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

June 3, 1977

Docket Nos. 50-269
50-270
and 50-287

RECEIVED
JUN 6 1976
DUKE POWER
STEAM PRODUCTION DEPT.

Response due NLT 7/31/77

Duke Power Company
ATTN: Mr. William O. Parker, Jr.
Vice President
Steam Production
Post Office Box 2178
422 South Church Street
Charlotte, North Carolina 28242

Gentlemen:

RE: OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3

We are currently reviewing the onsite emergency power systems of all operating nuclear power facilities to assess the susceptibility of their safety related electrical equipment with regard to (1) sustained degraded voltage conditions at the offsite power sources and (2) interaction between the offsite and onsite emergency power systems.

We have completed our review of licensee responses to our previous generic request for information relative to the electrical power distribution systems. Based on this initial review, we have prepared the Safety Evaluation and Statement of Staff Positions contained in Enclosure 1.

We request that you compare the current design of the emergency power systems at your facility(ies) with the Staff Positions stated in the enclosure and:

(1) propose plant modifications as necessary to meet the Staff Positions, or

(2) provide a detailed analysis which shows your facility design has equivalent capabilities and protective features.

Additionally, we require that certain technical specifications be incorporated into all facility operating licenses. Model technical specifications, consistent with the Staff Positions contained in Enclosure 1, are provided in Enclosure 2.

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Accordingly, we request that you apply, within forty-five days of the receipt of this letter, for an amendment to your facility operating license(s) to incorporate comparable technical specifications to those presented in the enclosure. Additionally, you should provide a description and a schedule for the completion of any plant associated modifications.

If you have any questions on this matter, please contact us.

Sincerely,

J. V. Wambach

for A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Enclosures:
1. Staff Positions
2. Model Technical Specifications

cc w/enclosures:
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Walhalla, South Carolina 29691

ENCLOSURE 1

SAFETY EVALUATION AND STATEMENT OF STAFF POSITIONS RELATIVE TO THE EMERGENCY POWER SYSTEMS FOR OPERATING REACTORS

A. INTRODUCTION

The onsite emergency power systems of operating nuclear power facilities are being reviewed to assess the susceptibility of their associated redundant safety-related electrical equipment to:

(a) Sustained degraded voltage conditions at the offsite power source; and

(b) Interaction of the offsite and onsite emergency power systems.

We have completed our review of the responses to our generic request for additional information[1] relative to the electrical power distribution systems of currently operating nuclear power facilities. In response to our request, all licensees have analyzed their system designs to determine that the voltage levels at the safety-related buses have been optimized for the full load and minimum load conditions that are expected throughout the anticipated range of voltage variations for the offsite power sources. The transformer voltage tap adjustments that were necessary to optimize the voltage levels have been accomplished.

In addition to the above corrective action, we have developed the following staff positions for use in evaluation of each of the operating nuclear [redacted]ower plants with regard to the two items identified above. These positions [redacted] re developed on the basis of our review of the licensee response to our

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[redacted] Letters to all licensees, dated August 12 and 13, 1976.

requests for additional information and of other related information as cited in the text.

B. <u>POSITIONS</u>

1) <u>Position 1: Second Level of Under-or-Over Voltage Protection with a Time Delay</u>

We require that a second level of voltage protection for the onsite power system be provided and that this second level of voltage protection shall satisfy the following criteria:

a) The selection of voltage and time set points shall be determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels;

b) The voltage protection shall include coincidence logic to preclude spurious trips of the offsite power source;

c) The time delay selected shall be based on the following conditions:

(1) The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the FSAR accident analyses;

(2) The time delay shall minimize the effect of short duration disturbances from reducing the availability of the offsite power source(s); and

(3) The allowable time duration of a degraded voltage condition at all distribution system levels shall not result in failure of safety systems or components;

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d) The voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the voltage set point and time delay limits have been exceeded;

e) The voltage monitors shall be designed to satisfy the requirements of IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"; and

f) The Technical Specifications shall include limiting conditions for operation, surveillance requirements, trip set points with minimum and maximum limits, and allowable values for the second-level voltage protection monitors.

General Design Criterion 17 (GDC 17) "Electric Power Systems", of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR Part 50 requires: (a) two physically independent circuits from the offsite transmission network (although one of these circuits may be a delayed access circuit, one circuit must be automatically available within a few seconds following a loss-of-coolant accident); (b) redundant onsite A.C. power supplies; and (c) redundant D.C. power supplies.

GDC-17 further requires that the safety function of each a.c. system (assuming the other system is not functıoning) shall be to provide sufficient capacity and capability to assure that: (a) specified acceptable fuel design limits and the design conditions for the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences; and (b) the core is cooled and containment integrity and other vital functions are maintained during any of the postulated accidents.

Existing undervoltage monitors automatically perform the required function of switching from offsite power, the preferred power source, to the redundant onsite power sources when the monitored voltage degrades to a level of between 50 to 70 percent of the nominal rated safety bus voltage. This is usually accomplished after a one-half to one second time delay. These undervoltage monitors are designed to function on a complete loss of the offsite power source.

The offsite power system is the common source which normally supplies power to the redundant safety-related buses. Any transient or sustained degradation of this common source will be reflected onto the onsite system's safety-related buses.

A sustained degradation of the offsite power system's voltage could result in the loss of capability of the redundant safety loads, their control circuitry, and the associated electrical components required for performing safety functions.

The operating procedures and guidelines utilized by electric utilities and their interconnected cooperative organizations minimize the probability for the above conditions to occur. However, since degradation of an offsite power system that could lead to or cause the failure of redundant safety-related electrical equipment is unacceptable, we require the additional safety margins associated with implementation of the protective measures detailed above.

2) Position 2: <u>Interaction of Onsite Power Sources with Load Shed Feature</u>

We require that the current system designs automatically prevent load shedding of the emergency buses once the onsite sources are supplying power to all sequenced loads on the emergency buses. The design shall also include the capability of the load shedding feature to be automatically reinstated if the onsite source supply breakers are tripped. The automatic bypass and reinstatement feature shall be verified during the periodic testing identified in Position 3.

In the event an adequate basis can be provided for retaining the load shed feature when loads are energized by the onsite power system, we will require that the setpoint value in the Technical Specifications, which is currently specified as "...equal to or greater than..." be amended to specify a value having maximum and minimum limits. The licensees' bases for the setpoints and limits selected must be documented.

GDC 17 requires that provisions 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.

The functional safety requirement of the "loss-of-offsite power monitors" is to detect the loss of voltage on the offsite (preferred) power system and to initiate the necessary actions required to transfer the safety-related buses to the onsite system. The load shedding feature, which is required to function prior to connecting the onsite power sources to their respective buses can adversely interact with the onsite power sources if the load shedding feature is not bypassed after it has performed its required function. The load shed feature should also be reinstated to allow it to perform its function if the onsite sources are interrupted and are subsequently required to be reconnected to their respective buses.

3) Position 3: Onsite Power Source Testing

We require that the Technical Specifications include a test requirement to demonstrate the full functional operability and independence of the onsite power sources at least once per 18 months during shutdown. The Technical Specifications shall include a requirement for tests: (1) simulating loss of offsite power in conjunction with a safety injection actuation signal; and (2) simulating interruption and subsequent reconnection of onsite power sources to their respective buses. Proper operation shall be determined by:

a) Verifying that on loss of offsite power the emergency buses have been de-energized and that the loads have been shed from the emergency buses in accordance with design requirements.

b) Verifying that on loss of offsite power the diesel generators start from ambient condition on the autostart signal, the emergency buses are energized with permanently connected loads, the auto-connected emergency loads are energized through the load sequencer, and the system operates for five minutes while the generators are loaded with the emergency loads.

c) Verifying that on interruption of the onsite sources the loads are shed from the emergency buses in accordance with design requirements and that subsequent loading of the onsite sources is through the load sequencer.

GDC 17 requires that provisions be included to minimize the probability of losing electric power from any one of the remaining supplies as a result of or coincident with the loss of power generated by the reactor power unit, 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.

The testing requirements identified in Position 3 will demonstrate the capability of the onsite power system to perform its required function. The tests will also identify undesirable interaction between the offsite and onsite emergency power systems.

0 0 3 4 6 0 1 7 5

TABLE 3.3-3 (Continued)

ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION

FUNCTIONAL UNIT	TOTAL NO. OF CHANNELS	CHANNELS TO TRIP	MINIMUM CHANNELS OPERABLE	APPLICABLE OPERATING MODES**	ACTION ***
LOSS OF POWER					
a. 4.16 kv Emergency Bus Undervoltage (Loss of Voltage)	4(3)/Bus *	2/Bus	3(2)/Bus	1, 2, 3	A or B
b. 4.16 kv Emergency Bus Undervoltage (Degraded Voltage)	4(3)/Bus	2/Bus	3(2)/Bus	1, 2, 3	A or B

*(Entries in parenthesis are applicable for 2 out of 3 coincidence logic)

**Required when ESF equipment is required to be operable

***Action A for 2 out of 4 logic
Action B for 2 out of 3 logic

MODEL TECHNICAL SPECIFICATIONS

ENCLOSURE 2

TABLE 3.3-3 (Continued)

ACTION STATEMENTS

ACTION A - With the number of OPERABLE channels one less than the Total Number of Channels operation may proceed provided both of the following conditions are satisfied:

a. The inoperable channel is placed in the tripped condition within one hour.

b. The Minimum Channels OPERABLE requirement is met; however, one additional channel may be bypassed for up to 2 hours for surveillance testing per Specification (4.3.2.1.1).

ACTION B - With the number of OPERABLE Channels one less than the Total Number of Channels operation may proceed until performance of the next required CHANNEL FUNCTIONAL TEST provided the inoperable channel is placed in the tripped condition within 1 hour.

0 0 3 4 5 0 1 7 6 7

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION TRIP VALUES

FUNCTIONAL UNIT	TRIP VALUE	ALLOWABLE VALUES
LOSS OF POWER		
a. 4.16 kv Emergency Bus Undervoltage (Loss of Voltage)	(±) volts with a (±) second time delay	(±) volts with a (±) second time delay
b. 4.16 kv Emergency Bus Undervoltage (Degraded Voltage)	(±) volts with a (±) second time delay	(±) volts with a (±) second time delay

0 0 3 4 6 0 1 7 8 8

TABLE 4.3-2 (Continued)

ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	OPERATING MODES IN WHICH SURVEILLANCE REQUIRED
LOSS OF POWER				
a. 4.16 kv Emergency Bus Undervoltage (Loss of Voltage)	S	R	M	1, 2, 3
b. 4.16 kv Emergency Bus Undervoltage (Degraded Voltage)	S	R	M	1, 2, 3

S = at least once per 12 hours

R = at least once per 18 months

M = at least once per 31 days

4.8.1.1.X Each diesel generator shall be demonstrated OPERABLE:

a. At least once per 18 months during shutdown by:

1. Simulating a loss of offsite power in conjunction with a safety injection actuation test signal, and:

a) Verifying de-energization of the emergency busses and load shedding from the emergency busses.

b) Verifying the diesel starts from ambient condition on the auto-start signal, energizes the emergency busses with permanently connected loads, energizes the auto-connected emergency loads through the load sequencer and operates for $\geq$ 5 minutes while its generator is loaded with the emergency loads.

c) Verifying that on diesel generator trip, the loads are shed from the emergency busses and the diesel re-starts on the auto-start signal, the emergency busses are energized with permanently connected loads, the auto-connected emergency loads are energized through the load sequencer and the diesel operates for $\geq$ 5 minutes while its generator is loaded with the emergency loads.

DUKE POWER COMPANY
POWER BUILDING
422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

July 21, 1977

Mr. Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. A. Schwencer, Chief
Operating Reactors Branch #1

Dear Mr. Case:

Your letter of June 3, 1977 requested that we compare the design of the Oconee Nuclear Station emergency power systems with the staff positions to assess the susceptibility of safety-related electrical equipment with regard to (1) sustained degraded voltage conditions at the offsite sources, and (2) interaction between the offsite and onsite emergency power systems. It is our conclusion, as documented in the attached analysis, that the design of the Oconee emergency power system has equivalent capabilities and protective features to those described in the staff's position.

Your letter requested that an amendment to the Facility Operating License be proposed to incorporate comparable Technical Specifications to those provided in the staff position. This amendment will be submitted by September 15, 1977.

Very truly yours,

William O. Parker, Jr.

MST:vr

bcc: Mr. H. B. Tucker
Mr. P. H. Barton
Mr. F. C. Hayworth
Mr. K. S. Canady
Mr. D. C. Holt
Ms. L. J. Bare
Mr. J. E. Smith
Mr. R. T. Bond
Mr. T. P. Harrall
Mr. B. M. Rice
Mr. C. J. Wylie
Master File OS 801.01
Section File OS 801.01

OCONEE NUCLEAR STATION

Response to NRC Staff Position on Degraded System Conditions

The design of the Oconee Nuclear Station onsite emergency power system has been reviewed and compared with the Staff position as requested. It has been determined that the existing protection system, relating to degraded offsite system conditions, has equivalent capabilities and protection features to those described in the Staff's position.

The voltage protection incorporated in the design consists of two-out-of-three coincident undervoltage relay logic monitoring the offsite power system. The undervoltage relays in this logic have inverse time characteristics that will protect the onsite distribution system from the effects of varying degraded offsite system conditions. The undervoltage protection will initiate separation of the onsite emergency buses from the offsite power systems immediately upon complete loss of offsite power or at a time delay depending on the extent of the degraded condition.

For the postulated conditions when the emergency buses must be separated from the offiste power systems due to some degraded condition, emergency power is supplied from the onsite Keowee Hydro Station. Two 87.5 MVA hydro-electric generating units are available to serve the emergency buses as described in FSAR Section 8.2.3. Due to the enormous capacity of these onsite emergency power sources, load shedding and sequencing of the emergency loads is not required. Therefore, the present protection system incorporates all levels of protection required for degraded offsite power system conditions due to the inherent capabilitites of the inverse time undervoltage relay.

The following discussion addresses the comparison of the design of the Oconee Nuclear Station emergency power systems with the stated Staff positions:

Position 1

a) In response to the August 12, 1976 NRC request for information, an analysis of the Oconee electrical distribution system was performed, documented, and submitted to the Staff. A summary of this report is enclosed as Attachment I. This analysis, covering the voltage requirements of the electrical equipment under degraded conditions, defined the undervoltage trip setpoint for the inverse-time undervoltage protection relays as 88% of the rated bus voltage. This setpoint will initiate tripping at the following voltage levels and time delays, thereby providing protection over the full range of voltage decays:

Percent of Setpoint	Time Delay
99%	> 5 sec
95%	5.0 sec
90%	3.6 sec
80%	2.0 sec
50%	1.0 sec
<35%	$\leq$0.8 sec

This setting provides adequate margin sufficient to assure the operability of the emergency loads under short-time or long-time voltage degradation within the capability of the equipment and within the setpoint limits.

b) The design of the voltage protection system conforms to this position in that it provides two-out-of-three coincident undervoltage relay logic to preclude spuriously separating the emergency buses from the offsite power sources.

c) The time delays associated with the setpoints which are listed in the preceding response to Position 1(a) were selected based on the following considerations:

   1) The allowable time delay, including margin to trip offsite power and to provide emergency onsite power, does not exceed the 23 seconds period for a LOCA condition or the 23 minute period for a non-LOCA condition that is assumed in the FSAR accident analysis.

   2) The time delays selected prevent short term transient conditions from reducing the availability of the offsite power sources and minimize the effects of these disturbances.

   3) The inverse-time characteristic of the undervoltage relays used for voltage protection is well within the allowable limits established for the safety systems equipment. This protection will, therefore, separate the emergency buses from the offsite power sources before any voltage level is reached which may be detrimental to the safety systems or components.

d) The undervoltage protection logic automatically initiates the disconnection of the offsite power sources from the emergency buses whenever the voltage setpoint and time delay have been exceeded.

e) Although designed prior to the issuance of IEEE 279-1971, the undervoltage protection logic satisfies the requirements of this standards.

f) Technical Specifications will be revised to make provisions for the voltage protection monitors.

Position 2

The onsite emergency power for the Oconee Nuclear Station is supplied by the Keowee Hydro Station as described in the FSAR Section 8.2.3. Because of the ample capability of the two Keowee units (87.5 MVA each), no load shedding or sequencing of emergency loads is required. Therefore, no preventive interlocks, automatic bypasses, or re-instatement features are required.

<u>Position 3</u>

The Technical Specifications will be revised as appropriate to include test requirements that demonstrate the full functional operability and independence of the onsite power sources at least one per 18 months.

ATTACHMENT I

Summary of the Analysis of Oconee Emergency Power Distribution System

I. INTRODUCTION

The following analysis evaluates the Oconee emergency power distribution system to determine if the operability of safety-related equipment, including associated control circuitry and instrumentation is adversely affected by short term or long term degradation in grid system voltage. The evaluation has been directed toward identifying all possible voltage conditions (i.e., normal and degraded) that can exist on the plant distribution system and comparing equipment operating limits to these voltage conditions.

II. EVALUATION

Figure 1 shows a one-line diagram of the Oconee Unit 3 distribution system which is the basis of our analysis of voltage profiles throughout the distribution system. Since the distribution systems for Units 1 and 2 are similar to Unit 3, the results of this analysis are applicable to all units.

In performing the analysis on the Oconee system, the limitations of the safety-related equipment, including associated control circuitry and instrumentation, were defined to establish the voltage range over which the components could operate continuously in the performance of their design function. These continuous operating voltage ranges are:

Component	Voltage Rating	Limiting Voltage Range
Motors	4000 V	(±10%) 4400/3600V
	575 V	(±10%) 633/518V
	200 V	(±10%) 220/180V
M.O Valves	575 V	(±10%) 633/518V
	200 V	(±10%) 220/180V
Motor Controllers	600 V	(≥85%) 510V
	208 V	(≥85%) 177V

The voltage ranges defined for motor continuous operation are the most restrictive operating conditions and, therefore, establish the bounds of continuous system operation.

This analysis adresses the condition when the normal auxiliary loads are being supplied by offsite power from Duke's 230 kV system. These normal auxiliary loads are supplied from the offsite power system during refueling, plant startup, plant shutdown, and abnormal trip of the unit. During accident conditions the offsite source is the preferred source to supply the required safety loads also. This source of supply in either normal or accident conditions is available through startup transformer CT3 which supplies the 4.16 kV distribution buses.

Since the normal operating voltage range (i.e., 227 kV to 217 kV) for the grid system is below the nominal 230 kV system voltage, startup transformer CT3 is set on the 218,500 volt tap in order to optimize voltage profiles throughout the auxiliary system. All load center transformers as shown in Figure 1 are set on nominal taps. In order to determine the voltage profiles at the safety-related buses for full-load and no-load conditions and the range of normal grid voltages defined above, computer studies were run for the following two cases:

<u>Case 1</u>: With the grid voltage assumed operating at 227 kV and the auxiliary system under minimum loading conditions, the voltage profiles for the safety-related buses were calculated. This case provides the highest expected voltages of 4252/613/212V on the safety-related buses for the highest normal operating grid voltage. It should be noted that since a no load condition does not practically exist on the auxiliary system, the condition of minimum loading during cold shutdown has been used instead. Figure 2 summarizes the results of this case.

<u>Case 2</u>: With the grid voltage assumed operating at 217 kV and the auxiliary system under maximum loading (i.e., full load) conditions, the voltage profiles for the safety-related buses were calculated. This case provides the lowest expected voltages of 3802/548/189V on the safety-related buses for the lowest normal operating grid voltage. Figure 2 summarizes the results of this case.

For all other possible auxiliary system loading conditions with the 230 kV grid system operating between 227 kV and 217 kV, the voltage profiles for the safety-related buses will be within the range established by Case 1 and Case 2 defined above.

Under normal conditions the Oconee Unit 3 auxiliary loads are carried by the Unit 3 generator through unit auxiliary transformer 3T as shown in Figure 1. The normal operating range for the generator terminal voltage is 18.94 kV to 17.68 kV. In analyzing the voltage profiles at the safety-related buses, computer studies were run for normal generator operating voltages (i.e., Cases 3 and 4) as defined above and for degraded conditions (i.e., Cases 5 and 6) requiring generator trip. The case studies are as follows:

<u>Case 3</u>: With the generator voltage at its normal maximum value of 18.94 kV and the auxiliary system under minimum loading conditions corresponding to the condition of the unit tied to the transmission system and under load, the voltage profiles for the safety-related buses were determined. This provides the highest expected voltages of 4397/633/219V on the safety-related buses for the highest normal generator operating voltage. Figure 3 summarizes the results of this case.

<u>Case 4</u>: With the generator voltage at its normal minimum value of 17.68 kV and the auxiliary system under maximum loading conditions, the voltage profiles for the safety-related buses were determined. This provides the lowest expected voltages of 3978/573/198V on the safety-related buses for the lowest normal generator operating voltage. Figure 3 summarizes the results of this case.

Case 5: With the generator voltage assumed at the overvoltage setpoint of 19.91 kV requiring generator trip and the auxiliary system under minimum loading conditions corresponding to the Unit tied to the transmission system and under load, the voltage profiles for the safety-related buses were determined. This provides the highest possible operating voltages of 4626/667/230V on the safety-related buses with the generator voltage at the overvoltage setpoint of the Volts/Hertz protective relaying. Figure 4 summarizes the results of this case.

Case 6: With the 230 kV transmission system operating at its normal minimum value of 217 kV and with the generator assumed operating in a degraded loading condition (i.e., under-excited condition) corresponding to the loss-of-excitation relay setpoint, the voltage profiles (i.e., 3952/569/197V) for the safety-related buses were determined. Figure 4 summarizes the results of this.

III. CONCLUSIONS

All pertinent combinations of operating conditions were evaluated for the Oconee auxiliary system, and it was determined that all safety-related loads, including associated control circuitry and instrumentation, will perform their safety functions as required.

To ensure that the operability of system components is not adversely affected by short term or long term degradation in system grid voltage, the undervoltage relays that monitor the offsite power system are set at 88% (3660V). This ensures that an acceptable voltage level required for continuous operation of non-safety and safety-related equipment will exist. The time delay inherent in these relays will eliminate spurious trips and ensure that degraded undervoltages are detected and cleared before they can adversely affect safety-related loads.

Figure 5 shows the results of Case 7 which provides the voltage profiles on the safety-related buses under degraded offsite power conditions corresponding to the undervoltage relay setpoint of 88% (3660V).

This Case demonstrates that voltages below the continuous operating limits of the safety-related loads cannot exist without causing a separation from the degraded condition.

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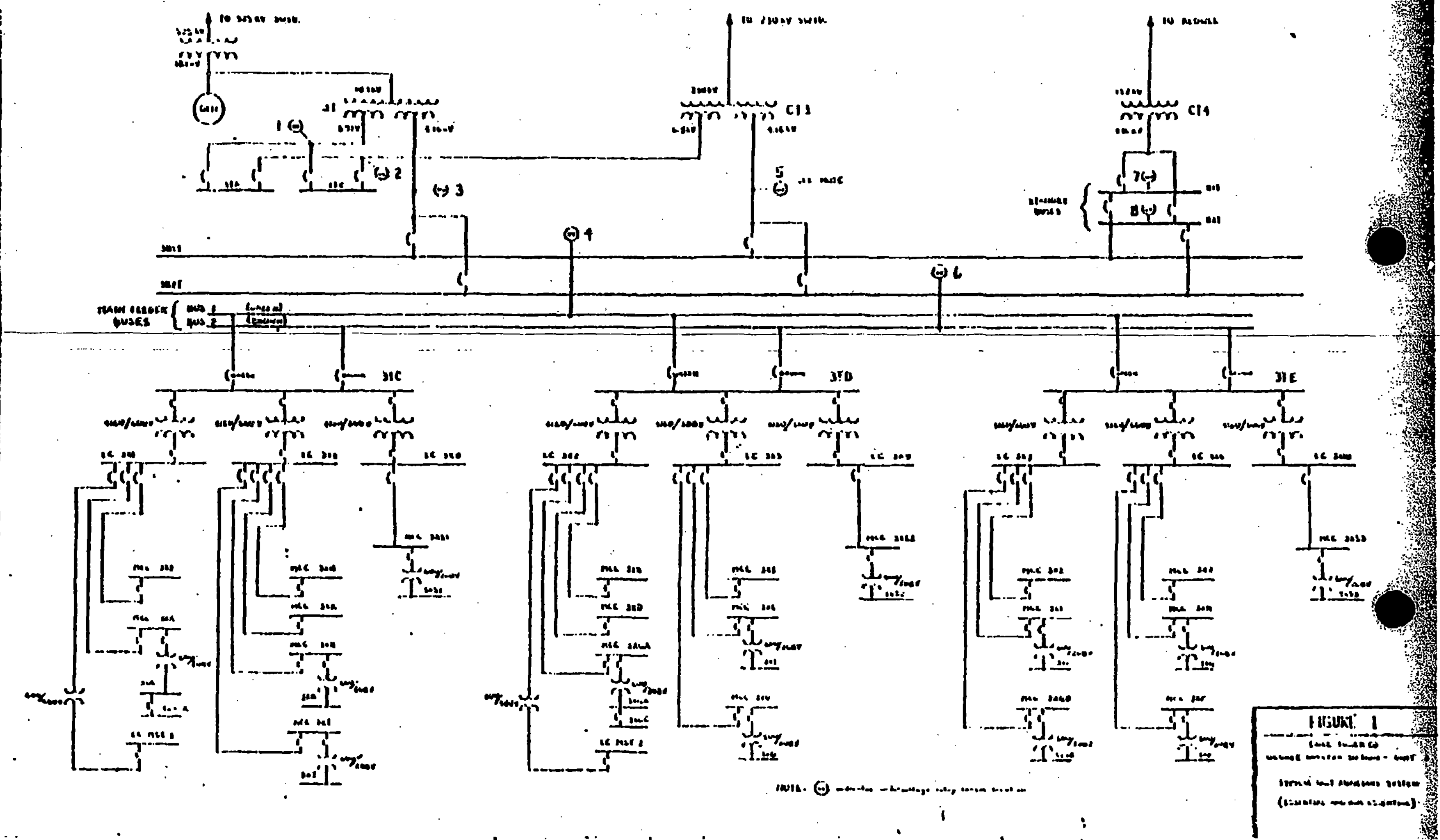
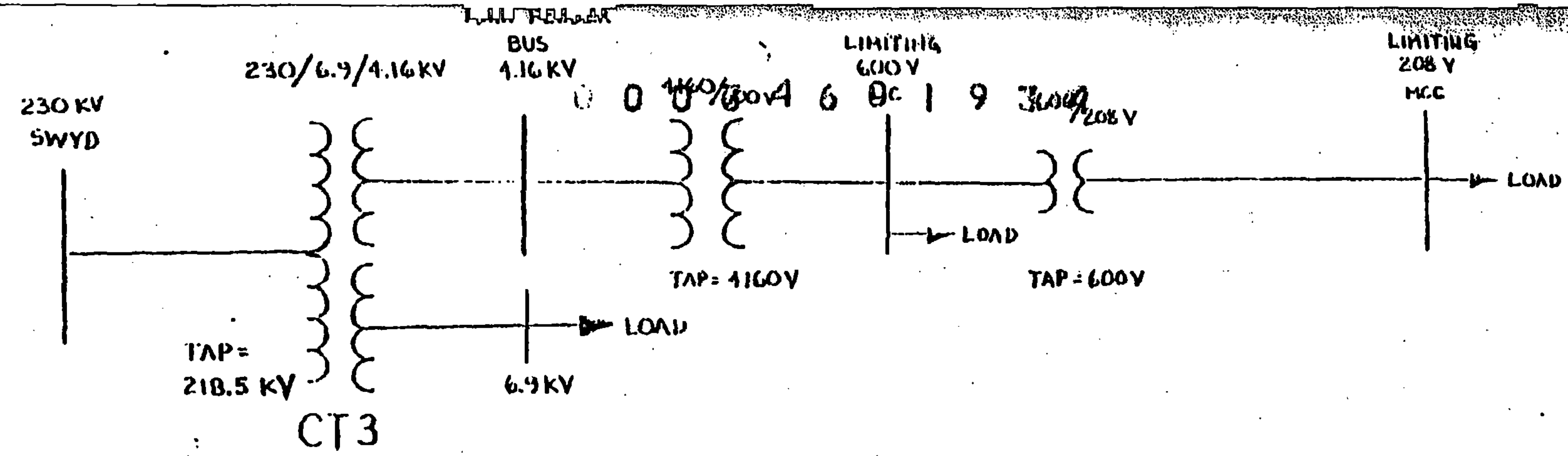
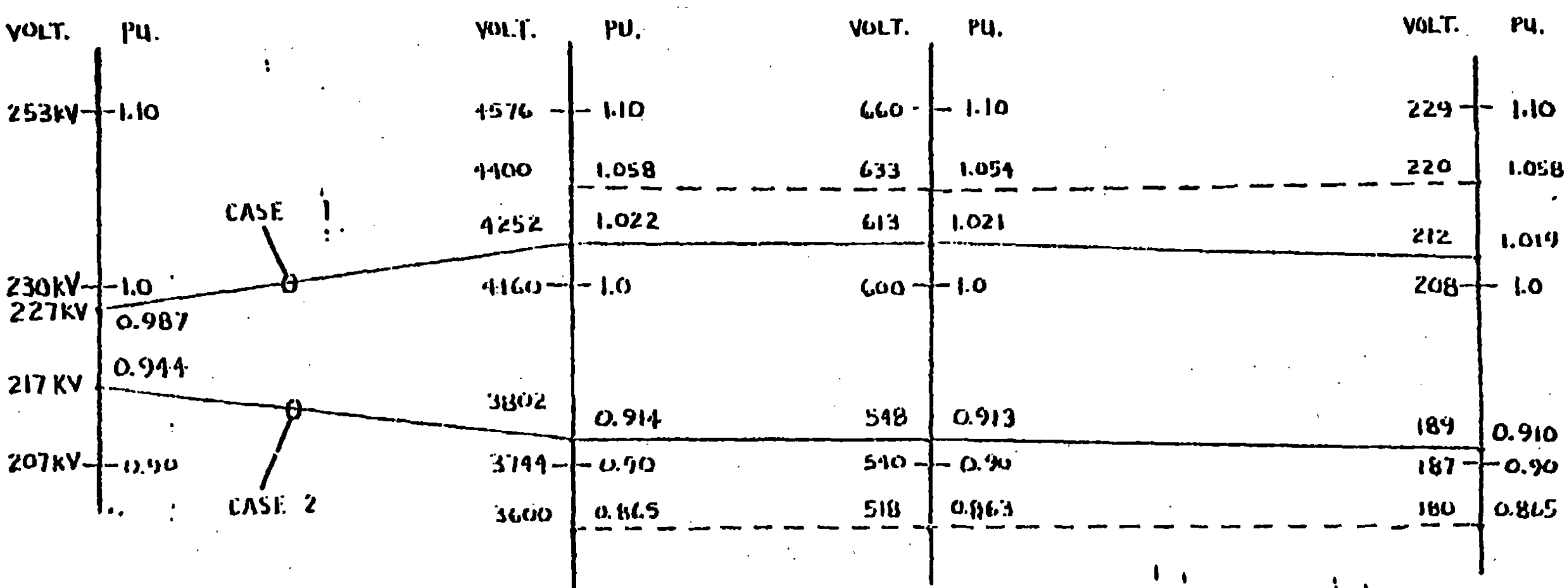
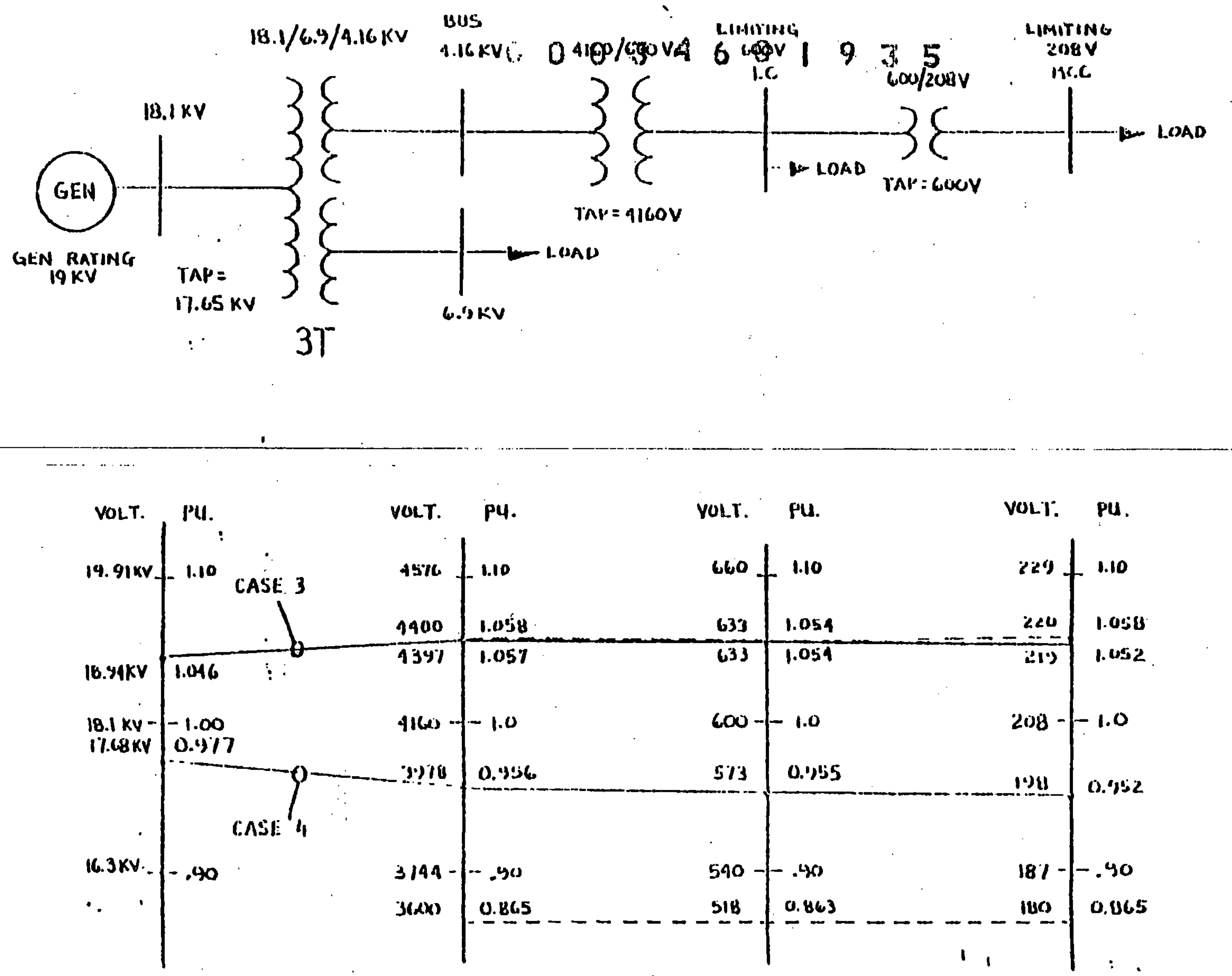




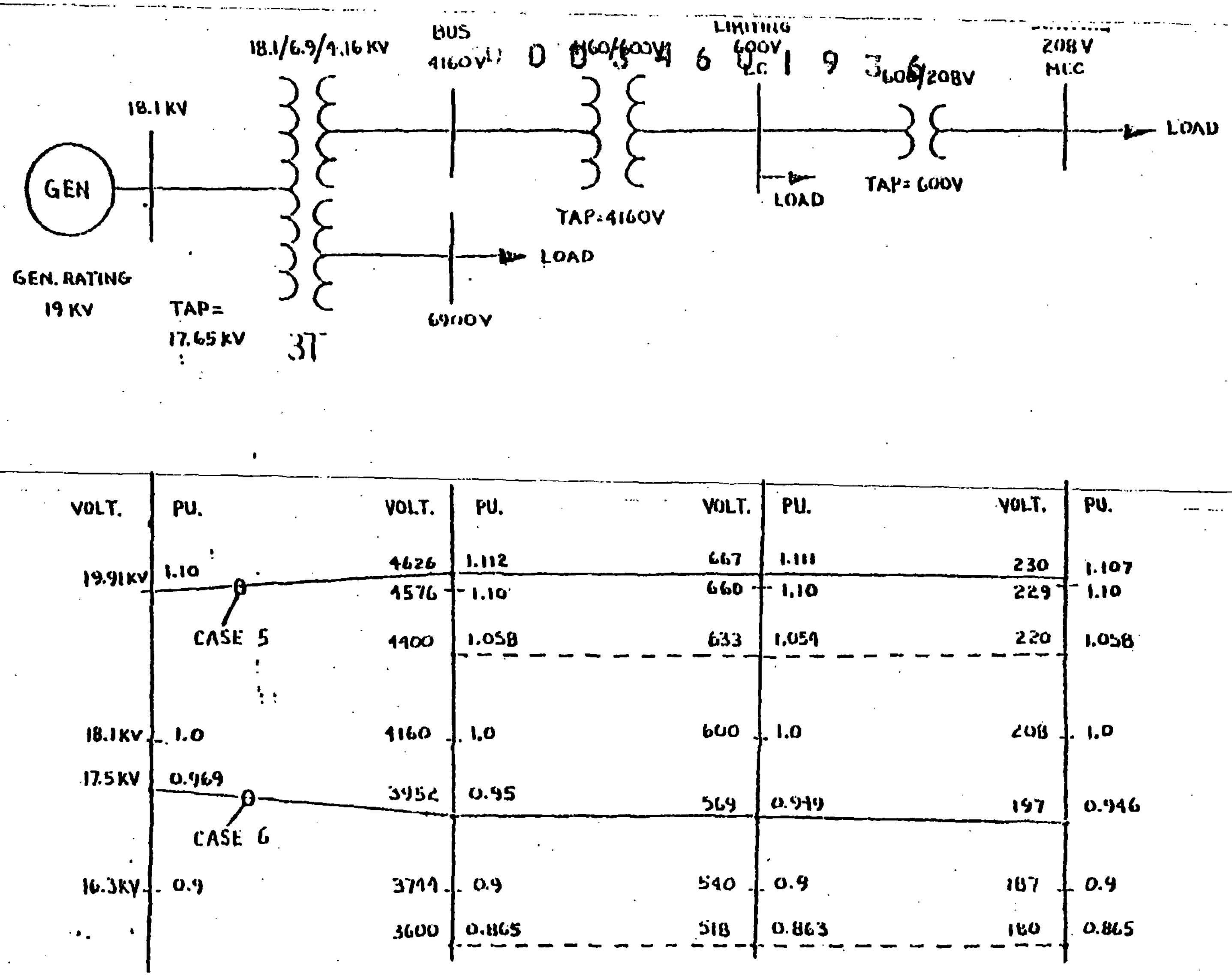


NOTE: The dotted lines represent the bounds of continuous equipment operation.



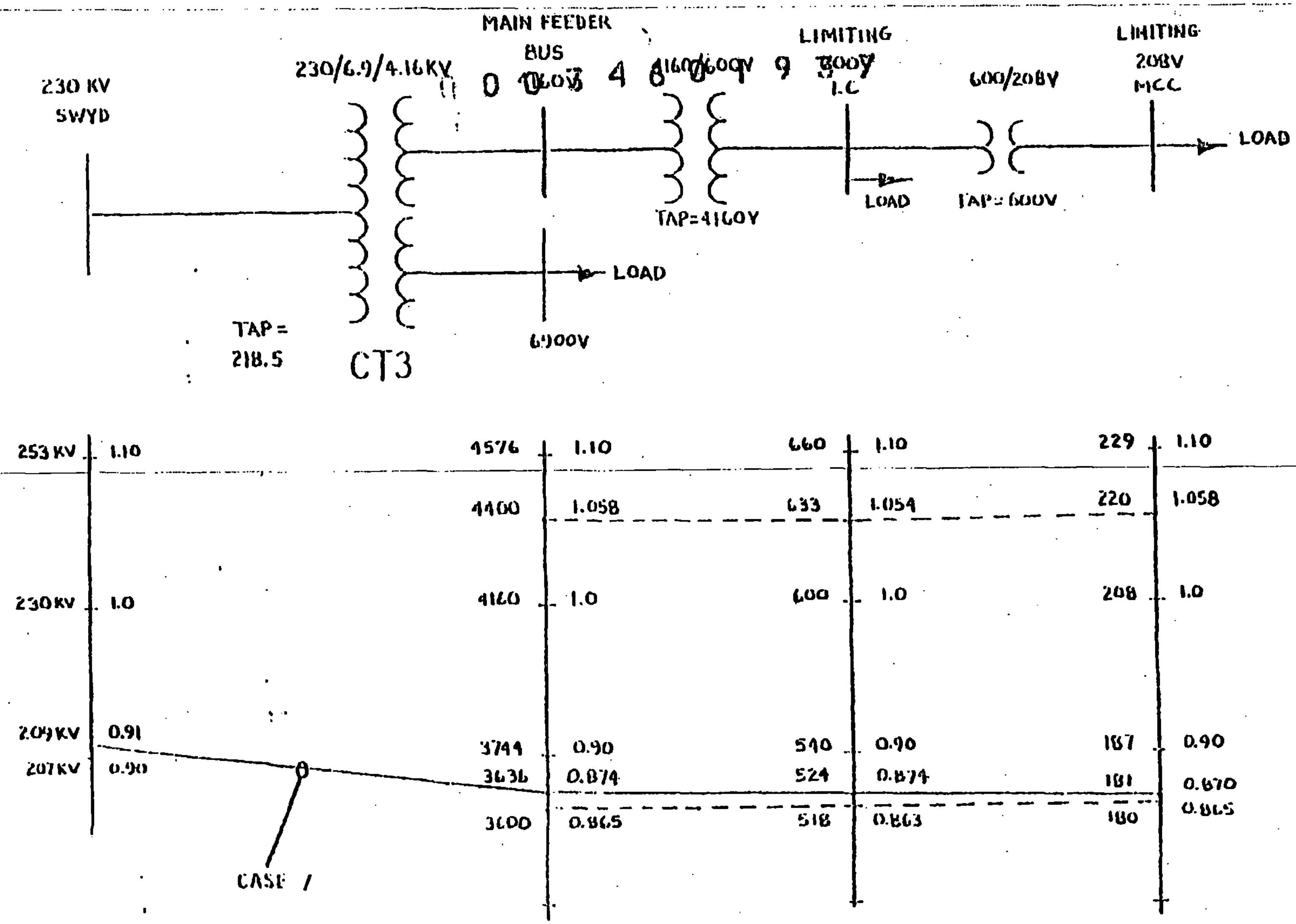
NOTE: The dotted lines represent the bounds of continuous equipment operation.

FIGURE 3 - CASE 3 AND 4
Voltage Profiles on Safety-Related Buses
under normal unit power conditions



NOTE: The dotted lines represent the bounds of continuous equipment operation.

FIGURE 4 - CASE 5 AND 6
Voltage Profiles on Safety-Related Buses
under degraded unit power conditions



NOTE: The dotted lines represent the bounds of continuous equipment operation.

FIGURE 5 - CASE 7

Voltage Profiles on Safety-Related Buses under degraded offsite power conditions corresponding to undervoltage trip setpoint.

Pls number + distribute

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

05801.01

December 20, 1978

Dockets Nos.: 50-269
50-270
and 50-287

Mr. William O. Parker, Jr.
Vice President - Steam Production
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Dear Mr. Parker:

By our letter dated June 3, 1977, we requested you to assess the susceptibility of the Class IE safety related electrical equipment to: (1) sustained degradation voltage conditions at the offsite power supply and (2) interaction between the offsite and onsite emergency power systems. By letters dated July 21, 1977 and October 7, 1977, you submitted the detail design of the Oconee Nuclear Station's emergency power systems.

The Oconee Nuclear Station originally had an undervoltage protection design to protect the Class IE equipment from a loss of voltage or a sustained degradation of grid voltage on the emergency buses. The protection system includes undervoltage relays with inverse time characteristics which have a trip setpoint set at 88% of the rated bus voltage, i.e., 4160 volts and with a five second time delay. This undervoltage protection design provides for two out of three coincident logic, monitoring the offsite power voltage on each 4160 volt bus. The undervoltage protection will initiate separation of the onsite emergency buses from the offsite power systems immediately upon complete loss of offsite power or at a time delay depending on the extent of the degraded voltage condition below 88% of nominal voltage. The lower the voltage the faster the trip.

For the conditions when the emergency buses must be separated from the offsite power systems due to a degraded voltage condition, the emergency buses are supplied power from the Keowee Hydro Station. The two 87.5 MVA hydroelectric generating units, power transmission systems (overhead and underground), and the transformers and circuits have adequate capabilities to serve the emergency buses with an acceptable voltage and therefore, no load shedding nor sequencing of the emergency loads are required.

In addition, we have determined through discussions with your staff that you have performed an acceptable voltage drop calculation of the 4160 volt and the 600 volt buses of the onsite system. As a result of your analysis, the transient (inrush) voltages were calculated to be 89% of the rated voltage on the 4160 volt bus and 82% of the rated voltage on the 600 volt bus. This voltage calculation was based on the assumptions of automatic transfer of plant loads from the unit auxiliary transformer to the start-up transformer or to the Keowee Hydro units and with the worst case of allowable combination loading. The voltage levels are adequate for starting all the engineered safety feature (ESF) loads when being started from either the start-up transformer or the Keowee Hydro units.

We have completed our review of the existing system design and have determined that the design affords adequate protection against degraded grid undervoltage conditions in accordance with the NRC letter of June 3, 1977, and is therefore acceptable.

Sincerely,

Morton B. Fairtile for

Robert W. Reid, Chief
Operating Reactors Branch #4
Division of Operating Reactors

cc: See next page

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DUKE POWER COMPANY

POWER BUILDING

422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

October 7, 1977

Mr. Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. A. Schwencer, Chief
Operating Reactors Branch #1

Re: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Mr. Case:

My letter of July 21, 1977 reported that the design of the Oconee emergency power system has capabilities and protective features equivalent to those presented in the staff position in your letter of June 3, 1977. Additionally, your letter requested a proposed amendment to incorporate Technical Specifications comparable to those in the staff position. Accordingly, and pursuant to 10CFR50, §50.90, please find attached a proposed amendment to the Oconee Nuclear Station Facility Operating License. This change revises sections of the Auxiliary Electrical Systems and Emergency Power Periodic Testing Technical Specifications. It includes the limiting conditions for operation and the surveillance requirements for the startup source voltage monitors, along with a modification to the on-site power source testing requirements. Please note that the attached pages have been revised to include the changes that had been previously submitted as a proposed amendment in my letter of September 29, 1977.

Very truly yours,

William O. Parker, Jr.

RLG:mlr
Attachment

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3.7 AUXILIARY ELECTRICAL SYSTEMS

Applicability

Applies to the availability of off-site and on-site electrical power for station operation and for operation of station auxiliaries.

Objective

To define those conditions of electrical power availability necessary to provide for safe reactor operation and to provide for continuing availability of engineered safety features systems in an unrestricted manner and to prescribe safety evaluation and reporting requirements to be followed in the event that the auxiliary electric power systems become degraded.

Specification

3.7.1 Except as permitted by 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, and 3.7.7, the reactor shall not be heated above 200°F unless the following conditions are met.

(a) At least two 230kV transmission lines, on separate towers, shall be in service.

(b) Two startup transformers shall be operable and available to the unit's 4160 volt Main Feeder Buses No. 1 and No. 2.

(c) One operable Keowee hydro unit shall be available to supply power through the Underground Feeder Bus, Transformer CT4 and the 4160 volt Standby Buses No. 1 and No. 2 to the units 4160 volt Main Feeder Buses No. 1 and 2. The second Keowee hydro unit shall be available to supply power automatically through a startup transformer to the units 4160 volt Main Feeder Buses No. 1 and 2.

(d) The two 4160 volt main feeder buses shall be energized.

(e) The three 4160 volt Engineered Safety Features switchgear buses shall be energized.

(f) Three 600 volt load centers plus the three 600 volt-208V Engineered Safety Features MCC Buses shall be energized.

(g) For each unit, all 125 VDC instrumentation and control batteries with their respective chargers, buses, diode monitors, and diodes supplying the unit's vital instrumentation and the four instrumentation and control panel boards shall be operable.

(h) The 125 VDC switching station batteries with their respective chargers, buses, and isolating diodes shall be operable.

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(i) The Keowee batteries with their respective chargers, buses and isolating diodes shall be operable.

(j) The level of the Keowee Reservoir shall be at least 775 feet above sea level.

(k) For each unit, three start-up source voltage monitoring channels shall be operable.

3.7.2 During hot standby or power operation, provisions of 3.7.1 may be modified to allow any one of the following conditions to exist:

(a) One of the two required startup transformers may be removed from service for 48 hours provided it is expected to be restored to service within 48 hours and the other required startup transformer is available for automatic connection to the unit's main feeder bus.

(b) One Keowee hydro unit may be inoperable for periods not exceeding 72 hours for test or maintenance provided the operable Keowee hydro unit is connected to the underground feeder circuit and is verified operable within one hour of the loss and every eight hours thereafter.

(c) The underground feeder circuit may be inoperable for periods not exceeding 72 hours for test and maintenance.

(d) In each unit, the following items may be inoperable for periods not exceeding 24 hours:

1. One 4160 volt main feeder bus.

2. One complete single string of any unit's Engineered Safety Features 4160 volt switchgear bus, 600 volt load center - 600V-208V MCC and their loads.

3. One complete single string of any unit's 125 VDC instrumentation and control batteries, chargers, buses, and all associated isolating and transfer diodes.

4. One 125 VDC instrumentation and control panel board and/or its associated loads.

(e) One complete single string of the 125 VDC switching station batteries, buses, chargers, and the related diode assemblies may be de-energized for test or maintenance for periods not exceeding 24 hours.

(f) One complete single string of the Keowee batteries, chargers, buses, and isolating diodes may be de-energized for test or maintenance for periods not exceeding 24 hours.

(g) One 4160 volt standby bus may be inoperable for test of maintenance for periods not exceeding 24 hours.

3.7.3 In the event that the conditions of Specification 3.7.1 are not met within the time specified in Specification 3.7.2, except as noted below in Specification 3.7.4, 3.7.5, 3.7.6, and 3.7.7 the reactor shall be placed in a hot shutdown condition within 12 hours. If these requirements are not met within an additional 48 hours, the reactor shall be placed in the cold shutdown condition within 24 hours.

3.7.4 In the event that all conditions in Specification 3.7.1 are met except that one of the two Keowee hydro units is expected to be unavailable for longer than the test or maintenance period of 72 hours, the reactor may be heated above 200°F if previously shutdown or be permitted to remain critical or be restarted provided the following restrictions are observed.

(a) Prior to heating the reactor above 200°F or prior to the restart of a shutdown reactor or within 72 hours of the loss of one Keowee hydro unit, the 4160 volt standby buses shall be energized by a Lee gas turbine through the 100 kV circuit. The Lee gas turbine and 100 kV transmission circuit shall be electrically separate from the system grid and non-safety-related loads.

(b) The remaining Keowee hydro unit shall be connected to the underground feeder circuit and this path shall be verified operable within 1 hour and weekly thereafter.

(c) The remaining Keowee hydro unit shall be available to the overhead transmission circuit but generation to the system grid shall be prohibited except for periods of test.

(d) Operation in this mode is restricted to periods not to exceed 45 days and the provisions of this specification may be utilized without prior NRC approval only once in three years for each Keowee hydro unit. Office of Inspection and Enforcement, Region II, will be notified within 24 hours.

3.7.5 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 the 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 non-safety-related loads.

(b) The reactor coolant T_{avg} shall be above 525°F. Reactor coolant pump power may be used to elevate the temperature from 500° to 525°F in the case of restart. If T_{avg} decreases below 500°F, restart is not permitted by this specification.

3.7.6 In the event that all conditions of Specification 3.7.1 are met, and planned tests or maintenance is required which will make both Keowee units unavailable, the 4160 volt standby buses shall first be energized by a Lee gas turbine through the 100 kV transmission circuit and shall be separate from the system grid and non-safety-related loads. The reactor shall then be permitted to remain critical for periods not to exceed 72 hours with both Keowee units unavailable.

3.7.7 In the event that all conditions of Specification 3.7.1 are met except that both Keowee hydro units become unavailable for unplanned reasons, the reactor shall be permitted to remain critical for periods not to exceed 24 hours provided the 4160 volt standby buses are energized within 1 hour by Lee gas turbine through the 100 kV transmission circuit and it shall be separate from the system grid and all offsite non safety-related loads.

3.7.8 Any degradation beyond Specification 3.7.2, 3.7.4, 3.7.5, 3.7.6 or 3.7.7 above shall be reported to the Office of Inspection and Enforcement, Region II, within 24 hours. A safety evaluation shall be performed by Duke Power Company for the specific situation involved which justifies the safest course of action to be taken. The results of this evaluation together with plans for expediting the return to the unrestricted operating conditions of Specification 3.7.1 above shall be submitted in a written report to the Office of Nuclear Reactor Regulation with a copy to the Office of Inspection and Enforcement, Region II, within five days.

3.7.9 In the event that one channel of the unit's startup source voltage monitoring becomes inoperable, the reactor shall be permitted to remain critical or be restarted provided the inoperable channel is placed in the tripped condition within one hour.

Bases

The auxiliary electrical power systems are designed to supply the required Engineered Safeguards loads in one unit and safe shutdown loads of the other two units and are so arranged that no single contingency can inactivate enough engineered safety features to jeopardize plant safety. These systems were designed to meet the following criteria:

> "Alternate power systems shall be provided and designed with adequate independency, redundancy, capacity and testability to permit the functions required of the engineered safety features of each unit."

The auxiliary power system meets the above criteria and the intent of AEC Criterion 17. The adequacies of the AC and DC systems are discussed below as are the bases for permitting degraded conditions for AC power.

Capacity of AC Systems

The auxiliaries of two units in hot shutdown (6.0MVa each) plus the auxiliaries activated by ESG signal in the other unit (4.8 MVa) require a total AC power capacity of 16.8 MVa. The continuous AC power capacity available from the on-site power systems (Keowee Hydro Units) is 20 MVa (limited by transformer CT4) if furnished by the underground circuit or 30 MVa (limited by CT1 or CT2) if furnished through the 230 kV off-site transmission lines. Capacity available from the backup 100 kV off-site transmission line (Lee Station Gas Turbine Generator) is 20 MVa (limited by CT5).

Thus, the minimum available capacity from any one of the multiple sources of AC power, 20 MVa, is adequate.

The startup source voltage monitors automatically initiate the disconnection of the offsite power sources from the safety-related buses upon either a sustained degradation of the offsite power system voltage or a complete loss of offsite power.

Capacity of DC Systems

Normally, for each unit AC power is rectified and supplies the DC system buses as well as keeping the storage batteries on these buses in a charged state. Upon loss of this normal AC source of power, each unit's DC auxiliary systems important to reactor safety have adequate stored capacity (ampere-hours) to independently supply their required emergency loads for at least one hour. One hour is considered to be conservative since there are redundant sources of AC power providing energy to these DC auxiliary systems. The loss of all AC power to any DC system is expected to occur very infrequently, and for very short periods of time. The following tabulation demonstrates the margin of installed battery charger rating and battery capacity when compared to one hour of operation (a) with AC power (in amps) and (b) without AC power (in ampere hours) for each of the three safety-related DC systems installed at Oconee:

A. 125 VDC Instrumentation and Control Power System

Charger XCA, XCB, or XCS	a. 600 amps each
Battery 1CA and 1CB Combined Capacity (X = 1, 2, or 3)	b. 698 ampere-hours
Actual active loads on both 125 VDC I & C buses XDCA and XDCB during 1st hour of LOCA (X = 1, 2, or 3)	a. First min. - 1371 amps next 59 min. - 568.5 amps b. 581.9 ampere-hours

B. 125 VDC Switching Station Power System

Charger SY-1, SY-2, or SY-s Rating	a. 50 amps each
Battery SY-1 or SY-2 Capacity	b. 14.4 ampere-hours

Actual active load per battery during 1st hour of LOCA	a. First min. - 130 amps next 59 min. - 10 amps b. 12 ampere-hours

C. 125 VDC Keowee Station Power System

Charger No. 1, No. 2 or Standby Rating	a. 200 amps each
Battery No. 1 or No. 2 Capacity	b. 233 ampere-hours
Actual active load per battery during 1st hour of LOCA	a. First min. - 1031 amps next 59 min. - 179.4 amps b. 193.6 ampere-hours

Redundancy of AC Systems

There are three 4160 engineered safety feature switchgear buses per unit. Each bus can receive power from either of the two 4160 main feeder buses per unit. Each feeder bus in turn can receive power from the 230 kV switchyard through the startup transformers, through the unit auxiliary transformer by backfeeding through the main step-up transformer, or from the 4160V standby bus. Another unit's startup transformer serving as an alternate supply can be placed in service in one hour. The standby bus can receive power from the Hydro Station through the underground feeder circuit or from a combustion turbine generator at the Lee Steam Station over an isolated 100 kV transmission line. The 230 kV switchyard can receive power from the on-site Keowee Hydro station or from several off-site sources via transmission lines which connect the Oconee Station with the Duke Power system power distribution network.

Redundancy of DC Systems

A. 125 VDC Instrument and Control Power System
All reactor protection and engineered safety features loads on this system can be powered from either the Unit 1 and Unit 2 or Unit 2 and Unit 3 or Unit 3 and Unit 1 125 VDC Instrument and Control Power Buses. The units' 125 VDC Instrument and Control Power Buses can be powered from two battery banks and three battery chargers. As shown above, one battery (e.g., 1CA) can supply all loads for one hour. Also, one battery charger can supply all connected ESF and reactor protection loads.

B. 125 VDC Switching Station Power System

There are two essentially independent subsystems each complete with an AC/DC power supply (battery charger), a battery bank, a battery charger bus, motor control center (distribution panel). All safety-related equipment and the relay house in which it is located are Class I (seismic) design. Each subsystem provides the necessary DC power to:

a. Continuously monitor operations of the protective relaying.

b. Isolate Oconee (including Keowee) from all external 230 kV grid faults,

c. Connect on-site power to Oconee from a Keowee hydro unit or,

d. Restore off-site power to Oconee from non-faulted portions of the external 230 kV grid.

Provisions are included to manually connect a standby battery charger to either battery/charger bus.

C. 125 VDC Keowee Station Power System

There are essentially two independent physically separated Class I (seismic) subsystems, each complete with an AC/DC power supply (charger) a battery bank, a battery/charger bus and a DC distribution center. Each subsystem provides the necessary power to automatically or manually start, control and protect one of the hydro units.

An open or short in any one battery, charger of DC distribution center, cannot cause loss of both hydro units.

The 230 KV sources, while expected to have excellent availability, are not under the direct control of the Oconee station and, based on past experience, cannot be assumed to be available at all times. However, the operation of the on-site hydro-station is under the direct control of the Oconee Station and requires no off-site power to startup. Therefore, an on-site backup source of auxiliary power is provided in the form of twin hydro-electric turbine generators powered through a common penstock by water taken from Lake Keowee. The use of a common penstock is justified on the basis of past hydro plant experience of the Duke Power Company (since 1919) which indicates that the cumulative need to dewater the penstock can be expected to be limited to about one day a year, principally for inspection, plus perhaps four days every tenth year.

Operation with one Keowee Hydro unit out of service for periods less than 72 hours is permitted. The operability of the remaining Keowee hydro unit is verified within one hour by starting the unit and energizing the standby buses through the underground feeder circuit. This action is repeated once every eight hours thereafter until the Keowee hydro unit is restored to service and will provide additional assurance of the operability of the remaining unit.

Provisions have been established for those conditions in which long term preventative maintenance of a Keowee Hydro unit ar necessary. The primary long term maintenance items are expected to be hydro turbine runner and discharge ring welding repairs which are estimated to be necessary every six to eight years. Also, generator thrust and guide bearing replacements will be necessary. Other items which manifest as failures are expected to be extremely rare and could possibly be performed during the permitted maintenance periods. Time periods of up to 45 days for each Keowee Hydro unit are permitted every three years. During these outages the remaining Keowee Hydro unit will be verified to be operable within one hour and weekly thereafter by starting the unit and energizing the underground feeder circuit. The remaining Keowee hydro unit will also be available through the overhead transmission path and will not be used for system peaking. Additionally, the standby buses will be energized continuously by one of the Lee gas turbines through the 100 kV transmission circuits

This transmission circuit would be electrically separated from the system grid and all off-site non-safety-related loads. This arrangement provides a high degree of reliability for the emergency power systems.

Operation with both Keowee Hydro units out of service is permitted for planned or unplanned outages for periods of 72 or 24 hours respectively. Planned outages are necessary for the inspection of common underwater areas such as the penstock and to enable the removal of one Keowee unit from service. This would be a controlled evolution in which the availability and condition of the off-site grid, startup transformers and weather would be evaluated and a Lee gas turbine would be placed in operation on the isolated 100 kV transmission line prior to commencement of the outage.

A time period of 24 hours for unplanned outages of both Keowee units is acceptable since a Lee gas turbine will be started within one hour and will energize the standby buses through the dedicated 100 kV transmission line. This period of time is reasonable to determine and rectify the situation which caused the loss of both Keowee units.

In the event that none of the sources of off-site power are available and it is considered important to continue to maintain an Oconee reactor critical or return it to criticality from a hot shutdown condition, one of the Lee gas turbines can be made available as an additional backup source of power, thus assuring continued availability as an auxiliary power to perform an orderly shutdown of a unit should a problem develop requiring shutdown of both hydro units.

4.6 EMERGENCY POWER PERIODIC TESTING

Applicability

Applies to the periodic testing surveillance of the emergency power sources.

Objective

To verify that the emergency power sources and equipment will respond promptly and properly when required.

Specification

4.6.1 Monthly, a test of the Keowee Hydro units shall be performed to verify proper operation of these emergency power sources and associated equipment. This test shall assure that:

a. Each hydro unit can be automatically started from the Unit 1 and 2 control room.

b. Each hydro unit can be synchronized through the 230 kV overhead circuit to the startup transformers.

c. Each hydro unit can energize the 13.8 kV underground feeder.

d. The 4160 volt startup transformer main feeder bus breakers and standby bus breaker shall be exercised.

4.6.2 Annually, the Keowee Hydro units shall be started using the emergency start circuits in each control room to verify that each hydro unit and associated equipment will carry the equivalent of the maximum safeguards load of one Oconee unit within 25 seconds of a simulated requirement for engineered safety features.

4.6.3 Monthly, the Keowee Underground Feeder Breaker Interlock shall be verified to be operable.

4.6.4 Annually, a simulated emergency transfer of the 4160 volt main feeder buses to the startup transformer (CT1, CT2 or CT3) and to the 4160 volt standby buses, and a retransfer to the startup transformers shall be made to verify proper operation.

4.6.5 Quarterly, the External Grid Trouble Protection System logic shall be tested to demonstrate its ability to provide an isolated power path between Keowee and Oconee.

4.6.6 Annually and prior to planned extended Keowee outages, it shall be demonstrated that a Lee Station combustion turbine can be started and connected to the 100 kV line. It shall be demonstrated that the 100 kV line can be separated from the rest of the system and supply power to the 4160 volt main feeder buses.

4.6.7 Annually, it shall be demonstrated that a Lee station combustion turbine can be started and connected to the isolated 100 kV line and carry the equivalent of the maximum safeguards load of one Oconee unit (4.8 MVA) within one hour.

4.6.8 Annually, it shall be demonstrated that a Lee station combustion turbine can be started and carry the equivalent of the maximum safeguards load of one Oconee unit plus the safe shutdown loads of two Oconee units on the system grid.

4.6.9 Batteries in the 125 VDC systems shall be tested as follows:

a. The voltage and temperature of a pilot cell in each bank shall be measured and recorded five times per week for the Instrument and Control, Keowee Hydro, and Switching Station batteries.

b. The specific gravity and voltage of each cell shall be measured and recorded monthly for the Instrument and Control, Keowee Hydro, and Switching Station batteries.

c. Annually, a one-hour discharge test at the required maximum safeguards load shall be made on the instrument and control batteries.

d. Before initial operation and annually thereafter, a one-hour discharge test shall be made on the Keowee Hydro and Switching Station batteries.

4.6.10 The operability of the individual diode monitors in the Instrument and Control and Keowee Station 125 VDC systems shall be verified monthly by imposing a simulated diode failure signal on the monitor.

4.6.11 The peak inverse voltage capability of each auctioneering diode in the Instrument and Control, Switchyard and Keowee Hydro 125 VDC systems shall be measured and recorded semiannually.

4.6.12 The tests specified in 4.6.9, 4.6.10, and 4.6.11 will be considered satisfactory if control room indication and/or visual examination demonstrate that all components have operated properly.

4.6.13 Monthly, it shall be demonstrated that each startup source voltage monitoring channel is operable.

4.6.14 Annually, the startup source voltage monitors shall be calibrated to ensure that they can initiate a trip of the startup source breakers upon both a complete loss of voltage and a degraded voltage condition.

Bases

The Keowee Hydro units, in addition to serving as the emergency power sources for the Oconee Nuclear Station, are power generating sources for the Duke system requirements. As power generating units, they are operated frequently, normally on a daily basis at loads equal to or greater than required by Table 8.5 of the FSAR for ESF bus loads. Normal as well as emergency startup and operation of these units will be from the Oconee Unit 1 and 2 Control Room. The frequent starting and loading of these units to meet Duke system power requirements assures the continuous availability for emergency power for the Oconee auxiliaries and engineered safety features equipment. It will be verified that these units will carry the equipment of the maximum safeguards load within 25 seconds, including instrumentation lag, after a simulated requirement for engineered safety features. To further assure the reliability of these units as emergency power sources, they will be, as specified, tested for automatic start on a monthly basis from the Oconee control room. These tests will include verification that each unit can be synchronized to the 230 kV bus and that each unit can energize the 13.8 kV underground feeder.

The interval specified for testing of transfer to emergency power sources is based on maintaining maximum availability of redundant power sources.

Starting a Lee Station gas turbine, separation of the 100 kV line from the remainder of the system, and charging of the 4160 volt main feeder buses are specified to assure the continuity and operability of this equipment. The one hour time limit is considered the absolute maximum time limit that would be required to accomplish this.

The startup source voltage monitors are provided to detect and initiate proper action for either a sustained degradation of offsite power system voltage or a complete loss of offsite power. Monthly these monitors will be functionally checked and annually they will be calibrated to ensure proper operation within the required trip settings.

REFERENCE

FSAR Section 8

Duke Power Company
P.O. Box 33198
Charlotte, N.C. 28242

Hal B. Tucker
Vice President
Nuclear Production
(704)373-4531

05-801.01

DUKE POWER

May 8, 1990

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Switchyard Degraded Voltage

Dear Sir:

On April 26, 1990, a conference call between members of my staff and members of the NRC staff was held. The purpose of the call was to discuss the switchyard degraded voltage issue. During this phone call, the staff requested that information regarding the proposed modification to resolve the problems identified be submitted to them for their information. To this end, a description of the modification is provided. In addition, simplified one line drawings to aid in the understanding of the modification are also provided.

The initial concern was discovered as a result of the 230KV Design Basis Documentation (DBD) effort. It was discovered that during a LOCA event concurrent with a 230KV switchyard voltage less than 219KV, the unit could be vulnerable to a single failure event, due to the relative setpoint of the undervoltage relaying of the startup source breakers and the undervoltage relaying of the switchyard isolate circuitry. This situation is fully described in LER 269/90-04 submitted April 30, 1990. This LER provides detailed information regarding this event, the root cause, the corrective actions taken and to be taken, the basis for continued safe operation of the units, and an assessment of the safety consequences and implications of the event. In addition, the LER also stated that another concern was identified. This new concern had identified the possibility that the E breakers could close when the 230KV switchyard voltage is degraded (less than 219KV). This finding was also determined to be reportable. A separate LER on this problem will be submitted May 24, 1990. Please note that the operability evaluation provided by LER 269/90-04 is also applicable to the new concern identified.

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As I stated earlier, to resolve the problems identified, a modification to the plant was proposed. This modification is to install three undervoltage relays to monitor the switchyard voltage on the line side of each of the three startup transformers. Each of the undervoltage relays will be connected to one of three existing single phase spare potential transformers. These relays will be connected in a two out three configuration and timed to provide a permissive in each of the two redundant switchyard isolate circuits through one of two redundant Cutler Hammer relays. This logic will provide inputs for alarms via the Operator Aid Computer, the Event Recorder, an annuniciator in the unit 1 and 2 control room, an alarm in the Power System Control Area Operation Center, and would initiate switchyard isolate if an ES signal is present on any of the three units. This logic which is safety related, will be fed from the switchyard 125VDC system.

For your information, every effort is being made to implement this modification in a timely manner. I currently anticipate that the above modification will be installed on all three units by no later than July 1, 1990. An outage of the units is not required to implement the modification. If further discussion is desired regarding this issue or the modification, please don't hesitate to contact us through normal licensing channels.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

SYDVOLT/PFG

xc: Mr S. D. Ebneter
Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta St. NW
Atlanta, GA 30323

Mr. P. H. Skinner
NRC Resident Inspector
Oconee Nuclear Station

Mr. L. A. Wiens
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

MODIFICATION DESCRIPTION

The modification will install equipment that will provide an annuniciator alarm in the Unit 1 and 2 control room, an alarm via the unit Operator Aid Computer an alarm to the Power Systems Control Area Operation Center and an event recorder point and, if an ES signal occurs on any unit while the voltage is at or below the setpoint, will automatically isolate the switchyard by initiating the External Grid Trouble Protection (EGTPS) system. The new logic will ensure the overhead power path from Keowee is available during an ES event, even if the switchyard voltage is below 219KV. The modification will install several relays to accomplish this logic.

The EGTPS is designed to detect undervoltage or underfrequency conditions on both buses in the 230KV switchyard and to isolate the yellow bus, (and thus the Keowee overhead path), from the transmission system if these conditions occur. To address the difference between the minimum analyzed voltage for starting LOCA loads and the voltage at which the EGTPS is automatically initiated, the above modification was proposed.

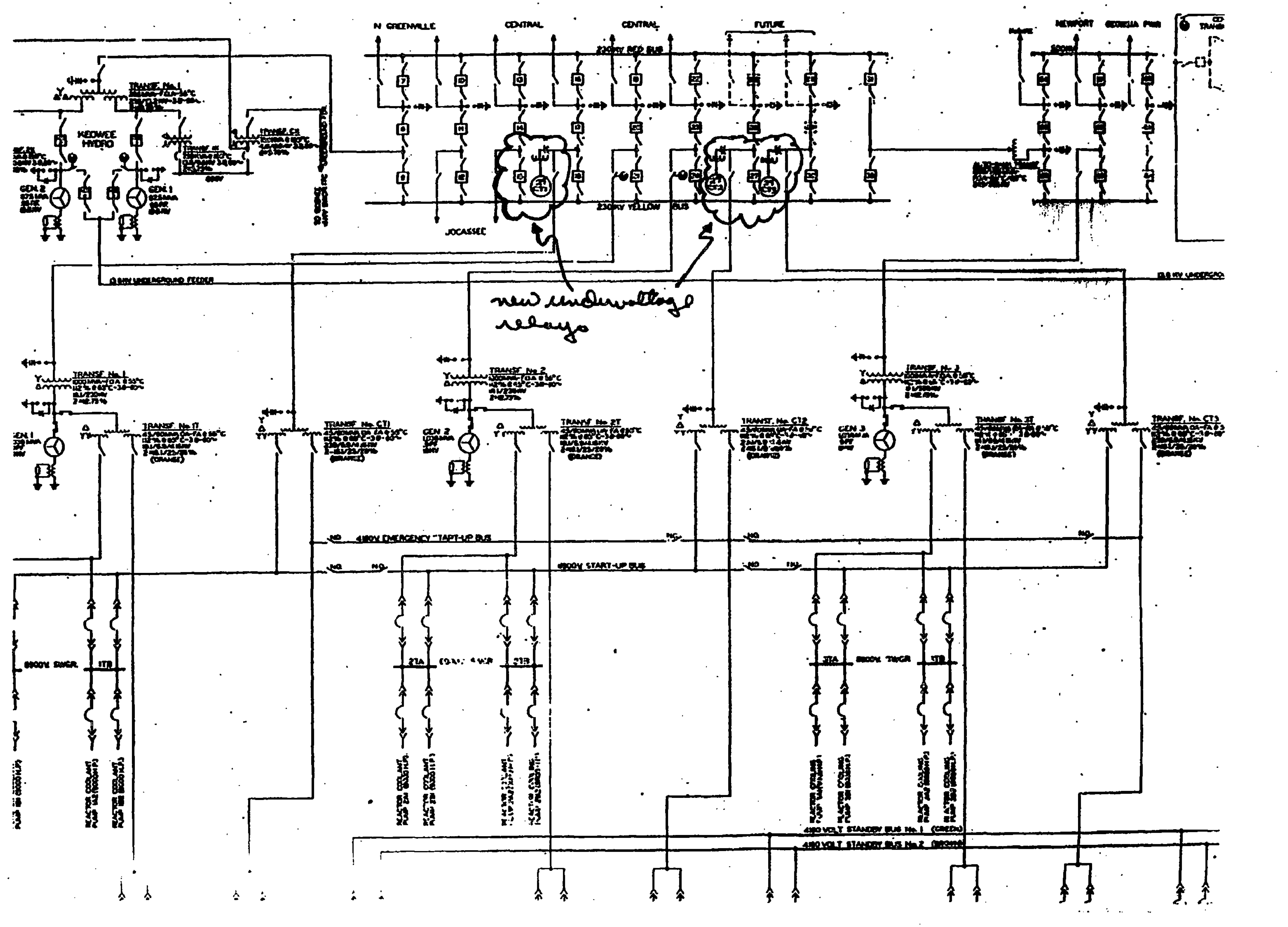
The voltage will be measured by existing potential transformers (PTs).. The failure modes of these PTs are in the safe direction. The safety related voltage relay contacts used in the switchyard isolation logic will be arranged in a 2 out of 3 (2/3) logic. The output of the 2/3 logic will be connected to actuate two redundant safety related relays. If this 2/3 logic is satisfied and an ES signal occurs on any of the three units, both channels of the EGTPS will be activated. If the EGTPS is actuated by a failure of this new logic, unit generation would not be interrupted since the EGTPS does not operate the unit tie breakers.

The Engineered Safeguards Protective System (ESPS) is a three channel redundant system employing 2/3 coincidence between measured variables. The ESPS consists of eight 2/3 coincidence logic networks for actuating the equipment in four safeguards systems, thus each system is actuated by a pair of 2/3 logic. Therefore a failure within one channel of the ESPS will not result in an ES signal being provided to the 230KV Switchyard Degraded Voltage Protection Circuitry (230KV SDVP). Further details regarding the ESPS at Oconee is provided by section 7.3.2 of the Oconee FSAR. An inadvertent EGTPS actuation would allow the units to continue to operate safely, since the generator output breakers would remain aligned to the system grid through the 230KV Switchyard red bus (units 1 and 2) or 525KV Switchyard (unit 3). In this condition, the units' auxiliary electrical power would continue to be supplied from auxiliary transformer 1T, 2T, or 3T, respectively. An EGTPS actuation due to degraded grid voltage and a concurrent ESPS signal would allow the unaffected units to continue to operate in the manner just described, while power to the affected unit would be automatically available through:

a) The 4160V standby buses if previously powered from the dedicated line to the Lee Gas Turbines,

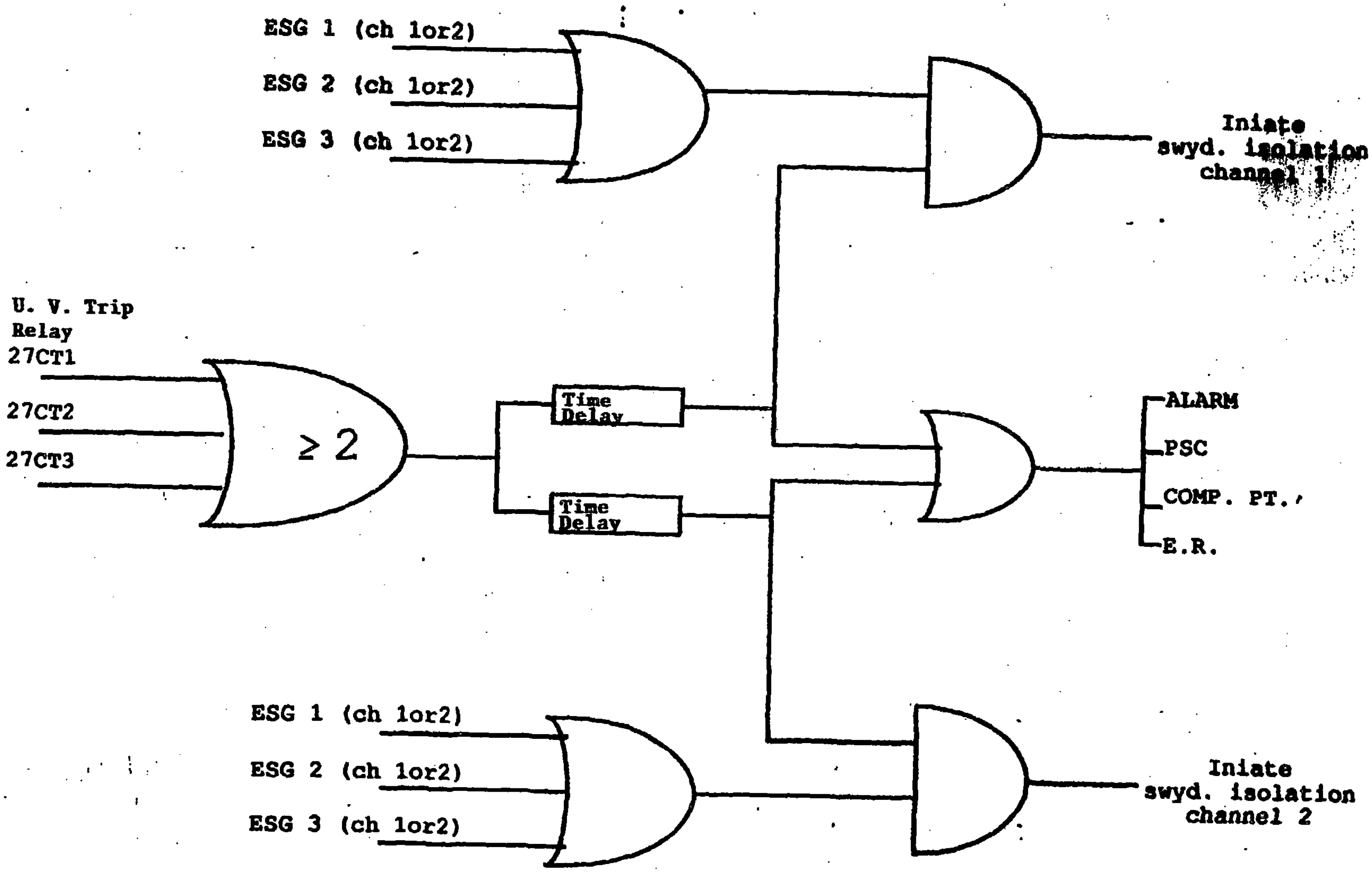
b) The 4160V standby buses from the underground on-site emergency power path from Keowee, or

c) The overhead on-site emergency power path from Keowee.



N GREENVILLE
CENTRAL
CENTRAL
FUTURE
NEWPORT
230KV RED BUS
230KV YELLOW BUS
JOCASSEE
KEOWEE HYDRO
13.8KV UNDERGROUND FEEDER
new undervoltage relays
TRANSF No. 1
TRANSF No. 2
TRANSF No. 3
TRANSF No. 1T
TRANSF No. CT1
TRANSF No. 2T
TRANST. No. CT2
TRANSF No. 3T
TRANSF No. CT3
GEN 1
GEN 2
GEN 3
4160V EMERGENCY START-UP BUS
6900V START-UP BUS
4160 VOLT STANDBY BUS No. 1
4160 VOLT STANDBY BUS No. 2

PRELIMINARY



PRELIMINARY

Oconee Nuclear Station
Preliminary Logic Diagram
230KV Switchyard Degraded Voltage Protection
NSM ON-52850
May 4, 1990

Duke Power Company
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DUKE OWER

June 18, 1990

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Switchyard Degraded Voltage

Dear Sir:

By my letter of May 8, 1990, I had provided preliminary information regarding a conceptual design of a proposed modification to resolve problems concerning the 230KV switchyard that my staff recently identified. On June 6, 1990, a conference call between members of my staff and members of the NRC staff was held. During the phone call, the staff raised a concern about the impact of degraded voltage on safety related equipment during normal plant operation. To address this concern, Please find attached a discussion of the impact that degraded voltage has on safety related equipment during normal plant operation.

The resolution of the problems that we have identified through our Design Basis Documentation effort is a high priority item at Duke Power. The proposed modification to be implemented is moving forward. My staff is developing a revision to the technical specification, which will be submitted in the near future. Your continued cooperation and assistance in resolving this issue is greatly appreciated.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

volt01/pfg

A001 Add: NRR/DET/EMEB 1/1

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INFORMATION CONCERNING GRID VOLTAGE ADEQUACY

The N&E breakers utilize the Westinghouse CV-7 relays for undervoltage detection. Relays associated with these breakers are set at 105V tap with 3 sec time delay at 84 volts and tolerance of ± 3%. Based on this setting and considering the tolerance factor, this setting could effectively be as low as 84.875% of the 4160V bus rating. These relays are inverse-time induction type relays.

According to Westinghouse type CV-7 relay published information and at the present relay setting, these relays would trip in approximately 6 seconds at 90% of relay setting. No information is provided on time required for relay to trip while voltage is at relay setting value. See relay curves attached (Attachment 1).

Considering 84.875% of bus voltage and normal unit loads running an analysis was performed to determine voltage levels at safety-related buses and load terminals.

An evaluation of the impact of this voltage on safety-related unit equipment was performed utilizing existing power system calculations and using engineering judgement. A justification of voltage adequacy is summarized below:

- 4KV Motors:
  With 84.875% bus voltage the minimum voltage on a safety-related 4KV motor would be approximately 84.4% (4160V base) which is equivalent to 87.75% (motor base). An analysis was performed using Westinghouse information to examine impact of continuously running the motors at 80% voltage on motor life. This analysis concluded that this condition would not have significant impact on motor life. Copy of analysis is attached. (Attachment 2)

- Overcurrent protective relaying on 4KV Motors:
  Safety-related motor overcurrent relays are set for motor starting. The adequacy of these settings were examined for motor starting at voltages significantly less than 84.87%. The current values associated with continuously running at 84.87% are considerably below the overcurrent relay settings.

- Bus & Cable:
  These are current sensitive equipment. Lower voltage should not have any impact on them. Current capacity of buses & cables are not exceeded.

- 600V &208V Contactors:
  84.875% of bus voltage should not impact contactor coils. See attached manufacturer test information. (Attachment 3)

- 600/208VAC Motors:
  Based on an evaluation of the 600V RBCF motors and similarity to the 4KV motors, the 600/208V safety-related motors which are normally running should not be impacted by this condition.

- Overload Heaters:
  In safety-related applications, one overload heater is sized properly for the load but it only provides alarm indication in the control room. Overload heaters capable of tripping the motors are considerably oversized for the load and is provided to protect the cable.

- Fuses associated with 600V & 208V Circuits:
  Generally, fuses are only provided to protect the control transformers. Control transformers are sized significantly larger than what is recommended by starter manufacturer. Control transformer and fuse current rating should not be exceeded due to lower voltage. Attachment 3 provides more information on this.

- DC Equipment:
  The Battery Chargers are designed to provide rated output DC voltage with input voltage as low as -15% of nominal voltage (575V). With 84.875% of 4KV bus voltage, the input voltage at the chargers would be approximately 82.5% (600V base) or 86% (575V base).

  Based on that the DC system should be at rated voltage. (See attached manufacturer data sheet).

- AC Vital:
  Since the DC is at rated voltage this condition should not have any impact on the AC vital bus.

GC 3/4/86
DXP 3/4/86

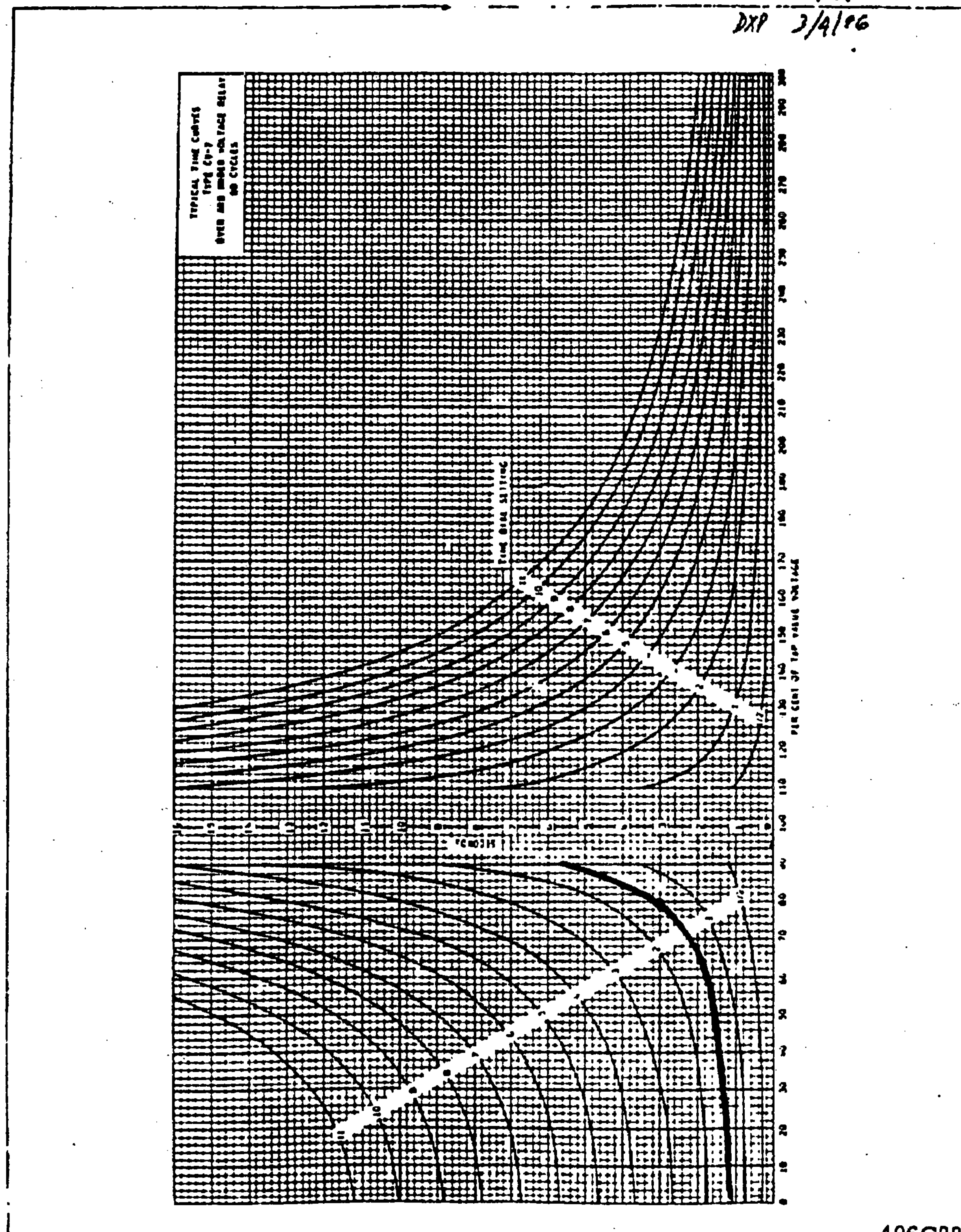

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Fig. 16. Typical 60-cycle time curves of the type CV7 Short Time Over and Undervoltage Relay.

05-801.01

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

November 14, 1990

Docket Nos. 50-269, 50-270
50-287

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
P.O. Box 1007
Charlotte, North Carolina 28201-1007

Dear Mr. Tucker:

SUBJECT: SAFETY EVALUATION FOR DEGRADED GRID PROTECTION (TACs 76743/76744/76745)

Your Licensee Event Reports (LERs) 269/90-04 dated April 30, 1990, 269/90-04 dated May 24, 1990, and 269/90-05 dated May 24, 1990, reported situations related to design deficiencies of the degraded grid protection hardware and provided corrective actions. These deficiencies may leave the station vulnerable to a single failure and/or render safety-related equipment inoperable or damaged during a degraded voltage condition. However, your letter of May 8, 1990, described conceptually a new permanent degraded grid protection modification to be installed in the near future that would, to a great extent, resolve these design deficiencies. The NRC staff has completed a review of these submittals. Enclosed is the related Safety Evaluation.

The staff has concluded that the proposed modifications to the design would provide additional undervoltage protection. Also, in consideration of the complexity of the plant's existing undervoltage protection system and the on-site electrical distribution system, the staff finds the proposed degraded grid protection modification acceptable.

Sincerely,

Leonard A. Wiens, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reaction Regulation

Enclosure:
As stated

cc w/enclosure:
See next page

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DUKE POWER CO.
REGULATOR

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO DEGRADED GRID PROTECTION
DUKE POWER COMPANY
OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3
DOCKET NOS. 50-269, 50-270 AND 50-287

1.0 INTRODUCTION

By Licensee Event Report (LER) 269/90-04 dated April 30, 1990, the licensee for Oconee Nuclear Station reported a situation where one of the two required onsite emergency electrical paths could be rendered inoperable during a degraded grid condition leaving the station vulnerable to a single failure. Also in LER 269/90-04 and LER 269/90-05 dated May 24, 1990, the licensee reported an additional situation where safety-related equipment could be subjected to low voltages which could render them inoperable or damaged during degraded grid conditions. The root causes for these conditions were determined to be design deficiencies.

In a letter dated May 8, 1990, the licensee provided a description of the conceptual design for a degraded grid protection hardware modification intended as the permanent corrective action. We have reviewed the conceptual design and find it acceptable as discussed below.

2.0 DISCUSSION

During normal operation, electrical power to each of the three Oconee units is supplied through its corresponding auxiliary transformer and N breakers (see attached figure). If a unit's normal path is unavailable, electrical power is then supplied through the E breakers via the unit's startup transformer which is fed from the 230 kV switchyard.

On a loss-of-offsite power condition (230 kV grid voltage below 160 kV), undervoltage relays, which are part of the External Grid Trouble Protection System, start the onsite Keowee hydroelectric units and isolate the 230 kV switchyard from the offsite electrical grid. Emergency electrical power is then available from Keowee to each unit through the underground feeder circuit via transformer CT 4 and the SK breakers or through the overhead path via the

230 kV switchyard and each unit's startup transformer and E breakers. For the overhead path to be established through Keowee breakers, a "Switchyard Isolate Complete" signal must be generated when the necessary breakers in the 230 kV switchyard isolate the switchyard from the offsite grid and align the switchyard to the Keowee overhead path.

For a degraded grid condition (230 kV grid voltage less than 211 kV) undervoltage relays (1 per phase with 2 out-of-three logic) on the secondary side of each unit's auxiliary transformer open the unit's N breakers. Similarly, undervoltage relays on the secondary side of each unit's startup transformer open the unit's E breakers. Upon opening of the N and E breakers, non-safety related undervoltage relays on each unit's 4 kV main feeder buses sense a loss-of-voltage condition and start the Keowee hydroelectric units. Emergency power is available through the Keowee underground path and, if the grid voltage continues to decrease below 160 kV, through the Keowee overhead path by the protective action of the External Grid Trouble Protection System.

2.1 <u>LER 269/90-04</u>

In LER 269/90-04, the licensee reported a design deficiency in the degraded grid protection circuitry. As can be seen from the above discussion, when the grid voltage falls below 211 kV, emergency power is supplied to each unit via the underground path from the Keowee hydroelectric station but the redundant Keowee overhead path for emergency power is not available until the grid voltage falls below 160 kV. If the grid voltage should remain below 211 kV but above 160 kV, only the single underground path is available leaving all three Oconee units vulnerable to a single failure. During degraded grid conditions this could cause the inability of safety systems to mitigate the consequences of a design basis accident/transient unless the operator took action to manually align switchyard breakers for the overhead path.

2.2 LER 269/90-04 AND LER 269/90-05

In LER 269/90-04 and LER 269/90-05, the licensee reported an additional design defect involving the inability of the degraded grid protection circuitry to protect against electrical distribution system voltages falling below minimum values recommended by equipment manufacturers and possibly causing equipment inoperability and/or damage. Between 1979 and 1982, the licensee submitted various analyses and justification to support the selection of 219 kV as the undervoltage relay setpoint for degraded grid protection. The documentation submitted by the licensee established that with a grid voltage as low as 217 kV, corresponding voltages at class 1E equipment input terminals would be sufficient to start and continuously operate the equipment within their voltage ratings for the worst case electrical system loading. With the actual setpoint placed at 211 kV (or as low as 203 kV considering instrument errors), the class 1E equipment performance and/or condition was questionable for design basis scenarios occurring with grid voltages degraded between 217 kV and 203 kV. In LER 269/90-05 the licensee stated that all post-trip equipment except for post-LOCA 208 V MOVs (high and low pressure injection valves, building spray valves) would operate and that the reduction in 4 kV motor life is insignificant. Operator action would be necessary to restore adequate voltage to the valves or to manually operate the MOVs during the degraded grid condition.

3.0 EVALUATION

For immediate corrective action of the design deficiencies, the plant operators will monitor the 230 kV switchyard voltage every two hours. If the voltage drops below 225.2 kV, an attempt to increase the grid voltage will be made, the Keowee underground path will be verified to be operable, electrical power from the Lee gas turbines will be made available to the units' standby buses, and Technical Specification 3.0 will be entered. If grid voltage remains degraded, the units will be in hot shutdown in 12 hours and cold shutdown within the next 24 hours.

In a letter dated May 8, 1990, the licensee provided a conceptual description of the permanent hardware modification intended to eliminate the design deficiencies. New undervoltage relays with setpoints of 222.5kV will be installed utilizing existing potential transformers in one phase on the primary side of each unit's startup transformer. Two-out-of-three logic will be used to generate an undervoltage signal. After a 9 second time delay this signal will then generate alarms in the control rooms and, if an ES signal from any unit's Engineered Safeguards Protective System exists, will then isolate the 230 kV switchyard from the offsite 230 kV electrical grid.

The guidance for the staff's review of the proposed modification is contained in Branch Technical Position (BTP) PSB-1, "Adequacy of Station Electrical Distribution System Voltages." The specific requirements of the BTP for degraded grid undervoltage protection of Class 1E equipment and our evaluation of the proposed design modification against those requirements are as follows:

1. *Setpoints and time delays shall be determined from an analysis of Class 1E equipment voltage requirements.*

   The licensee has selected a setpoint of 222.5 kV for the new undervoltage relays. This setpoint is based on the value 219 kV, which the staff previously approved, plus 1.6% to account for instrumentation errors. The time delay for the downstream timers has been fixed at 9 seconds to allow for short-duration voltage transients to occur without initiation of undervoltage alarms and equipment protective action.

2. A short time delay shall be provided to allow motor starting transients to occur. Following this delay, a control room alarm should sound to alert the operator to the degraded grid condition. If a subsequent LOCA should occur, the onsite Class 1E electrical distribution system should be separated immediately from the offsite electrical grid.

As stated above, the licensee has selected a 9 second time delay which should be adequate to allow for voltage transients during motor startup. After the 9 seconds have passed, a subsequent LOCA will result in immediate separation of the Class 1E distribution from the offsite grid.

3. A longer time delay, of limited duration such that Class 1E equipment will not be damaged, shall be provided to allow the operator to attempt to restore adequate voltages to the Class 1E equipment. Following this delay, the Class 1E distribution system should be separated from the offsite electrical grid if adequate voltage is unavailable.

   The design modification has only the 9 second fixed delay. A second, longer time delay has not been incorporated into the design. Also, the undervoltage condition in itself does not result in the separation of the Class 1E distribution system from the offsite grid; an ES (LOCA, MSLB) signal must exist coincidentally before undervoltage protective action occurs.

   In response to a staff question, the licensee stated, in a phone conference call, that after a degraded grid alarm is received, steps will be taken to re-establish an adequate voltage level on the grid. For a sustained degraded grid condition, analyses (see licensee's letter dated June 18, 1990) related to LERs 269/90-04 and 269/90-05 have been performed covering equipment and plant performance down to the worst setpoint (203 kV) of the existing degraded grid protection circuitry. This circuitry will remain installed and will provide automatic separation from the grid for scenarios without an ES signal and where voltages drop to levels near where equipment/plant performance is unanalyzed.

4. The voltage sensors of the undervoltage circuitry shall be Class 1E and shall be located at and electrically connected to Class 1E switchgear.

   In response to a staff question, the licensee stated in a phone call that all relays, timers, and auxiliary relays used in the new undervoltage scheme would be Class 1E. Although it is derived from a Class 1E source, the 125 vdc control power will be non-Class 1E utilizing components similar to Class 1E components. The non-Class 1E potential transformers (PTs) are also similar to Class 1E PTs and are seismically mounted.

5. An independent undervoltage scheme shall be provided for each Class 1E division.

   The new degraded grid protection circuitry is not divisionalized and is shared by all three Oconee units. This is consistent with the overall design of the emergency electrical power system at Oconee which has two hydroelectric units shared by all three units with the overhead path from Keowee having some common components with the preferred offsite source. The overall design philosophy at Oconee is to ensure that all the emergency 4 kV buses are fed from the same reliable source selected by a "good voltage" seeking, automatic transfer scheme.

6. Coincident logic on a per bus basis shall be utilized.

   The proposed degraded grid protection circuitry utilizes 2-out-of-3 coincident logic to preclude spurious trips. As stated above, the circuitry and its logic are not divisionalized and are not on a per bus basis. The coincident logic is shared by all three Oconee units.

7. Test and calibration capability during power operation shall be provided for the voltage sensors.

   Since 2-out-of-3 coincident logic is utilized in the new design, it appears that the undervoltage sensors (PTs and relays) should be testable without interfering with normal operation.

8. Bypass annunciation shall be provided in the control room. The staff's review of the proposed design modification indicates that bypasses are not used in the design.

9. Technical specifications shall include limiting conditions for operation, surveillance requirements, and trip setpoints and allowable values for undervoltage relays and time delay devices.

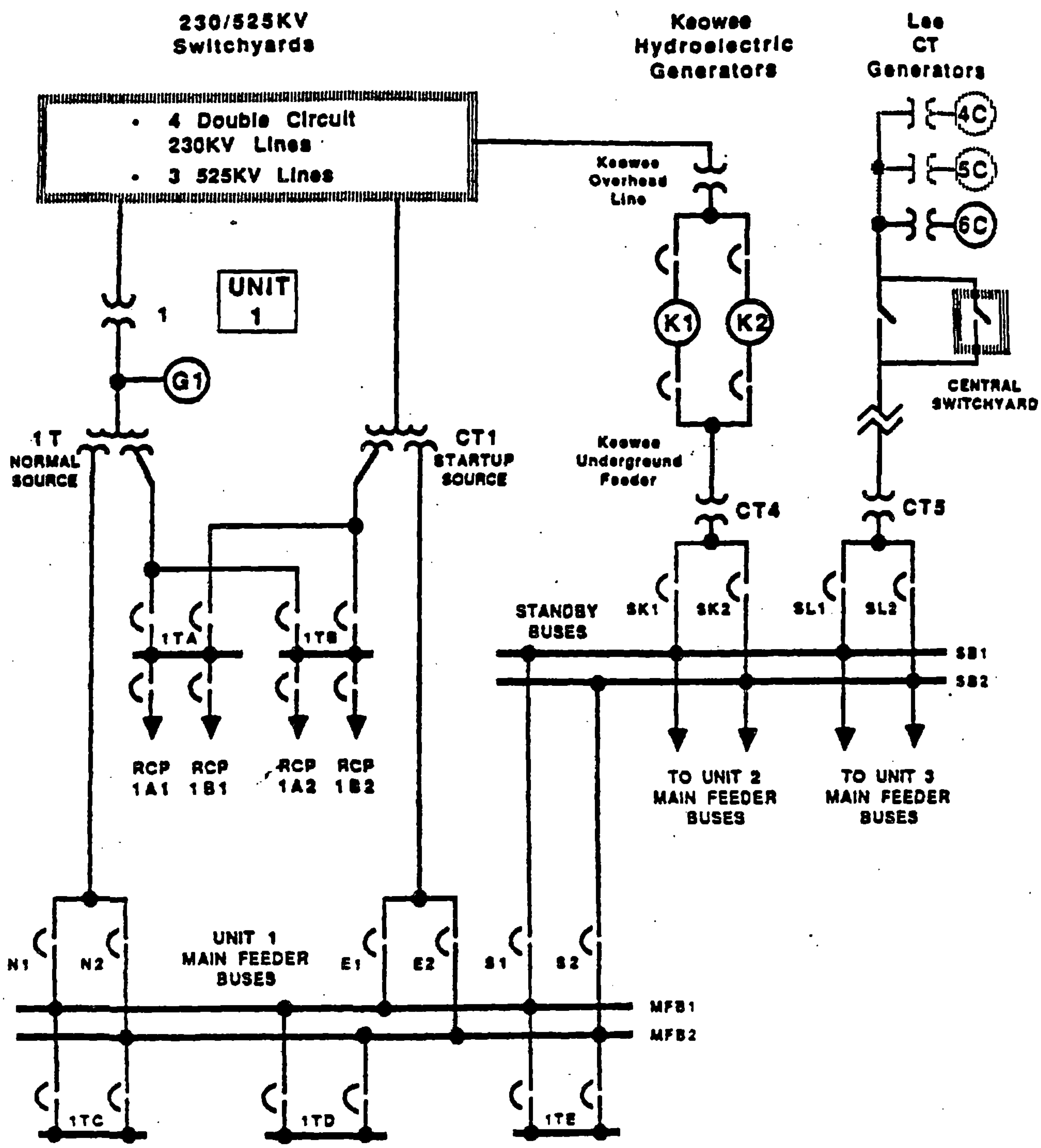
   In response to a staff question, the licensee stated that technical specifications will be proposed but setpoints and time delays will not be specifically identified.

4.0 CONCLUSION

From the discussion above, it can be concluded that the licensee's proposed modification does not fully meet BTP PSB-1 in several areas. Requirements similar to those contained in the BTP were generically applied to every plant (circa 1978). In the northeastern part of the country, low grid quality necessitated the staff to back away somewhat from the BTP requirements, particularly for the requirement to automatically separate the onsite Class 1E electrical distribution system from the degraded grid. For the northeast plants, the staff permitted the use of alarms, procedures and manual operator actions, in lieu of automatic action, to ensure that the safety-related components of the Class 1E systems would not be adversely affected during low voltage conditions. This compromise to the requirements of the BTP was granted due to the known weakness of the New England grid whereby the forced shutdown of one nuclear plant could lead to shutdown of other plants in a cascading manner.

For Oconee, the proposed modification will add another layer of undervoltage protection to the existing, degraded grid protection circuitry. Due to the complexity of the plant's existing undervoltage protection scheme and the onsite electrical distribution system coupled with the speculation that the quality of the grid servicing the Oconee site may have similar weaknesses to what exists in the Northeast, we conclude that it is not prudent to impose the complete requirements of the BTP. Therefore, we find that the licensee's proposed degraded grid protection modification (excluding Technical Specification changes which will be evaluated in a separate SE) is acceptable.

OCONEE NUCLEAR STATION
Power System



Adequacy of Oconee Nuclear Station Electric Distribution System Undervoltage Protection During Postulated Degraded Grid Voltage Events

1. **Executive Summary**

During the 2014 NRC Component Design Basis Inspection (CDBI) the NRC team identified an unresolved item (URI) to determine whether a performance deficiency exists with respect to the licensee's degraded voltage relay scheme (Degraded Voltage Relay Scheme [05000269, 270, 287/2014007-04 URI Section [R21.2.b.iv]).

This paper will address both the current and historical licensing and technical issues related to the systems that are credited for both the detection and mitigation of a degraded grid event.

The Oconee Nuclear Station (ONS) was originally constructed with two layers of off-site power degraded voltage protection. These layers consisted of the Oconee 4kV Safety Related Power Undervoltage Protection System (4kV UV) and the Oconee External Grid Trouble Protective System (EGTPS).

The Oconee Degraded Grid Undervoltage (DGUV) System was added in the 1990s time frame to correct an issue identified in an April 30, 1990 License Event Report (LER) concerning unanticipated system interactions during an undervoltage condition in the 230kV switchyard. These unanticipated interactions could have caused the Keowee Overhead path to be unavailable during certain postulated degraded grid scenarios and thus result in the failure of one of two power paths (Keowee Overhead and Underground paths) from the onsite emergency AC source (Keowee). This system alerts Oconee Nuclear Station operators and Duke Energy grid system operations to degraded grid voltage conditions prior to the actuation of the 4kV Undervoltage protection system. This system will also isolate the switchyard and start Keowee in the event of an Engineered Safeguards (ES) system actuation during the degraded grid condition as further explained in this document.

An operating experience (OE) review was performed and it was determine that some nuclear power plants ultimately rely upon manual or administration actions (via their control rooms or their grid operation center) to protect safety related buses from adverse undervoltage effects related to degraded grid conditions.

Ultimately, Oconee relies upon the automatic actions of safety related components to protect Class 1E equipment from adverse impacts due to undervoltage during postulated degraded grid conditions.

2. Overview of ONS Degraded Off-site Voltage Protection

a. Oconee External Grid Trouble Protective System Overview (EGTPS)

The External Grid Trouble Protective System Undervoltage system consists of two redundant channels. Each channel is physically and electrically separated. Each channel consists of six undervoltage relays which are each connected to a phase of both the red and yellow buses. When 2 relays on the same phase actuate, this will then actuate a local red light and another event recorder point. If two out of three relays are actuated, these two relays will energize four tripping relays which will initiate the operation of the External Grid Trouble Protective System and automatically initiate a start of the Keowee Hydro units. Also, this will actuate a computer point, event recorder point, and status alarm.

b. Oconee Degraded Grid Undervoltage (DGUV) System Overview

The Degraded Grid Undervoltage relays consists of three undervoltage relays which are connected to the 230 kV Yellow Bus in a 2 out of 3 logic scheme. One relay is connected to each phase to detect any abnormal conditions. When 2 out of 3 relays operate, this will start a 9 second timer. If the UV conditions recover above the relay setpoint, the 9-second timer will de-energize. This is designed to eliminate any voltage transients that occur during switching and faults external to the Oconee switchyard. If at the end of 9 seconds the undervoltage condition has not recovered, a signal will be sent to the statalarm, OAC, Dispatcher and Event Recorder. If an undervoltage condition is present on 2 out of 3 phases along with an Engineered Safeguards (ES) signal, the 230 kV Yellow Bus will isolate and automatically initiate a start of the Keowee Hydro units to energize the startup transformers.

This system was added as an additional degraded voltage protection system to clear the onsite emergency power source overhead path. See section 3.d of this document for additional history regarding this system.

c. Oconee 4kV Safety Related Power Undervoltage Protection System (4kV UV) Overview

The 4kV normal incoming breakers provide power during normal operation to the Main Feeder Bus (MFB) from the respective unit's auxiliary transformer (1/2/3T). The normal source of power to the unit auxiliary transformer is the unit generator, although the capability is provided for providing power to 1/2/3T from the switchyard.

If an undervoltage is sensed on two out of three phases of the normal source, the normal breakers will trip and isolate the safety related Main feeder Bus from the grid. The emergency source "E" breakers utilize the same logic.

The 84.77% nominal voltage analysis is performed at the "must drop out" value of the 27N & E relays, 97% tap. At the 97% tap value, the 27N & E relays will begin to operate the disc and after a time delay will provide a trip to either the normal or startup breakers. This trip will isolate the safety related buses from the degraded source of power.

A Source voltage of 84.77% nominal will bound all degraded conditions due to the following:

1. It has been analyzed that all operating safety related equipment will survive a degraded voltage of 84.77% nominal.

2. Uncertainty associated with the 84.77% nominal voltage setting (97% tap) is bounded by testing that is performed at 99% tap.

3. It has been demonstrated that the undervoltage relays will drop out and actuate on 4kV undervoltage at 84.77% nominal.

In a July 21, 1977 letter from Oconee to the NRC regarding the assessment of the susceptibility of safety related equipment to sustained degraded voltage, it was shown analytically that the safety related loads are protected from degraded grid voltage conditions. Attachment 1, Section III "Conclusions" states the following:

To ensure that the operability of system components is not adversely affected by short term or long term degradation in system grid voltage, the undervoltage relays that monitor the offsite power system are set at 88% (3660V) . This ensures that an acceptable voltage level required for continuous operation of non-safety, and safety-related equipment will exist. The time delay inherent in these relays will eliminate spurious trips and ensure that degraded undervoltages are detected and cleared before they can adversely affect safety-related loads.

Figure 5 shows the results of Case 7 which provides the voltage profiles on the safety-related buses under degraded offsite power conditions corresponding to the undervoltage relay setpoint of 88% (3660V).

This Case demonstrates that voltages below the continuous operating limits of the safety-related loads cannot exist without causing a separation from the degraded condition."

In a December 20, 1978 letter from the NRC to Oconee, the NRC stated that, "the design affords adequate protection against degraded grid undervoltage conditions in accordance with the NRC letter of June 3, 1977, and therefore is acceptable.

See sections 3.a and b of this document for additional history regarding this system.

3. Licensing History

a. Original Plant Design for the Class 1E Electrical Distribution System Undervoltage Protection

No original licensing documentation could be located that explicitly describes and evaluates the undervoltage protection features of the Class 1E electrical distribution system. The Oconee Nuclear Station originally had an undervoltage protection design (4kV UV) to protect the Class IE equipment from a loss of voltage or a sustained degradation of grid voltage on the emergency buses. This undervoltage protection design provides for two out of three coincident logic, monitoring the offsite power voltage on each 4160 volt bus. The undervoltage protection will initiate separation of the onsite emergency buses from the offsite power systems immediately upon complete loss of offsite power or at a time delay depending on the extent of the degraded voltage condition. Due to the inverse time trip characteristics of the undervoltage relays, the lower the voltage, the faster the trip.

b. August 12, 1976 to December 20, 1978 Correspondence Related to the Millstone Event

In an August 12, 1976 letter from the NRC to Oconee, the plant operation and equipment failures during a degraded grid voltage condition events that occurred at Millstone Unit No. 2 were described. At that time the NRC requested that Oconee investigate the vulnerability of their facility to similar degraded voltage conditions and provide a response by telephone.

In a June 3, 1977 letter from the NRC to Oconee, the NRC felt that it was necessary for all licensees to conduct a thorough evaluation of the problem and submit formal reports regarding the design of their respective Class 1E electrical distribution systems and their vulnerability to both long and short term degradation in the grid system voltage within the range where the offsite power is relied upon to supply important equipment.

As requested, Oconee provided multiple responses to the NRC describing the operation of our Class 1E electrical distribution systems. In a July 21, 1977 letter from Oconee to the NRC, an evaluation performed that showed the Class 1E system is not vulnerable to the same conditions that were experienced during the Millstone event. The letter states the following:

"To ensure that the operability of system components is not adversely affected by short term or long term degradation in system grid voltage, the undervoltage relays that monitor the offsite power system are set at 88% (3660V). This ensures that an acceptable voltage level required for continuous operation of non-safety and safety-related equipment will exist. The time delay inherent in these relays will eliminate spurious trips and ensure that degraded undervoltages are detected and cleared before they can adversely affect safety-related loads."

In a December 20, 1978 letter from the NRC to Oconee, the NRC stated that, "the design affords adequate protection against degraded grid undervoltage conditions in accordance with the NRC letter of June 3, 1977, and therefore is acceptable. The NRC further stated in this letter, "The Oconee Nuclear Station originally had an undervoltage protection design to protect the Class IE equipment from a loss of voltage or a sustained degradation of grid voltage on the emergency buses. The protection system includes undervoltage relays with inverse time characteristics which have a trip setpoint set at 88% of the rated bus voltage, i.e., 4160 volts and with a five second time delay. This undervoltage protection design provides for two out of three coincident logic, monitoring the offsite power voltage on each 4160 volt bus. The undervoltage protection will initiate separation of the onsite emergency buses from the offsite power systems immediately upon complete loss of offsite power or at a time delay depending on the extent of the degraded voltage condition below 88% of nominal voltage. The lower the voltage, the faster the trip."

c. **August 8, 1979 to March 21, 1983 Correspondence Related to the Arkansas Nuclear One (ANO) Event**

In an August 8, 1979 Generic Letter from the NRC to all Power Reactor Licensees, an event was discussed that occurred at the Arkansas Nuclear One (ANO) station on September 16, 1978 that brought into question the conformance of the station electric distribution system to GDC-17, in two separate regards. Specifically, licensees must confirm the acceptability of the voltage conditions on the station electric distribution systems with regard to both (1) potential overloading due to transfers of either safety or non-safety loads, and (2) potential starting transient problems in addition to the concerns expressed in our June 2, 1977 correspondence with regard to degraded voltage conditions due to conditions originating on the grid.

GDC-17 requires, in part, that (1) electric power from the transmission network for the onsite distribution system shall be supplied by two physically independent circuits (not necessarily on separate-rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and environmental conditions and (2) provision 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 unit, or the loss of power from the transmission network. The ANO station did not fully meet these requirements.

In a letters from Oconee to the NRC on March 13, 1980 and June 4, 1980, Oconee further described Class 1E electrical distribution system operation and analyses in light of the ANO event and GDC-17. Oconee is not a GDC-17 plant due to its licensing prior to General Design Criterion.

In a March 21, 1983 letter from the NRC to Oconee, the NRC stated that they had completed their review and determined the following:

"Based on the results of your distribution system voltage verification tests, performed in accordance with our guidelines, for the Unit 3 distribution system, we find your voltage analysis acceptable, Due to the close similarity of the design and loading of the distribution systems for all 3 units, we agree to accept the results of the Unit 3 tests as being valid for Units 1 and 2 also. Therefore separate verification testing for Units 1 and 2 will not be necessary. The voltage analysis you submitted, indicates that the distribution voltages at the safety buses were unacceptable when one unit startup transformer is shared between two units. Your staff has agreed to implement Technical Specifications (TSs) to prohibit the connection of more than one unit auxiliary and Class 1E loads to a single startup transformer." Oconee Technical Specification 3.8.1 Condition A states the following, "Both required offsite sources and the overhead emergency power path inoperable due to inoperable unit startup transformer."

NRC Conclusions
We have reviewed the EG&G Technical Evaluation Report and concur in the findings that:

1. The voltages are within the operating limits of Class 1E equipment for projected combinations of plant load and offsite power grid conditions provided one startup transformer is used for one unit.

2. Spurious separation from the offsite power system due to the operation of voltage protective relays will not occur (with the offsite grid voltage within its expected limits) as a result of starting safety loads.

3. DPC has determined (by analysis) that no potential for either a simultaneous or consequential loss of both offsite power sources exists.

4. The tests performed by DPC verifies the accuracy of their analysis.

We, therefore, find Oconee Nuclear Units 1, 2 and 3 design to be acceptable with respect to adequacy of station electric distribution system voltages subject to the implementation of technical specifications change prohibiting the use of one startup transformer for more than one unit."

d. April 30, 1990 to November 14, 1999 Correspondence Related to the Oconee License Event Reports

In a April 30, 1990 Licensee Event Report (LER) from Oconee to the NRC, it was reported that Oconee Design Engineering, while developing a Design Basis Document, determined that the switchyard 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 switchyard 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 230 kV switchyard and its associated incoming transmission lines to be unavailable to provide their required support function.

These conditions are possible because the 230 kV switchyard bus 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 a degraded switchyard voltage exists between these relative setpoints, then power to the ES buses may not be automatically available from either source.

Design Engineering also initiated a Station Problem Report which resulted in the later development of Nuclear Station Modification (NSM) 52850. This NSM detailed 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 provided an annunciator, digital computer and events recorder indication to plant operators as well as input to the Operator Aid Computer (OAC) when 230 kV switchyard degraded voltage conditions exist. This modification automatically initiated existing switchyard isolate logic if degraded voltage conditions and an engineered safeguards (ES) signal on any Oconee unit occur concurrently. This system is known today as Oconee Degraded Grid Undervoltage (DGUV) System.

In a November 14, 1990 Safety Evaluation for Oconee Degraded Grid Protection, the NRC concluded the following:

"Your Licensee Event Reports (LERs) 269/90-04 dated April 30, 1990, 269/90-04 dated May 24, 1990, and 269/90-05 dated May 24, 1990, reported situations related to design deficiencies of the degraded grid protection hardware and provided corrective actions. These deficiencies may leave the station vulnerable to a single failure and/or render safety-related equipment inoperable or damaged during a degraded voltage condition.

However, your letter of May 8, 1990, described conceptually a new permanent degraded grid protection modification to be installed in the near future that would, to a great extent, resolve these design deficiencies. The NRC staff has completed a review of these submittals. Enclosed is the related Safety Evaluation. The staff has concluded that the proposed modifications to the design would provide additional undervoltage protection. Also, in consideration of the complexity of the plant's existing undervoltage protection system and the on-site electrical distribution system, the staff finds the proposed degraded grid protection modification acceptable."

4. **NRC Regulatory Issue Summary 2011-12, Revision 1, Adequacy of Station Electric Distribution System Voltages**

Criteria a) The selection of voltage and time delay set-points shall be determined from an analysis of the voltage requirements of the safety-related loads at all station electric power system distribution levels;

Note: Voltage requirements of all safety-related loads should be determined based on manufacturers design and operating requirements. For example, safety injection motors have starting and running voltage requirements. Motor operated valves have minimum operating voltage requirements. Motor Control Center contactors have minimum pickup and operating voltages. All voltage requirements for all safety-related loads need to be preserved by the DVR circuit(s) during all operating and accident conditions.

Oconee's Design to Criteria a) The voltage setpoints for the 4kV Safety Related Power Undervoltage Protection System relays were shown via analyses to automatically protect the connected equipment during a postulated degraded grid scenario.

Criteria b) The voltage protection shall include coincidence logic to preclude spurious trips of the offsite power source;

Oconee's Design to Criteria b)

The 4kV Safety Related Power System Undervoltage Protection and Degraded Grid Undervoltage (DGUV) Systems utilize 2 out of 3 logic. This requires that 2 out of the 3 phases are in a degraded voltage condition prior to actuation.

Criteria c) The time delay selected shall be based on the following conditions:

Criteria c-1) The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the final safety analysis report (FSAR) accident analyses;

Note: Time delay condition (1) indicates that the DVR circuits should be designed assuming coincident sustained degraded grid voltage and accident events. Upon the onset of the coincident accident and degraded grid event, the time delay for the DVR circuit should allow for separation of the 1E buses from the offsite circuit(s) and connection to the 1E onsite supplies in time to support safety system functions to mitigate the accident in accordance with the FSAR accident analyses.

Oconee's Design to Criteria c-1)

The DGUV system, as stated in Section 2 of this paper, will actuate if an undervoltage condition is present on 2 out of 3 phases along with an Engineering Safeguard (ES) signal, the tripping relays (94V Channel 1 or 2) located in the External Grid Protection System (EGPS) will operate isolating the 230 kV Yellow Bus and starting Keowee Hydro to energize the startup transformers. The time delay for this postulated event is well bounded by LOCA/LOOP analyses. The 9 second degraded voltage relay timer + 11 second (transfer to standby bus) is less than the 23 seconds required by the UFSAR. Keowee will start from an ES signal and not wait for the 9 second timer.

If an accident signal (ES) is not present, the buses will be protected by the 4kV UV system at each respective unit's 4kV bus. Evaluation showed that the 4kV UV system response time is one minute or less.

Criteria c-2) The time delay shall override the effect of expected short duration grid disturbances, preserving availability of the offsite power source(s).

Oconee's Design to Criteria c-2)

For the DGUV system, a 9 second delay is utilized to override the effect of expected short duration grid disturbances, preserving availability of the offsite power source.

The 4kV UV system voltage setpoints arelower than the DGUV setpoints. Expected short duration grid disturbances would not reach the lower setpoints. Due to the inverse time trip characteristics of the undervoltage relays, the lower the voltage, the faster the trip. This provides an inherent mechanism which is resistant to nuisance tripping.

Criteria c-3) The allowable time duration of a degraded voltage condition at all distribution system levels shall not result in failure of safety-related systems or components.

Oconee's Design to Criteria c-3)

Due to the design of the 4kV UV system, during a degraded voltage below 87.33% nominal it has been demonstrated that all operating equipment will survive and be available if needed for an ES actuation. It has also been demonstrated that a safety related load can be started and survive to be able to operate at this degraded voltage. Additionally, it has been shown that the undervoltage relays would actuate at 84.77% nominal to separate the safety related loads from the degraded source of power. This actuation has been shown to occur in less than two minutes. It is also important to note that once the undervoltage relays drop out the voltage has to recover to 100% tap (105 volts) or higher to reset the relay. Although analysis demonstrates that all safety related loads would survive during a sustained degraded voltage condition of 84.77% nominal, the relays would automatically separate the ES buses from the degraded source or the voltage would have to recover to an acceptable level, 100% tap (87.5% nominal) or higher.

Criteria d) The voltage monitors (or DVRs as defined above) shall automatically initiate the disconnection of offsite power source(s) whenever the voltage and time delay limits have been exceeded.

Oconee's Design to Criteria d)

The 4kV UV system undervoltage protection relays would actuate at 84.77% nominal to separate the safety related loads from the degraded source of power.

The Oconee Degraded Grid Undervoltage (DGUV) system will isolate the switchyard and start Keowee in the event of an Engineered Safeguards (ES) system actuation during the degraded grid condition.

Any proceduralized manual actions for DGUV alarms are preliminary actions. The class 1E buses are automatically protected by the 4kV UV system.
Criteria e) The voltage monitors (DVRs) shall be designed to satisfy the requirements of IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"

Oconee's Design to Criteria e)

All relays, timers, and auxiliary relays used in The Oconee Degraded Grid Undervoltage (DGUV) system are Class 1E. Although they are derived from a Class 1E source, the 125 vdc control power are non-Class 1E utilizing components similar to Class 1E components. The non-Class 1E potential transformers (PTs) are also similar to Class 1E PTs and are seismically mounted.

The 4kV UV system satistfies the requirements of IEEE 279-197 1 per a July 21, 1977 from Duke to the NRC.

Criteria f) The Technical Specifications shall include limiting conditions for operation, surveillance requirements, trip setpoints with minimum and maximum limits, and allowable values for second-level voltage protection DVRs.

Oconee's Design to Criteria f)

The current Oconee Technical Specifications (TS) 3.3.19 include limiting conditions for operation (LCOs) and Surveillance Requirements (SRs). No trip setpoints are included in the TS.

ONS Operating License and Technical Specifications were issued in the early 1970's. 10 CFR 50.36 (c)(2)(iii) states that a licensee is not required to propose to modify technical specifications that are included in any license issued before August 18, 1995, to satisfy the criteria in paragraph (c)(2)(ii) of this section. As such, ONS was not required to modify technical specifications to include items that meet Criterions 1, 2, 3, and 4. Note that 10 CFR 50.36 was modified to include criteria for inclusion of items in Technical Specifications in 1995. See section 5.d of this document for additional background information.

The DGUV system channel redundancy limitations and setpoints are included in Oconee TS 3.3.19.

5. NRC CDBI Questions/Concerns

a. Does scheme meet AEC 39 (UFSAR 3.1.39), 1977 letter?

ONS Response to 5.a

Criterion 39 (Emergency Power for Engineered Safety Features) states the following, "Alternate power systems shall be provided and designed with adequate independency, redundancy, capacity, and testability to permit the functioning required of the engineered safety features. As a minimum, the on-site power system and the off-site power system shall each, independently, provide this capacity assuming a failure of a single active component in each power system.

ONS UFSAR section 3.1.39 states:
"The electrical systems meet the intent of the criterion as discussed in UFSAR Chapter 8. Three alternate emergency electric power supplies are provided for the station from which power to the engineered safety feature buses of each unit can be supplied. These are the 230 KV switching station with multiple off-site interconnections and two on-site independent 87,500 KVA hydroelectric generating units. Each nuclear unit can receive emergency power from the 230 KV switching station through its start-up transformer as a preferred source. Each unit can receive emergency power from one hydroelectric generating unit through a 13.8 KV underground connection to standby transformer CT4. The other hydroelectric generating unit serves as a standby emergency power source and can supply power to each unit's startup transformer when required. Both on-site hydroelectric generating units will start automatically upon loss of all normal power or upon an engineered safety feature action.

Two additional sources of alternate power are available, as each nuclear unit is capable of supplying any other unit through the 230 KV switching station. In addition, a connection to the 100 KV transmission network is provided as an alternate source of emergency power whenever both hydroelectric generating units are unavailable."
No single active failure could prevent the ability of the on-site power system and the off-site power system, independently, to provide power to the engineered safety features."

b. Do manual actions "after a DG (Degraded Grid) Alarm steps to resolve" – are these required to protect 4kV,etc.?

ONS Response to 5.b

No. As described in sections 2(a-c) of this paper, the degraded voltage relay protection systems provide automatic isolation initiation prior to Class 1E electrical distribution system bus voltages reaching any analyzed limits. Proceduralized actions by Oconee operators are considered conservative and prudent measures to be taken prior to the initiation of automatic protective actions.

c. **Does the automatic systems each meet the requirements (1977, BTP, RIS)? (Analysis vs. set points)**

ONS Response to 5.c

Yes. Past and current analyses show that the setpoints of the automatic system (4kV UV) are adequate to protect the Class 1E electrical distribution systems during postulated periods of degraded grid voltage. See section 3.b of this document for additional information.

d. **Are 4kV set points credible since not in TS, and should they be per 10 CFR 50.36 (c)(2)(iii)?**

ONS Response to 5.d

ONS Operating License and Technical Specifications were issued in the early 1970's. 10 CFR 50.36 (c)(2)(iii) states that a licensee is not required to propose to modify technical specifications that are included in any license issued before August 18, 1995, to satisfy the criteria in paragraph (c)(2)(ii) of this section. As such, ONS was not required to modify technical specifications to include items that meet Criterions 1, 2, 3, and 4. Note that 10 CFR 50.36 was modified to include criteria for inclusion of items in Technical Specifications in 1995.

The ONS Technical Specifications currently require three channels of each of the following EPSL voltage sensing circuits to be OPERABLE: a) Startup Transformer, b) Standby Bus 1; c) Standby Bus 2: and d) Auxiliary Transformer in MODES 1, 2, 4, 4, 5, and 6, and during movement of irradiated fuel assemblies. The EPSL voltage sensing circuits are required for the engineered safeguards (ES) equipment to function in any accident with a loss of offsite power. Per the ONS TS 3.3.18 Bases the EPSL voltage sensing circuits satisfy Criterion 3 of 10 CFR 50.36. SR 3.3.18.1 requires a CHANNEL FUNCTIONAL TEST be performed every 24 months (per SFCP). The test is a functional test of the logic and does not verify the setpoint. This verification is performed by testing not controlled by Technical Specifications. The exclusion of the setpoint verification from TSs is addressed below under TS history.

EPSL TS History

On March 11, 1993, Duke Energy submitted a complete rewrite of Section 3.7, Auxiliary Electrical Systems, using a format consistent with standard technical specifications (NUREG 1430). The custom Technical Specifications (CTS) that existed at the time of submittal did not include surveillance requirements for the EPSL voltage sensing circuits (4kV UV). As such, Duke Energy proposed to add surveillance requirements to require a refueling frequency CHANNEL TEST as an additional restriction that was not currently included in Technical Specifications. The proposed TS Bases for the SR very clearly stated that the actual setpoints for the undervoltage relays on the N and E breakers are verified independently as a prerequisite to the TS SR. As a result of NRC Requests for

Additional Information (RAIs) and associated Duke Energy RAI responses and to make the LAR adhere to the STS Writers Guide and associated NUREG, Duke Energy re-submitted the proposed TS on September 3, 1997. No changes were made to the proposed TS on EPSL Voltage Sensing Circuits and the NRC issued the TS and Bases as originally proposed (Amendment No. 232, 232, and 231). NRC evaluated proposed TS 3.7.4 for EPSL Voltage Sensing Circuits starting on page 28 of the Safety Evaluation (SE) restating in their summary of proposed SR 3.7.4.1 that the actual setpoint values for the undervoltage relays for the N and E breakers are to be verified independently as a prerequisite to the this SR. The NRC concluded based on the bases of the discussion and evaluation provided in Section 4.0 of the SE that the technical requirements contained in TS 3.7 are consistent with design requirements, the current ONS TS with differences justified, the Bases for TS 3.7 and technical requirements contained in the revised STS (refer to Section 5.0 Summary on page 46 of SE). Section 6.0 of the SE addresses ITS Involvement stating that the SE also provides the review for the technical changes that are included in Section 3.8 of the ONS ITS that is currently under review, but are beyond the scope of the ITS program indicating that both sets of specifications (3.7 for this amendment and 3.8 for the ITS conversion) address the same provisions of the electrical TS. As a result the NRC staff determined that it was satisfactory to approve TS 3.7 and delay implementation so that implementation was coincident with the ITS amendments. Note that EPSL instrumentation was located in the instrumentation Section of Technical Specification during ITS conversion so the TS for EPSL Voltage Sensing circuits is 3.3.18 and for EPSL 230kV Switchyard DGVP is 3.3.19.

e. **Commitments to IEEE-603 / 279 for Emergency Power / Off-site connection**

ONS Response to 5.e

In a July 21, 1977 letter from Oconee to the NRC, regarding the 4kV UV system, it was stated that, "Although designed prior to the issuance of IEEE 279-1971, the undervoltage (4kV UV) protection logic satisfies the requirements of these standards."

All relays, timers, and auxiliary relays used in The Oconee Degraded Grid Undervoltage (DGUV) system are Class 1E. Although they are derived from a Class 1E source, the 125 vdc control power are non-Class 1E utilizing components similar to Class 1E components. The non-Class 1E potential transformers (PTs) are also similar to Class 1E PTs and are seismically mounted.

6. **Degraded Voltage Protection Industry Precedence and Operating Experience (OE)**

Summary: As shown below, due to the reliance on manual and administrative actions (instead of automatic actions) for the protective of safety related buses, the NRC decided to issue a backfit to implement modifications to bring these facilities in compliance with BTP PSB-1, "Adequacy of Station Electric Distribution System Voltages." Per a telephone conservation with Southern Nuclear Operating Company personnel on August 4, 2014, plants Farley and Hatch relied exclusively upon manual actions (either by plant operations or the transmission control department) to protect safety related components from the adverse effects of degraded grid voltage protection. Their argument was primarily based upon the improbability of such a degraded grid voltage condition.

a. Farley Nuclear Plant Backfit Issue

Following a July 1976 event at Millstone involving a degraded voltage condition, the NRC staff developed generic positions on power systems for operating reactors. Since degradation of the offsite power system can lead to or cause the failure of redundant Class 1 E safety-related electrical equipment, the NRC required that licensees install degraded voltage protection as described in NRC letter dated June 2, 1977, "Statement of Staff Positions Relative to Emergency Power Systems for Operating Reactors" (ADAMS Legacy No. 4007002656). The letter states that "the voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits have been exceeded." The letter further states that "the voltage monitors shall be designed to satisfy the requirements of IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations." This automatic feature ensures the adequacy of the offsite power system and the onsite distribution system and ensures that the electrical system has sufficient capacity and capability to automatically start and operate all required safety loads.

Contrary to the June 2, 1977 letter, an NRC Safety Evaluation Report (SER) for FNP (ADAMS Legacy No. 951211 0043) accepted manual operator actions to compensate for degraded grid conditions.

b. Hatch Nuclear Plant Backfit Issue

In a letter dated June 17, 2011, SNC disagreed with the conclusion in the May 25, 2011, report and appealed the NRC's decision to issue the backfit under the "compliance exception" provision of 10 CFR 50.109(a)(4)(i). In your appeal, you stated that a cost justified substantial safety backfit analysis, per 10 CFR 50.109(a)(3), was required. At issue was the reliance on administrative controls and manual actions at HNP, as approved in the 1995 NRC Safety Evaluation Report (SER), for maintaining adequate voltage to protect Class 1E (safety-related) electrical equipment in the event of degraded voltage conditions.

After review and consideration of SNC's response, the NRC has concluded that the decision to use the "compliance exception" provision as allowed by 10 CFR 50.109(a)(4)(i) was appropriate. The staff maintains its position that SNC's electrical analysis for HNP must show that the existing setpoints and time delays are adequate to ensure that all safety-related loads have the required minimum voltage measured at the component terminal to start and operate safety related equipment necessary to mitigate the consequences of the worst-case design basis event (DBE), without any credit for administratively controlled bus voltage levels. The staff maintains that this position is consistent with regulatory requirements specified in 10 CFR 50.55a(h)(2) and GDC-17. This staff position is also consistent with the guidance provided in Standard Review Plan, NUREG-0800 (July 1981), Branch Technical Positions (BTPs) of Appendix 8-A (PSB), containing BTP PSB-1, "Adequacy of Station Electric Distribution System Voltages."

Further, the staff concludes that the NRC change in position, from that in the 1995 SER, regarding the acceptability of relying on manual operator action to demonstrate compliance with SNC 2 the applicable provisions of GDC-17 and 10 CFR 50.55a(h)(2), constitutes backfitting as defined in 10 CFR 50.109(a)(1). The backfitting action is necessary for compliance with GDC-17 and 10 CFR 50.55a(h)(2) and is consistent with applicable guidance and practices in effect at the time that the NRC staff erroneously approved the use of manual actions responding to degraded grid voltage condition in 1995.

c. Operating Experience (OE) Summary

In summary, the above backfit OE does not apply to Oconee due to the fact that Oconee ultimately relies upon the automatic actions of the undervoltage relays on the incoming breakers for the safety related 4kV buses to protect the Class 1E electrical power distribution system from degraded grid conditions. As described in sections 2(a-c) of this paper, the degraded voltage relay protection system (4kV UV) provide automatic isolation initiation prior to Class 1E electrical distribution system bus voltages reaching any analyzed limits. Any manual actions by ONS are only conservative and prudent measures taken prior to reaching these limits.