

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

November 5, 1985

IE INFORMATION NOTICE NO. 85-86: LIGHTNING STRIKES AT NUCLEAR POWER
GENERATING STATIONS

Addressees:

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

Purpose:

This notice is provided to alert recipients of a potentially significant problem of reactor trips and instrument damage caused by lightning strikes. It is expected that recipients will review the information for applicability to their facilities and consider actions, if appropriate, to preclude a similar problem occurring at their facilities. However, suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

The NRC is continuing to evaluate pertinent information. Recipients of this notice will be notified of additional information or if specific actions are required.

Description of Circumstances:

A number of plant trips and instrumentation problems attributable to lightning have occurred over the past 6 years. Since solid state circuitry designs are being increasingly employed in safety related systems, the impact of lightning induced line surges on those circuits is emphasized in this notice. Descriptions of several of the more significant events are presented below. Events involving lightning strikes of switchyards and the consequential impact on power distribution systems are not covered by this notice. However, INPO SER 76-84 covers this latter subject as well as summarizing earlier INPO documents dealing with lightning strikes at nuclear power plants.

Zion Power Station Units 1 and 2

On August 17, 1979, both units tripped simultaneously during a severe lightning storm. Investigation indicated that a lightning strike in close proximity to the plant caused either a momentary surge or interruption in the ac power supply circuits to the rod control power supply cabinets. This transient tripped the overload protection devices for the dc power supply cabinet, resulting in a power interruption to the control rod stationary gripper coils,

which caused the rods to drop into the core. The resulting high, negative flux rate initiated the reactor trip signal. Tests verified that noise induced on the ac input to one power supply would actuate the overvoltage protection trips on the main and auxiliary power supplies. In addition to the noise spikes, one Unit 2, 24-V positive power supply was damaged by the lightning strike and had to be replaced. The following corrective actions were initiated:

- The control rod system neutral was isolated from the station ground.
- The overvoltage protection trip setting was changed from 27 to 29 V.
- A low-pass filter was installed on the input to each 24-V positive power supply.
- A volt trap (a voltage suppressor circuit designed to reduce large voltage surges and noise induced by lightning strikes) was installed across the 50-ohm motor generator neutral resistor.
- A volt trap was installed across the power feed to the auxiliary power supply.
- The power feed for the auxiliary power supply was changed from the 480-V system to the control rod drive (CRD) motor generators.

Zion Unit 2 experienced additional reactor trips attributed to lightning on April 3 and July 16, 1980, before the above listed corrective actions were implemented. In these cases it was determined that the transient tripped the overload protection devices, as was the case in the trip of both units on August 17, 1979. However, no power supplies or other equipment were damaged during the latter two trips.

Again, on December 2, 1982, Zion Unit 2 reactor tripped from 100% power during an electrical storm. It was concluded that lightning induced a disturbance in the electrical system causing a reactor trip from a generator trip. Additional lightning protection for the containment building was provided and the static wire associated with the 345-kV line was isolated from the power station structural steel.

Salem Power Station Unit 1

On June 8, 1980, the reactor tripped during an electrical storm. Lightning struck at the south penetration area of reactor containment causing a transient on seven main steam pressure transmitters. Two of these pressure transmitters were damaged and had to be replaced. The transient caused a high steam line pressure differential reactor trip signal and a safety injection signal. The licensee believes the lightning strike hit main steam vent pipes which extend above the penetration area roof and the surge was carried into the building via piping connections.

Kewaunee Power Station

On August 19, 1980, two of four instrument busses lost power during an electrical storm. This resulted in a spurious safety injection (SI) actuation signal, and the unit tripped from full power. In addition to inducing the instrumentation transients, the inverter fuses were blown. These fuses were replaced, and no other evidence of equipment failure was observed.

Byron Power Station Unit 1

On July 13, 1985, when lightning struck the Unit 1 containment, the reactor tripped from approximately 11% power because of induced voltage surges in instrument and control cables in one of four containment penetration areas. The induced voltage caused failure of four rod drive power supplies, including 1 redundant pair. The failure of the redundant supplies resulted in 10 control rods dropping into the core. A power range negative-flux-rate reactor trip resulted from the rod insertion. In addition to the reactor trip, damage occurred to 30 plant instruments. The following systems were affected by the damaged instrumentation: protection channel II, one train of the 48-volt power supply for the solid state protection system, the meteorological tower, control rod drive, and loose-parts monitoring.


A review of cable routings showed that a significant common denominator existed in containment penetrations. All damaged instruments were associated with cables passing through penetrations located in one containment region. In addition to the damaged instrumentation, the lightning damaged a significant amount of security equipment.

The licensee determined that an improved lightning protection system was required to prevent recurrence of a similar incident. By installing copper conductors, external to containment, from the roof mounted lightning rods directly to ground rods in the earth, a low impedance path to ground was provided for future lightning strikes. This modification is similar to the Zion modification described above.

Arkansas Power Station Unit 2

On August 5, 1985, the reactor tripped from 100% power on a low departure-from-nucleate-boiling ratio (DNBR) signal as the result of a lightning strike transient induced in two of the core protection system channels. The licensee's followup investigation revealed no damage to the plant's electrical equipment or instrumentation measuring systems.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the Regional Administrator of the appropriate regional office or this office.


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Attachment: List of Recently Issued IE Information Notices

LIST OF RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
85-85	Systems Interaction Event Resulting In Reactor System Safety Relief Valve Opening Following A Fire-Protection Deluge System Malfunction	10/31/85	All power reactor facilities holding an OL or CP
85-84	Inadequate Inservice Testing Of Main Steam Isolation Valves	10/30/85	All power reactor facilities holding an OL or CP
85-83	Potential Failures Of General Electric PK-2 Test Blocks	10/30/85	All power reactor facilities holding an OL or CP
85-82	Diesel Generator Differential Protection Relay Not Seismically Qualified	10/18/85	All power reactor facilities holding an OL or CP
85-81	Problems Resulting In Erroneously High Reading With Panasonic 800 Series Thermoluminescent Dosimeters	10/17/85	All power reactor facilities holding an OL or CP and certain material and fuel cycle licensees
85-80	Timely Declaration Of An Emergency Class Implementation Of An Emergency Plan, And Emergency Notifications	10/15/85	All power reactor facilities holding an OL or CP
85-17 Sup. 1	Possible Sticking Of ASCO Solenoid Valves	10/1/85	All power reactor facilities holding an OL or CP
85-79	Inadequate Communications Between Maintenance, Operations, And Security Personnel	9/30/85	All power reactor facilities holding an OL or CP; research and nonpower reactor facilities; fuel fabrication and processing facilities

OL = Operating License
CP = Construction Permit