UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

April 9, 1993

NRC INFORMATION NOTICE 93-28: FAILURE TO CONSIDER LOSS OF DC BUS IN THE EMERGENCY CORE COOLING SYSTEM EVALUATION MAY LEAD TO NONCONSERVATIVE ANALYSIS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees that a single failure of a 125-Vdc bus has been identified as potentially the worst case single failure in the emergency core cooling system (ECCS) evaluation for certain boiling water reactors (BWR-3 and BWR-4). It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On July 30, 1992, the Nebraska Public Power District, licensee for the Cooper Nuclear Station, notified the NRC that the worst case single failure in the ECCS had not been correctly identified in the analysis of the loss-of-coolant accident (LOCA) in conjunction with a loss of offsite power. To satisfy regulatory requirements, the most limiting single failure, which results in the most severe calculated consequences, must be considered in performing the LOCA analysis. The previous licensee analysis assumed that the worst case single failure was a failure of the low pressure coolant injection (LPCI) system injection valve in the ECCS train that is connected to one recirculation loop, concurrent with a pipe break in the other recirculation loop. In July 1992, the licensee recognized that failure of a 125-Vdc bus that provides the control power for the LPCI injection valve serving the unbroken recirculation loop is the worst single failure for this accident. The licensee discovered the problem while performing a plant design basis reconstitution.

Discussion

The low-pressure trains of the ECCS are shown conceptually in Figures 1 and 2. Trains A and B each include a core spray pump and two residual heat removal (RHR) pumps that function as LPCI pumps during a LOCA. The two RHR pumps in

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each train share common piping and a common injection valve to the associated recirculation loop. When offsite power is lost, two emergency diesel generators (EDGs) supply power to the pump motors and two 250-V batteries supply motive power to the valve motors. Two 125-V batteries provide control power to the valve motors and the output circuit breakers for the EDGs.

In the previous ECCS analysis, as shown in Figure 1, the licensee assumed a guillotine break in one recirculation loop and failure of the LPCI injection valve for the other recirculation loop. If this event were to occur, coolant from RHR pumps B1 and B2 would not reach the reactor vessel because the coolant would flow out through the broken recirculation loop, and RHR pumps A1 and A2 would not pump coolant to the reactor vessel because of the failure of the LPCI injection valve to open. However, it was concluded that both core spray pumps would pump coolant to the reactor vessel and the temperature of fuel cladding would increase but remain less than the regulatory limit.

The licensee has now determined that the worst single failure would be the failure of one of the two 125-Vdc buses. As shown in Figure 2, failure of the 125-Vdc bus for train A would prevent closure of the output breaker for EDG A. Motors for RHR pumps A1 and B2 and core spray pump A would not receive emergency power and would not supply coolant to the reactor vessel. Likewise, the LPCI injection valve for recirculation loop A would fail to open and RHR pump A2, which receives power from EDG B, would be unable to pump coolant to the reactor vessel. If the break were in recirculation loop B, then RHR pump B1 would pump coolant to the broken loop, leaving only core spray pump B to pump coolant to the reactor vessel, which is insufficient to perform the intended ECCS function. To avoid the possibility that the temperature of the fuel cladding might exceed the regulatory limit, the licensee reduced the reactor power level pending completion of modifications to correct the problem. The licensee took this action based on analyses by the General Electric Company.

Although the combined probability of occurrence of a guillotine rupture, loss of offsite power, and failure of the 125-Vdc bus for the ECCS train serving the intact recirculation loop is very low, the licensee has modified the control power for the LPCI injection valves and recirculation pump discharge valves so that they are powered from the 250-Vdc buses, while leaving the 125-Vdc control power for the EDG output breakers unchanged.

Related Generic Communications

The General Electric Company submitted a report to the NRC as an attachment to a letter dated November 1, 1978, addressing the effect of a failure of a direct current power supply on BWR-3 and BWR-4 reactors. General Electric concluded that peak cladding temperature would be greater than previously anticipated for a small break LOCA, but less than the regulatory limit, and that the peak clad temperature would be unaffected for large breaks. The report indicated that at least two ECCS pumps would be available.

The NRC sent letters to licensees on April 25, 1980, requesting that addressees confirm the validity of the conclusions made by the General Electric report. The letters asked that responses include lists of ECCS equipment that would be available for breaks in the suction and discharge piping connected to pumps in the recirculation loops. Based on the recent analysis performed at Cooper, the conclusion in the General Electric report that at least two ECCS pumps would remain available may not be true for all scenarios involving direct current power supply failure.

The NRC recently issued Information Notice 93-11, "Single Failure Vulnerability of Engineered Safety Features Actuation Systems," to alert licensees to a design deficiency identified at Millstone Nuclear Power Station, Unit 2, that causes a spurious engineered safety feature actuation when one train of DC electrical power is deenergized. In addition, in Generic Letter 89-18, "Systems Interactions in Nuclear Power Plants," the NRC highlighted concerns regarding actuation system designs, including electrical power system designs, that could cause adverse system interactions.

This information notice requires no specific action or written response. If you have any question about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Brian Grimes

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contacts: David L. Skeen, NRR
(301) 504-1174

Elmo E. Collins, RIV
(817) 860-8291

Attachments: Filed in Jacket
1. Figure 1: Low Pressure ECCS Trains...
   Figure 2: Break in Recirculation Loop...
2. List of Recently Issued Information Notices

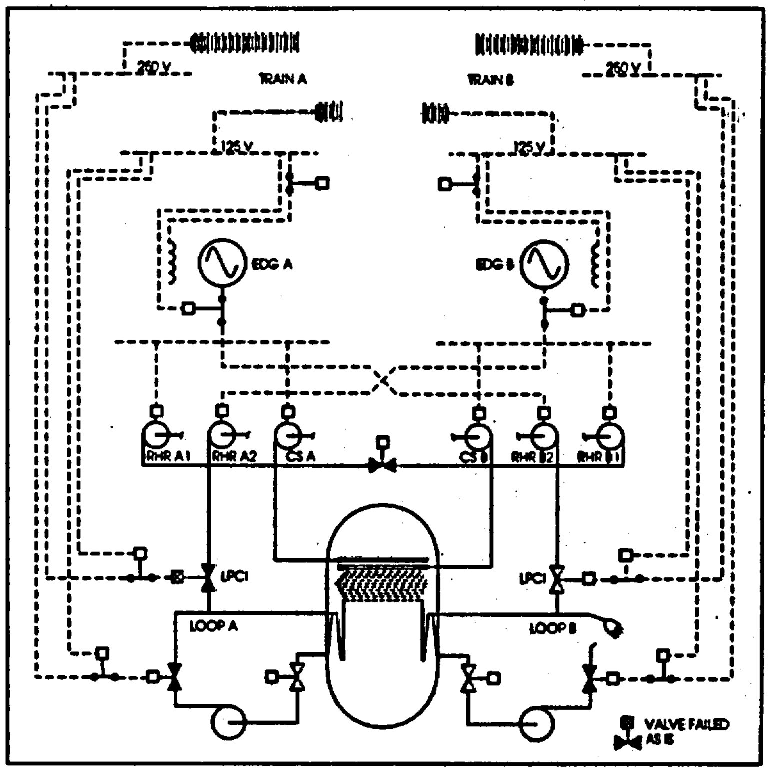

Figure 1: Low pressure ECCS trains showing break in recirculation loop B with loss of offsite power and failure of the 'A' LPCI injection value.

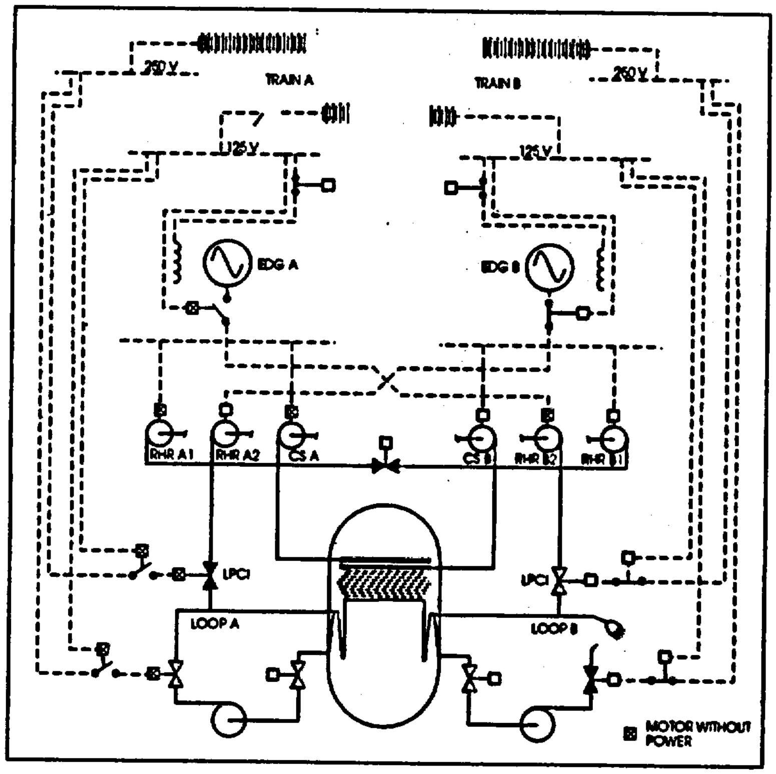

Figure 2: Break in recirculation loop B with loss of offsite power and one 125-Vdc bus.

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-27	Level Instrumentation Inaccuracies Observed during Normal Plant Depressurization	04/08/93	All holders of OLs or CPs for nuclear power reactors.
93-26	Grease Solidification Causes Molded Case Circuit Breaker Failure to Close	04/07/93	All holders of OLs or CPs for nuclear power reactors.
93-25	Electrical Penetration Assembly Degradation	04/01/93	All holders of OLs or CPs for nuclear power reactors.
93-24	Distribution of Revision 7 of NUREG-1021, "Operator Licensing Examiner Standards"	03/31/93	All holders of operator and senior operator licenses at nuclear power reactors.
93-23	Weschler Instruments Model 252 Switchboard Meters	03/31/93	All holders of OLs or CPs for nuclear power reactors.
93-22	Tripping of Klockner-Moeller Molded-Case Circuit Breakers due to Support Level Failure	03/26/93	All holders of OLs or CPs for nuclear power reactors.
93-21	Summary of NRC Staff Observations Compiled during Engineering Audits or Inspections of Licensee Erosion/Corrosion Programs	03/25/93	All holders of OLs or CPs for light water nuclear power reactors.
93-20	Thermal Fatigue Cracking of Feedwater Piping to Steam Generators	03/24/93	All holders of OLs or CPs for PWRs supplied by Westinghouse or Combustion Engineering.
93-19	Slab Hopper Bulging	03/17/92	All nuclear fuel cycle licensees.

OL = Operating License
CP = Construction Permit

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Original signed by
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Attachments:
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   Figure 2: Break in Recirculation Loop...
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* SEE PREVIOUS CONCURRENCES

OEAB	SC:DRP:RIV	RPB:ADM	SC:OEAB	PM:PD41	D:DRP:RIV
RWWoodruff*	EECollins*	JDMain*	RLDennig*	RBBevan*	ABBeach*
02/04/93	02/04/93	11/17/92	02/04/93	01/26/93	02/04/93
C:EELB	C:SRXB	C:OEAB	OGCB	C:OGCB	D:DORS
CHBerlinger*	RCJones*	AEChaffee*	JBirmingham*	GHMarcus*	BKGrimes
02/10/93	02/19/93	02/22/93	03/01/93	03/01/93	04/7 /93

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02/04/93	02/04/93	11/17/92	02/04/93	01/26/93	02/04/93
C:EELB	C:SRXB	C:OEAB	OGCB	C:OGCB	D:DORS
CHBerlinger*	RCJones*	AEChaffee*	JBirmingham*	GHMarcus*	BKGrimes
02/10/93	02/19/93	02/22/93	03/01/93	03/01/93	/ /93

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4/8/93

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Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contacts: Roger W. Woodruff, NRR
(301) 504-1152 new or old number

Elmo E. Collins, RIV
(817) 860-8291

Attachment: 1. Figure 1: Low Pressure ECCS Trains...
Figure 2: Break in Recirculation Loop... X
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	per telephone with DLS				per telephone with DLS
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RWWoodruff	EECollins	JDMain *	RLDennig	RBBevan *	ABBeach
2/4/93	2/4/93	~~/ /93~~ 1/17/92	2/4/93	~~/ /93~~ 1/26/92	2/4/93
C:EELB	C:SRXB	C:OEAB	C:OGCB	D:DORS	
CHBerlinger	RCJones	AEChaffee	GHMarcus	BKGrimes	
2/16/93	2/15/93	2/22/93	/ /93	/ /93	

With significant change CHB

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* PREVIOUSLY CONCURRED