

Appendix 8A. Tables

Table 8-1. Loads to be Supplied from the Emergency Power Source

This table will provide a list of Oconee loads which automatically start after a LOOP or LOCA, and the Oconee loads which are required to mitigate the event. This table demonstrates that the transformers have adequate capacity to supply the required Oconee loads. Loads may be added at the option of the operator to help mitigate the event. The additional loads are not listed in this table.

I. Equipment automatically loaded after load shed (KVA).

| Equipment | Unit 1 | | Unit 2 | | Unit 3 | |
|----------------------------------|----------|----------|----------|----------|----------|----------|
| | LOCA | LOOP | LOCA | LOOP | LOCA | LOOP |
| H.P. Injection Pump | 1800 hp | 1200 hp | 1800 hp | 1200 hp | 1800 hp | 1200 hp |
| L.P. Injection Pump | 800 hp | 0 | 800 hp | 0 | 800 hp | 0 |
| L.P. Service Pump ⁽¹⁾ | 1200 hp | 600 hp | 600 hp | 600 hp | 1200 hp | 600 hp |
| R.B. Spray Pump | 500 hp | 0 | 500 hp | 0 | 500 hp | 0 |
| Emerg. Fdw Pump | 1000 hp | 1000 hp | 1200 hp | 1200 hp | 1200 hp | 1200 hp |
| R.B. Cooling Fans | 225 hp | 225 hp | 225 hp | 225 hp | 225 hp | 225 hp |
| ESV Pump ⁽²⁾ | 50 hp | 50 hp | 50 hp | 50 hp | 50 hp | 50 hp |
| Pene Rm. Vent Fans | 10 hp | 0 | 10 hp | 0 | 10 hp | 0 |
| MOVs ⁽³⁾ | 100 kva | 0 | 100 kva | 0 | 100 kva | 0 |
| Safety MCCs | 375 kva | 375 kva | 375 kva | 375 kva | 375 kva | 375 kva |
| Auto Load LCs ⁽⁴⁾ | 1290 kva | 1290 kva | 1290 kva | 1290 kva | 1290 kva | 1290 kva |
| Keowee Aux. Power | 750 kva | 750 kva | 0 | 0 | 0 | 0 |
| Total ⁽⁵⁾ | 7743 kva | 5130 kva | 6274 kva | 4489 kva | 6803 kva | 4489 kva |

II. Equipment required to run for event mitigation (KVA)

| | | | | | | |
|---------------------|----------|----------|----------|----------|----------|----------|
| H.P. Injection Pump | 600 hp | 600 hp | 600 hp | 600 hp | 600 hp | 600 hp |
| L.P. Injection Pump | 400 hp | 0 | 400 hp | 0 | 400 hp | 0 |
| L.P. Service Pump | 600 hp | 600 hp | 600 hp | 600 hp | 600 hp | 600 hp |
| R.B. Spray Pump | 250 hp | 0 | 250 hp | 0 | 250 hp | 0 |
| Emerg. Fdw Pump | 0 | 1000 hp | 0 | 1200 hp | 0 | 1200 hp |
| R.B. Cooling Fans | 225 hp | 225 hp | 225 hp | 225 hp | 225 hp | 225 hp |
| HPSW Pumps | 1000 hp | 1000 hp | 0 | 0 | 0 | 0 |
| Pene Rm. Vent Fans | 10 hp | 0 | 10 hp | 0 | 10 hp | 0 |
| ESV Pump | 25 hp | 25 hp | 25 hp | 25 hp | 25 hp | 25 hp |
| Safety MCCs | 375 kva | 375 kva | 375 kva | 375 kva | 375 kva | 375 kva |
| Auto Load LCs | 1290 kva | 1290 kva | 1290 kva | 1290 kva | 1290 kva | 1290 kva |

| | | | | | | |
|--------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Keowee Aux. Power | 750 kva | 750 kva | 0 | 0 | 0 | 0 |
| Chiller Comp ⁽⁶⁾ | 350 hp | 350 hp | 350 hp | 350 hp | 825 hp | 825 hp |
| Chill. SW Pumps ⁽⁶⁾ | 25 hp | 25 hp | 25 hp | 25 hp | 0 | 0 |
| Chill. Wtr Pm ⁽⁶⁾ | 30 hp | 30 hp | 30 hp | 30 hp | 0 | 0 |
| AC Sys. Fan ⁽⁶⁾ | 20 hp | 20 hp | 20 hp | 20 hp | 0 | 0 |
| Total ⁽⁵⁾ | 5534 kva | 5834 kva | 3902 kva | 4378 kva | 4255 kva | 4731 kva |

III. Combined Load Demand for Station

| | Starting | Running |
|-------------------------|---------------|---------------|
| LOCA KVA | 7743 | 5534 |
| LOOP KVA ⁽⁷⁾ | 4489 | 4003 |
| LOOP KVA ⁽⁷⁾ | 4489 | 4003 |
| Total KVA | 16,721 | 13,540 |

IV. Source Size

Two Keowee Units 2@87.5 MVA = 175 MVA
 Startup Transformers (CT1, CT2, CT3) = 45/60 MVA each
 Standby Transformers (CT4, CT5) = 12/16/20/22.4 MVA each

V. Summary

Transformers CT1, CT2, CT3, CT4, CT5 and Keowee hydro generators are sized adequately to provide power for Oconee loads required to start and/or run during a LOCA/LOOP event. There is sufficient margin in the transformer and generator sizing to allow the operator to start additional loads as desired to assist in event mitigation. There is sufficient guidance given to the operator so that transformer ratings will not be exceeded.

Note:

1. LPSW-B pump is shown fed from Unit 1.
2. The ESV Pumps will automatically start 2 minutes after power becomes available.
3. Loading for MOVs is an approximate value.
4. Auto loading non-safety load centers will delay loading for 30 seconds when the Standby Bus is supplied from a Lee Combustion Turbine.
5. KVA was calculated using a combined power factor-efficiency of .85 for all loads shown in horsepower.
6. Only 1 unit would be supplying a chiller. Unit 3 would supply a temporary chiller if the other 2 were out of service.
7. LOOP loads are loaded approximately 20 seconds after the LOCA loads.

Table 8-2. Single Failure Analysis for 125 Volt DC Switching Station Power Systems

| Component | Malfunction | Comments & Consequences | |
|---------------------------------------|-------------------------------------|------------------------------------|---|
| 1. 480V AC Power Supply to Charger | Loss of power to one | | No consequence - power from battery is available to supply power without interruption. |
| 2. Battery Charger | Loss of power from one | (a) | The 125 volt dc bus would continue to receive power from its respective battery without interruption except as in (c) below. |
| | | (b) | Standby battery charger may be manually aligned. |
| | | (c) | Battery Charger internal faults may cause high short circuit currents to flow resulting in voltage reduction on the 125 volt dc bus until the fault is cleared by the isolating circuit breakers. Complete loss of voltage on the 125 volt dc bus may result if the battery circuit breakers open. However, redundant protective relaying and panelboards are provided and are supplied from the other redundant 125 volt dc bus. |
| 3. 125V DC Battery | Loss of power from one | | Only those 125 volt dc control panelboards supplied from the affected bus will be lost. The redundant panelboards supplied from the other 125 volt dc bus would be unaffected and continue to provide power for protection and control. |
| 4. DC Distribution Center Buses P-N | Bus shorted | | Same comment as 3. |
| 5. 125V DC Bus SY-1, SY-2, SY-3, SY-4 | Grounding a single bus (P or N) | | The 125 volt dc system is an ungrounded electrical system. Ground detector equipment monitors and alarms upon a ground anywhere on the 125 volt dc system. A single ground will not cause any malfunction or prevent operation of any safety feature. |
| 6. 125V DC Bus SY-1, SY-2, SY-3, SY-4 | Gradual decay of voltage on one bus | | Each 125 volt bus is monitored to detect the voltage decay on the bus and initiate an alarm at a setting above a voltage where the battery can deliver power for safe and orderly shutdown of the station. Upon detection power will be restored by correcting the deficiency. |

| | Component | Malfunction | Comments & Consequences |
|----|---|----------------------------------|--|
| 7. | DC Distribution Center Load Feeder Cables | Cables shorted | Same comments as 3. |
| 8. | 125V DC Primary or Backup Panelboards | Bus shorted in one panelboard | <p data-bbox="813 369 1414 464">(a) Voltage on associated 125 volt dc bus will decay until isolated by isolating circuit breakers.</p> <p data-bbox="813 485 1414 653">(b) Protective relaying connected to the affected panelboards may be lost; however, redundant protective relaying supplied from the other 125 volt dc bus would provide protection.</p> <p data-bbox="813 674 1414 831">(c) One source of control power may be lost to the switching station power circuit breakers; however, a redundant source of control power is provided from the other 125 volt dc bus.</p> |

Table 8-3. Single Failure Analysis for the Keowee Hydro Station

| Component | Malfunction | Comments & Consequences |
|---|---------------------------|---|
| 1. Keowee Hydro Units | Loss of one | (a) One emergency power source would be lost; however, the other unit would supply 100% of emergency power load. |
| | | (b) If the 13.8 kV underground feeder were selected to the unit which was lost, it would also be lost; however, the other unit would supply power through the stepup transformer and the 230 kV switching station to the startup transformers and the underground feeder could be transferred by the Oconee operator to the running unit. |
| 2. Generator Circuit Breakers and Buses | Loss of one | Same as 1 above. |
| 3. Stepup Transformer, Low Side Buses, 230 kV Overhead Line and PCB-9 | Loss of one | Both hydro units would be separated from the 230 kV switching station; however, one hydro unit would supply emergency power through the 13.8 kV underground circuit. |
| 4. 13.8 kV Underground Feeder Circuit Breaker, Cables, or Transformer | Loss of one | One circuit of emergency power would be lost; however, both units could supply emergency power over the 230 kV overhead line. Although a ground fault would cause the underground unit to lockout, the lockout could be reset allowing the Keowee Unit to restart so that it could supply emergency power over the 230 kV overhead line. |
| 5. Keowee Hydro Unit Automatic Startup and Unit Control Systems | Loss of one unit's system | Same as 1 above. |
| 6. Keowee Hydro Unit 125V DC Control Battery, Panelboard, Feeders, etc. | Loss of one | Same as 1(a) above. |
| 7. Keowee Hydro Unit Emergency Startup and Switching Logic | Loss of one | Same as 1(a) above. |

| | Component | Malfunction | Comments & Consequences |
|----|---|--|---|
| 8. | Keowee Hydro Unit Emergency Startup and Switching Circuits from Oconee | Loss of one | No Consequence, since independent and redundant underground signal cables are provided. |
| 9. | Underground assigned Keowee Hydro Unit generating to the grid during commercial generation or testing | Loss of underground assigned Keowee Hydro Unit and overhead path | Overhead assigned Keowee Hydro Unit would be automatically realigned to provide power to underground path. Auxiliary loads for overhead assigned Keowee Hydro Unit would be automatically realigned to receive power from Transformer CX. |

Table 8-4. Single Failure Analysis for the Emergency Electrical Power Systems

| | Component | Malfunction | Comments & Consequences |
|----|--|---|--|
| 1. | Any 230 kV Bus, PCB-18, 27 and PCB-30, 230 kV Circuit to Startup Transformers, CT1, CT2, CT3, and Associated Buses | Loss of one | On loss of the yellow bus, the 230 kV emergency power circuit would be lost until the Oconee operator could reroute this supply in the switching station. However, emergency power would be available through the 13.8 kV underground circuit from one of the Keowee units. Other singular losses would have no consequence. |
| 2. | 230 kV Power Circuit Breaker Trip Coils or 125V DC Trip Coil Power Supply | Loss of one | No consequence as two trip coils are provided for each circuit breaker and each trip coil is provided with a separate 125 volt dc control circuit. |
| 3. | 13.8 kV Underground Circuit from Keowee Hydro or Transformer No. CT4 | Loss of one | One circuit of emergency power would be lost; however, both hydro units could supply emergency power over the 230 kV overhead line. Although a ground fault would cause the underground unit to lockout, the lockout could be reset allowing the Keowee Unit to restart so that it could supply emergency power over the 230 kV overhead line. |
| 4. | 4160V Main Feeder Buses, 4160V Stand-by Power Buses and Feeder Circuit Breakers | (a) One circuit breaker fails to close when required to supply emergency power. | No consequence, as sufficient redundant circuit breakers and buses are provided with redundant switching logic. |
| | | (b) One bus section faults | No consequence as sufficient redundant circuit breakers and buses are provided with redundant switching logic. |
| 5. | 4160 V Auxiliary Switchgear Bus Section | Loss of one | Same as 4(a) above. |
| 6. | 600V Auxiliary Switchgear Bus Sections | Loss of one | One 600 volt bus section containing engineered safeguards would fail to receive emergency power; however, sufficient redundant engineered safeguards will be supplied from the remaining redundant buses to perform the engineered safeguards function. |

| | Component | Malfunction | Comments & Consequences |
|----|---------------------------|--------------------|--|
| 7. | 125V DC System | Single failures | See Section 8.3.2.2.1 and Table 8-5 for single failure analysis. |
| 8. | 120V AC Vital Power Buses | Single failures | See Section 8.3.2.2.3 and Table 8-6 for single failure analysis. |

Table 8-5. Single Failure Analysis for 125 Volt DC Instrumentation and Control Power System

| | Component | Malfunction | Comments & Consequences |
|----|---------------------------------------|------------------------|---|
| 1. | 600V AC Power Supply to charger | Loss of power to one | Power from battery is available to supply power without interruption until standby charger is switched in. |
| 2. | Battery Charger | Loss of power from one | <p>(a) The 125 volt dc bus would continue to receive power from its respective battery without interruption except as in (2c) below.</p> <p>(b) Standby battery charger may be manually aligned.</p> <p>(c) Battery Charger internal faults may cause high short circuit currents to flow resulting in voltage reduction on the 125 volt dc bus until the fault is cleared by the isolating circuit breakers. Complete loss of voltage on the 125 volt dc distribution center may result if the battery circuit breakers open. However, power to reactor protection systems and engineered safeguards instrumentation and control would be unaffected since they are supplied from redundant feeders.</p> |
| 3. | 125V DC Battery | Loss of power from one | <p>(a) Those 125 volt dc control panelboards supplied from the affected bus will continue to receive uninterrupted power from their alternate power supplies through isolating diodes.</p> <p>(b) All power could be lost to the other loads supplied from the faulted bus; however, they are not associated with reactor instrumentation, protective systems, or engineered safeguards.</p> |
| 4. | 125V DC Distribution Center Buses P-N | Bus shorted | Same comment as 3a and 3b . |

| | Component | Malfunction | | Comments & Consequences |
|----|---|--|-----|---|
| 5. | 125V DC Distribution Center DCA, DCB | Grounding a single bus (P or N) | (a) | The 125 volt dc system is an ungrounded electrical system. Ground detector equipment monitors and alarms a ground anywhere on the 125 volt dc system. A single ground will not cause any malfunction or prevent operation of any safety feature. |
| 6. | 125V DC Distribution Center DCA, DCB | Gradual decay of voltage on one bus | (a) | Each 125 volt bus is monitored to detect the voltage decay on the bus and initiate an alarm at a setting above a voltage where the battery can deliver power for safe and orderly shutdown of the station. Upon detection, power will be restored either by correcting the deficiency by switching to a redundant source or by employing one of the redundant circuits. |
| 7. | DC Distribution Center Load Feeder Cables | Cables shorted | (a) | Same comments as 3a 3b. |
| 8. | Isolating Diodes | Failure of one | (a) | If the diode fails "shorted" then the other series diodes will still provide adequate isolation and power will be uninterrupted. |
| | | | (b) | If the diode fails "open" then the other redundant supply through its isolating diodes will continue to supply power without interruption. |
| 9. | 125V DC Control Power Panelboard 1DIA, 1DIB, 1DIC, 1DID, 2DIA, 2DIB, 2DIC, 2DID, 3DIA, 3DIB, 3DIC or 3DID | Bus shorted | (a) | Voltage on two of the 125 volt dc bus systems will decay until isolated by the isolating circuit breakers causing consequences same as comments 3a and 3b. At most, one panelboard in a single unit could be lost. |

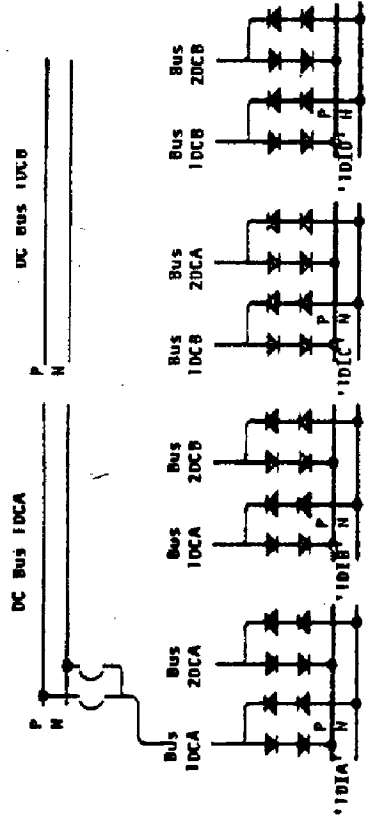
| Component | Malfunction | Comments & Consequences |
|-----------|-------------|---|
| | | (b) For one unit, one-half of control and instrumentation power not associated with reactor instrumentation and protective systems or engineered safeguards will be degraded until the shorted panel board isolates, after which one-fourth of the loads would be lost. Control and instrumentation power associated with reactor instrumentation and protective systems or engineered safeguards is covered in 9(g). |
| | | (c) For one unit, one-half of 6900 volt switchgear closing control power could be lost but dual trip coils and redundant tripping power supplies are provided. |
| | | (d) For one unit, one-third of the 4160 volt switchgear closing control power could be lost. Dual trip coils and redundant tripping control power are provided. The remaining redundant switchgear is adequate and is supplied control power from the other dc panels. |
| | | (e) For one unit, the 4160 volt main feeder bus circuit breakers on only one of the two buses could lose closing control. All 4160 volt circuit breakers have redundant trip coils and power supplies. The remaining main feeder bus and circuit breakers are supplied control power from the other dc panels, permitting the switching of 4160 volt emergency power to any unit. |
| | | (f) For one unit, the 600 volt load center(s) associated with the affected panel will lose dc control power; however, each load connected to the load center(s) has an alternate feed from a redundant load center. |

| Component | Malfunction | Comments & Consequences |
|-----------|-------------|--|
| | | (g) One static inverter would be lost and power to one instrument bus would be lost temporarily until a manual transfer could be made to a regulated instrument bus. The temporary loss of one vital instrument bus would result in the temporary loss of one channel of reactor protection and instrument systems and engineered safeguards systems. Other remaining channels will receive vital instrument control power from the other panelboards. |

Table 8-6. Single Failure Analysis for the 120 Volt AC Vital Power System

| | Component | Malfunction | Comments & Consequences |
|----|--|--------------------|--|
| 1. | 125V DC Control Power Panelboard 1DIA, 1DIB, 1DIC, 1DID, 2DIA, 2DIB, 2DIC, 2DID, 3DIA, 3DIB, 3DIC or 3DID | Bus shorted | One static inverter would be lost and power to one instrument bus would be lost temporarily until a manual transfer could be made to a regulated instrument bus. The temporary loss of one vital instrument bus would result in the temporary loss of one channel of reactor protection and instrument systems and engineered safeguards systems. Other remaining channels will receive vital instrument control power from the other panelboards. |
| 2. | Static Inverter Feeder Cable | Failure | Same as comment 1. |
| 3. | Static Inverter | Failure | Same as comment 1. |
| 4. | Vital Instrument Power Panelboard 1KVIA, 1KVIB, 1KVIC, 1KVID, 2KVIA, 2KVIB, 2KVIC, 2KVID, 3KVIA, 3KVIB, 3KVIC or 3KVID | Failure of one | For any one bus failure only one channel of any system associated with reactor instrumentation and protective systems or engineered safeguards would be lost. Sufficient redundant channels supplied from other vital instrument buses would provide adequate protection. |

Table 8-7. 125 Volt DC Panelboard Fault Analysis



| FAULT | EQUIPMENT LOSS | PHB'S AFFECTED | COMMENTS |
|----------------|----------------------------------|------------------|--|
| Ph1bd 1DIA Bus | Ph1bd 1DIA & (No. 1DCA D.C. Bus) | 1D1B, 3D1A, 3D1B | All would receive power from redundant DC buses in Oconee 1, 2, or 3 (See Below) |
| Ph1bd 1DIB Bus | Ph1bd 1DIB & (No. 1DCA D.C. Bus) | 1D1A, 3D1A, 3D1B | All would receive power from redundant DC buses in Oconee 1, 2, or 3 (See Below) |
| Ph1bd 1DIC Bus | Ph1bd 1DIC & (No. 1DCB D.C. Bus) | 1D1D, 2D1C, 2D1D | All would receive power from redundant DC buses in Oconee 1, 2, or 3 (See Below) |
| Ph1bd 1DID Bus | Ph1bd 1DID & (No. 1DCB D.C. Bus) | 1D1A, 2D1A, 2D1B | All would receive power from redundant DC buses in |

| Panelboard No. | OCONEE 1 | OCONEE 2 | OCONEE 3 |
|-------------------|---------------------------|---------------------------|---------------------------|
| Supplied from bus | 1D1A 1D1B 1D1C 1D1D | 2D1A 2D1B 2D1C 2D1D | 3D1A 3D1B 3D1C 3D1D |
| | 1DCA 1DCB 1DCB 1DCB | 2DCA 2DCB 2DCB 2DCB | 3DCA 3DCB 3DCB 3DCB |
| | 2DCA 2DCB 2DCA 2DCB | 3DCA 3DCB 3DCA 3DCB | 1DCA 1DCB 1DCA 1DCB |