE: CS = Core Spray, LPCI = Low Pressure Coolant Injection
LSL = Loop Selection Logic, D/G = Emergency Diesel Generator

TABLE 3

Page 2

CORE SPRAY LINE BREAK INSIDE THE DRYWELL

FAILURE COMBINATIONS CONSIDERED

NOTE: THE FOLLOWING CASES ASSUME A DIVISION II CORE SPRAY LINE BREAK

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
23										
24	X									
25					X				X	
26					X					X
27						X			X	
28						X				X
29							X		X	
30							X			X
31								X	X	
32								X		X

NOTE: THE FOLLOWING CASES ASSUME A DIVISION II CORE SPRAY LINE BREAK AND A LOSS OF OFFSITE POWER

	Div I CS Pump	Div II CS Pump	Div I D/G	Div II D/G	Div I Inj Valve	Div II Inj Valve	Div I 125 VDC	Div II 125 VDC	LPCI LSL Div I Valve	LPCI LSL Div II Valve
33										
34	X									
35			X							
36				X						
37					X				X	
38					X					X
39						X			X	
40						X				X
41							X		X	
42							X			X
43								X	X	
44								X		X

NOTE: CS = Core Spray, LPCI = Low Pressure Coolant Injection
LSL = Loop Selection Logic, D/G = Emergency Diesel Generator

TABLE 4

CORE SPRAY LINE BREAK INSIDE THE DRYWELL
EQUIPMENT AVAILABLE FOR SPECIFIC FAILURE COMBINATIONS

Case No	Additional Failures to a Division I Core Spray Line Break	ECCS Equipment Available*
1	None	1 CS + 4 RHR + HPCI
2	Loss of Div II Core Spray Pump	4 RHR + HPCI
	Loss of Div I LPCI Injection valve and:	
3	LPCI Loop selection logic selects Div I injection valve	1 CS + HPCI
4	LPCI Loop selection logic selects Div II injection valve	1 CS + 4 RHR +HPCI
	Loss of Div II LPCI Injection valve and:	
5	LPCI Loop selection logic selects Div I injection valve	1 CS + 4 RHR + HPCI
6	LPCI Loop selection logic selects Div II injection valve	1 CS + HPCI
	Loss of Div I 125 DC Power and:	
7	LPCI Loop selection logic selects Div I injection valve	1 CS + 2 RHR + HPCI
8	LPCI Loop selection logic selects Div II injection valve	1 CS + 2 RHR + HPCI
	Loss of Div II 125 DC Power and	
9	LPCI Loop selection logic selects Div I injection valve	2 RHR
10	LPCI Loop selection logic selects Div II injection valve	2 RHR

* ADS is not included since it will be available in all cases.

Note: CS = Core Spray Pump, RHR = Residual Heat Removal Pumps or LPCI pumps
LPCI = Low Pressure Coolant Injection, D/G = Emergency Diesel Generator

TABLE 4

Page 2

CORE SPRAY LINE BREAK INSIDE THE DRYWELL

Case No	Additional Failures to a Division I Core Spray Line Break	ECCS Equipment Available
11	Loss of Offsite Power	1 CS + 4 RHR + HPCI
12	Loss of Offsite Power and Loss of Div II Core Spray Pump	4 RHR + HPCI
13	Loss of Offsite Power and Loss Div I D/G	1 CS + 2 RHR + HPCI
14	Loss of Offsite Power and Loss Div II D/G	2 RHR + HPCI
	Loss of Offsite Power and Loss of Div I LPCI Injection valve and:	
15	LPCI Loop selection logic selects Div I injection valve	1 CS + HPCI
16	LPCI Loop selection logic selects Div II injection valve	1 CS + 4 RHR + HPCI
	Loss of Offsite Power and Loss of Div II LPCI Injection valve and:	
17	LPCI Loop selection logic selects Div I injection valve	1 CS + 4 RHR + HPCI
18	LPCI Loop selection logic selects Div II injection valve	1 CS + HPCI
	Loss of Offsite Power and Loss of Div I 125 DC Power and:	
19	LPCI Loop selection logic selects Div I injection valve	1 CS + HPCI
20	LPCI Loop selection logic selects Div II injection valve	1 CS + 2 RHR + HPCI
	Loss of Offsite Power and Loss of Div II 125 DC Power and:	
21	LPCI Loop selection logic selects Div I injection valve	2 RHR
22	LPCI Loop selection logic selects Div II injection valve	None

TABLE 4

Page 3

CORE SPRAY LINE BREAK INSIDE THE DRYWELL

Case No	Additional Failures to a Division II Core Spray Line Break	ECCS Equipment Available
23	None	1 CS + 4 RHR + HPCI
24	Loss of Div I Core Spray Pump	4 RHR + HPCI
	Loss of Div I LPCI Injection valve and:	
25	LPCI Loop selection logic selects Div I injection valve	1 CS + HPCI
26	LPCI Loop selection logic selects Div II injection valve	1 CS + 4 RHR +HPCI
	Loss of Div II LPCI Injection valve and:	
27	LPCI Loop selection logic selects Div I injection valve	1 CS + 4 RHR + HPCI
28	LPCI Loop selection logic selects Div II injection valve	1 CS + HPCI
	Loss of Div I 125 DC Power and:	
29	LPCI Loop selection logic selects Div I injection valve	2 RHR + HPCI
30	LPCI Loop selection logic selects Div II injection valve	2 RHR + HPCI
	Loss of Div II 125 DC Power and	
31	LPCI Loop selection logic selects Div I injection valve	1 CS + 2 RHR
32	LPCI Loop selection logic selects Div II injection valve	1 CS + 2 RHR

CORE SPRAY LINE BREAK INSIDE THE DRYWELL

Case No	Additional Failures to a Division II Core Spray Line Break	ECCS Equipment Available
33	Loss of Offsite Power	1 CS + 4 RHR + HPCI
34	Loss of Offsite Power and Loss of Div I Core Spray Pump	4 RHR + HPCI
35	Loss of Offsite Power and Loss Div I D/G	2 RHR + HPCI
36	Loss of Offsite Power and Loss Div II D/G	1 CS + 2 RHR + HPCI
	Loss of Offsite Power and Loss of Div I LPCI Injection valve and:	
37	LPCI Loop selection logic selects Div I injection valve	1 CS + HPCI
38	LPCI Loop selection logic selects Div II injection valve	1 CS + 4 RHR + HPCI
	Loss of Offsite Power and Loss of Div II LPCI Injection valve and:	
39	LPCI Loop selection logic selects Div I injection valve	1 CS + 4 RHR + HPCI
40	LPCI Loop selection logic selects Div II injection valve	1 CS + HPCI
	Loss of Offsite Power and Loss of Div I 125 DC Power and:	
41	LPCI Loop selection logic selects Div I injection valve	HPCI
42	LPCI Loop selection logic selects Div II injection valve	2 RHR + HPCI
	Loss of Offsite Power and Loss of Div II 125 DC Power and:	
43	LPCI Loop selection logic selects Div I injection valve	1 CS + 2 RHR
44	LPCI Loop selection logic selects Div II injection valve	1 CS