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.

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.

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.

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 are 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

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.

REFERENCE

FSAR Section 8

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 (i.e., CT1, CT2 or CT3) and to the 4160 volt standby buses 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.