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

December 11, 1989

NRC INFORMATION NOTICE NO. 89-83: SUSTAINED DEGRADED VOLTAGE ON THE OFFSITE ELECTRICAL GRID AND LOSS OF OTHER GENERATING STATIONS AS A RESULT OF A PLANT TRIP

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees to potential problems resulting from a sustained degraded grid voltage on the offsite electrical system. This problem could occur as a result of a plant trip if the generator backup relays of other generating stations on the electrical grid are improperly set, causing additional generating stations to be lost. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On July 11, 1989, Virgil C. Summer Nuclear Station was operating at 100-percent power during a record power demand on the South Carolina Electric & Gas Company (SCE&G) system. During maintenance activities, the generator stator cooling water signal was inadvertently lost, causing a turbine trip and a reactor trip. This turbine trip caused an unexpectedly large voltage disturbance on the grid; subsequently, several other electrical generating stations were lost within the SCE&G system, resulting in an estimated loss of about 1500 megawatts. This significant loss of power resulted in a degraded grid voltage condition at Summer, which caused the station's second level undervoltage protection relays (degraded grid voltage protection) to initiate load shedding and automatic starting and loading of the diesel generators.

Previously, on July 20, 1976, as a result of a unit trip at Millstone Nuclear Power Station, the grid voltage dropped from 352 kV to 333 kV. This voltage drop, in conjunction with the voltage drops produced by the applicable step-down transformers, reduced the control power voltage within individual motor control centers and individual 480-volt controllers to a level that was insufficient to actuate the main line controller contactors. As a result,

IDHR-IIC

when the motors were signaled to start, the contactor control power fuses were blown, making several motors powered from the 480-volt motor control centers inoperable.

Both the Millstone trip and the recent Summer trip resulted in a degraded voltage condition at the plant safety buses. To resolve the Millstone concern, the staff recommended in Branch Technical Position PSB-1, "Adequacy of Station Electric Distribution System Voltages," that a time-delayed, degraded grid voltage detection scheme be incorporated into the plant's safety-related electrical distribution system to protect the Class 1E safety-related equipment. This undervoltage protection has been implemented at all operating plants. As described in the above event at Summer, the second level of undervoltage relays separates the safety buses from the offsite power system (load shedding) and initiates operation of the diesel generators.

A licensee evaluation of the event at Summer showed that a grid instability after the turbine trip and subsequent cascade tripping of other generation stations occurred because the SCE&G system could not compensate for the loss of the 440 MVARs being delivered by Summer. The 115-kV line voltage degraded to 102-kV, and the 230-kV line voltage degraded to 205-kV. This evaluation further showed that the setpoints of the generator backup relays at other generating stations, McMeekin and Saluda, were lower than the standard settings. These setpoints were established many years ago and were never reverified. (Note: Generator backup relays provide protection to the generator against internal and external faults not properly cleared by other relays.) With the generators at McMeekin and Saluda in the automatic voltage control mode, the generators tried to increase voltage in response to the loss of power at Summer. This attempt to raise voltage resulted in a reactive generation increase that caused the oversensitive generator backup relays to trip the units. The as-found relay settings for those generating stations were 118 and 107 percent of generator output. SCE&G stated that its present, standard setting for the generator backup relays is 150 percent of the generator MVA rating. Even with the relay settings of four Fairfield pumped storage stations set at 150 percent, the large voltage decrease that resulted from the loss of the Summer, McMeekin, and Saluda units and the automatic voltage regulation response of the Fairfield units also caused the Fairfield units to trip.

Discussion:

The offsite power system is the preferred and the most reliable source of power for nuclear plant safety systems. Therefore, plants remain connected to the preferred source for as long as possible, that is, for as long as the capability and capacity of the offsite source permits, before switching to the emergency diesel generators. A loss of generation capacity from a plant challenges the offsite power supply availability; thus, during licensing, plants perform a grid stability analysis to ensure that the offsite power system will remain stable in the event of the loss of the largest single supply to the grid or the loss of the largest load from the grid.

The events that occurred at Summer and at Millstone were the result of these plants being operated outside the analyzed conditions of their grid stability analyses. The Summer licensee has confirmed that in the past there had been other scrams from 100-percent power without degraded grid voltage problems. However, the maximum MVARs supplied to the grid during those plant trips was 317 MVARs whereas, during the recent event, the generator was supplying 440 MVARs to the grid. One short-term corrective measure taken by Summer was to limit MVAR generation to 300 MVARs unless otherwise approved by their general manager of nuclear plant operations. Thus, it appears that the licensee did not consider its maximum reactive output in its grid stability analysis.

Licensees perform the grid stability analysis on the basis of system information, such as transmission, generation, and load, that is available at the time the plant is licensed. However, licensees may wish to review their grid stability analysis whenever transmission, generation, or load system changes occur that affect the original design basis condition to ensure that the original design basis of the plant remains valid in accordance with General Design Criterion 17, "Electric Power Systems." Moreover, to avert recurrence of conditions that occurred at Summer, licensees may also wish to periodically check the setpoints of the generator backup relays.

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 NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Om Chopra, NRR
(301) 492-0835

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-82	Recent Safety-Related Incidents at Large Irradiators	12/7/89	All NRC licensees authorized to possess and use sealed sources at large irradiators.
89-59, Supp. 1	Suppliers of Potentially Misrepresented Fasteners	12/6/89	All holders of OLs or CPs for nuclear power reactors.
89-81	Inadequate Control of Temporary Modifications to Safety-Related Systems	12/6/89	All holders of OLs or CPs for nuclear power reactors.
89-80	Potential for Water Hammer, Thermal Stratification, and Steam Binding in High-Pressure Coolant Injection Piping	12/1/89	All holders of OLs or CPs for nuclear power reactors.
89-79	Degraded Coatings and Corrosion of Steel Containment Vessels	12/1/89	All holders of OLs or CPs for LWRs.
89-56, Supp. 1	Questionable Certification of Material Supplied to the Defense Department by Nuclear Suppliers	11/22/89	All holders of OLs or CPs for nuclear power reactors.
89-78	Failure of Packing Nuts on One-Inch Uranium Hexafluoride Cylinder Valves	11/22/89	All NRC licensees authorized to possess and use source material and/or special nuclear material for the heating, emptying, filling, or shipping of uranium hexafluoride in 30- and 48-inch diameter cylinders.
89-77	Debris in Containment Emergency Sumps and Incorrect Screen Configurations	11/21/89	All holders of OLs or CPs for PWRs.

OL = Operating License
CP = Construction Permit

The events that occurred at Summer and at Millstone were the result of these plants being operated outside the analyzed conditions of their grid stability analyses. The Summer licensee has confirmed that in the past there had been other scrams from 100-percent power without degraded grid voltage problems. However, the maximum MVARs supplied to the grid during those plant trips was 317 MVARs whereas, during the recent event, the generator was supplying 440 MVARs to the grid. One short-term corrective measure taken by Summer was to limit MVAR generation to 300 MVARs unless otherwise approved by their general manager of nuclear plant operations. Thus, it appears that the licensee did not consider its maximum reactive output in its grid stability analysis.

Licensees perform the grid stability analysis on the basis of system information, such as transmission, generation, and load, that is available at the time the plant is licensed. However, licensees may wish to review their grid stability analysis whenever transmission, generation, or load system changes occur that affect the original design basis condition to ensure that the original design basis of the plant remains valid in accordance with General Design Criterion 17, "Electric Power Systems." Moreover, to avert recurrence of conditions that occurred at Summer, licensees may also wish to periodically check the setpoints of the generator backup relays.

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 NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Om Chopra, NRR
(301) 492-0835

Attachment: List of Recently Issued NRC Information Notices

Document Name: IN ON GRID INSTABILITY

*SEE PREVIOUS CONCURRENCES

			D/DOEA:NRR CERossi 12/5/89	*C/OGCB:DOEA:NRR CHBerlinger 11/28/89
*OGCB:DOEA:NRR DProchnow 10/20/89	*SELB:DET:NRR OChopra 10/20/89	*C/SELB:DET:NRR FRosa 10/20/89	*D/DET:NRR AThadani 10/20/89	*RPB:ARM TechEd 10/23/89

~~The NRC staff has concluded that~~ The events that occurred at Summer and at Millstone were the result of these plants being operated outside the analyzed conditions of their grid stability analyses. The Summer licensee has confirmed that in the past there had been other scrams from 100-percent power without degraded grid voltage problems. However, the maximum MVARs supplied to the grid during those plant trips was 317 MVARs whereas, during ~~this~~ recent event, the generator was supplying 440 MVARs to the grid. One short-term corrective measure taken by Summer was to limit MVAR generation to 300 MVARs unless otherwise approved by their general manager of nuclear plant operations. Thus, it appears that the licensee did not consider its maximum reactive output in its grid stability analysis.

Licensees perform the grid stability analysis on the basis of system information, such as transmission, generation, and load, that is available at the time the plant is licensed. However, licensees may wish to review their grid stability analysis whenever transmission, generation, or load system changes occur that affect the original design basis condition to ensure that the original design basis of the plant remains valid in accordance with General Design Criterion 17, "Electric Power Systems." Moreover, to avert recurrence of conditions that occurred at Summer, licensees may also wish to periodically check the setpoints of the generator backup relays.

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 NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Om Chopra, NRR
(301) 492-0835

Attachment: List of Recently Issued NRC Information Notices

Document Name: IN ON GRID INSTABILITY

*SEE PREVIOUS CONCURRENCES

			D/DOEA:NRR	C/OGCB:DOEA:NRR
			CERossi	CHBerlinger
			11/ /89	11/28/89
*OGCB:DOEA:NRR	*SELB:DET:NRR	*C/SELB:DET:NRR	*D/DET:NRR	*RPB:ARM
DProchnow	OChopra	FRosa	AThadani	TechEd
10/20/89	10/20/89	10/20/89	10/20/89	10/23/89

Final approved by O Chopra in telephone conversation with E. Rossi on 12/5/89.

The NRC staff has concluded that the events that occurred at Summer and at Millstone were the result of these plants being operated outside the analyzed conditions of their grid stability analyses. The Summer licensee has confirmed that in the past there had been scrams from 100 percent power without degraded grid voltage problems; however, the maximum MVARs supplied to the grid during these plant trips was 317 MVARs. During this recent event, the generator was supplying 440 MVARs to the grid. One short-term corrective measure was to limit MVAR generation at Summer station. Thus, it appears that the licensee did not include the worst possible condition in its grid stability analysis. General Design Criterion 17, "Electric Power Systems", states that provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Thus, voltage degradation following a plant trip could violate GDC 17 if the offsite power system does not have the capability to automatically start as well as operate all required safety loads. Although protection is provided from the degraded grid by a second level of undervoltage protection systems, this situation becomes a safety problem if a plant trip results in degraded voltage and unnecessarily challenges the diesel generators to start and provide power to the safety loads.

Licensees perform the grid stability analysis on the basis of system information, such as transmission, generation, and load, that is available at the time the plant is licensed. However, licensees may wish to perform the grid stability analysis whenever system changes occur that affect the original design-basis condition to ensure that the original design-basis of the plant remains valid in accordance with GDC-17. Moreover, to avert recurrence of conditions that occurred at Summer, licensees may also wish to periodically check the setpoints of the generator backup relays.

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 NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Om Chopra, NRR
(301) 492-0835

Attachment: List of Recently Issued NRC Information Notices

OGCB:DOEA:NRR	SELB:DET:NRR	RPB:ARM	C/OGCB:DOEA:NRR	D/DOEA:NRR
DProchnow	OChopra	TechEd BC	CHBerlinger	CERossi
10/20/89	10/20/89	10/23/89	10/ /89	10/ /89

C/SELB:DET:NRR
F. ROSA
10/20/89

D/DET:NRR
A. THADANI for
10/20/89