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SUBJECT: LER 90-004-00:on 900301,unanticipated sys interaction during undervoltage condition in 230 kV switchyard.

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DUKE POWER

April 30, 1990

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 269/90-04

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 269/90-04 concerning unanticipated system interaction during undervoltage condition in the 230 KV switchyard results in failure to comply with Technical Specifications.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(i)(B). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron
Station Manager

RSM/ftr

Attachment

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NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 1	0 5 0 0 0 2 6 9	1 OF 1 3

TITLE (4) Unanticipated System Interaction During Undervoltage Condition In The 230KV Switchyard Results In Failure To Comply With Technical Specifications

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 3	0 1	9 0	9 0	0 0 4	0 0	0 4	3 0	9 0	Oconee, Unit 2	0 5 0 0 0 2 7 0
									Oconee, Unit 3	0 5 0 0 0 2 8 7

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(a)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(a)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
	AREA CODE
Henry R. Lowery, Chairman Oconee Safety Review Group	8 0 3 — 8 8 5 - 3 0 3 4

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On March 1, 1990, with all three Oconee Units at 100% full power, it was discovered that the impact of a possible degraded voltage condition in the 230 kV Switchyard (SWYD) could be unacceptable under design basis assumptions. Design Engineering, while developing a Design Basis Document, determined that SWYD voltage could drop below the minimum voltage level (219kV) required for worst case loading during a unit trip and Loss-Of-Coolant-Accident on the tripped unit. Further review of the degraded voltage scenario revealed that one of the two required on-site emergency power paths, the Keowee Overhead, could be unavailable for automatic connection to the Oconee 230 kV switching station because of the relative setpoints of the under voltage relays serving the startup breaker logic and the external grid trouble protection system. In addition, this same undervoltage condition could prevent the startup transformer 4160 V breakers from closing in causing the SWYD and its associated incoming transmission lines to be unavailable to provide their required support function. Both situations are contrary to Technical Specification requirements. In review of available data over the last 8 years, one instance was found which indicated SWYD voltage was in fact degraded below 219 kV. The root cause of this event is classified Design Deficiency, unanticipated interaction of systems. Corrective actions were to revise an Operations procedure requiring special monitoring of SWYD voltage and to provide appropriate operator required actions if indicated voltage was below 225.2 kV. Also, a SWYD modification was initiated to resolve the undervoltage problem.

* U.S.GPO:1984-0-454-481/18759

BACKGROUND

The normal power supply to a unit's auxiliary load is provided through the unit auxiliary transformer [EIIS:XFMR] connected to the generator bus. If power is not available from the unit's generator [EIIS:TB] through the unit's auxiliary transformer, power is supplied to the unit through its startup transformer fed from either or both of the buses in the 230 kV switching station. Power to the startup transformer can flow through the 230 kV switching station from any one of thirteen supplies. Redundant external grid protection systems are provided to isolate the 230 kV switching station on failure of the external transmission network.

The Oconee 230 kV Switchyard [EIIS:FK] is an interface between the 230 kV Duke transmission line network and Oconee Units (see Attachment 1 diagram). Abnormal conditions in the 230 kV Switchyard result in switching operations that are initiated by protective relaying. One of the protective relaying circuits is the External Grid Trouble Protection System [EIIS:EK]. This system is designed to monitor the voltage and frequency of both the red and yellow buses in the 230 kV Switchyard. When this system detects abnormal conditions, it initiates an automatic startup of the Keowee Hydro Units [EIIS:EK] and provides a path for emergency power from Keowee to the Oconee Startup Transformers CT-1, CT-2, and CT-3 via the 230 kV switching station. In order for this path (Keowee Overhead) to be established, several Power Circuit Breakers (PCBs) are closed and others are tripped open to isolate the yellow bus from the grid.

The "Switchyard Isolate Complete" circuitry functions following an external grid trouble protective relay actuation. This circuitry provides an automatic close permissive to either Keowee's Air Circuit Breaker, ACB 1 or 2, which connects Keowee Unit 1 or 2, respectively, to the dedicated overhead emergency power path. The "Switchyard Isolate Complete" signal is generated when the logic indicates that the 230 kV Switchyard has been separated from a faulted external grid and that the switchyard PCBs are aligned to supply power to the Oconee Startup Transformers. The correct combination of closed and open PCBs is necessary to accomplish the switchyard isolation and alignment of the Keowee Hydro Unit to the Startup Transformers.

Technical Specification 3.7.2 (a) states "One of the two independent on-site emergency power paths, as defined in 3.7.1 (b), may be inoperable for periods not exceeding 72 hours for test or maintenance, provided the alternate power path is verified operable within one hour of the loss and every eight hours thereafter."

Technical Specification 3.7.5 parts (a), (c) and (d) state the following:

"In the event that all conditions of Specification 3.7.1 are met except that all 230 kV transmission lines are lost, the reactor shall be permitted to remain critical or be restarted provided the following restrictions are observed:

(a) Prior to restart of a shutdown reactor or within 1 hour of losing all 230 kV transmission lines for an operating reactor, the 4160 volt standby buses shall be energized by one of the Lee gas turbines through the 100 kV transmission circuit. The Lee gas turbine and the 100 kV transmission circuit shall be completely separate from the system grid and offsite non-safety-related loads.

(c) If all 230 kV transmission lines are lost, restore at least one of the inoperable 230kV offsite sources to operable status within 24 hours or be in at least hot standby within the next 6 hours. With only one offsite source restored, restore at least two 230kV offsite circuits to operable status within 72 hours from time of initial loss or be in at least hot standby within the next 6 hours and in cold shutdown within the following 30 hours.

(d) After loss of all 230 kV transmission lines, this information shall be reported within 24 hours to the U.S. NRC Regional Office, Region II. If the outage is expected to exceed 24 hours, a written report shall be submitted detailing the circumstances of the outage and the estimated time to return the 230kV transmission lines to operating condition."

EVENT DESCRIPTION

This Licensee Event Report (LER) addresses a potential problem whereas the Keowee Overhead emergency power path and/or the 230 KV Grid may not be automatically available if the 230 kV Switchyard (SWYD) voltage decreases to a point below the analyzed minimum value (219 kV). The 230 kV SWYD may not be available due to the setpoints of the protective relaying on the startup transformer breakers (E breakers). Additionally the overhead path would not be automatically available if the SWYD voltage stays above 160 kV. This is because the External Grid Trouble Protective System was designed to actuate and isolate the yellow bus upon detection of an imminent collapse of the grid. All Oconee Units have operated in all operational modes under these potential conditions. This problem was detected while conducting a program established within Duke Power Company (DPC) to review/analyze certain plant systems and to document their design

basis. The program is a documented study referred to as Design Basis Documentation (DBD).

DPC reviewed the electric power system at Oconee Units 1, 2, and 3 upon request by the NRC in August 1979. The review consisted of:

(a) Determining analytically the capacity and capability of the offsite power system and onsite distribution system to automatically start as well as operate all required loads within their required voltage ratings in the event of (1) an anticipated transient, or (2) an accident (such as LOCA) without manual shedding of any electric loads.

(b) Determining if there are any events or conditions which could result in the simultaneous or, consequential loss of both required circuits from the offsite network to the onsite electric distribution system.

An NRC Generic Letter dated August 8, 1979 included staff guidelines for performing the required voltage analysis and the licensee was further required to perform a test in order to verify the validity of the analytical results. DPC responded by letters dated October 29, 1979, January 31, 1980, June 4, 1980, February 5, 1982, and November 8, 1982. A detailed review and technical evaluation of the DPC submittals was performed by a vendor under contract to the NRC. This work was reported in Technical Evaluation Report, "Adequacy of Station Electric Distribution System Voltages, Oconee Nuclear Station, Units 1, 2 and 3", dated January 1983. The evaluation results found that the offsite power and the onsite distribution systems were capable of providing acceptable voltages for worst case station electric load and grid voltages.

On November 15, 1985, as a result of continuing load studies on the Oconee power distribution systems, fifteen safety related Motor Operated Valves (MOV) were identified which potentially would not operate with a degraded voltage condition in the 230 kV SWYD. This assumed an accident condition which results in a unit trip, a transfer of loads from the normal power source to the offsite (preferred) power source, and an Engineered Safeguards (ES) [EIIS:JE] actuation during a degraded 230 kV SWYD voltage condition. On November 19, 1985, after further evaluation, it was determined that six 208 VAC MOVs 1BS-1,1BS-2, 2BS-1, 2BS-2, 3BS-1, and 3BS-2 could not be assured of performing their intended safety function under the above conditions. The remaining nine MOVs were found capable of performing their safety function under the stated conditions. This incident was reported to the NRC under LER 269/85-14. With the implementation of a nuclear station modification, the potential low voltage conditions at the Reactor Building Spray 208 VAC MOVs resulting from a postulated degraded SWYD voltage was corrected. Based on the

transmission and generating system capability at that time, the lowest expected voltage during a postulated degraded grid voltage condition was 219 kV.

On March 1, 1990, Design Engineering, while performing a design basis study of the 230 kV SWYD, discovered that, during certain 230 kV SWYD degraded voltage conditions, both the 230 kV SWYD and the Keowee Overhead emergency power path could be unavailable to the Oconee Units. These conditions are possible because the 230 kV SWYD must be greater than 219 kV in order to adequately supply ES loads while the automatic actuation voltage setpoint for the Keowee Overhead emergency power path is less than 160 kV. If degraded SWYD voltage exists between these relative setpoints, then power to the ES buses may not be automatically available from either source.

Upon this discovery, Design Engineering contacted the Oconee Nuclear Station Compliance section, initiated a Problem Investigation Report, and began an Operability Evaluation (OE) on the system in question. Various sections of Technical Specification 3.7 were reviewed for applicability to this finding. The initial OE was approved on March 3, 1990 and later revised on April 2, 1990 to add conservatism in respect to a required monitored voltage on the SWYD.

On March 7, 1990, a review of historical 230 kV SWYD voltage data was conducted. The data revealed one instance in the past 8 years where SWYD voltages decreased below the 219 kV minimum value.

On March 8, 1990, station action was taken to revise Operations procedure PT/1/A/600/01, "Periodic Instrument Surveillance", requiring operators to monitor SWYD voltage every two hours. Procedure instructions were provided to declare the startup transformers inoperable for all Oconee Units greater than 200 degrees F. if the SWYD voltage was below 222 kV.

Design Engineering also initiated a Station Problem Report which resulted in the later development of Nuclear Station Modification (NSM) 52850. This NSM details the installation of an additional two out of three logic arrangement of undervoltage relays which sense the 230 kV input to each units startup transformers. The NSM will also provide an annunciator [EIIS:IB], digital computer and events recorder indication to plant operators as well as input to the Operator Aid Computer (OAC) when 230 kV SWYD degraded voltage conditions exist. This modification will automatically initiate existing SWYD isolate logic if degraded voltage conditions and a LOCA on any Oconee unit occur concurrently.

On March 29, 1990, after further discussions between Design Engineering personnel, station Operations Engineering support, and DPC Operating Department (Dispatcher) concerning the operability evaluation, a second

revision was made to procedure PT/1/A/600/01. This change requires the operators to declare the startup transformers inoperable at 225.2 kV. This action was believed necessary to add additional conservatism until the planned modification could be implemented.

On April 5, 1990, at 0900 hours, station management determined that Technical Specification (TS) 3.7.5 (230 kV Transmission Lines - Offsite Power), as well as TS 3.7.2 (a) (Onsite Emergency Power Path) had been unknowingly violated during the prior event when SWYD voltage had been below 219 kV. These Technical Specification requirements rather than TS 3.7.2 (i) (Startup Transformer) were found applicable to the undervoltage event. The NRC was notified on the same date.

A pre-existing task force established to re-write Technical Specification 3.7 was charged with the responsibility to prepare a proposed technical specification submittal that will clarify TS 3.7.5 requirements in view of the planned SWYD modification.

On April 18, 1990, during this LER investigation and further DBD studies of the 230 kV SWYD, a potential problem relating to the undervoltage relay settings for the startup transformer breakers was discovered. Continued investigation revealed that this newly identified potential problem could cause ES equipment to be supplied from the 230 kV SWYD when degraded voltage exists. This finding is also reportable under 10CFR50.72 and 10CFR50.73 as determined on April 24, 1990. A separate LER (269/90-05) will address this problem.

Operations procedure PT/1/A/600/01 (as applicable for each Oconee Unit) was changed to require Operations to enter TS 3.0 (shutdown in 12 hours) if monitored SWYD voltage is found below 225.2 kV. This change was implemented on April 19, 1990 and will be required until installation of NSM 52850.

CONCLUSIONS

The Design Basis Documentation program was established in 1989 with the intent to provide readily available documents on current design basis for certain systems. For inclusion to this document, systems must be evaluated in-depth so that a full understanding is reached and can be documented. On March 1, 1990, a study of the 230 kV system was being conducted by Design personnel when this 230 kV SWYD undervoltage problem was identified. This problem has existed from the onset of placing the power distribution grid and associated systems into operation at Oconee Nuclear Station. The root cause of this event is classified as Design Deficiency, unanticipated interaction of systems.

Duke Power Company's (DPC's) failure to recognize this situation allowed Oconee Nuclear Station to operate unknowingly in non-compliance with Technical Specifications 3.7.2 (a) and 3.7.5.

Past responses to NRC Generic Letter dated August 8, 1979 will be reviewed by DPC Regulatory Compliance and Design Engineering for adequacy in view of these newly discovered unacceptable conditions caused by possible undervoltage on the 230 kV SWYD. All previous responses found to be incorrect/inappropriate will be corrected and resubmitted to the NRC.

The consequences of the later discovery, ES equipment on affected unit being supplied from a degraded SWYD, will be reported by Duke Power Company in a separate Licensee Event Report (LER 269/90-05).

Several 230 kV SWYD problems have occurred in the last two years. The reports associated with these events were reviewed, and as a result, this event was classified as non-recurring. The specific equipment involved in this incident was not involved in earlier SWYD related problems.

The health and safety of the public were not compromised as a result of these unknown conditions. The Unit trip/LOCA scenario described in this report as required to present these undervoltage conditions has not occurred at Oconee Nuclear Station. There were no equipment malfunctions or component failures involved in this discovery, therefore no NPRDS reportable conditions exist. There were no radioactive releases, radiation exposures, or personnel injuries resulting from this event.

All three Oconee Units continue to safely operate within current design for the following reasons:

1. SWYD voltage is presently adequate.
2. SWYD voltage is being monitored to assure continued adequacy.
3. In the event of a SWYD voltage decrease approaching a degraded condition;

    a) the operators have instructions to enter TS 3.0 (shutdown in 12 hours) due to the Offsite Transmission system and the Keowee Overhead power path being considered inoperable.
    b) the operators have instructions to align backup power to the Standby Buses from the Lee Gas Turbines.
    c) the operators have instructions to contact the System Dispatcher (electrical distribution system controller) to immediately take steps to increase SWYD voltage.

4. The above short term corrective actions also assure acceptable operation in view of the problem with the undervoltage relay settings of the startup transformer breakers.

CORRECTIVE ACTIONS

Immediate:

1. Operations procedure PT/1/A/600/01 (as applicable to each unit) was revised to have operators monitor Switchyard (SWYD) voltage every two hours. Should voltage drop below 225.2 kV on the 230 kV SWYD yellow bus, the following procedure instructions are given to the operator:

   - notify the dispatcher and increase voltage.
   - verify the Keowee Underground power path is operable.
   - align backup power to the Standby Buses from the Lee Gas Turbines.
   - place the Units under Technical Specification 3.0 which requires the condition to be corrected or the Units placed in hot shutdown conditions within 12 hours. If still degraded, place the Units in cold shutdown conditions within the next 24 hours.

Subsequent:

1. Design Engineering initiated a Station Problem Report which resulted in the origination of an urgent station modification to resolve the problem of the Keowee Overhead power path being unavailable for automatic start and alignment between approximately 160 kV and 219 kV for design basis events. This modification (NSM 52850) will provide early warning to the operators of degraded voltage conditions in the 230 kV Switchyard.

2. Further investigation through the Design Basis Documentation program was conducted by Design Engineering to document degraded voltage allowable limits and basis for design.

3. Technical Specifications (TS) were further evaluated by both the Oconee Nuclear Station and General Office Compliance sections to determine the proper TS that applied for "degraded voltage".

4. Operator Training Package 90-05 was developed to provide operators with information in respect to actions required in the event such a condition as herein described should exist at Oconee.

Planned:

1. Nuclear Station Modification (NSM) 52850 will be implemented on all three Oconee Units.

2. Revisions to past responses for NRC Generic letter dated August 8, 1979 will be submitted as appropriate to the NRC by General Office Regulatory Compliance.

3. A Technical Specification revision to the applicable section of TS 3.7 will be submitted to clarify the effect of degraded voltage and the use of the External Grid Protection system.

SAFETY ANALYSIS

It is possible that the E breakers would have closed with the 230 kV switchyard at less than 219 kV due to calibration drift in the associated relay settings. The closing of these breakers onto a voltage-reduced power source will be addressed by the forthcoming responses to the NRC Generic Letter dated August 8, 1979 and LER 269/90-05. This Safety Analysis addresses only the scenario of the E breakers not closing during a undervoltage condition associated with a reactor trip/LOCA event.

LOCA

Without assuming any additional failures, if a LOCA had occurred on any unit while the 230 kV switchyard was between 160 kV and 219 kV, electrical power would have been automatically provided to the LOCA unit from the Keowee Hydroelectric Station via the underground path (see Attachment 2 diagram). As previously discussed, the E breakers may not have closed to provide power from the switchyard because of the degraded voltage. However, if needed, the Emergency Power Switching Logic (EPSL) [EIIS:EK] was capable of initiating the delivery of power through the underground path from Keowee as designed without accident mitigation being hampered.

If the E breakers did not close and a single failure is assumed that would disable the underground power path then electrical power would not have been automatically provided in the scenario of a LOCA concurrent with a switchyard voltage between 160 kV and 219 kV. Normally on loss of the underground path, the EPSL would align the accident unit to the startup source which receives power from the 230 kV switchyard or the overhead path. The overhead path is the power supply route only after a switchyard isolation is signaled and the yellow bus is isolated. In this case, the EPSL would not attempt to retransfer to the startup source because voltage of less than 219 kV would prevent E breaker closure and voltage greater

than 160 kV would not initiate switchyard isolation. The setpoint of the external grid protection undervoltage relays is 160 kV.

Without automatic emergency power, there remained two alternative actions. One option was for the operators to isolate the switchyard. This action would have allowed the EPSL to automatically align the overhead emergency power path. The other option was for the operators to close the SL breakers to receive power from the 100 kV grid via Central Switchyard. This latter action is the most likely because it is described in the "Loss of Power" procedure (AP/1,2,3/A/1700/11). Central Switchyard is a very capable source of power in accident conditions; however, this switchyard does not meet the NRC's requirements for degraded grid protection (reference LER 269/89-10). If Central Switchyard was found in a degraded condition then it is felt that the operators would have recognized the need to isolate the 230kV switchyard and provide power via the Keowee Overhead emergency power path.

During a LOCA and loss of power situation, the operators know to expect power in 11 seconds and at such time if power is not received they would immediately seek an alternate power source. The time it takes for the operators to progress through the "Loss of Power" procedure or to isolate the switchyard cannot be predicted with accuracy. It has been estimated that one minute is sufficient time for the necessary valves to open, pumps to start and lines to fill with water; therefore, operator action to restore power within two minutes would inject water into the vessel within three minutes. From a best-estimate perspective, substantial fuel damage is not expected within three minutes. Operator action to restore power within one minute would inject water into the vessel within two minutes. From a best-estimate perspective, fuel damage within two minutes is expected to be negligible. Fuel damage, as used here, refers to clad integrity; therefore, dose consequences would have been negligible also.

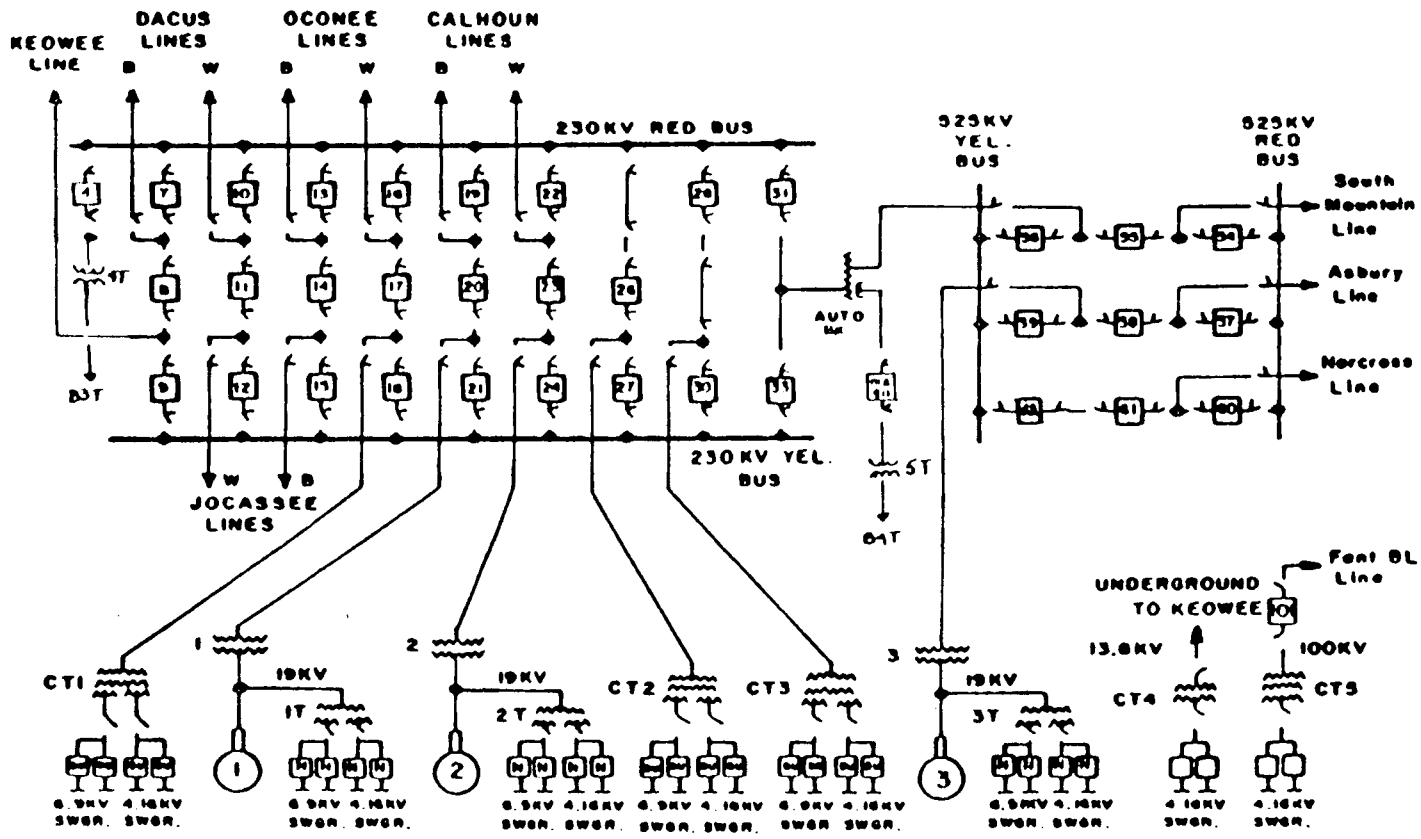
Reactor Trip

When the reactor trips, the unit's loads are transferred from the normal source to the startup source of which the E breakers are a part. If the reactor had tripped and the E breakers did not close due to the reduced voltage of the 230 kV switchyard then the Main Feeder Bus [EIIS:EA] Monitor Panel (MFBMP) would have detected this condition and initiated power restoration by Keowee via the underground path. If a single failure is assumed that would disable the underground path then operator action would have been necessary as described in the LOCA scenario. In a non-accident situation, there is adequate time to search for an alternate power source. FSAR Section 15.8.3 states that in the event of a loss of all power, the turbine-driven emergency feedwater pump and the gravity flow of the Emergency Condenser Cooling Water System will ensure core

protection. The Standby Shutdown Facility (SSF) also provides an alternate means to maintain hot shutdown conditions on an affected unit.

In these postulated scenarios of a LOCA or reactor trip, greatest concern is derived from assuming the worst case single failure which disables the underground emergency power path. The Keowee Underground power path has been very reliable and was unavailable for only 42.6 hours during 1989 which is typical of its many years of reliable service. The portion of this path which would be susceptible to a single failure is the Standby Transformer (CT-4). By being a passive component, the transformer's hourly failure probability is low and has been estimated to be 1.51E-05. Multiplying this probability by the probability of a LOCA or reactor trip during the times the switchyard voltage was reduced makes these situations very improbable. The accidents postulated in this Safety Analysis have never occurred; therefore, the health and safety of the public were not affected.

ATTACHMENT 1



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TEXT (If more space is required, use additional NRC Form 366A's) (17)

ATTACHMENT 2

OCONEE NUCLEAR STATION
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