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AUTH.NAME	AUTHOR AFFILIATION
PARKER,W.O.	Duke Power Co.

RECIP.NAME	RECIPIENT AFFILIATION
DENTON,H.R.	Office of Nuclear Reactor Regulation
REID,R.W.	Operating Reactors Branch 4

SUBJECT: Responds to 790808 request for info re power sys.Forwards evaluation of adequacy of station distribution sys voltages.

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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
373-4083

October 29, 1979

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. R. W. Reid, Chief
Operating Reactors Branch No. 4

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

Dear Sir:

In response to an August 8, 1979 NRC request, the Oconee Nuclear Station electric power system has been evaluated analytically to verify that it has sufficient capacity and capability to perform its intended function under postulated worst-case loading conditions in combination with degraded grid voltage. The postulated worst-case loading conditions were determined to result from a requirement for safeguards actuation while the grid voltage was assumed to be at the historic low value recorded for the Oconee 230 KV switchyard.

The evaluation of the power system specifically analyzes the voltage conditions on the safety-related distribution system for the transfer of normally operating loads from the unit auxiliary transformer to the startup transformer and the subsequent starting of all required safety-related loads. The analysis method consists of a static analysis in which normally running loads are modeled as constant power devices while starting loads are modeled as the static equivalents of their locked-rotor impedance. The evaluation is presented in Attachment 1.

With regard to GDC 17, each Oconee unit has two independent circuits connecting the station switchyard to its onsite distribution system. For each unit, the circuit from the 230 KV switchyard to the startup transformer is designed to be available immediately following a unit trip and is shown in the attached evaluation to have sufficient capacity and capability to provide electric power for the required safety functions. For each unit, the second circuit is from the 230 KV switchyard (525 KV for Unit 3) to the unit normal transformer via the main stepup transformer. This circuit has a similar capacity and capability

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to that of the immediately available circuit and is designed to be available in a time frame consistent with the plant accident analysis to assure that acceptable fuel design limits and RCS design conditions are not exceeded. Unlike the preferred power system design described in the NRC Staff's letter of August 8, 1979, each Oconee unit has two independent sources of offsite power and meets the requirements of GDC 17.

With regard to testing, the Oconee electric power system (offsite and onsite) is periodically tested in accordance with the Technical Specifications to verify proper system operation.

Very truly yours,

William O. Parker, Jr.
By

William O. Parker, Jr.

RLG:scs
Attachment

ATTACHMENT 1

OCONEE NUCLEAR STATION
EVALUATION OF THE ADEQUACY OF STATION DISTRIBUTION SYSTEM VOLTAGES

This evaluation of the Oconee Nuclear Station electric distribution system voltages is in response to an August 8, 1979 NRC request. The request is based on expanded NRC interest in electric power systems following the Millstone and Arkansas events.

The purpose of this evaluation is to confirm by analysis that for a single unit trip resulting in a requirement for safeguards actuation, the units associated startup transformer is capable of:

1) Accepting and carrying the normally operating unit loads that are transferred from the normal auxiliary transformer to the startup transformer following the unit trip, and

2) Starting and operating all required safety-related loads.

In analyzing 1 and 2 above, it is further assumed that the offsite power system voltage as seen by the startup transformer is at its historic low value.

The Oconee Unit 3 auxiliary power system as shown in Diagram 1 is the basis of this analysis. The results of the analysis are also applicable to Units 1 and 2 because of similarity.

Background

Under normal operating conditions, power for unit auxiliaries is supplied by the unit generator through the normal auxiliary transformer (3T). In the event of a unit trip, the unit auxiliaries are automatically transferred from the normal auxiliary transformer (3T) to the startup transformer (CT3). Following the unit trip, there is no shedding of load; therefore, all normally operating auxiliaries will transfer to the startup transformer (CT3).

To establish the normal operating load of the auxiliary system, measurements of both voltage and current were taken at selected buses and the equivalent loads were then determined (see Table 1).

The evaluation of the adequacy of the auxiliary power system while fed from the offsite source requires that a series of different conditions be studied. The case studies that follow describe the conditions being modeled and Figures 1-4 summarize selected voltages throughout the system.

Case 1 - Voltage Conditions Before ESG Signal

The Unit 3 auxiliary system is modeled with the startup transformer CT3 supplying the load from the 230 KV system. It should be noted that the 230 KV system normally operates below the nominal 230 KV value, and startup transformer CT3 is set on the 218 KV tap to optimize voltages throughout the auxiliary power system.

For the purpose of this analysis, it is assumed that the 230 KV system voltage as seen by the startup transformer is at its historic low value (217 KV), and the auxiliary power system load is at its normal maximum (≈40 MW).

This case represents the system voltage conditions existing just after the normally operating loads have automatically transferred from the normal auxiliary transformer (3T) to the startup transformer (CT3) but just prior to ESG load start. The voltage profiles for this case are shown in Figure 1.

Case 2 - Starting Required Safety Loads with Minimum System Voltage

With the auxiliary system in the same state as modeled in Case 1, the ESG signal actuates the starting of the required safety-related loads. These loads are:

Starting Loads	HP
High Pressure Injection (2)	600
Low Pressure Injection (2)	400
Reactor Building Spray (2)	250
Low Pressure Service Water (1)	600
Reactor Building Cooling Fan (1)	75
Penetration Room Vent Fans (2)	5
MOVs (Misc)	92.3 (Total hp)
Emergency Feedwater (2)	600

The total starting load for this case is 4477.3 horsepower.

This case represents the simultaneous starting of all of the above motor loads with the normal "house" load already running. It should be noted that load sequencing is not provided in the Oconee design. The voltage profiles for this case are as shown in Figure 2 and are those existing on the buses upon initial locked-rotor current inrush.

Case 3 - Voltages After Starting Safety-Related Loads

The voltages of the system recover from the initial inrush to a steady-state condition. The time required to reach this steady-state condition depends upon the time the motors require to accelerate their respective loads to their rated speed. The final loading in this case includes the normal maximum unit load and the running load of the required safety-related loads. Figure 3 shows the voltage conditions after the required safety-related motors have started and are operating at their running load. In the case of motor operated valves, each motor has unseated the valve and is drawing full load amperes.

Case 4 - Voltages After All Safety Loads Started and All Valve Motors are Off

The system reaches final steady-state conditions after all required loads have reached rated conditions and all valve motors have performed their operations. Figure 4 shows the voltage existing with the running load of Case 3 less the load of the required motor operated valves.

Summary

The cases presented above provide the voltage profiles for the Unit 3 auxiliary power system upon the transfer of the normally running unit loads from the normal auxiliary transformer (3T) to the startup transformer (CT3), upon the starting and running of all required safety-related loads while maintaining the normally operating loads, and upon achieving steady-state conditions.

As seen in Figure 2, upon starting the required safety-related loads, the voltages on the 600 VAC and 208 motor control centers (MCC) dip below the rated starting voltages for their loads. However, detailed studies of these conditions show that the motors will start and accelerate their load as required.

The worst case voltage dip conditions occur on the 600 VAC and 208 VAC MCCs designated 3XS3. Just prior to the start of loads on these two MCCs, the bus voltage is above 90% (See Figure 1) which is adequate to pick up the motor contactors and initiate motor starting. Following the contactor pickup and initial inrush, the MCCs experience a voltage dip to 72% and 71%, respectively on the MCC voltage base or 75% and 74%, respectively on the rated motor voltage base. These voltages are still high enough to maintain the contactors at the MCCs.

The loads on the 3XS3 MCCs which are required to start are one 600 VAC Reactor Building Cooling Unit (RBCU) fan motor and three 208 VAC motor operated valves (2.3 total hp).

RBCU Fan Motor Analysis

A dynamic simulation using the speed-torque curves of the fan motor and load shows that the motor will start and accelerate the fan to rated speed in approximately 5 seconds with the MCC voltage dipping to 72% upon motor start. This compares to a starting time of approximately 3 seconds with rated motor voltage at the motor terminals. Further analysis shows that the fan motor will start and reach rated speed in 7 seconds even if a 70% nominal voltage is maintained at the motor terminals and no credit taken for voltage recovery after starting. It is therefore concluded that the RBCU fan motor can perform its intended function under postulated degraded voltage conditions.

MOV Analysis

Valve loads are torque-dependent, and therefore valve operators are designed to develop sufficient torque to move the valve. If terminal voltage is initially too low for a valve operator to develop the required torque, the operator will stall and draw locked-rotor current until the required torque can be developed. As other loads on the system start and come up to speed, the terminal voltage at the valve operators will increase to the required value necessary to develop sufficient torque to move the valve.

An analysis of the overall Unit 3 distribution system shows that the voltages at the 600 VAC and 208 VAC levels can be expected to recover to a value that will allow the valve operators to develop the required torque to move the valve. The analysis shows that the voltage recovery will occur within 5 to 6 seconds after start initiation.

It is therefore concluded that the valve operators will perform their intended function under postulated degraded voltage conditions.

Conclusions

The evaluation of the station electric distribution system voltages shows that the system has the capacity and capability to accept and operate normally running loads transferred to the startup transformer and to start all required safety-related loads under postulated degraded grid voltage conditions.

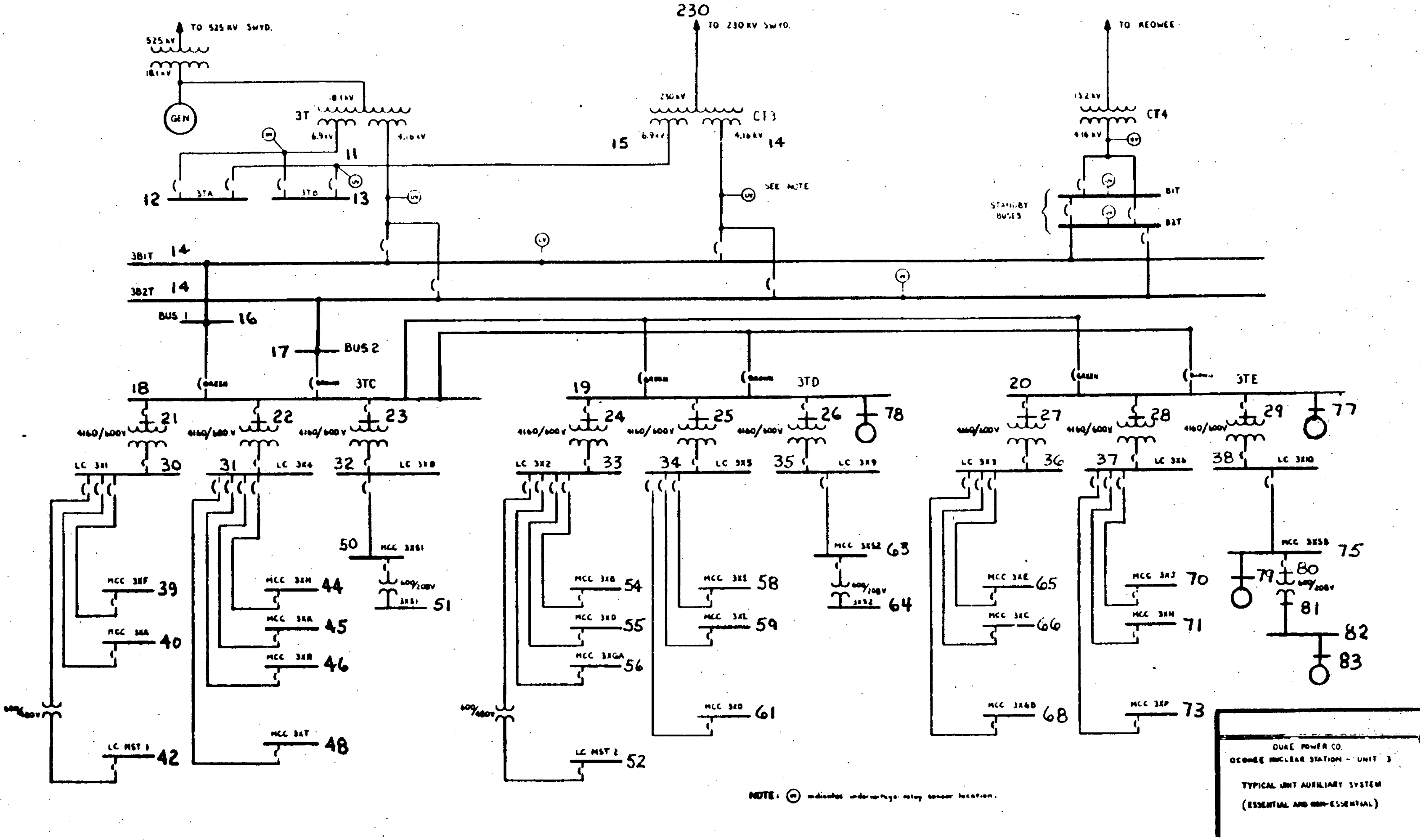


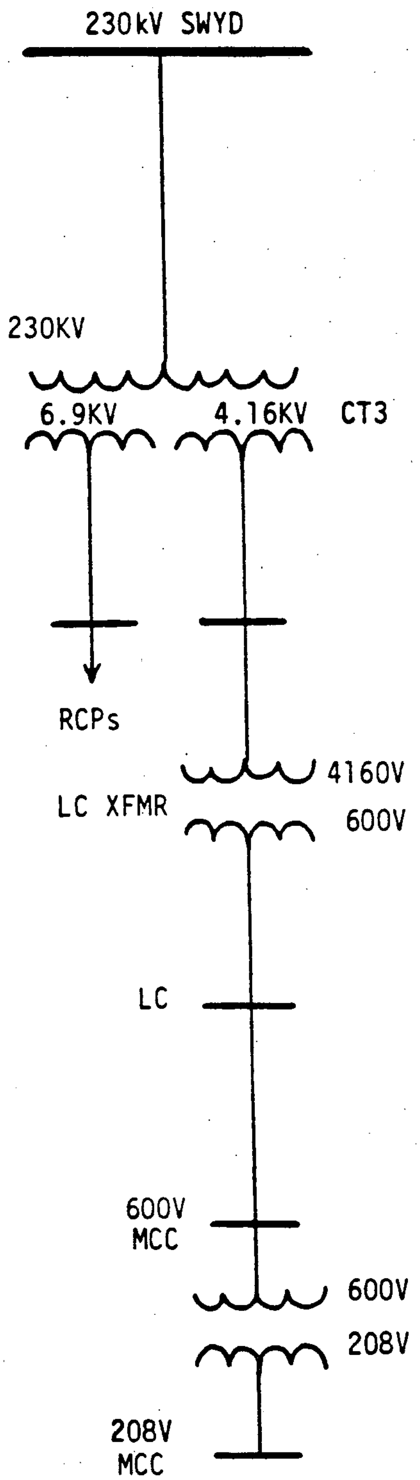
DIAGRAM I

Oconee Nuclear Station - Unit 3

VOLTAGE	BUS NAME	BUS #	NORMAL LOADING	CONNECTED*	XFMR RATING (KVA)
6900V	3TA	12	12.38+j5.23 MVA	14.25+j5.63 MVA	
	3TB	13	12.38+j5.23 MVA	14.25+j5.63 MVA	
4160V	3TC	18	3.59+j3.21 MVA	9.67+j6.04 MVA	
	3TD	19	4.35+j3.79 MVA	9.04+j4.75 MVA	
	3TE	20	3.32+j2.87 MVA	8.73+j4.59 MVA	
600V	LC 3X1	30	0+j0	735.1+j377.5 KVA	1500
	3X2	33	0+j0	660.2+j349.7 KVA	1500
	3X3	36	0+j0	493.5+j239.2 KVA	1500
	3X4	31	0+j0	1177.5+j190.2 KVA	1500
	3X5	34	0+j0	1001.6+j212.0 KVA	1500
	3X6	37	0+j0	896.0+j166.2 KVA	1500
	3X8	32	120.9+j58.9 KVA	277.5+j96.6 KVA	1000
	3X9	35	120.9+j58.9 KVA	300+j103.5 KVA	1000
	3X10	38	0+j0	263.4+j86.9 KVA	300
	MCC 3XF	39	114.2+j55.3 KVA	165.1+j85.1 KVA	
	3XA	40	108.1+j52.4 KVA	449.2+j217.5 KVA	
	3XH	44	402.8+j0.0 KVA	537.0+j0.0 KVA	
	3XK	45	126.0+j0.0 KVA	168.0+j0.0 KVA	
	3XR	46	158.2+j76.6 KVA	270.0+115.1 KVA	
	3XT	48	151.9+j56.4 KVA	202.5+j75.1 KVA	
	3XS1	50	95.0+j0.0 KVA	156.6+j37.7 KVA	
	3XB	54	51.1+j27.3 KVA	68.2+j36.4 KVA	
	3XD	55	176.7+j89.4 KVA	235.5+j119.2 KVA	
	3XGA	56	176.7+j89.4 KVA	235.6+j119.2 KVA	
	3XI	58	378.0+j0.0 KVA	504.0+j0.0 KVA	
	3XL	59	188.8+j73.3 KVA	251.7+j97.7 KVA	
	3XO	61	184.4+j85.7 KVA	245.9+114.3 KVA	
	3XS2	63	112.0+j10.5 KVA	179.1+j44.6 KVA	
	3XE	65	75.5+j35.1 KVA	164.0+j79.4 KVA	
	3XC	66	129.4+j62.8 KVA	172.5+j83.7 KVA	
	3XGB	68	117.2+57.1 KVA	157.0+j76.1 KVA	
	3XJ	70	378.0+j0.0 KVA	504.0+j0.0 KVA	
	3XN	71	135.3+j67.4 KVA	180.3+j89.9 KVA	
	3XP	73	158.7+57.3 KVA	211.6+j76.3 KVA	
	3XS3	75	47.0+j10.5 KVA	263.4+j86.9 KVA	
480V	MST1	42	120.8+j74.9 KVA	120.8+j74.9 KVA	
	MST2	52	120.8+j74.9 KVA	120.8+j74.9 KVA	
208V	3XS1	51	0+j0	16.6+j8.0 KVA	30
	3XS2	64	0+j0	25.5+j10.9 KVA	30
	3XS3	82	0+j0	6.3+j3.1 KVA	15

*Includes loads fed by lower voltage feeders.

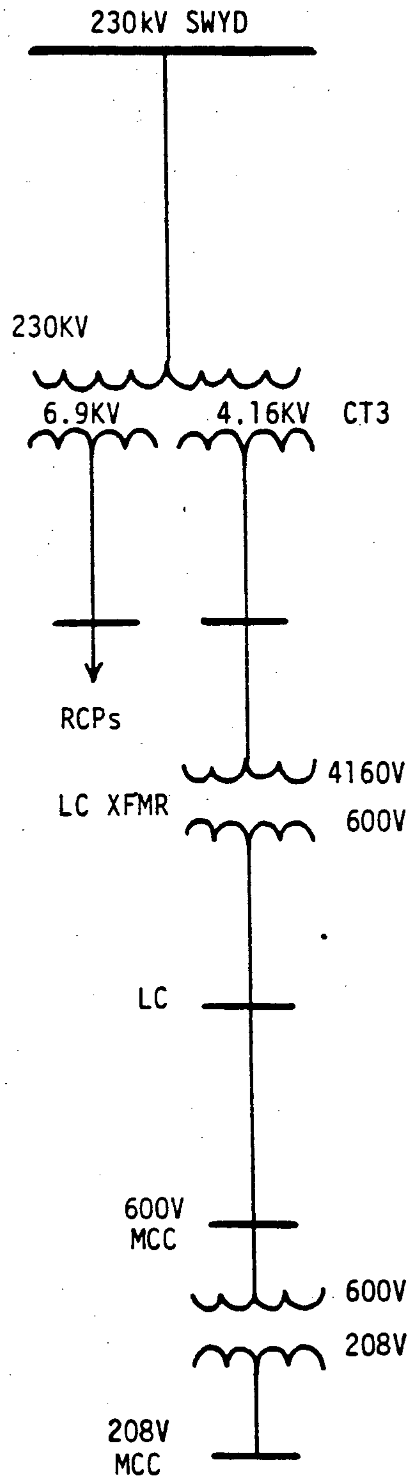
TABLE 1



LOCATION	BUS NAME	PER UNIT VOLTAGE NOMINAL BASE	VOLTAGE	PER UNIT VOLTAGE MOTOR BASE
SWYD	230KV SWYD	0.9435	217 KV	NA
6.9KV SWGR	3TA	0.9411	6.49 KV	0.984
	3TB	0.9410	6.49 KV	0.984
4.16KV SWGR	3TC	0.9202	3828 V	0.957
	3TD	0.9200	3827 V	0.957
	3TE	0.9199	3827 V	0.957
600V LC	3X8	0.9147	549 V	0.954
	3X9	0.9135	548 V	0.953
	3X10	0.9180	551 V	0.958
600V MCC	3XS1	0.9145	549 V	0.954
	3XS2	0.9131	548 V	0.953
	3XS3	0.9172	550 V	0.957
208V MCC	3XS1	0.9145	190 V	0.951
	3XS2	0.9131	190 V	0.950
	3XS3	0.9172	191 V	0.954

FIGURE 1

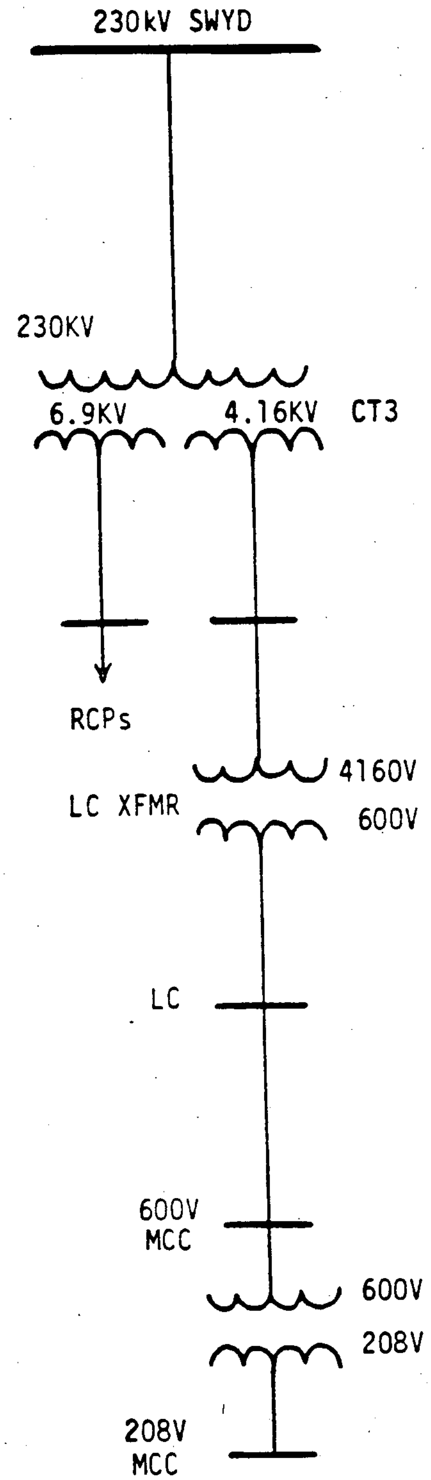
VOLTAGES EXISTING BEFORE ESG SIGNAL



LOCATION	BUS NAME	PER UNIT VOLTAGE NOMINAL BASE	VOLTAGE	PER UNIT VOLTAGE MOTOR BASE
SWYD	230KV SWYD	0.9435	217 KV	NA
6.9KV SWGR	3TA	0.9172	6.33 KV	0.959
	3TB	0.9172	6.33 KV	0.959
4.16KV SWGR	3TC	0.8125	3380 V	0.845
	3TD	0.8119	3378 V	0.844
	3TE	0.8117	3377 V	0.844
600V LC	3X8	0.7909	475 V	0.825
	3X9	0.7894	474 V	0.824
	3X10	0.7323	439 V	0.764
600V MCC	3XS1	0.7902	474 V	0.825
	3XS2	0.7883	473 V	0.823
	3XS3	0.7231	434 V	0.755
208V MCC	3XS1	0.7367	153 V	0.766
	3XS2	0.7459	155 V	0.776
	3XS3	0.7084	147 V	0.737

FIGURE 2

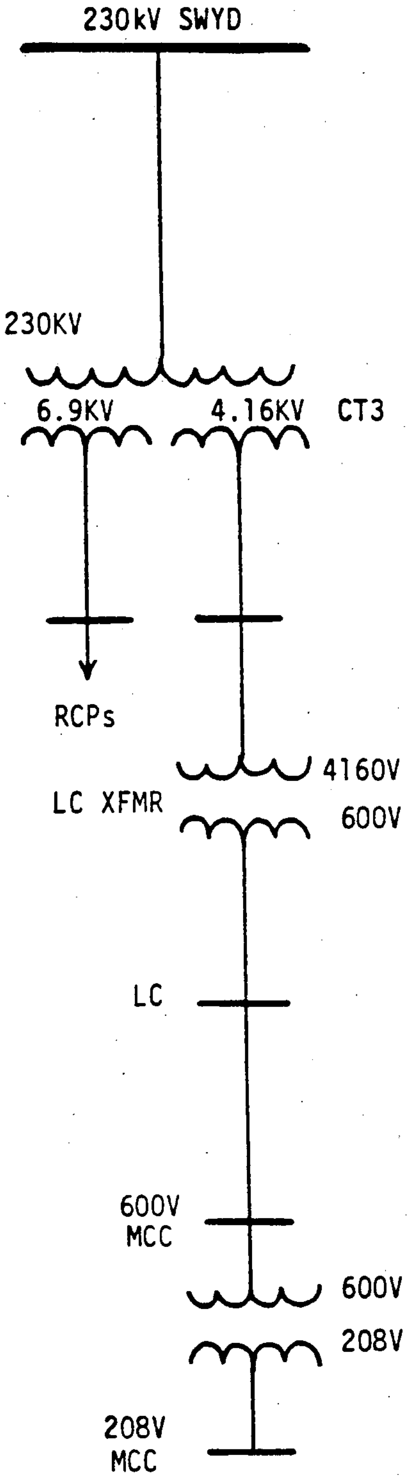
VOLTAGES UPON STARTING REQUIRED SAFETY LOADS (INITIAL INRUSH)



LOCATION	BUS NAME	PER UNIT VOLTAGE NOMINAL BASE	VOLTAGE	PER UNIT VOLTAGE MOTOR BASE
SWYD	230KV SWYD	0.9435	217 KV	NA
6.9KV SWGR	3TA	0.9383	6.47 KV	0.981
	3TB	0.9382	6.47 KV	0.981
4.16KV SWGR	3TC	0.9086	3780 V	0.945
	3TD	0.9083	3779V	0.945
	3TE	0.9082	3778V	0.945
600V LC	3X8	0.9005	540 V	0.940
	3X9	0.8992	540 V	0.938
	3X10	0.8862	532 V	0.925
600V MCC	3XS1	0.9001	540 V	0.940
	3XS2	0.8986	539 V	0.938
	3XS3	0.8829	530 V	0.921
208V MCC	3XS1	0.8923	186 V	0.928
	3XS2	0.8925	186 V	0.928
	3XS3	0.8300	183 V	0.915

FIGURE 3

VOLTAGES AFTER ALL SAFETY LOADS RUNNING



LOCATION	BUS NAME	PER UNIT VOLTAGE NOMINAL BASE	VOLTAGE	PER UNIT VOLTAGE MOTOR BASE
SWYD	230KV SWYD	0.9435	217 KV	NA
6.9KV SWGR	3TA	0.9384	6.47 KV	0.981
	3TB	0.9383	6.47 KV	0.981
4.16KV SWGR	3TC	0.9090	3781 V	0.945
	3TD	0.9087	3780 V	0.945
	3TE	0.9086	3779 V	0.945
600V LC	3X8	0.9034	542 V	0.943
	3X9	0.9021	541 V	0.941
	3X10	0.8870	532 V	0.926
600V MCC	3XS1	0.9032	542 V	0.942
	3XS2	0.9018	541 V	0.941
	3XS3	0.8837	530 V	0.922
208V MCC	3XS1	0.9032	188 V	0.939
	3XS2	0.9018	188 V	0.939
	3XS3	0.8837	184 V	0.919

FIGURE 4

VOLTAGES WITH SAFETY LOADS RUNNING - ALL VALVES OFF