UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

August 12, 1996

NRC INFORMATION NOTICE 96-45: POTENTIAL COMMON-MODE POST-ACCIDENT FAILURE OF CONTAINMENT COOLERS

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 to a potential common-mode post-accident failure of containment coolers. 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 February 13, 1996, the licensee for Diablo Canyon determined that the containment fan coolers were susceptible to component cooling water flashing in the cooler unit cooling coils during a design-basis loss-of-coolant accident (LOCA) with a concurrent loss of offsite power or with a delayed sequencing of safety-related equipment. Diablo Canyon has five fan coolers per unit. The containment fan coolers are designed to remove heat from the containment atmosphere during normal operation. The fan coolers are also automatically initiated engineered safety features, which help maintain containment integrity by reducing post-accident containment pressure by the condensation of steam and the removal of heat in conjunction with operation of the containment spray system. The fan coolers are cooled by component cooling water under both normal and accident conditions.

During a postulated design-basis LOCA with a concurrent loss of offsite power, the component cooling water pumps and the fan cooler fans would lose power. The component cooling water flow stops almost immediately, while the fans coast down over a period of minutes. The first fan cooler will restart on slow speed approximately 22 seconds after the loss of offsite power. The component cooling water pumps will restart 26 to 30 seconds after the accident. In this scenario, the high temperature containment atmosphere would be forced across the cooling coils for several seconds with no component cooling water flow. This process may cause the stagnant component cooling water to boil, thereby creating steam voids in the cooling coils and the

component cooling water piping. When the component cooling water pumps restart, the pumped liquid would collapse the steam voids and may create significant hydrodynamic loads (waterhammer). The hydrodynamic loads may adversely affect the integrity of the fan coolers or the associated component cooling water piping. This problem may cause the fan cooler pipes to rupture and could cause a significant loss of component cooling water inventory, which could threaten cooling to emergency core cooling system components. The licensee for Diablo Canyon evaluated this potential failure mechanism and has installed a nitrogen pressurization system on the component cooling water head tank to increase the margin to boiling.

On July 22, 1996, the licensee for Haddam Neck declared all four of its containment air recirculation fans inoperable and initiated a plant shutdown. The air recirculation fans are the only credited heat removal system for post-accident containment heat loads, and the associated cooling coils are cooled by the station service water system. The fans were declared inoperable after the licensee review of the consequences of two-phase service water flow following a LOCA concurrent with a loss of normal power. The licensee analysis predicted hydrodynamic loads that exceeded the service water piping and support structural limits.

Discussion

At many plants, containment fan coolers provide a significant safety function in reducing containment pressure and removing heat from the containment building. The postulated failure scenario could cause a common failure of all the containment coolers, thereby potentially challenging the integrity of the containment building. In certain cases, failure of the cooling water system piping could cause a potential containment bypass flow path and may jeopardize cooling to other safety-related loads.

An individual plant vulnerability to these postulated failures is dependent on a number of factors. The coastdown rates of the cooling water flow and the cooler fans, the operating pressure and pressure decay rate of the cooling water system, the timing of cooling water pump restart, the containment temperature profile during the design-basis accident, and other site-specific parameters have an effect on facility vulnerability to this potential failure mode. This failure mode would also be applicable to the design-basis main steam line break in containment.

Westinghouse issued Nuclear Safety Advisory Letter NSAL-96-003, "Containment Fan Cooler Operation During a Design Basis Accident," to alert their customers to this concern. NSAL-96-003 is provided as an attachment to this information notice.

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

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Attachments:
1. Nuclear Safety Advisory Letter NSAL-96-003, dated 06/20/96
2. List of Recently Issued NRC Information Notices

Attachment filed in Jacket.

Westinghouse Energy Systems Business Unit

ESBU

NUCLEAR SAFETY ADVISORY LETTER

THIS IS A NOTIFICATION OF A RECENTLY IDENTIFIED POTENTIAL SAFETY ISSUE PERTAINING TO BASIC COMPONENTS SUPPLIED BY WESTINGHOUSE. THIS INFORMATION IS BEING PROVIDED TO YOU SO THAT A REVIEW OF THIS ISSUE CAN BE CONDUCTED BY YOU TO DETERMINE IF ANY ACTION IS REQUIRED.

P.O. Box 355, Pittsburgh, PA 15230-0355

Subject: Containment Fan Cooler Operation During a Design Basis Accident	**Number:** NSAL-96-003
Basic Component: Containment Fan Coolers	**Date:** 6/20/96
Plants: Westinghouse and MHI NSSS Plants	

Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a)	Yes ☐	No ☐
Transfer of Information Pursuant to 10 CFR 21.21(b)	Yes ☐	
Advisory Information Pursuant to 10 CFR 21.21(c)(2)	Yes ☒	

Reference:

SUMMARY

The purpose of this letter is to provide Westinghouse NSSS Owners information regarding the potential performance of some containment fan cooler units (CFCUs) during accident conditions which may compromise the containment cooling system capability.

This Westinghouse Nuclear Safety Advisory Letter deals with the potential susceptibility for the cooling water of certain CFCUs to flash to steam during a design basis Loss of Coolant Accident (LOCA) with either a concurrent Loss of Offsite Power (LOOP) or a delayed sequencing of safety-related equipment. The applicability of this issue to a given nuclear unit depends on plant specific aspects of the containment cooling system design and its heat removal system. The Nuclear Regulatory Commission has been notified by an LER (Reference 1).

Additional information, if required, may be obtained from the originator. Telephone 412-374-5750.

Originator(s): J. T. Crane
Regulatory & Licensing Initiatives

W. R. Rice, Interim Manager
Regulatory & Licensing Initiatives

ATTACHMENT 1

ISSUE DESCRIPTION

The potential for this condition was discovered during an investigation into Component Cooling Water (CCW) system design issues by a Westinghouse NSSS Owners The CCW System provides cooling water directly to the CFCUs in that plant's design. Depending on the specific design conditions, it may be applicable to plants that utilize cooling water systems other than the CCW for their CFCUs.

This issue concerns a type of containment cooling design that has a single set of CFCUs for heat removal during both normal operating conditions and accident conditions. In the Licensee's design the CFCUs are equipped with a two-speed blower that operates at about 1200 rpm for normal operation and about 600 rpm for accident conditions. Cooling water to the heat exchanger coils for both normal and accident operation is supplied by the CCW system. The Licensee's containment analysis assumes the fan coolers operate during postulated accidents, removing heat so as to maintain containment pressure within design basis limits.

During a postulated LOOP coincident with a design basis LOCA, power is lost to both the CCW pumps and the CFCU blowers. The CCW pumps are calculated to coast down to 0 rpm within 1-2 seconds while the CFCU blowers are calculated to coast down from a nominal speed of 1200 rpm to 600 rpm in approximately 30 seconds and then to 0 rpm an estimated 700 seconds later. Accounting for diesel-generator start times and emergency buss loading sequence, the CFCU blowers are re-energized approximately 20 seconds after the initiation of the LOOP, and the CCW pumps are re-energized about 30 seconds after the initiation of the LOOP. This timing of events provides for hot, steam-laden containment air to be drawn over the heat exchanger coils at a relatively high velocity for 30 seconds before cooling liquid flow is reestablished to the coils.

The high heat content of containment atmosphere under accident conditions being drawn over the CFCU heat exchanger coil with no pumped liquid flow has been calculated to result in steaming of the stationary liquid inventory of the coils. When the CCW pumps are re-energized, the pumped liquid flow acts to collapse the steam void in the CFCU piping. Collapsing the steam void is predicted to result in a waterhammer with sufficient energy and force that may impact the integrity of either the heat exchanger coil or its associated piping, resulting in a loss of integrity of the CCW system.

To prevent flashing of the CFCU cooling water, the Licensee has installed a nitrogen pressurization system on the CCW system.

TECHNICAL EVALUATION

The following discussion provides several items to consider in evaluating your CFCUs.

In general, a plant that has CFCUs with a 2 speed blower motor and a diesel loading sequence that results in water flow through the cooler coil later than 15 seconds after a design basis large break LOCA, may have a similar situation. However, there are other plant specific aspects that can impact CFCU functioning. The containment cooling design in this issue has a single set of fan coolers that are used for containment cooling during both normal and accident conditions. Flashing and subsequent void collapse may not apply if a plant has separate sets of equipment where the accident CFCUs are not operating prior to a design basis accident. These accident related fan coolers would be at containment ambient conditions with no forced convective heat transfer at the beginning of the

accident. Since their fans would not be operating at the beginning of the postulated accident (as compared to a single set of fan coolers which would be coasting down) the heat release from a design basis accident would be transferred to the coil cooling water at a much slower rate.

Flashing of the CFCU cooling water may not occur in a specific plant design because of factors such as heat transfer capability, saturation pressure of the cooling system, coastdown time of the fan blower, and coastdown time of the cooling water pump(s). Also, the timing of when ECCS equipment will start in a design basis accident can determine if the CFCUs do or do not have stagnant cooling water.

In summary, the issue is whether safety related CFCUs will function as intended during a design basis event, if they are postulated to experience flashing of the water in the cooling coils. If flashing can be postulated, then the issue of whether the CFCUs will maintain structural integrity during subsequent void collapse should be addressed.

ASSESSMENT OF SAFETY SIGNIFICANCE

Westinghouse cannot determine the potential for flashing in the CFCUs on a generic basis because of the various plant specific designs for the containment cooling system and situation specific heat transfer conditions. Thus the most effective action that can be taken is a notification to all Westinghouse plants.

REPORTABILITY

The NRC is aware of this issue via an LER (Reference 1).

RECOMMENDED ACTIONS

Licensees should review their containment cooling system to determine if their safety related containment fan coolers are susceptible to cooling water void formation and subsequent void collapse and waterhammer during a design basis accident.

REFERENCE

1. Pacific Gas & Electric letter: PG&E DCL-96-097, April 26, 1996 to U. S. Nuclear Regulatory Commission, "Licensee Event Report 1-96-005-00 (Voluntary) Potential for Flashing in Containment Fan Cooler Units"

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-44	Failure of Reactor Trip Breaker from Cracking of Phenolic Material in secondary contact assembly	8/05/96	All holders of OLs or CPs for nuclear power reactors
96-43	Failures of General Electric Magne-Blast Circuit Breakers	08/02/96	All holders of OLs or CPs for nuclear power reactors
96-42	Unexpected Opening of Multiple Safety Relief Valves	08/05/96	All holders of OLs or CPs for nuclear power reactors
96-41	Effects of a Decrease in Feedwater Temperature on Nuclear Instrumentation	07/26/96	All holders of OLs or CPs for pressurized water reactors
96-40	Deficiencies in Material Dedication and Procurement Practices and in Audits of Vendors	07/25/96	All holders of OLs or CPs for nuclear power reactors
96-09, Supp. 1	Damage in Foreign Steam Generator Internals	07/10/96	All holders of OLs or CPs for pressurized-water reactors
96-39	Estimates of Decay Heat Using ANS 5.1 Decay Heat Standard May Vary Significantly	07/05/96	All holders of OLs or CPs for nuclear power reactors
96-38	Results of Steam Generator Tube Examinations	06/21/96	All holders of OLs or CPs for pressurized water reactors
96-37	Inaccurate Reactor Water Level Indication and Inadvertent Draindown During Shutdown	06/18/96	All pressurized water reactor facilities holding an operating license or a construction permit
96-36	Degradation of Cooling Water Systems Due to Icing	06/12/96	All holders of OLs or CPs for nuclear power reactors

OL = Operating License
CP = Construction Permit

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Attachments:
1. Nuclear Safety Advisory Letter NSAL-96-003, dated 06/20/96
2. List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\JRT\CONTCLR.IN

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Official Record Copy

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OFFICE	Contacts	C/SPLB:DSSA	C/PECB:DRPM	D/DRPM
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DATE	/ /96	4/7/96	/ /96	/ /96

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