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

August 16, 1993

NRC INFORMATION NOTICE 93-67: BURSTING OF HIGH PRESSURE COOLANT INJECTION STEAM LINE RUPTURE DISCS INJURES PLANT PERSONNEL

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 remind addressees of the hazards associated with steam driven coolant injection systems such as the high pressure coolant injection (HPCI) system and the reactor core isolation cooling (RCIC) system at BWRs and the auxiliary feedwater system at PWRs. 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.

Background

The purpose of HPCI steam exhaust rupture discs is to protect the HPCI turbine casing and associated exhaust piping from an overpressure event if the normal exhaust path to the suppression pool becomes blocked. At Quad Cities Station, two 40.6-cm [16-inch] stainless steel discs are installed in series with a 6.4-cm [2.5-inch] spacer between them to allow for a pressure sensor instrumentation line. The pressure sensor, while serving no control function, actuates an alarm in the control room at 68.9 kPa [10 psig] to alert the operators that the inner disc is leaking. The normal range of the HPCI exhaust steam pressure is 172 to 207 kPa [25 to 30 psig]. The HPCI high exhaust pressure turbine trip setpoint is 689 kPa [100 psig] and is sensed by pressure sensors located downstream from where the section of piping containing the rupture discs branches off from the exhaust piping. The section of piping containing the rupture discs is mounted vertically over the turbine exhaust and vents directly to the HPCI room. Pressure greater than 1034 kPa [150 psig] in the exhaust line will cause the inner disc to rupture and impact the outer disc, releasing steam into the HPCI room.

Description of Circumstances

During a quarterly inservice test of the HPCI pump at the Commonwealth Edison Quad Cities Station, Unit 1, on June 9, 1993, the exhaust steam line rupture

discs burst, releasing steam into the HPCI room, burning, and slightly contaminating, five workers. The rupture discs burst within one second after the turbine was started. Fire doors between the Unit 1 and Unit 2 HPCI rooms were blown off their hinges into the Unit 2 HPCI room. Both sets of double doors that are part of the secondary containment boundary were also blown open. The floor latch on the inner containment door was bent; the outer doors were also slightly damaged, but were repaired, closed and sealed approximately 35 minutes after the event. The steam release was terminated by automatic isolation of the steam supply line on high HPCI turbine area temperature about 20 seconds into the event.

Discussion

Upon investigating the event, the licensee determined that water had accumulated in the turbine casing because the drain system level switches for the Unit 1 HPCI system had failed. In April 1992, the licensee performed a reliability-centered maintenance study which recommended the level switches be included in the preventive maintenance program but the recommendation had not been acted on at the time of the event. The Unit 2 HPCI drain system level switches were also found to be inoperable.

The slug of water created during the HPCI turbine roll passed from the turbine casing to the vertical exhaust line and compressed the air in the 40.6 cm [16 inch] line containing the rupture discs. The resulting pressure pulse caused the inner rupture disc to burst, which impacted the outer disc as designed and caused it to burst as well. The exhaust line pressure sensors, located in the horizontal 61 cm [24 inch] exhaust line that tees off from the vertical 40.6 cm [16 inch] rupture disc line, did not detect a high pressure (see Figure 1). The pressure switches were within tolerance and should have immediately isolated the steam supply upon sensing a high exhaust pressure before the rupture discs burst. The fact that a high exhaust line pressure was not detected indicates two possible causes for the disc rupture. Either the inner rupture disc was degraded and burst at lower-than-design pressure, or the pressure pulse actually exceeded the design pressure and caused the disc to burst, relieving the exhaust line pressure before the downstream pressure sensors detected a high pressure condition.

While inspection of the rupture discs did not reveal any degradation from corrosion or aging, the vendor, Black Sivalls & Bryson, Inc, stated that the discs are warranted for one year of service under normal conditions. The HPCI and RCIC rupture discs at Quad Cities Station had been in service for 20 years and were not part of any scheduled inspection or preventive maintenance program. When consulted about the event, the vendor advised against using the spare discs in the plant storeroom because they were purchased at the same time as the failed discs. The licensee later replaced the failed discs with new units. Before this event, the licensee recently replaced a HPCI rupture disc during a refueling outage at the Dresden Station, a plant similar to Quad Cities, after finding a crack in the disc during an inspection. The rupture discs were inspected at the Dresden station as part of an enhancement to the preventive maintenance program that was recommended by a reliability-centered analysis.

The steam injured five workers, four of whom were participating in the HPCI pump surveillance test. The fifth, and most severely injured worker was a health physics technician in the room on routine rounds, who was not aware of the danger posed by the surveillance test. The test procedure contained no specific guidance on room occupancy. Interviews with the workers revealed that they had performed the surveillance in the past and were familiar with the process. This familiarity may have led to a relaxed attitude toward personal safety. The workers stated that during previous surveillances they sometimes evacuated the room before rolling the turbine, or stood near the doors to be ready to escape. The licensee made no routine announcement over the plant paging system to alert plant personnel before the HPCI turbine start, and the workers were not prepared for the turbine to start.

A lack of constant communication between the workers and the control room may have contributed to the personnel injuries. If a control room operator had been in contact with the workers in the HPCI room during the turbine roll, the workers would have been aware of the impending turbine start and, after start, the steam supply might have been manually isolated or the turbine manually tripped before the automatic isolation caused by the high area temperature in the HPCI room.

When the Unit 1 HPCI rupture disc failure caused the fire doors to be blown off their hinges and into the Unit 2 HPCI room, one of the doors impacted a pipe hanger in the room and moved it 5.1 centimeters [2 inches]. If the steam release had resulted from a high energy line break from the inlet side of the HPCI steam line instead of the exhaust line, the damage to the Unit 2 HPCI system could have been more severe. While high energy line breaks have been analyzed for safety systems at all plants, the doors to rooms containing high energy steam lines may not have been included in the analysis. For example, at Duane Arnold Energy Center, the licensee discovered that while the HPCI and RCIC rooms were qualified for pressures of 26.2 kPa [3.8 psig], the doors between these rooms and the reactor building would yield at 6.9 kPa [1 psig].

The licensee for the Quad Cities Station will implement a preventive maintenance schedule for both the HPCI and RCIC rupture discs and the level switches. The licensee will review the surveillance test procedure and evaluate the missile hazard created by the fire doors. The licensee replaced the rupture discs for the Unit 2 HPCI and RCIC systems with new ones after the event at Unit 1 and is considering burst testing the removed discs to determine if they are degraded.

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

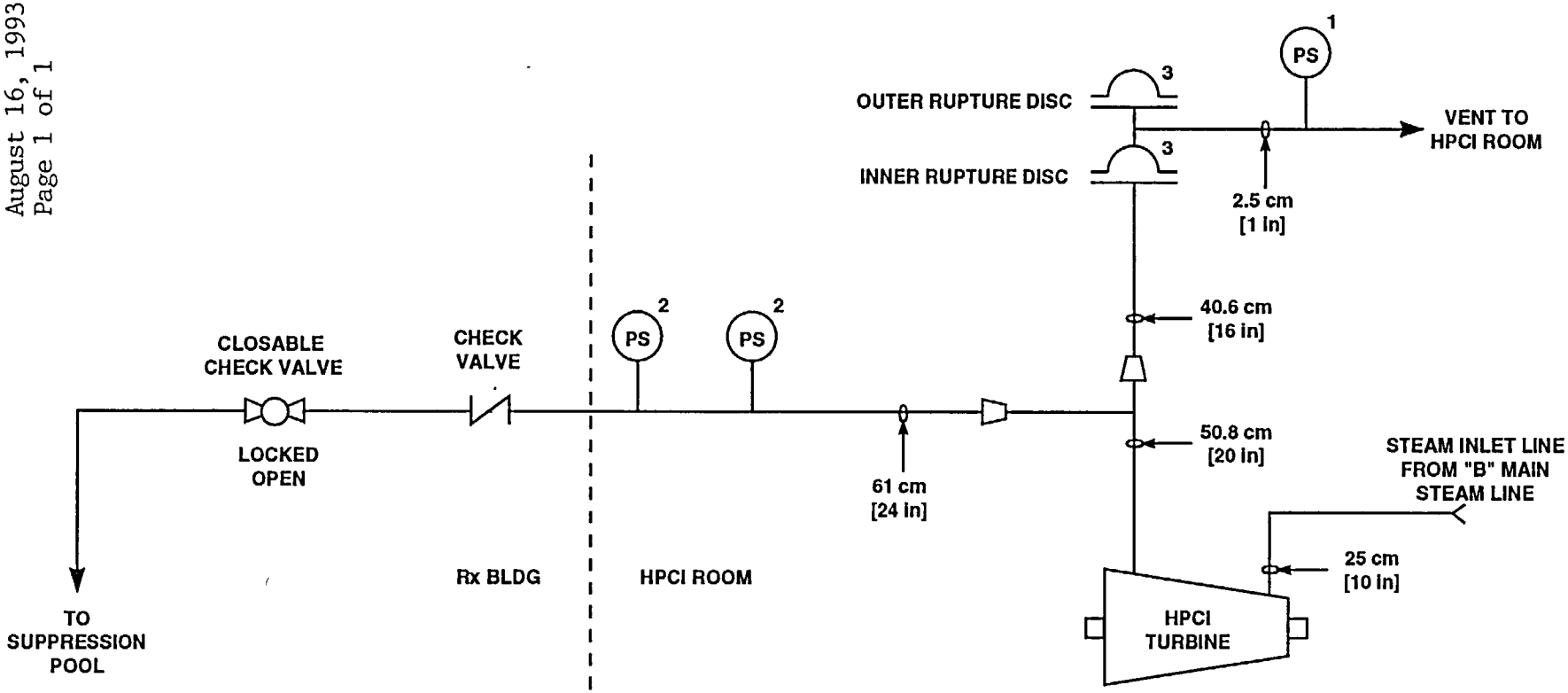
CI Grimes

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

Technical contacts: Clark Vanderniet, RIII
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachments:
1. Figure 1, "Simplified Layout of Quad Cities Station HPCI Turbine Exhaust Steam Line"
2. List of Recently Issued NRC Information Notices



NOTES:

1. PRESSURE SWITCH ACTUATES ALARM IN CONTROL ROOM WHEN PRESSURE BETWEEN THE INNER RUPTURE DISC AND OUTER RUPTURE DISC IS GREATER THAN 68.9 kPa [10 psig]. ALARM IS FOR INNER RUPTURE DISC LEAK DETECTION.
2. REDUNDANT PRESSURE SWITCHES IN EXHAUST STEAM LINE TRIP THE HPCI TURBINE IF PRESSURE IS GREATER THAN 689 kPa [100 psig].
3. RUPTURE DISC MAXIMUM DESIGN BURST PRESSURE IS 1034 kPa [150 psig].

Figure 1 - Simplified Layout of Quad Cities Station HPCI Turbine Exhaust Steam Line

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-66	Switchover to Hot-Leg Injection Following A Loss-of-Coolant Accident in Pressurized Water Reactors	08/16/93	All holders of OLs or CPs for pressurized water reactors.
93-65	Reactor Trips Caused by Breaker Testing with Fault Protection Bypassed	08/13/93	All holders of OLs or CPs for nuclear power reactors.
93-64	Periodic Testing and Preventive Maintenance of Molded Case Circuit Breakers	08/12/93	All holders of OLs or CPs for nuclear power reactors.
93-63	Improper Use of Soluble Weld Purge Dam Material	08/11/93	All holders of OLs or CPs for nuclear power reactors.
93-62	Thermal Stratification of Water in BWR Reactor Vessels	08/10/93	All holders of OLs or CPs for boiling water reactors.
93-61	Excessive Reactor Coolant Leakage Following A Seal Failure in A Reactor Coolant Pump or Reactor Recirculation Pump	08/09/93	All holders of OLs or CPs for nuclear power reactors.
93-60	Reporting Fuel Cycle and Materials Events to the NRC Operations Center	08/04/93	All fuel cycle and materials licensees.
93-59	Unexpected Opening of Both Doors in An Airlock	07/26/93	All holders of OLs or CPs for nuclear power reactors.
93-58	Nonconservatism in Low-Temperature Overpressure Protection for Pressurized-Water Reactors	07/26/93	All holders of OLs or CPs for pressurized-water reactors.

OL = Operating License
CP = Construction Permit

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

orig /s/'d by CIGrimes/for

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

Technical contacts: Clark Vanderniet, RIII
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachments:
1. Figure 1, "Simplified Layout of Quad Cities Station HPCI Turbine Exhaust Steam Line"
2. List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE.

OFC	*OEAB:DORS	*TECH:ED	*OGCB:DORS	*DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/14/93

OFC	*C:DRS:R-III	*SC:OEAB:DORS	*C/OEAB/DORS	*C:SPLB:DSSA
NAME	GWright	RDennig	AEChaffee	CEMcCracken
DATE	07/14/93	07/15/93	07/15/93	07/16/93

OFC	*D:DSSA	*C/OGCB:DORS	D/DORS
NAME	AThadani	GMarcus	BGrimes
DATE	07/24/93	07/29/93	08/10/93

[OFFICIAL RECORD COPY]
DOCUMENT NAME: 93-67.IN

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

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

Technical contacts: Clark Vanderniet, RIII
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachment:
List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE.

*D:DSSA
AThadani
07/24/93

OFC	*OEAB:DORS	*TECH:ED	*OGCB:DORS	*DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/14/93

OFC	*C:DRS:R-III	*SC:OEAB:DORS	*C/OEAB/DORS	*C:SPLB:DSSA
NAME	GWright	RDennig	AEChaffee	CEMcCracken
DATE	07/14/93	07/15/93	07/15/93	07/16/93

OFC	C/OGCB:DORS	D/DORS
NAME	GMarcus GHM	BGrimes
DATE	07/29/93	07/ /93

[OFFICIAL RECORD COPY]
DOCUMENT NAME: IN93_XX.QC1

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 (NRR) project manager.

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

Technical contacts: Clark Vanderniet, R-III
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE

OFFICE	*OEAB:DORS	*TECH:ED	*OGCB:DORS	*DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/14/93

*C:DRS:RIII	*SC:OEAB:DORS	*C:OEAB:DORS	C:SPLB:DSSA	D:DSSA
GWright	RDenning	AChaffee	CEMcCracken	ACThadani
07/14/93	07/15/93	07/15/93	07/16/93	07/21/93

C:OGCB:DORS	D:DORS
GHMarcus	BKGrimes
07/ /93	07/ /93

DOCUMENT NAME: QCHPCIIN.WEN (new name - IN93_XX.QC1

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 (NRR) project manager.

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

Technical contacts: Clark Vanderniet, R-III
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE

OFFICE	*OEAB:DORS	*TECH:ED	*OGCB:DORS	*DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/14/93

*C:DRS:RIII	SC:OEAB:DORS	C:OEAB:DORS	C:SPLB:DSSA	D:DSSA
GWright	RDenning	AChaffee	CEMcCracken	ACThadani
07/14/93	07/16/93	07/15/93	07/ /93	07/ /93

C:OGCB:DORS	D:DORS
GHMarcus	BKGrimes
07/ /93	07/ /93

DOCUMENT NAME: QCHPCIIN.WEN

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

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

Technical contacts: Clark Vanderniet, R-III
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE

OFFICE	*OEAB:DORS	*TECH:ED	OGCB:DORS	DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/14/93

C:DRS:RIII	SC:OEAB:DORS	C:OEAB:DORS	C:SPLB:DSSA	D:DSSA
GWright	RDenning	AChaffee	CEMcCracken	ACThadani
07/14/93	07/ /93	07/ /93	07/ /93	07/ /93

C:OGCB:DORS	D:DORS
GHMarcus	BKGrimes
07/ /93	07/ /93

DOCUMENT NAME: QCHPCIIN.WEN

14 JUL 93 8:50

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

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

Technical contacts: Clark Vanderniet, R-III
(708) 790-5594

David Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCE

OFFICE	*OEAB:DORS	*TECH:ED	OGCB:DORS	DRS:R-III
NAME	DSkeen	JMain	PWen	CVanderniet
DATE	07/08/93	07/08/93	07/14/93	07/ /93

C:DRS:RIII	SC:OEAB:DORS	C:OEAB:DORS	C:SPLB:DSSA	D:DSSA
GWright	RDenning	AChaffee	CEMcCracken	ACThadani
07/ /93	07/ /93	07/ /93	07/ /93	07/ /93

C:OGCB:DORS	D:DORS
GHMarcus	BKGrimes
07/ /93	07/ /93

DOCUMENT NAME: QCHPCIIN.WEN

OFC	OEAB:DORS	SC/OEAB:DORS	PUB:ADM	C/OEAB:DORS
NAME	DSkeen DLS	RDennig	Tech Ed JMain/JM	AChaffee
DATE	7/8/93	/93	7/8/93	/93

OFC	OGCB:DORS	C/DRS/R-III	DRS/R-III	
NAME	PWen	GWright	CVanderniet	
DATE	/93	/93	/93	/93

OFC	TECH BRANCH	CHF TECH BR	C/OGCB:DORS	D/DORS
NAME			GMarcus	BGrimes
DATE	/93	/93	/93	/93

[OFFICIAL RECORD COPY]
DOCUMENT NAME: IN93_XX.QC1