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

March 24, 1994

NRC INFORMATION NOTICE 94-24: INADEQUATE MAINTENANCE OF UNINTERRUPTIBLE POWER SUPPLIES AND INVERTERS

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 potential failures of uninterruptible power supplies and inverters because of inadequate maintenance. 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

Nine Mile Point Nuclear Station Unit 2 (NMP-2)

On August 13, 1991, an internal failure in the main transformer caused a degraded voltage which resulted in the simultaneous loss of power outputs from five uninterruptible power supplies. The power outputs from the five power supplies were lost because of a combination of a wiring problem and the failure of the internal batteries to supply control power. The five power supplies provide power to the main control room annunciator system and to other systems important to safety.

On March 26, 1992, a non-safety-related power supply failed to provide power to a radiation monitoring cabinet, causing an engineered safety features actuation. The licensee determined that an output breaker from the power supply failed to close because grease in the breaker had dried out and solidified.

Susquehanna Steam Electric Station Unit 1 (SSES-1)

On July 31, 1991, a relay in the switchyard was operated incorrectly, causing the loss of one of the offsite power sources to the plant. The loss of this power source, coupled with the failure of one uninterruptible power supply to transfer to its backup power supply, resulted in a loss of power to some ac instrument panels. The power supply failed to transfer because of problems

IDTR-IIC

PDR I&E Notice 94-024 940324

9403180068
Updated 940323

NFOI
'11

with the internal batteries. The loss of power to the instrument panels caused the loss of numerous instruments and control room indications, as well as some plant support equipment.

Discussion

Uninterruptible power supply units are designed to supply reliable ac power to their loads. Designs for such power supplies use an inverter to convert dc power from a battery to ac power. Some designs also provide a rectifier in combination with the inverter as one unit. The rectifier converts station power from ac to dc. The inverter then converts either the output of the rectifier (normal) or power from a battery (backup) from dc to ac. Offsite ac backs up the inverter ac output through a power transfer device. Direct current control power for the power supply is developed internally using power from external power sources. In some designs, back-up control power is provided by an internal battery bank.

Major contributing factors for the power supply failures at NMP-2 on August 13, 1991, and March 26, 1992, were inadequate maintenance of the batteries which supply power to the control logic and inadequate maintenance of the power supply output breakers respectively. The cause of the failure at Susquehanna was three failed cells in the power supply battery bank.

The NRC Office for Analysis and Evaluation of Operational Data (AEOD) recently prepared engineering evaluation AEOD/E93-03, "Electrical Inverter Operating Experience - 1985 to 1992," December 1993, to assess inverter operating experience in the nuclear industry over the last 7½ years. In the report, the staff concludes that the number of inverter failures has decreased, but some problems still warrant attention. Significant findings in the report are as follows:

(1) Inverter failures are still causing a large number of inadvertent engineered safety features actuations, reactor trips, and turbine runbacks.

(2) Component failures are still the predominant root cause of the failures, followed by human error.

(3) The components that failed most frequently were electrolytic capacitors, followed by transformers, silicon-controlled rectifiers, and transfer switches.

The staff concluded in this report that, based on a review of licensee event reports, some licensees obtained a marked decrease in the frequency of electrical inverter failures by (1) providing the inverter units with adequate cooling and (2) implementing a preventive maintenance program for the inverter units that periodically replaced selected components. The staff also concluded that the proper implementation of vendor recommendations for minor and major maintenance activities would reduce the number of failures because licensees would frequently identify and replace degraded components before they failed.

Related Generic Communications

The NRC has issued the following related generic communications: Information Notice (IN) 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," April 7, 1993, and Supplement 1 to IN 93-26, January 31, 1994; IN 91-64, "Site Area Emergency Resulting From a Loss of Non-Class 1E Uninterruptible Power Supplies," October 9, 1991, and Supplement 1 to IN 91-64, October 7, 1992; IN 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," August 8, 1988; and IN 87-24, "Operational Experience Involving Losses of Electrical Inverters," June 4, 1987.

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: J. G. Ibarra, AEOD
(301) 492-4441

F. S. Ashe, NRR
(301) 504-2785

Attachment:
List of Recently Issued NRC Information Notices
Computer Printout: See Jacket

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-23	Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program	02/22/94	All NRC Licensees.
94-22	Fire Endurance and Ampacity Derating Test Results for 3-Hour Fire-Rated Thermo-Lag 330-1 Fire Barriers	03/16/94	All holders of OLs or CPs for nuclear power reactors.
94-21	Regulatory Requirements when No Operations are being Performed	03/18/94	All fuel cycle and materials licensees.
94-20	Common-Cause Failures due to Inadequate Design Control and Dedication	03/17/94	All holders of OLs or CPs for nuclear power reactors.
94-19	Emergency Diesel Generator Vulnerability to Failure from Cold Fuel Oil	03/16/94	All holders of OLs or CPs for nuclear power reactors.
94-18	Accuracy of Motor-Operated Valve Diagnostic Equipment (Responses to Supplement 5 to Generic Letter 89-10)	03/16/94	All holders of OLs or CPs for nuclear power reactors.
94-17	Strontium-90 Eye Applicators: Submission of Quality Management Plan (QMP), Calibration, and Use	03/11/94	All U.S. Nuclear Regulatory Commission Medical Use Licensees.

OL = Operating License
CP = Construction Permit

Related Generic Communications

The NRC has issued the following related generic communications: Information Notice (IN) 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," April 7, 1993, and Supplement 1 to IN 93-26, January 31, 1994; IN 91-64, "Site Area Emergency Resulting From a Loss of Non-Class 1E Uninterruptible Power Supplies," October 9, 1991, and Supplement 1 to IN 91-64, October 7, 1992; IN 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," August 8, 1988; and IN 87-24, "Operational Experience Involving Losses of Electrical Inverters," June 4, 1987.

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.

Original signed by
Brian K. Grimes

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

Technical contacts: J. G. Ibarra, AEOD
(301) 492-4441

F. S. Ashe, NRR
(301) 504-2785

Attachment:
List of Recently Issued NRC Information Notices

* SEE PREVIOUS CONCURRENCES

OFFICE	RPB:ADM*	OGCB:NRR*	ROAB:AEOD*	C/ROAB:AEOD*	D/DSP:AEOD*
NAME	TechEd	AJKugler	GLanik	JRosenthal	GHolalan
DATE	01/04/94	01/06/94	01/21/94	01/21/94	01/24/94
OFFICE	EELB:NRR*	C/EELB:NRR*	D/DE:NRR*	AC/OGCB:NRR*	D/DORS:NRR
NAME	EWeiss	CHBerlinger	MWHodges	AJKugler	BKGrimes
DATE	01/27/94	02/22/94	02/24/94	03/04/94	03/19/94

DOCUMENT NAME: 94-24.IN

The manuals provided by manufacturers give specific maintenance requirements for particular UPS and inverter equipment. In addition, manufacturers may be able to give licensees new information that has been developed since the manuals were issued, that licensees can use to improve the design and maintenance of inverters and UPSs, and thus reduce the number of failures.

Related Generic Communications

The NRC has issued the following related generic communications: Information Notice (IN) 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," April 7, 1993 and Supplement 1 to IN 93-26, January 31, 1994; IN 91-64, "Site Area Emergency Resulting From a Loss of Non-Class 1E Uninterruptible Power Supplies," October 9, 1991 and Supplement 1 to IN 91-64, October 7, 1992; IN 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," August 8, 1988; and IN 87-24, "Operational Experience Involving Losses of Electrical Inverters," June 4, 1987.

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 contact(s): J. G. Ibarra, AEOD
(301) 492-4441

F. S. Ashe, NRR
(301) 504-2785

Attachment:
List of Recently Issued NRC Information Notices

* SEE PREVIOUS CONCURRENCES

OFFICE	RPB:ADM*	OGCB:NRR*	ROAB:AEOD*	C/ROAB:AEOD*	D/DSP:AEOD*
NAME	TechEd	AJKugler	GLanik	JRosenthal	GHolalan
DATE	01/04/94	01/06/94	01/21/94	01/21/94	01/24/94
OFFICE	EELB:NRR*	C/EELB:NRR*	D/DE:NRR*	AC/OGCB:NRR	D/DORS:NRR
NAME	EWeiss	CHBerlinger	MWHodges	AJKugler	BKGrimes
DATE	01/27/94	02/22/94	02/24/94	03/04/94	03/ /94

DOCUMENT NAME: INVERTER.IN

The manuals provided by manufacturers give specific maintenance requirements for particular pieces of equipment. The manufacturers may also be able to give licensees new information that has been developed since the manuals were issued, in order to improve the design and maintenance of inverters and UPSs, and thus reduce the number of failures.

Related Generic Communications

The NRC has issued other generic communications related to this subject. These generic communications included Information Notice (IN) 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," April 7, 1993 and Supplement 1 to IN 93-26, January 31, 1994; IN 91-64, "Site Area Emergency Resulting From a Loss of Non-Class 1E Uninterruptible Power Supplies," October 9, 1991 and Supplement 1 to IN 91-64, October 7, 1992; IN 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," August 8, 1988; and IN 87-24, "Operational Experience Involving Losses of Electrical Inverters," June 4, 1987.

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 contact(s): Jose Ibarra, AEOD
(301) 492-4441

F. S. Ashe, NRR
(301) 504-2785

Attachment: List of Recently Issued NRC Information Notices

* SEE PREVIOUS CONCURRENCES

OFFICE	RPB:ADM*	OGCB:NRR*	ROAB:AEOD*	C/ROAB:AEOD*	D/DSP:AEOD*
NAME	TechEd	AJKugler	GLanik	JRosenthal	GHolalan
DATE	01/04/94	01/06/94	01/21/94	01/21/94	01/24/94
OFFICE	EELB:NRR*	C/EELB:NRR	D/DE:NRR	AC/OGCB:NRR	D/DORS:NRR
NAME	EWeiss	CHBerlinger	MWHodges	AJKugler	BKGrimes
DATE	01/27/94	02/22/94	02/24/94	02/ /94	02/ /94

DOCUMENT NAME: INVERTER.IN

The manuals provided by the manufacturer give the specific maintenance requirements for a particular piece of equipment. The manufacturer may also be able to give the licensees new information that has been developed since the manuals were issued, in order to improve the design and maintenance of the inverters and reduce the number of maintenance-related failures.

Related Generic Communications

The NRC has issued other generic communications related to this subject. These generic communications included Information Notice (IN) 91-64, "Site Area Emergency Resulting From a Loss of Non-Class 1E Uninterruptible Power Supplies," October 9, 1991 and Supplement 1 to IN 91-64, October 7, 1992; IN 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," August 8, 1988; and IN 87-24, "Operational Experience Involving Losses of Electrical Inverters," June 4, 1987.

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 contact(s): Jose Ibarra, AEOD
(301) 492-4441

E. W. Weiss, NRR
(301) 504-3264

Attachment: List of Recently Issued NRC Information Notices

* SEE PREVIOUS CONCURRENCES

OFFICE	RPB:ADM*	OGCB:NRR	ROAB:AEOD	C/ROAB:AEOD	D/DSP:AEOD
NAME	TechEd	AJKugler	GLanik	JRosenthal	GHolahan
DATE	01/04/94	01/06/94	01/21/94	01/21/94	01/24/94
OFFICE	EELB:NRR	C/EELB:NRR	D/DE:NRR	C/OGCB:NRR	D/DORS:NRR
NAME	EWeiss	CHBerlinger	MWHodges	GHMarcus	BKGrimes
DATE	1/27/94	/ /94	/ /94	02/ /94	02/ /94

DOCUMENT NAME: INVERTER.IN

The manuals provided by the manufacturer give the specific maintenance requirements for a particular piece of equipment. The manufacturer may also be able to provide the licensees with new information that has been developed since the manuals were issued to improve the design and maintenance of the inverters and reduce the number of maintenance-related failures.

Related Generic Communications

The NRC has previously issued the following generic communications on this subject:

Information Notice 91-64, Supplement 1, "Site Area Emergency Resulting From A Loss of Non-Class 1E Uninterruptible Power Supplies," issued October 7, 1992

Information Notice 91-64, "Site Area Emergency Resulting From A Loss Of Non-Class 1E Uninterruptible Power Supplies," issued October 9, 1992

Information Notice 88-57, "Potential Loss of Safe Shutdown Equipment Due to Premature Silicone Controlled Rectifier Failure," issued August 8, 1988

Information Notice 87-24, "Operational Experience Involving Losses of Electrical Inverters," issued June 4, 1987

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 contact(s): Jose Ibarra, AEOD
(301) 492-4441

, NRR
(301) 504-

Attachment: List of Recently Issued NRC Information Notices

* SEE PREVIOUS CONCURRENCES

OFFICE	RPB:ADM	OGCB:NRR	ROAB:AEOD	C/ROAB:AEOD	D/DSP:AEOD
NAME	TechEd RS	AJKugler	GLanik	JRosenthal	GHolalan
DATE	01/4/94	01/ /94	01/ /94	01/ /94	01/ /94
OFFICE	EELB:NRR	C/EELB:NRR	D/DE:NRR	C/OGCB:NRR	D/DORS:NRR
NAME		CHBerlinger	MWHodges	GHMarcus	BKGrimes
DATE	/ /94	/ /94	/ /94	02/ /94	02/ /94

DOCUMENT NAME: INVERTER.IN