REPORT ON

VOLTAGE DROP STUDY

FOR

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNIT NO. 2

BY

UNITED ENGINEERS & CONSTRUCTORS INC.

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1.0 PURPOSE

1.1 This study is an analysis of the voltage regulation performance of the Brunswick Steam Electric Plant auxiliary distribution system. First, the optimum transformer tap settings were determined for the various auxiliary transformers. Second, using these tap settings, the voltage ranges at the various auxiliary load terminals were determined, for the expected generator and 230KV switchyard voltage variations, and for postulated variations in load conditions. Third, limitations on generator and 230KV switchyard voltage variations were determined. These limitations were established such that under expected normal operating conditions equipment design lifetimes would not be decreased. Under emergency operating conditions the limits were set to provide proper operation of all safety-related equipment.

2.0 SUMMARY OF RESULTS

2.1 SOURCE VOLTAGE RESTRICTIONS

2.1.1 Criteria

For those operating conditions which are expected to continue for long periods of time, the voltage criteria at the load buses were chosen to maximize motor life (90% to 110% of the motor rated voltage), and the source voltage restrictions for these cases were based on such criteria. (See Article 3.2.1). For the emergency operating conditions, the voltage criteria were chosen to ensure that all safety-related equipment would function, (85% to 110% of the motor control center voltage), with the possibility that motor life might be adversely affected if operation beyond either voltage limit continued for a long period of time. (See Article 3.2.1). For all motor starting cases, both accident-related and normal operation, the voltage criteria were chosen to ensure that the motors in question would start (70% or 75% for 4000-volt safety-related motors, 85% for all 460-volt motors and 4000-volt BOP motors), and that the 480-volt starters would not drop out (70%).

It is recommended, for the operating conditions shown, that the source voltages be held within the restrictions tabulated in 2.1.2 and 2.1.3.

2.1.2

GENERATOR AND SWITCHYARD VOLTAGES

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY (4160 VOLT BUSES COMMON B & COMMON A TIE BREAKER OPEN)

OPERATING VOLTAGE LIMITS

CASE	BUS	BASE VOLTAGE	PER-UNIT VOLTAGE	ACTUAL VOLTAGE	
UAT, LIGHT LOAD					
	GEN	24000.	1.0365	24876.	Max.
UAT, SCREEN WASH PUMP 2 A STARTING (FULL LOAD)					
	GEN	24000.	0.9665	23198.	Min.
SAT, SHUTDOWN (LIGHT LOAD)					
	SWYD	230000	1.0090	232068.	Max.
SAT, UNIT LOADS FED FROM UAT					
	SWYD	230000	1.0138	233185.	Max.
SAT, SCREEN WASH PUMP 2A STARTING (FULL LOAD)					
	SWYD	230000	0.9727	223711.	Min.
SAT, 2X LOCA START (FULL LOAD)					
	SWYD	230000	0.9593	220639.	Min.

2.1.3

GENERATOR AND SWITCHYARD VOLTAGES

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY (4160 VOLT BUSES COMMON B & COMMON A TIE BREAKER CLOSED)

OPERATING VOLTAGE LIMITS

CASE	BUS	BASE VOLTAGE	PER-UNIT VOLTAGE	ACTUAL VOLTAGE	
SAT, SCREEN WASH PUMP 2 A STARTING (FULL LOAD)					
	SWYD	230000.	0.9809	225607.	Min.
SAT, 2X LOCA START (FULL LOAD)					
	SWYD	230000	0.9720	223560.	Min.

2.2 TAP SETTINGS

Recommended transformer high-voltage winding tap settings are as follows:

UAT	1.00	(base)
SAT	.975	(-2.5%)
Unit Substations		
2E	.95	(-5%)
2F	.95	(-5%)
E7	.95	(-5%)
E8	.95	(-5%)
2SY	.975	(-2.5%)
Common D	.975	(-2.5%)
2L	1.00	(base)
4L	.975	(-2.5%)

The above tap settings will provide adequate voltage at the equipment terminals under the operating conditions evaluated and were used in calculating the source voltage limits govern in Table 2.1.2 and 2.1.3.

3.0 DISCUSSION

3.1 BASES FOR COMPARISON

3.1.1 Tap Settings

The criterion used to choose transformer tap settings was to determine, for each set of tap settings, the maximum 230 KV switchyard voltage required to meet the load voltage requirements. To accomplish this, for each tap setting combination, voltage drop calculations were performed for the SAT Shutdown (Light Load) case to determine the maximum switchyard voltage. The tap settings chosen are those which most closely approach the desired switchyard operating voltage range of 96.0 to 102%.[5.1] The tap settings chosen must also provide proper load voltages over the entire range of generator voltages from light load to full load. (See Article 3.2.1). The recommended tap settings do this. (See Article 2.2).

3.2 CRITERIA

3.2.1 Allowable Load Voltage Ranges

3.2.1.1 Motor voltage criteria vary with the class of the motor, as well as the voltage rating. For 4000-volt motors, non-Class-IE, the requirements are: (5.2)(5.3)

Running continuous	4000-V base	90%-110%	3600-4400V
Starting	4000-V base	85%-110%	3400-4400V
Running transient	4000-V base	85%-110%	3400-4400V

For 4000-volt motors, Class IE, specified and supplied by G.E., the requirements are: (5.4)(5.5)

Running continuous	4000-V base	90%-110%	3600-4400V
Starting	4000-V base	70%-110%	2800-4400V
Running transient	4000-V base	70%-110%	2800-4400V

For 4000-volt motors, Class IE, specified by UE&C, the requirements are: (5.6)

Running continuous	4000-V base	90%-110%	3600-4400V
Starting	4000-V base	75%-110%	3000-4400V
Running transient	4000-V base	75%-110%	3000-4400V

For 460-volt motors, the requirements for normal motor life are: (5.7)

Running continuous	460-V base	90%-110%	414-506V
Starting	460-V base	85%-110%	391-506V
Running transient	460-V base	*70.7%-110%	325-506V

*Based on 200% torque at rated voltage for NEMA design motors.

Motor control centers were specified for 480 volts, and the minimum hold-in voltage requirement for the starters is 70% of 480 volts, or 336 volts. The minimum pickup voltage requirement for starters is 85% of 480 volts, or 408 volts. (5.8)

3.2 CRITERIA (Cont'd)

3.2.1 Allowable Load Voltage Ranges (Cont'd)

3.2.1.2 For the normal operation cases, that is, for the UAT Full Load, SAT Full Load, UAT Light Load, and SAT Shutdown cases, the load voltage restrictions are based on the rated continuous running voltages of motors to achieve normal lifetimes (90% to 110% of rated voltage, 4000V or 460V). (See Articles 3.2.3 for definitions of these cases).

3.2.1.3 Operation at voltages higher than those given would probably result in abnormal heating of motors due to saturation. This heating would shorten the Mean Time Between Failures for the motors so exposed. The MTBF could be expected to decrease with increased time at high voltages, and to decrease rapidly with increased voltage levels above the voltage where saturation begins. At the other extreme, because the speed of an induction motor varies greatly with changes in frequency and only slightly on voltage, the load speed remains essentially constant with decreasing voltage. Therefore, the load power and electrical volt-ampere requirements remain essentially constant for decreasing motor voltage, and the current increases. Below the limiting values shown in Article 3.2.1.1, the I^2R losses due to this increased current could be expected to produce abnormal heating and again result in reduced MTBF's. Both of these effects are long-term results of high- or low-voltage operation, hence these limiting values apply only to

3.2 CRITERIA (Cont'd)

3.2.1 Allowable Load Voltage Ranges (Cont'd)

3.2.1.3 operating conditions expected to occur for a substantial portion of the forty-year plant lifetime. Since high voltages would occur with most motors stopped, while low voltages would occur with most motors running and therefore more motors would be exposed to the potentially damaging condition. Thus the decrease in reliability due to extended low-voltage operation would be much more severe than that due to extended high-voltage operation.

3.2.1.4 For 4000 volt motor starting cases, the criteria are simpler. At the 4160-volt level, the limitation is maintaining the minimum motor voltages cited in Article 3.2.1.1. Since motors can, without stalling, ride through a transient voltage dip at a voltage sufficient to start them, the limiting condition for the 4160-volt level is to maintain sufficient voltage to start the motors. At the 480-volt level, the limitation is that the starters of motors already running must not drop out when a 4000-volt motor starts. Starters are not guaranteed to hold in at voltages below 70% of their rated coil voltage, or in the case of BSEP, 70% x 480V or 336V. For 460 volt motor starting cases, the criterion is simply that the 460 volt motor must have no less than rated starting voltage (85% of 460V).

3.2 CRITERIA (Cont'd)

3.2.1 Allowable Load Voltage Ranges (Cont'd)

3.2.1.5 For the running LOCA and 2X LOCA cases, the postulated combination of depressed 230KV system voltage and heavy auxiliary load would not be expected to continue indefinitely. Because these are temporary conditions, and because such an accident could affect the operating life of the plant, reduction in motor MTBF becomes a secondary consideration. The important voltage limitation in these accident conditions is imposed by the requirement of 85% x 480V or 408V at the motor control centers to ensure that a starter will pick up.

3.2.1.6 Using the above values, voltage criteria were developed for buses and unit substations. At the 4160-volt level, the voltage drops due to cable impedances are negligible. Hence, the bus voltages are considered to be the same as the motor voltages. At the 480-volt level, the voltage drops between the unit substations and motor control centers, and between the motor control centers and the motor terminals are significant. VOLTS runs were made to determine the exact 480 Volt unit substation voltage required to maintain the required voltages at all motor control centers. It was found that if the voltage at Unit Substation E7 is above .8718, and that at Unit Substation E8 is above .8803, then all MCC voltages will be at least 85%. VOLTS runs were also made

3.2 CRITERIA (Cont'd)

3.2.1 Allowable Load Voltage Ranges (Cont'd)

3.2.1.6 to determine the minimum unit substation voltages to ensure that all MCC's will see not less than 70% voltage when 4000 volt motors start. It was found that if the Unit Substation E8 voltage is .7368 x 480V or more, all MCC's will see not less than 70% voltage. Note that specifying a single unit substation's voltage essentially specifies all unit substations' voltages, because unit substation voltages are determined by the 4KV system voltage.

3.2.1.7 Summary of Voltage Requirements

4160-Volt Buses	Minimum	Maximum
Running Voltage	3600	4400
Starting Voltage (non-Class IE)	3400	4400
Starting Voltage (Class IE Spec. by G.E.)	2800	4400
Starting Voltage (Class IE Spec. by UE&C)	3000	4400
460-Volt Motors		
Starting voltage at motor terminals	391	506

3.2.1.7 SUMMARY OF VOLTAGE REQUIREMENTS

480 VOLT UNIT SUBSTATION VOLTAGES

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

OPERATING VOLTAGE LIMITS

CASE	BUS	BASE VOLTAGE	PER-UNIT VOLTAGE	ACTUAL VOLTAGE
LOCA RUNNING LOADS, UNIT SUBSTATION E7 MOTOR CONTROL CENTERS				
	2CA	480.	0.8500	408.
	E7	480.	0.8718	418.
LOCA RUNNING LOADS, UNIT SUBSTATION E8 MOTOR CONTROL CENTERS				
	2CB	480.	0.8500	408.
	E8	480.	0.8803	423.
LOCA STARTING, UNIT SUBSTATION E7 MOTOR CONTROL CENTERS				
	2CA	480.	0.7000	336.
	E7	480.	0.7265	349.
LOCA STARTING, UNIT SUBSTATION E8 MOTOR CONTROL CENTERS				
	2CB	480.	0.7000	336.
	E8	480.	0.7368	354.
FULL LOAD, UNIT SUBSTATION E7 MOTOR CONTROL CENTERS				
	2CA	460.	0.9000	414.
	E7	480.	0.8797	422.
FULL LOAD, UNIT SUBSTATION E8 MOTOR CONTROL CENTERS				
	2CB	460.	0.9000	414.
	E8	480.	0.8864	425.
FULL LOAD, UNIT SUBSTATION 2E MOTOR CONTROL CENTERS				
	2TK	460.	0.9000	414.
	2E	480.	0.8715	418.
FULL LOAD, UNIT SUBSTATION 2F MOTOR CONTROL CENTERS				
	2TG	460.	0.9000	414.
	2F	480.	0.8730	419.
FULL LOAD, UNIT SUBSTATION COMMON D MOTOR CONTROL CENTERS				
	RWD	460.	0.9000	414.
	COM D	480.	0.8753	420.

Note: First line represents the MCC having the lowest bus voltage for the operating condition. The second line represents the unit substation to which the MCC is connected and the corresponding voltage on its bus.

3.2 CRITERIA (Cont'd)

3.2.2 Loads

4000 Volt motor loads were based on the load brake horsepower, using the motors' actual efficiencies and power factors to determine the electrical loads. The starting admittance values for both 4000 Volt and large 460 Volt motors were derived from the motors' actual inrush currents and power factors. Running loads on the 480 Volt system were taken from the 480 Volt Load Study[5.9]

3.2.3 Postulated Events and Plant Operating Conditions

3.2.3.1 "Normal Operation", as used in this study, includes the entire range of steady-state non-accident conditions from cold shutdown to full power operation. Any of the conditions included in this concept could be expected to continue for weeks or months at a time, and therefore the load voltage range for these conditions is that described in Article 3.2.1.2. The load conditions for normal operation are:

UAT	Full Load
SAT	Full Load
UAT	Light Load
SAT	Shutdown (Light Load)

3.2.3.2 "Motor Starting" cases refer to those motors which would be started at various times during normal plant operation. On each 4160 volt bus and each 480 volt unit substation, the largest motor was selected for study. It was assumed that the motor was starting while all other loads required for full power operation were running. If the largest motors

3.2 CRITERIA (Cont'd)

3.2.3 Postulated Events and Plant Operating Conditions (Cont'd)

3.2.3.2 on each bus can be started under this condition, it is reasonable to assume that all motors can be started under all "Normal Operation" conditions. These motor starting runs were made for both the UAT and SAT.

The following motors were studied:

Motor	HP	Fed From	Via
Reactor Recirculation Pump MG Set	7000	4160V Bus 2B	-
Circulating Water Intake Pump 2B	2250	4160V Bus 2D	-
Screen Wash Pump 2A	200	480V Unit Sub E7	MCC 2PA
Screen Wash Pump 2B	200	480V Unit Sub E8	MCC 2PB
Turbine Building Closed Cooling Water Pump 2A	200	480V Unit Sub 2E	MCC 2TJ
Turbine Building Closed Cooling Water Pump 2B	200	480V Unit Sub 2F	MCC 2TH
Backwash Air Blower 2-CFD-D063	150	480V Unit Sub Common D	MCC RWD
Reactor Building Closed Cooling Water Pumps 2A and 2C	75 + 75	480V Unit Sub E8	MCC 2XE

3.2 CRITERIA (Cont'd)

3.2.3 Postulated Events and Plant Operating Conditions (Cont'd)

3.2.3.3 "LOCA" cases are those initiated by a Loss of Coolant Accident on Unit 2. Both starting cases and running cases were studied. For detailed descriptions of the load conditions, see Article 3.2.4. The voltage criteria for these cases are described in Article 3.2.1.4 (starting) and 3.2.1.5 (running).

3.2.3.4 "2X LOCA" cases are those initiated by a Loss of Coolant Accident on Unit 2 and a false LOCA signal from Unit 1, resulting in the starting and running of both units' ESS loads. Again, both starting and running cases were studied. The voltage criteria for these cases are described in Article 3.2.1.4 (starting) and 3.2.1.5 (running).

3.2.3.5 "LOCA Motor Starting" and "2X LOCA Motor Starting" are the cases which address the problem of starting 460 volt motors after an accident, while the emergency motors are still running. The largest 460 volt motors fed from the emergency power system are the screen wash pumps, and starting and running of the screen wash pumps is blocked under LOCA conditions. The next largest motors on the 480 volt emergency system, which could start under LOCA conditions, are the 75 horsepower Reactor Building Closed Cooling Water Pumps. The worst case is a postulated simultaneous start of Reactor

3.2 CRITERIA (Cont'd)

3.2.3 Postulated Events and Plant Operating Conditions (Cont'd)

3.2.3.5 Building Closed Cooling Water Pumps 2A and 2C on loss of closed cooling water header pressure.

3.2.4 Load Conditions

The various load conditions studied are defined below:

3.2.4.1 UAT Full Load: This is the normal plant operating condition, with the generating unit at full power and with auxiliary loads fed as follows:

Source	UAT	SAT
4160V Bus 2B	X	
4160V Bus 2C	X	
4160V Bus 2D	X	
4160V Bus Common B		X
480V Bus 2E	X	
480V Bus 2F	X	
480V Bus E7	X	
480V Bus E8	X	
480V Bus 2SY		X
480V Bus Common D		X
480V Bus 2L		X
480V Bus 4L		X

3.2.4.2 SAT Full Load: This is the normal plant operating condition with the generating unit at full power and auxiliary loads fed from the SAT. The plant is in operation with the UAT out of service.

3.2.4.3 UAT Light Load: This represents the estimated minimum auxiliary load that would exist with the generator connected to the system. Load buses are fed from the same sources as cited under "UAT Full Load".

3.2.4.4 SAT Shutdown: (Light Load) This represents the minimum auxiliary load, with the plant shut down and all auxiliary loads fed from the SAT.

3.2 CRITERIA (Cont'd)

3.2.4 Load Conditions (Cont'd)

3.2.4.5	LOCA Start:	This represents the inrush condition at the start of an accident, with 2 RHR pumps and 2 Core Spray pumps simultaneously starting, with all other loads running as in the SAT Full Load condition except that the Turbine Building Air Conditioning Compressors are tripped.
3.2.4.6	LOCA Run:	This represents the steady-state condition during an accident, with 2 RHR pumps and 2 Core Spray pumps running in addition to the running loads cited in the LOCA Start case above.
3.2.4.7	2X LOCA Start:	This represents the simultaneous starting of all RHR pumps and Core Spray pumps, with all the other loads running as in the SAT Full Load condition except that the Turbine Building Air Conditioning Compressors are tripped.
3.2.4.8	2X LOCA Run:	This represents the steady-state condition following 2X LOCA Start with all RHR pumps, all Core Spray pumps and all other loads (except Turbine Building Air Conditioning Compressors) running. It should be noted that this condition applies during a LOCA on Unit 2 and simultaneous shutdown cooling of Unit 1.

3.3 METHOD OF ANALYSIS

3.3.1 Program

The UE&C computer program "VOLTS" was used to calculate bus voltages. This program performs a Gauss-Seidel load flow calculation, with provision for constant MVA loads to model running motors, and constant admittance loads to model starting motors. Up to 25 buses can be modeled. Transformers with tap changers can be represented. Bus voltages are computed by the program to a tolerance of $\pm.0001 \pm j.0001$ per unit.

3.3.2 Per Unit Values

Calculations were performed using a per-unit scheme with base values as follows:

System	Base Volts	Base MVA
230-KV	230 KV	100
24-KV	23.5 KV*	100
4160-V	4160-V	100
480-V	480-V	100

*23.5 KV is the base value for computer calculations only. Where generator voltages are expressed in %, the base value is the rated generator voltage, i.e., 24 KV.

3.3 METHOD OF ANALYSIS (Cont'd)

3.3.3. Impedances

The transformer impedances in the study are the actual impedances taken from the test reports.[9.10] Cable impedances were calculated from the manufacturer's data. In order to stay within the computer program's 25-bus limitation, cable impedances were combined with transformer impedances as required.

4.0 ANALYSIS OF ALTERNATES

4.1 ALTERNATIVES

Two alternative operating conditions have been reviewed. One operating condition is with the 4160 Volt Buses Common B and Common A Tie Breaker Open. This is a normal operating condition. The other operating condition is with this Tie Breaker closed. This condition could occur when the Unit No. 1 startup transformer is out of service.

4.2 4160 VOLT BUSES COMMON B & COMMON A TIE BREAKER OPEN

Review of the various VOLTS computer runs (Appendix A) determined six operating voltage limits. These limits are tabulated in 2.1.2. The minimum expected switchyard voltage of 100%(5.1) is above the 97.27% required for normal plant operation and the minimum post turbine generator trip switchyard of 96%(5.1) is above the 95.93% required for operating the ESS equipment. The maximum switchyard voltage of 102%(5.1) would normally occur when the unit was operating and the Startup Auxiliary Transformer was feeding both 4160 Volt Bus Common B and 4160 Volt Bus 2B. The additional load imposed by Bus 2B would allow the Switchyard Voltage to exceed the 101.38% limit. It is expected that with Unit No. 2 shutdown, the switchyard voltage would not exceed the 100.9% limit. In addition, any loads which might be operating during shutdown (i.e. circulating water pumps; service water pumps, etc.) would allow an increase of switchyard voltage beyond the 100.9%.

4.3 4160 VOLT BUSES COMMON B & COMMON A TIE BREAKER CLOSED

Review of the various VOLTS computer runs (Appendix B) determined two operating voltage limits. These limits are tabulated in 2.1.3. The minimum expected switchyard voltage of 100%(5.1) is above the 98.09% required for normal plant operation. The minimum post turbine trip

voltage of 96%[5.1] is below the 97.20% required for operation of the ESS equipment. This problem can be resolved in one of two ways:

a. Provide a minimum Switchard Voltage of 101.2% when tie breaker is closed

b. Reduce auxiliary load (UAT and SAT) to 31.5 MW and 18.8 MVAR when tie breaker is closed

The addition of the 4160 Volt Bus Common A loads will permit an increase in Switchyard Voltage above the limits of 100.9% and 101.38% noted in 4.2 and therefore cannot be considered an operating limit. For this reason the VOLTS runs were not performed.

5.0 REFERENCES

5.1 CP&L letter to NRC NC-80-;093 dated July 24, 1980.

5.2 United Engineers and Constructors, Miscellaneous Induction Motors 100 HP and Larger, Specification Number 9527-01-128-2, Revision 6, dated June 4, 1976.

5.3 United Engineers and Constructors, Synchronous Motors 100 HP and Larger, Specification Number 9527-01-128-3, Revision 4, dated July 11, 1975.

5.4 General Electric Company letter GU-894 to United Engineers and Constructors, dated April 21, 1971.

5.5 General Electric Company, Electric Motor List, GE Specification Number 22A827, Revision 1, dated November 23, 1970.

5.6 United Engineers and Constructors, Class I Induction Motors 100 HP and Larger, Specification Number 9527-01-128-4, Revision 4, dated June 9, 1976.

5.7 United Engineers and Constructors, Non-Special Alternating Current Induction Motors less than 100 HP in size, Specification Number 9527-01-128-1, Revision 4, dated December 23, 1974.

5.8 United Engineers and Constructors, 480 Volt Motor Control Centers, Specification Number 9527-01-143-1, Revision 4, dated August 9, 1976.

5.9 United Engineers and Constructors, 480 Volt Load Study for Carolina Power and Light Company, Brunswick Steam Electric Plant, Unit 2, Revision 1, dated March 31, 1978

5.10 Transformer Test Report

Transformer	Foreign Print Number
Main	F.P. 9527-30131
Unit Auxiliary	F.P. 9527-3873
Start up Auxiliary	F.P. 9527-3821
Unit Substations:	
2E	F.P. 9527-30073
2F	F.P. 9527-30072
E7	F.P. 9527-30069
E8	F.P. 9527-30071
2L	F.P. 9527-30075
4L	F.P. 9527-30075
2SY	F.P. 9527-30076
Common D	F.P. 9527-30073

5.11 Key Single Line Diagrams

9527-F-3043	230KV, 24KV, 4160V Key Single Line Diagram
9527-F-3044	480V System

5.12 Single Line Diagrams

9527-F-3002	4160V System SWGR 2B, 2C, 2D and Common "B"
9527-F-3003	4160V Emergency System Buses E3 and E4
9527-F-3004	4160V Emergency System Buses E1 and E2
9527-F-3005	480V System Unit Substations 2E, 2F, E7, E8 and Common "D"
9527-F-3045	480V Motor Control Centers 2TA, 2TB, 2TC, 2TF, 2TJ
9527-F-3047	480V Motor Control Centers 2TD, 2TE, 2TG, 2TH
9527-F-3048	480V Motor Control Centers 2TK, 2TL, 2TM, 2TN
9527-F-3049	480V Motor Control Centers 2XA, 2XC, 2XE, 2XG, 2XJ, 2XL
9527-F-3050	480 V Motor Control Centers 2XB, 2XD, 2XF, 2XH, 2XK, 2XM
9527-F-3051	480V Motor Control Centers RWA, RWB, RWC, RWD
9527-F-3052	480V Motor Control Centers BHA, SBA, WTA and WHA
9527-F-3053	480V Motor Control Centers 2CA, 2CB, 2PA, 2PB, 2SA
9527-F-3055	480V Motor Control Centers SYA, SYB, SYC and SYD
9527-F-3057	480V Motor Control Centers DGA, DGB, DGC and DGD

6.0 APPENDICIES

APPENDIX A

VOLTAGE DROP STUDY

FOR

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNIT NO. 2

BY

UNITED ENGINEERS & CONSTRUCTORS INC.

VOLTAGES

AND

IMPEDANCE DIAGRAMS

4160 VOLT BUSES COMMON B &

COMMON A TIE BREAKER OPEN

VOLTAGE DROP STUDY

APPENDIX A

GENERAL NOTES

1. The choice of source voltages to be studied was made as follows:
An initial VOLTS run was made at the appropriate limiting value determined by the source in question. For the full load, motor starting, and LOCA cases, the initial runs were made at 95% of 24KV for the UAT cases, and 95% of 230KV for the SAT cases. For the light load cases, the initial runs were made at 110% of 24KV for the UAT cases and 105% of 230KV for the SAT cases. If the voltages which resulted from a given initial run were satisfactory for all loads, then no further runs were made for that particular operating case. If the voltages were not satisfactory, then a second run was made at a voltage chosen so that the two voltages would bracket the limiting voltage. After load voltages were available for two source voltages, a linear interpolation calculation was done to determine the limiting voltage. The VOLTS run was then performed using the limiting source voltage, and these are the runs which are presented in those cases where the limiting voltage would be determined by the loads. In the accident cases a minimum voltage limited by the loads was determined in every case, even when this voltage was below the expected minimum 230KV switchyard voltage.

VOLTAGE DROP STUDY

APPENDIX A

UAT

LIGHT LOAD
(Fig. No. A1)

BUS NAMES	MAXIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	1.0365	24,876
4160 VOLT BUS 2B	1.1	4,576
4160 VOLT BUS 2C, 2D, E3 & E4	1.059	4,405
480 VOLT UNIT SUBSTATION E7	1.0648	511
480 VOLT UNIT SUBSTATION 2E	1.0721	515
480 VOLT UNIT SUBSTATION 2F	1.0685	513
480 VOLT UNIT SUBSTATION E8	1.0631	510

NOTE: ALL VOLTAGES, EXCEPT GENERATOR, ARE ON 4000 VOLT OR 460 VOLT BASE AS APPROPRIATE.

VOLTAGE DROP STUDY

APPENDIX A

UAT

FULL LOAD
(Fig. No. A2)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.95	22,800
4160 VOLT BUS 2B	.9448	3,930
4160 VOLT BUS 2C, 2D, E3 & E4	.9191	3,823
480 VOLT UNIT SUBSTATION E7	.9095	437
480 VOLT UNIT SUBSTATION 2E	.9175	440
480 VOLT UNIT SUBSTATION 2F	.9135	438
480 VOLT UNIT SUBSTATION E8	.9076	436

NOTE: ALL VOLTAGES ARE EXPRESSED IN PER UNIT ON THE BASE VOLTAGE SHOWN IN THE LEFT-HAND COLUMN

VOLTAGE DROP STUDY

APPENDIX A

UAT

REACTOR RECIRC. PUMP MG SET 2B MOTOR STARTING
(Fig. No. A3)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.95	22,800
4160 VOLT BUS 2B	.8093	3,367
4160 VOLT BUS 2C, 2D, E3 & E4	.9374	3,900
480 VOLT UNIT SUBSTATION E7	.93	446
480 VOLT UNIT SUBSTATION 2E	.9378	450
480 VOLT UNIT SUBSTATION 2F	.934	448
480 VOLT UNIT SUBSTATION E8	.9282	446
4000V REACTOR RECIRC. MG SET 2B MOTOR	.8307	3,322

NOTE: ALL VOLTAGES ARE ON THE BASE SHOWN IN THE LEFT-HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

UAT

CIRCULATING WATER PUMP STARTING
(Fig. No. A4)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.95	22,800
4160 VOLT BUS 2B	.9505	3,954
4160 VOLT BUS 2C, 2D, E3 & E4	.8723	3,629
480 VOLT UNIT SUBSTATION E7	.8563	411
480 VOLT UNIT SUBSTATION 2E	.865	415
480 VOLT UNIT SUBSTATION 2F	.8607	413
480 VOLT UNIT SUBSTATION E8	.8543	410
4000V CIRCULATING WATER PUMP 2B MOTOR	.8803	3,521

NOTE: ALL VOLTAGES ARE ON THE BASE SHOWN IN THE LEFT-HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

UAT

SCREEN WASH PUMP 2A STARTING
(Fig. No. A5)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.9665	23,198
4160 VOLT BUS 2B	.9628	4,005
4160 VOLT BUS 2C, 2D, E3 & E4	.9321	3,878
480 VOLT UNIT SUBSTATION E7	.8807	423
480 VOLT UNIT SUBSTATION 2E	.932	447
480 VOLT UNIT SUBSTATION 2F	.9281	445
480 VOLT UNIT SUBSTATION E8	.9222	443
480 VOLT MOTOR CONTROL CENTER 2PA	.8298	398
460 V SCREEN WASH PUMP 2A MOTOR TERMINALS	.8501	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

UAT

TURBINE BUILDING CLOSED COOLING WATER PUMP 2A STARTING
(Fig. No. A6)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.95	22,800
4160 VOLT BUS 2B	.9455	3,933
4160 VOLT BUS 2C, 2D, E3 & E4	.9135	3,800
480 VOLT UNIT SUBSTATION E7	.9031	433
480 VOLT UNIT SUBSTATION 2E	.8655	415
480 VOLT UNIT SUBSTATION 2F	.9072	435
480 VOLT UNIT SUBSTATION E8	.9012	433
480 VOLT MOTOR CONTROL CENTER 2TJ	.8338	400
460V TURBINE BUILDING CLOSED COOLING WATER PUMP 2A	.8573	394

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

UAT

TURBINE BUILDING CLOSED COOLING WATER PUMP 2B STARTING
(Fig. No. A7)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.956	22,944
4160 VOLT BUS 2B	.9519	3,960
4160 VOLT BUS 2C, 2D, E3 & E4	.9201	3,828
480 VOLT UNIT SUBSTATION E7	.9106	437
480 VOLT UNIT SUBSTATION 2E	.9187	441
480 VOLT UNIT SUBSTATION 2F	.8684	417
480 VOLT UNIT SUBSTATION E8	.9087	436
480 VOLT MOTOR CONTROL CENTER 2TH	.8381	402
460 V TURBINE BUILDING CLOSED COOLING WATER PUMP 2B	.8501	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

UAT

SCREEN WASH PUMP 2B STARTING
(Fig. No. A8)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
GENERATOR (24 KV BASE)	.9576	2,298
4160 VOLT BUS 2B	.9535	3,967
4160 VOLT BUS 2C, 2D, E3 & E4	.9223	3,837
480 VOLT UNIT SUBSTATION E7	.913	438
480 VOLT UNIT SUBSTATION 2E	.921	442
480 VOLT UNIT SUBSTATION 2F	.9171	440
480 VOLT UNIT SUBSTATION E8	.8681	417
480 VOLT MOTOR CONTROL CENTER 2PB	.832	399
460V SCREEN WASH PUMP 2B MOTOR TERMINALS	.8502	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

SHUTDOWN
(Fig. No. A9)

BUS NAMES	MAXIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	1.0090	232,068
4160 VOLT BUS 2B	1.0751	4,472
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	1.0599	4,409
480 VOLT UNIT SUBSTATION E7	1.0813	519
480 VOLT UNIT SUBSTATION 2E	1.0927	524
480 VOLT UNIT SUBSTATION 2F	1.1001	528
480 VOLT UNIT SUBSTATION E8	1.0765	517
480 VOLT UNIT SUBSTATION 2SY	1.0809	519
480 VOLT UNIT SUBSTATION COMMON D	1.0813	519
480 VOLT UNIT SUBSTATION 2L	1.0549	506
480 VOLT UNIT SUBSTATION 4L	1.0725	515

NOTE: ALL VOLTAGES, EXCEPT SWITCHYARD, ARE ON 4000 VOLT OR 460 VOLT BASE AS APPROPRIATE.

VOLTAGE DROP STUDY

APPENDIX A

SAT

UNIT LOADS FED FROM UAT
(Fig. No. A10)

BUS NAMES	MAXIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	1.0138	233,185
4160 VOLT BUS COMMON B	1.0787	4,487
480 VOLT UNIT SUBSTATION 2SY	1.0999	528
480 VOLT UNIT SUBSTATION COMMON D	1.0931	525
480 VOLT SUBSTATION 2L	1.0738	515
480 VOLT UNIT SUBSTATION 4L	1.0922	524

NOTE: ALL VOLTAGES, EXCEPT SWITCHYARD, ARE ON 4000 VOLT OR 460 VOLT BASE AS APPROPRIATE.

VOLTAGE DROP STUDY

APPENDIX A

SAT

FULL LOAD
(Fig. No. A11)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	.95	218,500
4160 VOLT BUS 2B	.9384	3,904
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9119	3,794
480 VOLT UNIT SUBSTATION E7	.9013	433
480 VOLT UNIT SUBSTATION 2E	.9095	437
480 VOLT UNIT SUBSTATION 2F	.9055	435
480 VOLT UNIT SUBSTATION E8	.8994	432
480 VOLT UNIT SUBSTATION 2SY	.9243	444
480 VOLT UNIT SUBSTATION COMMON D	.9167	440
480 VOLT UNIT SUBSTATION 2L	.9027	433
480 VOLT UNIT SUBSTATION 4L	.9157	440

NOTE: ALL VOLTAGES ARE EXPRESSED IN PER UNIT ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

REACTOR RECIRC. PUMP MG SET 2B MOTOR STARTING
(Fig. No. A12)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.95	218,500
4160 VOLT BUS 2B	.8019	3,336
4160 VOLT BUS 2C, 2D, COMMON B, E3 & E4	.9004	3,746
480 VOLT UNIT SUBSTATION E7	.8882	426
480 VOLT UNIT SUBSTATION 2E	.8965	430
480 VOLT UNIT SUBSTATION 2F	.8924	428
480 VOLT UNIT SUBSTATION E8	.8863	425
480 VOLT UNIT SUBSTATION 2SY	.9123	438
480 VOLT UNIT SUBSTATION COMMON D	.9046	434
480 VOLT UNIT SUBSTATION 2L	.891	428
480 VOLT UNIT SUBSTATION 4L	.9036	434
4000V REACTOR RECIRC. PUMP MG SET MOTOR TERMINALS	.8231	3,292

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

CIRCULATING WATER PUMP 2B MOTOR STARTING
(Fig. No. A13)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.95	218,500
4160 VOLT BUS 2B	.9348	3,889
4160 VOLT BUS 2C, 2D, COMMON B, E3 & E4	.8642	3,595
480 VOLT UNIT SUBSTATION E7	.847	407
480 VOLT UNIT SUBSTATION 2E	.8559	411
480 VOLT UNIT SUBSTATION 2F	.8515	409
480 VOLT UNIT SUBSTATION E8	.845	406
480 VOLT UNIT SUBSTATION 2SY	.8747	420
480 VOLT UNIT SUBSTATION COMMON D	.8667	416
480 VOLT UNIT SUBSTATION 2L	.8544	419
480 VOLT UNIT SUBSTATION 4L	.8656	415
4000V CIRCULATING WATER PUMP MOTOR 2B	.8721	3,488

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

SCREEN WASH PUMP 2A STARTING
(Fig. No. A14)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.9727	223,711
4160 VOLT BUS 2B	.9623	4,003
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9319	3,877
480 VOLT UNIT SUBSTATION E7	.8807	423
480 VOLT UNIT SUBSTATION 2E	.8318	399
480 VOLT UNIT SUBSTATION 2F	.9279	445
480 VOLT UNIT SUBSTATION E8	.9221	443
480 VOLT UNIT SUBSTATION 2SY	.9451	454
480 VOLT UNIT SUBSTATION COMMON D	.9377	450
480 VOLT UNIT SUBSTATION 2L	.9229	443
480 VOLT UNIT SUBSTATION 4L	.9367	450
480 VOLT MOTOR CONTROL CENTER 2PA	.8299	398
460V SCREEN WASH PUMP 2A	.8502	391

NOTE: BASE VOLTAGES ARE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

TURBINE BUILDING CLOSED COOLING WATER PUMP 2A MOTOR STARTING
(Fig. No. A15)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	.95	218,500
4160 VOLT BUS 2B	.9379	3,902
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9061	3,769
480 VOLT UNIT SUBSTATION E7	.8947	429
480 VOLT UNIT SUBSTATION 2E	.8579	412
480 VOLT UNIT SUBSTATION 2F	.8989	431
480 VOLT UNIT SUBSTATION E8	.8928	429
480 VOLT UNIT SUBSTATION 2SY	.9182	441
480 VOLT UNIT SUBSTATION COMMON D	.9106	437
480 VOLT UNIT SUBSTATION 2L	.8968	430
480 VOLT UNIT SUBSTATION 4L	.9096	437
480 VOLT MOTOR CONTROL CENTER 2TJ	.8265	397
460V TURBINE BUILDING CLOSED COOLING WATER PUMP 2A	.8498	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

TURBINE BUILDING CLOSED COOLING WATER PUMP 2B START
(Fig. No. A16)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	.9623	221,329
4160 VOLT BUS 2B	.9511	3,957
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.92	3,827
480 VOLT UNIT SUBSTATION E7	.9104	437
480 VOLT UNIT SUBSTATION 2E	.9185	441
480 VOLT UNIT SUBSTATION 2F	.8684	417
480 VOLT UNIT SUBSTATION E8	.9085	436
480 VOLT UNIT SUBSTATION 2SY	.9326	448
480 VOLT UNIT SUBSTATION COMMON D	.9252	440
480 VOLT UNIT SUBSTATION 2L	.9108	437
480 VOLT UNIT SUBSTATION 4L	.9242	444
480 VOLT MOTOR CONTROL CENTER 2TH	.8382	402
460 V TURBINE BUILDING CLOSED COOLING WATER PUMP 2B	.8501	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

SCREEN WASH PUMP 2B STARTING
(Fig. No. A17)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	.9638	221,674
4160 VOLT BUS 2B	.9527	3,963
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9222	3,836
480 VOLT UNIT SUBSTATION E7	.9126	438
480 VOLT UNIT SUBSTATION 2E	.9207	442
480 VOLT UNIT SUBSTATION 2F	.9167	440
480 VOLT UNIT SUBSTATION 2SY	.8679	417
480 VOLT UNIT SUBSTATION COMMON D	.9347	449
480 VOLT UNIT SUBSTATION 2L	.9273	445
480 VOLT UNIT SUBSTATION 4L	.9263	445
480 VOLT MOTOR CONTROL CENTER 2PB	.8319	399
460 V SCREEN WASH PUMP 2B	.8501	391

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

LOCA START

(Fig. No. A18)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.9115	209,645
4160 VOLT BUS 2B	.9218	3,835
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.7577	3,152
480 VOLT UNIT SUBSTATION E7	.7457	358
480 VOLT UNIT SUBSTATION 2E	.7151	343
480 VOLT UNIT SUBSTATION 2F	.7079	340
480 VOLT UNIT SUBSTATION E8	.7366	354
480 VOLT UNIT SUBSTATION 2SY	.7603	365
480 VOLT UNIT SUBSTATION COMMON D	.7485	359
480 VOLT UNIT SUBSTATION 2L	.7419	356
480 VOLT UNIT SUBSTATION 4L	.7468	358
4000 VOLT CORE SPRAY PUMP 2A	.7735	3,094
4000 VOLT RHR PUMP 2A	.7807	3,123
4000 VOLT CORE SPRAY PUMP 2B	.7705	3,082
4000 VOLT RHR PUMP 2B	.7777	3,111

NOTE: BASE VOLTAGES FOR ALL LOADS ARE THE RATED VOLTAGES SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

LOCA RUN
(Fig. No. A19)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.9291	213,693
4160 VOLT BUS 2B	.9478	3,943
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.8843	3,679
480 VOLT UNIT SUBSTATION E7	.8876	426
480 VOLT UNIT SUBSTATION 2E	.8637	415
480 VOLT UNIT SUBSTATION 2F	.8582	412
480 VOLT UNIT SUBSTATION E8	.8804	423
480 VOLT UNIT SUBSTATION 2SY	.8927	428
480 VOLT UNIT SUBSTATION COMMON D	.8828	424
480 VOLT UNIT SUBSTATION 2L	.8711	418
480 VOLT UNIT SUBSTATION 4L	.8814	423

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

LOCA

REACTOR BUILDING CLOSED COOLING WATER PUMPS STARTING
(Fig. No. A20)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.9509	218,707
4160 VOLT BUS 2B	.97	4,035
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9049	3,764
480 VOLT UNIT SUBSTATION E7	.8776	421
480 VOLT UNIT SUBSTATION 2E	.8873	426
480 VOLT UNIT SUBSTATION 2F	.882	423
480 VOLT UNIT SUBSTATION E8	.9035	434
480 VOLT UNIT SUBSTATION 2SY	.9142	439
480 VOLT UNIT SUBSTATION COMMON D	.9045	434
480 VOLT UNIT SUBSTATION 2L	.8921	428
480 VOLT UNIT SUBSTATION 4L	.9032	434
480 VOLT MOTOR CONTROL CENTER 2XE	.8267	397
460V REACTOR BUILDING CLOSED COOLING WATER PUMP 2A	.8501	391
460V REACTOR BUILDING CLOSED COOLING WATER PUMP 2C	.8535	393

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

2X LOCA START
(Fig. No. A21)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.9593	220,639
4160 VOLT BUS 2B	.9673	4,024
4160 VOLT BUS 2C, 2D, E3, E4, & COMMON B	.758	3,153
480 VOLT UNIT SUBSTATION E7	.7459	358
480 VOLT UNIT SUBSTATION 2E	.7154	343
480 VOLT UNIT SUBSTATION 2F	.7082	340
480 VOLT UNIT SUBSTATION E8	.7368	354
480 VOLT UNIT SUBSTATION 2SY	.7605	365
480 VOLT UNIT SUBSTATION COMMON D	.7487	359
480 VOLT UNIT SUBSTATION 2L	.7421	356
480 VOLT UNIT SUBSTATION 4L	.7471	359
4000 VOLT CORE SPRAY PUMP 2A	.7737	3,095
4000 VOLT RHR PUMP 1A	.7798	3,119
4000 VOLT RHR PUMP 2A	.7809	3,124
4000 VOLT CORE SPRAY PUMP 2B	.7708	3,083
4000 VOLT RHR PUMP 1B	.7811	3,124
4000 VOLT RHR PUMP 2B	.7709	3,084

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

2X LOCA RUN
(Fig. No. A22)

BUS NAMES	MINIMUM VOLTAGE	
	PER UNIT VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	.9351	215,073
4160 VOLT BUS 2B	.9534	3,966
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.8843	3,679
480 VOLT UNIT SUBSTATION E7	.8876	426
480 VOLT UNIT SUBSTATION 2E	.8636	415
480 VOLT UNIT SUBSTATION 2F	.8581	412
480 VOLT UNIT SUBSTATION E8	.8803	423
480 VOLT UNIT SUBSTATION 2SY	.8926	428
480 VOLT UNIT SUBSTATION COMMON D	.8827	424
480 VOLT UNIT SUBSTATION 2L	.871	418
480 VOLT UNIT SUBSTATION 4L	.8814	423

NOTE: ALL VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

VOLTAGE DROP STUDY

APPENDIX A

SAT

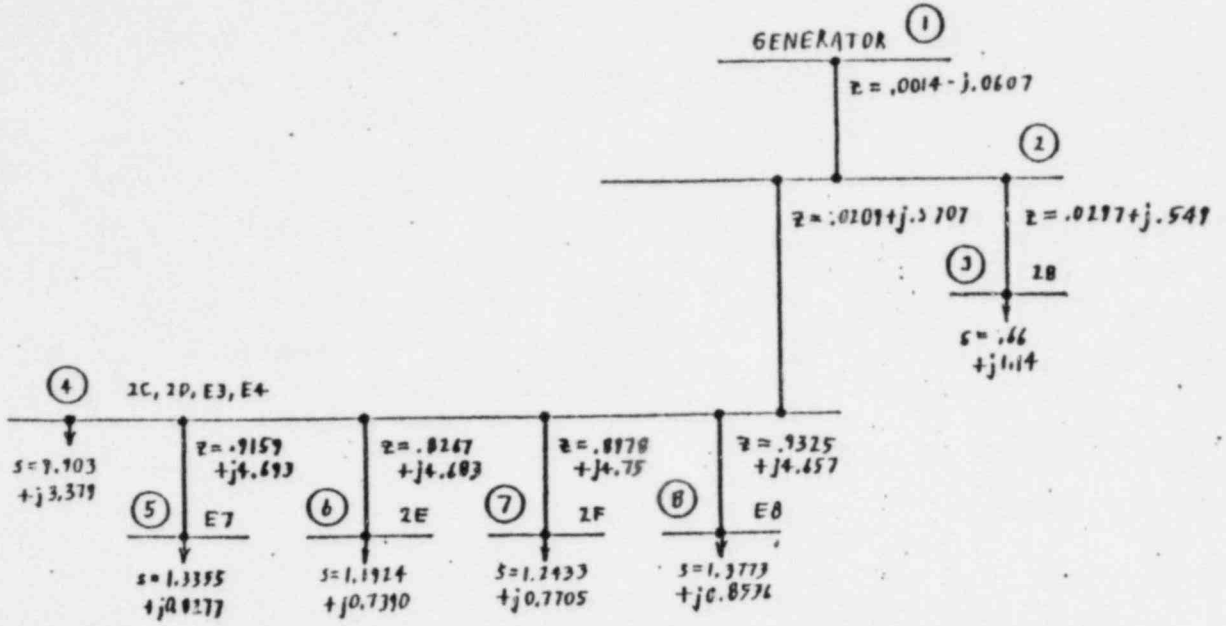
2X LOCA

REACTOR BUILDING CLOSED COOLING WATER PUMPS 2A AND 2C START

(Fig. No. A23)

BUS NAMES	MINIMUM VOLTAGE PER UNIT VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	.955	219,650
4160 VOLT BUS 2B	.9739	4,051
4160 VOLT BUS 2C, 2D, E3, E4 & COMMON B	.9048	3,764
480 VOLT UNIT SUBSTATION E7	.8775	421
480 VOLT UNIT SUBSTATION 2E	.8872	426
480 VOLT UNIT SUBSTATION 2F	.8819	423
480 VOLT UNIT SUBSTATION E8	.9033	434
480 VOLT UNIT SUBSTATION 2SY	.9141	439
480 VOLT UNIT SUBSTATION COMMON D	.9044	434
480 VOLT UNIT SUBSTATION 2L	.892	428
480 VOLT UNIT SUBSTATION 4L	.9031	433
480 VOLT MOTOR CONTROL CENTER 2XE	.8266	397
460V REACTOR BUILDING CLOSED COOLING WATER PUMP 2A	.85	391
460V REACTOR BUILDING CLOSED COOLING WATER PUMP 2C	.8534	393

NOTE: ALL LOAD VOLTAGES ARE ON THE BASE VOLTAGE SHOWN IN THE LEFT HAND COLUMN.

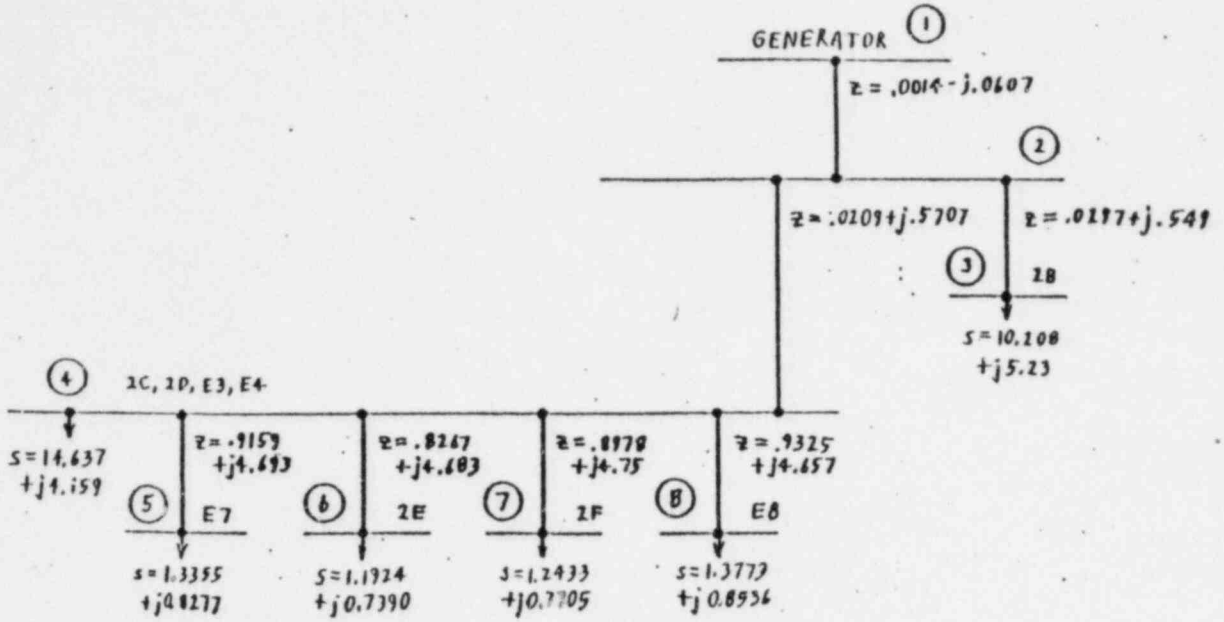


UAT IMPEDANCE DIAGRAM
LIGHT LOAD

PLIGHTU

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

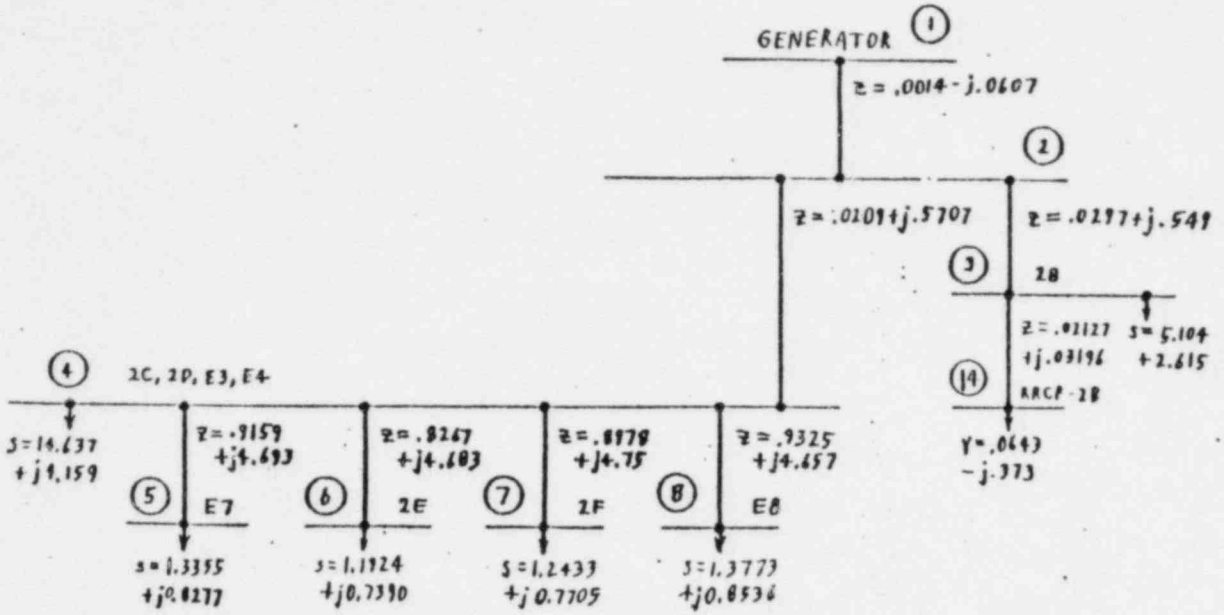
FIG. A1



UAT IMPEDANCE DIAGRAM
FULL LOAD

[FULL]/2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

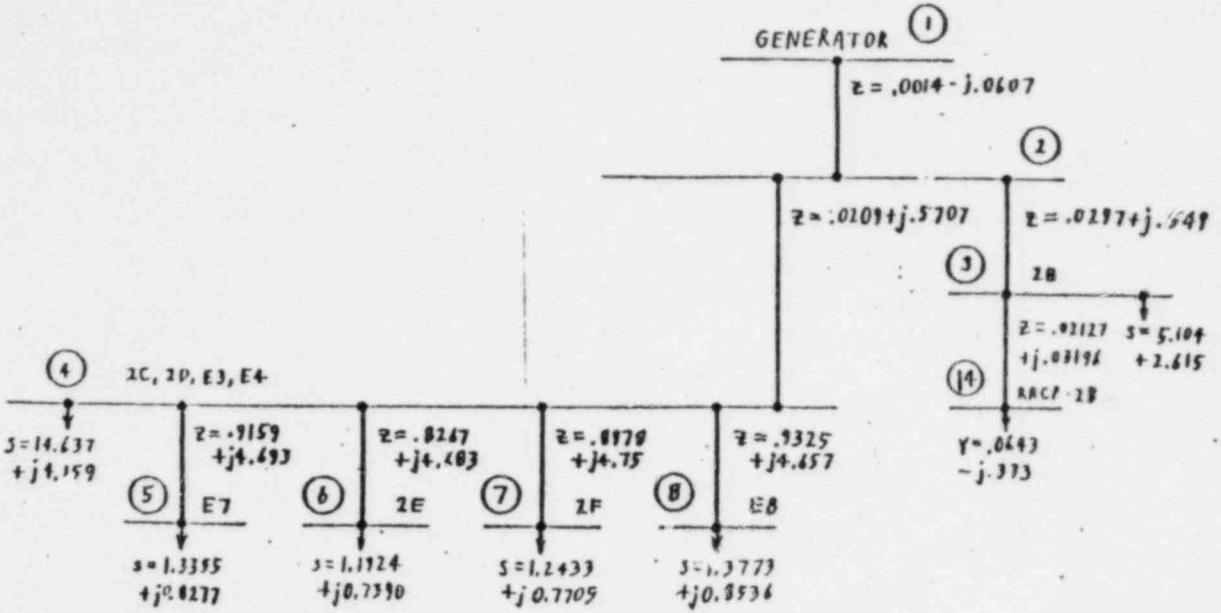
FIG. A2



UAT IMPEDANCE DIAGRAM
REACTOR RECIRC. PUMP MG SET 2B
MOTOR STARTING

DRR PSUG
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

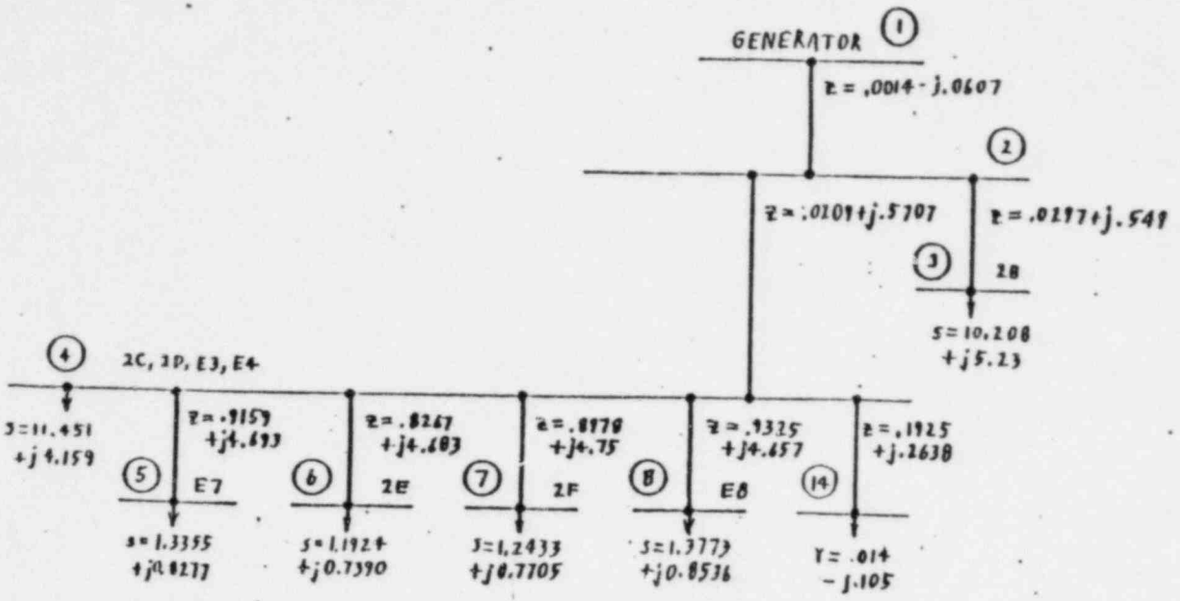
FIG. A3



UAT IMPEDANCE DIAGRAM
REACTOR RECIRC. PUMP MG SET 2B
MOTOR STARTING

PRRPSUQ
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

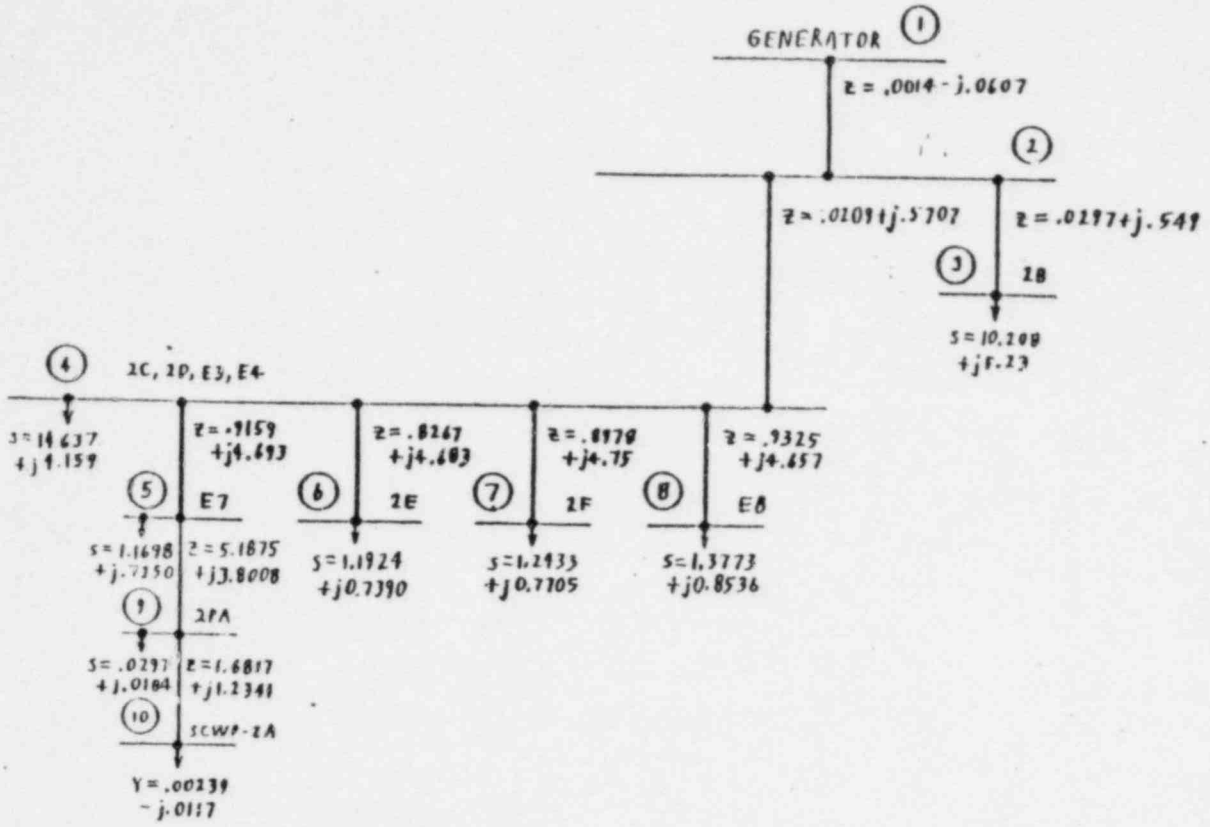
FIG. A3



UAT IMPEDANCE DIAGRAM
CIRCULATING WATER PUMP
STARTING

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

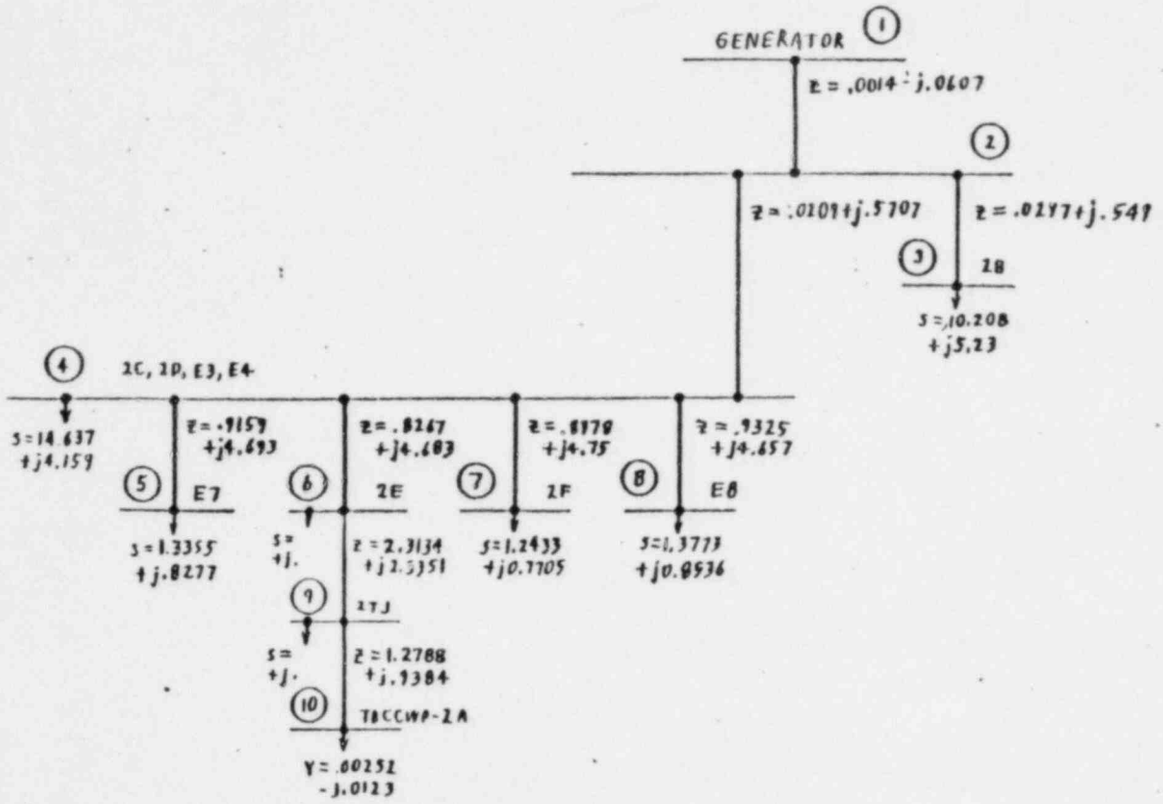
FIG. A4



UAT IMPEDANCE DIAGRAM
SCREEN WASH PUMP 2A
STARTING

ESSAEU
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A5

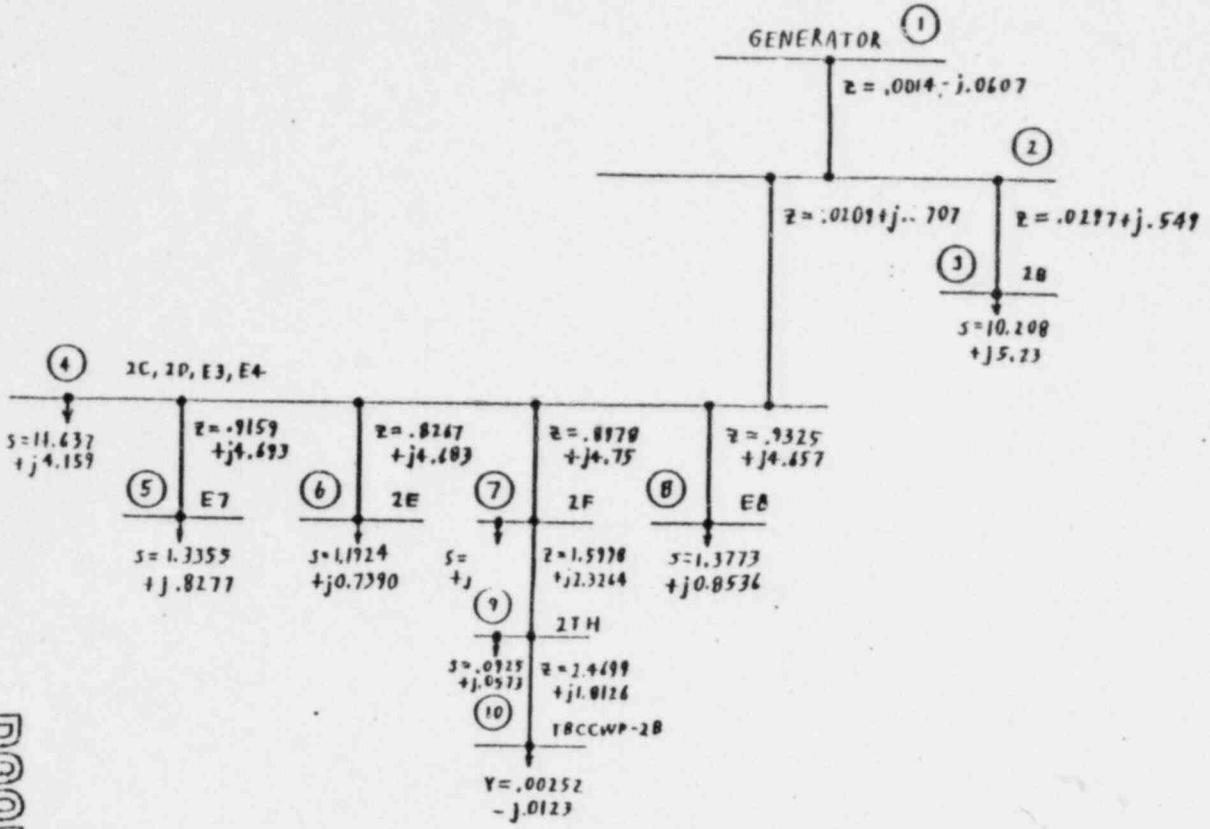


UAT IMPEDANCE DIAGRAM
TURBINE BLDG. CLOSED COOLING
WATER PUMP 2A STARTING

PLWASU

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A6

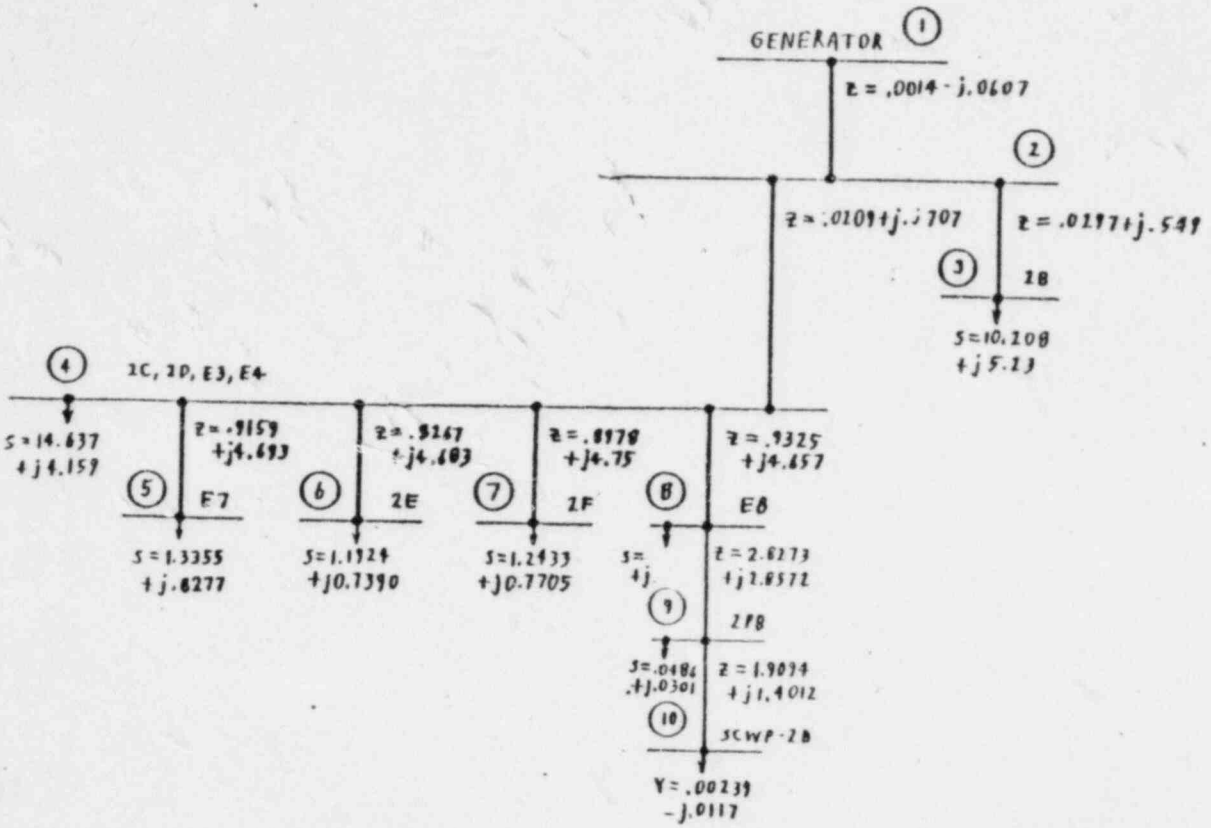


UAT IMPEDANCE DIAGRAM
TURBINE BLDG. CLOSED COOLING
WATER PUMP 2B STARTING

DIC:WFS11

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

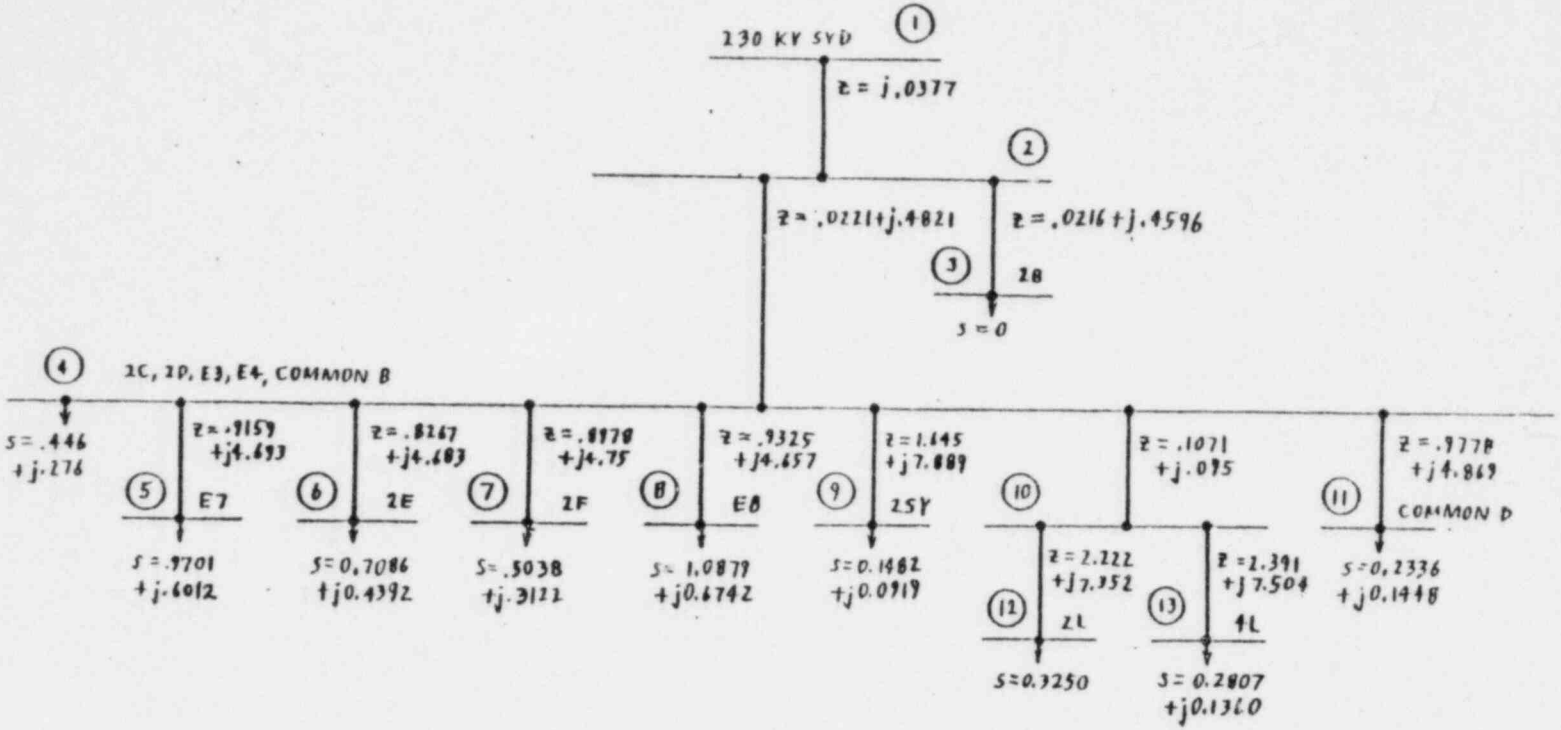
FIG. A7



UAT IMPEDANCE DIAGRAM
SCREEN WASH PUMP 2B
STARTING

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A8

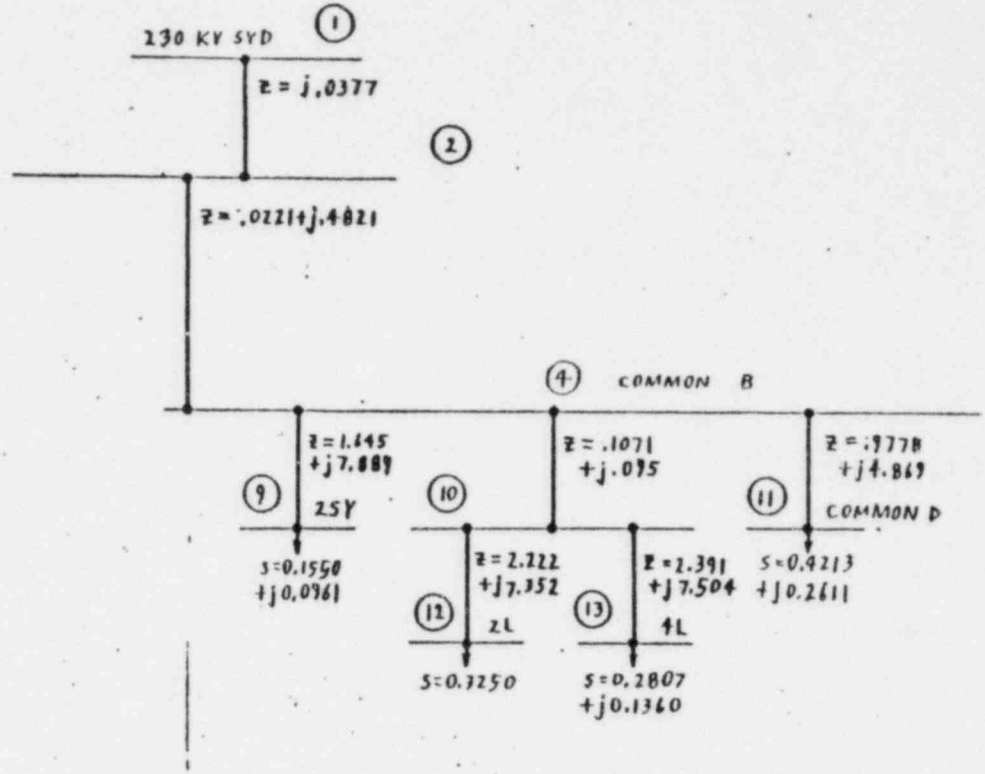


SAT IMPEDANCE DIAGRAM
SHUTDOWN

PLIGHTO

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

FIG. A9

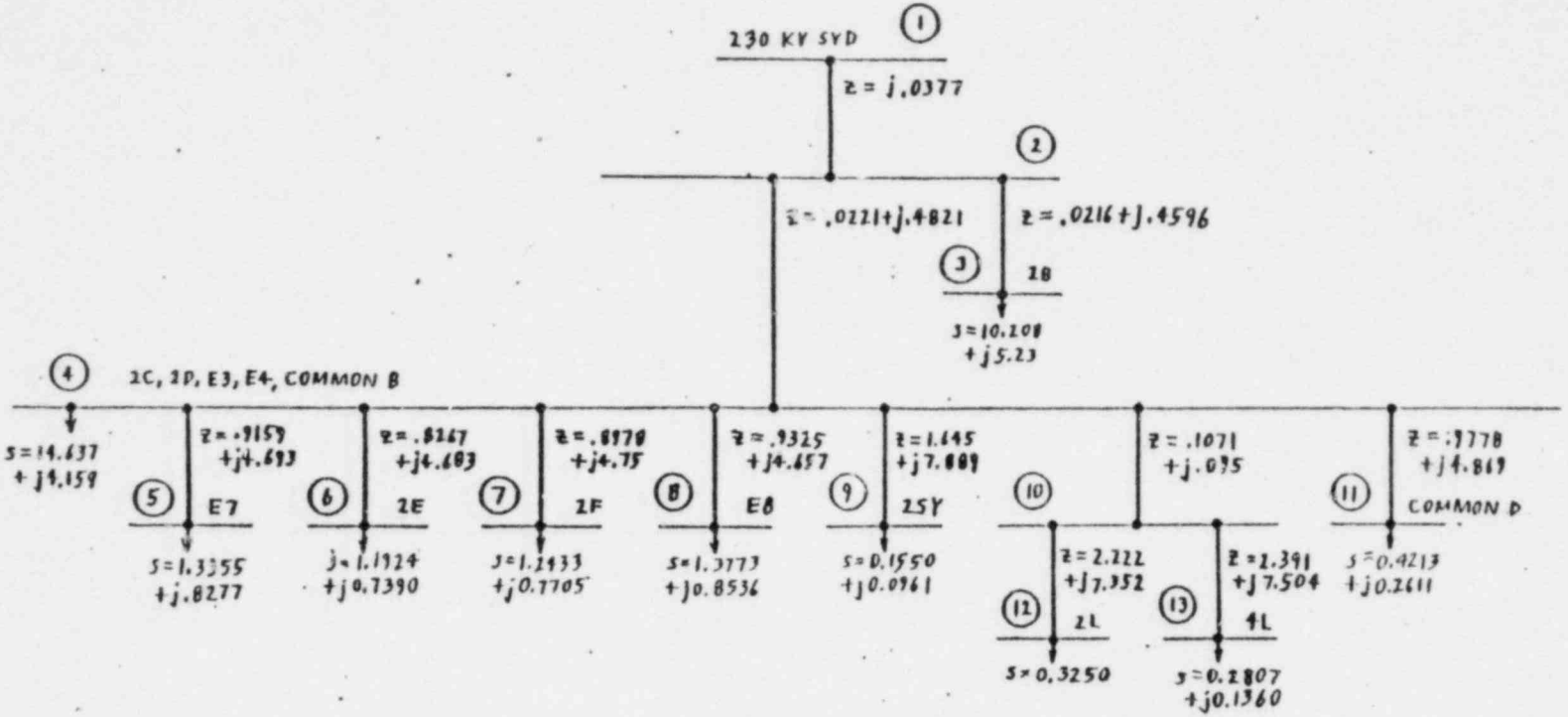


SAT IMPEDANCE DIAGRAM

UNIT LOADS FED FROM UAT

DSATFIG2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

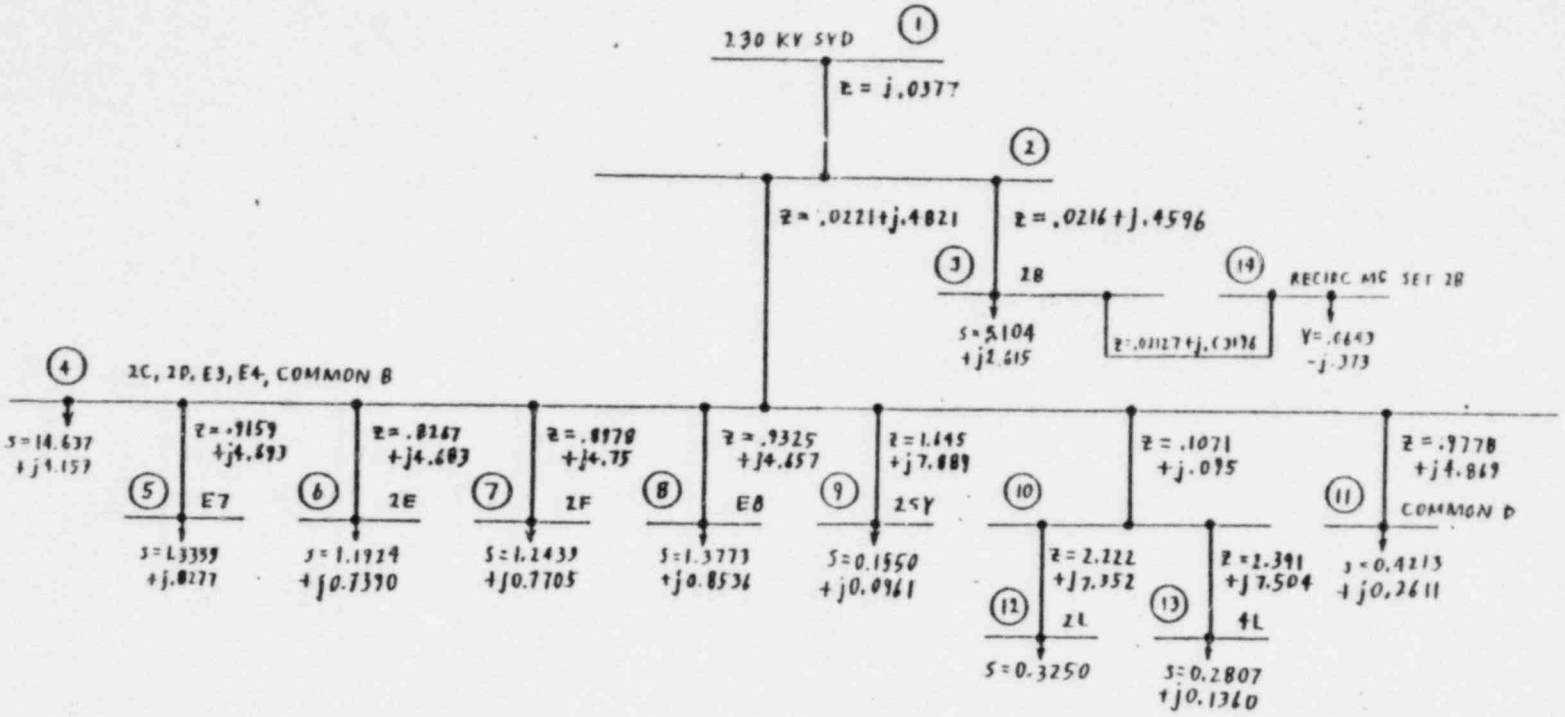
FIG. A10



SAT IMPEDANCE DIAGRAM
FULL LOAD

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

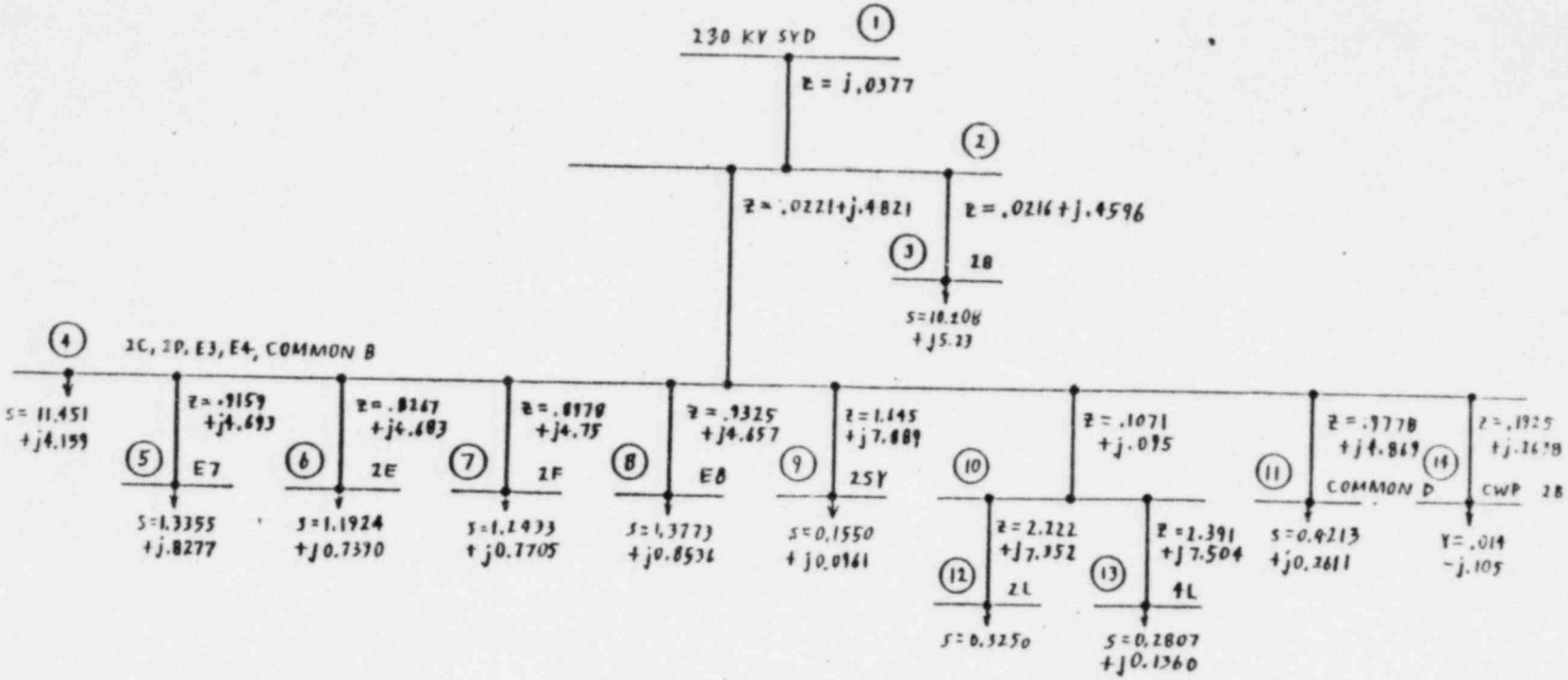
FIG. A11



SAT IMPEDANCE DIAGRAM
REACTOR RECIRC. PUMP MG SET 2B
MOTOR STARTING

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

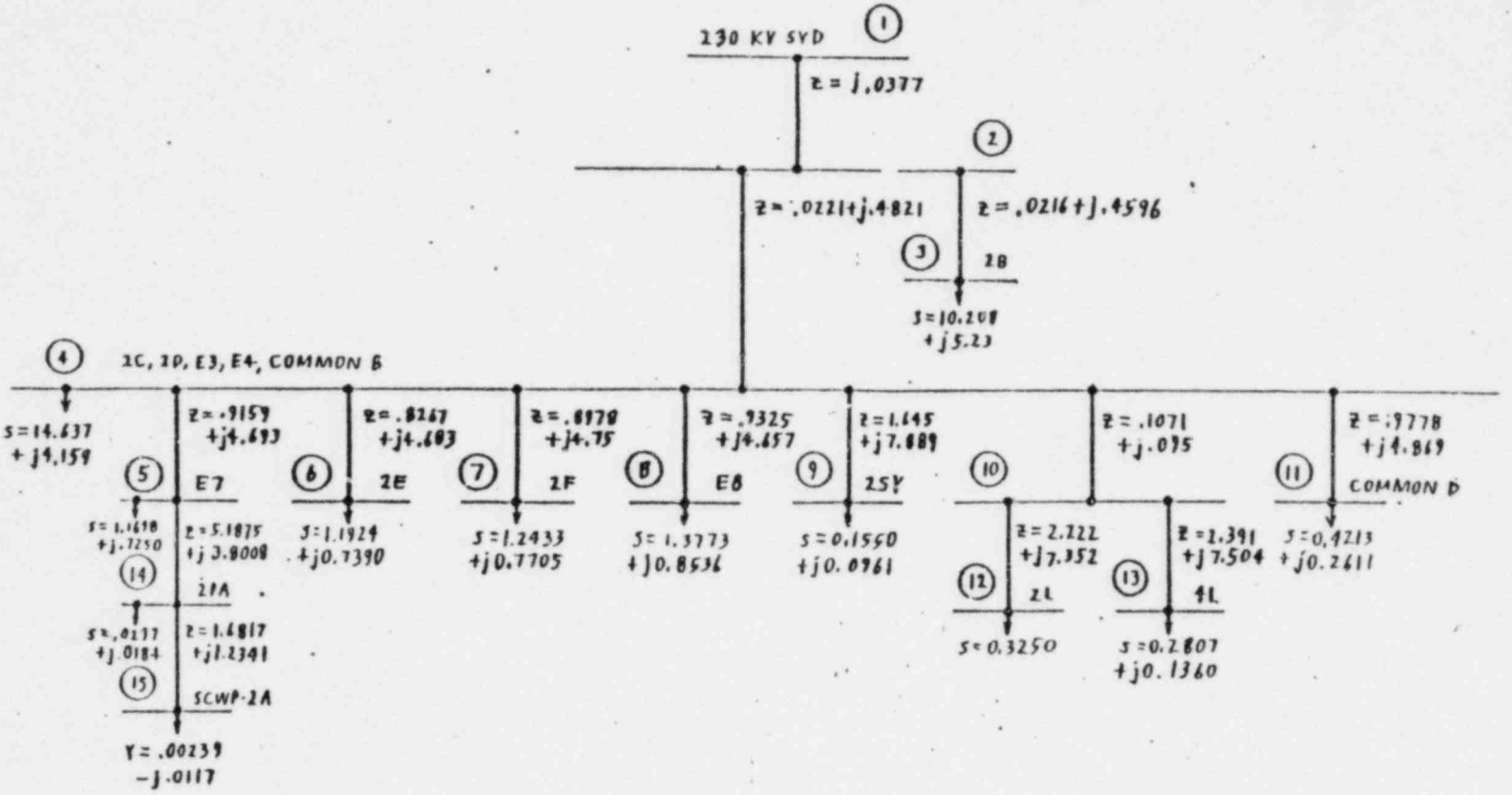
FIG. A12



SAT IMPEDANCE DIAGRAM
CIRCULATING WATER PUMP 2B MOTOR
STARTING

CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A13

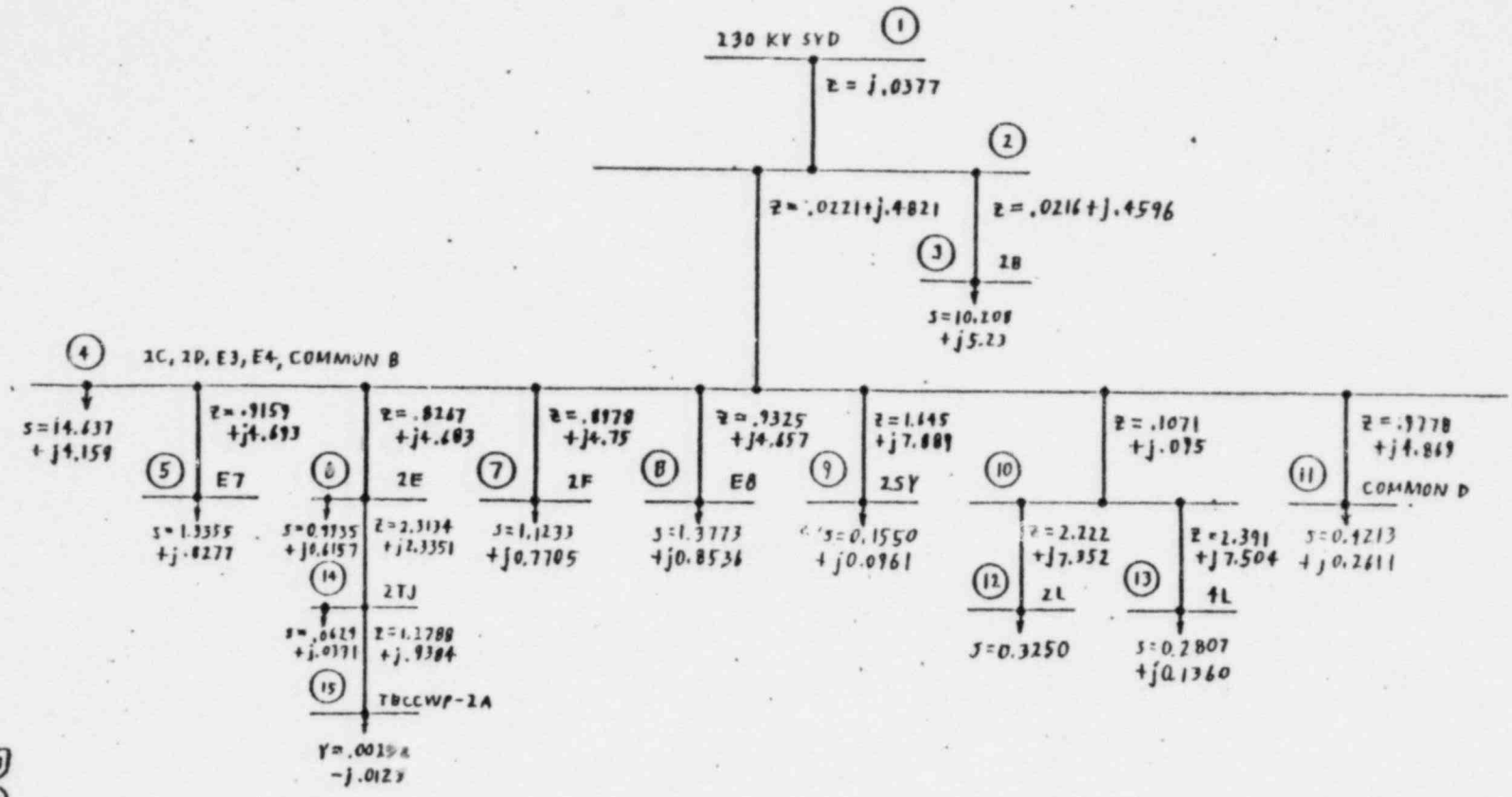


POOR ORIGINAL

SAT IMPEDANCE DIAGRAM
SCREEN WASH PUMP 2A
STARTING

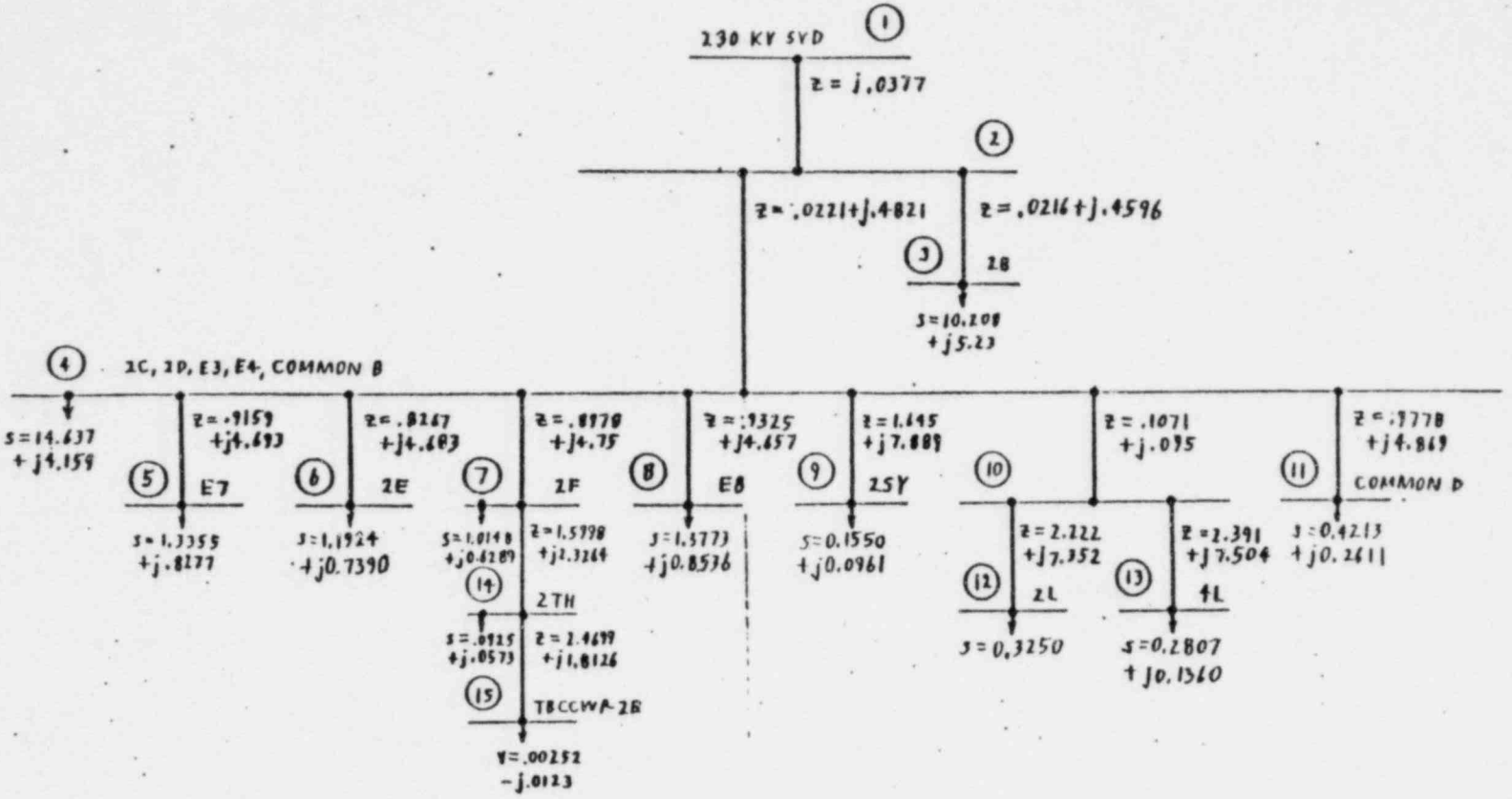
DSW/PASQ2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A14



SAT IMPEDANCE DIAGRAM
TURBINE BLDG. CLOSED COOLING
WATER PUMP 2A MOTOR STARTING

PTCWASG2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2
FIG. A15

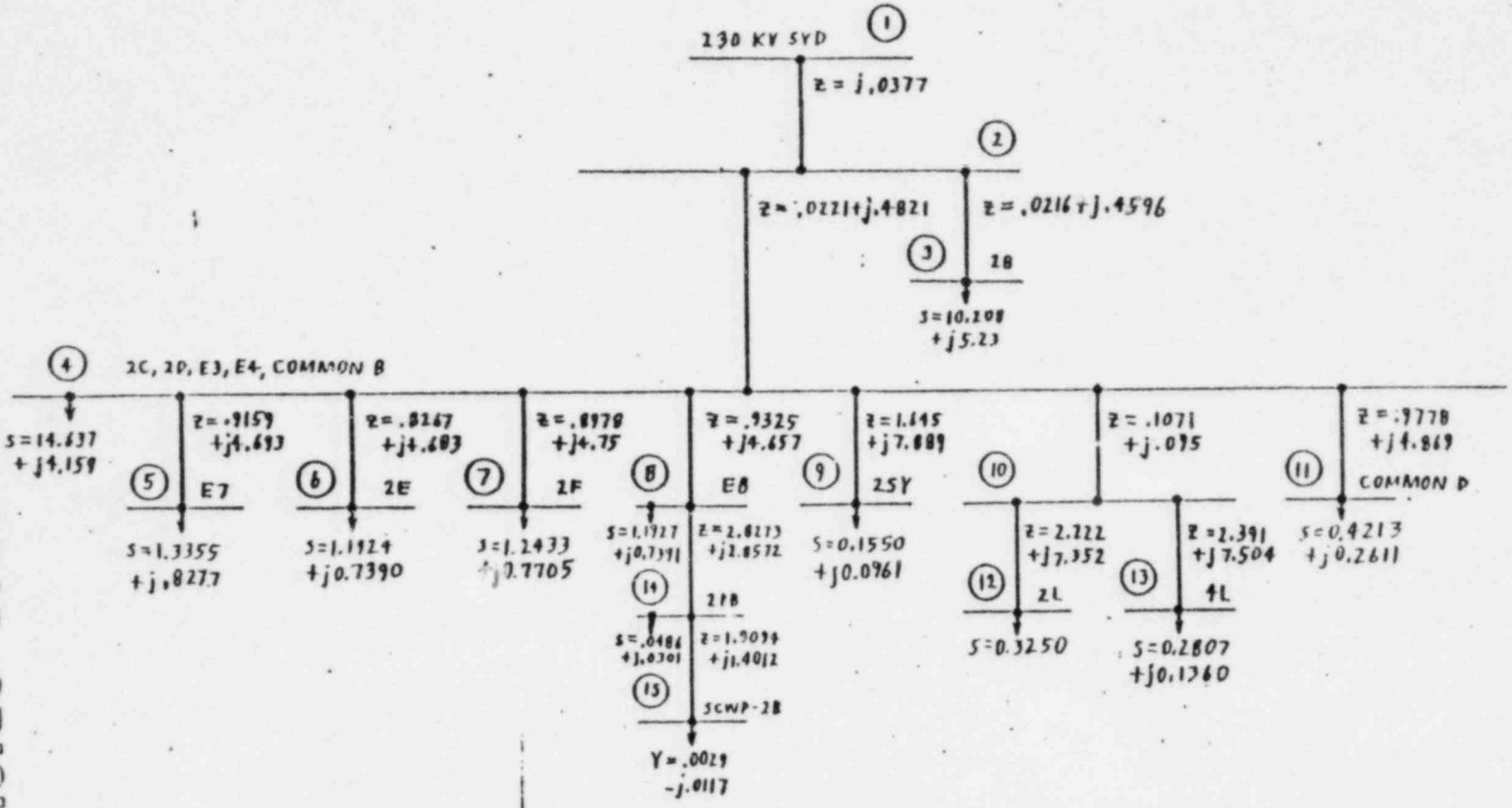


POOR ORIGINAL

SAT IMPEDANCE DIAGRAM
TURBINE BLDG. CLOSED COOLING
WATER PUMP 2B STARTING

PTCWB3Q2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

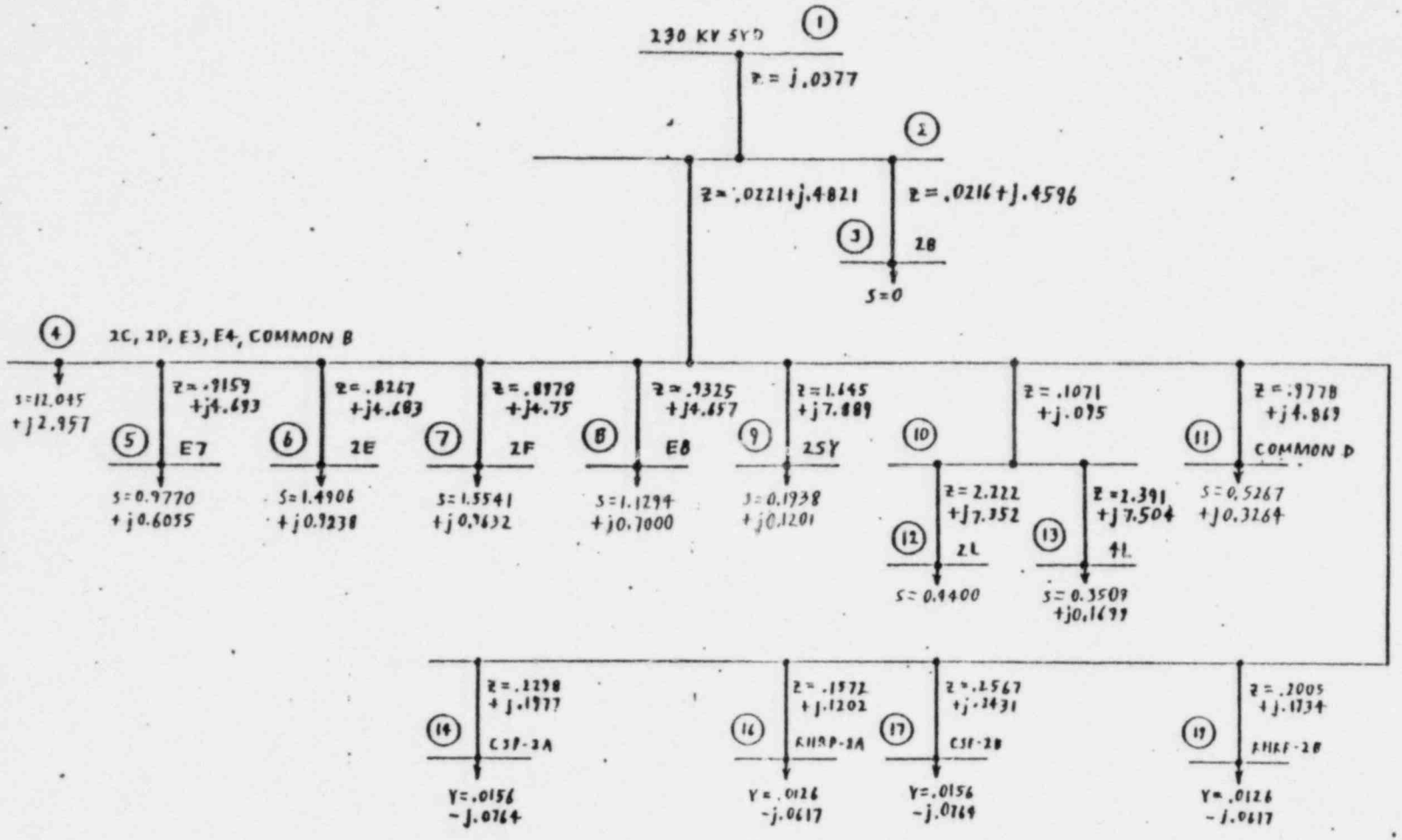
FIG. A16



SAT IMPEDANCE DIAGRAM
SCREEN WASH PUMP 2B
STARTING

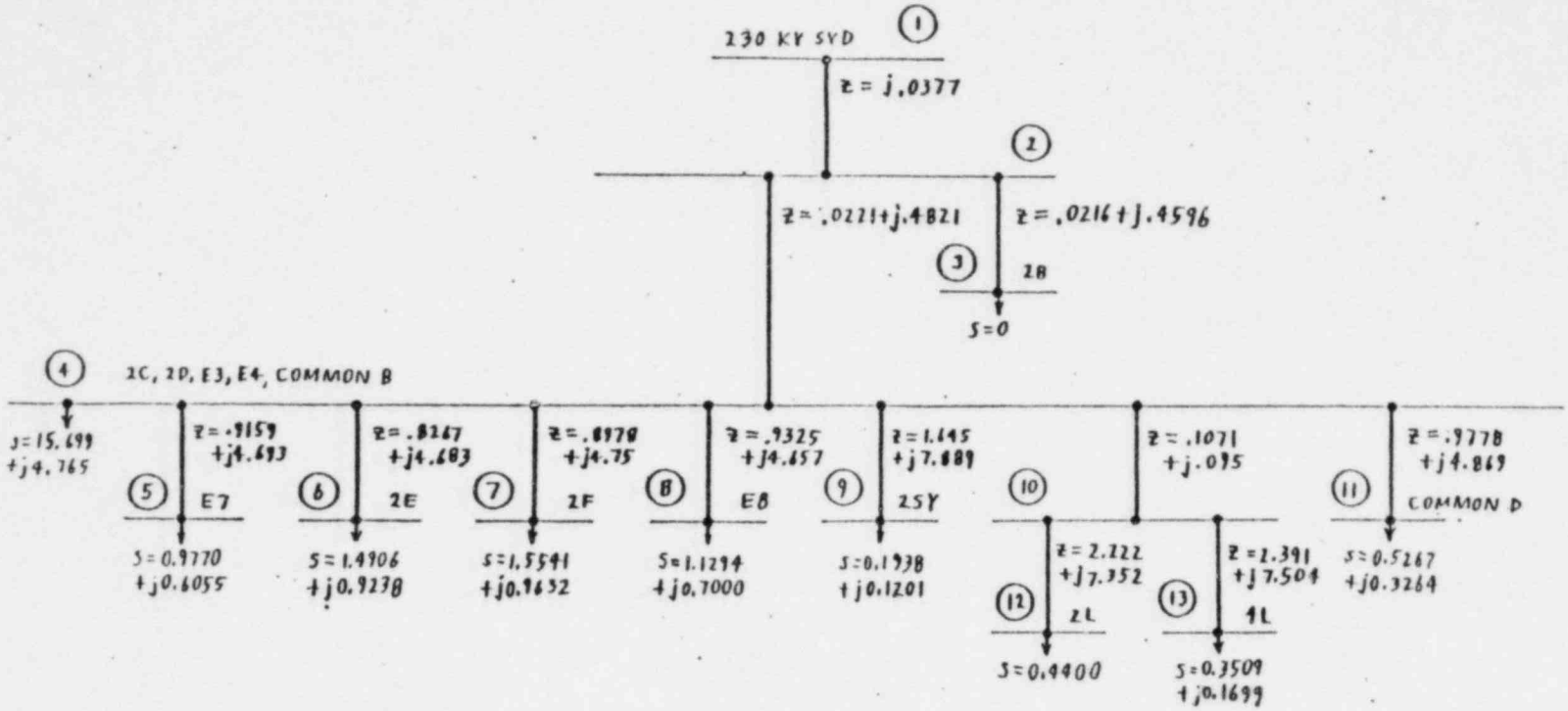
DSW/PBJQ2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2

FIG. A17



SAT IMPEDANCE DIAGRAM
LOCA START

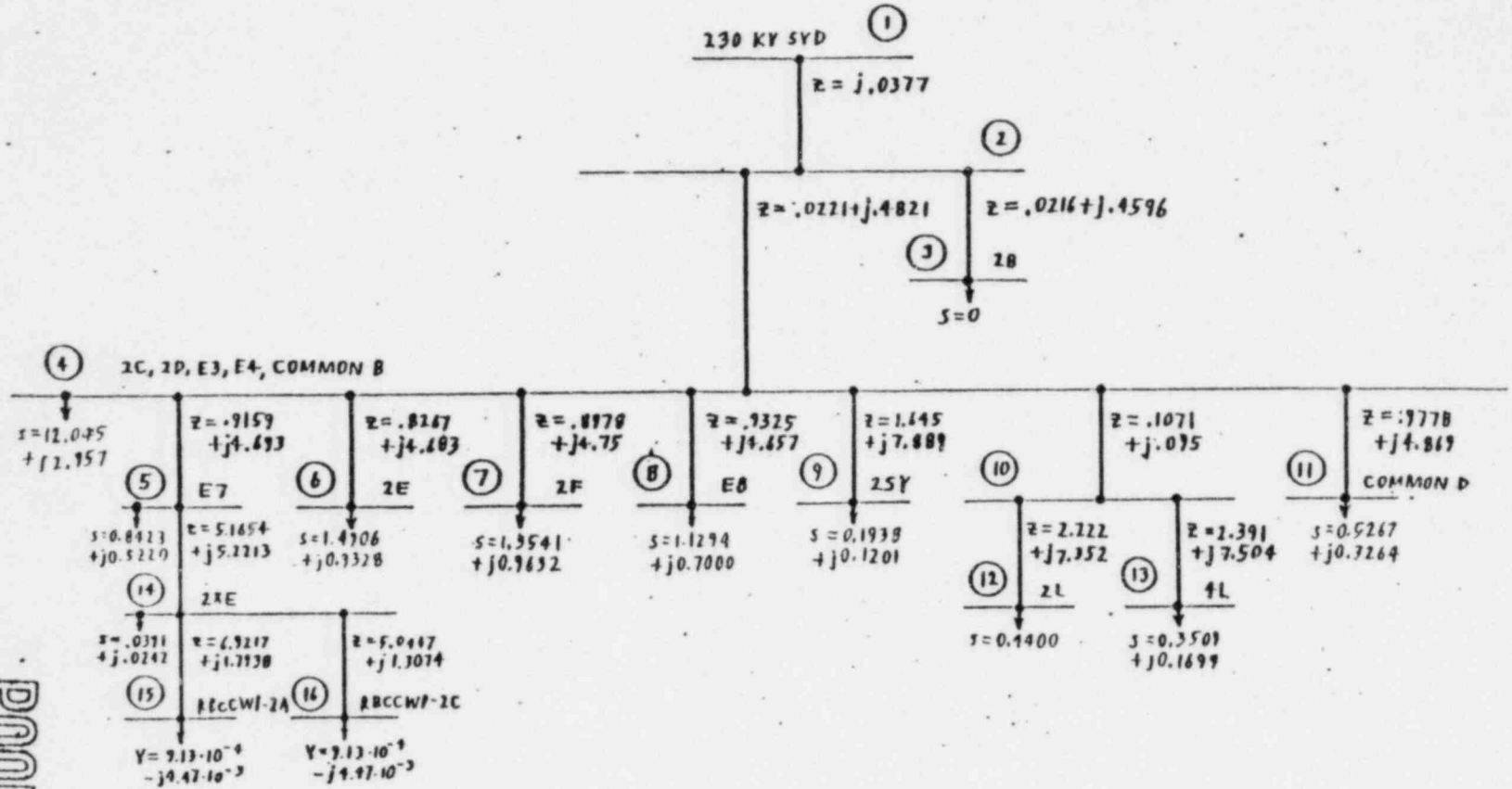
PLCASO2
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2
FIG. A18



SAT IMPEDANCE DIAGRAM
LOCA RUN

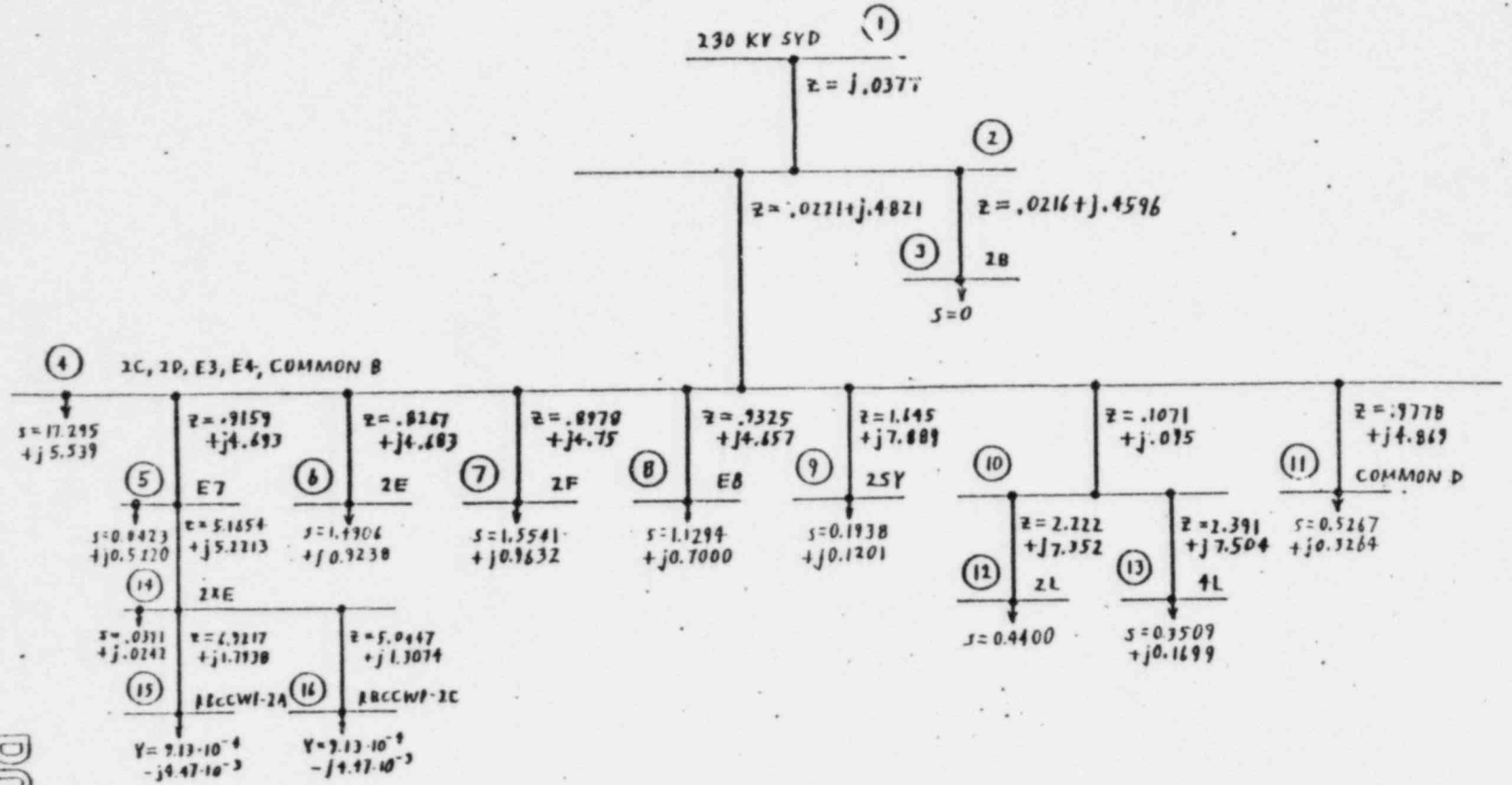
LOCA C2
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2

FIG. A19



SAT IMPEDANCE DIAGRAM
LOCA
REACTOR BLDG. CLOSED COOLING WATER
PUMPS STARTING

DRPPASM2
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2
FIG. A20



SAT IMPEDANCE DIAGRAM
2X LOCA
REACTOR BLDG CLOSED COOLING WATER
PUMPS 2A & 2C START

DEBPAS12
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2
FIG. A23

APPENDIX B

VOLTAGE DROP STUDY

FOR

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNIT NO. 2

BY

UNITED ENGINEERS & CONSTRUCTORS INC.

VOLTAGES

AND

IMPEDANCE DIAGRAMS

4160 VOLT BUSES COMMON B &

COMMON A TIE BREAKER CLOSED

VOLTAGE DROP STUDY

APPENDIX B

GENERAL NOTES

1. The choice of source voltages to be studied was made as follows: The VOLTS runs of 4160V Buses Common A & Common B Tie Breaker Closed were made for the worst cases of minimum Switchyard Voltage based on the previous studies with the tie breaker open (Appendix A). Both the normal operating conditions and accident conditions were considered for the VOLTS runs. The worst case Switchyard Voltage for the normal operating condition is SAT, Screen Wash Pump 2A Starting (Full Load). The worst case Switchyard Voltage for the accident condition is SAT, 2X LOCA Start (Full Load).
2. Impedance input data for the VOLTS runs duplicated the input data utilized in Appendix A VOLTS runs. Load input data for the VOLTS runs was the same as input data in Appendix A with the exception of the 4160 Volt Bus Loads. These loads were increased to reflect the additional loads from 4160 Volt Bus Common A.
3. The Switchyard input voltage to the VOLTS run was then increased to compensate for the additional load. The resulting Switchyard Voltages meet the criteria established in 3.2.

VOLTAGE DROP STUDY

APPENDIX B

SAT

SCREEN WASH PUMP 2A STARTING
(Fig. No. B1)

BUS NAMES	MINIMUM VOLTAGE P. U. VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHARD	0.9809	225,607
4160 VOLT BUS 2B	0.9703	4,037
4160 VOLT BUS 2C, 2D, E3, E4.COMMON B, COMMON A	0.9326	3,880
480 VOLT UNIT SUBSTATION E7	0.8815	423
480 VOLT UNIT SUBSTATION 2E	0.9326	448
480 VOLT UNIT SUBSTATION 2F	0.9288	446
480 VOLT UNIT SUBSTATION E8	0.9228	443
480 VOLT UNIT SUBSTATION 2SY	0.9457	454
480 VOLT UNIT SUBSTATION COMMON D	0.93884	450
480 VOLT UNIT SUBSTATION 2L	0.9236	443
480 VOLT UNIT SUBSTATION 4L	0.9374	450
480 VOLT MOTOR CONTROL CENTER 2PA	0.8307	399
460 VOLT SCREEN WASH PUMP 2A	0.8510	391

NOTE: P. U. VOLTAGES ARE BASED ON BASE VOLTAGE SHOWN IN LEFT-HAND COLUMN

VOLTAGE DROP STUDY

APPENDIX B

SAT

2X LOCA START
(Fig. No. B2)

BUS NAMES	MINIMUM VOLTAGE P. U. VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHARD	0.9720	223,560
4160 VOLT BUS 2B	0.9793	4,074
4160 VOLT BUS 2C, 2D, E3, E4, COMMON B, COMMON A	0.7582	3,154
480 VOLT UNIT SUBSTATION E7	0.7462	358
480 VOLT UNIT SUBSTATION 2E	0.7157	344
480 VOLT UNIT SUBSTATION 2F	0.7086	340
480 VOLT UNIT SUBSTATION E8	0.7372	354
480 VOLT UNIT SUBSTATION 2SY	0.7608	365
480 VOLT UNIT SUBSTATION COMMON D	0.7490	360
480 VOLT UNIT SUBSTATION 2L	0.7424	356
480 VOLT UNIT SUBSTATION 4L	0.7474	359
4000 VOLT CORE SPRAY PUMP 2A	0.7740	3,096
4000 VOLT RHR PUMP 1A	0.7801	3,120
4000 VOLT RHR PUMP 2A	0.7812	3,125
4000 VOLT CORE SPRAY PUMP 2B	0.7711	3,084
4000 VOLT RHR PUMP 1B	0.7814	3,125
4000 VOLT RHR PUMP 2B	0.7782	3,113

NOTE: P. U. VOLTAGES ARE BASED ON BASE VOLTAGES SHOWN IN LEFT-HAND COLUMN

VOLTAGE DROP STUDY

APPENDIX B

SAT

2X LOCA RUN
(Fig No. B3)

BUS NAMES	MINIMUM VOLTAGE P. U. VOLTAGE	ACTUAL VOLTAGE
230 KV SWITCHYARD	0.9460	217,580
4160 VOLT BUS 2B	0.9637	4,009
4160 VOLT BUS 2C, 2D, E3, E4, COMMON B, COMMON A	0.8848	3,681
480 VOLT UNIT SUBSTATION E7	0.8881	426
480 VOLT UNIT SUBSTATION 2E	0.8642	415
480 VOLT UNIT SUBSTATION 2F	0.8587	412
480 VOLT UNIT SUBSTATION E8	0.8809	423
480 VOLT UNIT SUBSTATION 2SY	0.8931	429
480 VOLT UNIT SUBSTATION COMMON D	0.8833	424
480 VOLT UNIT SUBSTATION 2L	0.8716	418
480 VOLT UNIT SUBSTATION 4L	0.8819	423

NOTE: P. U. VOLTAGES ARE BASED ON BASE VOLTAGES SHOWN IN LEFT-HAND COLUMN

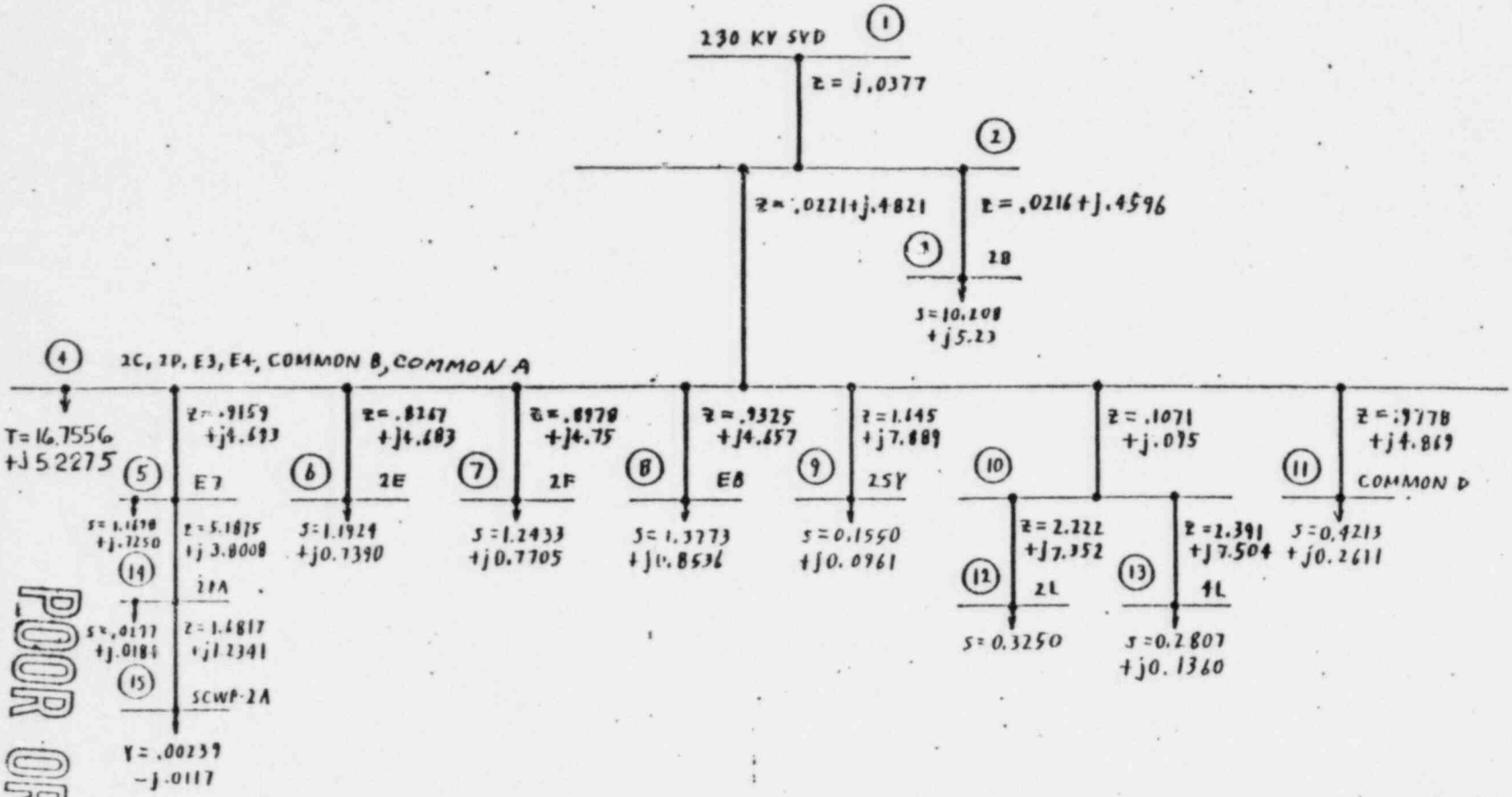
VOLTAGE DROP STUDY

APPENDIX B
SAT
2X LOCA
(Fig. No. B4)

REACTOR BUILDING CLOSED COOLING WATER PUMPS 2A AND 2C START

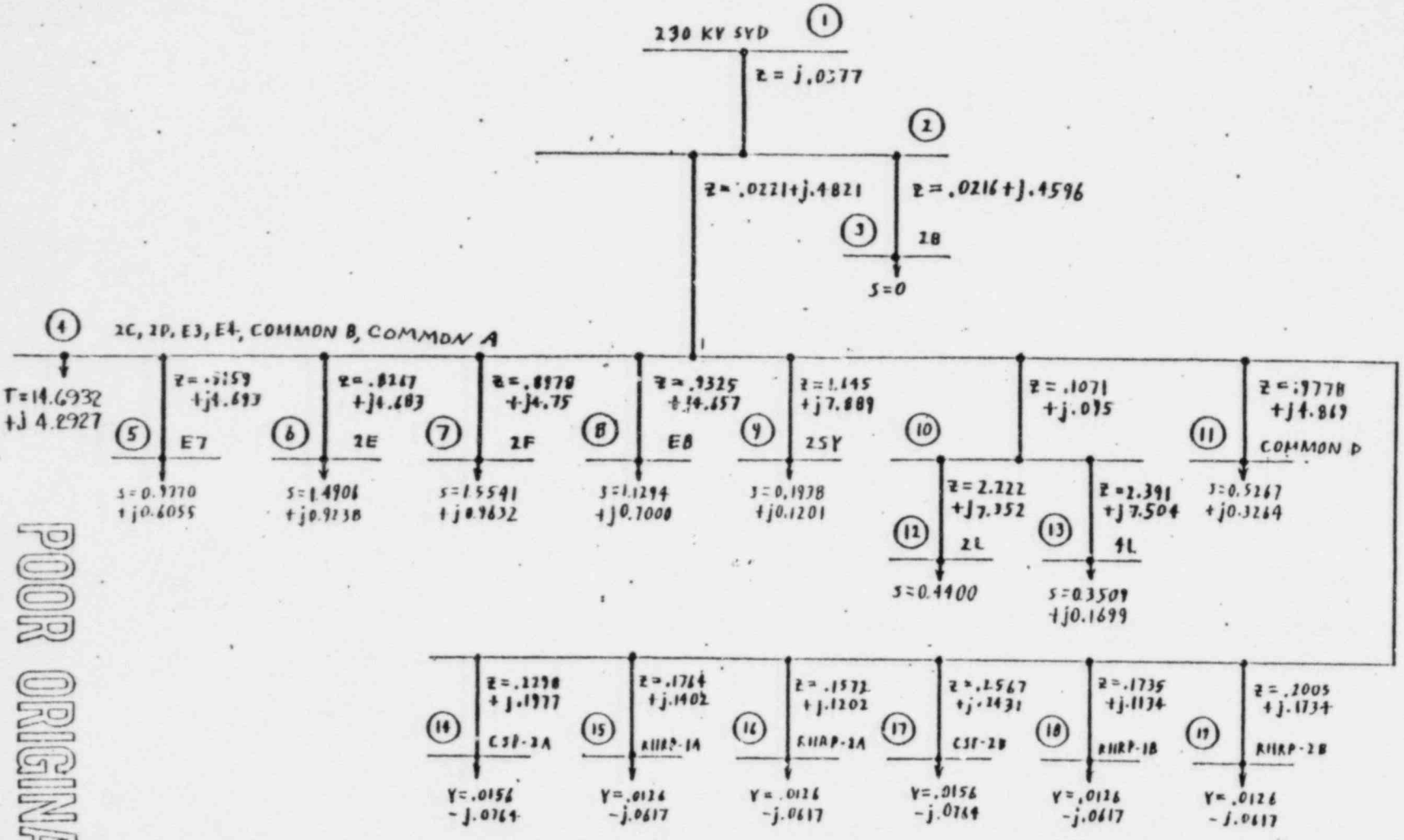
BUS NAMES	MINIMUM VOLTAGE P. U. VOLTAGE	MINIMUM VOLTAGE ACTUAL VOLTAGE
230 KV SWITCHYARD	0.9670	222,410
4160 VOLT BUS 2B	0.9852	4,099
4160 VOLT BUS 2C, 2D, E3, E4, COMMON B, COMMON A	0.9050	3,765
480 VOLT UNIT SUBSTATION E7	0.8775	421
480 VOLT UNIT SUBSTATION 2E	0.8875	426
480 VOLT UNIT SUBSTATION 2F	0.8821	423
480 VOLT UNIT SUBSTATION E8	0.9036	434
480 VOLT UNIT SUBSTATION 2SY	0.9143	439
480 VOLT UNIT SUBSTATION COMMON D	0.9047	434
480 VOLT UNIT SUBSTATION 2L	0.8922	428
480 VOLT UNIT SUBSTATION 4L	0.9033	434
480 VOLT MOTOR CONTROL CENTER 2XE	0.8265	397
460 VOLT REACTOR BUILDING CLOSED COOLING WATER PUMP 2A	0.8499	391
460 VOLT REACTOR BUILDING CLOSED COOLING WATER PUMP 2C	0.8533	393

NOTE: P. U. VOLTAGES ARE BASED ON BASE VOLTAGES SHOWN IN LEFT-HAND COLUMN



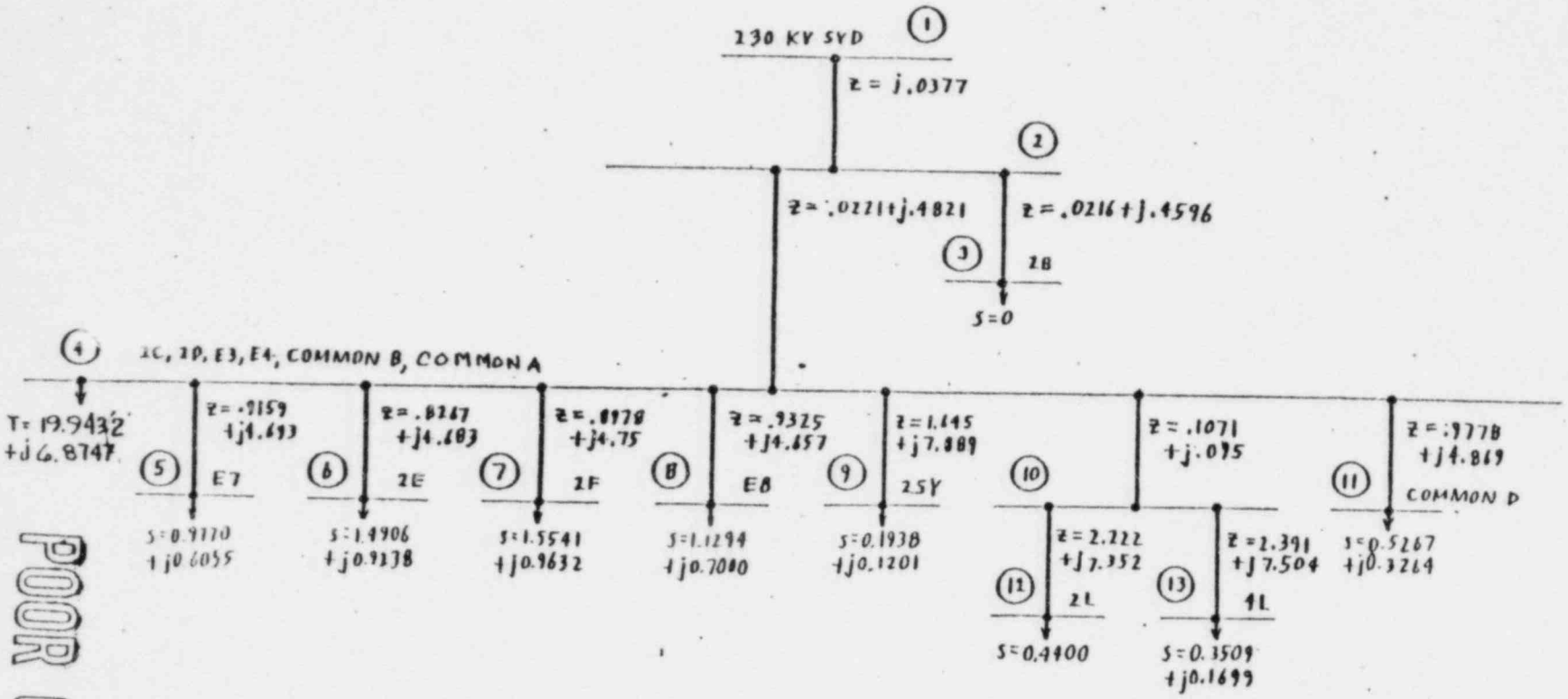
SAT IMPEDANCE DIAGRAM
SCREEN WASH PUMP 2A
STARTING

DSOUI
CAROLINA POWER
& LIGHT COMPANY
BRUNSWICK STEAM
ELECTRIC PLANT
UNIT NO. 2
FIG. B1



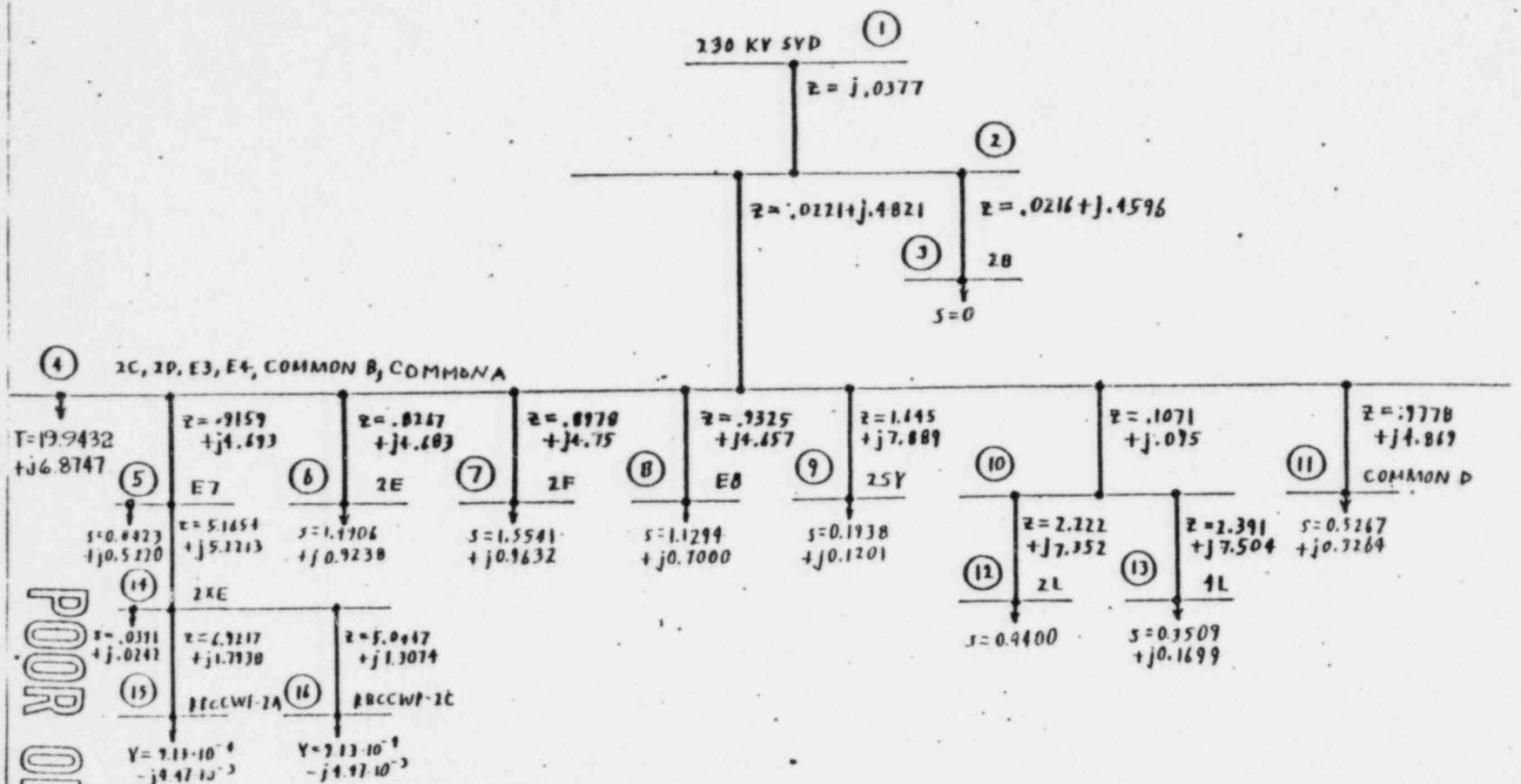
SAT IMPEDANCE DIAGRAM
2X LOCA START

DS002
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2
FIG. B2



SAT IMPEDANCE DIAGRAM
2X LOCA RUN

DSOU3
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2
FIG. B3.



SAT IMPEDANCE DIAGRAM
2X LOCA
REACTOR BLDG CLOSED COOLING WATER
PUMPS 2A & 2C START

DS004
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNIT NO. 2
FIG. B-4

APPENDIX C

VOLTAGE DROP STUDY

FOR

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNIT NO. 2

BY

UNITED ENGINEERS & CONSTRUCTORS INC.

LOADS

Form 5015 Rev. 11/74

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-5-E-1
FINAL	
VOID	
SHEET C2 OF	
J.O. 9527-032	

REV	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S 1 & 2

SUBJECT VOLTAGE DROP STUDY

4160V RUNNING LOADS

NOTE: UNIT SUBSTATION LOADS ARE NOT INCLUDED IN THE BUS LOADS

LOAD CONDITION		BUS 2B	2C	2D	E3	E4	COMMON B	X=2D+E3+E4+B TOTAL
LIGHT (SAT)	MW	0	0	0	0	.446	0	.446
	MVAR	0	0	0	0	.276	0	.276
LIGHT (UAT)	MW	.66	2.889	5.815	.599	.6	0	9.903
	MVAR	1.14	.601	2.067	.356	.355	0	3.379
FULL	MW	10.208	5.462	7.976	.599	.6	0	14.637
	MVAR	5.23	1.075	2.373	.356	.355	0	4.159
LOCAS	MW	0	4.166	6.68	.599	.6	0	12.045
	MVAR	0	.474	1.772	.356	.355	0	2.957
LOCAR	MW	0	4.166	6.68	2.238	2.615	0	15.699
	MVAR	0	.474	1.772	1.151	1.368	0	4.765
2LOCAS	MW	0	4.166	6.68	.599	.6	0	12.045
	MVAR	0	.474	1.772	.356	.355	0	2.957
2LOCAR	MW	0	4.166	6.68	3.036	3.413	0	17.295
	MVAR	0	.474	1.772	1.538	1.755	0	5.539

Form 5015 Rev. 11/74

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-5-E-1
FINAL	
VOID	
SHEET C 3 OF	
J.O. 9527-032	

REV.	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S 2

SUBJECT VOLTAGE DROP STUDY

BOP MOTOR STARTING CASES
4160V RUNNING LOADS

STARTING MOTOR		2B	2C	2D	E3	E4	COMMON B	2C+2D+E3+E4 +CD TOTAL
CIRC	MW	10.208	5.462	4.790	.579	.600	0	11.451
WATER	MVAR	5.230	1.075	2.373	.356	.355	0	4.159
PUMP	FED FROM			X				
2B	CABLE R			.1925				
	X			.2638				
	MOTOR G			.014				
	B			.105				
REACTOR	MW	5.104	5.462	7.976	.599	.600	0	14.637
RECIRC	MVAR	2.615	1.075	2.373	.356	.355	0	4.159
PUMP	FED FROM	X						
2B	CABLE R	.02127						
	X	.03196						
	MOTOR G	.0643						
	B	.373						

Form 5015 Rev. 11/74

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-S-E-1
FINAL	
VOID	
SHEET C4 OF	
J.O. 9527-032	

REV	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S 1&2

SUBJECT VOLTAGE DROP STUDY

MOTOR	RATED VOLTAGE V	HORSEPOWER	LOCKED-ROTOR CURRENT A	LOCKED-ROTOR POWER FACTOR	PER-UNIT ADMITTANCE COND.	PER-UNIT ADMITTANCE SUSC.
REACTOR RECIRC MG SET FP-5353	4000	7000	$5.05 \cdot 10^3$	.17	$6.43 \cdot 10^{-2}$	$3.73 \cdot 10^{-1}$
CIRC. WATER PUMP ☆	4000	2250	$1.408 \cdot 10^3$	.133	$1.40 \cdot 10^{-2}$	$1.05 \cdot 10^{-1}$
CORE SPRAY PUMP FP-5687	4000	1250	$1.04 \cdot 10^3$	.2	$1.56 \cdot 10^{-2}$	$2.69 \cdot 10^{-2}$
RHR PUMP FP-5727	4000	1000	$8.40 \cdot 10^2$	.2	$1.26 \cdot 10^{-2}$	$6.17 \cdot 10^{-2}$
NUCLEAR S.W. PUMP FP-3102	4000	300	$2.42 \cdot 10^2$	.3	$5.43 \cdot 10^{-3}$	$1.73 \cdot 10^{-2}$
FIRE PUMP FP-4164	4000	250	$1.82 \cdot 10^2$	.3*	$4.09 \cdot 10^{-3}$	$1.30 \cdot 10^{-2}$
SCREEN WASH PUMP FP-3647	460	200	$1.38 \cdot 10^3$	.2*	$2.39 \cdot 10^{-3}$	$1.17 \cdot 10^{-2}$
TURB. BLDG. CCW PUMP FP-3552	460	200	$1.45 \cdot 10^3$	.2*	$2.52 \cdot 10^{-3}$	$1.23 \cdot 10^{-2}$
BACKWASH AIR BLOWER	460	150	$1.23 \cdot 10^3$†	.2*	$2.12 \cdot 10^{-3}$	$1.04 \cdot 10^{-2}$
REACT. BLDG. CCW PUMP	460	75	$5.26 \cdot 10^2$≠	.2*	$9.13 \cdot 10^{-4}$	$4.47 \cdot 10^{-3}$

☆ CHARACTERISTICS FROM PORTEC DATA SHEET: 89% REVERSE ROTATION

* ESTIMATED

† ESTIMATED BASED ON 1KVA PER HORSEPOWER RUNNING, STARTING CURRENT = 6.5 x RUNNING CURRENT.

≠ SEE SH. 8 10.1

Form 5015 Rev. 11/74

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-S-E-1
FINAL	
VOID	
SHEET C5 OF	
J.O. 9527-032	

REV.	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S 1 & 2

SUBJECT VOLTAGE DROP STUDY

REACTOR BUILDING CLOSED COOLING WATER PUMP STARTING

LOCKED ROTOR CODE LETTER
F : 5.0 - 5.59 KVA/HP.

USING 5.59 KVA/HP,

$$I_{LR} = \frac{5.59 \cdot 75 \cdot 1000}{\sqrt{3} \cdot 460} = 526 \text{ A}$$

Form 5015 Rev. 11/74

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-S-E-1
FINAL	
VOID	
SHEET C 6 OF	
J.O. 9527-032	

REV	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S 2

SUBJECT VOLTAGE DROP STUDY

460V MOTOR STARTING DATA

UNIT SUBSTATION	LARGEST MOTOR MCC	MOTOR	HP	CABLE NO.	LENGTH	TYPE
2E	2TJ	TCC-2A	200	MF1-NGØ	73	3/C 350 MCM
2F	2TH	TCC-2C	200	D17-NG2	141	3/C 350 MCM
E7	2PA	SCW-2A	200	EØ2-NK6	96	3/C350 MCM
E8	2PB	SCW-2B	200	E42-NK7	109	3/C350 MCM
COMMON D	RWB	2-CFD-D063	150	BG5-P42	77	3/C #4Ø

UNIT SUBSTATION	MCC	MOTOR G	MOTOR B	CABLE R	CABLE X	MOTOR FP
2E	2TJ	.00252	.0123	1.2788	.9384	3552
2F	2TH	.00252	.0123	2.4699	1.8126	3552
E7	2PA	.00239	.0117	1.6817	1.2341	3647
E8	2PB	.00239	.0117	1.9094	1.4012	3647
COMMON D	RWB	.00212	.0104	2.2020	.9929	DATA ESTIMATED

Form 5015 Rev. 11/74

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	9527-032-S-E-1
FINAL	
VOID	
SHEET C 7 OF	
J.O. 9527-032	

REV	COMP. BY	CHK'D BY
0	DATE	DATE
	DATE	DATE

NAME OF COMPANY CP&L BRUNSWICK UNIT/S. 2

SUBJECT VOLTAGE DROP STUDY

UNIT SUBSTATION	MCC	MOTOR	HP	CABLE NO.	LENGTH	TYPE
E7	2XE	RBCCWP-2A	75	EA1-NF6	118	4/C #1/0
E7	2XE	RBCCWP-2C	75	EA7-NF8	86	4/C #1/0
E8	2XF	RBCCWP-2B	75	ED7-NF7	356	4/C #1/0

UNIT SUBSTATION		MCC	MOTOR G	MOTOR B	CABLE R	CABLE X
E7	(2A)	2XE	$9.13 \cdot 10^{-4}$	$4.47 \cdot 10^{-3}$	6.9217	1.7938
E7	(2C)	2XE	$9.13 \cdot 10^{-4}$	$4.47 \cdot 10^{-3}$	5.0447	1.3074
E8	(2B)	2XF	$9.13 \cdot 10^{-4}$	$4.47 \cdot 10^{-3}$	20.8826	5.4119

CAROLINA POWER AND LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

UNIT SUBSTATION E7 MOTOR CONTROL CENTERS

FROM BUS	TO BUS	CABLE IMPEDANCES RESISTANCE	REACTANCE
E7	2XA	3.3854	2.4783
E7	2XC	3.3854	2.4783
E7	2XE	5.1654	5.2213
E7	2XG	2.0178	2.1753
E7	2XL	4.9349	4.3954
E7	1XA-2	6.7665	7.0312
E7	1XJ	7.5868	7.6693
E7	2CA	3.2882	3.3229
E7	2PA	5.1875	3.8008
E7	DGC	0.9792	0.5347
E7	2A	7.8950	7.6345

CAROLINA POWER AND LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

UNIT SUBSTATION 2E MOTOR CONTROL CENTERS

FROM BUS	TO BUS	CABLE IMPEDANCES RESISTANCE	REACTANCE
2E	2TA	3.7934	3.8235
2E	2TB	2.6432	2.6736
2E	2TC	2.6432	2.6736
2E	2TF	2.7908	2.8212
2E	2TJ	2.3134	2.3351
2E	2TK	1.6580	2.4088
2E	2TL	1.8403	2.6736
2E	2ETB	6.9314	2.2135

CAROLINA POWER AND LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

UNIT SUBSTATION 2F MOTOR CONTROL CENTERS

FROM BUS	TO BUS	CABLE IMPEDANCES RESISTANCE	REACTANCE
2F	2TD	1.8663	1.3672
2F	2TE	1.8663	1.3672
2F	2TG	1.6823	1.2335
2F	2TH	1.5998	2.3264
2F	2TM	1.1892	1.7318
2F	2TN	3.0859	2.2613
2F	2FTB	0.5925	1.9140

CAROLINA POWER AND LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

UNIT SUBSTATION E8 MOTOR CONTROL CENTERS

FROM BUS	TO BUS	CABLE IMPEDANCES RESISTANCE	REACTANCE
E8	2XB	1.6580	1.2153
E8	2XD	2.6345	2.6649
E8	2XF	8.2031	7.5521
E8	2XH	3.4770	3.9770
E8	2XM	5.8594	4.4835
E8	1XB-2	6.1198	5.9939
E8	1XK	7.0356	7.1137
E8	2PB	2.8273	2.8572
E8	2CB	4.6875	4.7396
E8	DGD	0.6120	0.6163
E8	E11,E12	0.3906	0.1754
E8	2B	13.0599	12.3220

CAROLINA POWER AND LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

UNIT SUBSTATION COMMON D MOTOR CONTROL CENTERS

FROM BUS	TO BUS	CABLE IMPEDANCES RESISTANCE	REACTANCE
COMMON D	RWB	1.7990	1.8181
COMMON D	RWD	4.7613	4.8090
COMMON D	2SA	9.1797	9.2752
COMMON D	CRANE	14.7352	8.0469

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS 2B, FULL LOAD AND ACCIDENT CONDITIONS

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
REACTOR RECIRC PUMP 2A	6520.	6520.	0.8900	0.9530	5.1038	2.6148
REACTOR RECIRC PUMP 2B	6520.	6520.	0.8900	0.9530	5.1038	2.6148
TOTAL					10.2076	5.2295

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS 2B, RECIRC PUMP 2B MOTOR STARTING CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
REACTOR RECIRC PUMP 2A	6520.	6520.	0.8900	0.9530	5.1038	2.6148
REACTOR RECIRC PUMP 2B	0.	6520.	0.8900	0.9530	0.	0.
TOTAL					5.1038	2.6148

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2C LOADS, FULL LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2A	2060.	2250.	1.0000	0.9645	1.5933	0.
CIRCULATING WATER PUMP 2C	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2A	1243.	1250.	0.9000	0.9460	0.9804	0.4749
CONDENSATE BOOSTER PUMP 2C	0.	1250.	0.9000	0.9460	0.	0.
HEATER DRAIN PUMP 2B	0.	1000.	0.8950	0.9260	0.	0.
CONDENSATE PUMP 2B	0.	1000.	0.8800	0.9260	0.	0.
CHILLER 2B-RM-TB	1650.	1650.	0.9070	0.9500	1.2957	0.6016
TOTAL					5.4628	1.0765

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2C LOADS, UAT LIGHT LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2A	0.	2250.	1.0000	0.9645	0.	0.
CIRCULATING WATER PUMP 2C	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2A	0.	1250.	0.9000	0.9460	0.	0.
CONDENSATE BOOSTER PUMP 2C	0.	1250.	0.9000	0.9460	0.	0.
HEATER DRAIN PUMP 2B	0.	1000.	0.8950	0.9260	0.	0.
CONDENSATE PUMP 2B	0.	1000.	0.8800	0.9260	0.	0.
CHILLER 2B-RM-TB	1650.	1650.	0.9070	0.9500	1.2957	0.6016
TOTAL					2.8890	0.6016

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 3L, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.90

MCC	HORSEPOWER	MVA	MW	MVAR
WHA	222.00	0.2220	0.1998	0.0968
1W1	24.38	0.0244	0.0219	0.0106
1W2	28.77	0.0288	0.0259	0.0125
1W2-1	5.60	0.0056	0.0050	0.0024
1W3	30.00	0.0300	0.0270	0.0131
PNLC	159.34	0.1593	0.1434	0.0695
TOTAL	470.	0.4701	0.4231	0.2049

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2C LOADS, ACCIDENT (LOCA AND 2XLOCA) CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2A	2060.	2250.	1.0000	0.9645	1.5933	0.
CIRCULATING WATER PUMP 2C	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2A	1243.	1250.	0.9000	0.9460	0.9804	0.4749
CONDENSATE BOOSTER PUMP 2C	0.	1250.	0.9000	0.9460	0.	0.
HEATER DRAIN PUMP 2B	0.	1000.	0.8950	0.9260	0.	0.
CONDENSATE PUMP 2B	0.	1000.	0.8800	0.9260	0.	0.
CHILLER 2B-RM-TB	0.	1650.	0.9070	0.9500	0.	0.
TOTAL					4.1671	0.4749

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2D LOADS, FULL LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2B	2060.	2250.	1.0000	0.9645	1.5933	0.
CIRCULATING WATER PUMP 2D	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2B	1243.	1250.	0.9000	0.9460	0.9804	0.4749
HEATER DRAIN PUMP 2A	855.	1000.	0.8950	0.9260	0.6888	0.3433
HEATER DRAIN PUMP 2C	855.	1000.	0.8950	0.9260	0.6888	0.3433
CONDENSATE PUMP 2A	705.	1000.	0.8800	0.9260	0.5680	0.3066
CONDENSATE PUMP 2C	705.	1000.	0.8800	0.9260	0.5680	0.3066
CHILLER 2A-RM-TB	1650.	1650.	0.9070	0.9500	1.2957	0.6016
TOTAL					7.9763	2.3762

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2D LOADS, CIRC WATER PUMP 2B START, FULL LOAD

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2B	0.	2250.	1.0000	0.9645	0.	0.
CIRCULATING WATER PUMP 2D	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2B	1243.	1250.	0.9000	0.9460	0.9804	0.4749
HEATER DRAIN PUMP 2A	855.	1000.	0.8950	0.9260	0.6888	0.3433
HEATER DRAIN PUMP 2C	855.	1000.	0.8950	0.9260	0.6888	0.3433
CONDENSATE PUMP 2A	705.	1000.	0.8800	0.9260	0.5680	0.3066
CONDENSATE PUMP 2C	705.	1000.	0.8800	0.9260	0.5680	0.3066
CHILLER 2A-RM-TB	1650.	1650.	0.9070	0.9500	1.2957	0.6016
TOTAL					6.3830	2.3762

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2D LOADS, UAT LIGHT LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2B	0.	2250.	1.0000	0.9645	0.	0.
CIRCULATING WATER PUMP 2D	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2B	1243.	1250.	0.9000	0.9460	0.9804	0.4749
HEATER DRAIN PUMP 2A	855.	1000.	0.8950	0.9260	0.6888	0.3433
HEATER DRAIN PUMP 2C	855.	1000.	0.8950	0.9260	0.6888	0.3433
CONDENSATE PUMP 2A	0.	1000.	0.8800	0.9260	0.	0.
CONDENSATE PUMP 2C	705	1000.	0.8800	0.9260	0.5680	0.3066
CHILLER 2A-RM-TB	1650.	1650.	0.9070	0.9500	1.2957	0.6016
TOTAL					5.8150	2.0696

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

BUS 2D LOADS, ACCIDENT (LOCA AND 2XLOCA) CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CIRCULATING WATER PUMP 2B	2060.	2250.	1.0000	0.9645	1.5933	0.
CIRCULATING WATER PUMP 2D	2060.	2250.	1.0000	0.9645	1.5933	0.
CONDENSATE BOOSTER PUMP 2B	1243.	1250.	0.9000	0.9460	0.9804	0.4749
HEATER DRAIN PUMP 2A	855.	1000.	0.8950	0.9260	0.6888	0.3433
HEATER DRAIN PUMP 2C	855.	1000.	0.8950	0.9260	0.6888	0.3433
CONDENSATE PUMP 2A	705.	1000.	0.8800	0.9260	0.5680	0.3066
CONDENSATE PUMP 2C	705.	1000.	0.8800	0.9260	0.5680	0.3066
CHILLER 2A-RM-TB	0.	1650.	0.9070	0.9500	0.	0.
TOTAL					6.6806	1.7745

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E3 LOADS, NORMAL OPERATING CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2A	0.	1250.	0.9000	0.9400	0.	0.
RHR SERVICE WATER PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
CONTROL ROD DRIVE HYD. PUMP	190.	250.	0.8860	0.9270	0.1529	0.0800
NUCLEAR SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
TOTAL					0.5989	0.3564

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E3 LOADS, SHUTDOWN CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2A	0.	1250.	0.9000	0.9400	0.	0.
RHR SERVICE WATER PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
CONTROL ROD DRIVE HYD. PUMP	0.	250.	0.8860	0.9270	0.	0.
NUCLEAR SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
TOTAL					0.4460	0.2764

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E3 LOADS, LOCA CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2A	1060.	1250.	0.9000	0.9400	0.8412	0.4074
RHR SERVICE WATER PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1A	0.	1000.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2A	1000.	1000.	0.9000	0.9350	0.7979	0.3864
CONTROL ROD DRIVE HYD. PUMP	190.	250.	0.8860	0.9270	0.1529	0.0800
NUCLEAR SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
TOTAL					2.2380	1.1503

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E3 LOADS, 2XLOCA CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2A	1060.	1250.	0.9000	0.9400	0.8412	0.4074
RHR SERVICE WATER PUMP 2A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1A	1000.	1000.	0.9000	0.9350	0.7979	0.3864
RHR SERVICE WATER PUMP 1A	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2A	1000.	1000.	0.9000	0.9350	0.7979	0.3864
CONTROL ROD DRIVE HYD. PUMP	190.	250.	0.8860	0.9270	0.1529	0.0800
NUCLEAR SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2A	275.	300.	0.8500	0.9200	0.2230	0.1382
TOTAL					3.0358	1.5367

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E4 LOADS, FULL LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2P	0.	1250.	0.9000	0.9400	0.	0.
RHR SERVICE WATER PUMP 2B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1B	0.	1000.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2B	0.	1000.	0.9000	0.9350	0.	0.
CONTROL ROD DRIVE HYD. PUMP	0.	250.	0.8860	0.9270	0.	0.
NUCLEAR SERVICE PUMP 2B	0.	300.	0.8500	0.9200	0.	0.
CONVENTIONAL SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 1A	275.	300.	0.8500	0.9200	0.2230	0.1382
FIRE PUMP	190.	250.	0.8890	0.9200	0.1541	0.0794
TOTAL					0.6000	0.3557

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E4 LOADS, UAT LIGHT LOAD CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2B	0.	1250.	0.9000	0.9400	0.	0.
RHR SERVICE WATER PUMP 2B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1B	0.	1000.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2B	0.	1000.	0.9000	0.9350	0.	0.
CONTROL ROD DRIVE HYD. PUMP	0.	250.	0.8860	0.9270	0.	0.
NUCLEAR SERVICE PUMP 2B	0.	300.	0.8500	0.9200	0.	0.
CONVENTIONAL SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 1A	275.	300.	0.8500	0.9200	0.2230	0.1382
FIRE PUMP	0.	250.	0.8890	0.9200	0.	0.
TOTAL					0.4460	0.2764

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E4 LOADS, LOCA CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2B	1060.	1250.	0.9000	0.9400	0.8412	0.4074
RHR SERVICE WATER PUMP 2B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1B	0.	1000.	0.9000	0.9350	0.	0.
RHR SERVICE WATER PUMP 1B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2B	1000.	1000.	0.9000	0.9350	0.7979	0.3864
CONTROL ROD DRIVE HYD. PUMP	190.	250.	0.8860	0.9270	0.1529	0.0800
NUCLEAR SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 1A	275.	300.	0.8500	0.9200	0.2230	0.1382
FIRE PUMP	190.	250.	0.8890	0.9200	0.1541	0.0794
TOTAL					2.6150	1.3678

MOTOR LIST

CP&L BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2

VOLTAGE DROP STUDY

4160 VOLT BUS E4 LOADS, 2XLOCA CONDITION

MOTOR	BRAKE HP	RATED HP	POWER FACTOR	EFF	MW	MVAR
CORE SPRAY PUMP 2B	1060.	1250.	0.9000	0.9400	0.8412	0.4074
RHR SERVICE WATER PUMP 2B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 1B	1000.	1000.	0.9000	0.9350	0.7979	0.3864
RHR SERVICE WATER PUMP 1B	0.	800.	0.9000	0.9350	0.	0.
RHR PUMP 2B	1000.	1000.	0.9000	0.9350	0.7979	0.3864
CONTROL ROD DRIVE HYD. PUMP	190.	250.	0.8860	0.9270	0.1529	0.0800
NUCLEAR SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2230	0.1382
CONVENTIONAL SERVICE PUMP 2B	275.	300.	0.8500	0.9200	0.2233	0.1382
CONVENTIONAL SERVICE PUMP 1A	275.	300.	0.8500	0.9200	0.2230	0.1382
FIRE PUMP	190.	250.	0.8890	0.9200	0.1541	0.0794
TOTAL					3.4129	1.7542

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E7, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XA	36.19	0.0290	0.0246	0.0153
2XC	85.63	0.0685	0.0582	0.0361
2XE	193.45	0.1548	0.1315	0.0815
2XG	503.67	0.4029	0.3425	0.2123
2XL	159.42	0.1275	0.1084	0.0672
1XA-2	25.63	0.0205	0.0174	0.0108
1XJ	81.67	0.0653	0.0555	0.0344
2CA	408.70	0.3270	0.2779	0.1722
2PA	243.65	0.1949	0.1657	0.1027
DGC	150.92	0.1207	0.1026	0.0636
2A	75.00	0.0600	0.0510	0.0316
TOTAL	1964.	1.5711	1.3355	0.8277

Note:

Load MVA is given based on horsepower times load factor expressed in P. U. on 100 MVA base.

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E7, SCWP 2A START, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XA	36.19	0.0290	0.0246	0.0153
2XC	85.63	0.0685	0.0582	0.0361
2XE	193.45	0.1548	0.1315	0.0815
2XG	503.67	0.4029	0.3425	0.2123
2XL	159.42	0.1275	0.1084	0.0672
1XA-2	25.63	0.0205	0.0174	0.0108
1XJ	81.67	0.0653	0.0555	0.0344
2CA	408.70	0.3270	0.2779	0.1722
DGC	150.92	0.1207	0.1026	0.0636
2A	75.00	0.0600	0.0510	0.0316
TOTAL	1720.	1.3762	1.1698	0.7250

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E7, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XA	14.50	0.0116	0.0099	0.0061
2XC	81.55	0.0652	0.0555	0.0344
2XE	155.50	0.1244	0.1057	0.0655
2XG	503.50	0.4028	0.3424	0.2122
2XL	153.55	0.1228	0.1044	0.0647
1XA-2	0.	0.	0.	0.
1XJ	41.50	0.0332	0.0282	0.0175
2CA	264.45	0.2116	0.1798	0.1114
2PA	43.00	0.0344	0.0292	0.0181
DGC	94.00	0.0752	0.0639	0.0396
2A	75.00	0.0600	0.0510	0.0316
TOTAL	1427.	1.1412	0.9701	0.6012

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E7, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XA	36.19	0.0362	0.0308	0.0191
2XC	36.78	0.0368	0.0313	0.0194
2XE	158.45	0.1585	0.1347	0.0835
2XG	122.17	0.1222	0.1038	0.0644
2XL	23.97	0.0240	0.0204	0.0126
1XA-2	25.63	0.0256	0.0218	0.0135
1XJ	1.67	0.0017	0.0014	0.0009
2CA	408.70	0.4087	0.3474	0.2153
2PA	43.40	0.0434	0.0369	0.0229
DGC	217.42	0.2174	0.1848	0.1145
2A	75.00	0.0750	0.0638	0.0395
TOTAL	1149.	1.1494	0.9770	0.6055

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E7, RBCCWP 2A AND 2C START, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XA	36.19	0.0362	0.0308	0.0191
2XC	36.78	0.0368	0.0313	0.0194
2XG	122.17	0.1222	0.1038	0.0644
2XL	23.97	0.0240	0.0204	0.0126
1XA-2	25.63	0.0256	0.0218	0.0135
1XJ	1.67	0.0017	0.0014	0.0009
2CA	408.70	0.4087	0.3474	0.2153
2PA	43.40	0.0434	0.0369	0.0229
DGC	217.42	0.2174	0.1848	0.1145
2A	75.00	0.0750	0.0638	0.0395
TOTAL	991.	0.9909	0.8423	0.5220

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2E, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TA	116.41	0.0931	0.0792	0.0491
2TB	149.75	0.1198	0.1018	0.0631
2TC	225.67	0.1805	0.1535	0.0951
2TF	250.69	0.2006	0.1705	0.1056
2TJ	292.49	0.2340	0.1989	0.1233
2TK	362.69	0.2902	0.2466	0.1528
2TL	280.89	0.2247	0.1910	0.1184
2ETB	75.00	0.0600	0.0510	0.0316
TOTAL	1754.	1.4029	1.1924	0.7390

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2E, TBCCWP 2A START, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TA	116.41	0.0931	0.0792	0.0491
2TB	149.75	0.1198	0.1018	0.0631
2TC	225.67	0.1805	0.1535	0.0951
2TF	250.69	0.2006	0.1705	0.1056
2TK	362.69	0.2902	0.2466	0.1528
2TL	280.39	0.2247	0.1910	0.1184
2ETB	75.00	0.0600	0.0510	0.0316
TOTAL	1461.	1.1689	0.9935	0.6157

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2E, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TA	57.63	0.0461	0.0392	0.0243
2TB	69.50	0.0556	0.0473	0.0293
2TC	179.50	0.1436	0.1221	0.0756
2TF	72.00	0.0576	0.0490	0.0303
2TJ	29.50	0.0236	0.0201	0.0124
2TK	284.50	0.2276	0.1935	0.1199
2TL	274.50	0.2196	0.1867	0.1157
2ETB	75.00	0.0600	0.0510	0.0316
TOTAL	1042.	0.8337	0.7086	0.4392

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2E, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TA	116.41	0.1164	0.0989	0.0613
2TB	149.75	0.1498	0.1273	0.0789
2TC	225.67	0.2257	0.1918	0.1189
2TF	250.69	0.2507	0.2131	0.1321
2TJ	292.49	0.2925	0.2486	0.1541
2TK	362.69	0.3627	0.3083	0.1911
2TL	280.89	0.2809	0.2388	0.1480
2ETB	75.00	0.0750	0.0638	0.0395
TOTAL	1754.	1.7536	1.4906	0.9238

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2F, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TD	256.51	0.2052	0.1744	0.1081
2TE	325.94	0.2608	0.2216	0.1374
2TG	546.94	0.4376	0.3719	0.2305
2TH	335.98	0.2688	0.2285	0.1416
2TM	228.32	0.1827	0.1553	0.0962
2TN	59.70	0.0478	0.0406	0.0252
2FTB	75.00	0.0600	0.0510	0.0316
TOTAL	1828.	1.4627	1.2433	0.7705

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2F, TBCCWP 2B START, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TD	256.51	0.2052	0.1744	0.1081
2TE	325.94	0.2608	0.2216	0.1374
2TG	546.94	0.4376	0.3719	0.2305
2TM	228.32	0.1827	0.1553	0.0962
2TN	59.70	0.0478	0.0406	0.0252
2FTB	75.00	0.0600	0.0510	0.0316
TOTAL	1492.	1.1939	1.0148	0.6289

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2F, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TD	90.50	0.0724	0.0615	0.0381
2TE	29.88	0.0239	0.0203	0.0126
2TG	344.50	0.2756	0.2343	0.1452
2TH	129.50	0.1036	0.0881	0.0546
2TM	4.50	0.0036	0.0031	0.0019
2TN	67.00	0.0536	0.0456	0.0282
2FTB	75.00	0.0600	0.0510	0.0316
TOTAL	741.	0.5927	0.5038	0.3122

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2F, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2TD	256.51	0.2565	0.2180	0.1351
2TE	325.94	0.3259	0.2770	0.1717
2TG	546.94	0.5469	0.4649	0.2881
2TH	335.98	0.3360	0.2856	0.1770
2TM	228.32	0.2283	0.1941	0.1203
2TN	59.70	0.0597	0.0507	0.0314
2FTB	75.00	0.0750	0.0638	0.0395
TOTAL	1828.	1.8284	1.5541	0.9632

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E8, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XB	45.54	0.0364	0.0310	0.0192
2XD	81.13	0.0649	0.0552	0.0342
2XF	164.33	0.1315	0.1117	0.0693
2XH	508.50	0.4068	0.3458	0.2143
2XM	120.97	0.0968	0.0823	0.0510
1XB-2	25.63	0.0205	0.0174	0.0108
1XK	81.67	0.0653	0.0555	0.0344
2PB	271.50	0.2172	0.1846	0.1144
2CB	396.90	0.3175	0.2699	0.1673
DGD	151.92	0.1215	0.1033	0.0640
E11	70.67	0.0565	0.0481	0.0298
E12	31.64	0.0253	0.0215	0.0133
2B	75.00	0.0600	0.0510	0.0316
TOTAL	2025.	1.6203	1.3773	0.8536

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E3, SCWP 2B START, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XB	45.54	0.0364	0.0310	0.0192
2XD	81.13	0.0649	0.0552	0.0342
2XF	164.33	0.1315	0.1117	0.0693
2XH	508.50	0.4068	0.3458	0.2143
2XM	120.97	0.0968	0.0823	0.0510
1XB-2	25.63	0.0205	0.0174	0.0108
1XK	81.67	0.0653	0.0555	0.0344
2CB	396.90	0.3175	0.2699	0.1673
DGD	151.92	0.1215	0.1033	0.0640
E11	70.67	0.0565	0.0481	0.0298
E12	31.64	0.0253	0.0215	0.0133
2B	75.00	0.0600	0.0510	0.0316
TOTAL	1754.	1.4031	1.1927	0.7391

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E8, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XB	24.50	0.0196	0.0167	0.0103
2XD	75.30	0.0602	0.0512	0.0317
2XF	163.00	0.1304	0.1108	0.0687
2XH	522.50	0.4180	0.3553	0.2202
2XM	125.65	0.1005	0.0854	0.0530
1XB-2	0.	0.	0.	0.
1XK	81.50	0.0652	0.0554	0.0343
2PB	71.00	0.0568	0.0483	0.0299
2CB	265.40	0.2123	0.1805	0.1118
DGD	93.67	0.0749	0.0637	0.0395
E11	70.67	0.0565	0.0481	0.0298
E12	31.64	0.0253	0.0215	0.0133
2B	75.00	0.0600	0.0510	0.0316
TOTAL	1600.	1.2799	1.0879	0.6742

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E8, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XB	45.54	0.0455	0.0387	0.0240
2XD	37.73	0.0377	0.0321	0.0199
2XF	179.33	0.1793	0.1524	0.0945
2XH	138.50	0.1385	0.1177	0.0730
2XM	15.97	0.0160	0.0136	0.0084
1XB-2	25.63	0.0256	0.0218	0.0135
1XK	1.67	0.0017	0.0014	0.0009
2PB	71.25	0.0713	0.0606	0.0375
2CB	396.90	0.3969	0.3374	0.2091
DGD	238.92	0.2389	0.2031	0.1259
E11	70.67	0.0707	0.0601	0.0372
E12	31.64	0.0316	0.0269	0.0167
2B	75.00	0.0750	0.0638	0.0395
TOTAL	1329.	1.3288	1.1294	0.7000

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION E8, RBCCWP 2B START, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2XB	45.54	0.0455	0.0387	0.0240
2XD	37.73	0.0377	0.0321	0.0199
2XH	138.50	0.1385	0.1177	0.0730
2XM	15.97	0.0160	0.0136	0.0084
1XB-2	25.63	0.0256	0.0218	0.0135
1XK	1.67	0.0017	0.0014	0.0009
2PB	71.25	0.0713	0.0606	0.0375
2CB	396.90	0.3969	0.3374	0.2091
DGD	238.92	0.2389	0.2031	0.1259
E11	70.67	0.0707	0.0601	0.0372
E12	31.64	0.0316	0.0269	0.0167
2B	75.00	0.0750	0.0638	0.0395
TOTAL	1149.	1.1494	0.9770	0.6055

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2SY, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
SYB	227.96	0.1824	0.1550	0.0961
TOTAL	228.	0.1824	0.1550	0.0961

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2SY, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
2YB	217.96	0.1744	0.1482	0.0919
TOTAL	218.	0.1744	0.1482	0.0919

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2SY, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
SYB	227.96	0.2280	0.1938	0.1201
TOTAL	228.	0.2280	0.1938	0.1201

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON D, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
RWB	267.36	0.2139	0.1818	0.1127
RWD	209.33	0.1675	0.1423	0.0882
2SA	77.90	0.0623	0.0530	0.0328
CRANE	65.00	0.0520	0.0442	0.0274
TOTAL	620.	0.4957	0.4213	0.2611

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON D, BACKWASH AIR BLR START, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
RWD	209.33	0.1675	0.1423	0.0882
2SA	77.90	0.0623	0.0530	0.0328
CRANE	65.00	0.0520	0.0442	0.0274
TOTAL	352.	0.2818	0.2395	0.1484

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON D, SHUTDOWN CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
RWB	80.28	0.0642	0.0546	0.0338
RWD	132.80	0.1062	0.0903	0.0560
2SA	65.50	0.0524	0.0445	0.0276
CRANE	65.00	0.0520	0.0442	0.0274
TOTAL	344.	0.2749	0.2336	0.1448

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON D, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85.

MCC	HORSEPOWER	MVA	MW	MVAR
RWB	267.36	0.2674	0.2273	0.1408
RWD	209.33	0.2093	0.1779	0.1103
2SA	77.90	0.0779	0.0662	0.0410
CRANE	65.00	0.0650	0.0553	0.0342
TOTAL	620.	0.6196	0.5267	0.3264

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2L, FULL LOAD AND SHUTDOWN CONDITIONS

LOAD FACTOR = 0.80 POWER FACTOR = 1.00.

MCC	HORSEPOWER	MVA	MW	MVAR
2A	138.62	0.1109	0.1109	0.
2B	169.08	0.1353	0.1353	0.
2D	132.25	0.1058	0.1058	0.
TOTAL	440.	0.3520	0.3520	0.

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 2L, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 1.00.

MCC	HORSEPOWER	MVA	MW	MVAR
2A	138.62	0.1386	0.1386	0.
2B	169.08	0.1691	0.1691	0.
2D	132.25	0.1323	0.1323	0.
TOTAL	440.	0.4400	0.4400	0.

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 4L, FULL LOAD AND SHUTDOWN CONDITIONS

LOAD FACTOR = 0.80 POWER FACTOR = 0.90.

MCC	HORSEPOWER	MVA	MW	MVAR
HR8	89.00	0.0712	0.0641	0.0310
201	35.29	0.0282	0.0254	0.0123
202	18.95	0.0152	0.0136	0.0066
203	2.71	0.0022	0.0020	0.0009
204	7.50	0.0060	0.0054	0.0026
2S2	16.02	0.0128	0.0115	0.0056
SBA	220.42	0.1763	0.1587	0.0769
TOTAL	390.	0.3119	0.2807	0.1360

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 4L, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.90.

MCC	HORSEPOWER	MVA	MW	MVAR
HR8	89.00	0.0890	0.0801	0.0388
201	35.29	0.0353	0.0318	0.0154
202	18.95	0.0190	0.0171	0.0083
203	2.71	0.0027	0.0024	0.0012
204	7.50	0.0075	0.0068	0.0033
2S2	16.02	0.0160	0.0144	0.0070
SBA	220.42	0.2204	0.1984	0.0961
TOTAL	390.	0.3899	0.3509	0.1699

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON C, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR = 0.85

MCC	HORSEPOWER	MVA	MW	MVAR
RWA	283.54	0.2268	0.1928	0.1195
RWC	251.73	0.2014	0.1712	0.1061
BHA	615.65	0.4925	0.4186	0.2595
WTA	621.77	0.4974	0.4228	0.2620
1SA	77.90	0.0623	0.0530	0.0328
TOTAL	1851.	1.4805	1.2584	0.7799

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION COMMON C, LOCA CONDITION

LOAD FACTOR - 1.00 POWER FACTOR - 0.85

MCC	HORSEPOWER	MVA	MW	MVAR
RWA	283.54	0.2835	0.2410	0.1494
RWC	251.73	0.2517	0.2140	0.1326
RHA	615.65	0.6157	0.5233	0.3243
WTA	621.77	0.6218	0.5285	0.3275
1SA	77.90	0.0779	0.0662	0.0410
TOTAL	1851.	1.8506	1.5730	0.9749

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 1SY, FULL LOAD CONDITION

LOAD FACTOR = 0.80 POWER FACTOR - 0.85

MCC	HORSEPOWER	MVA	MW	MVAR
SYA	295.89	0.2367	0.2012	0.1247
TOTAL	296.	0.2367	0.2012	0.1247

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 1SY, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 0.85

MCC	HORSEPOWER	MVA	MW	MVAR
SYA	295.89	0.2959	0.2515	0.1559
TOTAL	296.	0.2959	0.2515	0.1559

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 1L, FULL LOAD AND SHUTDOWN CONDITIONS

LOAD FACTOR = 0.80 POWER FACTOR = 1.00

MCC	HORSEPOWER	MVA	MW	MVAR
1A	112.48	0.0900	0.0900	0
1B	161.64	0.1293	0.1293	0
1D	126.51	0.1012	0.1012	0
TOTAL	401.	0.3205	0.3205	0

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 1L, LOCA CONDITION

LOAD FACTOR = 1.00 POWER FACTOR = 1.00

MCC	HORSEPOWER	MVA	MW	MVAR
1A	112.48	0.1125	0.1125	0
1B	161.64	0.1616	0.1616	0
1D	126.51	0.1265	0.1265	0
TOTAL	401.	0.4006	0.4006	0

CAROLINA POWER AND LIGHT COMPANY, BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 AND 2, 480 VOLT LOAD STUDY

UNIT SUBSTATION 3L, FULL LOAD AND SHUTDOWN CONDITIONS

LOAD FACTOR = 0.80 POWER FACTOR - 0.90

MCC	HORSEPOWER	MVA	MW	MVAR
WHA	222.00	0.1776	0.1598	0.0774
1W1	24.38	0.0195	0.0176	0.0085
1W2	28.77	0.0230	0.0207	0.0100
1W2-1	5.60	0.0045	0.0040	0.0020
1W3	30.00	0.0240	0.0216	0.0105
PNLC	159.34	0.1275	0.1147	0.0556
TOTAL	470.	0.3761	0.3385	0.1639