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DOCKET NUMBER 50-269/270/287

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TO:	FROM:	DATE OF DOCUMENT
Mr. Benard C. Rusche	Duke Power Company Charlotte, North Carolina Mr. William O. Parker, Jr.	11/15/76 DATE RECEIVED 11/18/76

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DESCRIPTION

Ltr. re our 8/12/76 ltr....trans the following:

(1-P)

PLANT NAME:

Oconee Units 1-2-3

ENCLOSURE

Concerns susceptability of station operation and equipment to degraded grid voltage conditions.

(13-P)

ACKNOWLEDGED

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

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
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November 15, 1976

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U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. Benard C. Rusche, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. A. Schwencer

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

Dear Sir:

In response to your letter dated August 12, 1976, a study of the Oconee Nuclear Station has been conducted to determine the susceptability of station operation and equipment to degraded grid voltage conditions. A summary of the results of this study which specifically address those concerns described in your letter is attached.

Very truly yours,

William O. Parker, Jr.

MST:ge
Attachment

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OCONEE NUCLEAR STATION
SUSCEPTABILITY TO DEGRADED GRID VOLTAGE

I. INTRODUCTION

In response to the Request for Information relative to the potential implications of the events which occurred at the Millstone Unit No. 2, July 5, 1976, the Oconee Class 1E electrical distribution system has been evaluated to determine if the operability of safety-related equipment, including associated control circuitry and instrumentation, can be adversely affected by short term or long term degradation in grid system voltage. Our evaluation has been directed toward identifying all possible voltage conditions (i.e., normal and degraded) that can exist on the plant auxiliary system and to comparing equipment operating limits to these voltage conditions.

II. EVALUATION

The following evaluation of the Oconee Class 1E electrical distribution system addresses items 1 through 3 of the Request for Information. The item numbers referred to in our response are identical to the item numbers in your Request for Information.

Response to Item 1.a: Plant auxiliary systems (safety-related and non-safety related) will be supplied by offsite power during plant refueling, plant startup, plant shut-down, and abnormal trip of the unit. The estimated fraction of normal plant operating time in which plant auxiliaries are supplied by offsite power is approximately 16%.

Response to Item 1.b: Offsite power is supplied by Duke's 230KV transmission system. The normal operating range for the grid system voltage at Oconee is between 227KV and 217KV. The corresponding operating range at the 4.16KV safety-related buses is between 4240V and 3940V. It should be noted that these voltage ranges were established on the basis of observed voltages over a period of several months under various plant/system operating conditions.

Response to Item 1.c: Figure 1 shows a one-line diagram of the Oconee Unit 3 auxiliary system and was the basis of our analysis of voltage profiles throughout the auxiliary system. Since the auxiliary systems for Units 1 and 2 are similar to Unit 3, the results of our analysis are also applicable to these units. Under offsite power conditions transformer CT3 supplies 4160V Main Feeder Buses 1 and 2 which in turn supply 4160V Engineered Safeguard Switchgear Buses 3TC, 3TD, and 3TE. These safeguard buses supply non-safety related loads (i.e., Load Centers 3X1, 3X4, 3X2, 3X5, 3X3, and 3X6) and the three safety-related Load Centers 3X8, 3X9, and 3X10. Since the normal operating range (i.e., 227KV to 217KV) for the grid system voltage is below the nominal 230KV 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:

CASE 1: With the grid voltage assumed operating at 227KV 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 the no load condition does not practically exist on the auxiliary system the condition of minimum loading during cold shut-down has been used instead. Figure 2 summarizes the results of this case.

CASE 2: With the grid voltage assumed operating at 217KV 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 230KV grid system operating between 227KV and 217KV, the voltage profiles for the safety-related buses will be within the range established by Case 1 and Case 2 defined above.

Response to Item 1.d: Under normal conditions the Oconee Unit 3 auxiliary loads are carried by the Unit 3 generator through transformer 3T as shown in figure 1. Under this condition, transformer 3T supplies 4160V Main Feeder Buses 1 and 2 in the same manner as transformer CT3 described in response to item 1.c. The normal operating range for the generator terminal voltage is 18.94KV to 17.68KV. 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:

CASE 3: With the generator voltage at its normal maximum value of 18.94KV 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.

CASE 4: With the generator voltage at its normal minimum value of 17.68KV 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 19.91KV requiring generator trip 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 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 230KV transmission system operating at its normal minimum value of 217KV 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.

Response to Item 1.e: Figure 1 shows the sensor locations for the undervoltage relaying for switching power to the safety-related buses. In addition, the 230KV switchyard is equipped with redundant undervoltage and underfrequency logic designed to detect severe system undervoltage and underfrequency conditions.

The undervoltage trip setpoints for the safety-related switching systems are as follows:

UV Point	Trip Setpoint
1	68% voltage (Time Delay ≈ 5.0 sec.)
2	68% voltage (Time Delay ≈ 5.0 sec.)
3	68% voltage (Time Delay ≈ 5.0 sec.)
4	68% voltage (Time Delay ≈ 5.0 sec.)
5	68% voltage (Time Delay ≈ 5.0 sec.)
6	68% voltage (Time Delay ≈ 5.0 sec.)
7	55% voltage (Time Delay ≈ 5.0 sec.)
8	55% voltage (Time Delay ≈ 5.0 sec.)

The setpoints for the 230KV switchyard system are as follows:

Undervoltage:	68% voltage (Time Delay ≈ 6.0 sec.)
Underfrequency:	57 Hertz (Time Delay ≈ 15 cycles)

The basis for the above undervoltage settings is to detect sudden and complete loss of power conditions with sufficient time delay to ride over voltage transients.

Response to Item 1.f: The maximum 230KV system voltage of 227KV is normally attained when all three Oconee generators are running and supplying MVARS to the 230KV transmission system. Steady-state transmission voltages in excess of 227KV cannot exist at the Oconee switchyard without a significant change in our system generation MVAR output. Therefore, the 227KV system voltage and auxiliary system loading defined in Case 1 (see response to Item 1.c. and Figure 2) provide the maximum safety-related bus voltages under offsite power conditions. There is no overvoltage trip when the auxiliaries are operating on offsite power through the startup transformers.

As could be concluded from our response to Item 1.e., the relay undervoltage setpoints can theoretically allow line voltages below 68% to exist on the safety-related buses. However, studies of our 230KV transmission system have indicated that sustained steady-state voltages at 68% are impossible because the Duke system would have experienced load-shedding and system separation at voltages considerably higher than 68% resulting in the switchyard under-frequency relays isolating the switchyard and starting the Keowee emergency units to supply power to the safety-related buses. Our minimum steady-state 230KV system voltage of 217KV is normally experienced when all three Oconee generators are disconnected from the transmission system. The 217KV system voltage and auxiliary system loading defined in Case 2 (see response to Item 1.c. and Figure 2) provide the minimum safety-related bus voltage under offsite power conditions.

Response to Item 1.g: The following is a definition of the voltage ranges over which safety-related and non-safety related components can operate continuously in the performance of their design function:

Component		Limiting Voltage Range
Motors	4000 V	4400/3600V.
	575 V	633/518V.
	200 V	220/180V.
Limitorque Values	575 V	633/518V.
	200 V	220/180V.
Motor Controllers	600 V	≥85% (510V.)
	208 V	≥85% (177V.)

As can be seen, the voltage ranges defined for motor continuous operation are the most restrictive operating conditions and, therfore, establish the bounds of continuous system operation. As defined in Cases 1 through 4 (see Figures 2 and 3) the maximum and minimum auxiliary system voltages are within the operating bounds established by the voltage ranges defined above. Therefore, all safety-related loads, including related control circuitry and instrumentation, will perform their safety functions as required.

Response to Item 1.h: The voltage monitoring and voltage alarms available in the control room for the Oconee Class 1E Power Distribution System are as described below:

1. 4KV Distribution System (See Figure 6 for identification of monitor points)

   A. Annunciators

      Annunciators alarming undervoltage conditions are provided for the following:

      1. Normal Source
      2. Start-Up Source
      3. Standby Bus #1
      4. Standby Bus #2
      5. Main Feeder Bus #1
      6. Main Feeder Bus #2
      7. Standby Source from Keowee
      8. Standby Source from Lee

   B. Computer

      Digital Computer points monitoring undervoltage conditions are provided for the following:

      1. Normal Source
      2. Start-Up Source
      3. Standby Bus #1
      4. Standby Bus #2
      5. Main Feeder Bus #1
      6. Main Feeder Bus #2

      Analog computer points indicating voltage conditions are provided for the following:

      1. Main Feeder Bus #1
      2. Main Feeder Bus #2
      3. Switchgear Group ITC
      4. Switchgear Group ITD
      5. Switchgear Group ITE

   C. Voltmeters

      Control room voltmeters are provided to monitor voltage on the following:

      1. Normal Source
      2. Start-Up Source
      3. Main Feeder Bus #1
      4. Main Feeder Bus #2
      5. Standby Source from Keowee
      6. Standby Source from Lee

2. 600V Essential Load Centers

A. Annunciators

Annunciators are provided which will alarm an undervoltage condition on any of the 600V Essential Load Centers.

3. 600/208V Essential Motor Control Centers

A. Annunciators

Annunciators are provided which will alarm on loss of power to any of the 600 or 208 volt Essential Motor Control Centers.

Response to Item 2: The load shedding feature of the Oconee Emergency Power System was designed to shed non-essential loads from the 4KV essential power system prior to the initiation of automatic transfers to the standby buses. Whenever an automatic transfer to the standby buses is initiated the load shed logic sheds non-essential loads by means of redundant logic circuits which actuate redundant trip coils of the breakers to be shed.

Because of the ample capacity of the standby sources at Oconee, no sequencing of Engineered Safeguards loads is required. Since sequencing is not required, no shedding of essential loads is necessary. Therefore, the load shed feature sheds only non-essential loads and is maintained throughout the event.

In summary, since the load shed feature has no direct interface with the essential loads, there is no potential for a condition similar to that experienced at Millstone 2.

Response to Item 3: The Oconee switchyard is protected by the redundant undervoltage and underfrequency logic system. This system provides blackout and underfrequency protection by automatically separating the generating units from the transmission system in the event of adverse system conditions. The setpoints for this system are defined in our response to Item l.e.

The three generating units are each rated for 1038 MVA at a .90 power factor. However, the maximum output power is 886 MW. The generating units at Oconee are dispatched to maintain the 230KV switchyard within the normal range of 217KV and 227KV.

Plant operating procedures and controls and instrumentation are provided to assure the facility is being operated as required by system conditions.

III. CONCLUSIONS

Study of Cases 1 through 6 indicate that all except Case 5 provide acceptable operating voltages on both safety and non-safety related buses. However, Case 5 and Case 6 represent degraded generator operating conditions that would require a malfunction in the generator exciter-regulator system in order to be realized. The resulting abnormal generator MVAR loading would be quickly detected by station operators and steps taken to correct these operating conditions.

All pertinent combinations of operating conditions have been evaluated for the Oconee auxiliary system. Voltage conditions similar to that which occurred at Millstone are not typical of or applicable to our Oconee Station.

IV. PROPOSED ACTIONS

Although an event similar to that which occurred at Millstone is not credible at Oconee, the undervoltage relays on the Emergency Power System will be set at 88% (3660V) to ensure that minimum voltage required for continuous operation of non-safety and safety-related equipment under any postulated degraded condition. This action will be completed by March 1, 1977. As discussed in our response to Item 1.e., the time delay for these relays is approximately five seconds. This will eliminate short duration voltage transients from causing spurious trips and ensure that degraded undervoltages are detected 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 proposed undervoltage relay setpoints of 88% (3660V).

This Case demonstrates that voltages below the continuous operating limits of the safety-related loads cannot exist without causing a trip and assumption of all essential loads by the emergency standby buses.

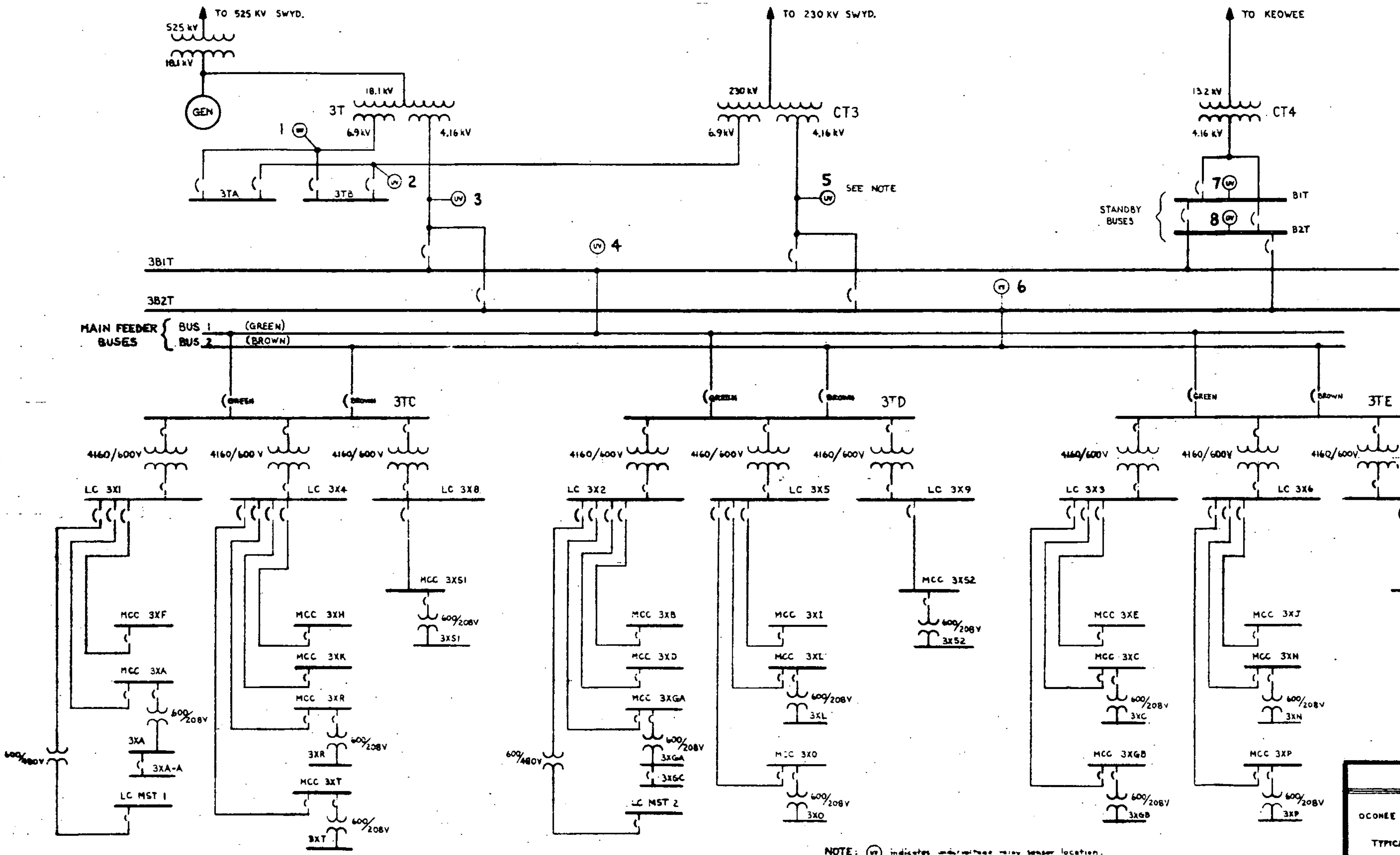
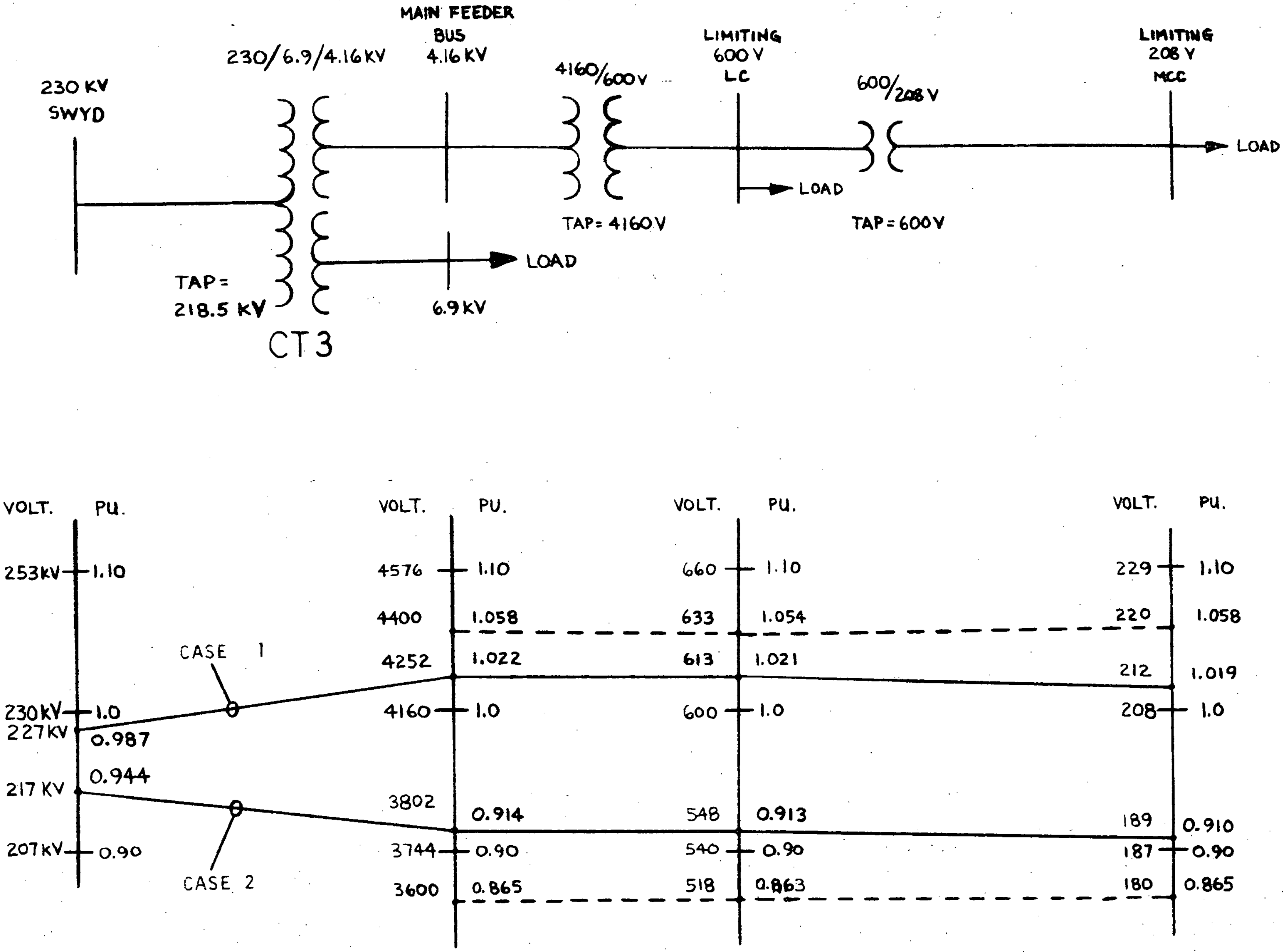


FIGURE 1

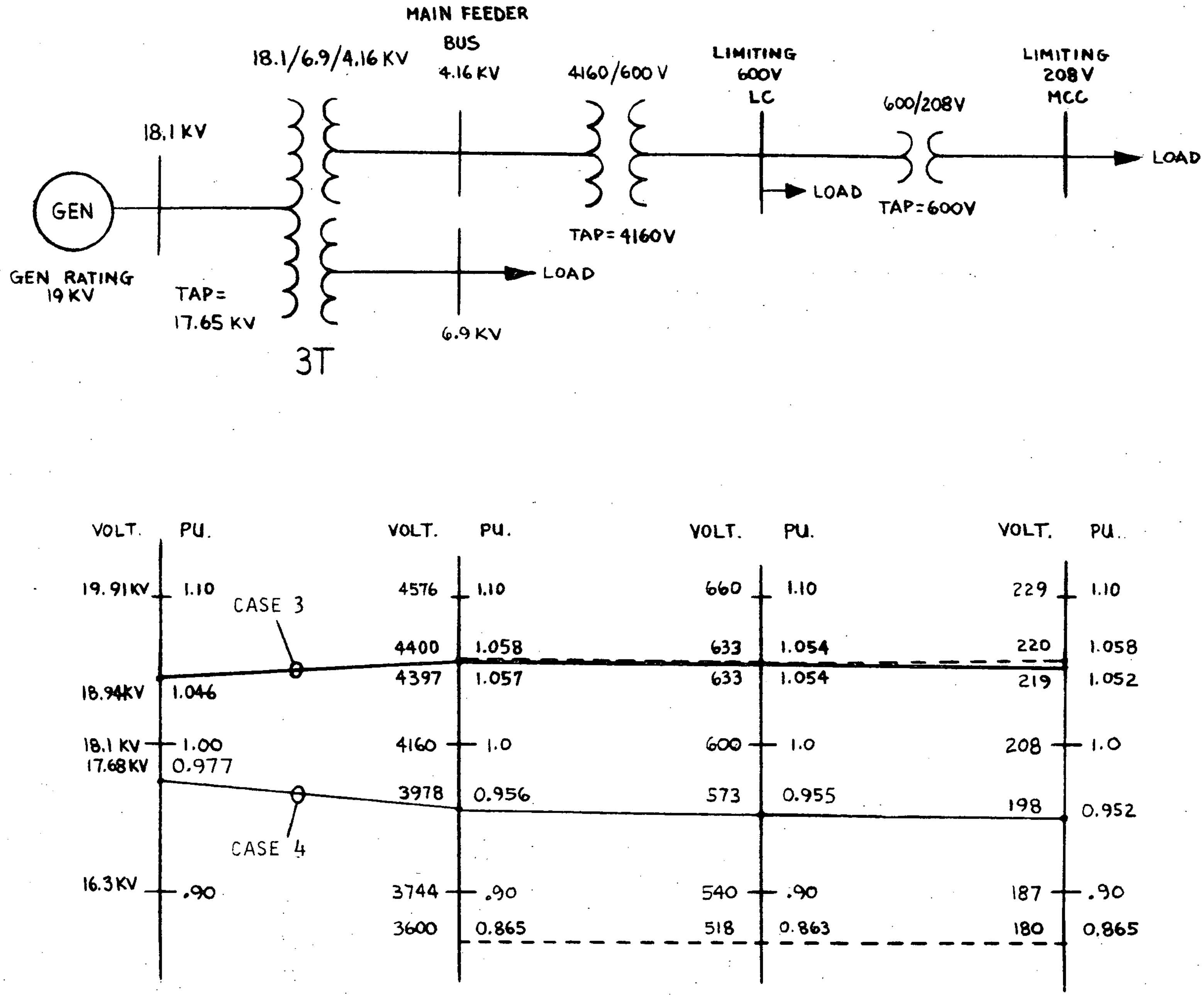
DUKE POWER CO.
OCONEE NUCLEAR STATION - UNIT 3

TYPICAL UNIT AUXILIARY SYSTEM
(ESSENTIAL AND NON-ESSENTIAL)



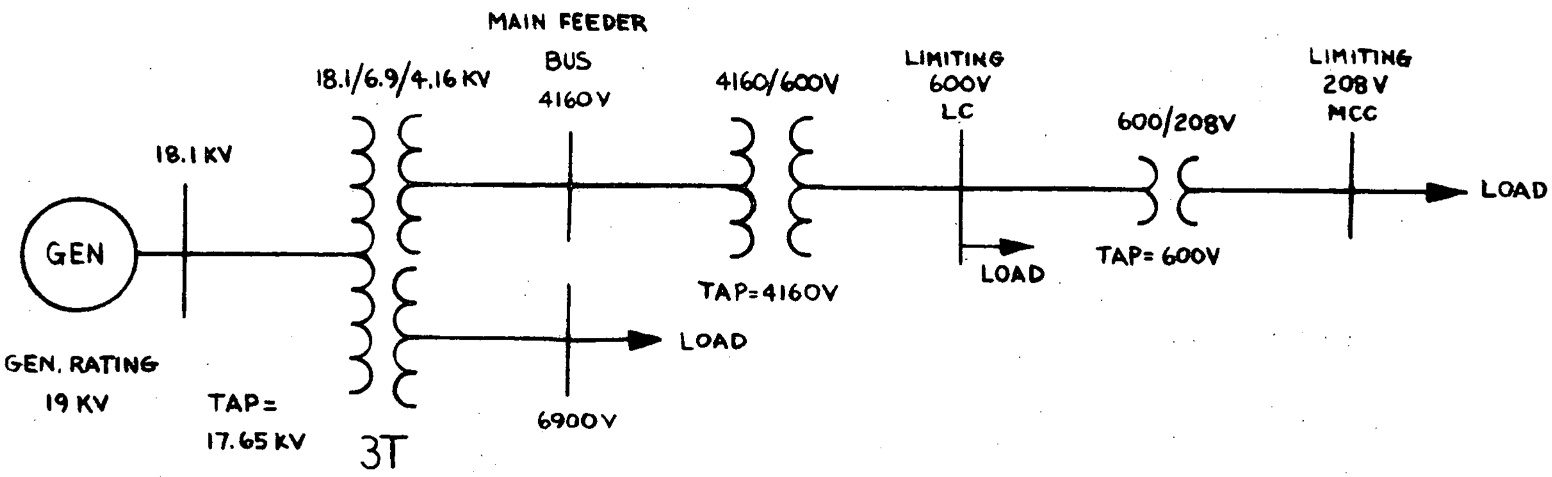
NOTE: The dotted lines represent the bounds of continuous equipment operation.

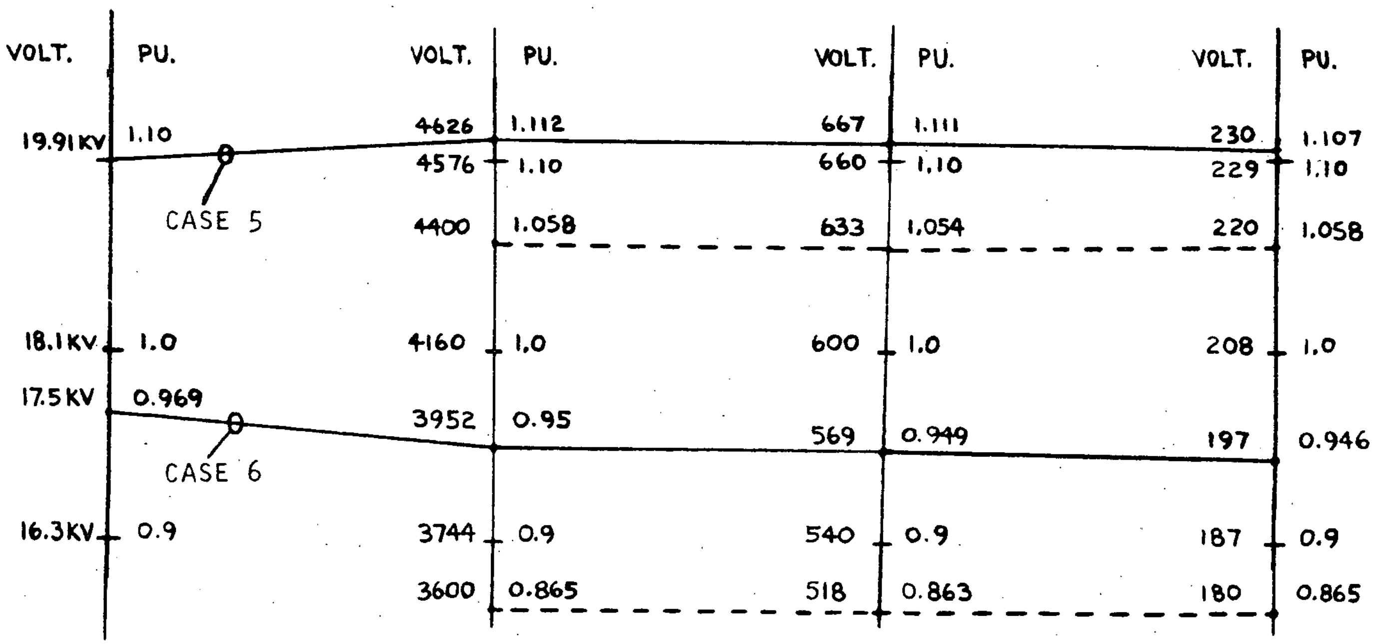
FIGURE 2 - CASE 1 AND 2
Voltage Profiles on Safety-Related Buses
under normal offsite power conditions



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

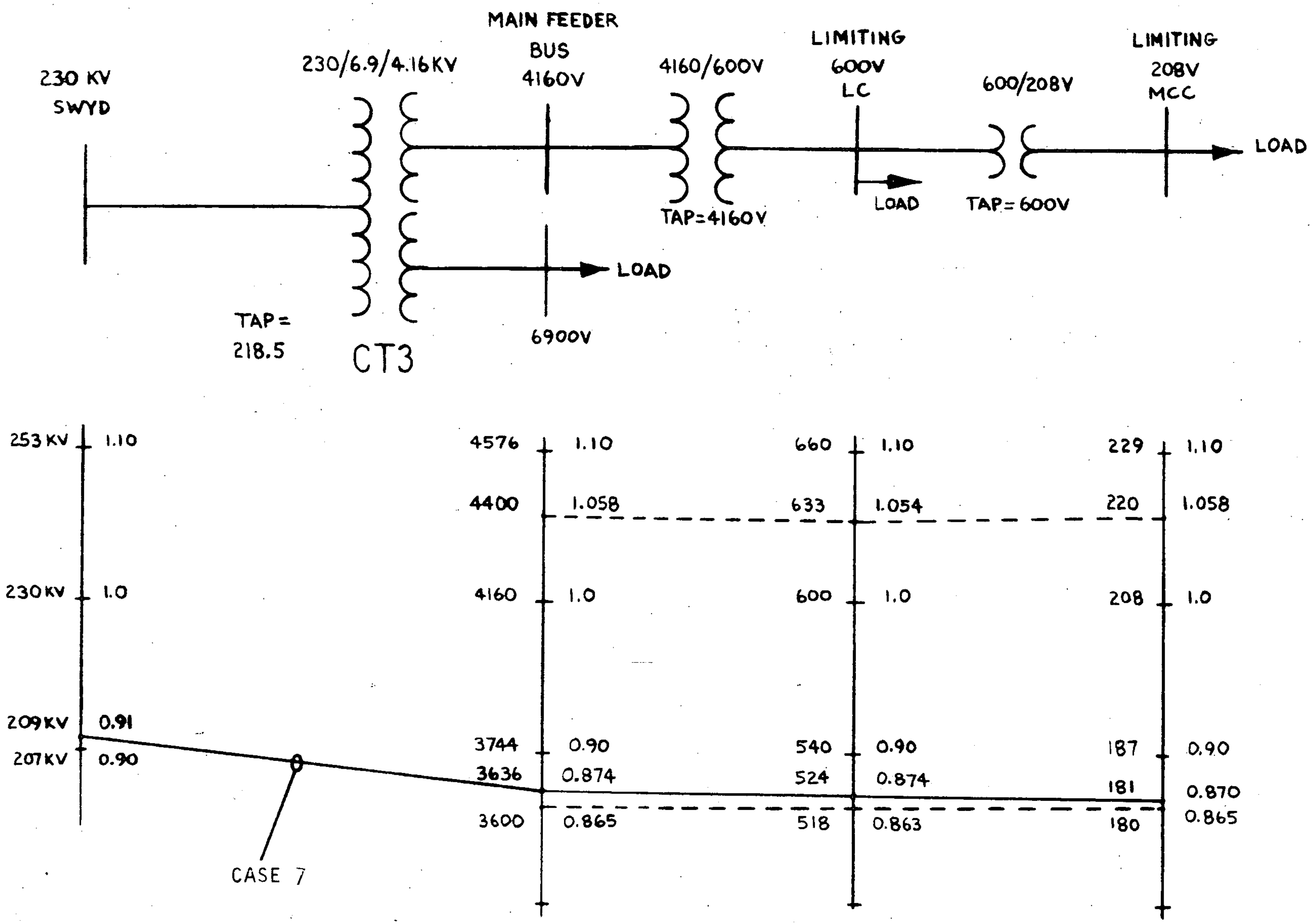
FIGURE 3 - CASE 3 AND 4
Voltage Profiles on Safety-Related Buses
under normal unit power conditions





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



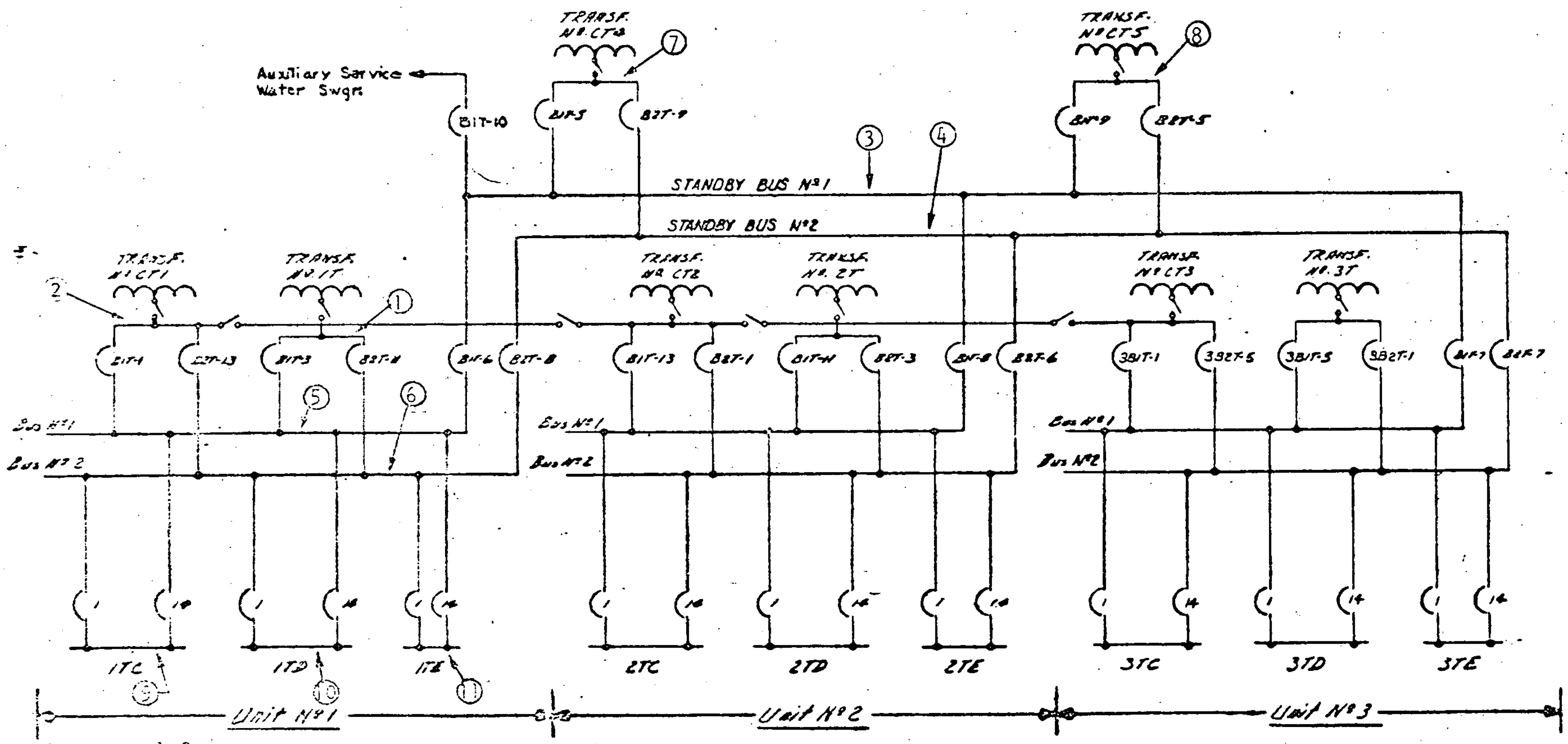
NOTE: The dotted lines represent the bounds of continuous equipment operation.

FIGURE 5 - CASE 7

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

DIAGRAMMATIC OF BUS LAYOUT

4 KV. SWITCHGEAR



* 1. Normal Source
* 2. Start Up Source
3. Standby Bus #1
4. Standby Bus #2
* 5. Main Feeder Bus #1
* 6. Main Feeder Bus #2
7. Standby Source from Keowee
8. Standby Source from Lee
* 9. Switchgear Group 1TC
*10. Switchgear Group 1TD
*11. Switchgear Group 1TE

* Similar Monitoring locations apply for Units 2 and 3.

FIGURE 6 - VOLTAGE MONITORING POINTS-4KV DISTRIBUTION SYSTEM