

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

August 24, 1995

NRC INFORMATION NOTICE 93-83, SUPPLEMENT 1: POTENTIAL LOSS OF SPENT FUEL POOL COOLING AFTER A LOSS-OF-COOLANT ACCIDENT OR A LOSS OF OFFSITE POWER

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 NRC staff findings regarding the risk associated with the potential loss of spent fuel pool (SFP) cooling. It is expected that recipients will review this information notice for applicability to their facilities and consider any appropriate actions. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

The staff has been evaluating a report made under Part 21, "Reporting of Defects and Noncompliance," of Title 10 of the *Code of Federal Regulations* (10 CFR), which two engineers, who formerly worked under contract for the Pennsylvania Power and Light Company, filed on November 27, 1992. In the report, the two engineers contended that the design of the Susquehanna Steam Electric Station (SSES) failed to meet numerous regulatory requirements with respect to a postulated sustained loss of the cooling function for the SFP that mechanistically results from a loss-of-coolant accident (LOCA) or a loss of offsite power (LOOP). The report provided a series of detailed technical and regulatory arguments to support this assertion. It also postulated that subsequent boiling of the SFP would cause failure of equipment necessary to mitigate the accident or to safely reach a shutdown condition because of the adverse environmental conditions created by SFP boiling within the reactor building. As a result of these equipment failures, severe offsite consequences would result.

Units 1 and 2 at SSES are boiling water reactors with Mark II containments designed by General Electric Company. The SFP and associated systems for each unit are located in each unit's reactor building. The surface of the SFPs is on the common refueling floor, which spans the uppermost level of the two reactor buildings. The two SFPs communicate through a common cask storage pit when the path is not isolated by gates. The SFP cooling system for each unit at the SSES consists of three parallel heat exchangers and three pumps. Water

9508180256

updated on 8/30/95

PDR I&E Notice 93-083

950824

JFD/11

to make up for evaporation and small leakage losses from the SFP is normally supplied by the condensate transfer system.

The normal SFP cooling system and the normal system used for adding SFP makeup water are not designed to remain functional after design-basis events. However, the residual heat removal (RHR) system is designed to operate after these events and can be aligned to cool the SFP by manual operation of valves in the reactor building. The emergency service water system is also designed to operate after these events and can be aligned to provide water to the SFP to make up for evaporative losses by manual operation of valves in the reactor building.

Description of Circumstances

The staff completed an assessment of safety with regard to a loss of SFP cooling and determined that the concerns identified in the Part 21 report were of low safety significance for SSES. The assessment included an engineering evaluation of the capability to recover from or mitigate a loss of SFP cooling, and a quantitative estimation of the frequency of a sustained loss of SFP cooling based on the findings of the engineering evaluation. This assessment is documented in a final safety evaluation report, which is available for public review. The staff considered comments on the draft safety evaluation report from the authors of the Part 21 report, from Pennsylvania Power and Light Company (the licensee for SSES), and from the Advisory Committee on Reactor Safeguards for inclusion in the final safety evaluation report. The report was issued to Pennsylvania Power and Light Company, Docket Nos. 50-387 and 50-388, on June 19, 1995.

While the staff was evaluating the Part 21 report, the licensee for SSES initiated several actions to improve the capability to recover from a loss of SFP cooling. These actions included the following: (1) committing to operate with the two SFPs cross-connected through the cask pit to increase the redundancy of cooling systems for the combined SFPs; (2) committing to conduct testing and analyses that support assumptions regarding the reliability of the SFP cooling assist mode of the RHR system; (3) completing analyses that support modifications and procedural changes; (4) completing installation of instrumentation to improve the capability to monitor SFP conditions; and (5) completing changes to off-normal and emergency procedures that improve the reliability of recovery from a loss-of-SFP-cooling event.

The staff used both deterministic and probabilistic safety assessment techniques to evaluate the safety implications of events involving a loss of SFP cooling. Because the staff did not consider a detailed evaluation of the effects of SFP boiling necessary, based on an initial assessment of risk, the staff elected to quantitatively estimate the frequency of SFP boiling and base decisions regarding further evaluations on that estimate.

The staff's deterministic engineering evaluation of the capability to recover from or mitigate a loss of SFP cooling identified important features of SSES for modeling in the probabilistic safety assessment. These characteristics included the following: (1) on the basis of licensee commitments and outage management procedures, the time to the onset of pool boiling after a loss of

cooling will exceed 25 hours; (2) natural circulation flow will maintain the temperature difference between the two pools less than 17°C [30°F] with the pools cross-connected through the common cask pit, thereby allowing a single fuel pool cooling system of adequate capacity aligned to either pool to prevent boiling in both pools; (3) equipment failures and human errors, which are explicitly modeled in the safety assessment, are the significant failure modes for the normal SFP cooling system; and (4) the SFP cooling assist mode of the RHR system will provide a reliable means of cooling one or both pools when access to the reactor building for manual system alignment is available.

The safety assessment quantitatively estimated the frequency of reaching a near-boiling condition, which could add significant heat and water vapor to the reactor building atmosphere, on the basis of the above information. The staff estimated that the actions the licensee has implemented to improve the capability to recover from a loss of SFP cooling have reduced the near-boiling frequency from 7.0E-5 per plant-year to 2.0E-5 per plant-year.

The dominant sequences for near-boiling frequency involve an extended LOOP, but sequences involving a LOCA or a shorter LOOP are also significant. The dominance of sequences involving a LOOP reflects the reliance of the normal SFP cooling system on offsite sources of electrical power and the limited availability of the RHR system for fuel pool cooling because of the RHR system's primary reactor vessel decay heat removal function. Sequences involving a LOCA were identified as significant specifically because the RHR system in the affected unit is assumed to be unavailable for fuel pool cooling.

Despite the relatively small fraction of an operating cycle that each unit at SSES was assumed to be in a refueling outage, the sequences occurring during refueling outage periods that were examined dominated the near-boiling frequency. Two factors contributed to this result: the relatively shorter time to reach boiling after a loss of SFP cooling because of the practice of conducting full-core off-loads at SSES and the practice of removing systems associated with the outage unit that contribute to SFP decay heat removal capability from service for maintenance during refueling outages.

To address generic concerns identified through the Part 21 report and separate concerns related to spent fuel storage pools identified during a special inspection at a permanently shutdown reactor facility (see NRC Bulletin 94-01, "Potential Fuel Pool Draindown Caused by Inadequate Practices at Dresden Unit 1," dated April 14, 1994), the staff has developed and begun implementing a generic action plan. The generic plan includes the following actions: (1) a search and analysis of information regarding spent fuel storage pool issues, (2) an assessment of the operation and design of spent fuel storage pools at selected reactor facilities, (3) an evaluation of the assessment findings for safety concerns, and (4) selection and execution of an appropriate course of action based on the safety significance of the findings. During these assessments, the staff will examine those features that were identified at SSES as important to the acceptably low level of risk from loss-of-SFP-cooling events.

Discussion

The functional capability to protect the reactor coolant pressure boundary, to mitigate the effects of potential design-basis events, and to shut down the reactor and maintain it in a safe shutdown condition are important safety attributes. Nuclear power plants are designed so that the potential for loss of the capability to perform any of these functions is remote. Adverse environmental conditions, which may affect many components simultaneously, have the potential to disable the redundant equipment that provides this capability.

The staff conducted a licensing-basis review for SSES, which is documented in Appendix A to the final safety evaluation report, and concluded that a loss of SFP cooling initiated by a seismic event (seismically induced LOOP) was considered in originally granting the facility's license. The staff concluded that, with the exception of seismically induced design-basis events, the development of an adverse environment in the reactor building as a result of a loss of SFP cooling is outside the licensing basis for SSES. However, it also concluded that the licensing basis with regard to SFP cooling at other facilities may vary widely from that of SSES. Therefore, the conclusion that the development of an adverse environment in the reactor building as a result of a loss of SFP cooling is outside the licensing basis at SSES may not be valid at other facilities.

The staff performed a safety assessment to evaluate the frequency of near-boiling events in the SFPs at SSES and found that the potential for such an event was acceptably remote at SSES. After analyzing the safety assessment results, the staff concluded that the potential for reaching a near-boiling condition in the SFP was remote principally because of the diverse installed systems available for fuel pool cooling and the administrative controls that ensured an extended period for recovery of cooling before the onset of boiling.

This information notice requires no specific action or written response. If you have any questions regarding 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.

Dennis M. Crutchfield
Dennis M. Crutchfield, Director
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
(301) 415-2833

Joseph Shea, NRR
(301) 415-1428

David Skeen, NRR
(301) 415-1174

Attachment:
List of Recently Issued NRC Information Notices

Attachment filed in Jacket

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
95-33	Switchgear Fire and Partial Loss of Offsite Power at Waterford Generating Station, Unit 3	08/23/95	All holders of OLs or CPs for nuclear power reactors.
95-10, Supp. 2	Potential for Loss of Automatic Engineered Safety Features Actuation	08/11/95	All holders of OLs or CPs for nuclear power reactors.
95-32	Thermo-Lag 330-1 Flame Spread Test Results	08/10/95	All holders of OLs or CPs for nuclear power reactors.
95-31	Motor-Operated Valve Failure Caused by Stem Protector Pipe Interference	08/09/95	All holders of OLs or CPs for nuclear power reactors.
95-30	Susceptibility of Low-Pressure Coolant Injection and Core Spray Injection Valves to Pressure Locking	08/03/95	All holders of OLs or CPs for nuclear power reactors.
94-66, Supp. 1	Overspeed of Turbine-Driven Pumps Caused by Binding in Stems of Governor Valves	06/16/95	All holders of OLs or CPs for nuclear power reactors.
95-29	Oversight of Design and Fabrication Activities for Metal Components Used in Spent Fuel Dry Storage Systems	06/07/95	All holders of OLs or CPs for nuclear power reactors.
95-28	Emplacement of Support Pads for Spent Fuel Dry Storage Installations at Reactor Sites	06/05/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

This information notice requires no specific action or written response. If you have any questions regarding 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.

orig /s/'d by DMCrutchfield

Dennis M. Crutchfield, Director
 Division of Reactor Program Management
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: 9383SP1.IN
 See previous concurrence

OFFICE	SPLB	PECB	DRPE	TECH ED	SC:SPLB
NAME	SJones*	DSkeen*	JShea*	RSanders*	GHubbard*
DATE	03/03/95	02/14/95	02/20/95	02/09/95	03/02/95

OFFICE	C:SPLB	D:DSSA	SC:PECB	PECB	C:PECB
NAME	CMcCracken*	GHolahan*	RDennig*	RKiessel*	AChaffee*
DATE	03/03/95	04/27/95	06/23/95	07/27/95	07/27/95

OFFICE	D:DRPM
NAME	DMCrutchfield
DATE	08/14/95

#1
 8/18/95

OFFICIAL RECORD COPY

This information notice requires no specific action or written response. If you have any questions regarding 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.

Dennis M. Crutchfield, Director
 Division of Reactor Program Management
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\DLS\IN9383S1.SFP
 See previous concurrence

OFFICE	SPLB	PECB	DRPE	TECH ED	SC:SPLB
NAME	SJones*	DSkeen*	JShea*	RSanders*	GHubbard*
DATE	03/03/95	02/14/95	02/20/95	02/09/95	03/02/95

OFFICE	C:SPLB	D:DSSA	SC:PECB	PECB	C:PECB
NAME	CMcCracken*	GHolahan*	RDennig*	RKiesel*	AChaffee*
DATE	03/03/95	04/27/95	06/23/95	07/27/95	07/27/95

OFFICE	D:DRPM
NAME	DMCrutchfield
DATE	08/ /95

#1
8/7

OFFICIAL RECORD COPY

This information notice requires no specific action or written response. If you have any questions regarding 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.

Dennis M. Crutchfield, Director
 Division of Reactor Program Management
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\DLS\IN95-XX-SFP ?
IW938351.SFP
 See previous concurrence

OFFICE	SPLB	OECB	DRPE	TECH ED	SC:SPLB
NAME	SJones*	DSkeen*	JShea*	RSanders*	GHubbard*
DATE	03/03/95	02/14/95	02/20/95	02/09/95	03/02/95

OFFICE	C:SPLB	D:DSSA	SC:OECB	OECB	C: OECB
NAME	CMcCracken*	GHolahan*	RDennig*	RKiesse <i>Jan for</i>	AChaffee <i>AK</i>
DATE	03/03/95	04/27/95	06/23/95	07/27/95	07/27/95

OFFICE	D:DOPS <i>RPM</i>
NAME	DMCrutchfield <i>DM</i>
DATE	07/ /95

#2
 7/28

This information notice requires no specific action or written response. If you have any questions regarding 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 K. Grimes, Director
 Division of Project Support
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\DLS\IN95-XX.SFP
 See previous concurrence

OFFICE	SPLB		OECB		DRPE		TECH ED		SC:SPLB	
NAME	SJones*		DSkeen*		JShea*		RSanders*		GHubbard*	
DATE	03/03/95		02/14/95		02/20/95		02/09/95		03/02/95	

OFFICE	C:SPLB		D:DSSA		SC:OECB		OECB		C:OECB	
NAME	CMcCracken*		GHolahan*		RDennig		RKiesel		AChaffee	
DATE	03/03/95		04/27/95		06/23/95		06/ /95		06/ /95	

OFFICE	D:DOPS	
NAME	BKGrimes	
DATE	06/ /95	

OFFICIAL RECORD COPY

This information notice requires no specific action or written response. If you have any questions regarding 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 K. Grimes, Director
 Division of Project Support
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\DLS\IN95-XX.SFP
 See previous concurrence

OFFICE	SPLB	OECB	DRPE	TECH ED	SC:SPLB
NAME	SJones*	DSkeen*	JShea*	RSanders*	GHubbard*
DATE	03/03/95	02/14/95	02/20/95	02/09/95	03/02/95

OFFICE	C:SPLB	D:DSSA	SC:OECB	OECB	C:OECB
NAME	CMcCracken*	GHolahan <i>MM</i>	RDennig	RKiesel	AChaffee
DATE	03/03/95 <i>#99 SFA</i>	02/27/95 <i>Jaw</i>	02/ /95	02/ /95	02/ /95

OFFICE	D:DOPS
NAME	BKGrimes
DATE	02/ /95

4 202

This information notice requires no specific action or written response. If you have any questions regarding 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 K. Grimes, Director
 Division of Project Support
 Office of Nuclear Reactor Regulation

Technical contacts: Steven Jones, NRR
 (301) 415-2833

Joseph Shea, NRR
 (301) 415-1428

David Skeen, NRR
 (301) 415-1174

Attachment:
 List of Recently Issued NRC Information Notices

DOCUMENT NAME: G:\DLS\IN95-XX.SFP

OFFICE	SPLB	OECB	DRPE	TECH ED	SC:SPLB
NAME	SJones <i>MS</i>	DSkeen <i>DR</i>	JSkea <i>D</i>	<i>Per Talacorn</i> RSanders <i>DR</i>	GHubbard <i>MS</i>
DATE	02/2/95	02/14/95	02/20/95	02/09/95	02/2/95

OFFICE	C:SPLB	D:DSSA	SC:OECB	OECB	C:OECB
NAME	CMcCracken <i>MS</i>	GHolahan	RDennig	RKiesel	AChaffee
DATE	02/3/95	02/ /95	02/ /95	02/ /95	02/ /95

OFFICE	D:DOPS
NAME	BKGrimes
DATE	02/ /95

OFFICIAL RECORD COPY