Jim McKnight
OF 522

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

December 5, 1994

NRC INFORMATION NOTICE NO. 94-82: CONCERNS REGARDING ESSENTIAL CHILLER RELIABILITY DURING PERIODS OF LOW COOLING WATER TEMPERATURE

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 concerns about the reliability of essential chillers during periods of low cooling water temperature. It is expected that recipients will review this information notice 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

Essential chillers operating in a simple refrigeration cycle (see Figure 1) are frequently used at nuclear power plants to transfer heat from safety-related components to an ultimate heat sink. These essential chillers are necessary to transfer heat in locations where the ultimate heat sink temperature is frequently near or above the temperature necessary to maintain safety-related components at an acceptable temperature by direct cooling. However, the chiller design may depend on special controls for continued operation when the cooling water temperature is abnormally low.

Description of Circumstances

South Texas Project Electric Generating Station

In the NRC diagnostic evaluation team report for the South Texas Project Electric Generating Station (STP), which was forwarded to Houston Lighting and Power Company (the licensee for STP) on June 10, 1993, the team noted that the licensee had not completely evaluated the potential for under-loading essential chillers following accident signal actuation during cold weather despite internal assessments identifying this concern.

Each plant at STP has three trains of essential chilled water, and each of these trains is cooled by one 150-ton chiller and one 300-ton chiller. The

PDR I&E Notice 94-082

9411300007
Updated on 12/8/94

ID&R-11c DF03

chillers originally had valve actuators that automatically controlled the refrigerant conditions in the condenser by varying the flow of cooling water.

However, in 1989, the licensee replaced the valve actuators with manual valve operators under a temporary modification because of continuing problems with the valve actuators. The licensee had evaluated essential chiller operation with manual control of cooling water flow for a range of cooling water temperatures at the design maximum heat removal rate, but had not evaluated potentially more limiting operation at lower heat removal rates.

After the NRC diagnostic evaluation, the licensee evaluated essential chiller operation at low cooling water temperatures, considering both maximum and minimum heat removal rates. On the basis of its evaluation, the licensee modified procedures and hardware to ensure stable operation of the essential chillers over the selected range of cooling water temperatures with minimal operator actions. The modifications included the installation of an instrumented bypass line with a throttle valve that allows precise control of cooling water flow to the chiller condenser; a procedural change that directs operators to block an automatic start of the 150-ton chillers at low cooling water temperatures, thereby increasing the load on the 300-ton chillers; and a change to the chilled water temperature controller that reduces the peak load on the 300-ton chillers.

Perry Nuclear Power Plant

Centerior Energy, the licensee for the Perry Nuclear Power Plant, reported both trains of control room emergency recirculation to be inoperable for 10 hours and 47 minutes on January 28 and January 29, 1994, because of the low temperature of emergency closed cooling water (Licensee Event Report 94-005, March 11, 1994). The control complex chillers are designed for an inlet temperature of condensing water greater than 13 °C [55 °F] from the emergency closed cooling system, which supplies cooling water when the control room heating, ventilation, and air conditioning system is in the emergency recirculation mode. At a supply temperature of emergency closed cooling water below 13 °C [55 °F], an emergency start and load of the control complex chillers could be prevented by a low refrigerant temperature trip.

The licensee also discovered that a similar condition had been noted at Perry in 1986. The corrective action taken by the licensee at that time was to install a small-diameter essential service water bypass line to restrict the flow of essential service water to the emergency closed cooling heat exchanger when the temperature of essential service water was below 13 °C [55 °F]. However, the calculations and procedural modifications supporting this design change only considered peak design heat loads for the emergency closed cooling system, not reduced heat loads on the system. The failure to consider reduced heat loads in the calculations and procedural modifications directly contributed to the failure to satisfy the design criterion for emergency closed cooling water temperature on January 28 and January 29, 1994.

To correct these problems, the licensee has committed to install a temperature control valve in the essential service water bypass line around the emergency closed cooling heat exchanger. The valve will be designed to automatically maintain emergency closed cooling water temperature above its design limit.

The licensee has also improved procedural guidance to maintain the temperature for emergency closed cooling above 13 °C [55 °F] until the design change is completed.

Discussion

Over-cooling the condenser refrigerant for essential chilled water systems when condenser cooling water supply temperature is abnormally low may cause unstable chiller operation or actuate a self-protection feature that removes the chiller from service. Because cold weather increases the rate of heat loss from both the source of cooling water and structures served by the chilled water loop, low cooling water temperatures and low chiller heat loads tend to occur concurrently during periods of cold weather. The potential for loss of a chiller at low cooling water temperatures due to over-cooling of the condenser refrigerant is increased at low heat loads. Because of a focus on peak heat loading during the design process, the potential for the loss of an essential chiller during periods of low cooling water temperature may be overlooked.

Although heat transfer through structures to the environment during periods of cold weather reduces the heat load on the chilled water system, some heat removal through an essential chiller may be necessary to prevent equipment temperatures from exceeding the maximum analyzed value. Safety-related equipment may fail if the equipment temperature exceeds its maximum analyzed value following a loss of essential chiller function caused by an abnormally low cooling water supply temperature.

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

Technical contact: Steven R. Jones, NRR
(301) 504-2833

Attachments:
1. Figure 1, A simple Refrigeration Cycle
2. List of Recently Issued NRC Information Notices

Attachments filed in Jacket

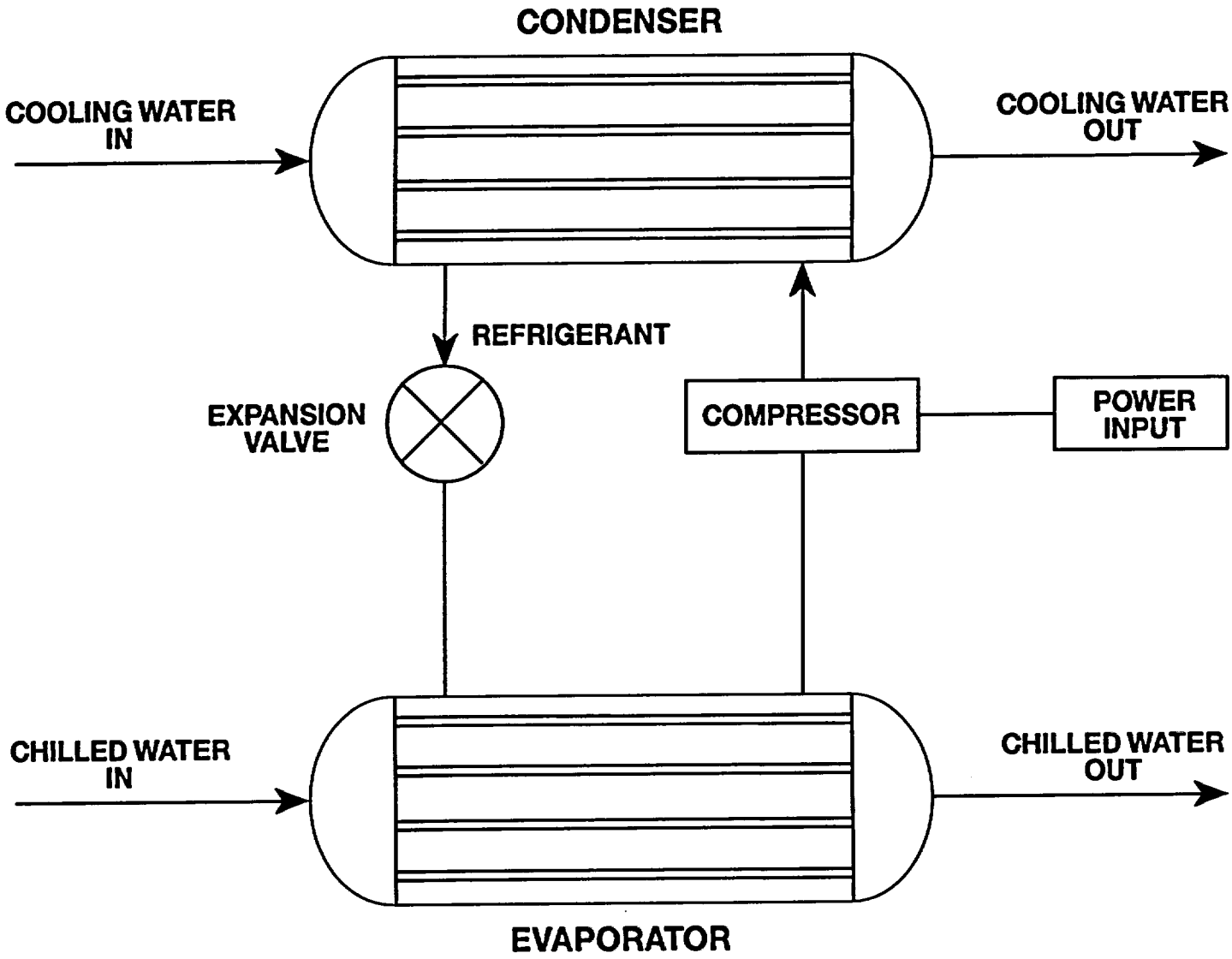

Figure 1. A Simple Refrigeration Cycle

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-81	Accuracy of Bioassay and Environmental Sampling Results	11/25/94	All U.S. Nuclear Regulatory Commission licensees
94-80	Inadequate DC Ground Detection in Direct Current Current Distribution Systems	11/25/94	All holders of OLs or CPs for nuclear power reactors.
94-79	Microbiologically Influenced Corrosion of Emergency Diesel Generator Service Water Piping	11/23/94	All holders of OLs or CPs for nuclear power reactors.
94-78	Electrical Component Failure due to Degradation of Polyvinyl Chloride Wire Insulation	11/21/94	All holders of OLs or CPs for nuclear power reactors.
94-77	Malfunction in Main Generator Voltage Regulator Causing Overvoltage at Safety-Related Electrical Equipment	11/17/94	All holders of OLs or CPs for nuclear power reactors.
94-76	Recent Failures of Charging/ Safety Injection Pump Shafts	10/26/94	All holders of OLs or CPs for pressurized water reactors.
93-60, Supp. 1	Reporting Fuel Cycle and Materials Events to the NRC Operations Center	10/20/94	All 10 CFR Part 70 fuel cycle licensees
94-75	Minimum Temperature for Criticality	10/14/94	All holders of OLs or CPs pressurized-water reactors (PWRs).

OL = Operating License
CP = Construction Permit

The licensee has also improved procedural guidance to maintain the temperature for emergency closed cooling above 13 °C [55 °F] until the design change is completed.

Discussion

Over-cooling the condenser refrigerant for essential chilled water systems when condenser cooling water supply temperature is abnormally low may cause unstable chiller operation or actuate a self-protection feature that removes the chiller from service. Because cold weather increases the rate of heat loss from both the source of cooling water and structures served by the chilled water loop, low cooling water temperatures and low chiller heat loads tend to occur concurrently during periods of cold weather. The potential for loss of a chiller at low cooling water temperatures due to over-cooling of the condenser refrigerant is increased at low heat loads. Because of a focus on peak heat loading during the design process, the potential for the loss of an essential chiller during periods of low cooling water temperature may be overlooked.

Although heat transfer through structures to the environment during periods of cold weather reduces the heat load on the chilled water system, some heat removal through an essential chiller may be necessary to prevent equipment temperatures from exceeding the maximum analyzed value. Safety-related equipment may fail if the equipment temperature exceeds its maximum analyzed value following a loss of essential chiller function caused by an abnormally low cooling water supply temperature.

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

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

Technical contact: Steven R. Jones, NRR
(301) 504-2833

Attachments:
1. Figure 1, A simple Refrigeration Cycle
2. List of Recently Issued NRC Information Notices

*See previous concurrence

OFFICE	SPLB	*	OGCB	*	Tech ED	*	SC:SPLB	*	C:SPLB	*
NAME	SRJones		PCWen		MMejac		GTHubbard		CEMcCracken	
DATE	09/23/94		09/23/94		09/23/94		09/23/94		09/23/94	

OFFICE	D:DSSA	*	C:OECB	*	D:DOPS	
NAME	GMHolahan		AEChaffee		BKGrimes	
DATE	09/30/94		11/08/94		12// /94	

DOCUMENT NAME: 94-82.IN

Closed cooling water systems, which may supply cooling water to essential chillers and air conditioning units, may reach abnormally high temperatures under limiting conditions following design basis events. Although many components can withstand a transient high cooling water temperature, essential chillers and air conditioning units may suffer a non-recoverable loss of function following exposure to a transient high cooling water temperature.

Although heat transfer through structures to the environment may provide some cooling, heat removal through an essential chiller or air conditioning unit may be necessary to prevent equipment temperatures from exceeding the maximum analyzed value. Safety-related equipment may fail if the equipment temperature exceeds its maximum analyzed value following a loss of essential chiller or air conditioning unit function caused by an abnormal cooling water supply temperature.

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

Technical contact: Steven R. Jones, NRR
(301) 504-2833

Attachments:
1. Figure 1, A simple Refrigeration Cycle
2. List of Recently Issued NRC Information Notices

*See previous concurrence

OFFICE	SPLB	*	OGCB	*	Tech ED	*	SC:SPLB	*	C:SPLB	*
NAME	SRJones		PCWen		MMejac		GTHubbard		CEMcCracken	
DATE	09/23/94		09/23/94		09/23/94		09/23/94		09/23/94	

OFFICE	D:DSSA	*	C:OECB	*	D:DOPS	
NAME	GMHolahan		AEChaffee		BKGrimes	
DATE	09/30/94		11/08/94		11/ /94	

DOCUMENT NAME: S:\DOPS_SEC\CHILLER.IN

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

Technical contact: Steven R. Jones, NRR
(301) 504-2833

Attachments:
1. Figure 1, A simple Refrigeration Cycle
2. List of Recently Issued NRC Information Notices

*See previous concurrence

OFFICE	SPLB	*	OGCB	*	Tech ED	*	SC:SPLB	*	C:SPLB	*
NAME	SRJones		PCWen		MMejac		GTHubbard		CEMcCracken	
DATE	09/23/94		09/23/94		09/23/94		09/23/94		09/23/94	

OFFICE	D:DSSA	*	C:OECB	*	D:DOPS	
NAME	GMHolahan		AEChaffee		BKGrimes	
DATE	09/30/94		11/08/94		11/ /94	

DOCUMENT NAME: S:\DOPS_SEC\CHILLER.IN

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

Technical contact: Steven R. Jones, NRR
(301) 504-2833

Attachments:
1. Figure 1, A simple Refrigeration Cycle
2. List of Recently Issued NRC Information Notices

OFFICE	SPLB	*	OGCB	*	Tech ED	*	SC:SPLB	*	C:SPLB	*
NAME	SRJones		PCWen		MMejac		GTHubbard		CEMcCracken	
DATE	09/23/94		09/23/94		09/23/94		09/23/94		09/23/94	

OFFICE	D:DSSA		C:OECB		D:DOPS	
NAME	GMHolahan		AEChaffee		BKGrimes	
DATE	10/30/94		10/6/94 VSB		10/ /94	

DOCUMENT NAME: CHILLER.IN

211

5/10/6/94
ARK 10/17/94

NOTES:

- THE PMs for STP (LARRY KOKAJKO) AND PERRY (JON HOPKINS) HAVE REVIEWED THE DRAFT IN.
  - MINOR COMMENTS RECEIVED FROM HOPKINS, HAVE BEEN INCORPORATED.
- REGION III (BOB GREGER, TOM TONGUE) AND REGION IV (BILL JOHNSON) HAVE REVIEWED THE DRAFT IN.
  - NO COMMENTS.

Peter Wen. 11/4/94.

components may exceed the maximum analyzed temperature for their operation in a short period of time. If the time to restore chiller operation is greater than the time to reach the maximum analyzed temperature, equipment may fail.

This information notice requires no specific action or written response. If you have any questions regarding 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 contact: Steven R. Jones, NRR
(301) 504-2833

Attachment:
List of Recently Issued NRC Information Notices

OFFICE	SPLB	OGCB	Tech ED	SC:SPLB	C:SPLB
NAME	SRJones	PCWen	MMejac	GTHubbard	CEMcCracken
DATE	09/23/94	09/23/94	09/23/94	09/23/94	09/23/94

OFFICE	D:DSSA	AC:OGCB	D:DORS
NAME	GMHolahan	ELDoolittle	BKGrimes
DATE	09/ /94	09/ /94	09/ /94

DOCUMENT NAME: CHILLER.IN