SSINS NO.: 6835
IN 83-11

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

March 14, 1983

IE INFORMATION NOTICE NO. 83-11: POSSIBLE SEISMIC VULNERABILITY OF OLD LEAD STORAGE BATTERIES

Addresses:

All nuclear power plant facilities holding an operating license (OL) or construction permit (CP).

Purpose:

This information notice informs you that lead-acid storage batteries approaching their end of operational life may be vulnerable to seismically induced failure.

Description of Circumstances:

A series of events involving spontaneous battery failure or degradation over the past few years, not related to seismic events, has caused concern in the NRC staff regarding the potential vulnerability of old batteries to a seismic event. In each of several events, spontaneous battery failure or degradation has been attributed to swollen positive plates and/or cracked cases. Even for those plants that have seismically qualified batteries, the batteries are rarely qualified by prototype testing of aged cells. Consequently, a pattern is developing of spontaneous failure of old batteries that suggests a seismic event could cause a common-mode failure of the plant DC systems.

One such example occurred at the Haddam Neck plant on September 19, 1982. While in Mode 2 (startup) the emergency DC Battery Bank B, cell 42, was discovered to be leaking eletrolyte through a seam crack. Further inspection revealed eleven other cells with casing cracks that did not extend through the wall. If cell 42 were jumpered out, battery bank voltage would have been 125.3 V DC, only just above the technical specification limit of 125 V DC. Consequently, the licensee decided to declare the Battery Bank B inoperable and completely replace it.

The occurrence on September 19, 1982, was preceded by a similar instance on June 18, 1982, when Battery Bank B, cell 23, was discovered leaking and was jumpered out.

After removing Battery Bank B, some of the failed cells were sent to the manufacturer for a determination of the failure mechanism.

The original "B" train battery that failed was composed of Gould FTA-15 cells each with a rated capacity of 840 ampere-hours. The "A" train battery was

composed of Gould FTA-17 designed cells with a rated capacity of 960 ampere-hours. Haddam Neck obtained Gould NCX-1500 cells from Calvert Cliffs as a temporary replacement for "B" battery. Haddam Neck is purchasing Gould NCX-1200 cells as a permanent replacement for the "B" battery.

The FTA design has not been manufactured by Gould for more than ten years. The FTA cells used at Haddam Neck comprised the original battery and were therefore about 15 years old at the time of their failure. (Operating license date is June 30, 1967.)

Other examples of cells failing because of swollen positive plates or cracked cases have been identified. An Licensee Event Report (LER) search revealed six other instances of battery case cracking.

LER#	Plant	Date(s)	Battery Manufacturer
81-5	Diablo Canyon	(10/81)	C & D, Div. of ELTRA
82-16, 82-7	Indian Point 2	(4/82) and (2/82)	Not described
81-42	Browns Ferry	(7/81)	C & D, Div. of ELTRA
77-55	FitzPatrick	(9/77)	Gould
74-5	Turkey Point 4	(10/74)	Not described

Although it is impossible to tell in every instance from the LER alone what precisely caused each failure, 5 of these LER's bear some similarity to the Haddam Neck battery failure. The battery failure at Diablo Canyon is attributed to a design flaw of the battery case and is not similar to the Haddam Neck failure.

Like the Gould FTA batteries at Haddam Neck, most batteries now used in nuclear power plants are not qualified to withstand a seismic event at their end-of-life condition. Even those batteries that are qualified in accordance with Regulatory Guide 1.100 "Seismic Qualification of Electric Equipment for Nuclear Power" are not necessarily brought to their end-of-life condition prior seismic testing. Regulatory Guide 1.100 endorses IEEE Std. 344 "Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations." At the end-of-life condition, the battery plates are more vulnerable because they are brittle. Also material can slough off the plates, shorting out the battery, or reducing its capacity.

Discussion:

Surveillance tests required by technical specifications will detect a degradation in a battery's ability to deliver it's rated charge, but will not detect those degradations of a battery's structure making it vulnerable to even a mild seismic event.

The structure of a battery is weakened as it becomes old because the positive plates crack and swell or because of a wide variety of other failure mechanisms. Usually, degradation of the positive plate is the limiting factor in the life

of a properly maintained battery. As the positive plate becomes more cracked and embrittled it becomes less able to resist seismic motion and to retain its mechanical integrity. For this reason the NRC staff suspects that the useful electrical life of a large lead storage battery may be longer than its seismic-qualified life. The NRC staff does not yet know of any definitive surveillance test for identifying incipient seismic vulnerability of an old battery other than seismic testing of selected cells.

Batteries not maintained at proper float voltage, stored or used at high temperatures, or subject to improper maintenance may undergo accelerated aging processes reducing the life of the battery and increasing its seismic vulnerability.

The Institute of Electrical and Electronics Engineers has published IEEE Std. 535-1979, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations." This standard requires, as part of a qualification process, bringing a prototype cell to its end-of-life condition prior to seismic testing. Battery cells qualified in accordance with IEEE Std. 535 will have a qualified life reflecting the increased seismic vulnerability of old batteries.

Although no seismically induced battery failure has occurred to date, the serious consequences of such a failure are worthy of concern. Several postulated examples follow: A seismic event might accelerate cracking of the case resulting in loss of electrolyte and complete loss of the battery. A seismic event might cause accelerated cracking of embrittled plates or loss of lead-dioxide coating of plates resulting in substantial drop in battery capacity almost instantly. A complete loss of the DC system would put the plant in a unanalyzed condition.

The NRC staff is considering research that will define the seriousness of age-related seismic vulnerability of lead storage batteries. Further regulatory guidance on the issues raised in this information notice may be forthcoming.

No written response to this information notice is required. If you need other information regarding this matter, please contact the Regional Administrator of the appropriate NRC Regional Office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: Eric Weiss, IE
(301) 492-4973

Attachment:
List of Recently Issued IE Information Notices

Attachment
IN 83-11
March 14, 1983

LIST OF RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
83-10	Clarification of Several Aspects Relating to Use of NRC-Certified Transport Packages	03/11/83	All NRC-licensed facilities and registered users of NRC-Certified transport packages
83-09	Safety and Security of Irradiators	03/09/83	All power reactor facilities holding an OL or CP
83-08	Component Failures Caused by Elevated DC Control Voltagw	03/09/83	All power reactor facilities holding an OL or CP
83-07	Nonconformities with Materials Supplied by Tube Line Corporation	03/07/83	All power reactor facilities holding an OL or CP
83-06	Nonidentical Replacement Parts	02/24/83	All power reactor facilities holding an OL or CP
83-05	Obtaining Approval for Disposing of Very-Low-Level Radioactive Waste - 10 CFR Section 20.302	02/24/83	All production and utilization facilities including nuclear power reactors and research and test reactors, holding an OL
83-04	Failure of ELMA Power	02/18/83	All power reactor facilities holding an OL or CP
83-03	Calibration of Liquid Level	01/28/83	All power reactor facilities holding an OL or CP
83-02	Limitorque H0BC, H1BC, H2BC, and H3BC Gearheads	01/28/83	All power reactor facilities holding an OL or CP

OL = Operating License
CP = Construction Permit

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

020555051558 1 99999
US NRC
CENTRAL FILES
WASHINGTON DC 20555