CAROLINA POWER & LIGHT COMPANY

NUCLEAR ENGINEERING & LICENSING DEPARTMENT

REPORT

AUXILIARY ELECTRICAL DISTRIBUTION SYSTEM STUDY FOR BRUNSWICK STEAM ELECTRIC PLANT UNITS NO. 1 & 2

CAROLINA POWER & LIGHT COMPANY
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ANALYSIS

FOR

4160V AND 480V

AUXILIARY ELECTRICAL DISTRIBUTION SYSTEM

For

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 and 2

SAFETY CLASSIFICATION: NUCLEAR SAFETY RELATED
SEISMIC CLASSIFICATION: N/A

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1.0 PURPOSE

The purpose of this study is to perform all electrical distribution system analyses for BSEP Units 1 and 2 necessary to demonstrate the adequacy of the 4160V and 480VAC Systems to supply safety loads during normal and emergency conditions in accordance with NRC guidelines in reference 7. This is achieved by:

1. Identification of the voltage requirements of the auxiliary electrical distribution system and equipment under various plant operating conditions. From the voltage requirements, establish distribution system voltage criteria which will assure adequate voltage at all loads.

2. Definition of the modes (cases) of plant operation requiring analysis in order to demonstrate electrical distribution system adequacy per NRC Guidelines.

3. Modeling and completing an analysis for the above cases. For each case, a source voltage (switchyard or generator) limit was determined. The expected source voltage must be within the limits established by analysis to meet the distribution system voltage criteria.

4. Comparison of the source voltage limits with the expected values of the source voltage. Examine in greater detail those cases where the criteria are not met to determine if the voltages at the loads are adequate. If voltages are not adequate, identify the changes necessary to provide adequate voltage at the loads.

2.0 SUMMARY OF RESULTS

Voltage drop studies have shown that the existing BSEP Electrical Distribution System can support all 4160V and 480VAC safety loads in accordance with present NRC guidelines for determining the adequacy of station electrical distribution system voltage.

A tap change from -2.5% to -5% is recommended on Unit Substation Common C to maintain adequate voltage on the nonsafety system.

3.0 METHOD OF ANAYSIS

3.1 Computer Programs

Voltage-drop studies for the BSEP auxiliary electrical distribution system were done using ASDOP (Auxiliary System Design Optimization Program). Aggregate load models were developed to represent the Unit Nos. 1 and 2 auxiliary systems under various postulated plant conditions. The plant conditions modeled include normal and accident plant conditions. For a detailed description of each of the models used, see Section 3.4. A CP&L procedure entitled "CP&L Benchmark Procedure for Auxiliary System Design Optiminization Program (ASDOP)" dated 04/05/84 compared actual field test data with ASDOP calculated values.

The Transmission Planning Unit of the Transmission Department supplied the expected or actual 230 KV switchyard voltage values in addition to study results of how transmission grid conditions can be controlled to provide optimum switchyard voltage levels. These studies were run using the POWERFLO computer program.

3.2 Equipment Voltage Criteria

The operating voltage requirements of all equipment fed from the auxiliary electrical distribution system collectively impose restrictions on the allowable voltage range of the auxiliary system source-of-feed. The auxiliary system voltage criteria, therefore, must conform to the equipment operating requirements but also be broad enough to allow for expected voltage fluctuations at the source - either the generator bus or the 230 KV switchyard bus.

A major consideration is to ensure that motors have sufficient terminal voltage to start and continue running. Since 4000-volt motors can, without stalling, ride through a transient voltage dip that is less than the minimum starting voltage, the limiting condition is to maintain sufficient voltage to start the motors. For Class 1E motors, the minimum starting voltage is 0.75 p.u. (3000 volts) for motors specified by UE&C and 0.70 p.u. (2800 volts) for motors specified by General Electric. The primary concern relative to the starting of large BOP (Balance of Plant) motors is that the voltage drop resulting from the motor start does not prevent safety loads from starting and running as designed. A secondary consideration is that the BOP motor maintain sufficient terminal voltage to start and run. The minimum terminal voltage required for starting will vary from motor to motor, depending upon individual torque characteristics of the motor and load. For purposes of this study, the minimum starting voltage for BOP motors is assumed to be 0.85 p.u. for both 4000 and 460V motors (Reference 9). If in individual cases motor terminal voltage drops below .85 p.u., those cases are examined to determine if adequate starting voltage is applied at the motor terminals. A tabulation of all motor starting and running voltage criteria can be found in Appendix C.

In addition to the 391 volts (0.85 p.u. on 460 volt base), minimum required for 460 volt motor starting, a minimum of 408 volts (0.85 p.u. on 480-volt base) is required at the MCC in order to pick up the motor contactors. In addition to motor starting considerations, sufficient voltage must be maintained (at the 480-volt level) to ensure that 460-volt motors will continue running during a transient voltage drop caused by the starting of a large 4000-volt motor. The voltage at the MCC must not drop below 336 volts (0.70 p.u. on 480 V base), which is the voltage required to ensure the motor contactor will not drop out.

It is also important to consider motor running voltage limitations necessary to prevent overheating and the resultant reduction in motor life. To maximize motor life, the terminal voltage needs to be maintained between 0.90 p.u. and 1.10 p.u. of rated voltage. This applies to both 4000 volt and 460 volt motors. The reduction in motor life that occurs when operating at voltages outside of this range becomes significant only if the over or undervoltage is maintained for an extended period. Therefore, only for those plant operating conditions that are expected to occur for a substantial portion of the forty-year plant life, is the 0.90 p.u. to 1.10 p.u. motor terminal voltage range considered in determining source voltage limits. For accident-related conditions, the running voltage limitation at MCC buses is 0.85 p.u. to 1.10 p.u.

Another consideration is the set point of undervoltage relays. Relay settings must be examined relative to the steady state and transient voltages expected to occur on the auxiliary system. When the voltage dips below the relay set point during motor starting, voltages must recover above the relay reset point in time to prevent the relay from tripping. Thus relevant relay settings are included in the voltage criteria in Appendix C. Appendix D also lists the undervoltage relays on the auxiliary system, relay settings and relay function.

3.3 Plant Operating Conditions

In evaluating the ability of the electrical distribution system to support auxiliary system safety loads, the equipment voltage criteria must be examined relative to the operating conditions expected to occur. By imposing the equipment voltage criteria to a particular operating condition, a source "voltage limit" is established. By selecting a set of operating conditions that establish the most restrictive voltage limits a "worst case" source voltage limit is defined. By comparison of the worst case minimum and maximum voltage limits with the expected values, the adequacy of the source voltage can be determined.

In this study, four operating conditions were selected for analysis. They are: Normal Power Operation, LOCA Start, LOCA Run and Light Load. Expected source voltages and source voltage limits will be different for each condition, and examination of all four is required to verify the adequacy of the dstribution system's voltage regulation performance. For each of the four conditions. power may be supplied from the 230KV Switchyard, via the Startup Auxiliary Transformer (SAT). Power can be supplied from the generator bus via the Unit Auxiliary Transformer (UAT) only for the Normal Power Operation and the Light Load (during power operation) conditions.

The accident scenario used in this analysis considers NRC guidelines and actual conditions which are likely to occur at the plant. A scenario based solely on NRC guidelines would consider a LOCA on one unit with the other unit (Also Operating) proceeding to an orderly shutdown. At BSEP "worse case" voltage levels would occur if a LOCA occurred on one unit with the other unit shutdown. Thus the latter scenario is used in this analysis. The accident scenario is discussed in greater detail in Appendix A.

3.4 Development Of Auxiliary System Models

Load models for the BSEP Unit Nos. 1 & 2 auxiliary electrical distribution system were developed to represent each of the plant conditions described in Section 3.3. These load models were integrated into ASDOP, and voltage-drop cases were run, which provided the information necessary to analyze the adequacy of the electrical distribution system.

With the exception of the light-load cases ("SAT Shutdown" and "UAT Light Load"), each of the models were developed to represent the auxiliary system with the tie breaker between 4160V buses Common A and Common B closed. This tie breaker is not under administrative clearance, and if closed, would increase the auxiliary system load, which would cause an increased voltage drop. Thus, using a load model that represents the Common A-Common B tie breaker closed provides "worst-case" voltage-drop information. The tie breaker is open for the light load cases to represent the minimum load on the auxiliary system. The Common Buses are always fed from the SAT, so those buses and the loads they feed are not included in the UAT models.

3.4.1 Basis for Model Development

All of the motor-starting models and the accident models were derived from a basic full-load model ("SAT Full Load"). This full load model was developed by identifying all of the 4160-volt loads that would normally be running when the unit is operating at full power.

The 480-volt loads were modeled as an aggregate at each Motor Control Center except for those motors being started. For the 460-volt motors, the KVA supplied was assumed to be equal to the rated horsepower where motor full load current was not known. This assumption has proved to be accurate for motors rated at 250 horsepower or less. Since all 480-volt loads would not be running at any one time, load factors were used to approximate the running load at each 480-volt bus. The load factor applied to each load was based upon the load being classified as one of the following:

Operation	Load Factor
Back-up	0.00
Battery Charger	0.50
Continuous Loads	1.00
Fans	1.00
Heater Load	0.50
Intermittent Loads	0.50
Lighting Transformer	0.75
Power Panelboard	0.50
Rotated	Variable*
Shutdown or Startup Only	0.00
Valve Motor	0.10
Welding Feeders	0.00

* For 2 out of 3 rotation, the minimum load factor shall be 2/3=0.67.
If the load is large enough to significantly affect bus loading, a load factor of 1.00 was assigned.

3.4.2 System Conditions and Cases Modeled

One lines of the auxiliary system models described in the following sections may be found in Appendix E.

3.4.2.1 Full-Load Model

Cases were developed for normal unit operation with the auxiliary system operating under normal full load conditions. The models were developed for both the Startup Auxiliary Transformer (SAT) and Unit Auxiliary Transformer (UAT) aligned to supply the Auxiliary System. Transient conditions are analyzed using the normal unit operation model by starting various distinctly modeled motors on the 4160V and 480V Systems. The steady state and motor start cases were developed to demonstrate that adequate voltages are maintained on the safety system during normal plant operation. The SAT alignment cases are used along with the voltage criteria to establish a minimum switchyard voltage limit during normal operations. The UAT cases were used along with the auxiliary system voltage criteria to establish a minimum generator voltage limit during normal operation. The SAT and UAT alignment cases are described below:

A. Startup Auxiliary Transformer Supplying the Load

CASE SAT1: SAT FULL LOAD

This case was modeled to represent auxiliary system with full auxiliary load fed from the SAT and the tie breaker between 4160V buses Common A and Common B closed.

CASE SAT3: SAT - 3rd CWP MOTOR START

This case was modeled to represent the auxiliary system load when starting a third 2500 hp CWP motor (2 CWP motors running) with full auxiliary load fed from the SAT and the breaker between buses Common A and Common B closed. The CWP with the longest feeder cable was started.

CASE SAT4: SAT - 4th CWP MOTOR START

This case was modeled to represent the auxiliary system load when starting a fourth 2500 hp Circulating Water Pump motor (3 CWP motors running) with full auxiliary load fed from the SAT and the tie breaker between buses Common A and Common B closed. The CWP with the longest feeder cable was started.

CASE SAT5: SAT - FUEL POOL COOLING PUMP MOTOR START @ 1XG (2XG)

This case was modeled to represent the auxiliary system load when starting a Fuel Pool Cooling Pump Motor on MCC 1XG for the Unit 1 analysis and on MCC 2XG for the Unit 2 analysis. Auxiliary load is fed from the SAT and the tie breaker between Common A and Common B is closed.

CASE SAT6: SAT - FUEL POOL COOLING PUMP MOTOR START @ 1XH (2XH)

This case was modeled to represent the auxiliary system load when starting a Fuel Pool Cooling Pump Motor on MCC 1XH for the Unit 1 analysis and on MCC 2XH for the Unit 2 analysis. The Auxiliary load is fed from the SAT and the tie breaker between Common A and Common B is closed.

CASE SAT7: SAT - REACTOR RECIRC PUMP MOTOR START

This case was modeled to represent the auxiliary system load when starting a Reactor Recirc Pump Motor. The auxiliary load is fed from the SAT and the tie breaker between Common A and B are closed.

CASE SAT8: SAT - RBCCW PUMP MOTOR START @ 1XE (2XE)

This case was modeled to represent the auxiliary load when starting a Reactor Building Closed Cooling Water Pump motor on MCC 1XE for Unit 1 and MCC 2XE for Unit 2. The auxiliary load is fed from the SAT and the tie breaker between Common A and B is closed.

CASE SAT18: SAT - SCREEN WASH PUMP MOTOR START @ 1SA (2SA)

This case was modeled to represent the auxiliary system load when starting a Screen Wash Pump Motor on MCC 1SA for the Unit 1 analysis and on MCC 2SA for the Unit 2 analysis. The auxiliary load is fed from the SAT and the tie breaker between Common A and B buses is closed.

CASE SAT19: SAT - TBCCW PUMP MOTOR START @ 1TM (2TM)

This case was modeled to represent the auxiliary system load when starting a Turbine Building Closed Cooling Water Pump Motor on MCC 1TM for the Unit 1 analysis and 2TM for the Unit 2 analysis. The auxiliary load is fed from the SAT and the tie breaker between Common A and B buses is closed.

B. UAT Supplying the Load

The UAT cases are identical to the SAT cases described above except the UAT is supplying the load. The Common A and Common B buses are not included in the UAT model since they are always supplied from the SAT. The UAT cases are:

Case UAT1: UAT - Full Load

Case UAT3: UAT - 3rd CWP Start

Case UAT4: UAT - 4th CWP Start

Case UAT5: UAT - Reactor Recirc. Pump Start

Case UAT6: UAT - Fuel Pool Cooling Pump Motor Start @ 1XG (2XG)

Case UAT7: UAT - Fuel Pool Cooling Pump Motor Start @ 1XH (2XH)

Case UAT8: UAT - RBCCW Pump Motor Start @ 1XE (2XE)

3.4.2.2 LOCA Start

The "LOCA Start" cases were modeled by adding the LOCA starting load to the system at a full-load operation. Loads that are automatically shed from a LOCA signal were removed from the full-load model for the "LOCA Start" and "LOCA Run" cases.

The LOCA Start cases were developed to demonstrate the capability to start the LOCA loads when connected to the off-site source with the grid at the minimum expected voltage. The LOCA start cases are used along with the auxiliary system voltage criteria to establish a minimum switchyard voltage limit upon receipt of a LOCA. This would be the minimum transient post turbine trip switchyard voltage when the LOCA loads are starting. The LOCA start cases are:

CASE SAT9: SAT - LOCA START (BLOCKED STARTING)

This case was modeled to represent the auxiliary system immediately after a turbine trip from a LOCA with all loads fed from the SAT. Two (2) Core Spray pumps and two (2) RHR pumps are simultaneously started.

CASE SAT10: LOCA START (SEQUENTIAL STARTING)

In addition to the "LOCA Start" model that represented block starting of the Core Spray and RHR pumps, a "LOCA Start" model was also developed to represent sequential starting of the Core Spray and RHR pumps. This model represents the starting of two Core Spray pump motors, five seconds after the RHR pumps have been started. The starting sequence and timing are the same as that used for starting the ECCS loads from the diesel generators. Because the starting power requirements of the ECCS load are imposed on the distribution system in smaller increments, sequential starting reduces the potential degredation of the auxiliary system voltage from a LOCA.

NOTE. LOCA logic at BSEP is presently configured for blocked starting of the ECCS loads. The sequential starting cases were run to determine the additional margin of voltage regulation performance which can be achieved by making such a modification.

3.4.2.3 LOCA RUN

The "LOCA Run" cases were modeled by adding the LOCA Run loads to the system at full-load operation. Loads that are automatically shed by a LOCA signal were removed from the full load model. In addition to a steady state LOCA Run case, several LOCA Run motor start cases were developed. These cases were developed to demonstrate the capability of the auxiliary system to start large non-safety loads with minimum expected grid voltage following a LOCA without adversely impacting the operation of the safety related loads. The LOCA Run cases are used along with the auxiliary system voltage criteria to establish a steady state switchyard voltage limit following a LOCA.

The LOCA Run cases are:

Case SAT11: SAT-LOCA Run

This case was modeled to represent the steady state condition after a LOCA with 2 Core Spray pumps and 2 RHR pumps running.

Case SAT12: SAT-LOCA Run, 3rd CWP Start

This case was modeled to represent the steady state condition after a LOCA except a 3rd CWP Motor (2 CWP motors running) is starting. The CWP with the longest feeder cable was started.

Case SAT13: SAT-LOCA Run, 4th CWP Motor Start

This case was modeled to represent the steady state condition after a LOCA except a 4th CWP motor (3 CWP running) is starting. The CWP with the longest feeder cable was started.

Case SAT14: SAT-LOCA Run Stator Coolant Pump Motor Start @ 1TD (2TD)

This case is identical to the steady state case (SAT11) except the Stator Coolant motor is starting on MCC 1TD for Unit 1 and 2TD for Unit 2.

Case SAT15: SAT-LOCA Run, Fuel Pool Cooling Motor Start @ 1XG (2XG)

This case is identical to Case SAT11, except the Fuel Pool Cooling Motor on MCC 1XG is starting for the Unit 1 analysis and the Fuel Pool Cooling Motor on MCC 2XG is started for the Unit 2 analysis.

Case SAT16: SAT-LOCA Run, Fuel Pool Cooling Motor Start @ 1XH (2XH)

This case is identical to Case SAT11, except the Fuel Pool Cooling Motor on MCC 1XH is started for the Unit 1 Analysis and the motor on MCC 2XH is started for the Unit 2 analysis.

Case SAT17: SAT-LOCA Run, TBCCW Pump Motor Start @ 1TM (2TM)

This case is identical to SAT11, except the Turbine Building Closed Cooling Water Pump Motor is starting on MCC 1TM for Unit 1 and MCC 2TM for Unit 2.

3.4.2.4 Light Load Models

Case SAT2: SAT-Shutdown

This case models the auxiliary system during unit shutdown with the minimum expected auxiliary load. This case was developed to demonstrate that auxiliary system voltage would be within equipment ratings with the grid voltage at the maximum expected value. This case along with equipment voltage limits is used to establish a switchyard maximum voltage limit when the unit is shutdown.

Case UAT2: UAT-Light Load

This case models the auxiliary system during unit operation with the Unit Auxiliary Transformer supplying the load. The auxiliary system load is at the minimum value expected for power operation. This case was developed to demonstrate that the auxiliary system voltage would be within equipment ratings at the maximum expected generator voltage. This case along with the equipment voltage criteria is used to establish a generator maximum voltage limit for normal unit operation.

4.0 STUDY RESULTS

4.1 Source Voltage Limits

For each of the plant operating conditions and cases listed in section 3.4.2, ASDOP runs were made with the expected source voltage and at other selected voltages to determine a source voltage limit. The establishment of source limits and expected source voltage ranges is discussed in Appendix G. The source voltage limits, which were based on the equipment voltage criteria, were compared to the actual source voltage range expected for that plant operating condition. For Normal Operation, LOCA Start and LOCA Run Cases, if the source voltage limit is below the minimum expected voltage range, it can be concluded that the distribution system voltage regulation is adequate for that plant operating condition. For shutdown and light load cases, if the source voltage limit is above the maximum expected voltage range, it can be concluded that the distribution system voltage regulation is adequate for that operating condition. If the expected source voltage is outside the source voltage limits established by the ASDOP Analysis, then further study is required to establish auxiliary system adequacy. Table 1 summarizes the result for each case analyzed for Unit 1. Table 2 summarizes the results for Unit 2. Listed is the source voltage limit, expected source voltage and the condition which established the source limit.

The source voltage for the SAT cases is the 230KV Switchyard. The source voltage for the UAT cases is the unit's generator. Using Table 1, the Unit 1 switchyard and generator voltage limits can be compared to the expected source voltage values. The expected voltages are within the calculated limits except for cases SAT9, SAT13, SAT17, SAT18 and SAT19. For these cases, the limiting condition was established by some non-safety MCCs and loads. The nonsafety MCCs and loads were examined in greater detail for these cases and the voltage at the loads were determined to be adequate (See section 4.4, paragraphs 1, 2, 3). In all cases (including cases SAT9, SAT13, SAT17, SAT18 and SAT19), the voltage meets the criteria on the safety buses. Thus, adequate voltage is maintained on the Unit 1 safety systems. Table 1 assumes a tap change (which has no impact on safety system voltage) is made on the transformer serving Unit Substation Common C. The purpose of the tap change is discussed in Section 4.4 Paragraph 4.

Using Table 2, the Unit 2 switchyard and generator voltage limits can be compared to the expected source voltage values. The expected voltages are within calculated limits except for cases SAT2, SAT17, SAT18 and SAT19. For case SAT2, the expected source voltage (1.017 pu) is only slightly greater (.007 pu) than the source voltage limit (1.010 pu). The voltage limit was set by non-safety MCC bus voltages and is discussed further in Section 4.4, Paragraph 5. The voltage is within limits on the safety buses and at safety loads.

For cases SAT17, SAT18 and SAT19 the limiting condition was established by some non-safety MCC and loads. The non-safety MCC and loads were examined in greater detail for these cases and determined to be adequate (See Section 4.4, paragraphs 1, 2, 3). In all cases (including SAT17, SAT18 and SAT19), the voltage meets the criteria for Unit 2 safety buses and loads. Thus adequate voltage is maintained on the Unit 2 safety system for all conditions analyzed.

TABLE 1 - SUMMARY OF RESULTS OF ASDOP ANALYSIS BSEP #1

PLANT MODE	CASE	MIN (MAX) EXPECTED SOURCE VOLTAGE (PU)	SOURCE VOLTAGE LIMIT	LIMITING CONDITIONS
Full Load	SAT1 - Full Load	1.009	1.007	460V Mtr Term. Volt.
	SAT3 - 3rd CWP Start	1.009	.984	CWP-1D Terminal Volt.
	SAT4 - 4th CWP Start	1.009	.993	CWP-1D Terminal Volt.
	SAT5 - Fuel Pool Cool Pump Start @ 1XG	1.009	.963	FPCP-1A Term. Volt.
	SAT6 - Fuel Pool Cool Pump Start @ 1XH	1.009	.968	FPCP-1B Term. Volt.
	SAT7 - Reac Recirc Pump Mtr Start @ 1B	1.009	.978	RRP-1B Terminal Volt.
	SAT8 - RBCCW Pump Mtr Start @ 1XE	1.009	.974	RBCCW Mtr Term. Volt.
	SAT18 - Screen Wash Pump Mtr Start @ 1SA	1.009*	1.046	SWP Terminal Voltage
	SAT19 - TBCCW Pump Start @ 1TM	1.009*	1.055	TBCCW Terminal Voltage
Full Load	UAT 1 - Full Load	1.009	1.000	460V Mtr Terminal Volt.
	UAT 3 - 3rd CWP Start	1.009	.977	CWP-1D Mtr Term. Volt.
	UAT 4 - 4th CWP Start	1.009	.986	CWP-1D Mtr Term. Volt.
	UAT 5 - Reac Recirc Pump Mtr Start @ 1B	1.009	.981	RRP-1B Terminal Volt.
	UAT 6 - Fuel Pool Cool Pump Start @ 1XG	1.009	.958	FPCP-1A Terminal Volt.
	UAT 7 - Fuel Pool Cool Pump Start @ 1XH	1.009	.963	FPCP-1B Terminal Volt.
	UAT 8 - RBCCW Pump Mtr Start @ 1XE	1.009	.972	RBCCW-1A Terminal Volt.
LOCA START	SAT 9 - LOCA, Blocked Starting	.965*	.966	480V Contactor Drop-out
	SAT 10 - LOCA, Sequential Starting	.965	.924	480V Contactor Drop-out
LOCA Run	SAT 11 - LOCA Run	.989	.979	480V Contactor Pickup
	SAT 12 - 3rd CWP Start	.989	.983	CWP-1D Terminal Volt.
	SAT 13 - 4th CWP Start	.989*	.993	CWP-1D Terminal Volt.
	SAT 14 - Stator Clnt Pump Mtr Start @ 1TD	.989	.952	SCP 1B Terminal Volt.
	SAT 15 - Fuel Pool Cool Pump Start @ 1XG	.989	.936	FPCP 1A Terminal Volt.
	SAT 16 - Fuel Pool Cool Pump Start @ 1XH	.989	.950	FPCP 1B Terminal Volt.
	SAT 17 - TBCCW Pump Motor Start @ 1TM	.989*	1.055	TBCCW Terminal Voltage
LIGHT LOAD	SAT 2 - SAT, Shutdown	(1.017)	1.017	460V Mtr Terminal Volt.
	UAT 2 - UAT, Light Load	(1.038)	1.095	460V Mtr Terminal Volt.

*These cases are examined further in Section 4.4 to determine if load characteristics are such that the nonsafety loads impacted will operate satisfactorily at the expected source voltage.

TABLE 2 - SUMMARY OF RESULTS OF ASDOP ANALYSIS BSEP #2

PLANT MODE	CASE	MIN (MAX) EXPECTED SOURCE VOLTAGE (PU)	SOURCE VOLTAGE LIMIT	LIMITING CONDITIONS
Full Load	SAT1 - Full Load	1.009	1.000	460V Mtr Term. Volt.
	SAT3 - 3rd CWP Start	1.009	.987	CWP-2D Terminal Volt.
	SAT4 - 4th CWP Start	1.009	.994	CWP-2D Terminal Volt.
	SAT5 - Fuel Pool Cool Pump Start @ 2XG	1.009	.960	FPCP-2A Terminal Volt.
	SAT6 - Fuel Pool Cool Pump Start @ 2XH	1.009	.982	FPCP-2B Terminal Volt.
	SAT7 - Reac Recirc Pump Mtr Start @ 2B	1.009	.981	RRP-2B Terminal Volt.
	SAT8 - RBCCW Pump Motor Start @ 2XE	1.009	.972	RBCCW Mtr Term. Volt.
	SAT18 - Screen Wash Pump Mtr Start @ 2SA	1.009*	1.056	SWP Terminal Voltage
	SAT19 - TBCCW Pump Start @ 2TM	1.009*	1.063	TBCCW Terminal Voltage
Full Load	UAT 1 - Full Load	1.009	.997	460V Mtr Term. Volt.
	UAT 3 - 3rd CWP Start	1.009	.979	CWP-2D Terminal Volt.
	UAT 4 - 4th CWP Start	1.009	.989	CWP-2D Terminal Volt.
	UAT 5 - Reac Recirc Pump Mtr Start @ 2B	1.009	.983	RRP-2B Terminal Volt.
	UAT 6 - Fuel Pool Cool Pump Start @ 2XG	1.009	.954	FPCP-2A Terminal Volt.
	UAT 7 - Fuel Pool Cool Pump Start @ 2XH	1.009	.977	FPCP-2B Terminal Volt.
	UAT 8 - RBCCW Pump Mtr Start @ 2XE	1.009	.967	RBCCW-2A Terminal Volt.
LOCA START	SAT9 - LOCA, Blocked Starting	.965	.926	480V Contactor Drop-out
	SAT10 - LOCA, Sequential Starting	.965	.884	480V Contactor Drop-out
LOCA Run	SAT11 - LOCA Run	.991	.964	27DV Relay Setting
	SAT12 - 3rd CWP Start	.991	.978	CWP-2D Terminal Volt.
	SAT13 - 4th CWP Start	.991	.989	CWP-2D Terminal Volt.
	SAT14 - Stator Clnt Pump Mtr Start @ 2TD	.991	.944	SCP-2B Terminal Volt.
	SAT15 - Fuel Pool Cool Pump Start @ 2XH	.991	.944	FPCP-2A Terminal Volt.
	SAT16 - Fuel Pool Cool Pump Start @ 2XG	.991	.927	FPCP-2B Terminal Volt.
	SAT17 - TBCCW Pump Mtr Start @ 2TM	.991*	1.059	TBCCW Terminal Voltage
LIGHT LOAD	SAT 2 - SAT, Shutdown	(1.017)*	1.010	460V Mtr Terminal Volt.
	UAT 2 - UAT, Light Load	(1.038)	1.058	460V Mtr Terminal Volt.

*These cases are examined further in Section 4.4 to determine if load characteristic are such that the nonsafety loads affected will operate satisfactorily at the expected source voltage.

4.2 Safety Bus Voltages with Expected Source Voltage

Table 3 and 4 summarize for Units 1 and 2 respectively the Auxiliary System safety bus voltages with the expected source voltage for the Full Load, LOCA Start, LOCA Run, and Light Load Conditions. The transient values listed for each mode of operation are the minimum transient voltages on the buses for the motor start cases analyzed for the particular mode of operation. In each case, the minimum transient voltage is caused by the start of a fourth CWP motor. For each case analyzed, ASDOP outputs which give bus voltages and selected motor terminal voltages may be found in Appendix H.

4.3 Comparison of Undervoltage Relay Setting with Steady State and Transient Voltage

Steady state and motor starting transient voltages were examined relative to the appropriate undervoltage relay set points. A 3rd CWP start (Cases UAT3, SAT3, SAT12), a 4th CWP start (Cases UAT4, SAT4, SAT13) and a LOCA Blocked Start (Case SAT9) result in a transient voltage dip below the safety bus undervoltage relay pickup voltage. Motor acceleration calculations were performed in these instances which verified the motors would accelerate and voltage would recover in time to prevent an undervoltage trip. The calculations, relay characteristics, and plots illustrating the results can be found in Appendix F. The calculations computed the motor acceleration time at several voltage values. The acceleration time was determined for the minimum expected motor terminal voltage. Additionally, the minimum terminal voltage at which the motor will start without tripping the undervoltage relay was determined.

4.4 Non-Safety Auxiliary System Voltages

The auxiliary system voltage criteria were developed to address all operating conditions at the plant including non-safety system loads. As discussed in the previous sections, voltages are adequate for safety-related loads for any condition or case analyzed. Additionally no case was identified where non-safety loads adversely affected safety loads.

Some non-safety loads (as described in Section 4.1) set source voltage limits which were outside the range of expected source voltages. The loads were analyzed in greater detail to determine if load characteristics would permit the loads to operate with the source voltage at the expected value. The following paragraphs summarize the results of this analysis:

1. TERMINAL VOLTAGE AT THE TBCCW PUMP AND SCREEN WASH PUMP (CASES SAT17, SAT19, SAT18): When starting the TBCCW pump during a LOCA (Case SAT17), the motor terminal voltage drops to .783 (460V base) for the Unit 1 analysis and to .7828 (460V base) for the Unit 2 analysis. During SAT-Full Load Operation (SAT19) starting the TBCCW pump drops the motor terminal voltage to .8037 (460V base) for the Unit 1 analysis and to .7957 pu for the Unit 2 analysis. During SAT-Full Load Operation (SAT18), starting the Screen Wash Pump causes the motor terminal voltage to drop to .8064 (460V base) in the Unit 1 analysis and to .7995 pu for the Unit 2 analysis. The motor terminal voltages are below the 85% starting criteria. Calculations were performed (see Appendix F) to determine if the motors would start at the ASDOP computed values. In all cases, the motors will start and accelerate at the expected terminal voltage values.

2. TERMINAL VOLTAGE AT CWP-1D WHEN STARTING A 4TH CWP DURING LOCA RUN (CASE - SAT13): When starting the fourth CWP during a LOCA on Unit 1, the CWP-1D motor terminal voltage dips to 0.8452 (4000V base). Although this voltage is below the .85 (4000V base) voltage criteria, the CWP is not a safety-related load and does not jeopardize the safety of the plant. Additionally, there is no problem with motor acceleration at the minimum expected terminal voltage.

3. VOLTAGE AT NON-SAFETY MCC CTO DURING LOCA BLOCK-START (CASE SAT9): When block starting the RHR pumps and Core Spray pumps on Unit 1 during a LOCA, MCC CTO bus voltage dips to 0.6980 (480V base). This voltage is below the 0.70 (480V base) voltage criteria for contactor drop-out. No safety-related loads are fed from CTO, therefore the possibility of contactor drop-out is not a safety concern and is not considered a problem. The MCC CTO voltage recovers to .8674 (480V base) after the motors accelerate. Therefore any loads which drop out due to low voltage can restart.

4. VOLTAGES ON LOADS FED FROM UNIT SUBSTATION COMMON C: With Unit Substation Common C transformer tapped at

the present setting (-2.5%), the Unit 1 analysis computed low voltages at the following loads fed from the unit substation:

a. Low motor terminal voltage at loads fed from MCC RWC during SAT-Full Load (SAT1).

b. Low bus voltage at MCC RWC during LOCA Block Start (SAT9).

c. Low bus voltage at MCC RWC during LOCA Run (SAT11).

The low voltages can be corrected by changing the substation transformer taps from -2.5% to -5%.

5. VOLTAGE ON NON-SAFETY MCC ON UNIT 2: As discussed in Section 4.2 a slight overvoltage on some non-safety motor control centers may occur for the shutdown case (SAT2) with the 230KV system voltage at the maximum expected value. The voltage at the non-safety MCC buses only slightly exceeds (.68% max. on MCC 2TE) the maximum allowable voltage at the load terminals. There will be some additional voltage drop between the motor control center and the load. Also, the time the source voltage will be maximum with the unit shutdown should be small. Therefore, the slight overvoltage calculated in the ASDOP computer studies is not considered significant.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our interpretation of NRC requirements and the results of voltage-drop studies, the electrical distribution system can supply power to the safety system within the equipment voltage limits. This is based on a "worst case" accident scenario of a LOCA on one unit with the other unit shutdown, as opposed to the accident scenario of a LOCA on one unit and simultaneous false LOCA on the other unit. The latter scenario was used in past voltage-drop studies, and subsequent NRC submittals were based on results of these studies; however, this scenario goes beyond the intent of any applicable regulatory requirements. A detailed discussion of the basis for the revised accident scenario can be found in Appendix A.

Specific instances were found in the analysis where non-safety loads required individual analysis. The actual voltages in these instances were demonstrated to be adequate and/or the non-safety system would operate satisfactory in all cases provided one change is made. A tap change from -2.5% to -5% is recommended on the transformer supplying Unit Substaiton Common C. The tap change will assure adequate voltage is maintained for all the non-safety loads fed from the unit substation.

5.1 Addendum to Results and Conclusions

The voltage drops covered in this report were conducted with the understanding that the Screen Wash Pump Motors (fed from nonsafety MCCs 1SA and 2SA) were automatically tripped upon initiation of a LOCA signal. Since completion of this analysis, it has been discovered that this load shedding feature has been removed. This impacts the load model used for analysis in that under worst case loading, the Screen Wash Pumps could be running during a LOCA. As a result, the affected cases have been reexaminaed, and it was determined that the impact on the voltage regulation of the safety-related bases is insignificant and the conclusions and recommendations will not change in any way.

Relative to the nonsafety loads, two (2) additional MCCs (1SA and RWC) do not meet the minimum criteria of 0.70 pu for a LOCA Start. This condition has been evaluated as having no adverse impact on safety-related systems in Section 4.4, Item 3.

TABLE 3

UNIT 1 SAFETY SYSTEM BUS VOLTAGES AT THE EXPECTED SOURCE VOLTAGE

Bus		FULL LOAD				LOCA START	LOCA RUN		LIGHT LOAD	
		UAT SUPPLYING LOAD		SAT SUPPLYING LOAD						
		Steady State (UAT1)	Transient (UAT4)	Steady State (SAT1)	Transient (SAT4)	Blocked Start (SAT9)	Steady State (SAT11)	Transient (SAT13)	UAT Supplying Load (UAT2)	Shutdown (SAT2)
4KV		.9438	.8758	.9426	.8702	.7747	.9187	.8473	.9794	1.0207
480V Bus	E5	.9259	.8474	.9246	.8408	.7559	.9188	.8387	.9665	1.0266
480V Bus	E6	.9309	.8530	.9296	.8466	.7527	.9163	.8359	.9712	1.0276
480V MCC	1XC	.9235	.8448	.9222	.8382	.7527	.9162	.8358	.9642	1.0245
	2XJ	.9131	.8334	.9118	.8268	.7556	.9186	.8384	.9543	1.0208
	1XE	.9127	.8329	.9114	.8263	.7430	.9083	.8272	.9538	1.0174
	1PA	.9240	.8454	.9228	.8388	.7529	.9164	.8361	.9647	1.0250
	1XL	.9147	.8351	.9134	.8285	.7535	.9169	.8365	.9558	1.0169
	DGA	.9241	.8454	.9228	.8389	.7527	.9162	.8358	.9647	1.0256
	1CA	.9017	.8208	.9004	.8140	.7258	.8944	.8118	.9433	1.0105
	1OG	.9141	.8344	.9128	.8278	.7413	.9069	.8256	.9552	1.0200
	1XG	.9104	.8304	.9091	.8238	.7509	.9148	.8342	.9517	1.0126
	1XA	.9225	.8437	.9212	.8371	.7517	.9154	.8350	.9632	1.0247
	1XD	.9298	.8519	.9285	.8454	.7513	.9152	.8347	.9702	1.0268
	2XB-2	.9275	.8494	.9263	.8429	.7486	.9129	.8322	.9680	1.0276
	DGB	.9256	.8473	.9243	.8408	.7426	.9080	.8268	.9661	1.0245
	2XK	.9144	.8350	.9131	.8284	.7524	.9160	.8356	.9554	1.0127
	1XF	.9220	.8433	.9207	.8368	.7374	.9038	.8221	.9627	1.0196
	1PB	.9293	.8514	.9280	.8449	.7508	.9148	.8342	.9697	1.0262
	1XM	.9220	.8433	.9207	.8368	.7504	.9144	.8338	.9626	1.0200
	1XH	.9137	.8343	.9125	.8277	.7429	.9083	.8271	.9548	1.0120
	1CB	.9139	.8344	.9126	.8278	.7315	.8991	.8169	.9549	1.0171
	2OG	.9159	.8367	.9146	.8301	.7340	.9011	.8191	.9569	1.0189
	1XB	.9275	.8493	.9262	.8428	.7485	.9129	.8321	.9679	1.0260
	2XA-2	.9246	.8460	.9234	.8395	.7544	.9176	.8373	.9653	1.0266

NOTE: Voltages are in per unit based on bus nominal voltage.

TABLE 4

UNIT 2 SAFETY SYSTEM BUS VOLTAGES AT THE EXPECTED SOURCE VOLTAGE LIMIT

Bus		FULL LOAD				LOCA START	LOCA RUN		LIGHT LOAD	
		UAT SUPPLYING LOAD		SAT SUPPLYING LOAD						
		Steady State (UAT1)	Transient (UAT4)	Steady State (SAT1)	Transient (SAT4)	Blocked Start (SAT9)	Steady State (SAT11)	Transient (SAT13)	UAT Supplying Load (UAT2)	Shutdown (SAT2)
4KVBus		.9407	.8724	.9386	.8680	.7795	.9257	.8537	.9640	1.0250
480V Bus	E7	.9325	.8547	.9301	.8497	.7707	.9339	.8541	.9627	1.0373
480V Bus	E8	.9336	.8562	.9312	.8512	.7732	.9355	.8561	.9597	1.0395
480V MCC	2XC	.9316	.8537	.9291	.8487	.7695	.9330	.8530	.9617	1.0367
MCC	1XJ	.9198	.8409	.9174	.8358	.7672	.9311	.8510	.9504	1.0314
MCC	2XE	.9192	.8402	.9168	.8351	.7580	.9235	.8427	.9499	1.0282
MCC	2PA	.9294	.8514	.9270	.8464	.7669	.9308	.8507	.9597	1.0346
MCC	2XL	.9218	.8430	.9193	.8380	.7649	.9292	.8489	.9523	1.0281
MCC	DGC	.9306	.8527	.9282	.8477	.7675	.9313	.8512	.9608	1.0363
MCC	2CA	.9149	.8355	.9125	.8304	.7492	.9164	.8348	.9509	1.0273
MCC	2XA	.9287	.8506	.9262	.8456	.7661	.9301	.8499	.9590	1.0350
MCC	2XG	.9164	.8370	.9139	.8319	.7637	.9281	.8478	.9470	1.0230
MCC	2XD	.9324	.8548	.9299	.8498	.7717	.9342	.8547	.9585	1.0385
MCC	1XB-2	.9326	.8551	.9302	.8501	.7720	.9345	.8550	.9587	1.0395
MCC	DGD	.9320	.8544	.9296	.8495	.7708	.9335	.8539	.9581	1.0386
MCC	2XB	.9279	.8499	.9254	.8449	.7663	.9298	.8499	.9541	1.0366
MCC	1XK	.9220	.8434	.9195	.8384	.7726	.9350	.8555	.9484	1.0291
MCC	2XF	.9160	.8369	.9135	.8318	.7517	.9179	.8368	.9425	1.0256
MCC	2PB	.9315	.8539	.9291	.8489	.7707	.9334	.8538	.9577	1.0377
MCC	2XM	.9237	.8453	.9212	.8403	.7693	.9322	.8525	.9500	1.0297
MCC	2XH	.9042	.8239	.9017	.8187	.7600	.9246	.8442	.9311	1.0188
MCC	2CB	.9088	.8290	.9063	.8238	.7429	.9107	.8289	.9356	1.0263

NOTE: Voltages are in PU based on bus nominal voltage.

6.0 REFERENCES

1. BSEP Updated FSAR, Sections 8.2 and 8.3, Vol. 6.

2. Brunswick Steam Electric Plant Units 1 and 2 Electrical Distribution System Load List, Duke Power Company, September 30, 1982.

3. CP&L letter to NRC, NO-81-288, February 16, 1981.

4. Internal CP&L Memorandum BSEP/81-0204, January 26, 1981.

5. NRC Regulatory Guide 1.81, Revision 1, January 1975.

6. NRC Internal Memorandum October 27, 1978; Voltage Degradation at Class 1E 480-volt buses.

7. NRC letter to All Power Reactor Licensees, August 8, 1979.

8. UE&C Letter to CP&L Nuclear Plant Engineering Department, Ref. CU-09227, November 11, 1976.

9. UE&C Report on Voltage Drop Study, BSEP Unit 2, Revision 2, December 15, 1980.

10. UE&C 480-volt Load Study, BSEP Units 1 and 2, Revision 1, March 1, 1978.

11. Calculation NT124-E-01-F, Auxiliary Electrical Distribution System Load and Cable Impedance Calculation for BSEP Unit 2, Revision 1, May 25, 1984.

12. Calculation NT124-E-02-F, Auxiliary Electrical Distribution System Load and Cable Impedance Calculation for BSEP Unit 1, Revision 0, June 1984.

13. CP&L Benchmark Procedure for Auxiliary System Design Optimization Program (ASDOP), Revision 0, April 10, 1984.

7.0 APPENDIX A

ACCIDENT SCENARIO CONSIDERATIONS

7.0 ACCIDENT SCENARIO CONSIDERATIONS

Previous BSEP Electrical Division System voltage-drop studies considered a postulated worst-case accident of a LOCA on one unit and a simultaneous false LOCA on the other unit (See "UE&C Report on Voltage-Drop Study for BSEP Unit 2", Revision 2, dated December 15, 1980.). The UE&C report indicated that the '2XLOCA' condition could cause the emergency bus voltage to degrade to unacceptable levels when the tie breaker between 4160-volt buses Common A and Common B is closed. A solution offered by UE&C to ensure sufficient emergency bus voltage for the "2XLOCA" scenario was to increase the normal 230 KV switchyard voltage from 1.000 p.u. to 1.012 p.u. when the tie breaker is closed.

The solution offered is based upon the incorrect assumption that after a turbine generator trip, the switchyard voltage would degrade a constant amount from its pre-trip voltage, regardless of whether the pre-trip voltage is at 1.000 p.u. or 1.012 p.u. This analysis does not take into consideration that the generating units supply a major portion of the VAR support that serves to hold the switchyard voltage at the required level. Upon a unit trip, this system VAR support is lost, and the drop in switchyard voltage is determined by the transmission system conditions, which dictate how much and from where the lost VAR support is made up. From Transmission System loadflow studies, it has been demonstrated that the actual drop in switchyard voltage caused by the loss of both units and the starting of the ECCS loads would be much greater than indicated in the UE&C report.

Based on an evaluation of NRC requirements relative to the adequacy of station electrical distribution system voltage, the "2XLOCA" accident scenario is more conservative than required. In the NRC's Guidelines for Voltage-Drop Calculations found in their letter to all power reactor licensees, dated August 8, 1979, Guideline No. 2 states "For multi-plant stations, a separate analysis should be performed for each unit, assuming (1) an accident in the unit being analyzed and simultaneous shutdown of all other units at that station, or; (2) an anticipated transient in the unit being analyzed (e.g., unit trip) and simultaneous shutdown of all other units at that station, whichever presents the largest load demand situation."

In the "2XLOCA" scenario, the simultaneous shutdown referred to in the above guideline is caused by simultaneous false accident signals that cause the automatic starting of the ECCS equipment. Regulatory Guide 1.81 states that because of the low probability of a major reactor accident, a suitable basis for multi-unit nuclear power plants is the assumption that the accident occurs in only one of the units at a time, with all remaining units proceeding to an orderly shutdown. Since an "orderly shutdown of the other unit" is clearly not the loss of the unit from spurious accident signals, the Regulatory Guide supports the basis for considering a LOCA on one unit only. This scenario is further supported by IEEE 308-1971, Paragraph 8.1.4 which states in part: "A multiunit station may share preferred power supply capacity between units. In such a case, as a minimum the total preferred capacity must be sufficient to operate the engineered safety features for a design basis accident on one unit and those systems required for a concurrent safe shutdown of the remaining units."

The NRC also provides guidelines for establishing the source voltage that is to be used for the station electrical distribution system voltage-drop studies. The same August 8, 1979, NRC letter referenced above states that the voltage at the terminals of each safety load should be calculated based on the assumption that the grid voltage is at its "minimum expected value". The minimum expected value should be based on the least of the following:

a. The minimum steady-state voltage experienced at the connection to the off-site circuit.

b. The minimum voltage expected at the connection to the off-site circuit due to contingency plans which may result in reduced voltage from the grid.

c. The minimum predicted grid voltage from grid stability analysis (e.g., load flow studies).

For all of the voltage-drop studies covered in this report, the minimum expected grid voltage was based on transmission system load flow studies ("c" above). For the "LOCA Start" cases, the load flow studies yielded the lowest voltage of the three methods covered in the NRC guidelines; however, for the "LOCA Run" cases the voltages from load flow studies were higher than the minimum steady-state voltage experienced at the connection to the off-site circuit ("a" above). A review of plant computer logs has revealed that the lowest steady-state voltage at the 230 KV switchyard of 222.7 KV (0.967 p.u.) occurred on August 25, 1975. This value was not used for the "LOCA Run" cases, however, for two reasons:

1. The steady-state grid voltage cannot be used to

predict the post-turbine trip grid voltage after a LOCA. As mentioned previously in this appendix, the generator serves to maintain the switchyard voltage at the required level, and, therefore, the voltage drop from an unanticipated loss of a generating unit cannot be controlled by maintaining the grid voltage with the generator.

2. Many changes have been made in the transmission system since 1975 when the lowest switchyard voltage occurred. These changes have impacted how the transmission system affects switchyard voltages.

Revised Accident Scenario

Based on an interpretation of NRC guidelines for degraded voltage analyses, the following accident scenario would apply to BSEP:

1. Both Brunswick units are operating with auxiliary electrical loads to support full-load operation.

2. The Common A to Common B bus tie breaker is closed.

3. There is a LOCA on BSEP Unit 2 (1); switchyard voltage degrades to the "minimum expected value".

4. The Unit 1 (2) operators simultaneously commence the process that will lead to a safe, orderly shutdown and cool-down condition.

The above accident scenario based on NRC Guidelines considers the LOCA occurring at a time when both units are operating. In the case of BSEP, an accident on a unit with the other unit shutdown results in the "worst case" voltage condition. The probability of an accident occurring on a unit with the other unit shutdown is approximately the same as when the other unit is operating. Therefore, it is reasonable the above scenario should be changed to consider the worse case condition. Therefore, the scenario used in this analysis is as follows:

1. One Brunswick Unit is operating at full load. The other is shutdown.

2. The Common A to Common B tie breaker is closed with the load supplied from the operating unit's Startup Auxiliary Transformer.

3. There is a LOCA on the operating unit; switchyard voltage degrades to the "minimum expected value".

4. Plant safety systems respond to the accident condition.

8.0 APPENDIX B

SOURCE VOLTAGE CONSIDERATIONS

8.0 SOURCE VOLTAGE CONSIDERATIONS

An important consideration for maintaining adequate electrical distribu-tion system voltages is to take the necessary steps to control the source voltage during normal plant operations and to ensure that the transmission system is operated in such a way as to minimize the loss of voltage from an uncontrolled unit trip.

Under normal operating conditions, the 230 KV switchyard voltage level is maintained in accordance with the BSEP Generation Voltage Schedule (GVS). The present GVS calls for the 230 KV switchyard voltage to be maintained between 232 KV and 234 KV. The desired switchyard voltage level is achieved through a coordinated effort between the plant opera-tors and the System Operations Load Dispatchers at the Skaale Energy Control Center. In the voltage-drop analyses covered in this report, the GVS was used as the expected source voltage range for non-accident operating conditions. The expected voltage was compared to the calculated voltage limit to determine whether adequate source voltage could be expected for the condition modeled. It should be pointed out that the GVS is subject to change, which could change the results of the voltage-drop studies themselves. The GVS is based on a combination of interdependent plant and grid operating conditions and requirements. The considerations involved in making changes to the GVS are somewhat complex, and it is not intended in this report to cover them in detail; however, it should be pointed out that before any change in the GVS is made, the impact on plant operations would be carefully considered.

Since the desired switchyard voltage is maintained primarily by making adjustments to the power factor of the generator unit, the GVS cannot be applied for determining the expected source voltage for accident conditions resulting in a unit trip. In the case of a unit trip from a LOCA, the switchyard voltage is degraded as a result of the loss of generation, as well as the inrush current required to start the ECCS loads. The greatest difficulty in maintaining sufficient switchyard voltage comes at the instant the unit trips and the ECCS loads are required to start. After the motor inrush current has tapered off and the transmission system has had time to make the necessary adjustment, the switchyard voltage can be maintained at a higher level.

The minimum expected switchyard voltages for the accident conditions in this report were based on transmission system load flow studies that modeled transmission facilities planned for service by the 1984 summer period. Since adequate switchyard voltage becomes more difficult to maintain as the system load increases, the desired conservatism is achieved by representing the forecasted summer peak load in the trans-mission system model. L. V. Sutton Steam Electric Plant Unit 3 helps support transmission voltage in the area. To develop the "worst case" transmission system conditions, all the studies except shutdown (SAT2) were run representing Sutton Unit No. 3, out of service. For the Shutdown Case (SAT2), Sutton Unit 3 was considered operating to develop the "worst case" maximum switchyard voltage.

9.0 APPENDIX C

VOLTAGE CRITERIA

9.0 BSEP EQUIPMENT VOLTAGE CRITERIA
VOLTAGE CONSTRAINTS

Equipment	Name Plate Rating	Continuous	Transient	Remarks	Reference
Nonclass 1E Motors	4000V	∓10% (3600 to 4400 volts)	-15% starting (3400 volts)		1
Nonclass 1E GE Motors	4000V	∓10% (3600 to 4400 volts)	-30% starting (2800 volts)	Applies to RHR and core spray pump motors only.	2
Class 1E UE&C Motors	4000V	∓10% (3600 to 4400 volts)	-25% starting (3000 volts)		2
All Motors	460V	∓10% (414 to 506 volts)	-15% starting (391 volts)	Applies to all 460 Volt motors. This criterion relaxed for accident conditions.	1
Motor Control Centers	480V	-15% (408 volts)	-30% (336 volts)	85% required for contactor pickup. 70% required for contactor hold in.	
E-Buses	4160V	89.5% (27DV relay setting) (3727.5 volts on E-bus) @ 10 sec.	82.5% (27/59E relay pick up setting)	27DV relay setting is 106.5V/10 sec. 27/59E inverse time relay setting is 105V/98V (5 secs. @ 75% V. 1.5 secs. @ 0% V)	3, 4, 5
BOP Buses	4160V	N/A	69% (27 relay setting) 2870 volts on BOP bus.	27 relay setting is 82T 1/2 L (2 secs. @ 0% V)	3, 4, 5

Equipment	Name Plate Rating	Continuous	Transient	Remarks	Reference
BOP Buses	4160V	N/A	69.8% (27/59S relay setting (2905 volts on BOP Bus)	27/59S setting is 105V/83V (5.5 sec. @ 0 v)	3, 4, 5
BOP Buses	4160V	N/A	69.8% (27/59U relay setting) (2905 volts on BOP Bus)	27/59U setting is 105/83V (5.5 sec. @ 0 V)	3, 4, 5

NOTES:

A. Limits established for motors are voltages at the motor terminals. A 3% running drop between motor control center and motor will be assumed to account for cable voltage drop.

B. All percentages are in 4160 Volt base, and PT ratio for all relays is 4200/120.

REFERENCES:

1. ANSI C50.41-1982.

2. UE&C voltage drop study, Rev. 2, December 15, 1980.

3. CP&L letter to NRC dated November 23, 1982 with Enclosure 1, BSEP Units 1 and 2 Adequacy of Station Electric Distribution System Voltages.

4. UC-24428 dated September 1, 1976 on "Relay Coordination Settings and Curves."

5. UC-29677 dated June 30, 1980 "Adequacy of Station Electrical Distribution System Voltages."

10.0 APPENDIX D

AUXILIARY SYSTEM RELAYS

10.0 AUXILIARY SYSTEM RELAYS

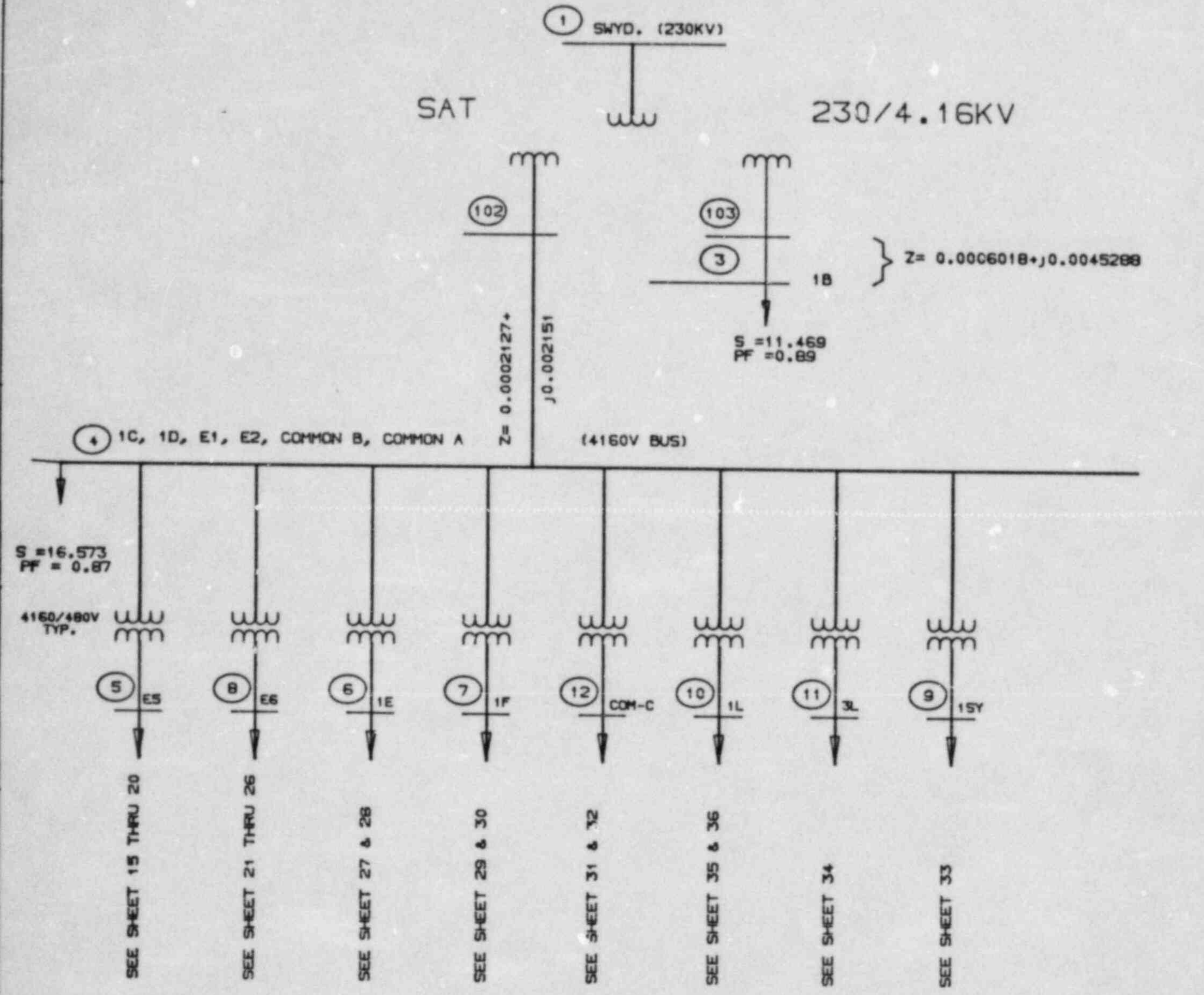
The NRC guidelines for voltage drop calculations, item 8, states that "The analysis should document the voltage setpoint and any inherent or adjustable (with nominal setting) time delay for relays which initiate or execute (1) automatic transfer of loads from one source to another; (2) automatic load shedding; or (3) automatic load sequencing." The relays, settings and functions are listed below. The appropriate relays are also included in voltage criteria, Appendix C (Section 9.0).

	Relay	Catalog No.	Setting	Function
a.	27/59S (BOP-Bus)	12IAV53K1A	105V/83 (5.5 sec when voltage drops to zero.	a. Load sheds all breakers on its associated bus. b. Trips its associated Feeder to Emergency Bus. c. Starts Diesel Generators
b.	27/59U (BOP-Bus)	12IAV53K1A	105V/83V (5.5 sec when voltage drops to zero	a. Load sheds all breakers on its associated bus b. Trips its associated Feeder to Emergency Bus c. Starts Diesel Generators
c.	27 (BOP-Bus)	12IAV54F1A	82Γ ½L (2 sec @ 0%)	a. Opens master-slave breakers to associated Emergency Bus. b. Sheds all BOP bus loads
d.	27-1 (BOP-Bus)	12HFA65D69H	Instantaneous	a. Permits sequential loading of RHR and Core Spray Pumps during DBA b. Permits bypass of sequential loading circuits if off-site power is available c. Permits operation of Conventional Service Water Pumps if off-site power is available

	Relay	Catalog No.	Setting	Function
e.	27/59E (E-bus)	12IAV53K1A	105V/98V (5 sec @ 70% V. (1.5 secs @ 0% V)	a. Permits closure of diesel generator breaker b. Load sheds all breakers on its associated bus c. Trips tie breakers
f.	59D (E-bus)	12IAV51A1A	55V/1L (.25 sec @ 100% V.)	a. Permits closure of diesel generator breaker
g.	27-1	12HFA65D69H	Instantaneous	a. Starts sequential loading
	27-2 (E-bus)	12HFA65D69H	Instantaneous	b. Permits bypass of sequential loading circuits if off-site power is available.
	27HS (E-bus)	12HGA17C63	Instantaneous	a. Starts its associated diesel generator
	27 DV (E-bus)	ITE - 27D	106.5V/10 sec	a. Isolates its associated emergency bus from off-site distribution system when voltage is below 89.5%

11.0 APPENDIX E

AUXILIARY SYSTEM MODEL ONE LINES



SAT FULL LOAD

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN	CK	RE	OPE	OPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

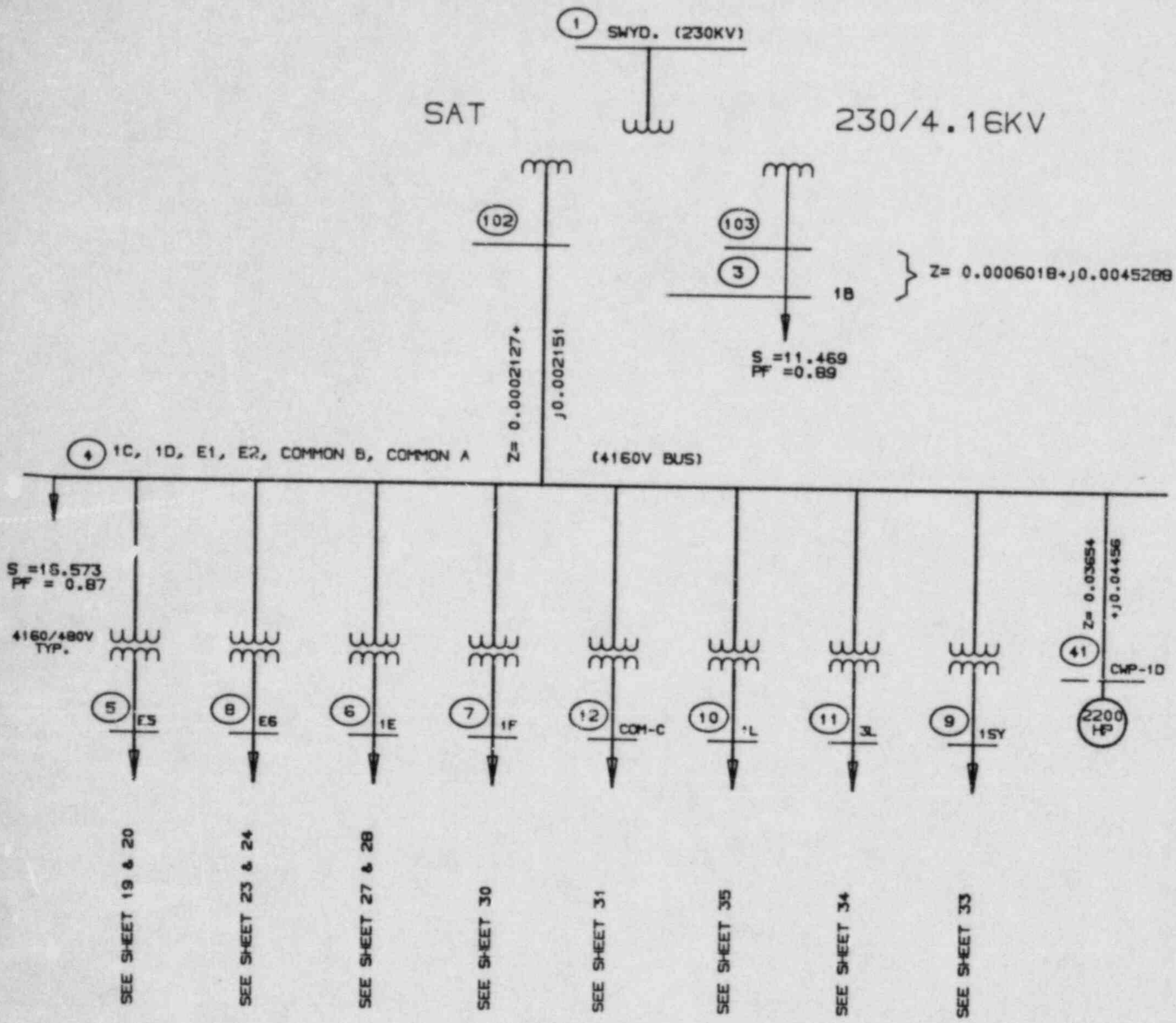
PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 1 OF 36 — REV. NO. 0

E2



SAT FULL LOAD
WITH 4TH CIR. WAT. PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

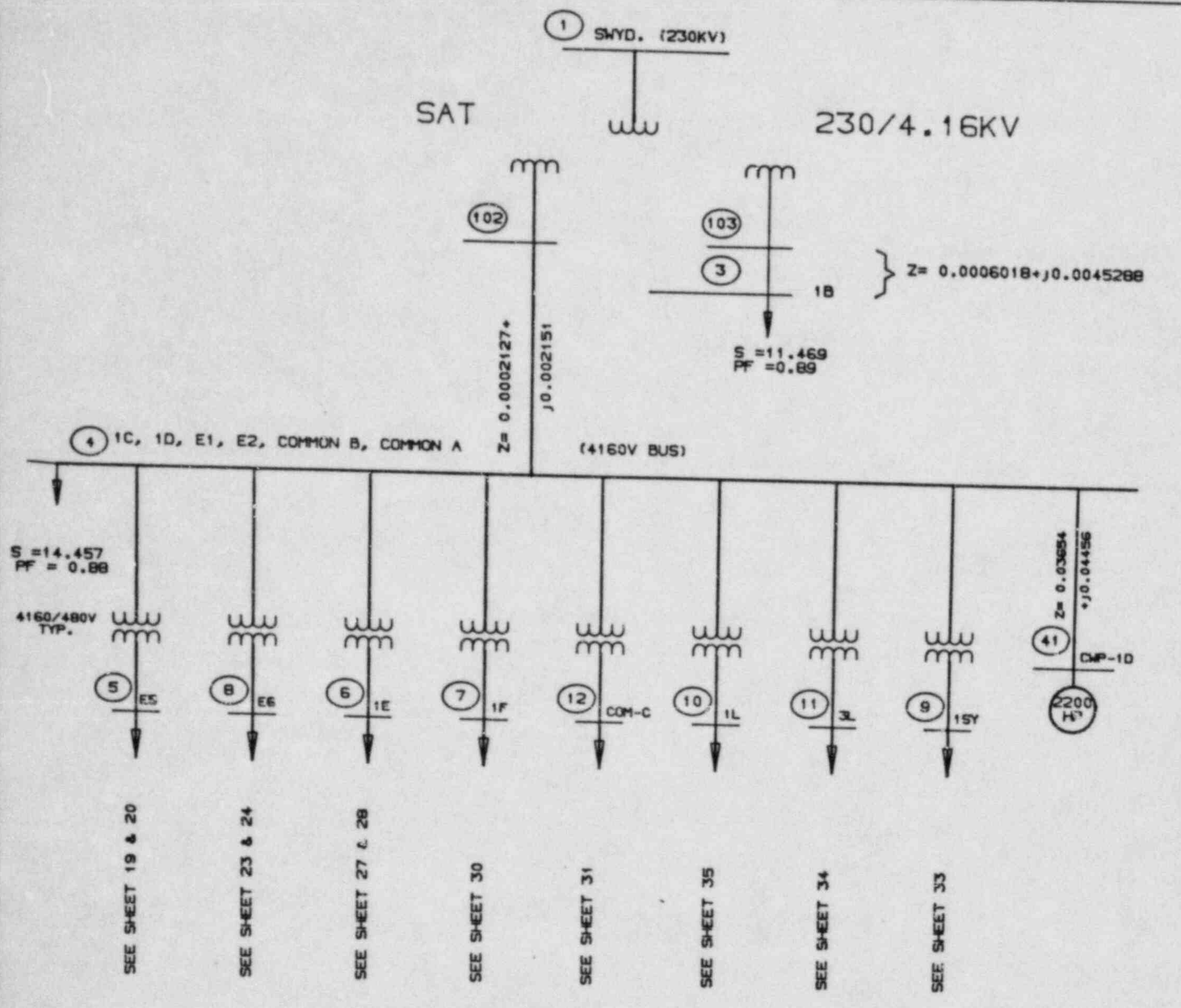
PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	GA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 2 OF 36 — REV. NO. 0

E3



SAT FULL LOAD
WITH 3RD CIR. WAT. PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5 25 84	ISSUE FOR NT-124						

DPE *WK Russell*

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

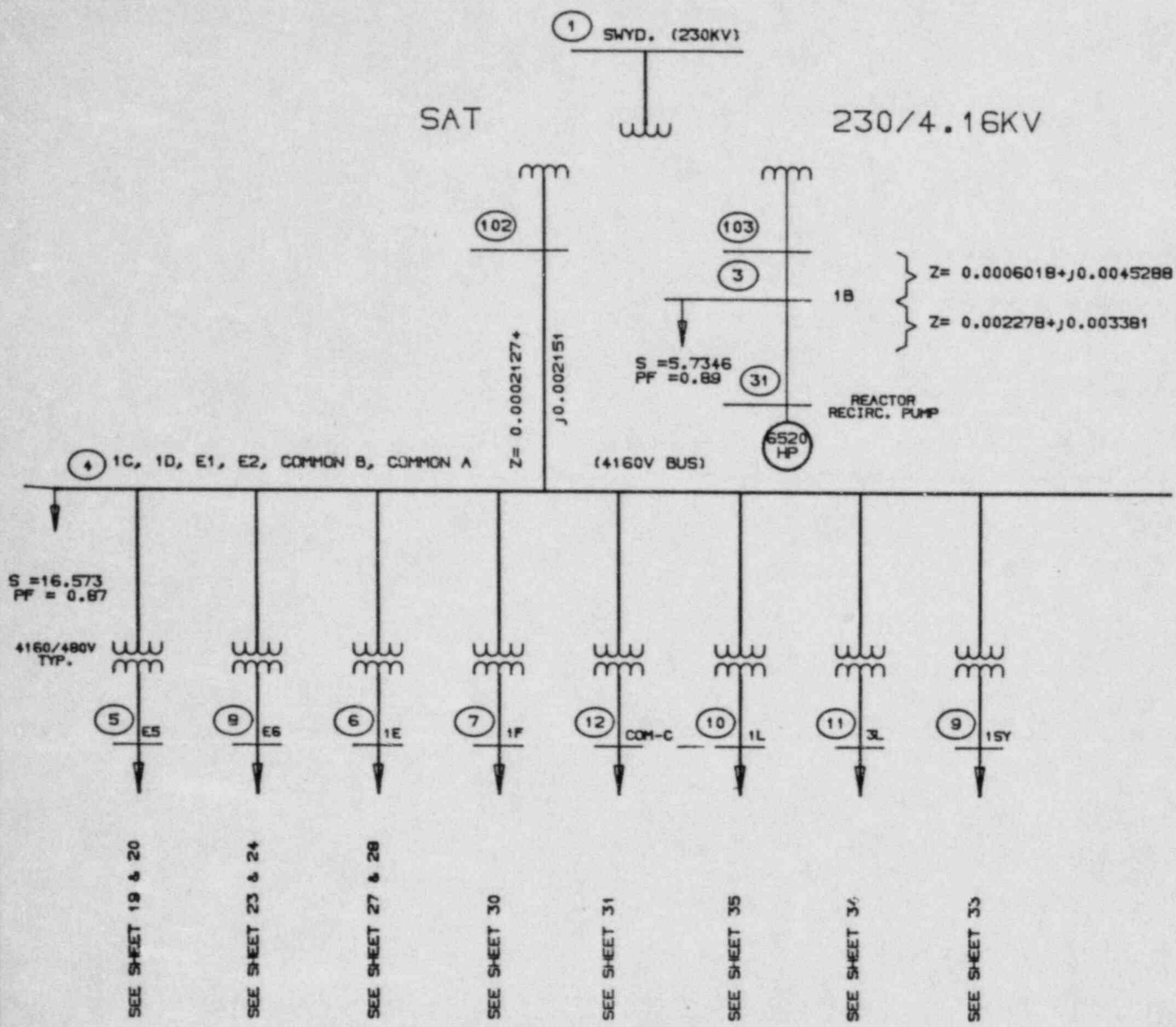
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 3 OF 36 REV. NO.: 0

EA



SAT FULL LOAD
WITH REACTOR RECIRC. PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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DPE: WK Russell

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NUCLEAR SAFETY RELATED

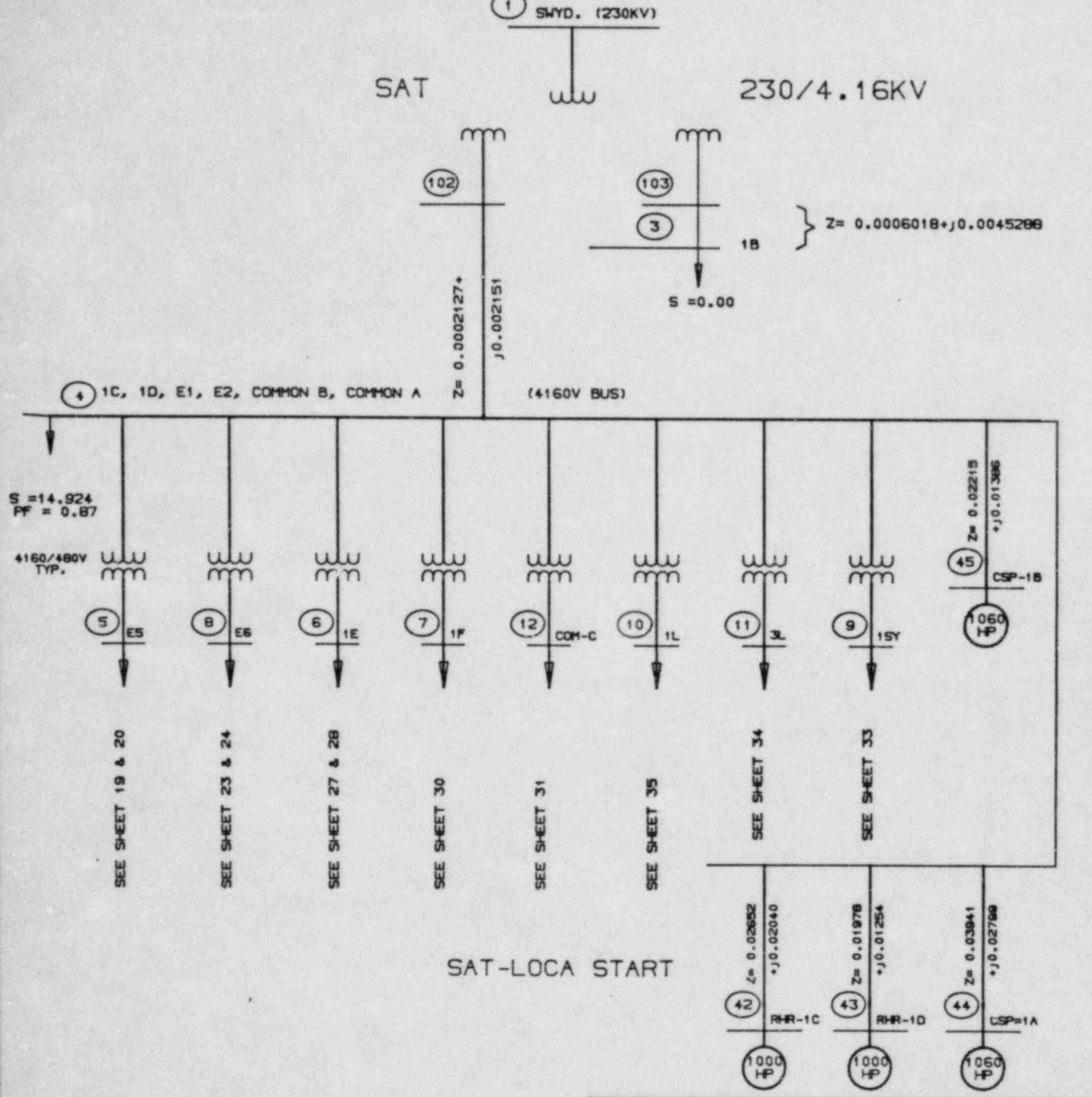
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 4 OF 36 REV. NO. 0



NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

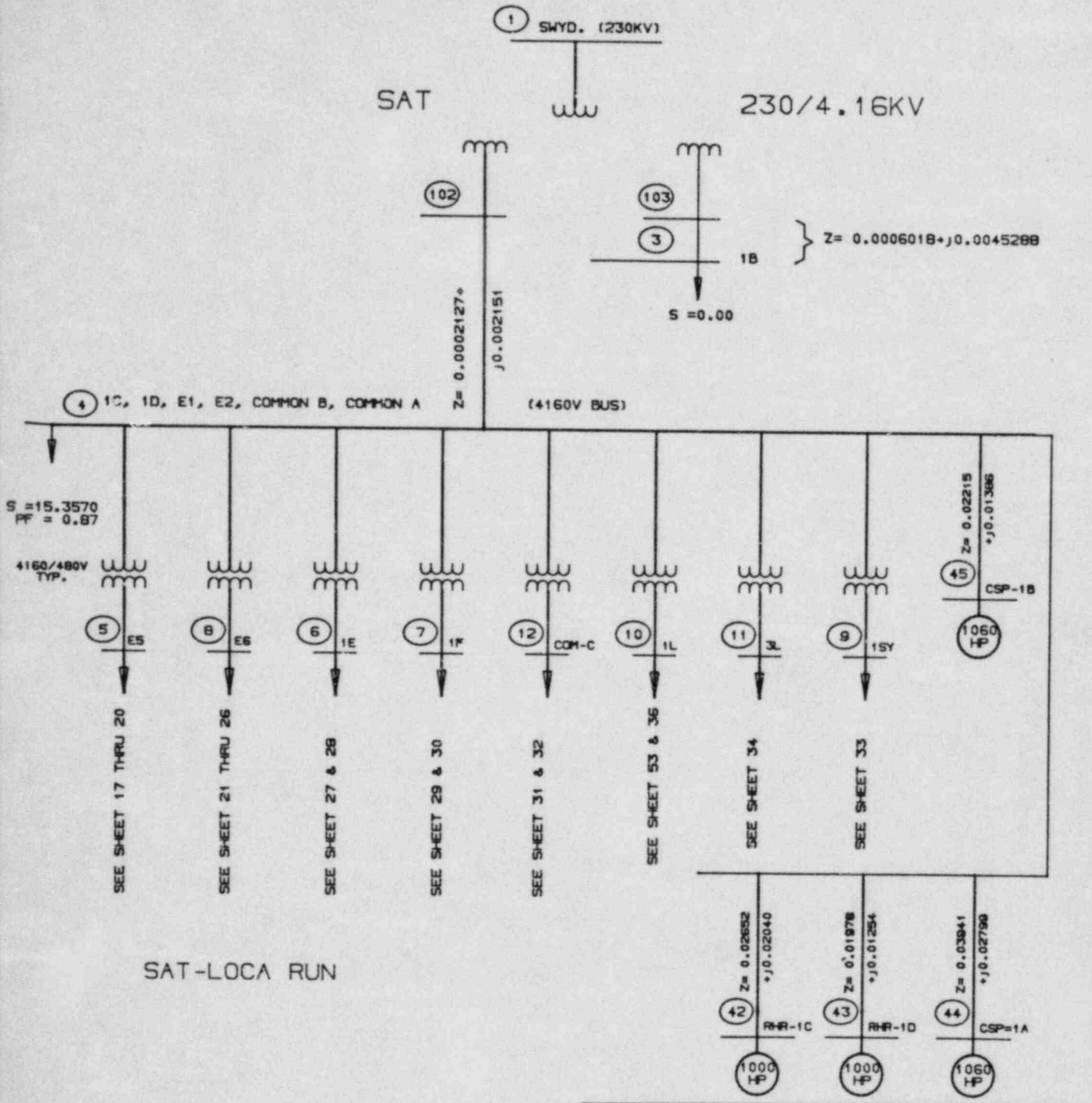
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 5 OF 34 REV. NO.: 0

E6



NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

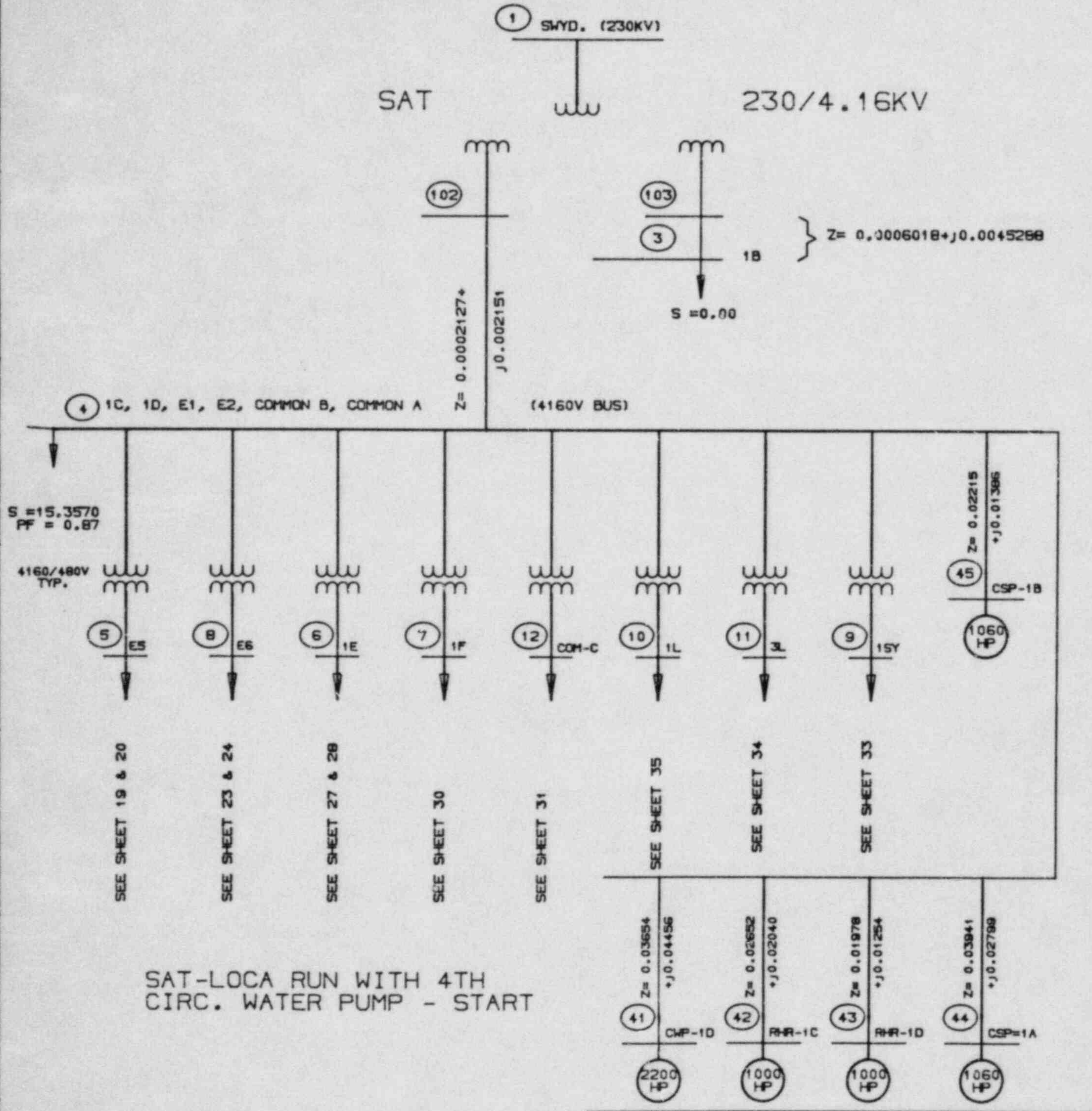
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 6 OF 36 — REV. NO. 0



SAT-LOCA RUN WITH 4TH
CIRC. WATER PUMP - START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 7 OF 36 — REV. NO.: 0

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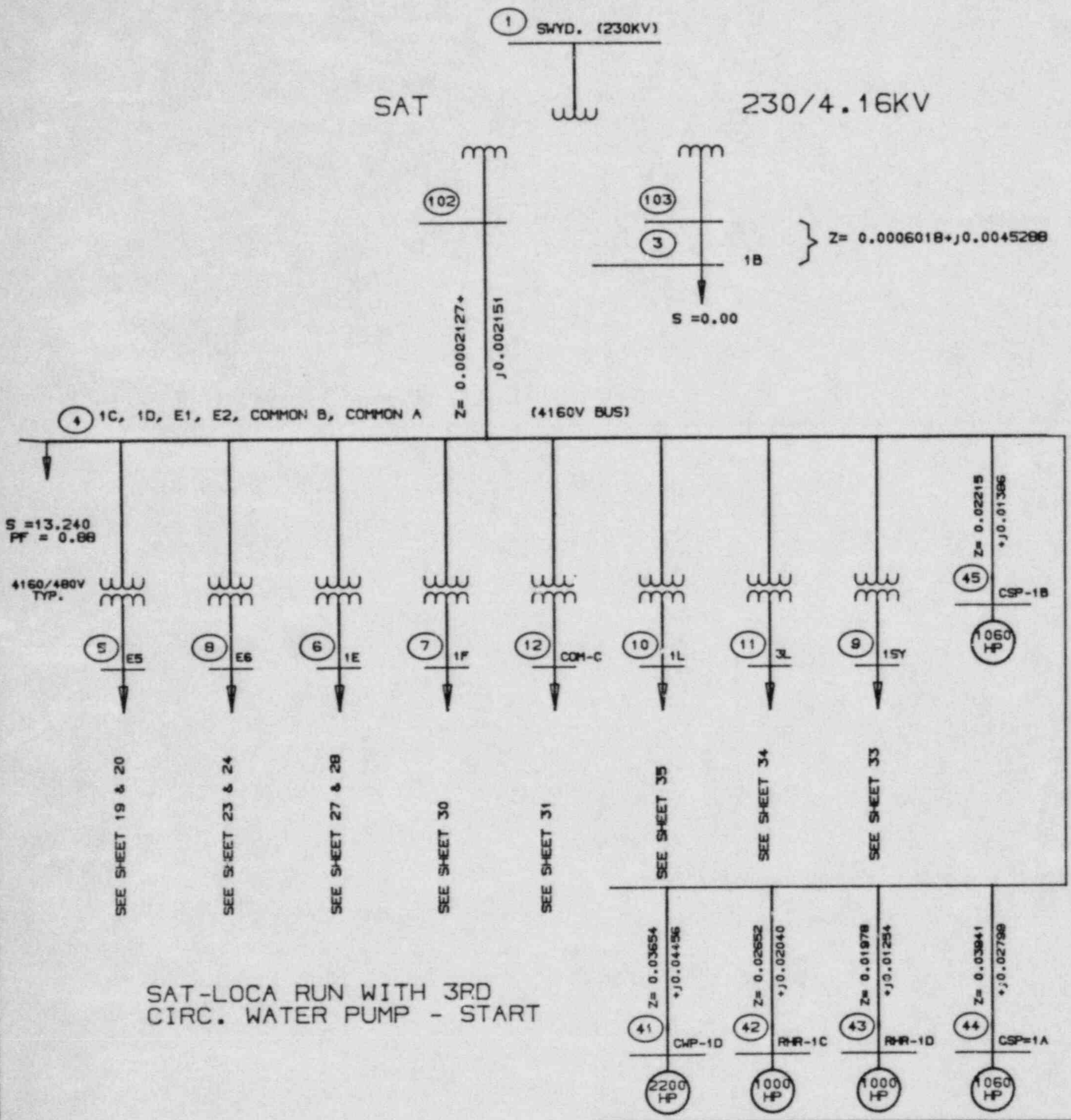

SAT-LOCA RUN WITH 3RD
CIRC. WATER PUMP - START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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DPE: WK Russell

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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

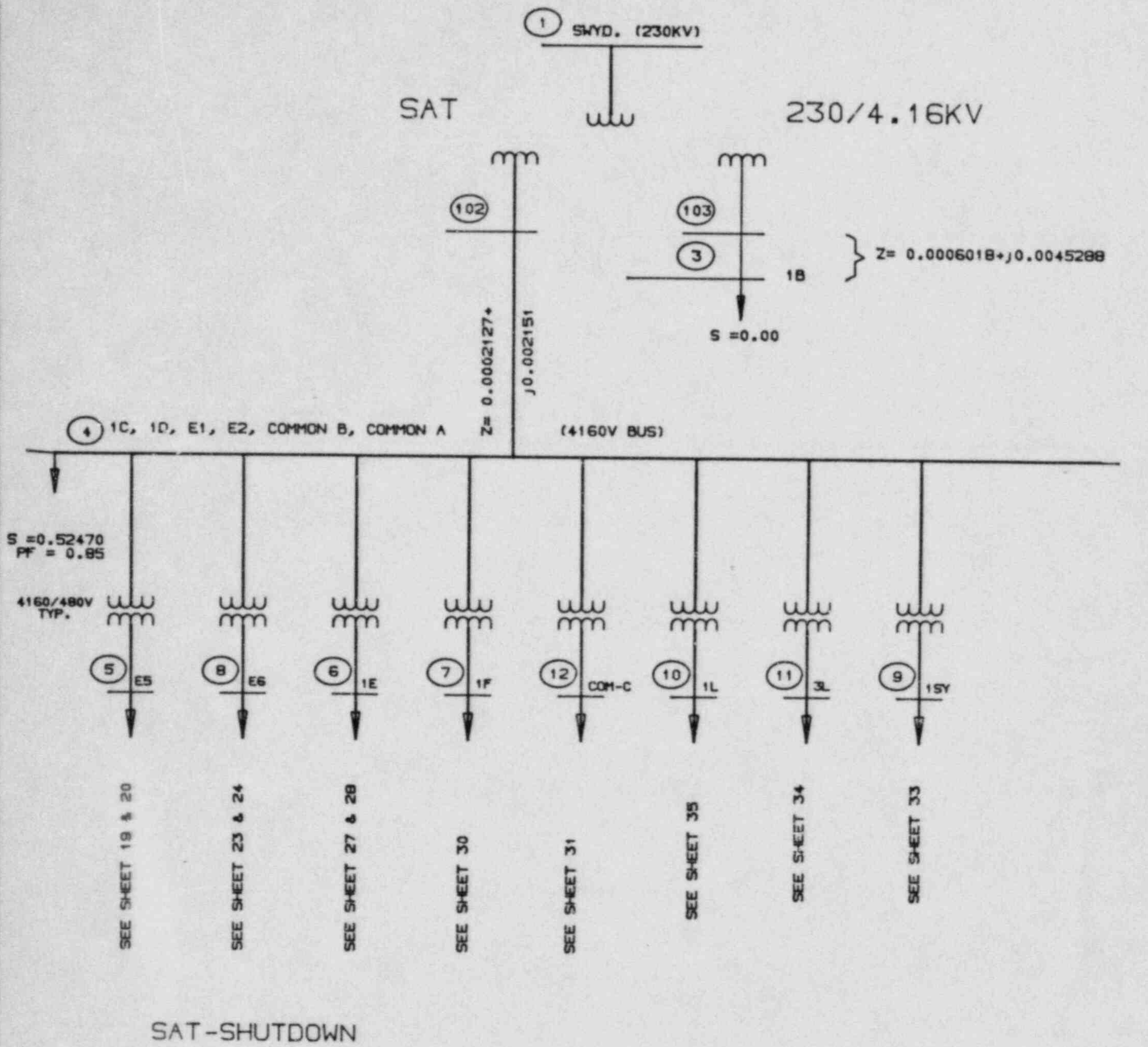
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 8 OF 36 — REV. NO.: 0



NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

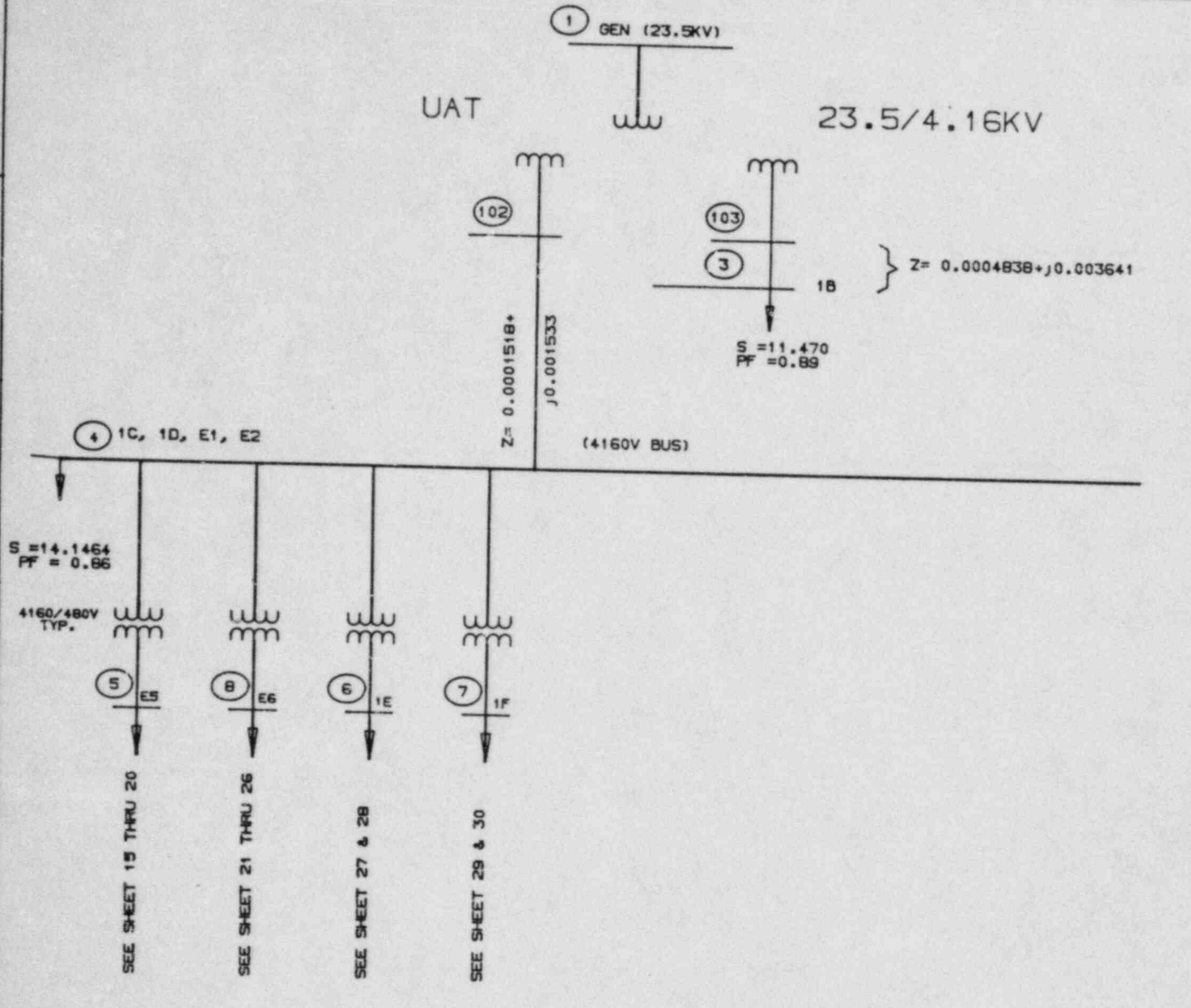
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 9 OF 36 — REV. NO.: 0



UAT FULL LOAD

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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DPE W.K. Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

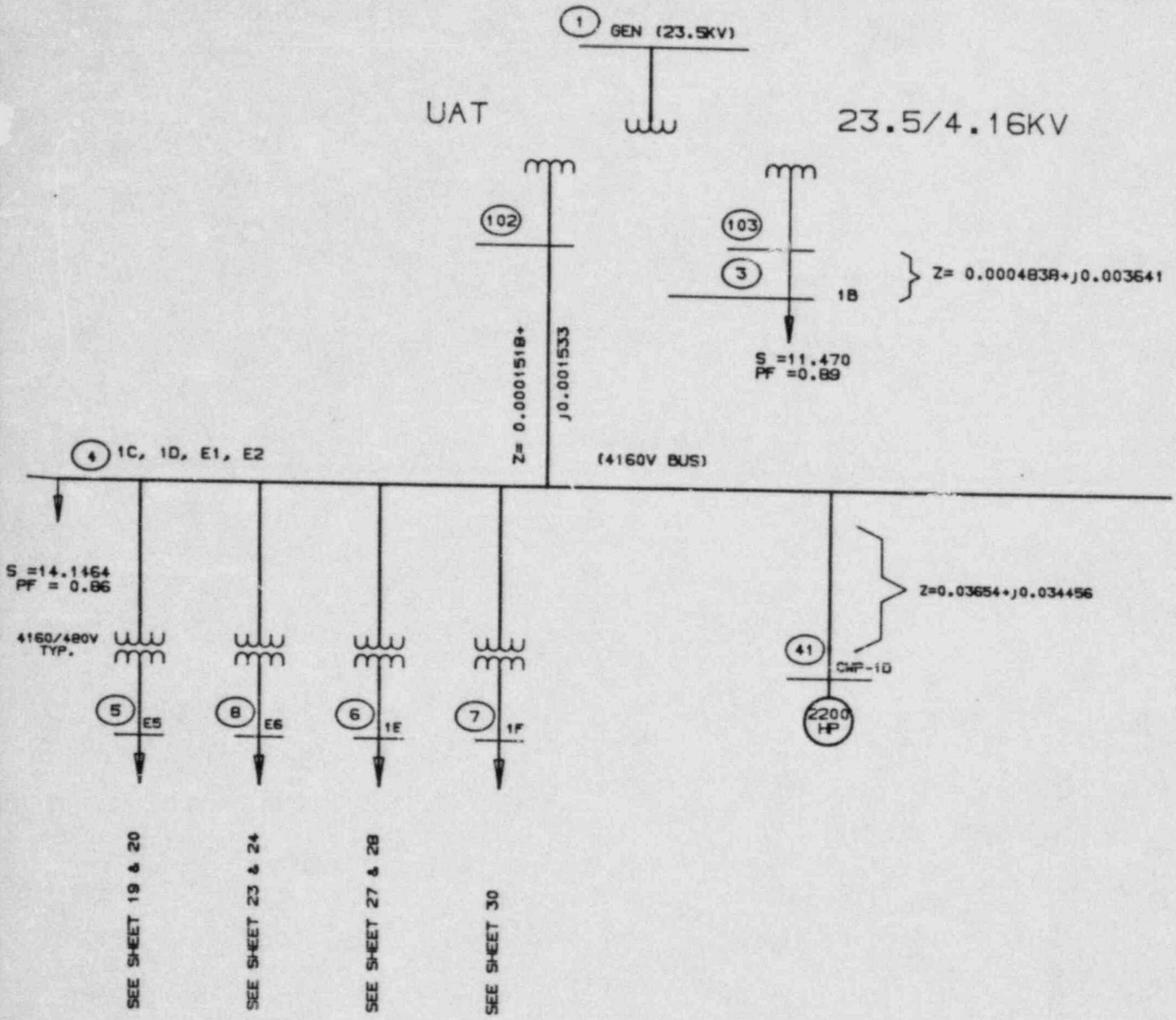
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 10 OF 36 REV. NO. 0



UAT FULL LOAD WITH 4TH
CIRC. WATER PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP ARE IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG		WKR			

DPE: W K Russell

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NUCLEAR SAFETY RELATED

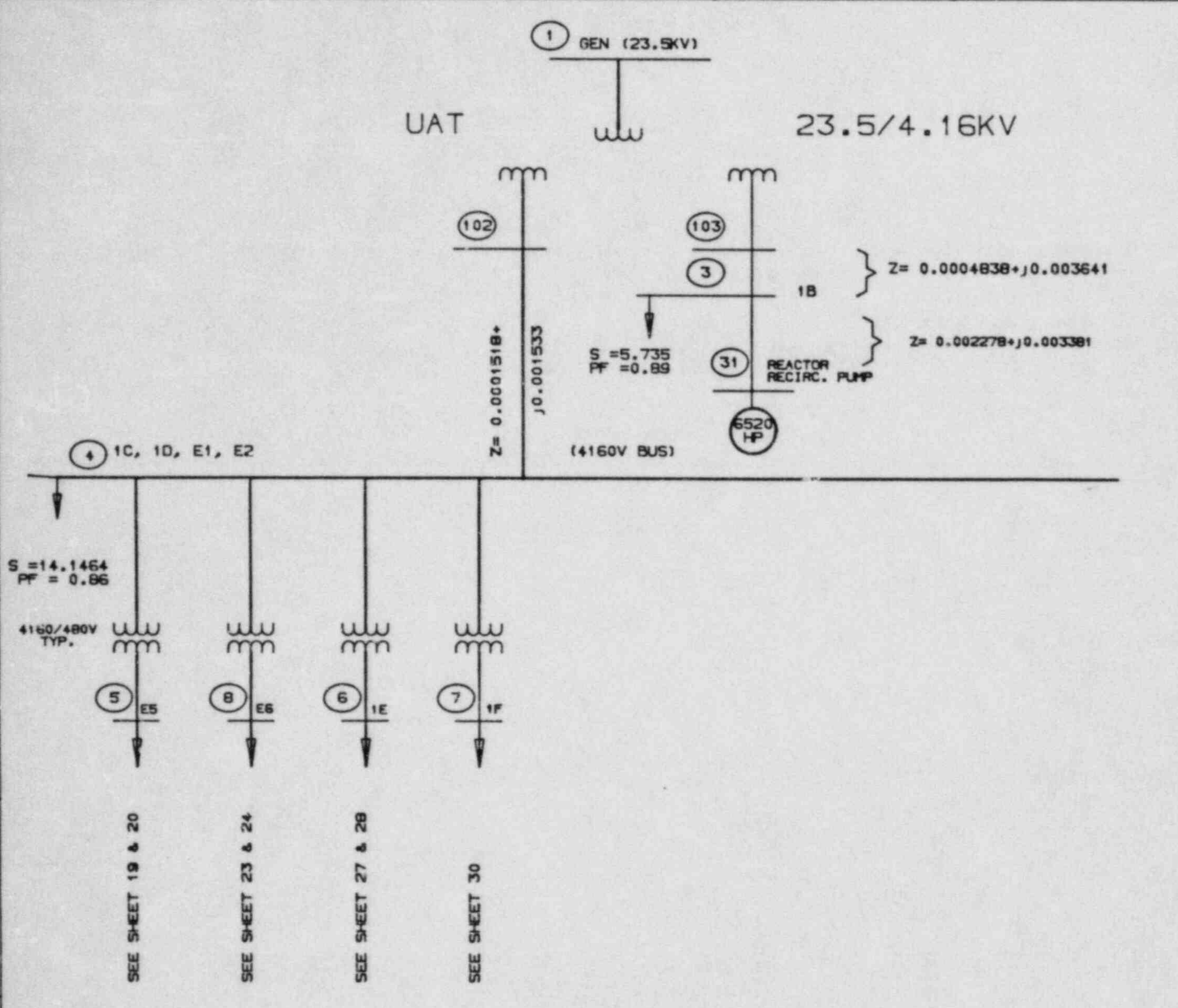
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 11 OF 36 — REV. NO. 0



UAT FULL LOAD WITH
REACTOR RECIRC. PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124						

DPE: W.K. Russell

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NUCLEAR SAFETY RELATED

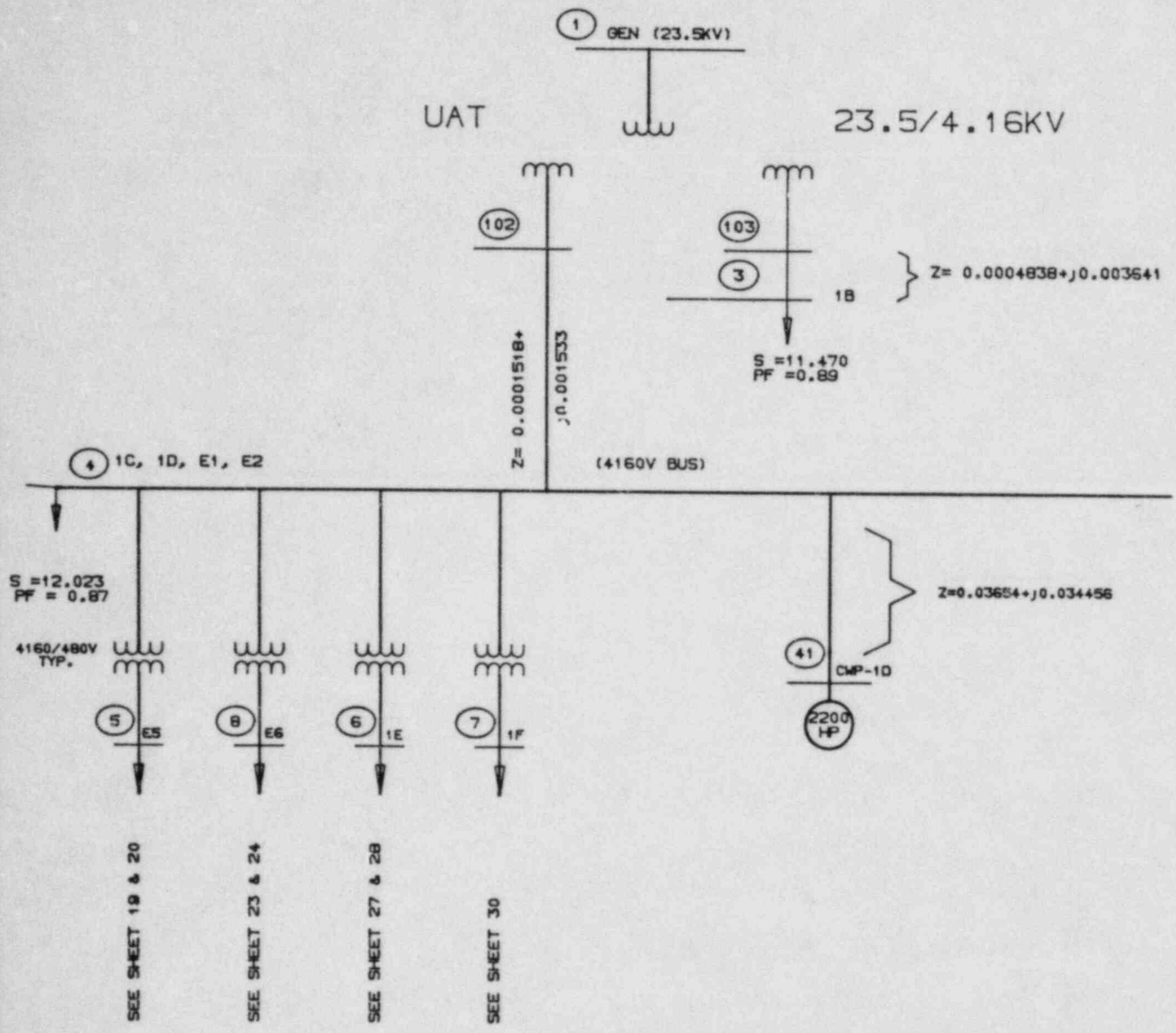
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP   UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002   SCALE: NONE   SHEET 12 OF 36   REV. NO. 0



UAT FULL LOAD WITH 3RD
CIRCULATING WATER PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	OPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

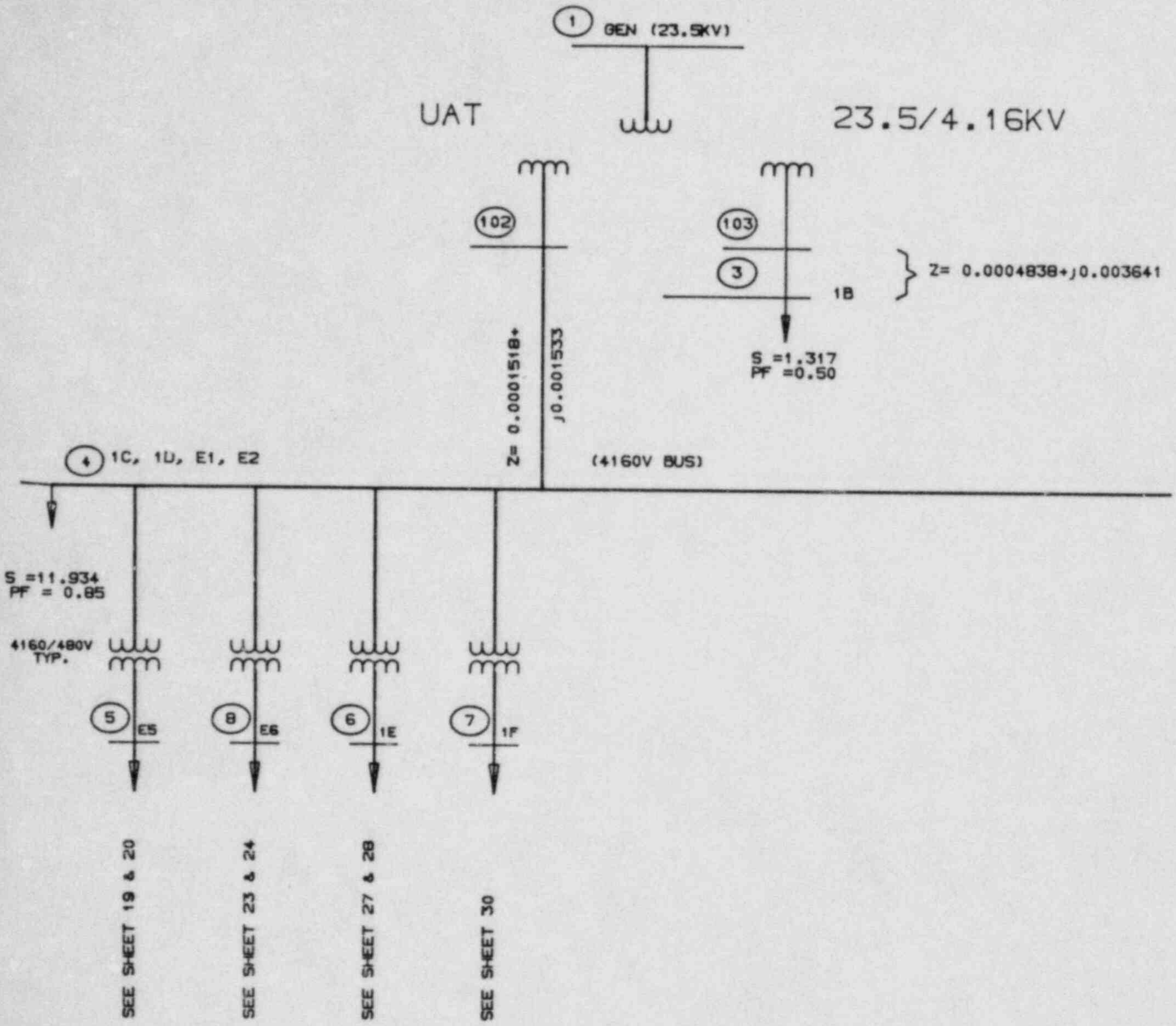
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 13 OF 36 REV. NO. 0

EIA



UAT LIGHT LOAD

NOTES:

1. IMPEDANCES ARE IN OHMS
2. LOADS (S) ARE IN MVA
3. ◯ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

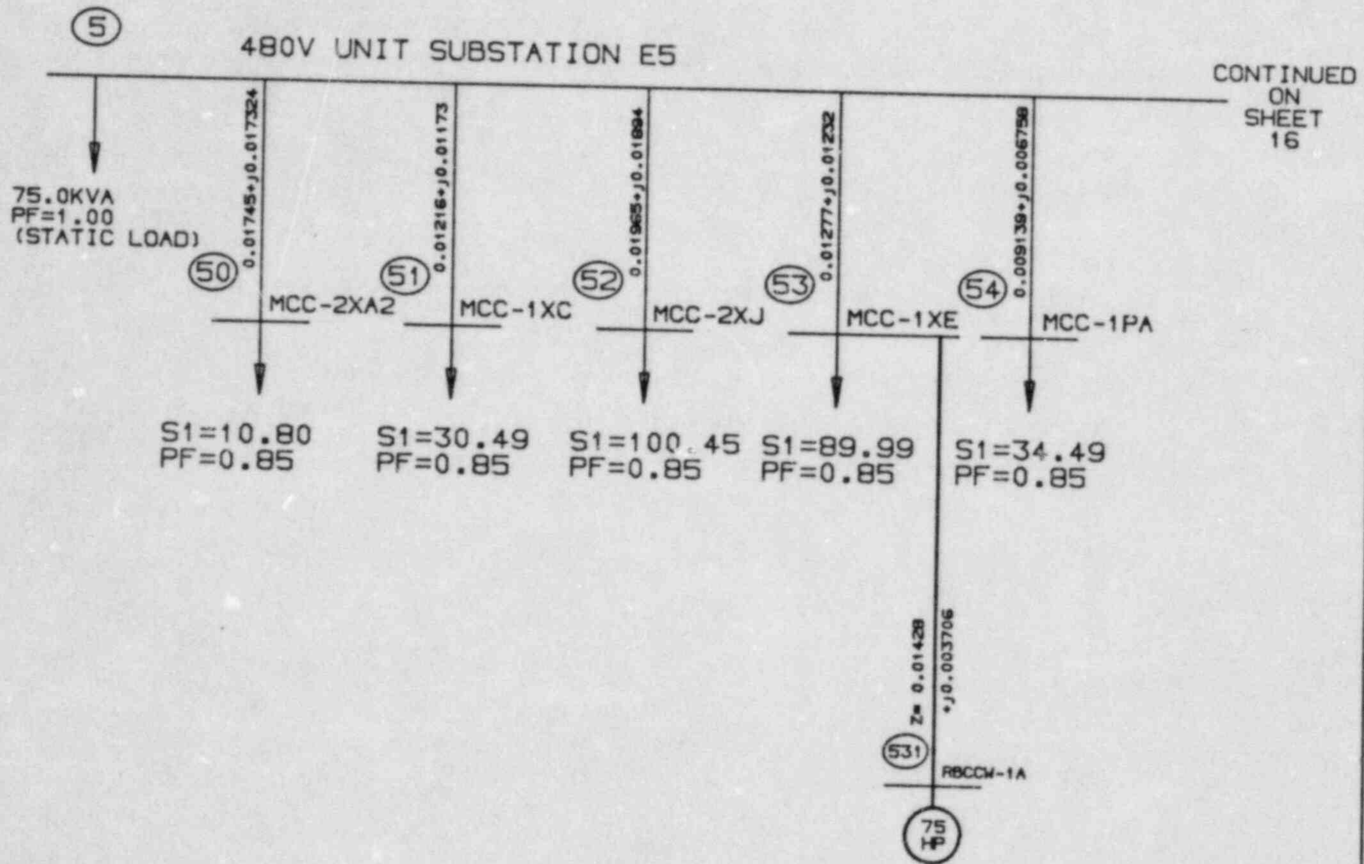
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 14 OF 36 REV. NO. 0

E15



480V UNIT SUBSTATION "E5" LOADS
RBCCW-1A PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. S1 = LOADS AT FULL LOAD IN KVA
3. ○ REFERENCES COMPUTER MODEL BUS #
4. HP IS DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG	ENL	HITN	WKR		HITN

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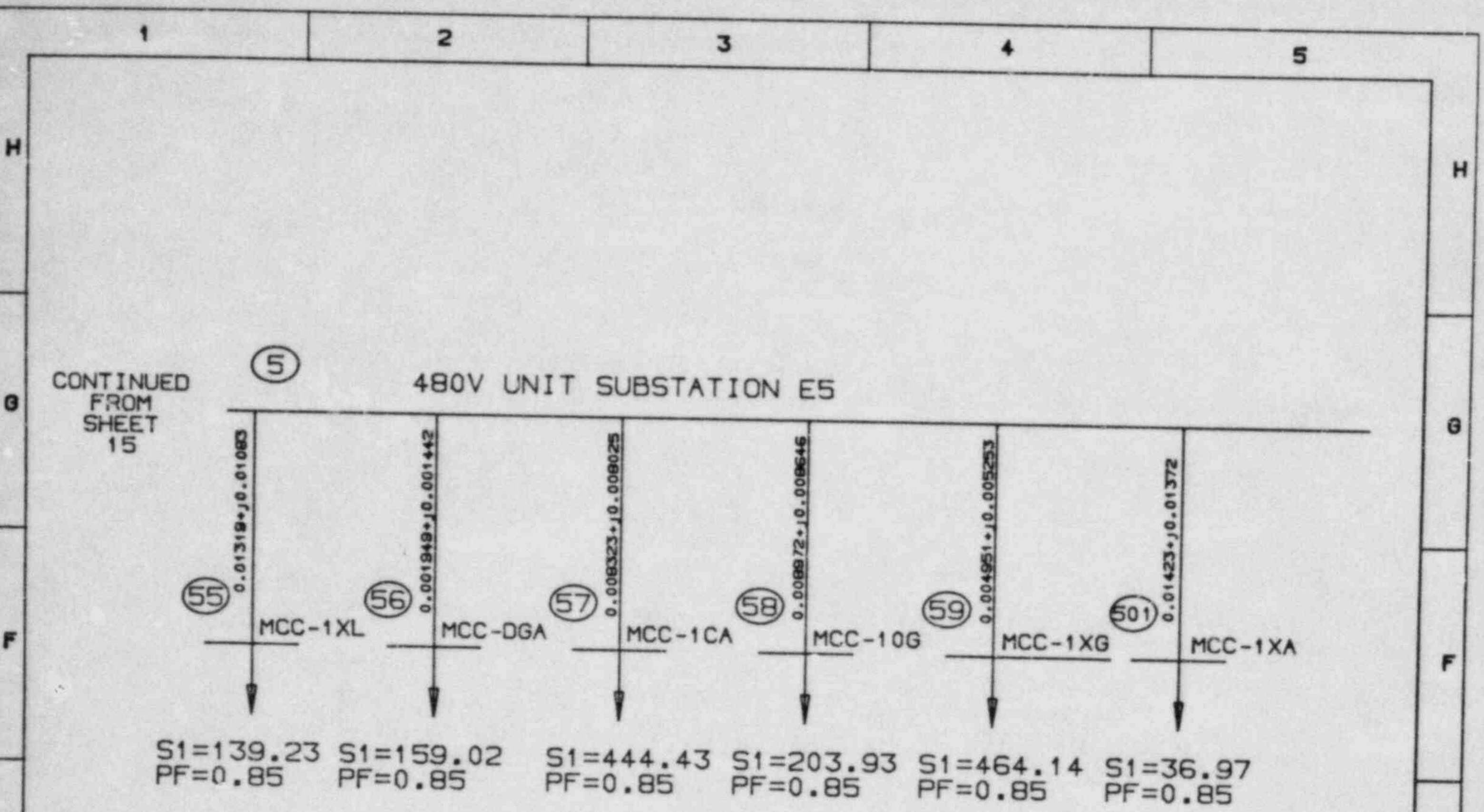
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 15 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "E5" LOADS
RBCCW-1A PUMP START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. S1 = LOADS AT FULL LOAD IN KVA
3. ○ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN	CK	PE	DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

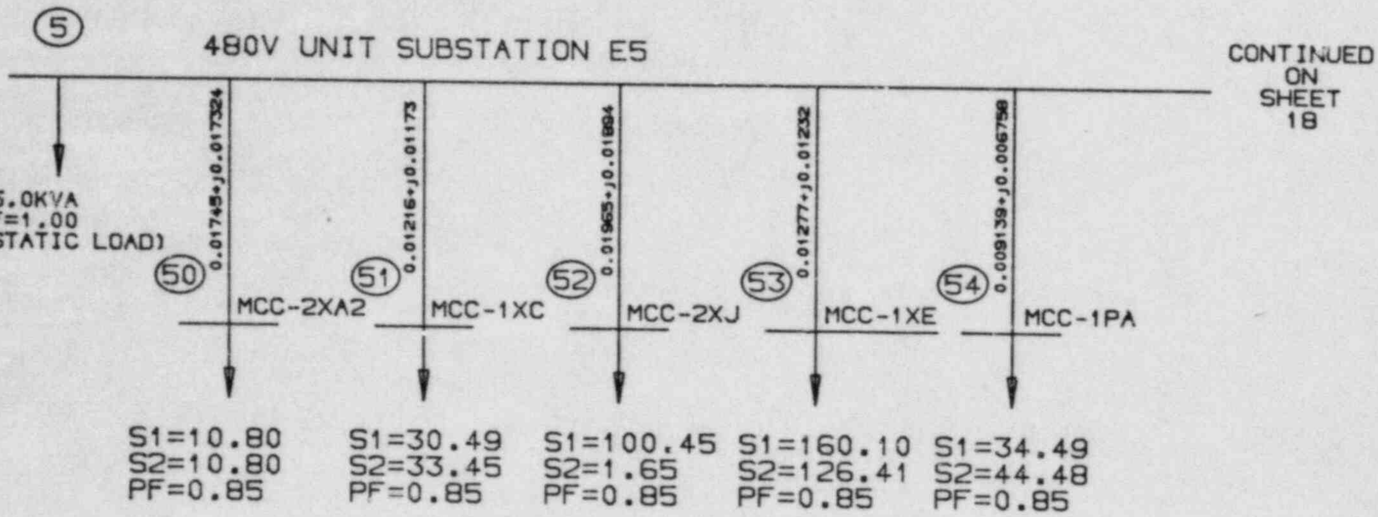
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 16 OF 36 REV. NO. 0



480V UNIT SUBSTATION "E5" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ○ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

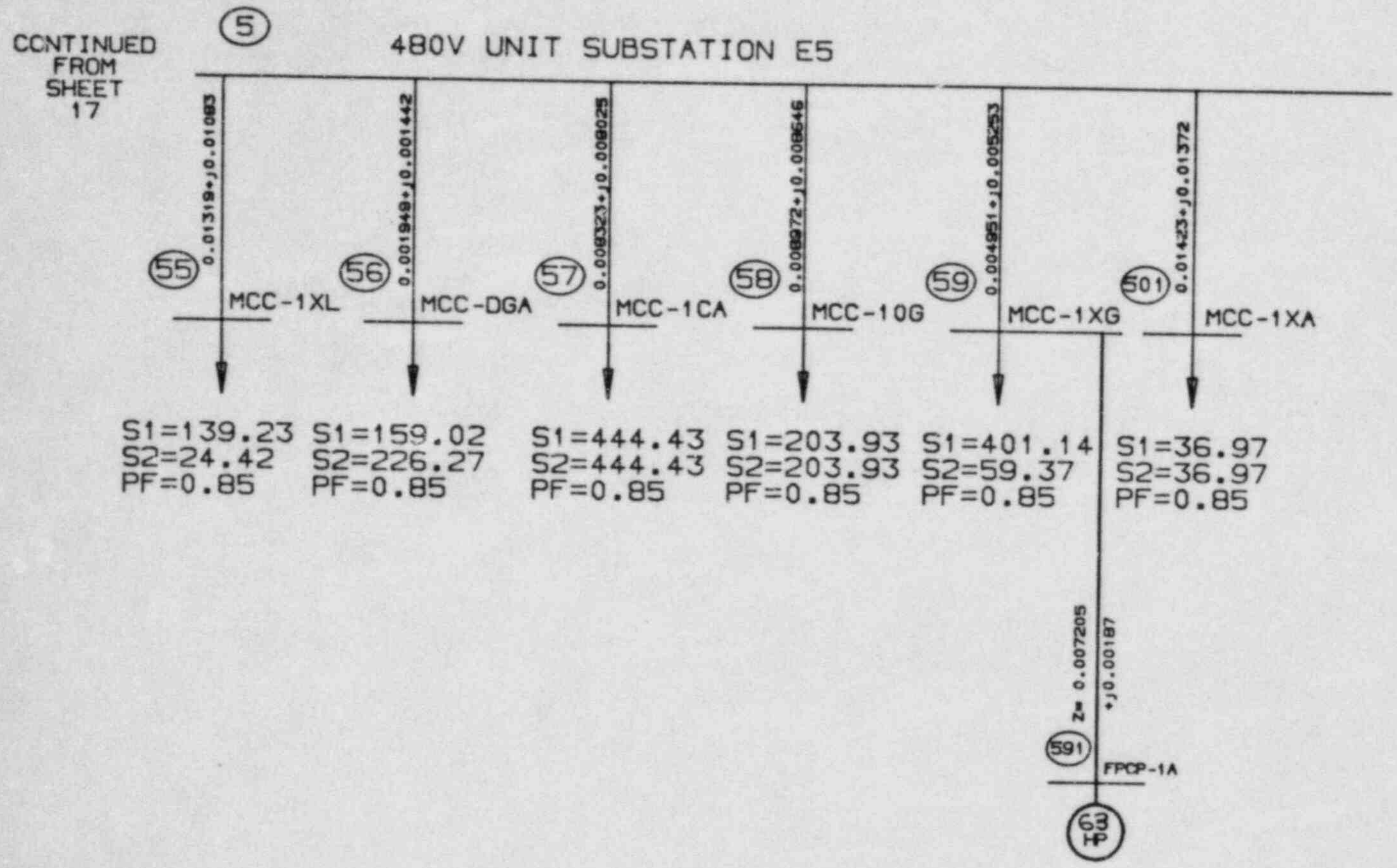
PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	GA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 17 OF 36 — REV. NO. 0

1 2 3 4 5



480V UNIT SUBSTATION "E5" LOADS
FUEL POOL COOLING PUMP-1A PUMP START

NOTES:

1. IMPEDANCES OR IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5 25 84	ISSUE FOR NT-124			WKR			

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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

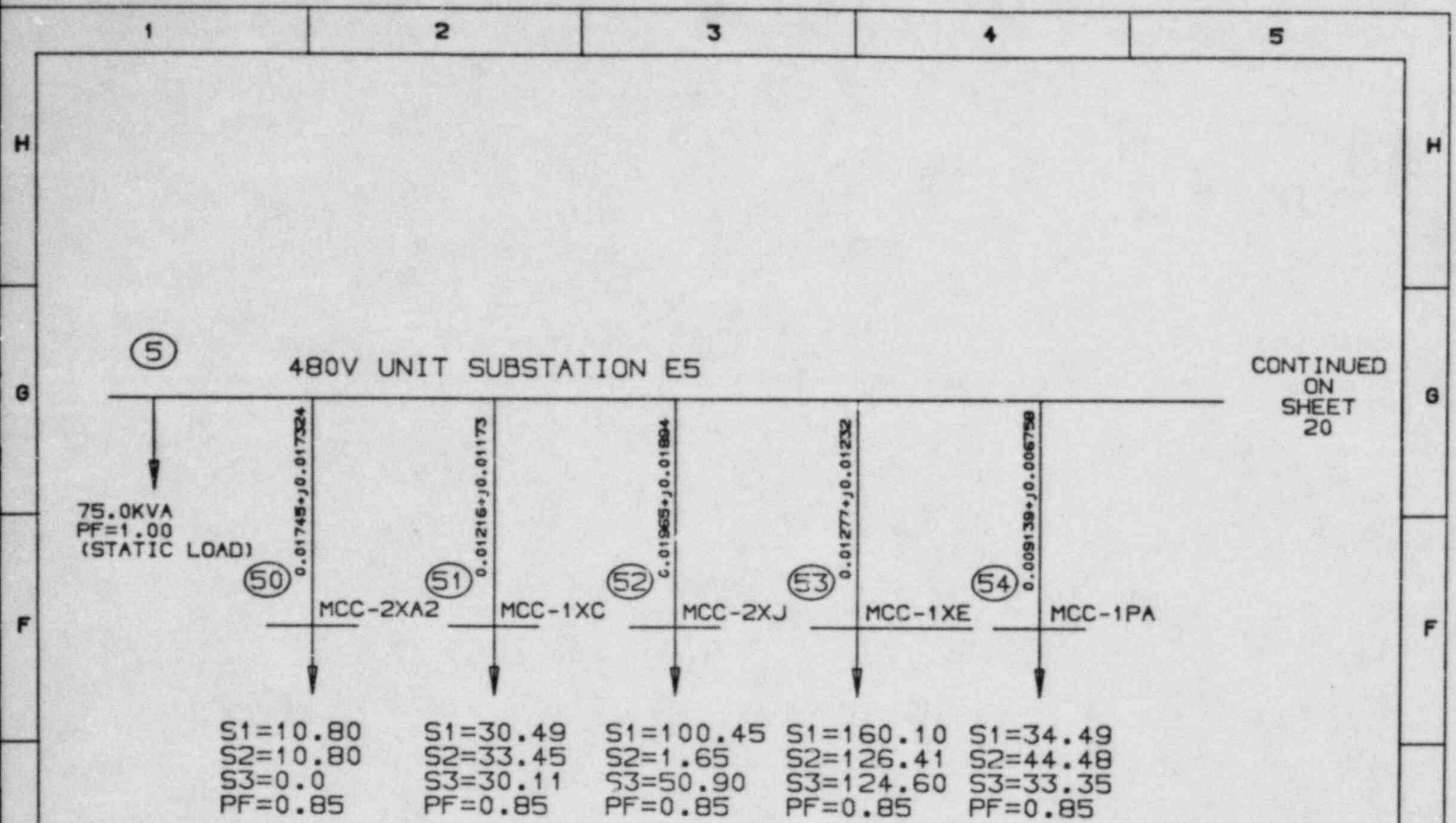
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 18 OF 36 REV. NO. 0

E19



480V UNIT SUBSTATION "E5" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	QA	STRUC	NUC	MECH	ELECT	I&C

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
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DPE: WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

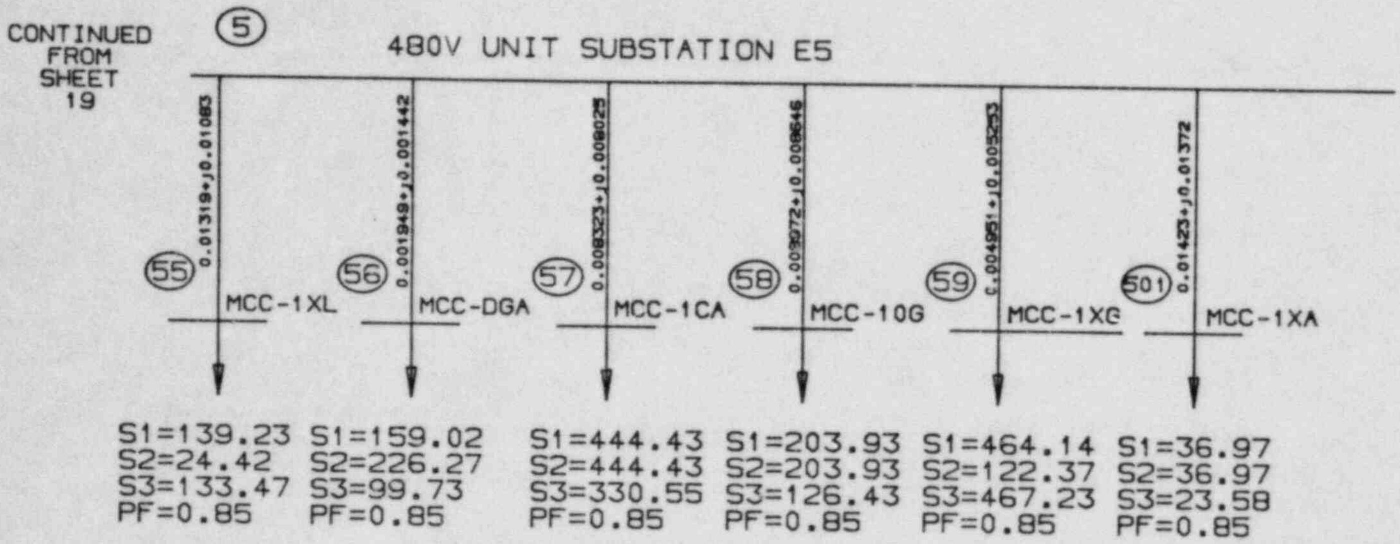
TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO.: T124-E-3002

SCALE: NONE

SHEET 19 OF 36

REV. NO.: 0



480V UNIT SUBSTATION "E5" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	OPE	DPPE	LE
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PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

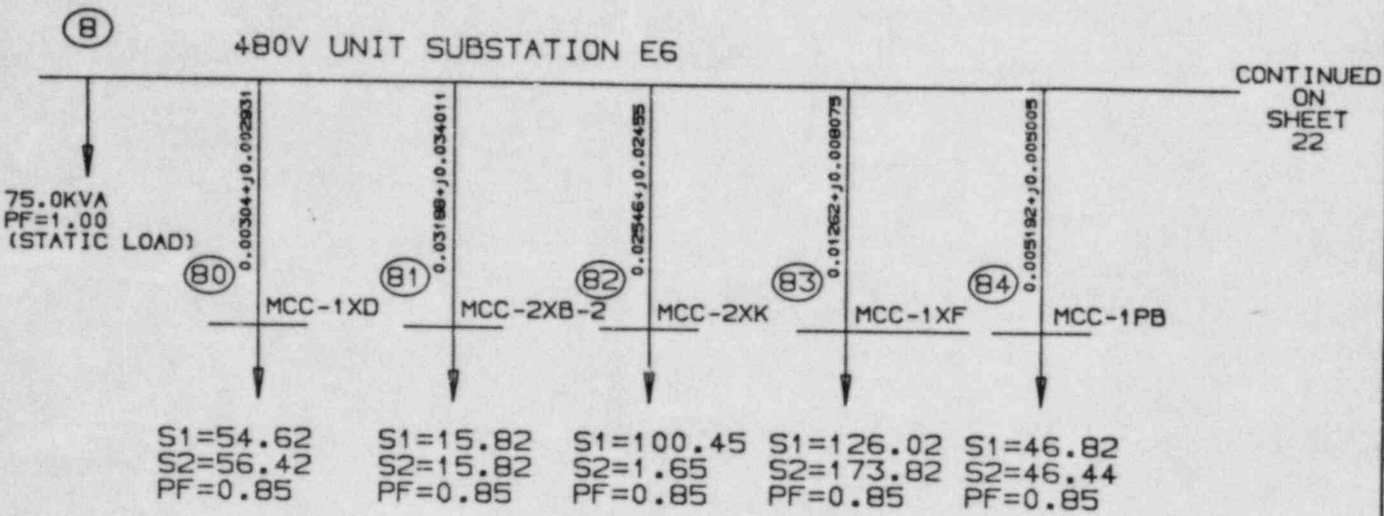
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 20 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "E6" LOADS
FUEL POOL COOLANT PUMP - 1B START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LR
0	5/25/84	ISSUE FOR NT-124						

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

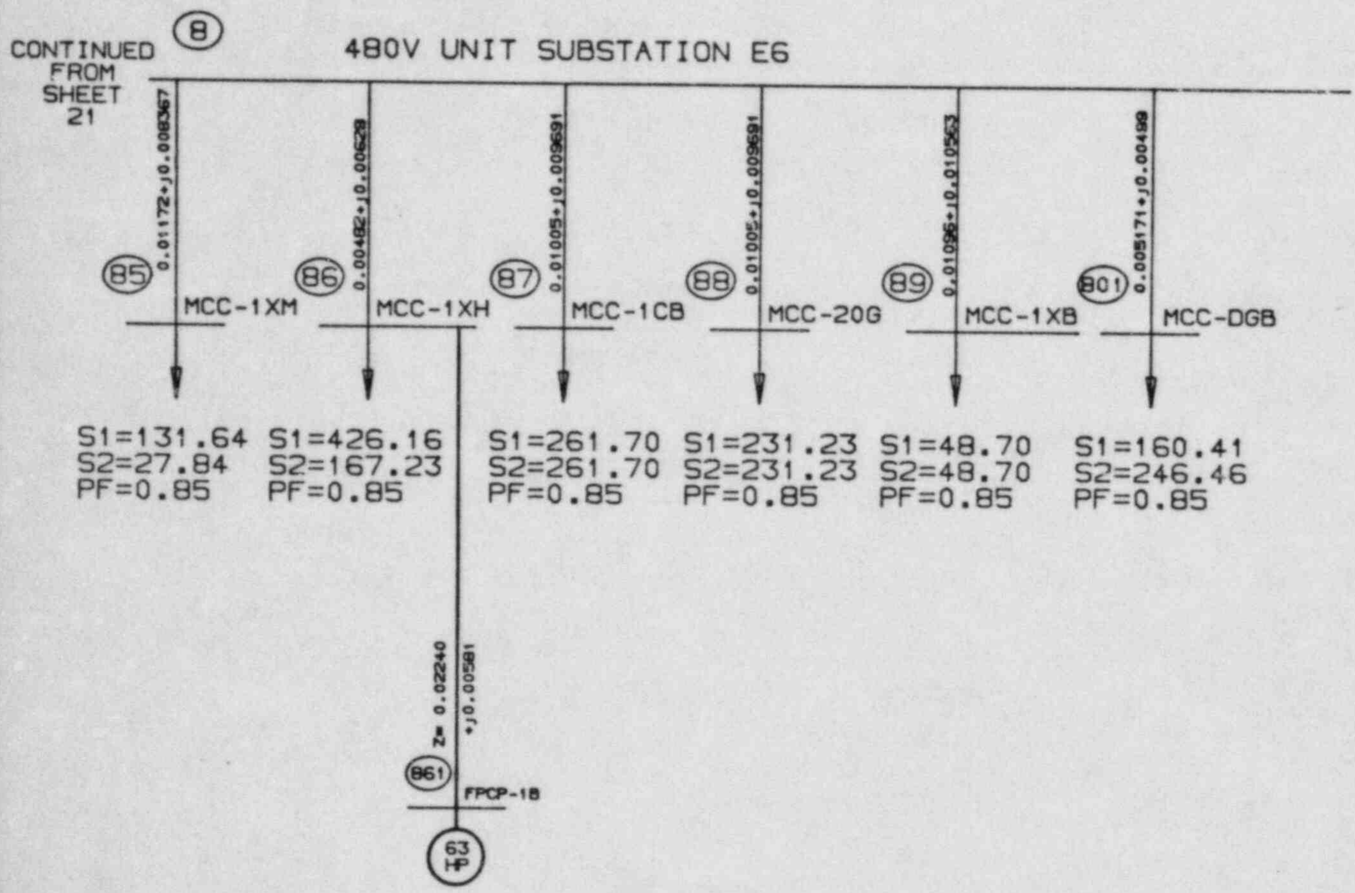
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 21 OF 36 REV. NO.: 0



480V UNIT SUBSTATION "E6" LOADS
FUEL POOL COOLANT PUMP - 1B START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124						

DPE WK Russel

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

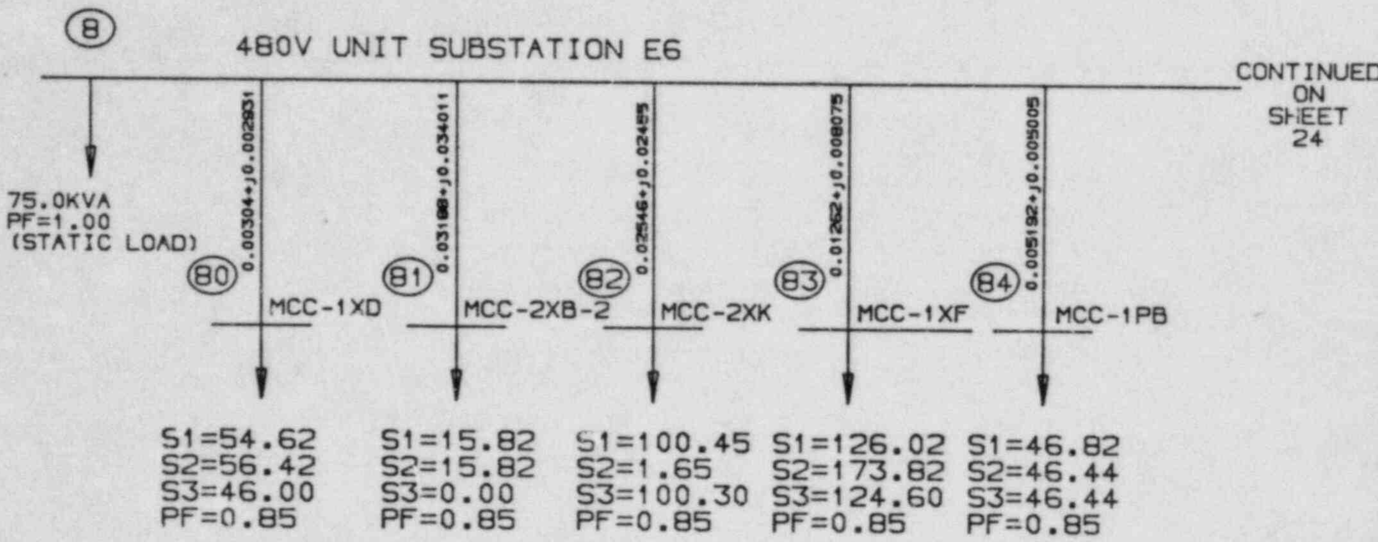
PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 22 OF 36 — REV. NO. 0

E23



480V UNIT SUBSTATION "E6" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE
0	5/25/84	ISSUE FOR NT-124				

DPE: WKRussell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

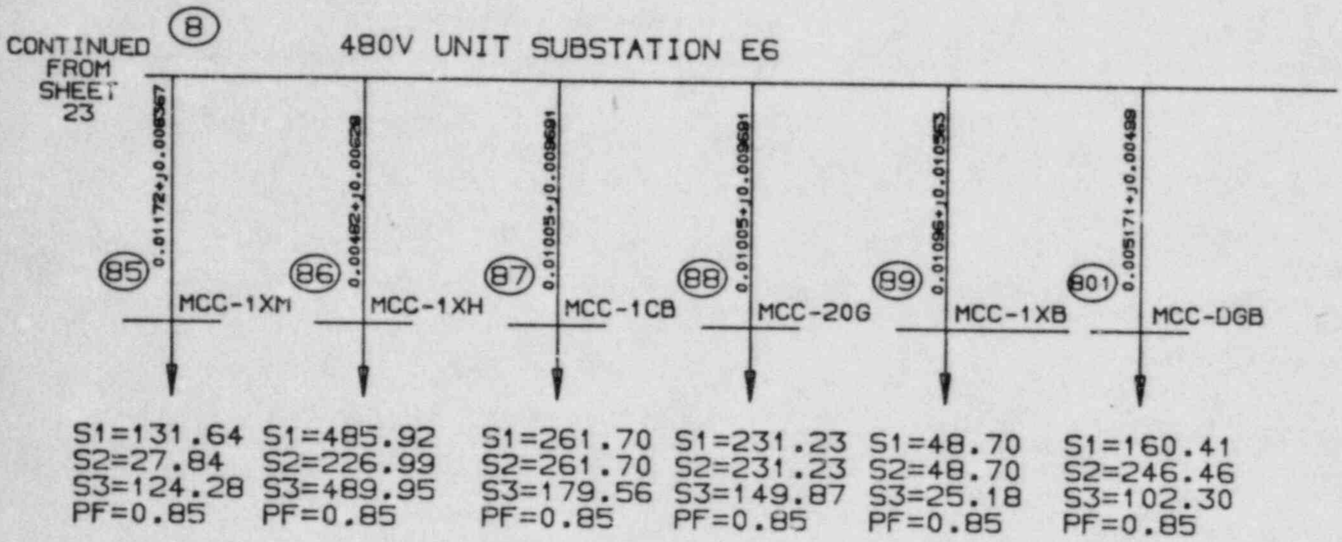
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 23 OF 36 REV. NO. 0



480V UNIT SUBSTATION "E6" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG / ENP	TTN / WKR		TTN

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

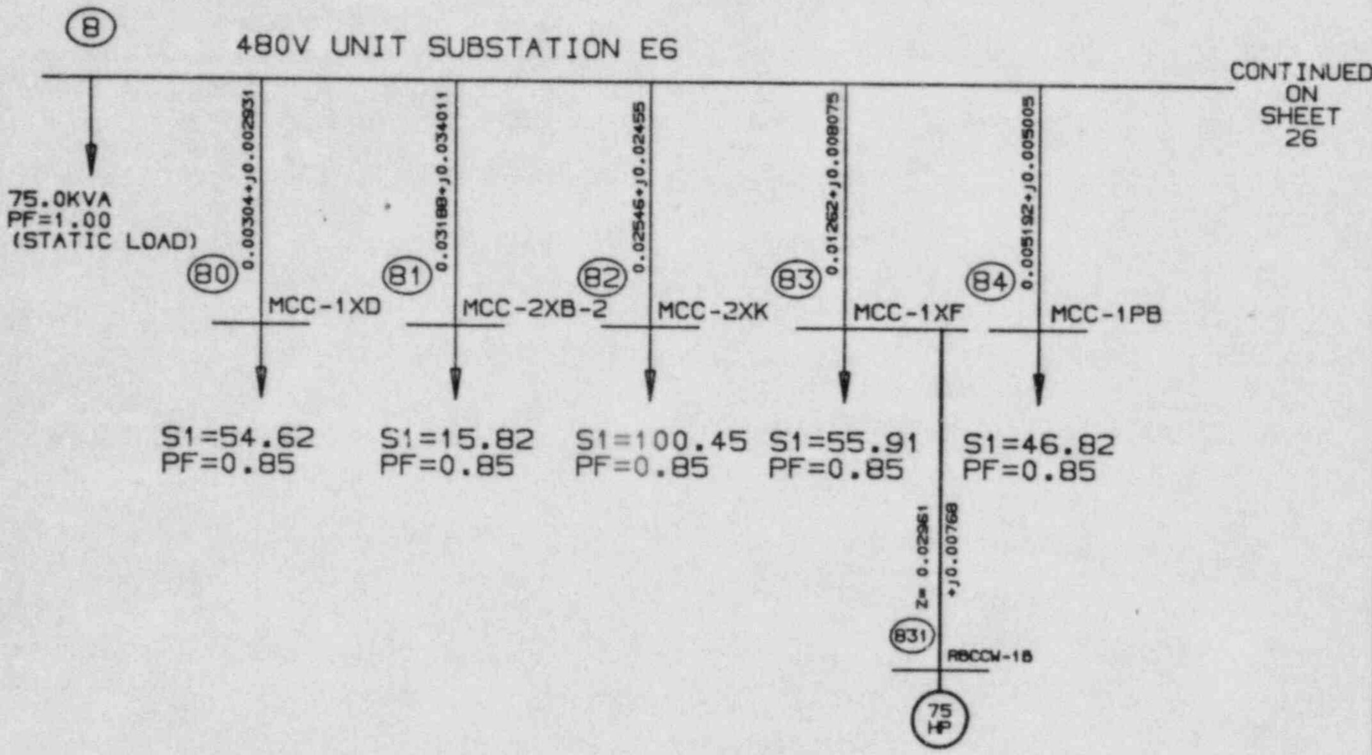
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 24 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "E6" LOADS
RBCCW PUMP - 1B START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG	HTTN	WKR		R	HTTN

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

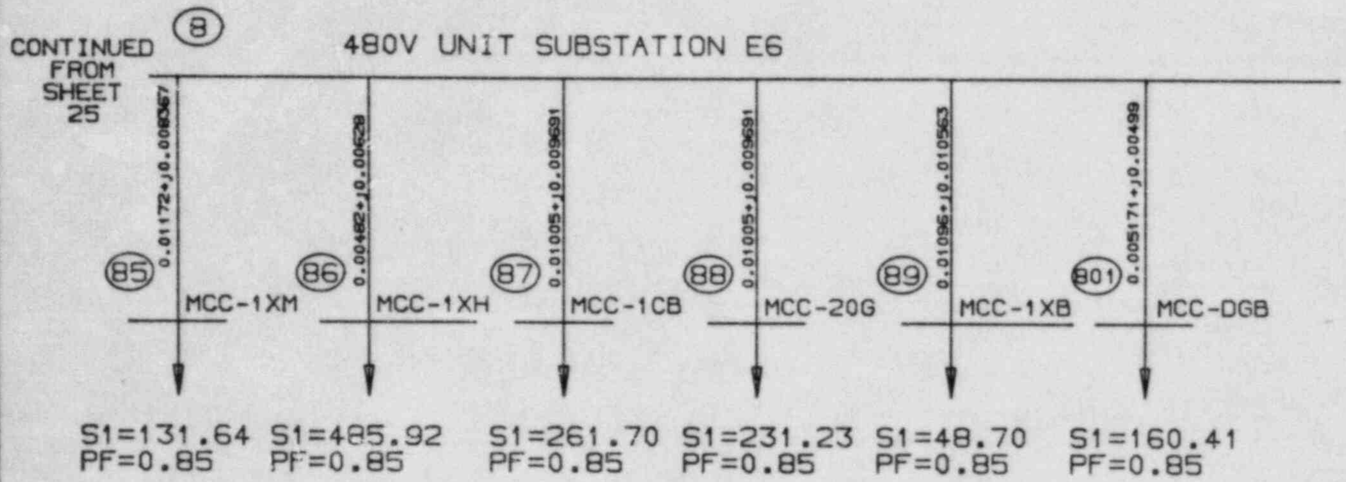
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 25 OF 36 REV. NO.: 0



480V UNIT SUBSTATION "E6" LOADS
RBCCW PUMP - 1B START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124						

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

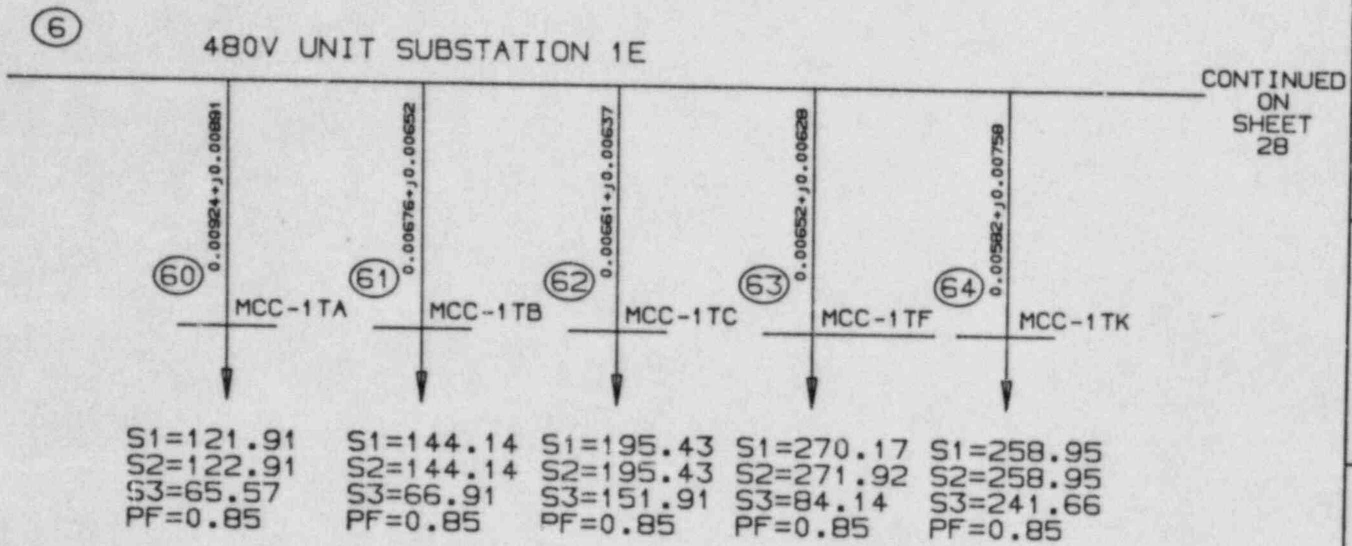
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 SCALE: NONE SHEET 26 OF 36 REV. NO.: 0



480V UNIT SUBSTATION "1E" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ○ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5 25 84	ISSUE FOR NT-124						

DPE WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

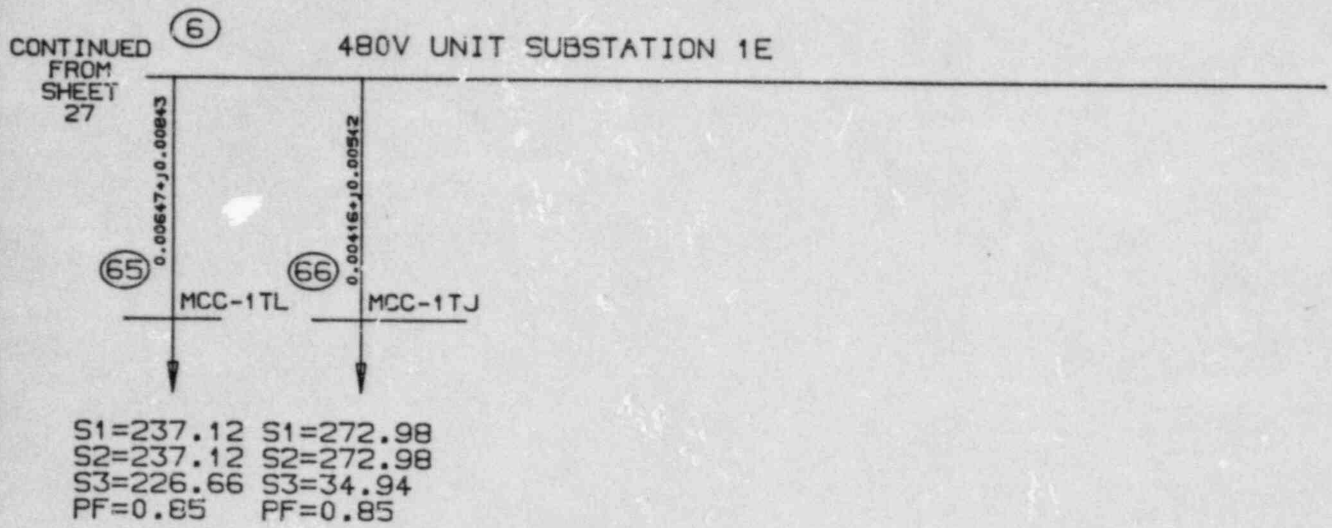
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 27 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "1E" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

ISSUE FOR NT-124

REV | DATE | DESCRIPTION | DWN | CK | RE | DPE | DPPE | LE

DPE WK Russell

PROFESSIONAL ENGINEER   REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

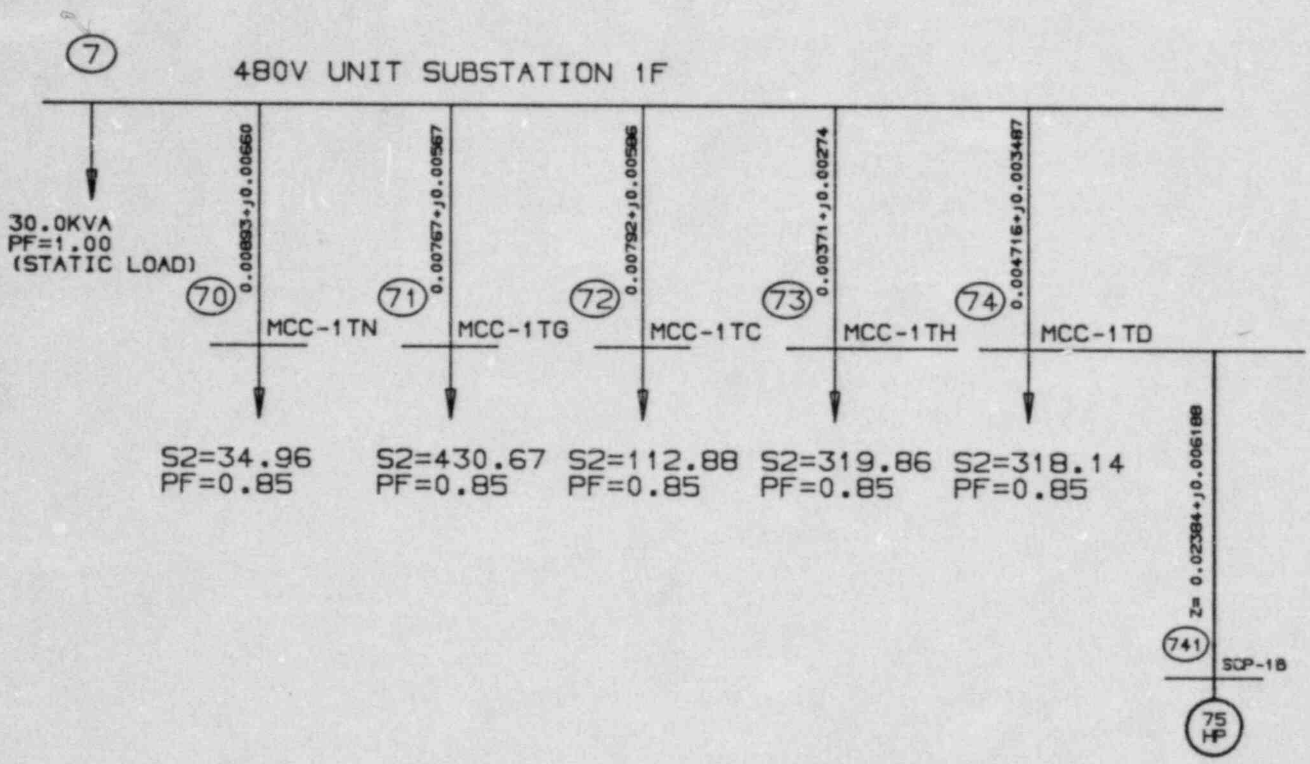
PLANT: BSEP   UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV | QA | STRUC | NUC | MECH | ELECT | I&C

DWG. NO. T124-E-3002   SCALE: NONE   SHEET 28 OF 36   REV. NO. 0

E29



480V UNIT SUBSTATION "1F" LOADS
STATOR COOLANT PUMP - 1B START

NOTES:

1. IMPEDANCES OR IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S2 = LOADS AT LOCA IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG / SLP	HTTN / WKR		HTTN

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

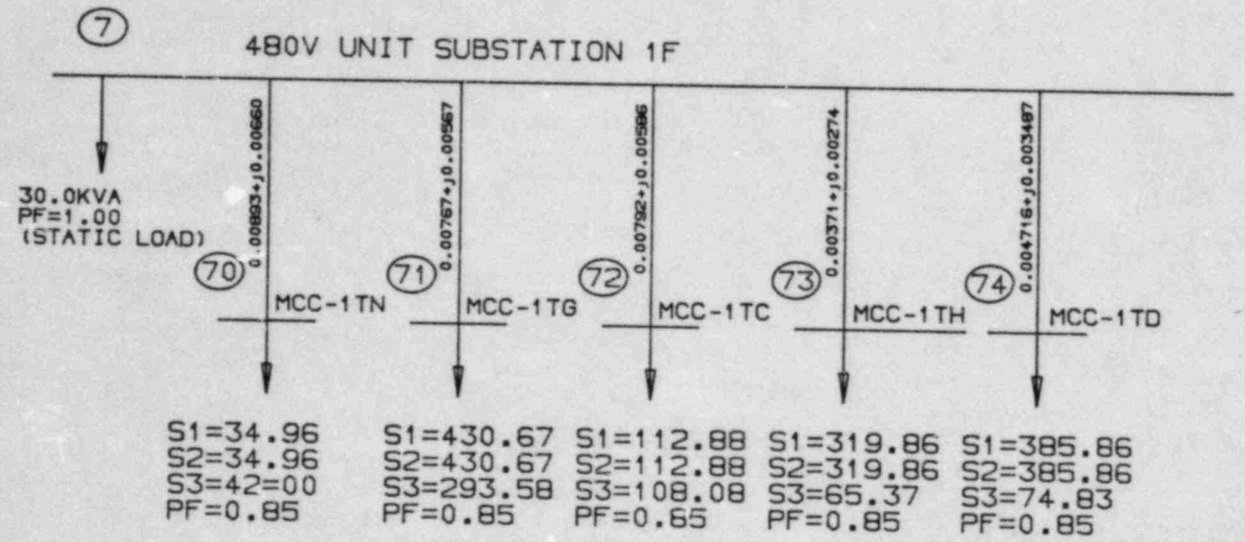
PLANT: BSEP — UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3002 — SCALE: NONE — SHEET 29 OF 36 — REV. NO.: 0

E30



480V UNIT SUBSTATION "1F" LOADS

NOTES:

1. IMPEDANCES OR IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD, LIGHT LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124	WG		HTTN	WKR		HTTN

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

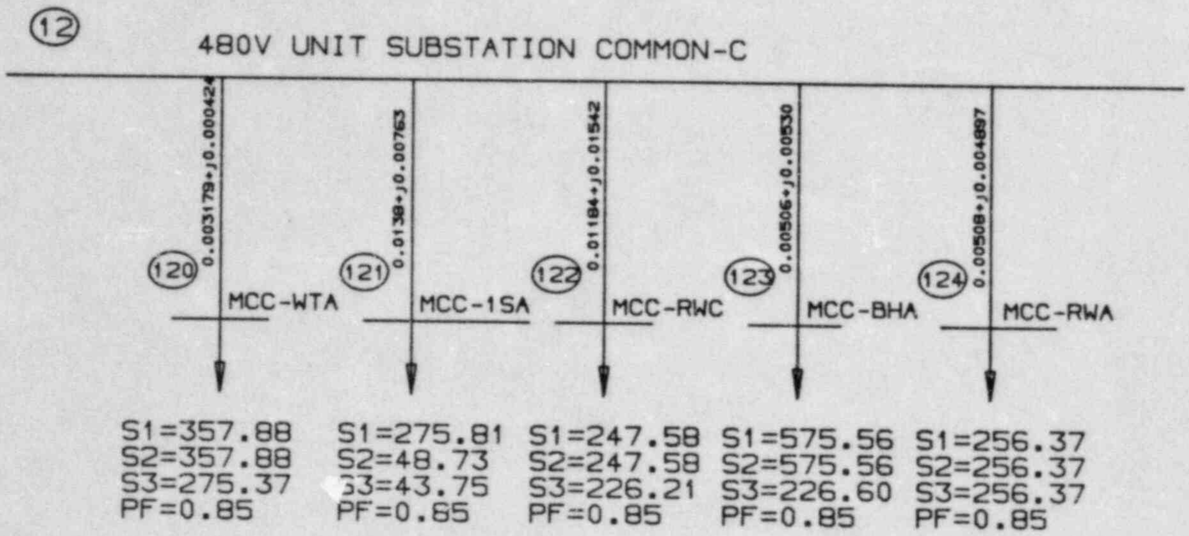
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 30 OF 36 REV. NO. 0



480V UNIT SUBSTATION "COMMON-C" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ○ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5 25 84	ISSUE FOR NT-124						

DPE: WK Russell
PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

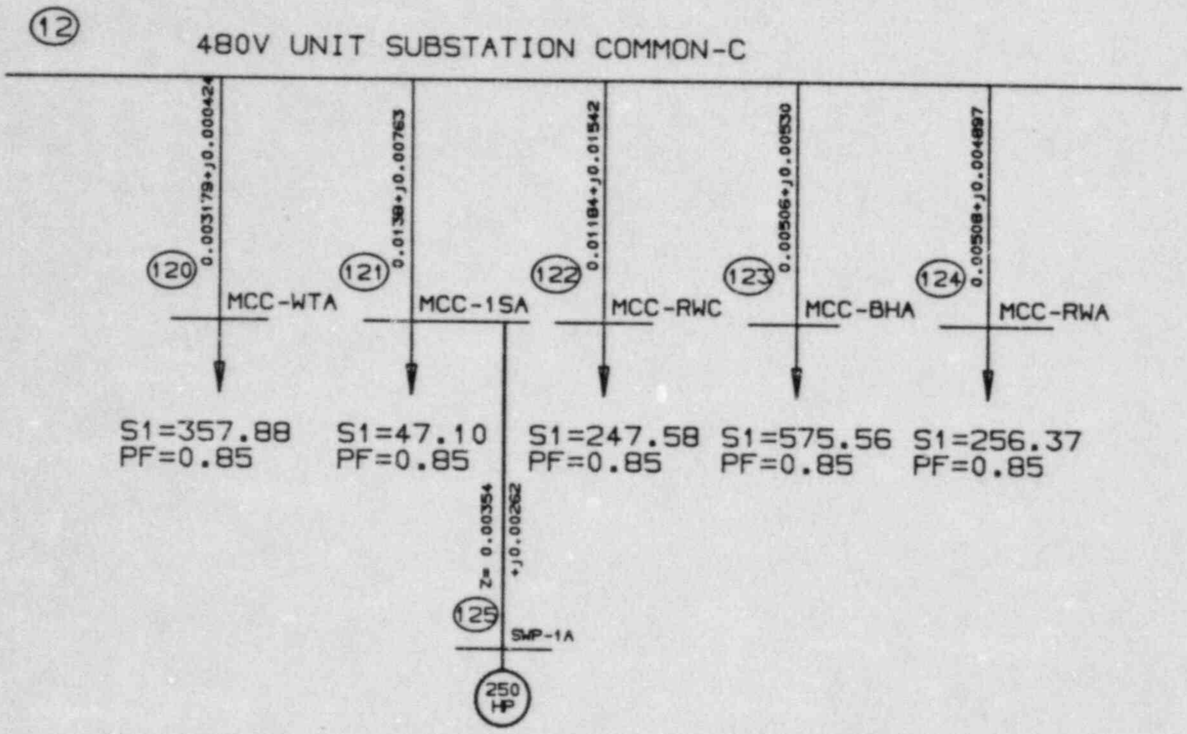
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 31 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "COMMON-C" LOADS
SCREEN WASH PUMP MOTOR - 1A START

NOTES:

1. IMPEDANCES OR IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION
0	5 25 84	ISSUE FOR NT-124

DPE WKRussell

PROFESSIONAL ENGINEER   REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

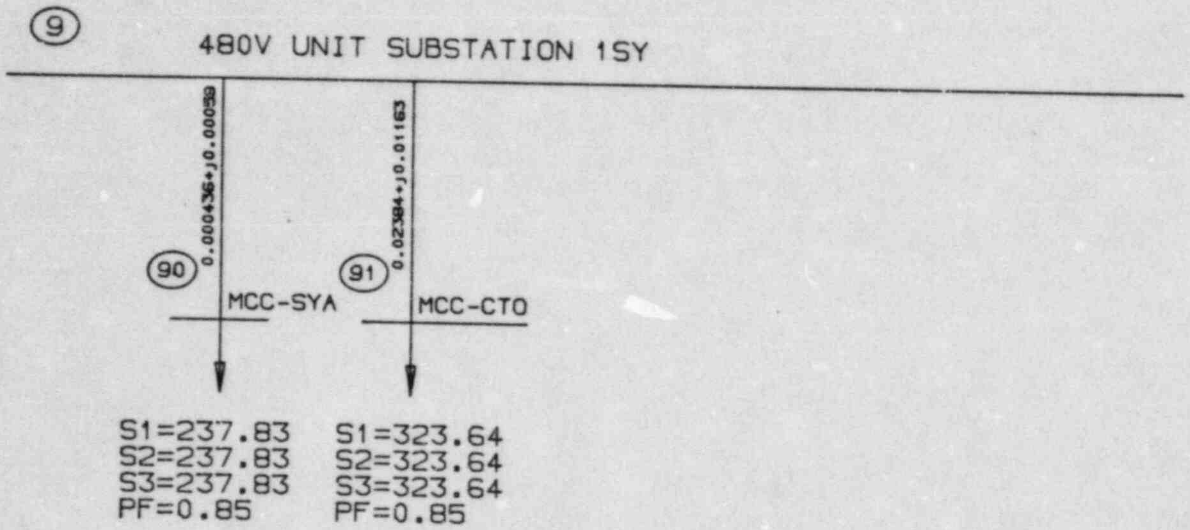
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP   UNIT 1

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002   SCALE: NONE   SHEET 32 OF 36   REV. NO. 0



480V UNIT SUBSTATION "1SY" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	5/25/84	ISSUE FOR NT-124						

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

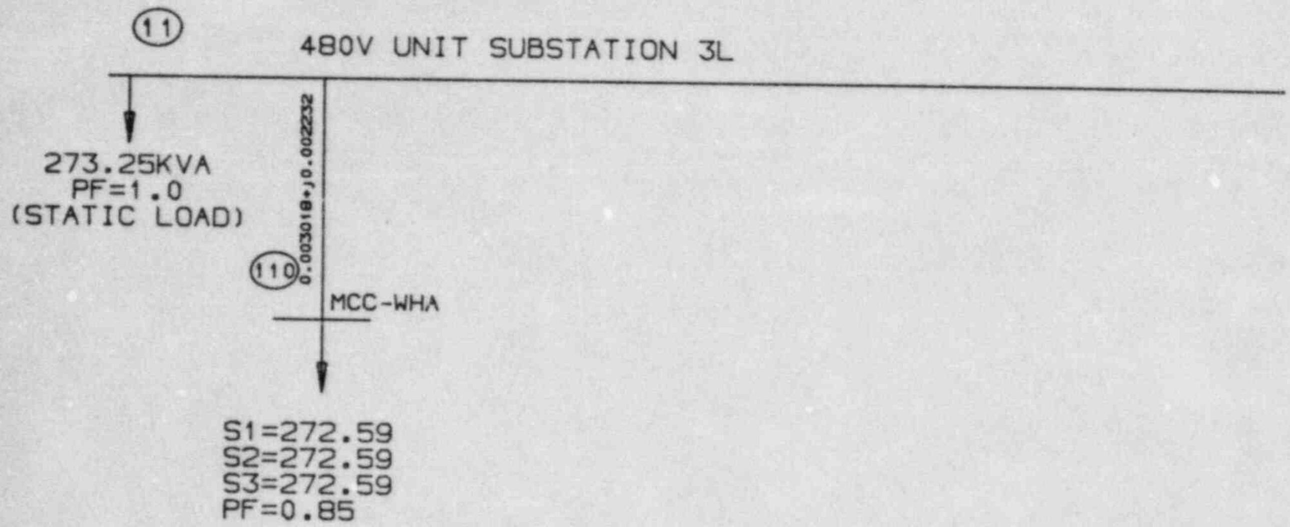
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 — SCALE: NONE — SHEET 33 OF 36 — REV. NO. 0



480V UNIT SUBSTATION "3L" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ○ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	OPE	OPPE	LE
0	5 25 84	ISSUE FOR NT-124	GW	HTTN	WKR			HTTN

OPE W K Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

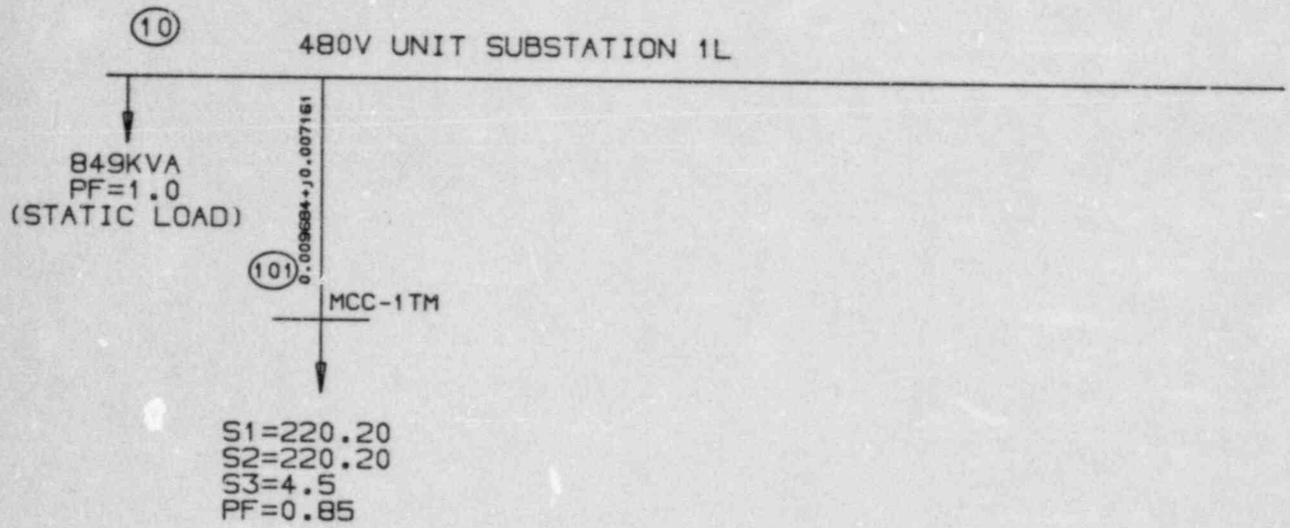
PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 34 OF 36 REV. NO. 0

E35



480V UNIT SUBSTATION "1L" LOADS

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	OPPE	LE
0	5 25 84	ISSUE FOR NT-124						

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

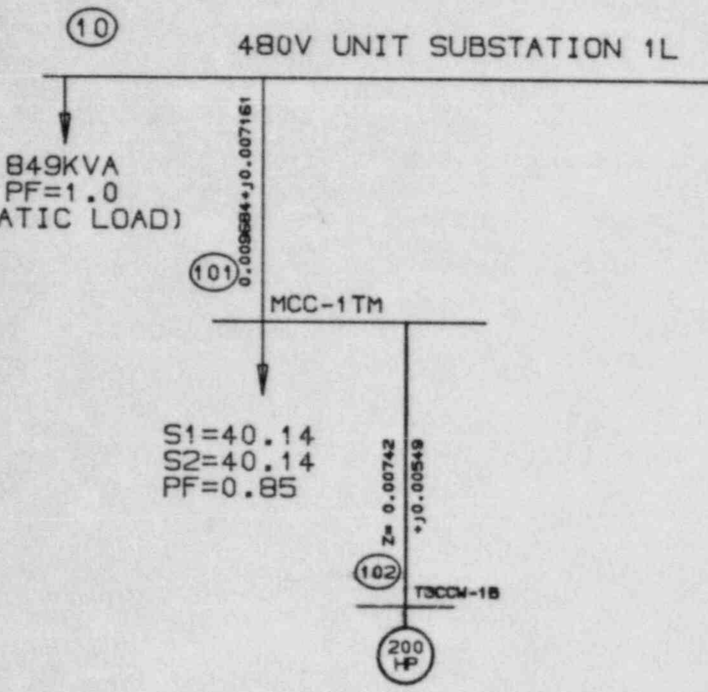
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 35 OF 36 REV. NO. 0



480V UNIT SUBSTATION "1L" LOADS
TURBINE BLDG. CLOSED COOLING
WATER PUMP - 1B START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. S1 = LOADS AT FULL LOAD IN KVA
   S2 = LOADS AT LOCA IN KVA
   S3 = LOADS AT SHUTDOWN IN KVA
4. HP IS IN DESIGN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	5 25 84	ISSUE FOR NT-124				

DPE WKRussell
PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

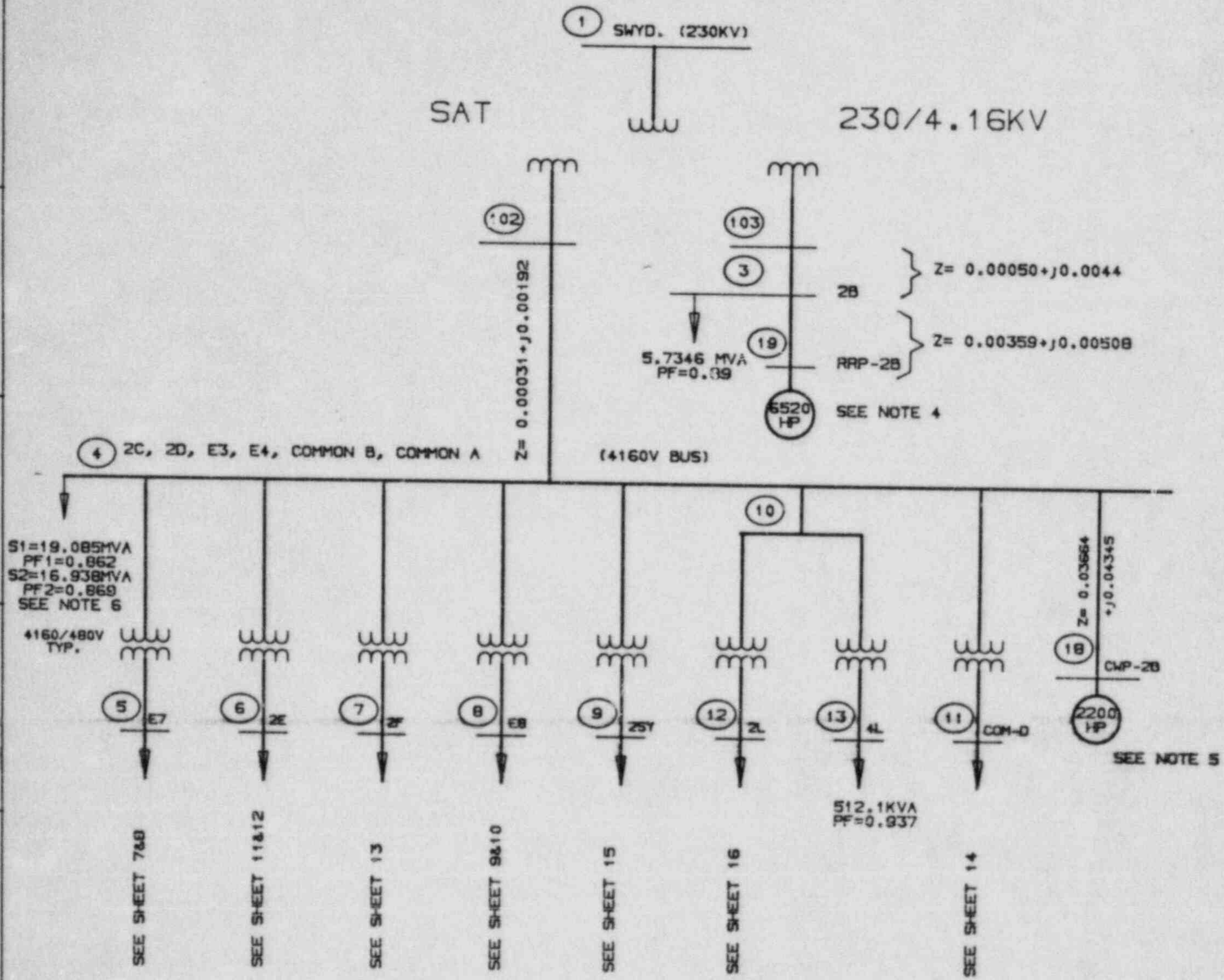
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 1

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3002 SCALE: NONE SHEET 36 OF 36 REV. NO. 0



SAT FULL LOAD

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. HP ARE IN DESIGN BRAKE HORSEPOWER
4. RRP-2B MOTOR STARTS IN ASDOP CASE 2SAT-7
5. CWP-2B MOTOR STARTS IN ASDOP CASE 2SAT-4
6. S1 & PF1 ARE USED FOR ASDOP CASE 2SAT-4 AND S2 & PF2 ARE USED FOR ASDOP CASE 2SAT-3, 2SAT-1

REV	GA	STRUC	NUC	MECH	ELECT	I&C

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	4 20 94	ISSUE FOR NT-124	WG	HTN / WKR	JWP	HTN

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

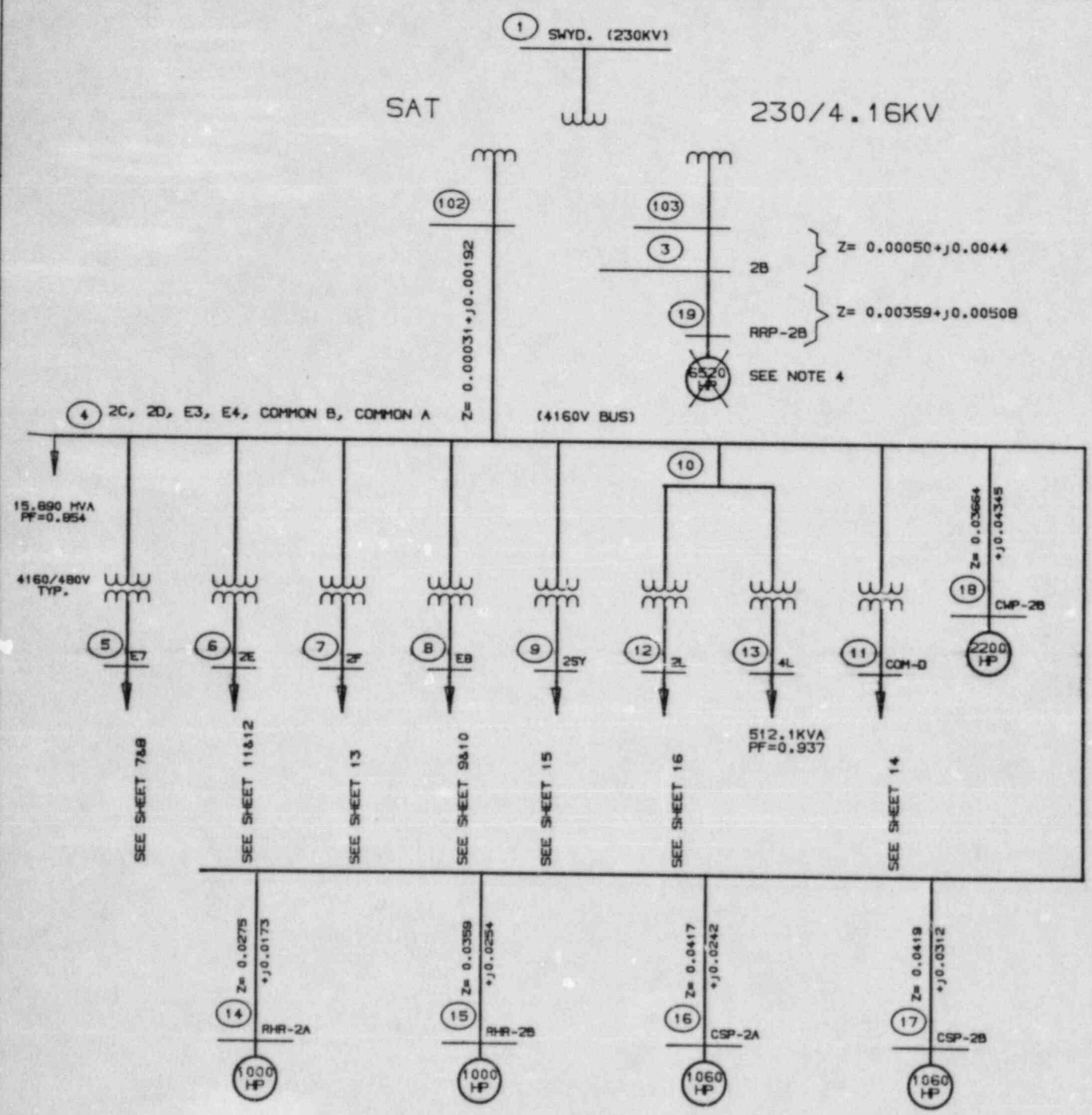
CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO. T124-E-3001 SCALE: NONE SHEET 1 OF 21 REV. NO. 0



SAT LOCA START

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. HP ARE IN DESIGN BRAKE HORSEPOWER
4. X INDICATES LOAD NOT OPERATING

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124	WG / EHP	HTTN / WKR	WWP	HTTN

DPE W.K. Russell
PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

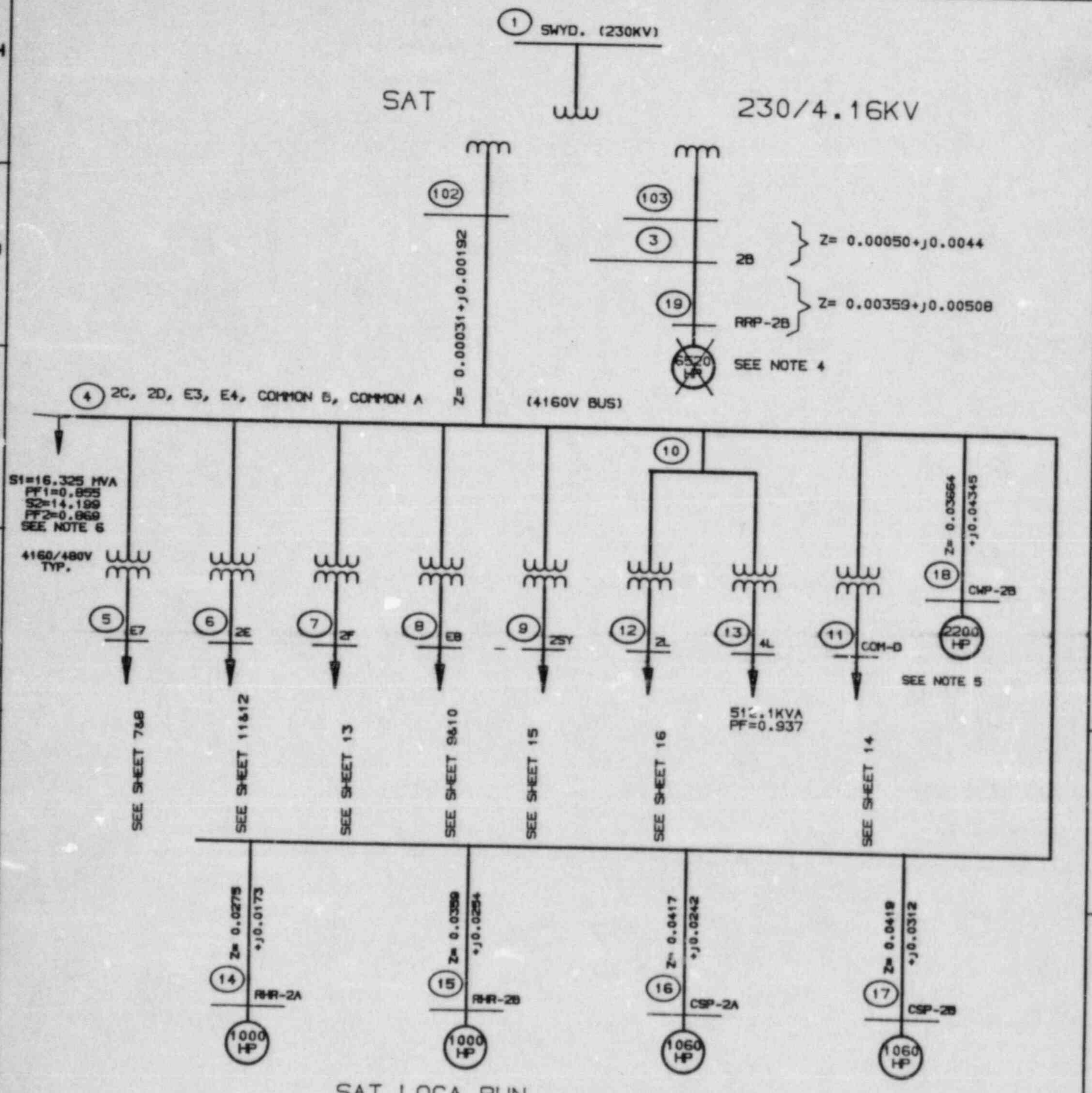
PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 2 OF 21 REV. NO. 0

E39



SAT LOCA RUN

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. HP ARE IN DESIGN BRAKE HORSEPOWER
4. X INDICATES LOAD NOT OPERATING
5. CWP-2B MOTOR STARTS IN ASDOP CASE 2SAT-13
6. S1 & PF1 ARE USED FOR ASDOP CASE 2SAT-13 AND S2 & PF2 ARE USED FOR ASDOP CASE 2SAT-12, 2SAT-11

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124						

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

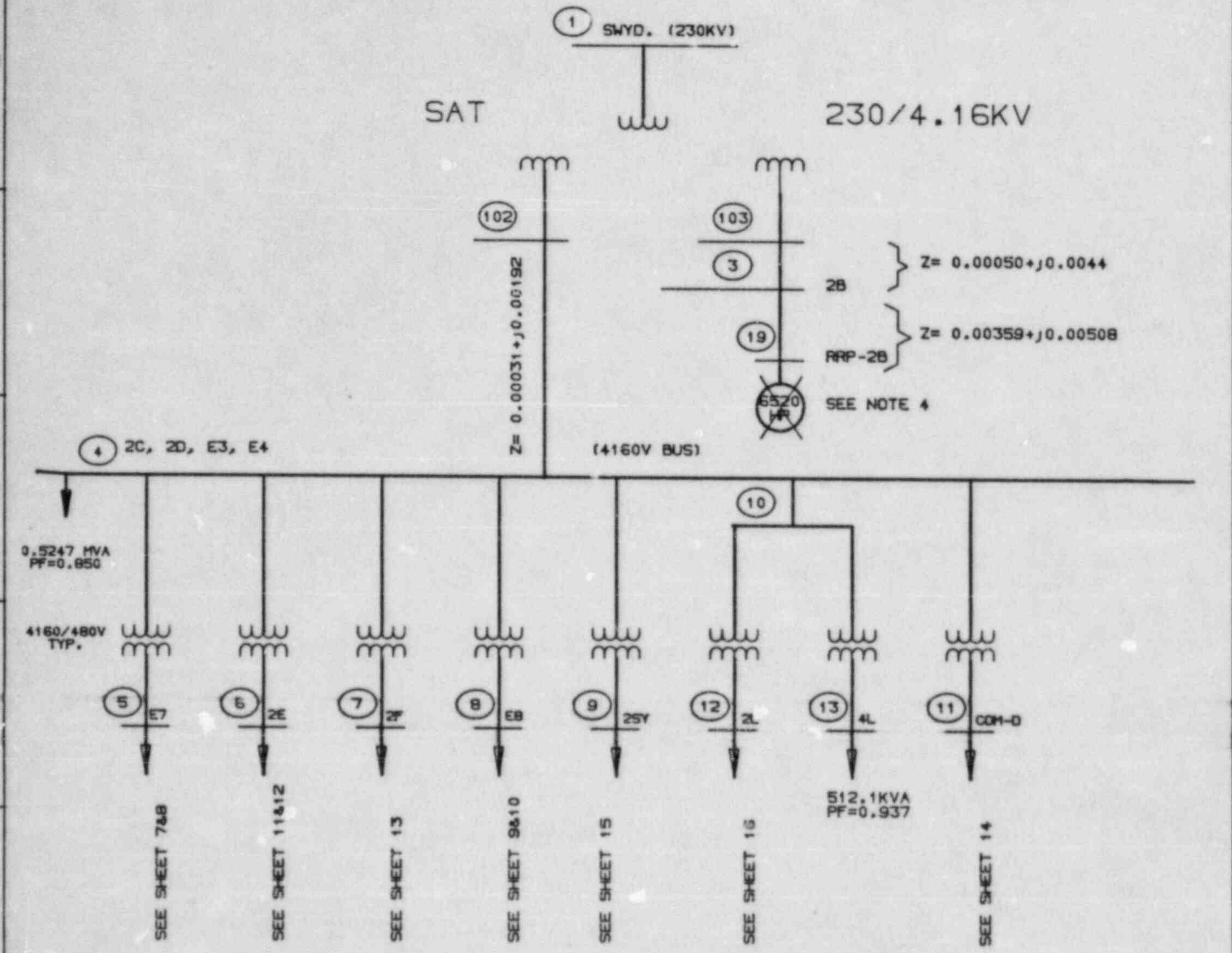
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3001 — SCALE: NONE — SHEET 3 OF 21 — REV. NO. 0



SAT SHUTDOWN

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. HP ARE IN DESIGN BRAKE HORSEPOWER
4. X INDICATES LOAD NOT OPERATING

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4/20/84	ISSUE FOR NT-124			WKR		wlp	

DPE W K Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

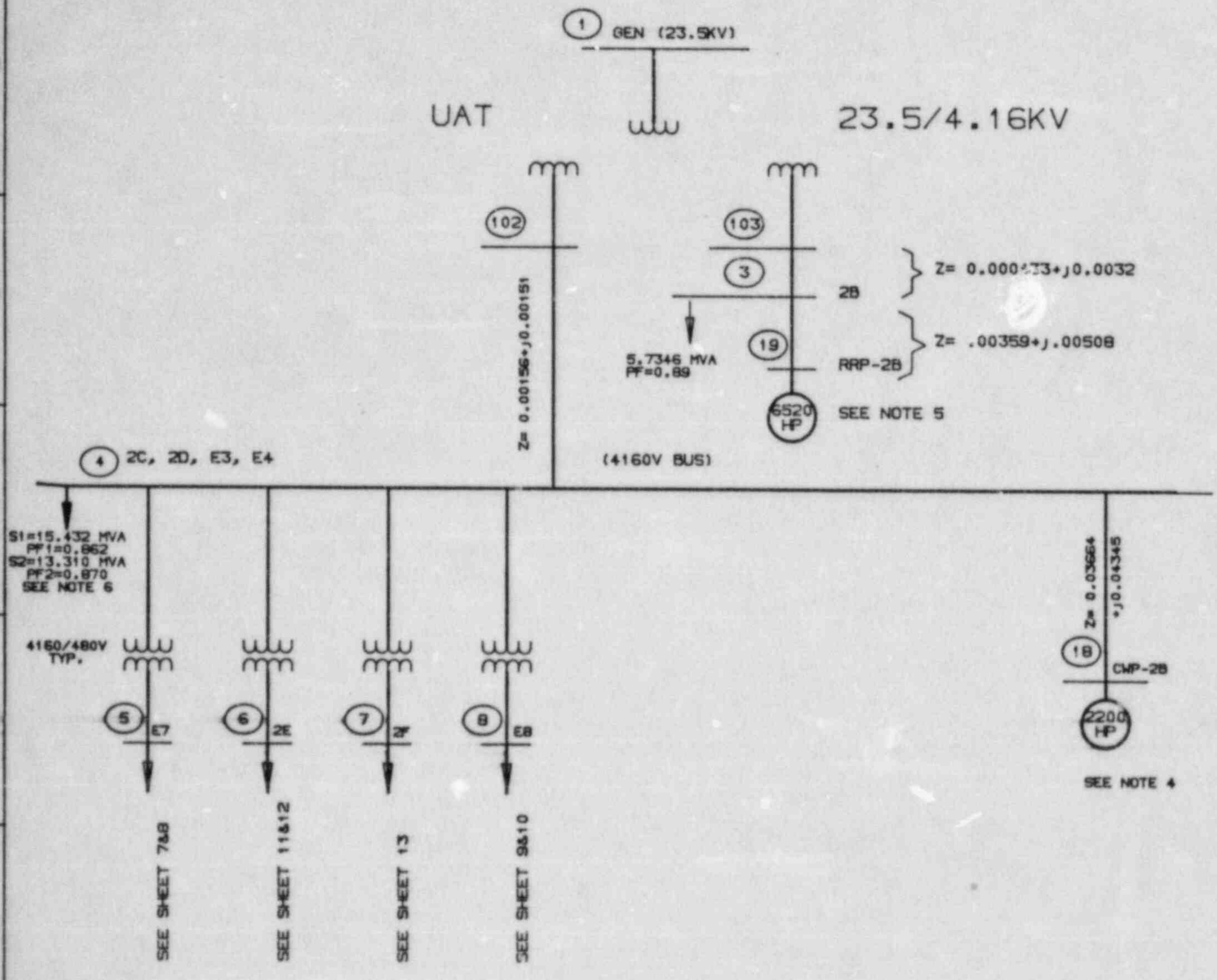
PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3001 SCALE: NONE SHEET 4 OF 21 REV. NO.: 0

E41



UAT FULL LOAD

NOTES:

1. IMPEDANCES ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #
3. HP ARE IN BRAKE HORSEPOWER
4. CWP-2B MOTER STARTS IN ASDOP CASE 2UAT-4
5. RRP-2B MOTOR STARTS IN ASDOP CASE 2UAT-5
6. S1&PF1 ARE THE LOADS AND PF AT 4160V BUS FOR ASDOP CASE 2UAT-4 AND S2&PF2 ARE FOR ASDOP CASE 2UAT-3, 2UAT-1

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	4-20-84	ISSUE FOR NT-124				

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

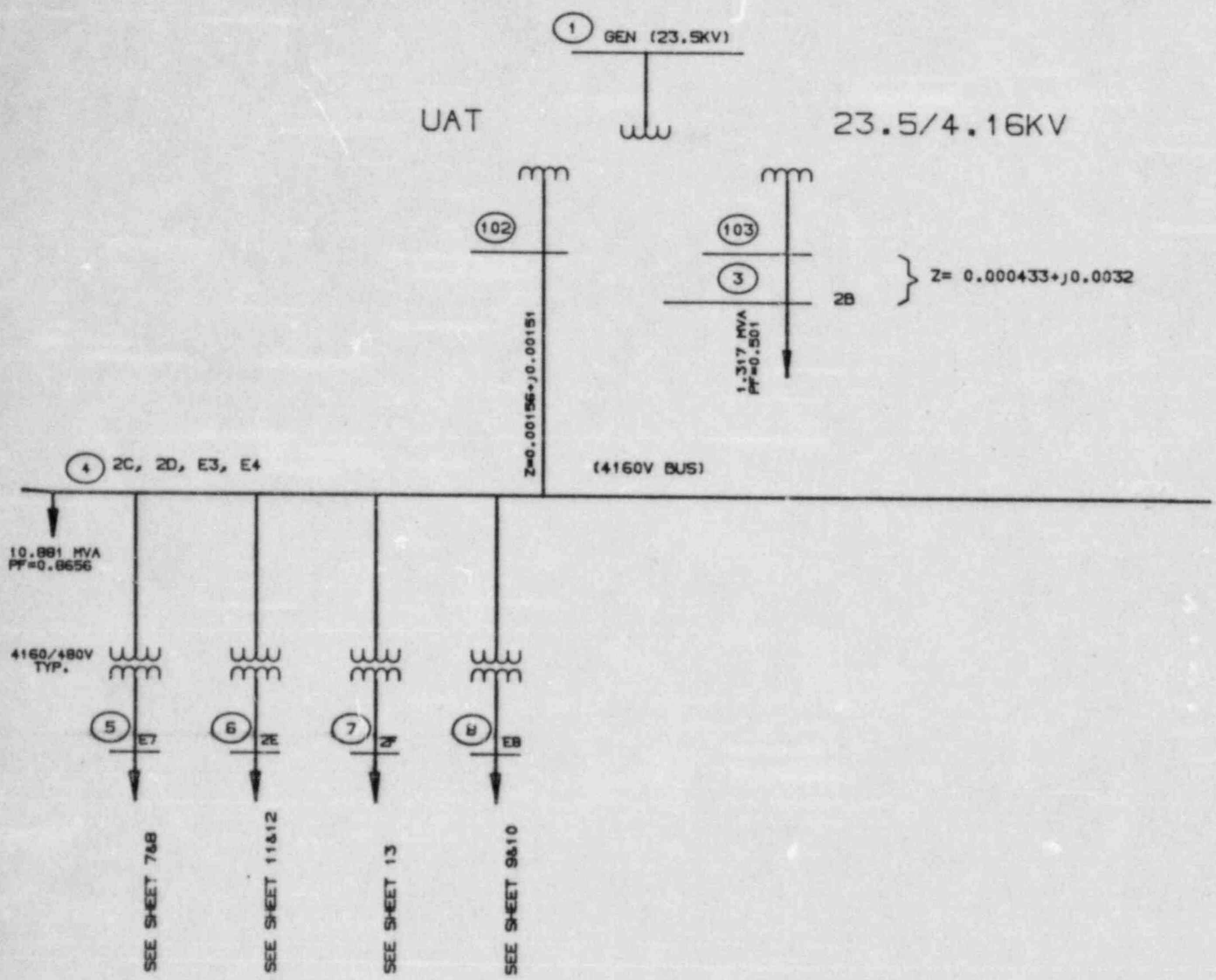
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 — SCALE: NONE — SHEET 5 OF 21 — REV. NO. 0



UAT LIGHT LOAD

NOTES:

1. IMPEDANCE ARE IN OHMS
2. ◯ REFERENCES COMPUTER MODEL BUS #

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4/20/84	ISSUE FOR NT-124						

DPE: AK Russell

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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

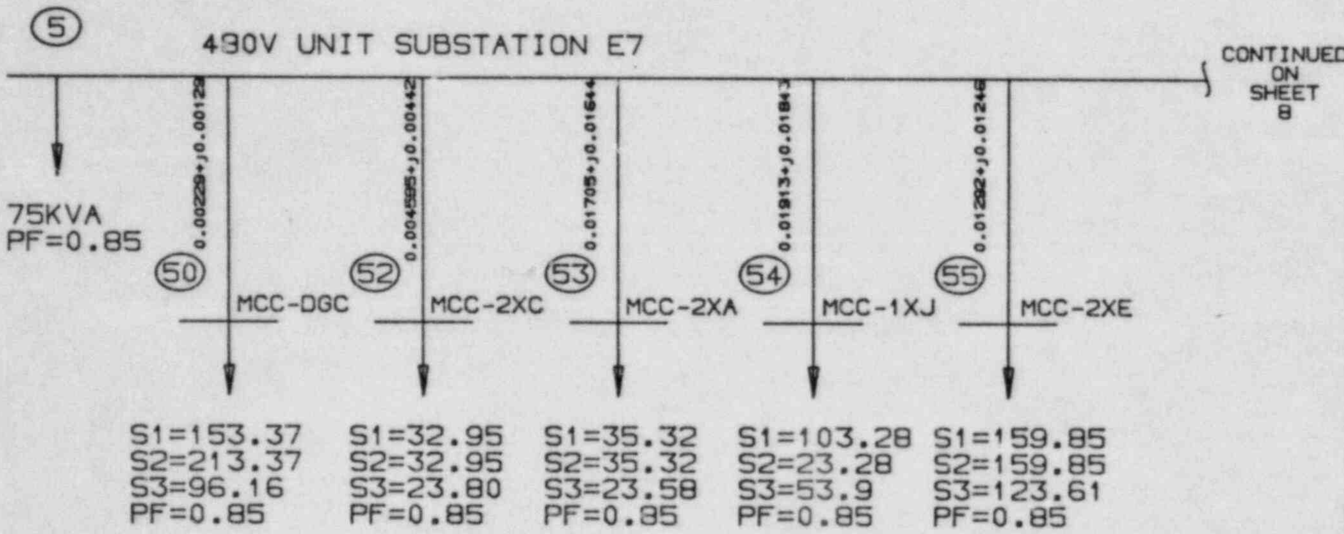
PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	UA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 — SCALE: NONE — SHEET 6 OF 21 — REV. NO. 0

F43



480V UNIT SUBSTATION "E7" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124	WG	M	HTTN	WKR	wrf	HTTN

DPE: WK Russell

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NUCLEAR SAFETY RELATED

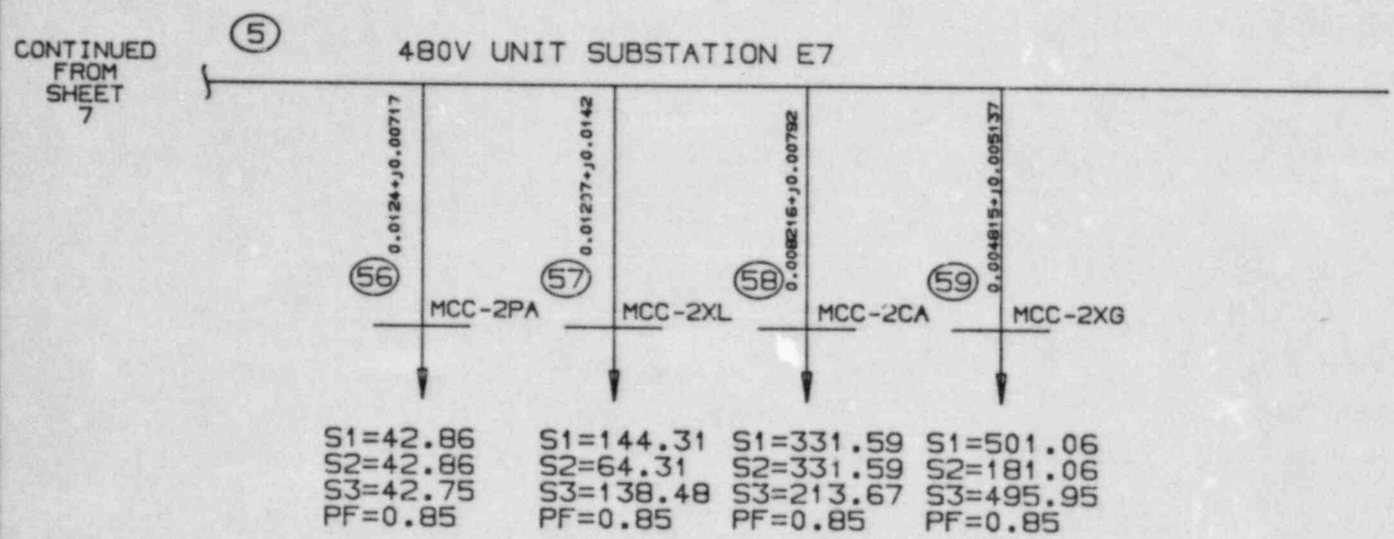
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 7 OF 21 REV. NO. 0



480V UNIT SUBSTATION "E7" LOADS

NOTES:

ALL S1, S2, S3 ARE IN KVA
- S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
- S2 = LOADS AT LOCA CONDITION
- S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4/20/84	ISSUE FOR NT-124						

DPE: WKRussell

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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

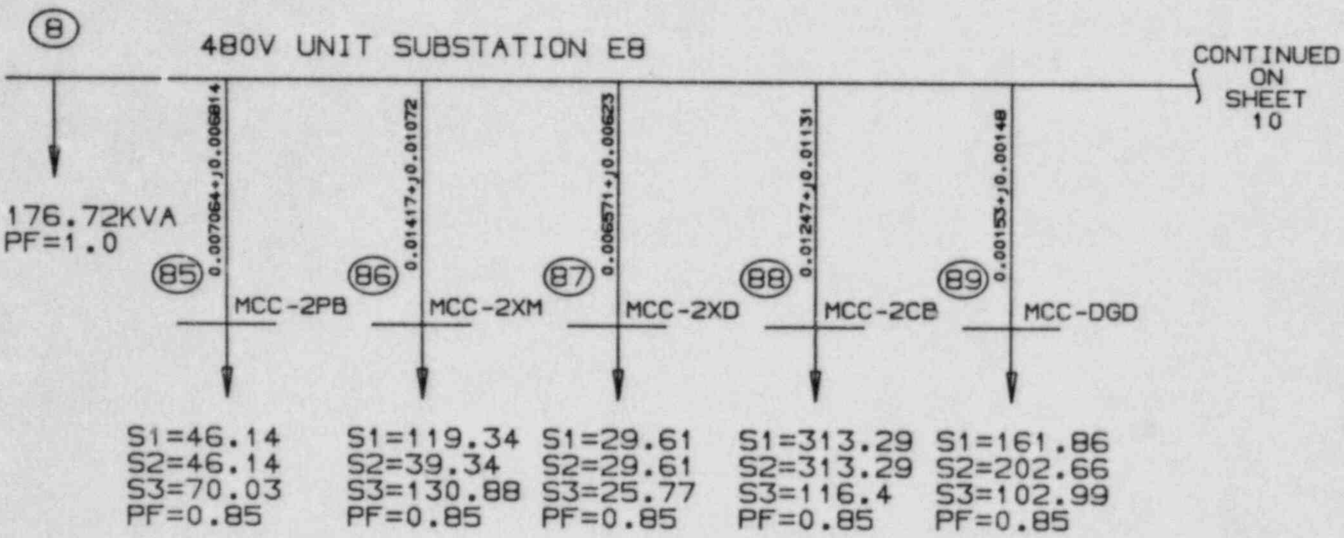
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 | SCALE: NONE | SHEET 8 OF 21 | REV. NO. 0



480V UNIT SUBSTATION "E8" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE
0	4 20 84	ISSUE FOR NT-124			WKR	

DPE WKRussell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

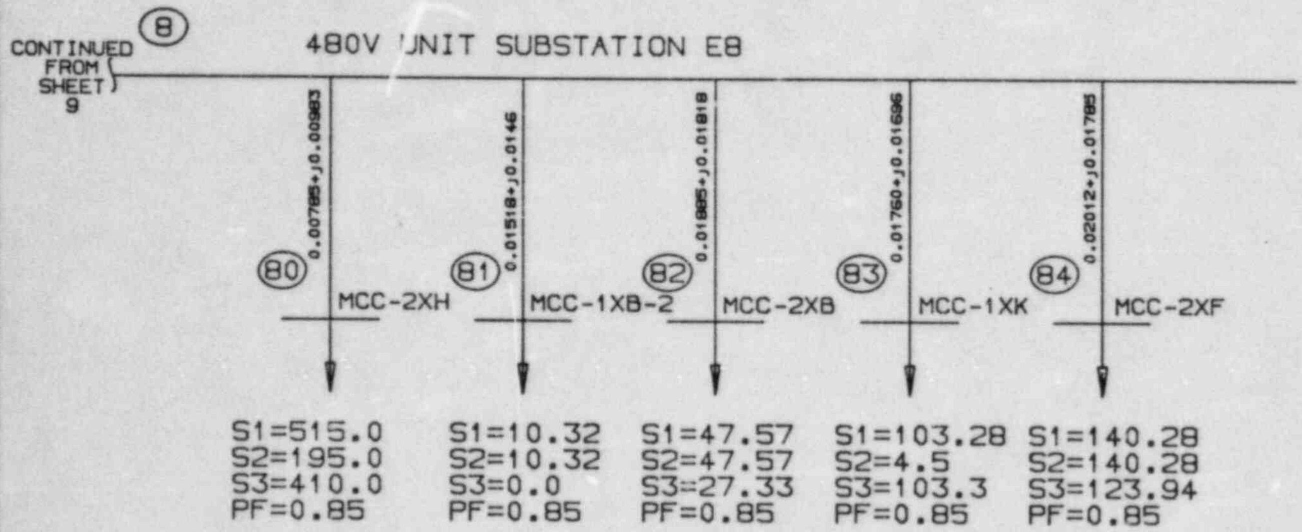
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3001 SCALE: NONE SHEET 9 OF 21 REV. NO.: 0



480V UNIT SUBSTATION "E8" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124	WC	EW	HTTN	WKR	WKR	HTTN

DPE WK Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

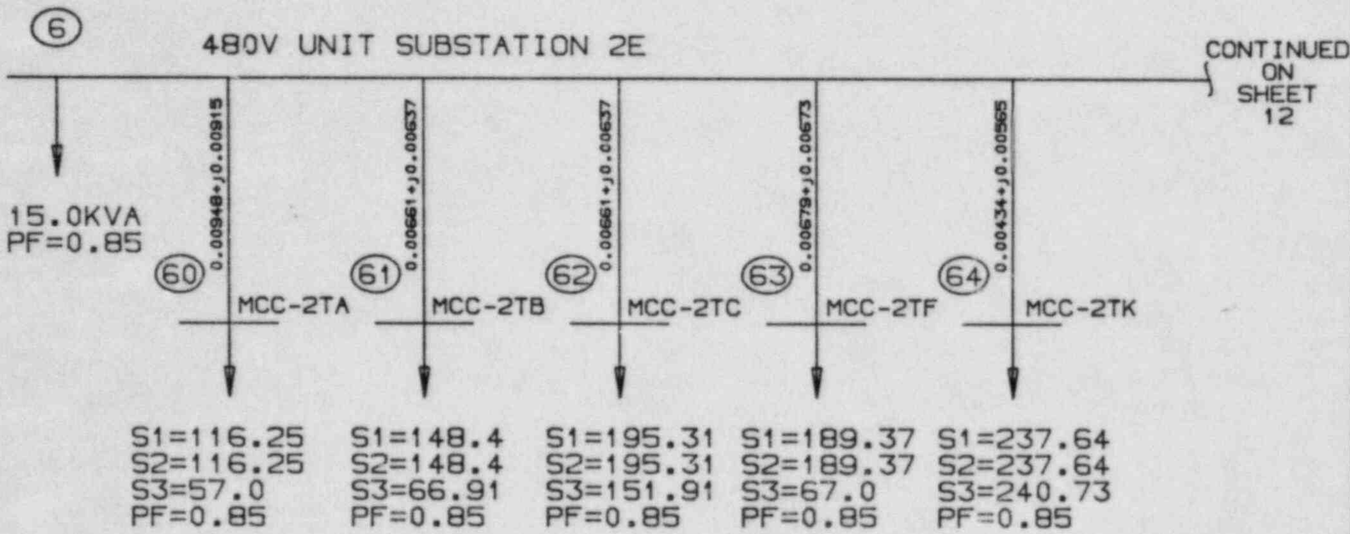
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STR C	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 10 OF 21 REV. NO. C



480V UNIT SUBSTATION "2E" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
- S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
- S2 = LOADS AT LOCA CONDITION
- S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	GA	STRUC	NUC	MECH	ELECT	I&C

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124						

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NUCLEAR SAFETY RELATED

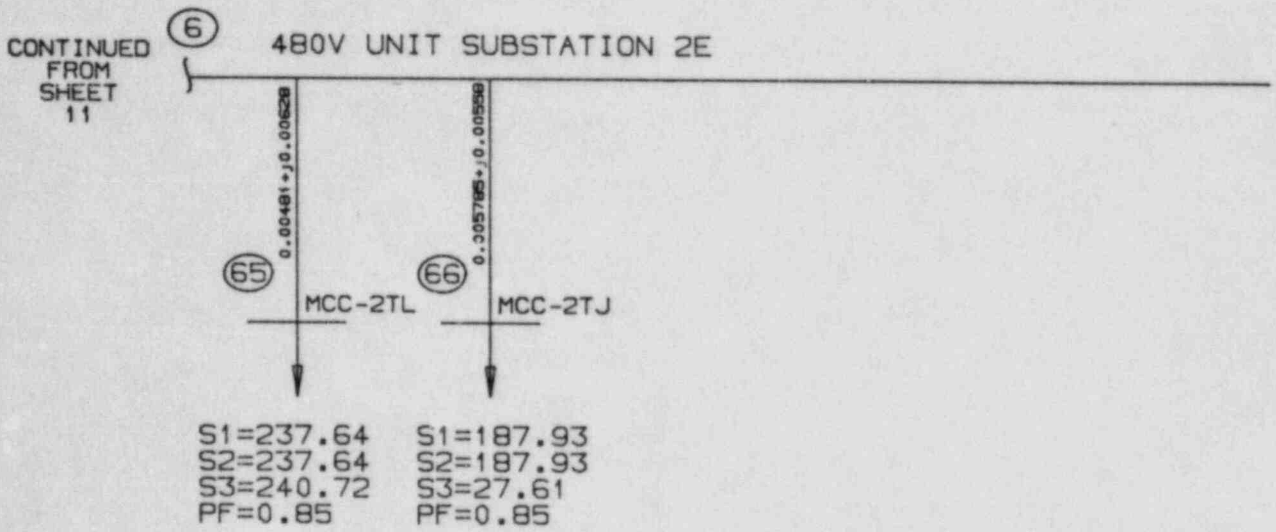
CAROLINA POWER & LIGHT COMPANY

NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO. T124-E-3001 SCALE: NONE SHEET 11 OF 21 REV. NO. 0



480V UNIT SUBSTATION "2E" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	GA	STRUC	HVAC	MECH	ELECT	I&C

REV	DATE	DESCRIPTION	DWN	CK	RE	OPE	OPPE	LE
0	4/20/84	ISSUE FOR NT-124						

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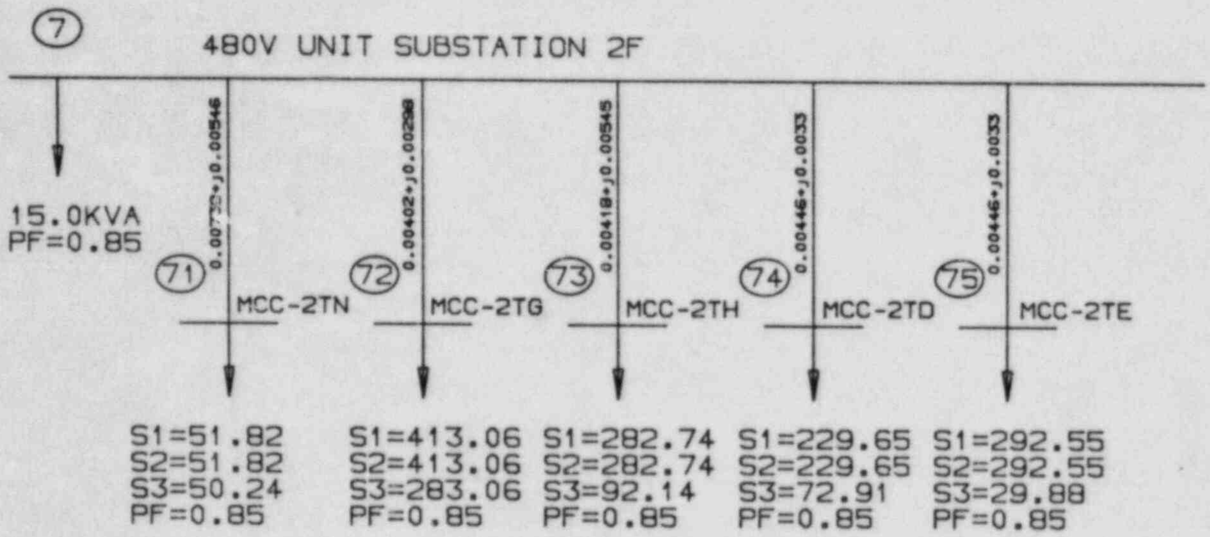
NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO.: T124-E-3001 SCALE: NONE SHEET 12 OF 21 REV. NO. 0



480V UNIT SUBSTATION "2F" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124		WKR	WKR	HTTN

DPE W.K. Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

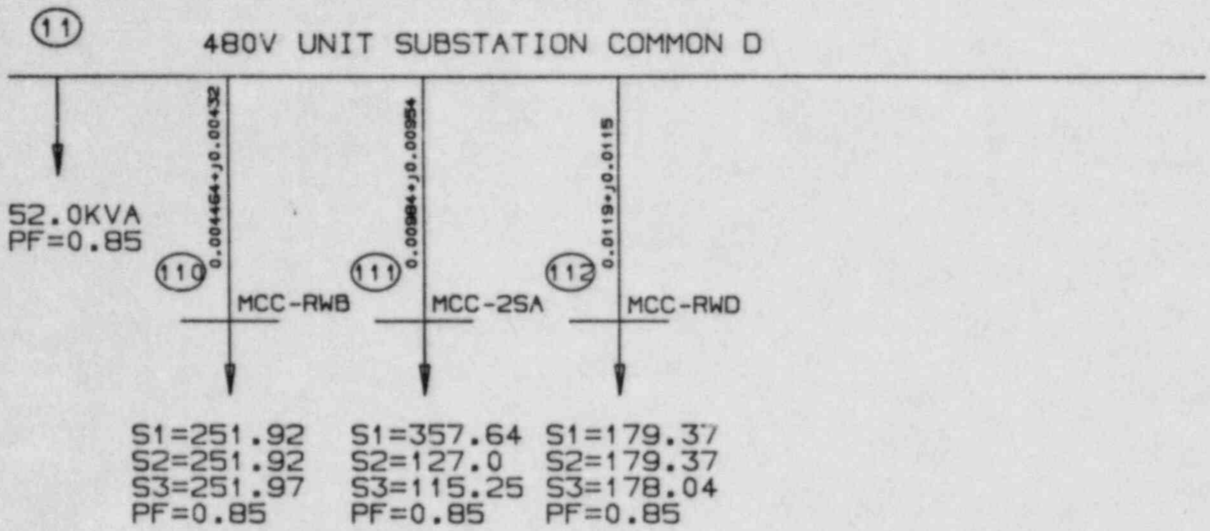
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 13 OF 21 REV. NO. 0



480V UNIT SUBSTATION "COMMON D" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4/20/84	ISSUE FOR NT-124	WG	SEP	WKR		WKR	HTN

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

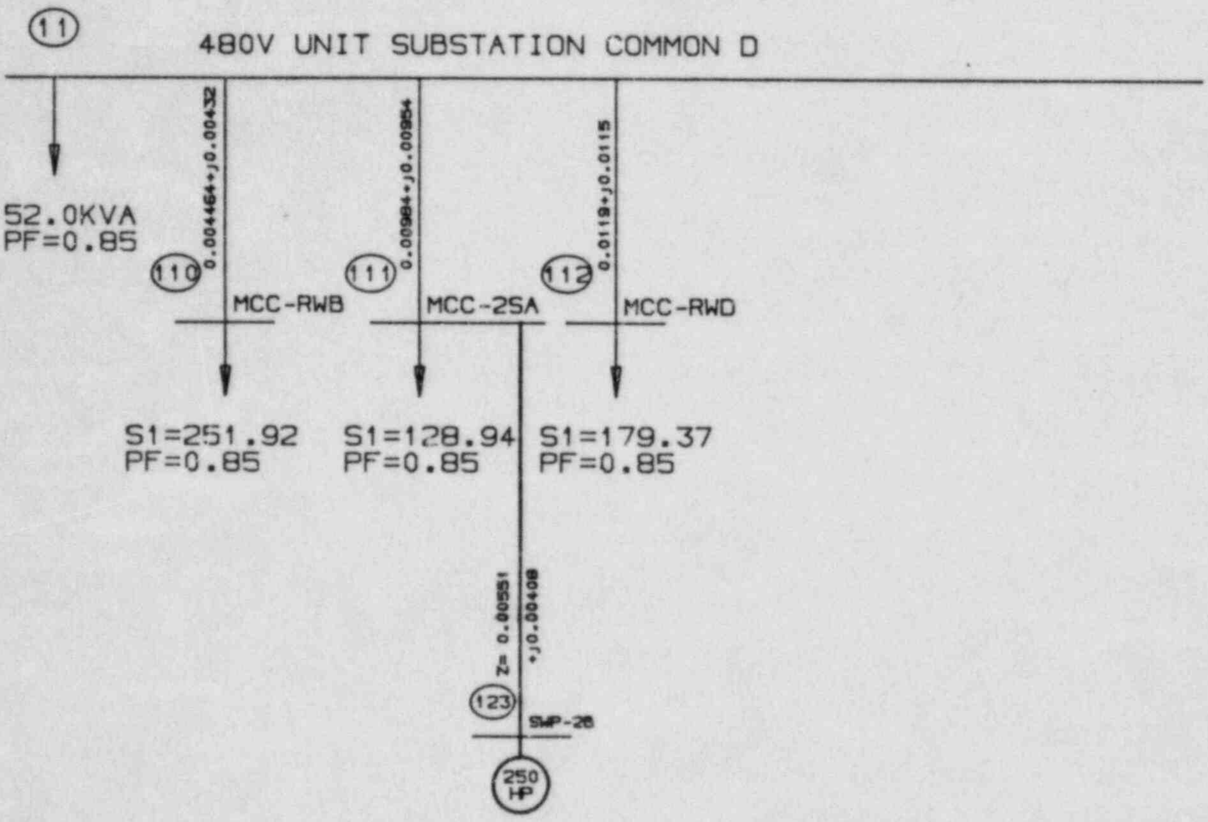
PLANT: BSEP — UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	GA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 — SCALE: NONE — SHEET 14 OF 21 — REV. NO. 0

E51



480V UNIT SUBSTATION "COMMON D" LOADS
AT SCREEN WASH PUMP START

NOTES:
1. S1 = LOADS AT FULL LOAD IN KVA
2. HP IS IN BRAKE HORSEPOWER

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	OPPE	LE
0	5/25/84	ISSUE FOR NT-124			WKR			HTTN

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PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

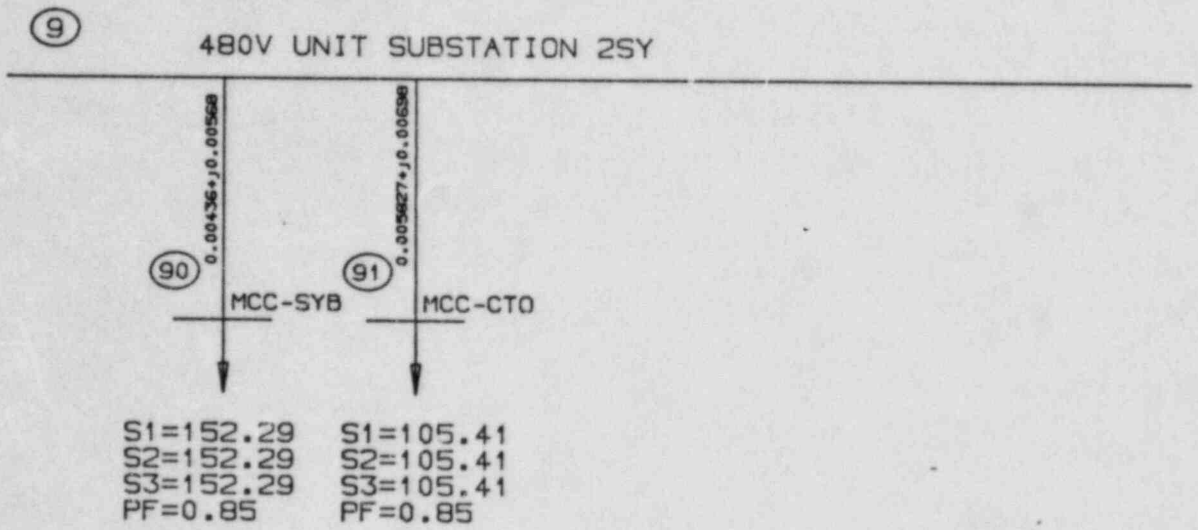
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 14A OF 21 REV. NO. 0



480V UNIT SUBSTATION "2SY" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	QA	STRUC	NUC	MECH	ELECT	I&C

REV	DATE	DESCRIPTION
0	4 20 84	ISSUE FOR NT-124

DPE: WK Russell

PROFESSIONAL ENGINEER — REG. NO.

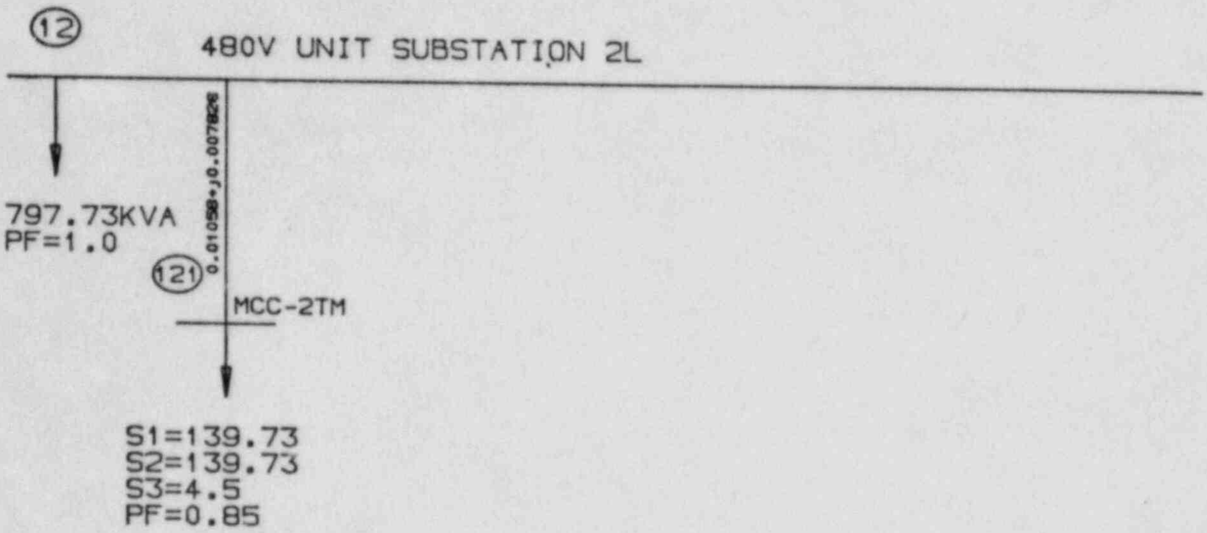
NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO.: T124-E-3001 SCALE: NONE SHEET 15 OF 21 REV. NO.: 0



480V UNIT SUBSTATION "2L" LOADS

NOTES:
ALL S1, S2, S3 ARE IN KVA
S1 = LOADS AT FULL LOAD, UAT-LIGHT LOAD CONDITION
S2 = LOADS AT LOCA CONDITION
S3 = LOADS AT SAT-SHUTDOWN CONDITION (LIGHT LOAD)

REV	DATE	DESCRIPTION	DWN	CK	NE	OPE	OPPE	LE
0	4/20/84	ISSUE FOR NT-124			WKR			HTTN

OPE W K Russell

PROFESSIONAL ENGINEER REG. NO.

NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY

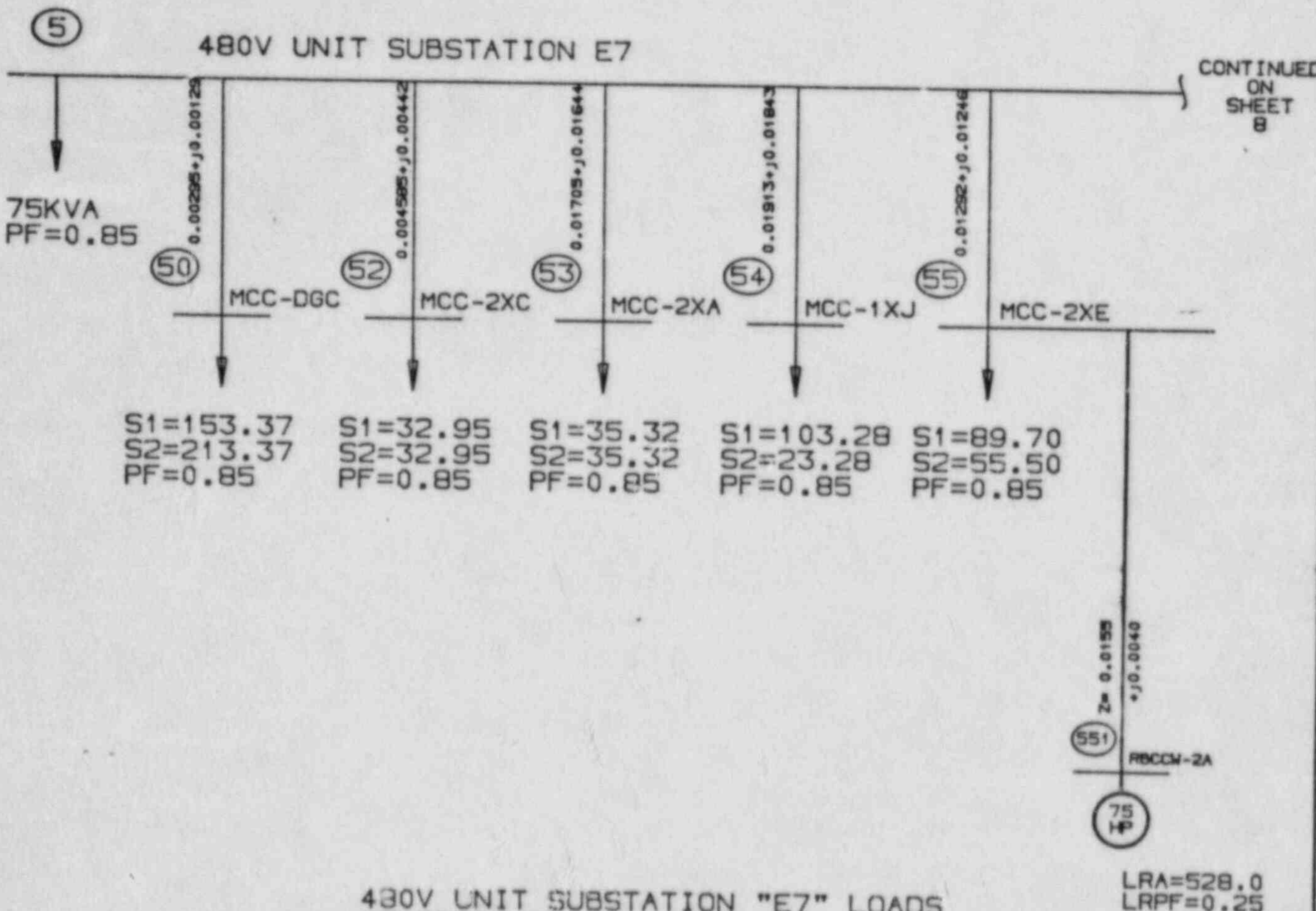
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 16 OF 21 REV. NO. 0



480V UNIT SUBSTATION "E7" LOADS
AT RBCCW-2A MOTOR START

NOTES:
ALL S1, S2 ARE IN KVA
S1 = LOADS AT FULL LOAD
S2 = LOADS AT LOCA CONDITION
Z = IMPEDANCE (IN OHMS)

REV	DATE	DESCRIPTION		
0	4/20/84	ISSUE FOR NT-124		

DPE: WK Russell
PROFESSIONAL ENGINEER — REG. NO.

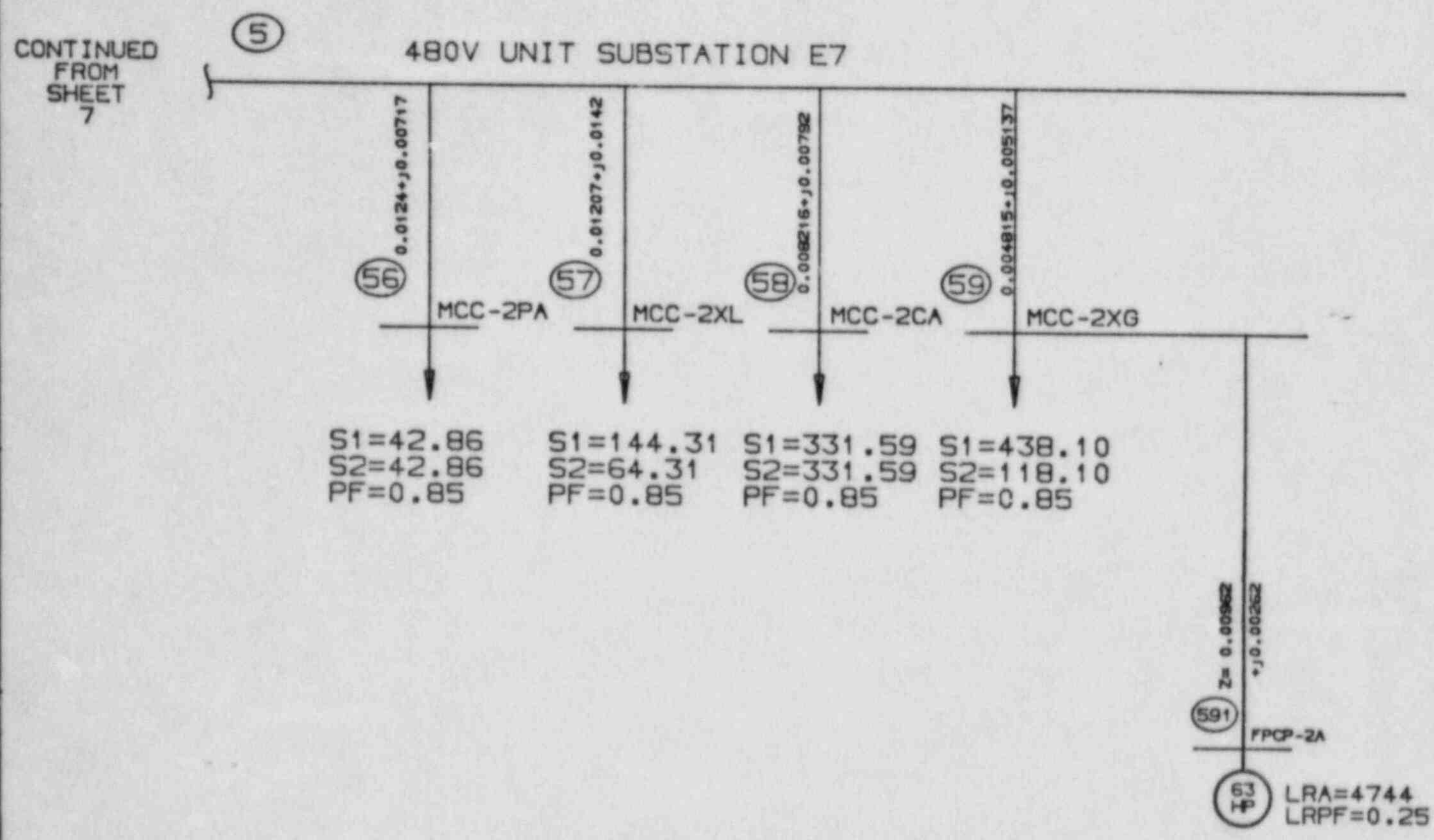
NUCLEAR SAFETY RELATED

PLANT: BSEP — UNIT 2

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO.: T124-E-3001 — SCALE: NONE — SHEET 17 OF 21 — REV. NO.: 0



480V UNIT SUBSTATION "E7" LOADS
AT FUEL POOL CLEANING PUMP MOTOR 2A START

NOTES:
ALL S1, S2 ARE IN KVA
S1 = LOADS AT FULL LOAD
S2 = LOADS AT LOCA CONDITION
Z = IMPEDANCE (IN OHMS)

REV	DATE	DESCRIPTION
0	4/20/84	ISSUE FOR NT-124

DPE: WK Russell
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NUCLEAR SAFETY RELATED

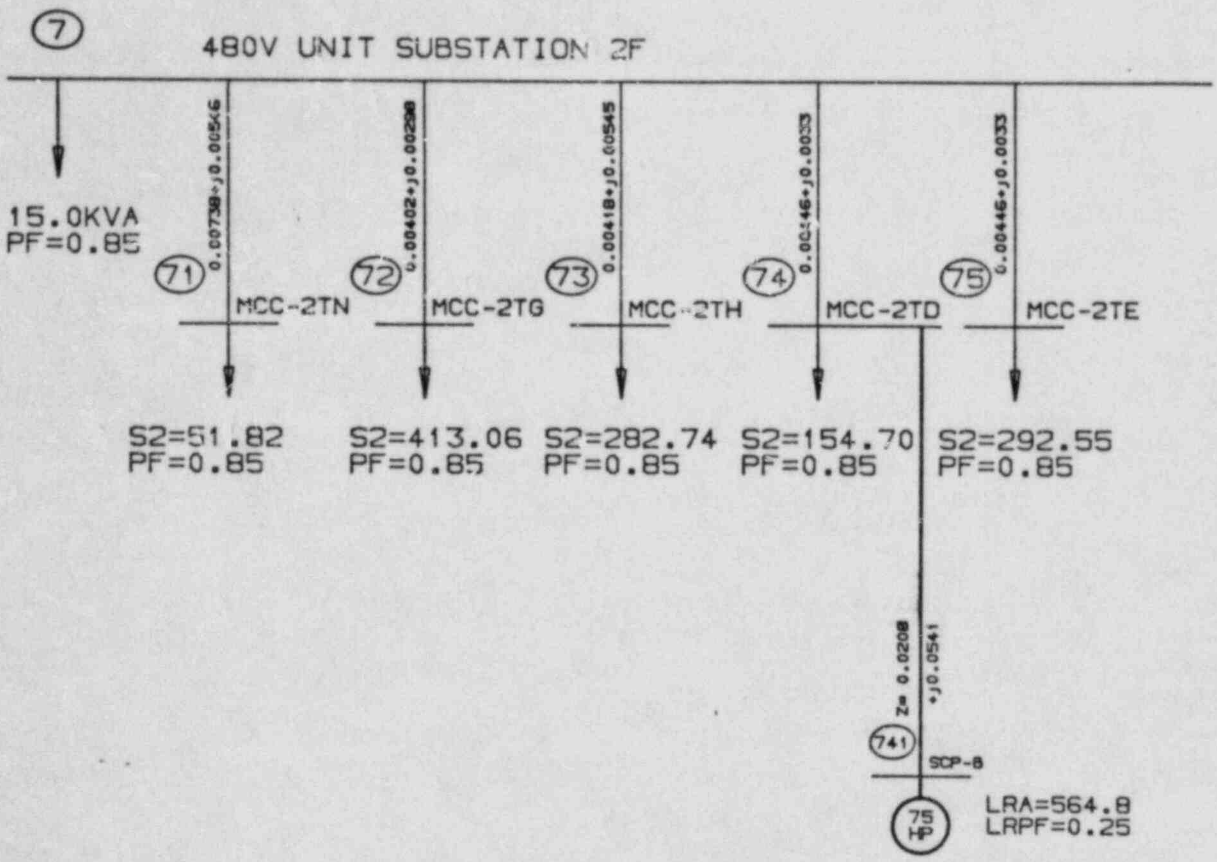
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

DWG. NO.: T124-E-3001 SCALE: NONE SHEET 18 OF 21 REV. NO.: 0

E56



480V UNIT SUBSTATION "2F" LOADS
AT STATOR COOLANT PUMP 2B MOTOR START

NOTES:
ALL S2 ARE IN KVA
S2 = LOADS AT LOCA CONDITION
Z = IMPEDANCE (IN OHMS)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	OPPE	LE
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DPE: W.K. Russell
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NUCLEAR SAFETY RELATED

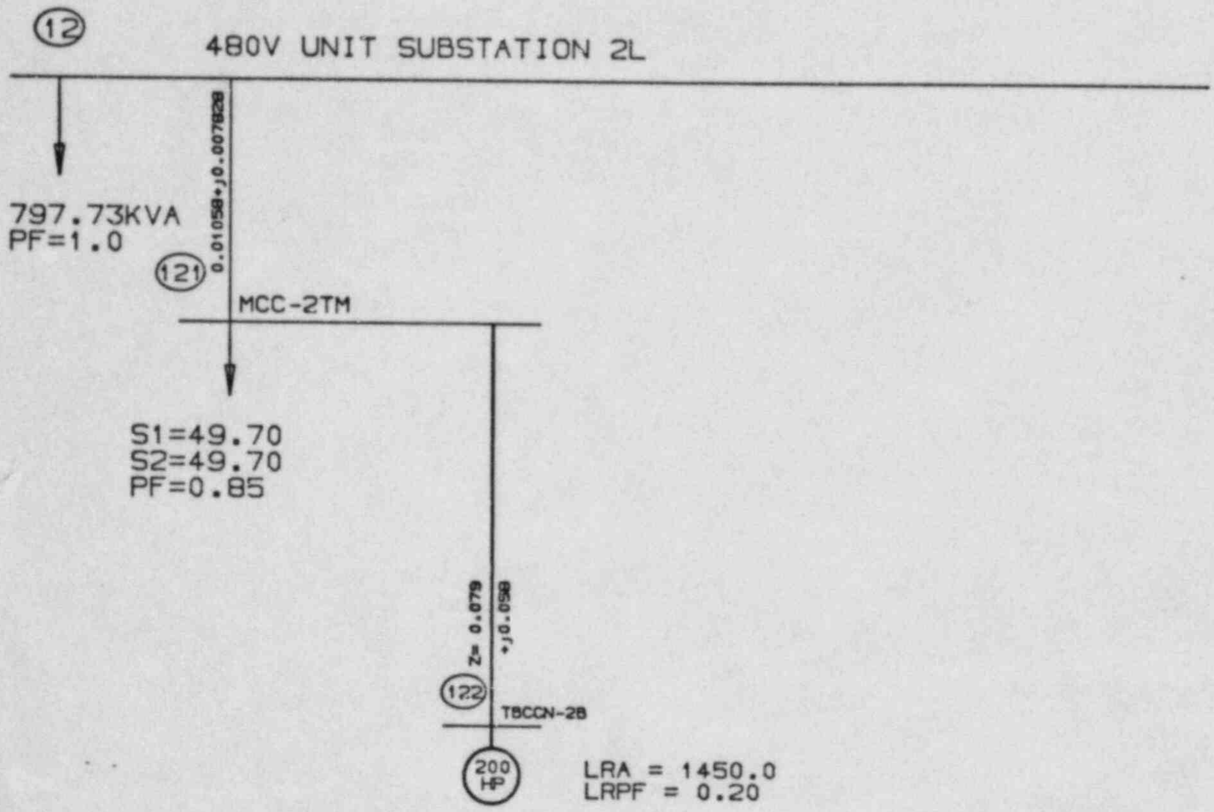
CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	GA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 19 OF 21 REV. NO. 0



480V UNIT SUBSTATION "2L" LOADS
AT TBCCW-2B MOTOR START

NOTES:
ALL S1, S2 ARE IN KVA
S1 = LOADS AT FULL LOAD
S2 = LOADS AT LOCA CONDITION
Z = IMPEDANCE (IN OHMS)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4-20-84	ISSUE FOR NT-124						

DPE: W K Russell

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CAROLINA POWER & LIGHT COMPANY

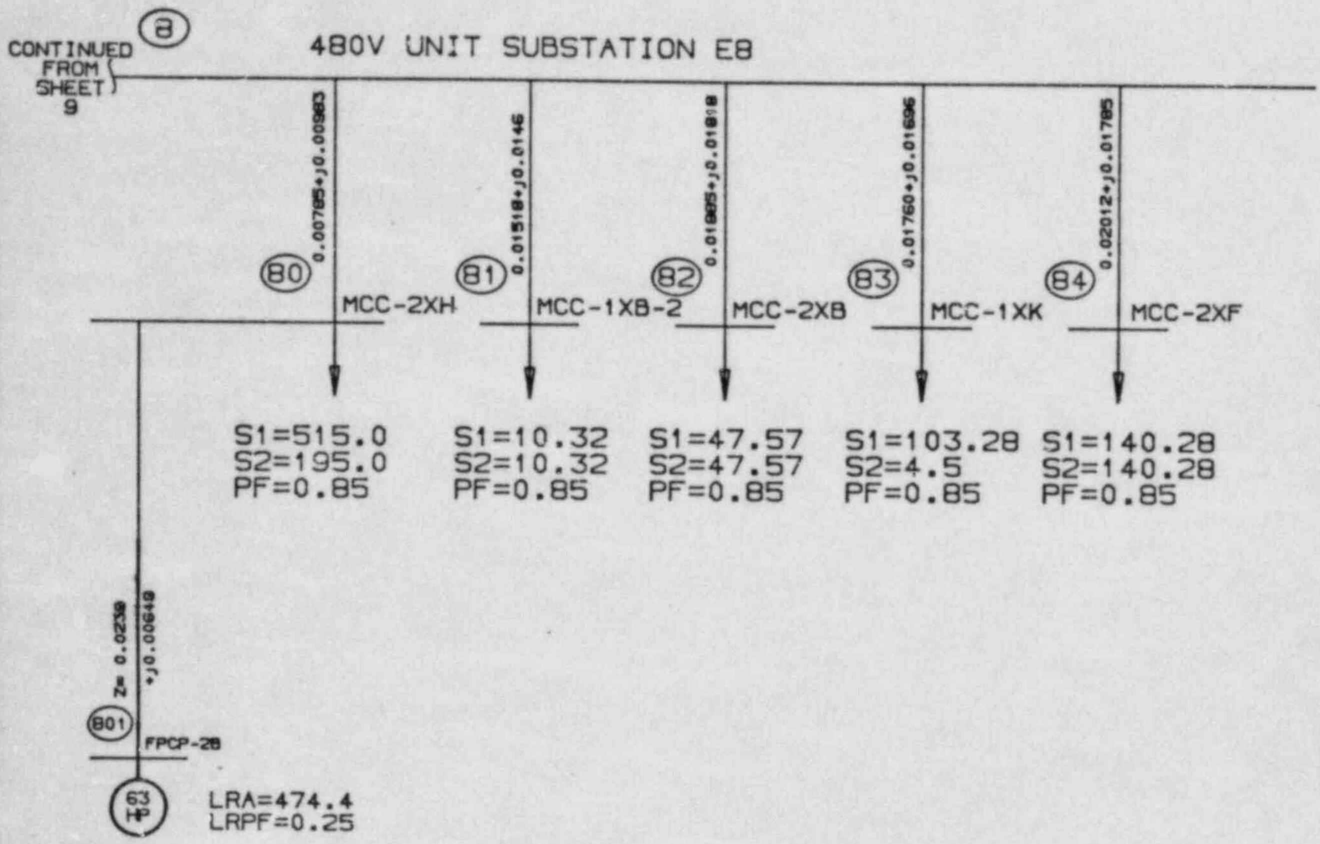
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION SYSTEM STUDY LOAD MODEL

REV	QA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 — SCALE: NONE — SHEET 20 OF 21 — REV. NO. 0



480V UNIT SUBSTATION "E8" LOADS
AT FUEL POOL CLEANING PUMP MOTOR 2B START

NOTES:
ALL S1, S2 ARE IN KVA
S1 = LOADS AT FULL LOAD
S2 = LOADS AT LOCA CONDITION
Z = IMPEDANCE (IN OHMS)

REV	DATE	DESCRIPTION	DWN	CK	RE	DPE	DPPE	LE
0	4 20 84	ISSUE FOR NT-124						

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NUCLEAR SAFETY RELATED

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT - RALEIGH, N.C.

PLANT: BSEP UNIT 2

TITLE: ELECTRICAL DISTRIBUTION
SYSTEM STUDY
LOAD MODEL

REV	GA	STRUC	NUC	MECH	ELECT	I&C

DWG. NO. T124-E-3001 SCALE: NONE SHEET 21 OF 21 REV. NO. 0

12.0 APPENDIX F

MOTOR ACCELERATION TIMES AND RELAY CHARACTERISTICS

Computed by: J.A. Kowalcheck Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen Date: 5-30-84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 1 of 9	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: MOTOR ACCELERATION TIME CALCULATIONS			
Status: Prelim. ☐ Final ☒ Void ☐			

A GRAPHICAL METHOD FOR PREDICTING INDUCTION MOTOR ACCELERATION TIME IS PRESENTED IN REFERENCE NO. 1. THIS METHOD WILL YIELD THE ACCELERATION TIME, IN SECONDS, IF THE FOLLOWING UNITS ARE USED:

VARIABLE	UNIT
MOTOR TORQUE (T) :	NEWTON - METER
MOMENT OF INERTIA (WR^2) :	KILOGRAM - METER^2
MOTOR SPEED :	RADIANS / SECOND

REFERENCE NO. 2 APPLIES A FACTOR TO THE ABOVE METHOD FOR USE WITH THE U.S. CUSTOMARY SYSTEM AS FOLLOWS:

$$EQ\#1: \text{TIME (SEC.)} = 0.00325 \frac{\text{CHANGE IN RPM} \times WR^2}{T_{\text{AVAILABLE FOR ACCELERATION}}}$$

AND BASED ON THE FOLLOWING UNITS:

VARIABLE	UNIT
MOTOR TORQUE (T) :	POUND - FEET (LB-FT.)
MOMENT OF INERTIA (WR^2) :	POUND - FEET^2 (LB-FT^2)
MOTOR SPEED :	REVOLUTIONS/MINUTE (RPM)

REFERENCE NO. 3 DEMONSTRATES A TABULAR METHOD FOR CALCULATING THE ACCELERATION TIME. THE EQUATION USED IS IDENTICAL WITH THAT USED IN REFERENCE NO. 2, WITH THE EXCEPTION THAT THE CONSTANT VALUE OF 0.00325 IS MOVED FROM THE NUMERATOR TO THE DENOMINATOR, SO THAT:

$$EQ\#2: \text{TIME (SEC)} = \frac{\text{CHANGE IN RPM} \times WR^2}{308 \times T_{\text{AVAILABLE FOR ACCELERATION}}}$$

(CONTINUED)

Computed by: J.A. Kowalcheck	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen	Date: 5/30/84		Pg. 2 of 9	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP Electrical Distribution System Study				
Calculation Title: Motor Acceleration Time Calculations				
Status: Prelim. ☐ Final ☒ Void ☐				

EQ #2 IS THE EQUATION USED IN THE "ELECTRONIC SPREADSHEETS" DEVELOPED FOR PREDICTING MOTOR ACCELERATION TIMES. IN ADDITION, THE SPREADSHEETS CLOSELY FOLLOW THE METHOD DESCRIBED IN REFERENCE #3.

THE VARIABLE "T" (MOTOR TORQUE) USED IN THE ABOVE EQUATIONS IS THE AVERAGE NET AVAILABLE TORQUE OVER A GIVEN SPEED RANGE. FOR THIS REASON, THE SPEED-TORQUE CURVE IS DIVIDED INTO 180 RPM (10% OF SYNCHRONOUS SPEED) SEGMENTS FROM 0 TO 1620 RPM (0-90%) AND 90 RPM SEGMENTS FROM 1620 TO 1800 RPM (90-100%). THESE AVERAGE MOTOR TORQUE AT A GIVEN SPEED, LESS THE AVERAGE LOAD TORQUE AT THE SAME SPEED IS THE AVERAGE NET TORQUE AVAILABLE.

THE VARIABLE "WR^2" (MOMENT OF INERTIA) IS THE SUM OF THE MOMENTS OF INERTIA OF THE MOTOR ROTOR AND LOAD.

REFERENCES:

1. ELECTRIC MACHINERY; A.E. FITZGERALD, C. KINGSLEY, JR., A. KUSKO; MCGRAW-HILL; 1971; PP. 510-512.

2. ELECTRIC MOTORS AND THEIR APPLICATIONS; T.C. LLOYD; JOHN WILEY & SONS; 1969; PP. 98-100.

3. "CALCULATING TORQUE AND HEAT BUILD-UP DURING MOTOR STARTING"; W.C. BRODERICK; ELECTRICAL CONSTRUCTION AND MAINTENANCE; FEBRUARY 1979; PP. 79-81.

Computed by: J.A. Kowalcheck	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen	Date: 5/30/84		Pg. 3 of 9	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: MOTOR ACCELERATION TIME CALCULATIONS				
Status: Prelim. ☐ Final ☒ Void ☐				

DATA REQUIREMENTS & EQUATIONS USED WITH <u>MOTOR ACCELERATION TIME CALCULATIONS</u> - <u>DATA FROM FIGURES</u> (SEE FIGURE 1).

Ⓐ & Ⓑ : VALUES FROM MOTOR DATA SHEETS

Ⓒ & Ⓓ : VALUES FROM LOAD DATA SHEETS

(E_1), (E_2), (E_3) : PERCENT OF NOMINAL MOTOR VOLTAGE AT WHICH SPEED-TORQUE CURVES ARE SUPPLIED.

Ⓕ : PERCENT OF MAXIMUM LOAD TORQUE; Ⓒ (AVERAGE VALUE OVER CORRESPONDING SPEED RANGE.)

(G_1), (G_2), (G_3) : PERCENT OF FULL-LOAD MOTOR TORQUE; Ⓐ (AVERAGE VALUE OVER CORRESPONDING SPEED RANGE.)

(H_1), (H_2), (H_3) : NET TORQUE AVAILABLE FOR ACCELERATION OVER CORRESPONDING SPEED RANGE AND MOTOR VOLTAGE.

e.g.: $H_1^{0-10} = \left[\left[G_1^{0-10} \times A\right] - \left[F \times C\right]\right] \div 100$ ETC.

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: DATE:
CHECKED BY: DATE:
PROJECT TITLE:
TAR NUMBER:
MOTOR NAME:

MOTOR FULL-LOAD TORQUE: (A) FT.-LBS.
MOTOR ROTOR INERTIA: (B) LBS.-FT.^2
MAXIMUM LOAD TORQUE: (C) FT.-LBS.
LOAD INERTIA: (D) LBS.-FT.^2

		MOTOR V = (E1) %			MOTOR V = (E2) %			MOTOR V = (E3) %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	(F) 0-10	(G1) 0-10	(H1) 0-10	(J1) 0-10	(G2) 0-10	(H2) 0-10	(J2) 0-10	(G3) 0-10	(H3) 0-10	(J3) 0-10
10-20										
20-30										
30-40										
40-50										
50-60										
60-70										
70-80										
80-90										
90-95										
95-100										

TOTAL TIME = (K1).00 TOTAL TIME = (K2).00 TOTAL TIME = (K3).00

DATA FROM FIGURES

FIGURE # 1

Computed by: J.A. Kowalcheck Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen Date: 5/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 4 of 9	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY.

Calculation Title: MOTOR ACCELERATION TIME CALCULATIONS

Status: Prelim. ☐ Final ☒ Void ☐

(J₁),(J₂),(J₃) : ELAPSED TIME FOR ACCELERATION OVER CORRESPONDING SPEED RANGE AND MOTOR VOLTAGE.

e.g.: For 10% (180 RPM) speed steps (0-10, 10-20, ... 80-90)

$$(J_1)^{0\text{-}10} = \left[180 \times \left[(B) + (D)\right]\right] \div \left[308 \times (H_1)^{0\text{-}10}\right] \quad \text{ETC.}$$

For 5% (90 RPM) speed steps (90-95, 95-100)

$$(J_2)^{95\text{-}100} = \left[90 \times \left[(B) + (D)\right]\right] \div \left[308 \times (H_2)^{95\text{-}100}\right] \quad \text{ETC.}$$

(K₁),(K₂),(K₃) : TOTAL TIME FOR ACCELERATION AT CORRESPONDING MOTOR VOLTAGE.

e.g.: $$(K_3) = (J_3)^{0\text{-}10} + (J_3)^{10\text{-}20} + \ldots + (J_3)^{90\text{-}95} + (J_3)^{95\text{-}100} \quad \text{ETC.}$$

NOTE: VALUES FOR (A) THROUGH (G_i) ARE SUPPLIED BY THE USER. VALUES FOR (H_i), (J_i) & (K_i) ARE CALCULATED BY THE SPREADSHEET PROGRAM.

Computed by: J.A. Kowalcheck Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen Date: 5/30/84		Pg. 5 of 9	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP Electrical Distribution System Study			
Calculation Title: Motor Acceleration Time Calculations			
Status: Prelim. ☐ Final ☒ Void ☐			

DATA REQUIREMENTS & EQUATIONS USED WITH MOTOR ACCELERATION TIME CALCULATIONS - DATA FROM CALCULATION (SEE FIGURE 2).

(A) & (B) : VALUES FROM MOTOR DATA SHEETS.

(C) & (D) : VALUES FROM LOAD DATA SHEETS.

(E_1) : PERCENT OF NOMINAL MOTOR VOLTAGE AT WHICH SPEED-TORQUE INFORMATION IS AVAILABLE.

(E_2) & (E_3) : PERCENT OF NOMINAL MOTOR VOLTAGE FOR WHICH SPEED-TORQUE DATA IS CALCULATED.

(F) : PERCENT OF MAXIMUM LOAD TORQUE; (C) (AVERAGE VALUE OVER CORRESPONDING SPEED RANGE.)

(G_1) : PERCENT OF FULL-LOAD MOTOR TORQUE; (A) (AVERAGE VALUE OVER CORRESPONDING SPEED RANGE.)

(G_2) & (G_3) : PERCENT OF FULL-LOAD MOTOR TORQUE; (A) (AVERAGE VALUE OVER CORRESPONDING SPEED RANGE.). CALCULATION IS BASED ON THE "INVERSE SQUARE" EFFECT ON MOTOR TORQUE.

e.g.: FOR MOTOR SPEED FROM 0 TO 9.5% OF FULL-LOAD SPEED.

$$(G_2)^{0-10} = \left[(E_2) \div (E_1)\right]^2 \times (G_1)^{0-10} \quad \text{ETC.}$$

(CONTINUED)

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: DATE:
CHECKED BY: DATE:
PROJECT TITLE:
TAR NUMBER:
MOTOR NAME:

MOTOR FULL-LOAD TORQUE: (A) FT.-LBS.
MOTOR ROTOR INERTIA: (B) LBS.-FT.^2
MAXIMUM LOAD TORQUE: (C) FT.-LBS.
LOAD INERTIA: (D) LBS.-FT.^2

		MOTOR V = (E1) %			MOTOR V = (E2) %			MOTOR V = (E3) %		
1	2	3	4	5	6	7	8	9	10	11
MOTOR SPEED (%)	LOAD TORQUE (%)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)
0-10	(F) 0-10	(G1) 0-10	(H1) 0-10	(J1) 0-10	(G2) 0-10	(H2) 0-10	(J2) 0-10	(G3) 0-10	(H3) 0-10	(J3) 0-10
10-20										
20-30										
30-40										
40-50										
50-60										
60-70										
70-80										
80-90										
90-95										
95-100										

TOTAL TIME = (K1).00 TOTAL TIME = (K2).00 TOTAL TIME = (K3).00

DATA FROM CALCULATION

FIGURE #2

Computed by: J.A. Kowalcheck Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-12-F	
Checked by: Ha Nguyen Date: 5/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 6 of 9	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP Electrical Distribution System Study

Calculation Title: Motor Acceleration Time Calculations

Status: Prelim. ☐ Final ☒ Void ☐

FOR MOTOR SPEED FROM 95 TO 100% OF FULL-LOAD SPEED, THE ABOVE EQUATION RESULTS IN AN EXCESSIVELY LOW VALUE OF MOTOR TORQUE AT MOTOR VOLTAGES BELOW NOMINAL. THIS IS BECAUSE THE MOTOR WILL REACH AN EQUILIBRIUM POINT (I.E.: STOP ACCELERATING) AT THE POINT WHERE THE AVAILABLE MOTOR TORQUE EQUALS THE REQUIRED LOAD TORQUE (SEE FIGURE #3)

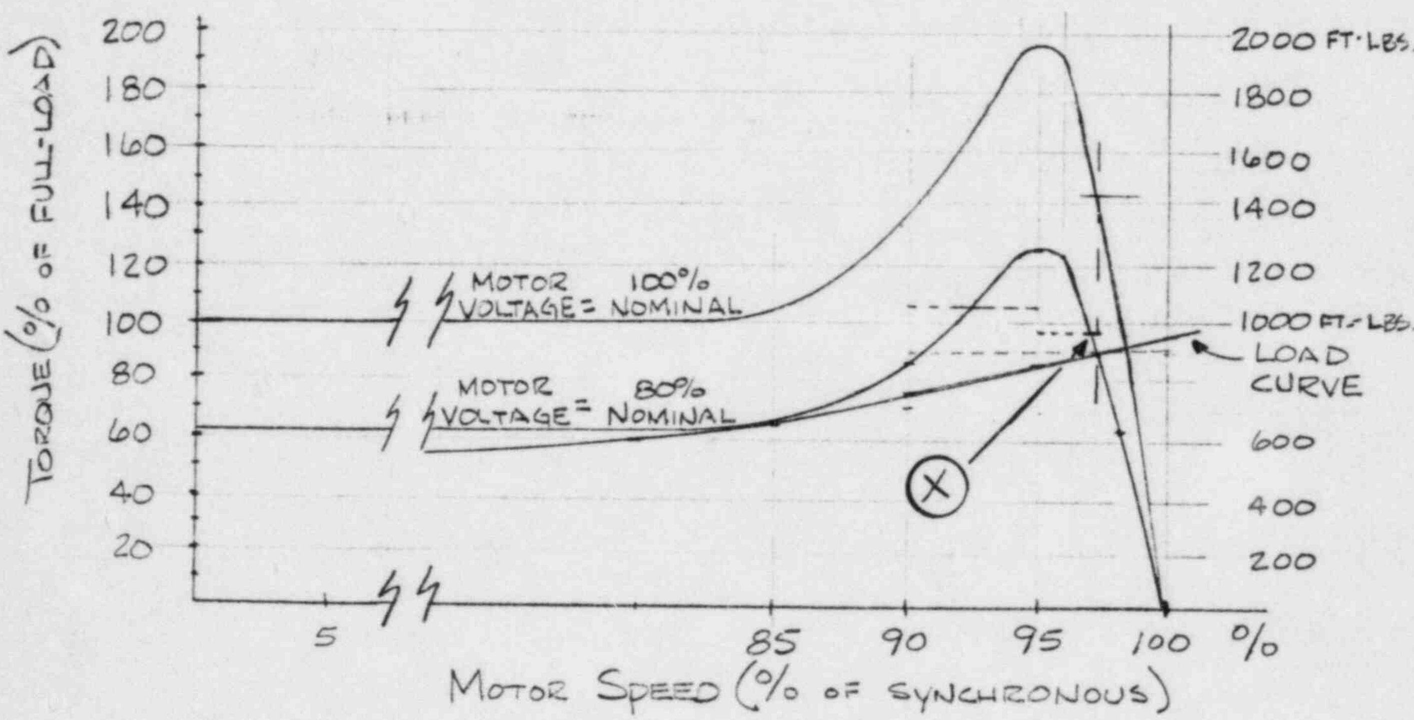


FIGURE #3

FOR EXAMPLE, IN THE HYPOTHETICAL CASE SHOWN IN FIGURE #3, AN AVERAGE MOTOR TORQUE OF ABOUT 143% IS CHOSEN FOR THE RANGE OF 95 TO 100% SPEED AT FULL VOLTAGE. IF THE EQUATION ABOVE IS APPLIED IN THIS SITUATION THE CALCULATED MOTOR TORQUE AT 80% VOLTAGE WOULD BE:

(CONTINUED)

$$G_2^{95\text{-}100} = [E_2 \div E_1]^2 \times G_1^{95\text{-}100}$$

$$= [80 \div 100]^2 \times 143\%$$

$$= 91.5\%$$

THIS POINT IS SHOWN ON THE 80% VOLTAGE CURVE ON FIGURE #3. NOTE, HOWEVER, THAT IN THIS CASE IT COINCIDES WITH THE POINT AT WHICH THE LOAD CURVE CROSSES THE MOTOR TORQUE CURVE. IF THIS POINT IS ALSO CHOSEN FOR THE AVERAGE LOAD TORQUE, FOR THE 95 TO 100% SPEED RANGE, ZERO (0) NET TORQUE WOULD BE AVAILABLE FOR ACCELERATTON. IN OTHER WORDS, IN THIS CASE WE WOULD NOT EXPECT THE MOTOR TO ACCELERATE BEYOND 95% SPEED AND WOULD NOT REACH A POINT OF STABILITY ON THE SPEED-TORQUE CURVE.

IN ORDER TO COMPENSATE FOR THE ABOVE SITUATION, AN ALTERNATE EQUATION IS USED FOR CALCULATING THE AVERAGE MOTOR TORQUE IN THE 95 TO 100% SPEED RANGE. BY TAKING THE MIDPOINT BETWEEN THE CALCULATED MOTOR TORQUE AT 90 TO 95%, AND THE LOAD TORQUE AT 95 TO 100%, AN APPROXIMATE MOTOR TORQUE FOR THE 95 TO 100% CAN BE CALCULATED. THEREFORE, IN THIS CASE:

$$G_2^{95\text{-}100} = [G_2^{90\text{-}95} + [F \times [C \div A]]] \div 2$$

$$= [105 + [92 \times [95 \div 100]]] \div 2$$

$$= 96.2\%$$

(CONTINUED)

THIS VALUE IS SHOWN AS POINT (X) ON FIGURE #3. BY INSPECTING FIGURE #3, IT CAN BE SEEN THAT THIS METHOD STILL PRODUCES A CONVERVATIVE VALUE FOR AVAILABLE MOTOR TORQUE AT 95 TO 100% SPEED.

(H1),(H2),(H3) : NET TORQUE AVAILABLE FOR ACCELERATION OVER CORRESPONDING SPEED RANGE AND MOTOR VOLTAGE.

e.g.: $$H_1^{0-10} = \left[\left[G_1^{0-10} \times A \right] - \left[F \times C \right] \right] \div 100 \quad \text{ETC.}$$

(J1),(J2),(J3) : ELAPSED TIME FOR ACCELERATION OVER CORRESPONDING SPEED RANGE AND MOTOR VOLTAGE.

e.g.: FOR 10% (180 RPM) SPEED STEPS (0-10, 10-20, ... 80-90)

$$J_1^{0-10} = \left[180 \times \left[B + D \right] \right] \div \left[308 \times H_1^{0-10} \right] \text{ETC.}$$

FOR 5% (90 RPM) SPEED STEPS (90-95, 95-100)

$$J_2^{95-100} = \left[90 \times \left[B + D \right] \right] \div \left[308 \times H_2^{95-100} \right] \text{ETC.}$$

NOTE: FOR VALUES OF $H_i \leq 0$, N/A WILL BE PRINTED IN THE ELAPSED TIME COLUMN — INDICATING THAT THE MOTOR WILL NOT FULLY ACCELERATE THE LOAD.

(CONTINUED)

(K_1) (K_2) (K_3) : TOTAL TIME FOR ACCELERATION AT CORRESPONDING MOTOR VOLTAGE.

e.g.: $(K_3) = (J_3)^{0-10} + (J_3)^{10-20} + \ldots + (J_3)^{90-95} + (J_3)^{95-100}$ ETC.

NOTE: VALUES FOR (A) THROUGH (F), AND (G_1) ARE SUPPLIED BY THE USER. VALUES FOR (G_2), (G_3), (H_i), (J_i) & (K_i) ARE CALCULATED BY THE SPREADSHEET PROGRAM.

Computed by: J.A. Kowalchek	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-13-F	
Checked by: Ha Nguyen	Date: 5/30/84		Pg. 1 of 1	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP Electrical Distribution System Study

Calculation Title: Motor Acceleration Time Calculations - Screen Wash Pumps

Status: Prelim. ☐ Final ☒ Void ☐

MINIMUM EXPECTED SWITCHYARD VOLTAGE = 1.009 p.u.
CORRESPONDING MOTOR TERMINAL VOLTAGE

1. SCREEN WASH PUMP 2B = 0.7998 p.u. (460 V. BASE)

2. SCREEN WASH PUMP 1A = 0.7826 p.u. (460 V. BASE)

CALCULATED ACCELERATION TIMES (SEE FIGURES #1 & #2)

MOTOR VOLTAGE p.u. (%)	ACCELERATION TIME SECONDS
1.00 (100%)	0.78
.80 (80%)	1.66
.70 (70%)	4.66
.684 (68.4%)	32.60
.683 (68.3%)	FAILURE TO ACCELERATE.

CONCLUSION: SINCE THE CALCULATED ACCELERATING TIME AT 70% MOTOR TERMINAL VOLTAGE IS LESS THAN 5 SEC., NO PROBLEM IS ANTICIPATED WITH STARTING AT 78.26% MOTOR TERMINAL VOLTAGE.

REFERENCES: BYRON JACKSON DRAWING NO. PC 24276-ST
GENERAL ELECTRIC DRAWING NO. 492HA165
GENERAL ELECTRIC DRAWING NO. 492HA347
ASDOP CASE # 1SAT18.

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY:JOHN A. KOWALCHECK DATE:05/07/84
CHECKED BY: DATE:
PROJECT TITLE:BSEP ELECTRICAL DISTRIBUTION SYSTEM
TAR NUMBER:NT-124
MOTOR NAME:SCREEN WASH PUMP(S)

MOTOR FULL-LOAD TORQUE: 740 FT.-LBS.
MOTOR ROTOR INERTIA: 52.66 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 705.22 FT.-LBS.
LOAD INERTIA: 29.53 LBS.-FT.^2

		MOTOR V = 100 %			MOTOR V = 80 %			MOTOR V = 70 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	5	100	704.74	.07	64.00	438.34	.11	49.00	327.34	.15
10-20	2	100	725.90	.07	64.00	459.50	.10	49.00	348.50	.14
20-30	6	100	697.69	.07	64.00	431.29	.11	49.00	320.29	.15
30-40	12	102	670.17	.07	65.28	398.45	.12	49.98	285.23	.17
40-50	20	104	628.56	.08	66.56	351.50	.14	50.96	236.06	.20
50-60	30	106	572.83	.08	67.84	290.45	.17	51.94	172.79	.28
60-70	42	110	517.81	.09	70.40	224.77	.21	53.90	102.67	.47
70-80	56	126	537.48	.09	80.64	201.81	.24	61.74	61.95	.78
80-90	72	160	676.24	.07	102.40	250.00	.19	78.40	72.40	.66
90-95	85	194	836.16	.03	124.16	319.35	.08	95.06	104.01	.23
95-100	95	142	380.84	.06	107.35	124.41	.19	92.80	16.74	1.43
		TOTAL TIME =		.78	TOTAL TIME =		1.66	TOTAL TIME =		4.66

DATA FROM CALCULATION

FIGURE #1

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: JOHN A. KOWALCHECK   DATE: 05/07/84
CHECKED BY: DATE:
PROJECT TITLE: BSEP ELECTRICAL DISTRIBUTION SYSTEM
TAR NUMBER: NT-124
MOTOR NAME: SCREEN WASH PUMP(S)

MOTOR FULL-LOAD TORQUE: 740 FT.-LBS.
MOTOR ROTOR INERTIA: 52.66 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 705.22 FT.-LBS.
LOAD INERTIA: 29.53 LBS.-FT.^2

		MOTOR V = 100 %			MOTOR V = 68.4 %			MOTOR V = 68.3 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	5	100	704.74	.07	46.79	310.95	.15	46.65	309.94	.15
10-20	2	100	725.90	.07	46.79	332.11	.14	46.65	331.10	.15
20-30	6	100	697.69	.07	46.79	303.90	.16	46.65	302.89	.16
30-40	12	102	670.17	.07	47.72	268.51	.18	47.58	267.48	.18
40-50	20	104	628.56	.08	48.66	219.02	.22	48.51	217.97	.22
50-60	30	106	572.83	.08	49.59	155.42	.31	49.45	154.35	.31
60-70	42	110	517.81	.09	51.46	84.64	.57	51.31	83.53	.58
70-80	56	126	537.48	.09	58.95	41.31	1.16	58.78	40.03	1.20
80-90	72	160	676.24	.07	74.86	46.18	1.04	74.64	44.56	1.08
90-95	85	194	836.16	.03	90.76	72.22	.33	90.50	70.25	.34
95-100	95	142	380.84	.06	90.65	.85	28.34	90.52	-.13N/A	
		TOTAL TIME =		.78	TOTAL TIME =		32.60	TOTAL TIME = N/A		

DATA FROM CALCULATION

FIGURE #2

Computed by: J.A. Kowalcheck	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-14-F	
Checked by: Ha Nguyen	Date: 5/21/84		Pg. 1 of 1	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: MOTOR ACCELERATION TIME CALCULATIONS – RHR PUMPS

Status: Prelim. ☐ Final ☒ Void ☐

MINIMUM EXPECTED SWITCHYARD VOLTAGE = 0.965 p.u.

MINIMUM EXPECTED MOTOR VOLTAGE:

4160 V. BASE	4000 V. BASE
0.7675 p.u.	0.7982 p.u.

CALCULATED ACCELERATION TIMES (SEE FIGURES #1, #2 & #3)

	MOTOR VOLTAGE p.u. (%)	ACCELERATION TIME SECONDS	
	1.00 (100%)	2.14	
	.80 (80%)	4.74	
USE THESE VALUES TO BE CONSERVATIVE	.748 (74.8%)	8.45	CALCULATIONS BASED ON MOTOR TORQUE VALUES GIVEN AT 70% VOLTAGE.
	.747 (74.7%)	8.56	
	.739 (73.9%)	8.39	CALCULATIONS BASED ON MOTOR TORQUE VALUES GIVEN AT 80% VOLTAGE
	.738 (73.8%)	8.51	
	.70 (70%)	89.41	

CONCLUSION: EXPECTED ACCELERATING TIME AT MOTOR TERMINAL VOLTAGE OF 0.7982 (4000 V. BASE) IS APPROXIMATELY 4.9 SECONDS (INTERPOLATED BETWEEN 0.80 p.u. AND 0.748 p.u.). MINIMUM VOLTAGE AT WHICH THE MOTOR WILL ACCELERATE IN LESS THAN 8.5 SECONDS IS 0.748 p.u. (8.5 SECONDS IS BASED ON THE MINIMUM TIME FOR DEGRADED VOLTAGE TRIP AT POST TURBINE-TRIP CONDITIONS.)

REFERENCES: BYRON JACKSON DRAWING No. PC 29800-2 (F.P. 9527-50785)
GENERAL ELECTRIC DRAWING No. 388HA329, REV. 1 (F.P. 9527-50266)
ASDOP CASE 1SAT9

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY:JOHN A. KOWALCHECK DATE:04/24/84
CHECKED BY: DATE:
PROJECT TITLE:BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY
TAR NUMBER:NT-124
MOTOR NAME:RESIDUAL HEAT REMOVAL

MOTOR FULL-LOAD TORQUE: 2954 FT.-LBS.
MOTOR ROTOR INERTIA: 820 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 2950 FT.-LBS.
LOAD INERTIA: 95 LBS.-FT.^2

		MOTOR V = 100 %			MOTOR V = 80 %			MOTOR V = 70 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	4	100	2836.00	.19	64	1772.56	.30	49	1329.46	.40
10-20	2	100	2895.00	.18	64	1831.56	.29	49	1388.46	.39
20-30	6	100	2777.00	.19	64	1713.56	.31	49	1270.46	.42
30-40	12	102	2659.08	.20	64	1536.56	.35	49	1093.46	.49
40-50	20	105	2511.70	.21	65	1330.10	.40	50	887.00	.60
50-60	30	110	2364.40	.23	67	1094.18	.49	50	592.00	.90
60-70	42	118	2246.72	.24	75	976.50	.55	54	356.16	1.50
70-80	56	132	2247.28	.24	85	858.90	.62	60	120.40	4.44
80-90	72	157	2513.78	.21	100	830.00	.64	74	61.96	8.63
90-95	86	192	3134.68	.09	122	1066.88	.25	93	210.22	1.27
95-100	95	150	1628.50	.16	112	505.98	.53	95	3.80	70.36
		TOTAL TIME =		2.14	TOTAL TIME =		4.74	TOTAL TIME =		89.41

DATA FROM FIGURES

FIGURE #1

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY:JOHN A. KOWALCHECK DATE:05/07/84
CHECKED BY: DATE:
PROJECT TITLE:B^EP ELECTRICAL DISTRIBUTION STUDY
TAR NUMBER:NT-124
MOTOR NAME:RESIDUAL HEAT REMOVAL

MOTOR FULL-LOAD TORQUE: 2954 FT.-LBS.
MOTOR ROTOR INERTIA: 820 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 2950 FT.-LBS.
LOAD INERTIA: 95 LBS.-FT.^2

		MOTOR V = 70 %			MOTOR V = 74.8 %			MOTOR V = 74.7 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	4	49	1329.46	.40	55.95	1534.77	.35	55.80	1530.36	.35
10-20	2	49	1388.46	.39	55.95	1593.77	.34	55.80	1589.36	.34
20-30	6	49	1270.46	.42	55.95	1475.77	.36	55.80	1471.36	.36
30-40	12	49	1093.46	.49	55.95	1298.77	.41	55.80	1294.36	.41
40-50	20	50	887.00	.60	57.09	1096.50	.49	56.94	1092.00	.49
50-60	30	50	592.00	.90	57.09	801.50	.67	56.94	797.00	.67
60-70	42	54	356.16	1.50	61.66	582.43	.92	61.49	577.56	.93
70-80	56	60	120.40	4.44	68.51	371.81	1.44	68.33	366.40	1.46
80-90	72	74	61.96	8.63	84.50	372.03	1.44	84.27	365.36	1.46
90-95	86	93	210.22	1.27	106.19	599.90	.45	105.91	591.52	.45
95-100	95	95	3.80	70.36	100.53	167.20	1.60	100.39	163.01	1.64
		TOTAL TIME =		89.41	TOTAL TIME =		8.45	TOTAL TIME =		8.56

DATA FROM CALCULATION

FIGURE #2

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: JOHN A. KOWALCHECK   DATE: 05/07/84
CHECKED BY: DATE:
PROJECT TITLE: BSEP ELECTRICAL DISTRIBUTION STUDY
TAR NUMBER: NT-124
MOTOR NAME: RESIDUAL HEAT REMOVAL

MOTOR FULL-LOAD TORQUE: 2954 FT.-LBS.
MOTOR ROTOR INERTIA: 820 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 2950 FT.-LBS.
LOAD INERTIA: 95 LBS.-FT.^2

		MOTOR V = 80 %			MOTOR V = 73.9 %			MOTOR V = 73.8 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	4	64	1772.56	.30	54.61	1495.24	.36	54.46	1490.88	.36
10-20	2	64	1831.56	.29	54.61	1554.24	.34	54.46	1549.88	.35
20-30	6	64	1713.56	.31	54.61	1436.24	.37	54.46	1431.88	.37
30-40	12	64	1536.56	.35	54.61	1259.24	.42	54.46	1254.88	.43
40-50	20	65	1330.10	.40	55.47	1048.45	.51	55.32	1044.02	.51
50-60	30	67	1094.18	.49	57.17	803.86	.67	57.02	799.29	.67
60-70	42	75	976.50	.55	64.00	651.52	.82	63.83	646.40	.83
70-80	56	85	858.90	.62	72.53	490.59	1.09	72.34	484.79	1.10
80-90	72	100	830.00	.64	85.33	396.69	1.35	85.10	389.87	1.37
90-95	86	122	1066.88	.25	104.10	538.24	.50	103.82	529.92	.50
95-100	95	112	505.98	.53	99.49	136.37	1.96	99.35	132.21	2.02
		TOTAL TIME =		4.74	TOTAL TIME =		8.39	TOTAL TIME =		8.51

DATA FROM CALCULATION

FIGURE #3

Computed by: J.A. Kowalcheck	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-15-F	
Checked by: Ha Nguyen	Date: 5/21/84		Pg. 1 of 1	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP Electrical Distribution System Study				
Calculation Title: Motor Acceleration Time Calculations - Core Spray Pumps				
Status: Prelim. ☐ Final ☒ Void ☐				

MINIMUM EXPECTED SWITCHYARD VOLTAGE = 0.965 p.u.

MINIMUM EXPECTED MOTOR VOLTAGE:

4160 V. BASE	4000 V. BASE
0.7624 p.u	0.7929 p.u.

CALCULATED ACCELERATION TIMES (SEE FIGURES #1 & #2)

MOTOR VOLTAGE p.u. (%)	ACCELERATION TIME SECONDS
1.00 (100%)	1.52
.80 (80%)	2.92
.70 (70%)	5.45
.667 (66.7%)	8.44
.666 (66.6%)	8.58

CONCLUSION: EXPECTED ACCELERATING TIME AT MOTOR TERMINAL VOLTAGE OF 0.7929 pu (4000 V. BASE) IS APPROXIMATELY 3.1 SECONDS. MINIMUM VOLTAGE AT WHICH MOTOR WILL ACCELERATE IN LESS THAN 8.5 SECONDS IS 0.667 p.u. (8.5 SECONDS IS BASED ON THE MINIMUM TIME FOR FOR DEGRADED VOLTAGE TRIP AT POST TURBINE-TRIP CONDITIONS.)

REFERENCES: BYRON JACKSON DRAWING No. PC29797-2 (F.P. 9527-50786)
GENERAL ELECTRIC DRAWING No. 338HA364 (F.P. 9527-5419)
ASDOP CASE No. 1SAT9

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: JOHN A. KOWALCHECK DATE: 04/24/84
CHECKED BY: DATE:
PROJECT TITLE: BSEP ELECTRICAL DISTRIBUTION STUDY
TAR NUMBER: NT-124
MOTOR NAME: CORE SPRAY

MOTOR FULL-LOAD TORQUE: 3678 FT.-LBS.
MOTOR ROTOR INERTIA: 750 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 2950 FT.-LBS.
LOAD INERTIA: 120 LBS.-FT.^2

		MOTOR V = 100 %			MOTOR V = 80 %			MOTOR V = 70 %		
1 MOTOR SPEED (%)	2 LOAD TORQUE (%)	3 MOTOR TORQUE (%)	4 NET TORQUE (FT.-LBS.)	5 ELAPSED TIME (SEC)	6 MOTOR TORQUE (%)	7 NET TORQUE (FT.-LBS.)	8 ELAPSED TIME (SEC)	9 MOTOR TORQUE (%)	10 NET TORQUE (FT.-LBS.)	11 ELAPSED TIME (SEC)
0-10	5	100	3530.50	.14	64	2206.42	.23	49	1654.72	.31
10-20	2	100	3619.00	.14	64	2294.92	.22	49	1743.22	.29
20-30	6	100	3501.00	.15	64	2176.92	.23	49	1625.22	.31
30-40	12	101	3360.78	.15	64	1999.92	.25	49	1448.22	.35
40-50	20	105	3271.90	.16	65	1800.70	.28	50	1249.00	.41
50-60	30	110	3160.80	.16	68	1616.04	.31	50	954.00	.53
60-70	43	118	3071.54	.17	75	1490.00	.34	53	680.84	.75
70-80	55	132	3232.46	.16	84	1467.02	.35	60	584.30	.87
80-90	72	157	3650.46	.14	100	1554.00	.33	74	597.72	.85
90-95	85	190	4480.70	.06	123	2016.44	.13	93	913.04	.28
95-100	95	140	2346.70	.11	105	1059.40	.24	90	507.70	.50
		TOTAL TIME =		1.52	TOTAL TIME =		2.92	TOTAL TIME =		5.45

DATA FROM FIGURES

Figure #1

CAROLINA POWER & LIGHT CO.
NUCLEAR ENGINEERING & LICENSING DEPT.
MOTOR ACCELERATION TIME CALCULATIONS

INPUT BY: JOHN A. KOWALCHECK   DATE: 05/07/84
CHECKED BY: DATE:
PROJECT TITLE: BSEP ELECTRICAL DISTRIBUTION STUDY
TAR NUMBER: NT-124
MOTOR NAME: CORE SPRAY

MOTOR FULL-LOAD TORQUE: 3678 FT.-LBS.
MOTOR ROTOR INERTIA: 750 LBS.-FT.^2
MAXIMUM LOAD TORQUE: 2950 FT.-LBS.
LOAD INERTIA: 120 LBS.-FT.^2

		MOTOR V = 70 %			MOTOR V = 66.7 %			MOTOR V = 66.6 %		
1	2	3	4	5	6	7	8	9	10	11
MOTOR SPEED (%)	LOAD TORQUE (%)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)	MOTOR TORQUE (%)	NET TORQUE (FT.-LBS.)	ELAPSED TIME (SEC)
0-10	5	49	1654.72	.31	44.49	1488.80	.34	44.36	1483.90	.34
10-20	2	49	1743.22	.29	44.49	1577.30	.32	44.36	1572.40	.32
20-30	6	49	1625.22	.31	44.49	1459.30	.35	44.36	1454.40	.35
30-40	12	49	1448.22	.35	44.49	1282.30	.40	44.36	1277.40	.40
40-50	20	50	1249.00	.41	45.40	1079.70	.47	45.26	1074.69	.47
50-60	30	50	954.00	.53	45.40	784.70	.65	45.26	779.69	.65
60-70	43	53	680.84	.75	48.12	501.38	1.01	47.98	496.07	1.02
70-80	55	60	584.30	.87	54.48	381.13	1.33	54.31	375.13	1.36
80-90	72	74	597.72	.85	67.19	347.15	1.46	66.99	339.75	1.50
90-95	85	93	913.04	.28	84.44	598.13	.43	84.19	588.83	.43
95-100	95	90	507.70	.50	80.32	151.57	1.68	80.19	146.91	1.73
		TOTAL TIME =		5.45	TOTAL TIME =		8.44	TOTAL TIME =		8.58

DATA FROM CALCULATION

FIGURE # 2

Computed by: W K Russell Date: 5/25/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-73-F	
Checked by: Ha Nguyen Date: 5-29-84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: CIRCULATING WATER PUMP MOTOR ACCELERATION TIME			
Status: Prelim. ☐ Final ☒ Void ☐			

PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO DETERMINE THE APPROXIMATE ACCELERATION TIME OF THE BSEP CIRCULATING WATER PUMP MOTORS AT THEIR MINIMUM EXPECTED TERMINAL VOLTAGE

LIST OF REFERENCES

1. – MCGRAW EDISON COMPANY, LOCKED & ACCELERATION TIME VS CURRENT CURVE FOR 2500 HP CWP MOTORS

2. ASDOP CASES:

1SAT4	2SAT4
1SAT13	2SAT13
1UAT4	2UAT4

BODY OF CALCULATION

FROM THE ABOVE REFERENCED ASDOP CASES, THE MINIMUM MOTOR TERMINAL VOLTAGE AT STARTING IS 0.8451 p.u. (ASDOP CASE 1SAT13)

FROM REFERENCE NO. 1 ACCELERATING TIMES ARE AVAILABLE FOR 80% AND 100% NOMINAL VOLTAGE. THEREFORE TO BE CONSERVATIVE THE 80% CURVE WILL BE USED TO DETERMINE THE MAXIMUM ACCELERATING TIME.

ACCELERATING TIME @ 80% TERMINAL VOLTAGE ≅ 5 SECONDS

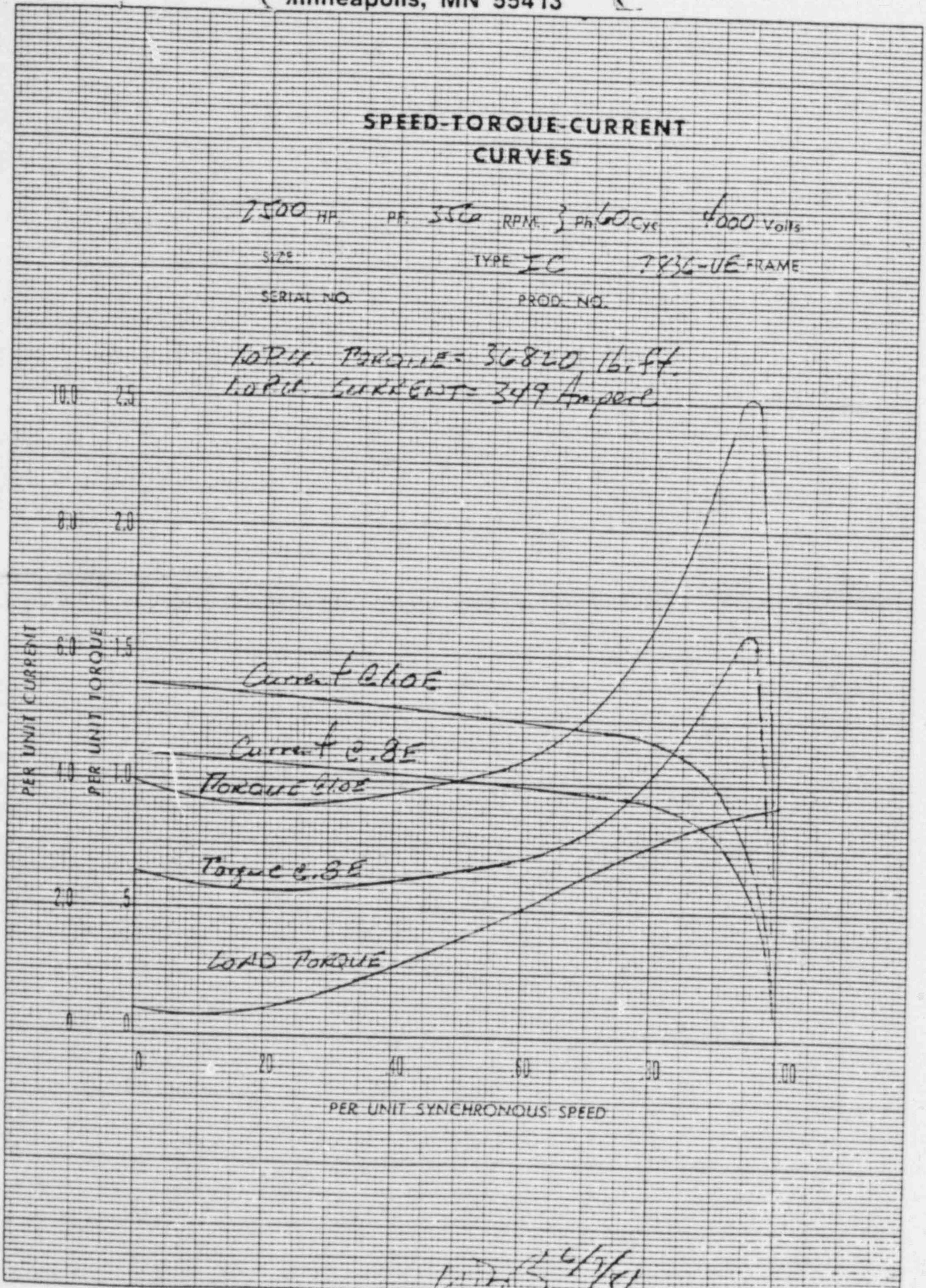
Computed by: W K Russell Date: 5/25/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-73-F	
Checked by: Ha Nguyen Date: 5/29/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: CIRCULATING WATER PUMP MOTOR ACCELERATION TIME			
Status: Prelim. ☐ Final ☒ Void ☐			

CONCLUSIONS

FOR THE PLANT CONDITIONS ANALYZED IT CAN BE REASONABILITY ASSUMED THAT THE ACCELERATION TIME OF THE CIRCULATING WATER PUMP MOTORS WILL BE LESS THAN 5 SECONDS.

FROM THE ABOVE REFERENCED ASDOP CASES THE MINIMUM 4160 VOLT BUS VOLTAGE FOR A CWP MOTOR START IS 0.7910 P.U. (CASE 1SAT13). FROM CALCULATION ID NT124-E-08-F REV. 0, THE ALLOWABLE ACCELERATION TIME BASED ON THE 27/59E VOLTAGE RELAY SETTING IS APPROXIMATELY 11 SECONDS. THEREFORE THE STARTING OF A CWP MOTOR DOES NOT DEGRADE THE ELECTRICAL DISTRIBUTION SYSTEM VOLTAGE TO A LEVEL THAT WILL ADVERSELY IMPACT THE OPERATION OF 4160 VOLT SAFETY RELATED LOADS.

ectric Machinery, Power Systems Group, McGraw-Edison Company
Minneapolis, MN 55413



Form No. ED-557 (Rev. 4-81)

Rec'd: July 6 1981 DHT

EE____________

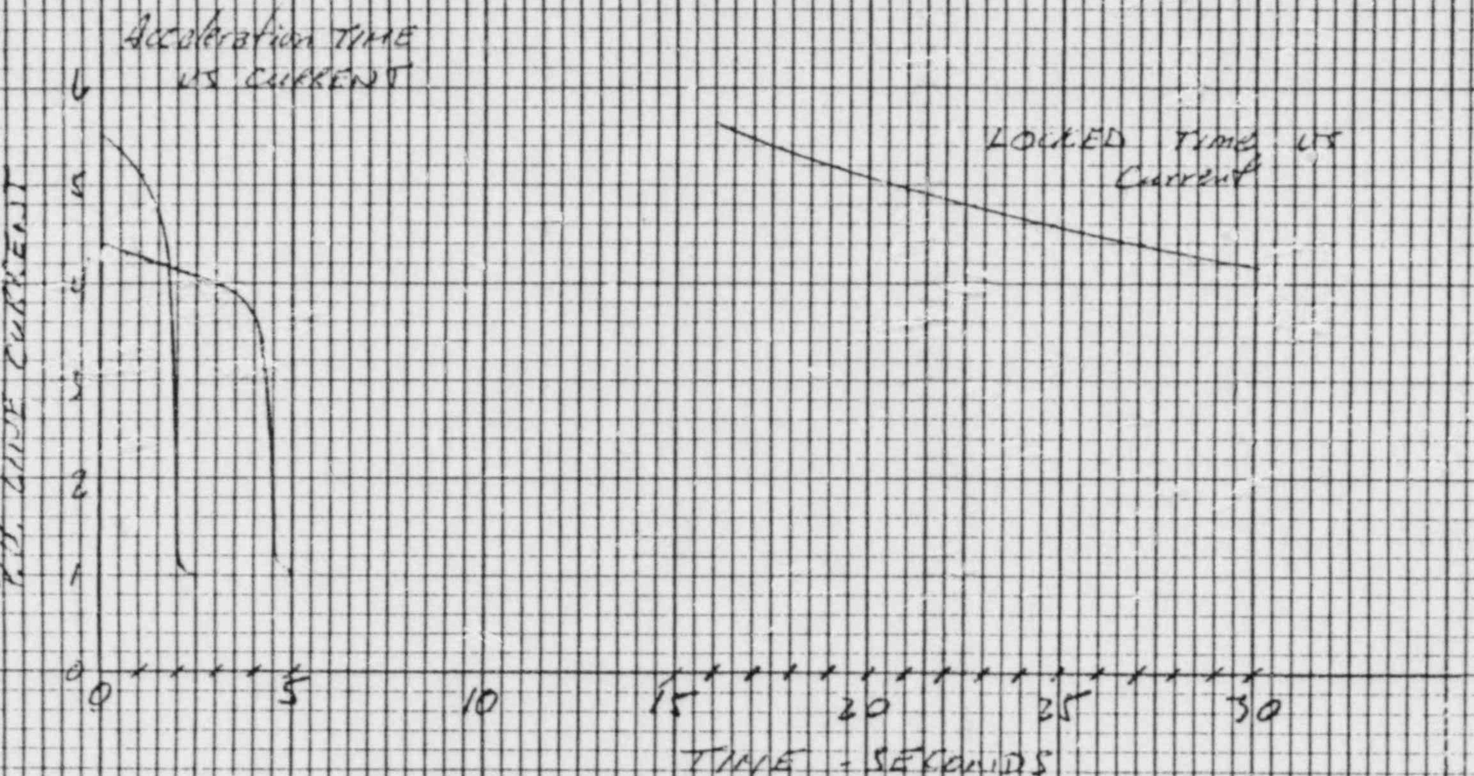
LOCKED AND ACCELERATION TIME VS CURRENT

2500 HP 20 POLE 3760/4000 INDUCTION MOTOR

1 P.U. Current = 348 Ampere

LOAD WK² = 12000 #ft²

LOAD TORQUE - Per EM Curve 5-062 Page 5 of 6.



Recd: July 6, 1981
PHT

F26

ED-628 (4-81)

EE

10 X 10 PER INCH

MADE IN U.S.A.

Computed by: WKRussell Date: 5/18/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-08-F	
Checked by: P.S.Reddy Date: 5/18/84		Pg. 1 of 4	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECT DIST SYS STUDY			
Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 1			
Status: Prelim. ☐ Final ☒ Void ☐			

PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO ESTABLISH EMERGENCY BUS VOLTAGE RELAY CHARACTERISTICS WHICH WILL BE USED TO EVALUATE TRANSIENT VOLTAGE CONDITIONS ON THE 4160 V EMERGENCY BUSES.

LIST OF REFERENCES

- GENERAL ELECTRIC INSTRUCTION BOOK GEH-1814E (IAV RELAYS)
- UE&C LETTER UC 29677, JUNE 30, 1980
- DESIGN BASIS DOCUMENT DBD-9527-041-1 REV. 1, 2/14/78, "DEGRADED VOLTAGE ON EMERGENCY BUS"

BODY OF CALCULATION

FROM LOCA START ANALYSIS (ASDOP CASE 15AT9):

MINIMUM VOLTAGE AT E-BUS = 0.7746 P.U. (4160 V BASE)
= 3222 V

SETTING OF 27/59E RELAY:

RIGHT CONTACT 98 VOLTS
LEFT CONTACT 105 VOLTS

PT RATIO = 4200/120 = 35/1

RIGHT CONTACT CLOSURE/ LEFT CONTACT PICKUP RATIO

= 98 X 35 / 105 X 35 = 3430/3675
= 0.825 pu / 0.883 p.u.
= 0.93

Computed by: WKRussell	Date: 5/18/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-08-F	
Checked by: D.S. Reddy	Date: 5/11/84		Pg. 2 of 4	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECT DIST SYS STUDY

Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 1

Status: Prelim. ☐ Final ☒ Void ☐

PER UNIT E-BUS VOLTAGE AS MULTIPLE OF LEFT CONTACT PICKUP:

$$\frac{0.7749}{0.883} = 0.88$$

THUS, FROM TIME-VOLTAGE CURVE FOR IAV 53 RELAY (93% CURVE) TRIP TIME AT 0.7749 p.u. ≅ 10 SECONDS

TO ESTABLISH TRIP ZONE OF 27/59E RELAY, THE FOLLOWING POINTS ARE TAKEN FROM THE IAV 53 TIME-VOLTAGE CURVE

P.U. E-BUS VOLTAGE	P.U. E-BUS VOLTAGE AS MULTIPLE OF LEFT CONTACT PICKUP VOLTAGE	TRIP TIME (SEC)
0.50	0.57	2.7
0.60	0.68	3.4
0.70	0.79	5.2
0.75	0.85	7.5
0.7749	0.88	10
0.80	0.91	12.5

CONCLUSION

ASSUMING CONSERVATIVELY THAT THE VOLTAGE ON THE E-BUS REMAINS AT 0.7749 DURING ACCELERATION OF THE "LOCA START" LOADS, 27/59E RELAY WILL ALLOW TEN (10) SECONDS FOR ACCELERATION.

Computed by: W.K. Russell Date: 5/3/84
Checked by: D.S. Rudy Date: 5/11/84
TAR No.: NT-124
Project Title: BSEP ELECTRICAL DIST SYS STUDY
Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 1
STATUS: FINAL

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT
CALCULATION SHEET

Calculation ID: NT124-E-08-F
Pg. 3 of 4 Rev. 0
File: BNT-124-AN-6543

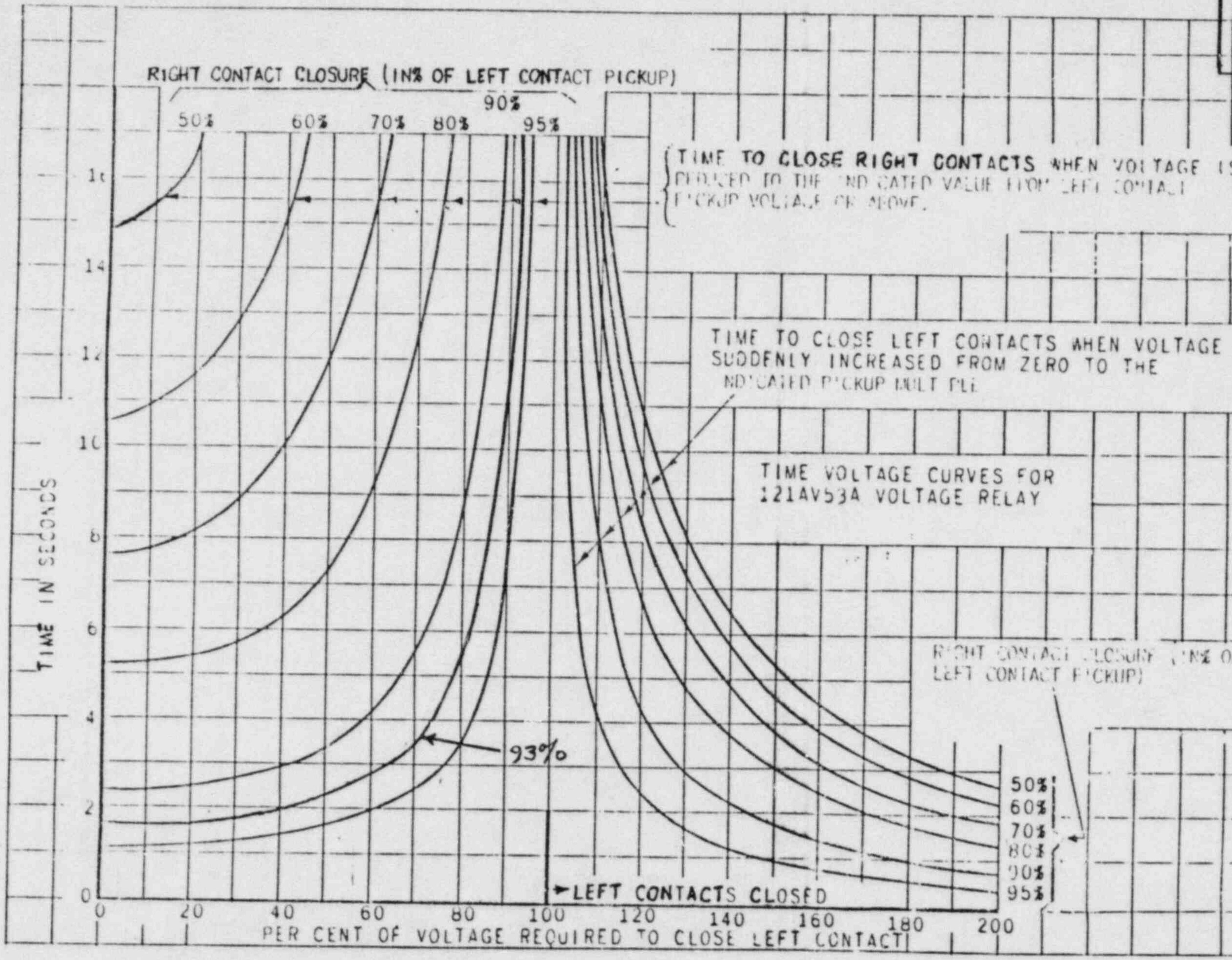
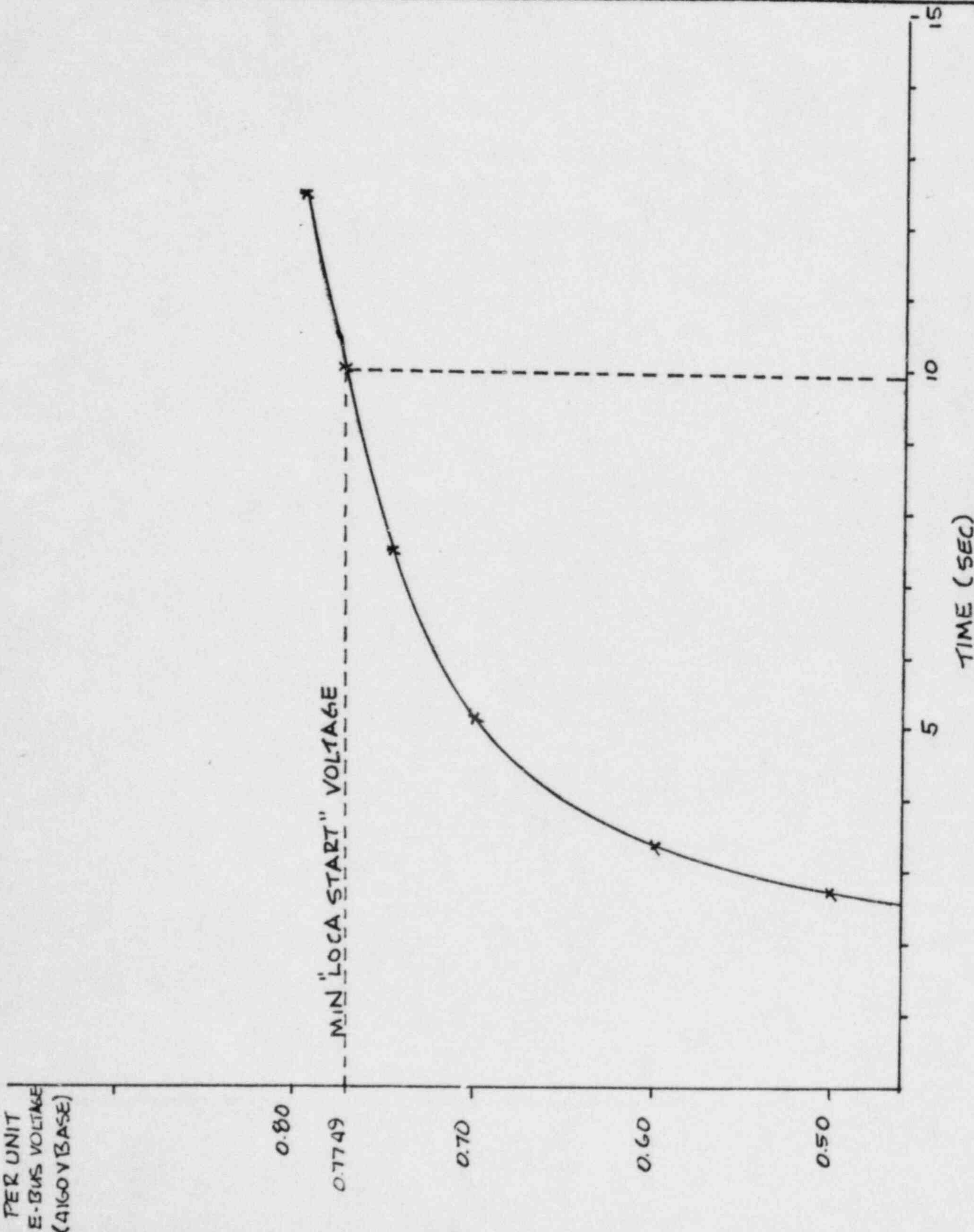


Fig. 13 (K-6306829-3) Time-voltage curves for types IAV53 and IAV54 relays

F29

Computed by: W K Russell	Date: 5/18/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-08-F	
Checked by: P. S Reddy	Date: 5/18/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 4 of 4	Rev. 0
TAR No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-55A3	
Project Title: BSEP ELECT. DIST. SYS STUDY				
Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 1				
Status: Prelim. ☐ Final ☒ Void ☐				



F30

Computed by: W K Russell Date: 5/18/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-03-F
Checked by: D S Reddy Date: 5/19/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 1 of 4 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECT DIST SYS STUDY

Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 2

Status: Prelim. ☐ Final ☒ Void ☐

PURPOSE:

THE PURPOSE OF THIS CALCULATION IS TO ESTABLISH EMERGENCY BUS VOLTAGE RELAY CHARACTERISTICS WHICH WILL BE USED TO EVALUATE TRANSIENT VOLTAGE CONDITIONS ON THE 4160 V EMERGENCY BUSES.

LIST OF REFERENCES:

- GENERAL ELECTRIC INSTRUCTION BOOK GEH-1814E (IAV RELAYS)
- UE&C LETTER UC 29677, JUNE 30, 1980
- DESIGN BASIS DOCUMENT DBD-9527-041-1, REV 1, 2/14/78, "DEGRADED VOLTAGE ON EMERGENCY BUS"

BODY OF CALCULATION

FROM LOCA START ANALYSIS (ASDOP CASE 2SAT9):

MINIMUM VOLTAGE AT E BUS = 0.7795 p.u. (4160 V BASE)
= 3243 V

SETTING OF 27/59E RELAY:

RIGHT CONTACT 98 VOLTS

LEFT CONTACT 105 VOLTS

PT RATIO = 4200/120 = 35/1

RIGHT CONTACT CLOSURE / LEFT CONTACT PICK UP RATIO

= 98 x 35 / 105 x 35 = 3430/3675

= 0.825 pu / 0.883 p.u

= 0.93

PER UNIT E-BUS VOLTAGE AS MULTIPLE OF LEFT CONTACT PICKUP:

$$\frac{0.7795}{0.883} = 0.88$$

THUS, FROM TIME-VOLTAGE CURVE FOR IAV53 RELAY (93% CURVE)

TRIP TIME @ 0.7795 pu. ≅ 10 SECONDS

TO ESTABLISH TRIP ZONE OF 27/59 RELAY, THE FOLLOWING POINTS ARE TAKEN FROM THE IAV53 TIME-VOLTAGE CURVE

P.U. E-BUS VOLTAGE	P.U. E-BUS VOLTAGE AS MULTIPLE OF LEFT CONTACT PICKUP VOLTAGE	TRIP TIME (SEC.)
0.50	0.57	2.7
0.60	0.68	3.4
0.70	0.79	5.2
0.75	0.85	7.5
0.7795	0.88	10
0.80	0.91	12.5

CONCLUSION

ASSUMING CONSERVATIVELY THAT THE VOLTAGE ON THE E-BUS REMAINS AT 0.7795 DURING ACCELERATION OF THE "LOCA START" LOADS, 27/59E RELAY WILL ALLOW 10 SECONDS FOR ACCELERATION.

Computed by: WK Russell Date: 4/13/84
Checked by: P.S. Reddy Date: 5/11/84
TAR No.: NT-124
Project Title: BSEP ELECTRICAL DIST SYS STUDY
Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT 2

CAROLINA POWER & LIGHT COMPANY
NUCLEAR PLANT ENGINEERING DEPARTMENT
CALCULATION SHEET

Calculation ID: NT124-E-03-F
Pg. 3 of 4
Rev. 0
File: BNT-124-AV-5543

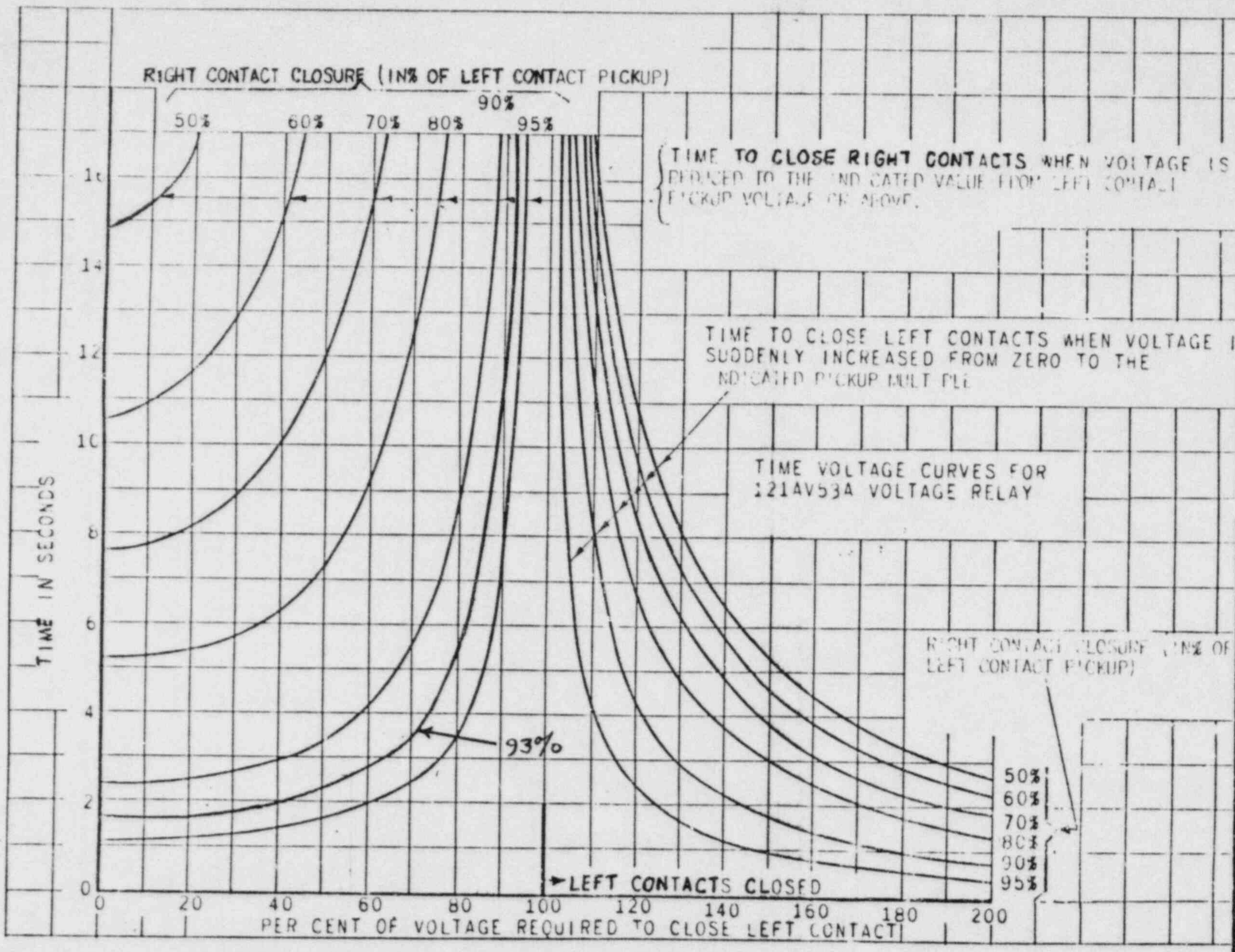


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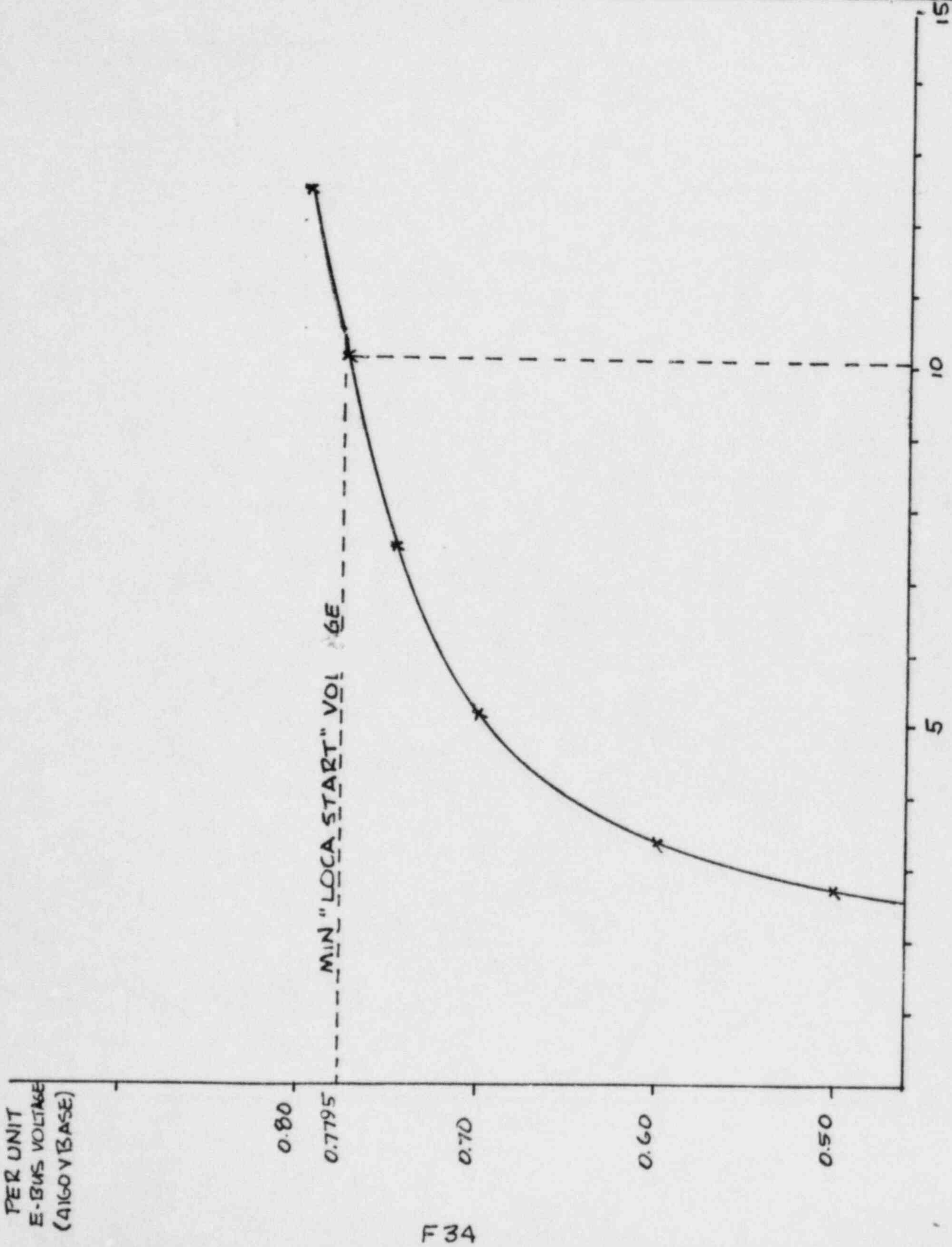
Fig. 13 (K-6306849-3) TIME-VOLTAGE CURVES FOR TYPES IAV53A AND IAV53B RELAYS

Computed by: W.K. Russell Date: 5/18/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-03-F	
Checked by: P.S. Reddy Date: 5/18/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 4 of 4	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-SEA3	

Project Title: BSEP ELECT DIST SYS STUDY

Calculation Title: 27/59E RELAY CHARACTERISTICS UNIT NO. 2

Status: Prelim. ☐ Final ☒ Void ☐



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13.0 APPENDIX G

DETERMINATION OF SOURCE VOLTAGE LIMITS

13.0 DETERMINATION OF SOURCE VOLTAGE LIMITS

The source voltage limits were determined by defining the mathematical relationship between the source voltage and the auxiliary system bus voltage in question. Once the voltage limit was determined, a computer run was made at that source voltage limit to verify the calculated results.

For an explanation of the method of establishing source voltage limits, Case 2SAT4, (Fourth 2500 hp CWP Motor Start), is used as an example. To establish a relationship between the motor terminal voltage and the switchyard voltage, computer runs were made at two switchyard voltages: .986 p.u., 1.009 p.u.. As can be seen from the graph on Page G-65, a plot of the motor terminal voltages to each corresponding switchyard voltage defines a straight line. Once defined, this linear relationship provides the capability of determining the source voltage corresponding to any selected motor terminal voltage and vice versa. It can be seen from the graph that the minimum motor starting voltage of 3400V corresponds to a switchyard voltage of 228.62 KV (0.994 p.u.). The 228.62 KV is the minimum required switchyard voltage (i.e., voltage limit) for a CWP motor start under the operating conditions specified.

Plots for each of the cases covered in the report follow.

Computed by: JA Keane	Date: 5/8/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-16-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT1 - FULL LOAD OPERATION

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN 460V MOTOR TERMINAL VOLTAGE ABOVE 90% ON A 460 V BASE* (USE WORST CASE MCC: CTO)

SWYD VOLTAGE	4160 V BUS COEA VOLTAGE	MCC CTO VOLTAGE 460 V BASE	MCC CTO VOLTAGE 480 V BASE	460 V MOTOR TERMINAL VOLTAGE 460 V BASE	460 V MOTOR TERMINAL VOLTAGE 480 V BASE
0.97	0.8966	0.8757	0.8392	0.8494	0.8140
1.009	0.9426	0.9298	0.8911	0.9019	0.8643

* ASSUME A 3% VOLTAGE DROP ON A 460 V BASE FROM THE MCC TO THE MOTOR TERMINALS

90% MOTOR TERMINAL VOLTAGE ON A 480V BASE = 0.8625

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8643 - 0.8140)$ $\quad m = \frac{0.039}{0.0503} = 0.775$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.775(0.8643) + b$ $\quad b = 0.339$

SWITCHYARD VOLTAGE LIMIT = $0.775(0.8625) + 0.339 = \underline{1.007}$

4160 V BUS COEA VOLTAGE: $Y_{0.9426} - Y_{0.8966} = m(X_{0.9426} - X_{0.8966})$

$0.9426 - 0.8966 = m(0.8643 - 0.8140)$ $\quad m = \frac{0.046}{0.0503} = 0.915$

$Y = mx + b$ @ 0.9426 COEA VOLTAGE (1.009 SWITCHYARD VOLTAGE)

$0.9426 = 0.915(0.8643) + b$ $\quad b = 0.152$

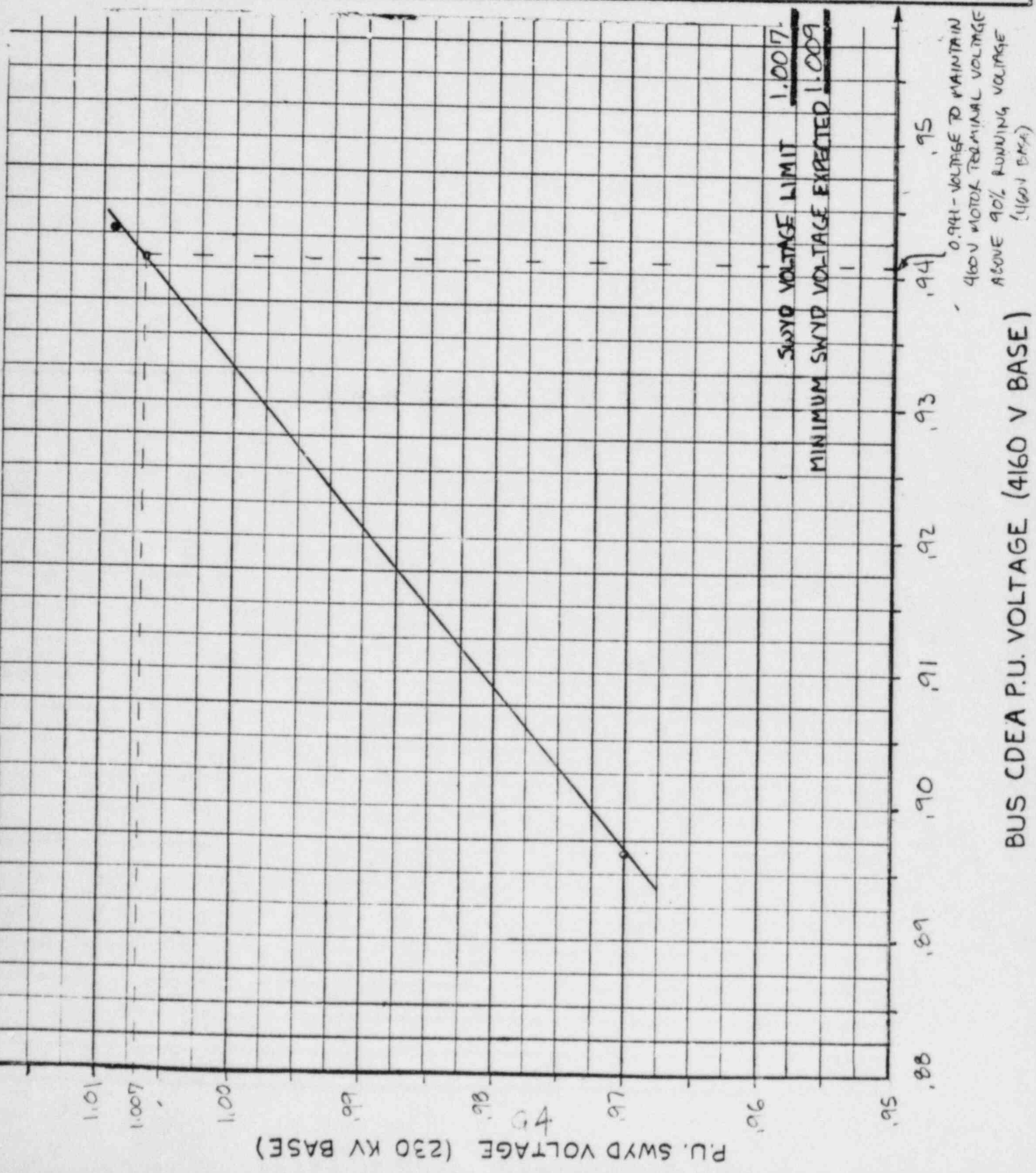
COEA BUS VOLTAGE LIMIT = $0.915(0.8625) + 0.152 = \underline{0.941}$

Computed by: JA Keane Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-16-F	
Checked by: J.A. Kowalcheck Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT1- FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



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Computed by: JA Koore	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-17-F	
Checked by: J.A. Kowalewer	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT2 - SHUTDOWN CONDITION.

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: LIMIT THE 460 V MOTOR TERMINAL VOLTAGE TO 110% (460 V BASE)*

SWYD. VOLTAGE	4160 V BUS COEA VOLTAGE	460 V MCC 1TE VOLTAGE
0.990	0.9923	1.0241
1.017	1.0207	1.0546

* ASSUME NO VOLTAGE DROP FROM MCC TO MOTOR TERMINALS
110% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 1.054.

SWITCHYARD VOLTAGE: $Y_{1.017} - Y_{.99} = m(X_{1.017} - X_{.99})$

$1.017 - 0.99 = m(1.0546 - 1.0241)$ $m = \frac{0.027}{0.0305} = 0.885$.

$Y = mx + b$ @ 1.017 SWITCHYARD VOLTAGE:

$1.017 = 0.885(1.0546) + b$ $b = 0.084$.

SWITCHYARD VOLTAGE LIMIT = $0.885(1.054) + 0.084 = \underline{1.0168}$

4160 V BUS COEA VOLTAGE: $Y_{1.0207} - Y_{0.9923} = m(X_{1.0207} - X_{0.9923})$

$1.0207 - 0.9923 = m(1.0546 - 1.0241)$ $m = \frac{0.0284}{0.0305} = 0.931$.

$Y = mx + b$ @ 1.0207 COEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$1.0207 = 0.931(1.0546) + b$ $b = 0.039$.

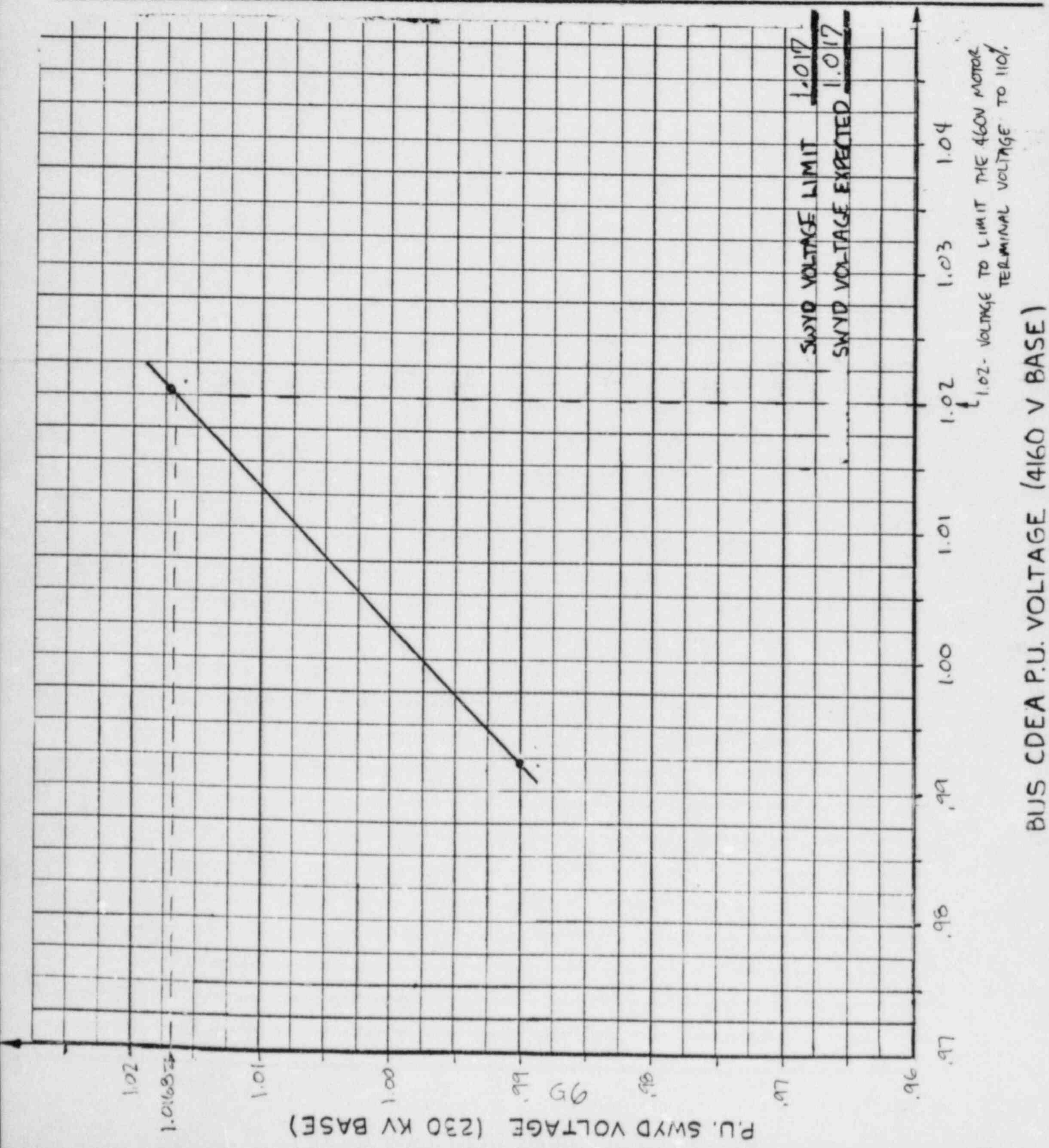
COEA BUS VOLTAGE LIMIT = $0.931(1.054) + 0.039 = \underline{1.020}$.

Computed by: JA Verne	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-17-F	
Checked by: J.A. Kowalchek	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT2- SHUTDOWN CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 5/9/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-18-F
Checked by: J.A. Kowalchek Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 1 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY		
Calculation Title: 1SAT3 - 3RD CWP MOTOR START		
Status: Prelim. ☐ Final ☒ Void ☐		

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL ABOVE 85% STARTING VOLTAGE (4000 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	CWP-1D MOTOR TERMINAL VOLTAGE 4000 V BASE	CWP-1D MOTOR TERMINAL VOLTAGE 4160 V BASE
0.97	0.8369	0.8348	0.8027
1.009	0.8801	0.8779	0.8441

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8441 - 0.8027)$ $\qquad m = \frac{0.039}{0.0414} = 0.942$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.942(0.8441) + b$ $\qquad b = 0.214$

SWITCHYARD VOLTAGE LIMIT $= 0.942(0.817) + 0.214 = \underline{0.984}$

4160 V BUS CDEA VOLTAGE: $Y_{0.8801} - Y_{0.8369} = m(X_{0.8801} - X_{0.8369})$

$0.8801 - 0.8369 = m(0.8441 - 0.8027)$ $\qquad m = \frac{0.0432}{0.0414} = 1.043$

$Y = mx + b$ @ 0.8801 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.8801 = 1.043(0.8441) + b$ $\qquad b = -0.0003$

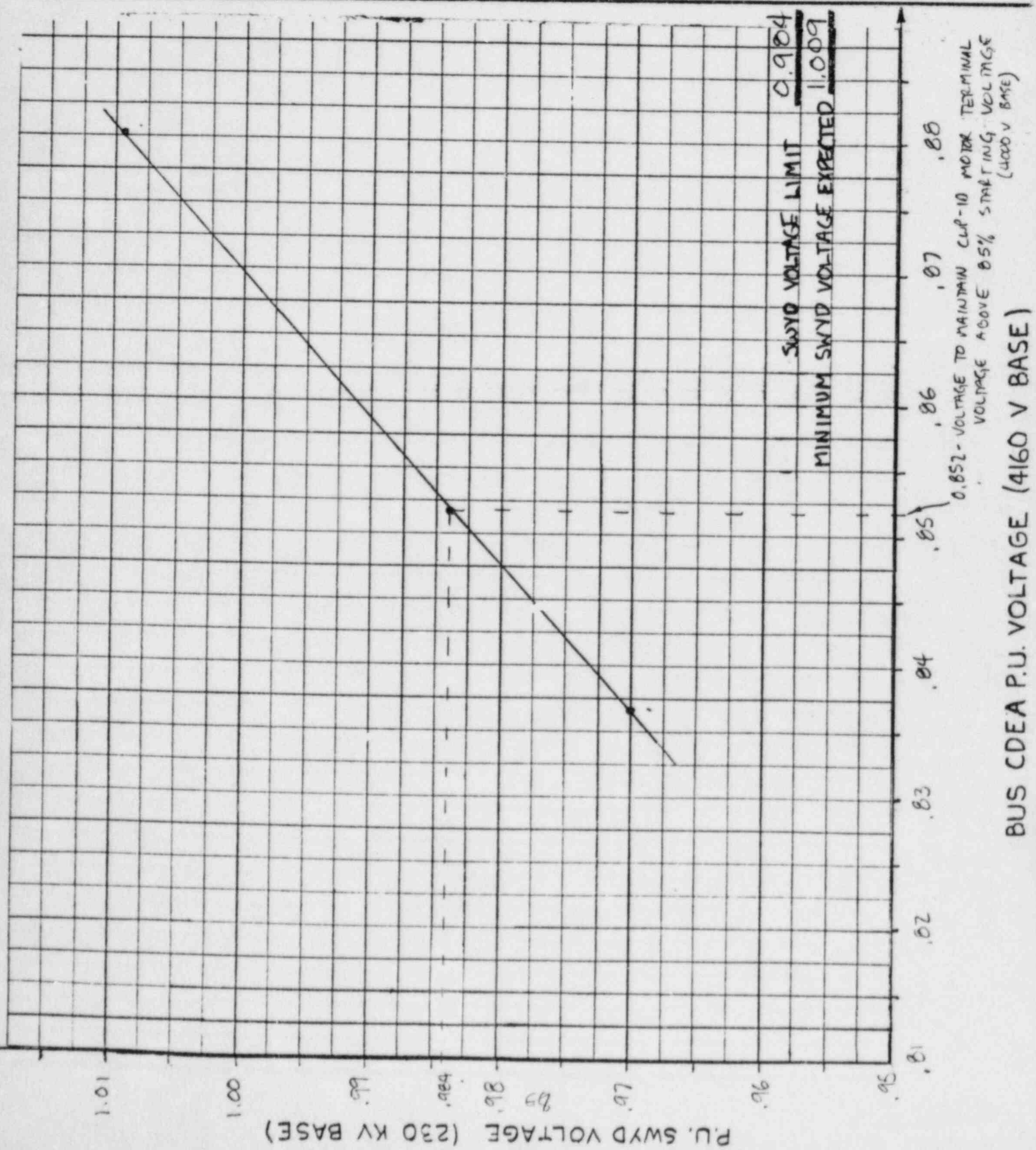
CDEA BUS VOLTAGE LIMIT $= 1.043(0.817) + (-0.0003) = \underline{0.852}$

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-18-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT3 - 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/9/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-19-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AH-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1DAT4 4TH CWP MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	CWP-1D MOTOR TERMINAL VOLTAGE 4000 V BASE	CWP-1D MOTOR TERMINAL VOLTAGE 4160 V BASE
0.97	0.8261	0.8240	0.7923
1.009	0.8702	0.8680	0.8346

85% MOTOR TERMINAL VOLTAGE ON 4160V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8346 - 0.7923)$ $\quad m = \frac{0.039}{0.0423} = 0.922$

$Y = mX + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.922(0.8346) + b$ $\quad b = 0.240$

SWITCHYARD VOLTAGE LIMIT $= 0.922(0.817) + 0.240 = \underline{\underline{0.993}}$

4160 V BUS CDEA VOLTAGE: $Y_{0.8702} - Y_{0.8261} = m(X_{0.8346} - X_{0.7923})$

$0.8702 - 0.8261 = m(0.8346 - 0.7923)$ $\quad m = \frac{0.0441}{0.0423} = 1.043$

$Y = mX + b$ @ 0.8702 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE)

$0.8702 = 1.043(0.8346) + b$ $\quad b = -0.0003$

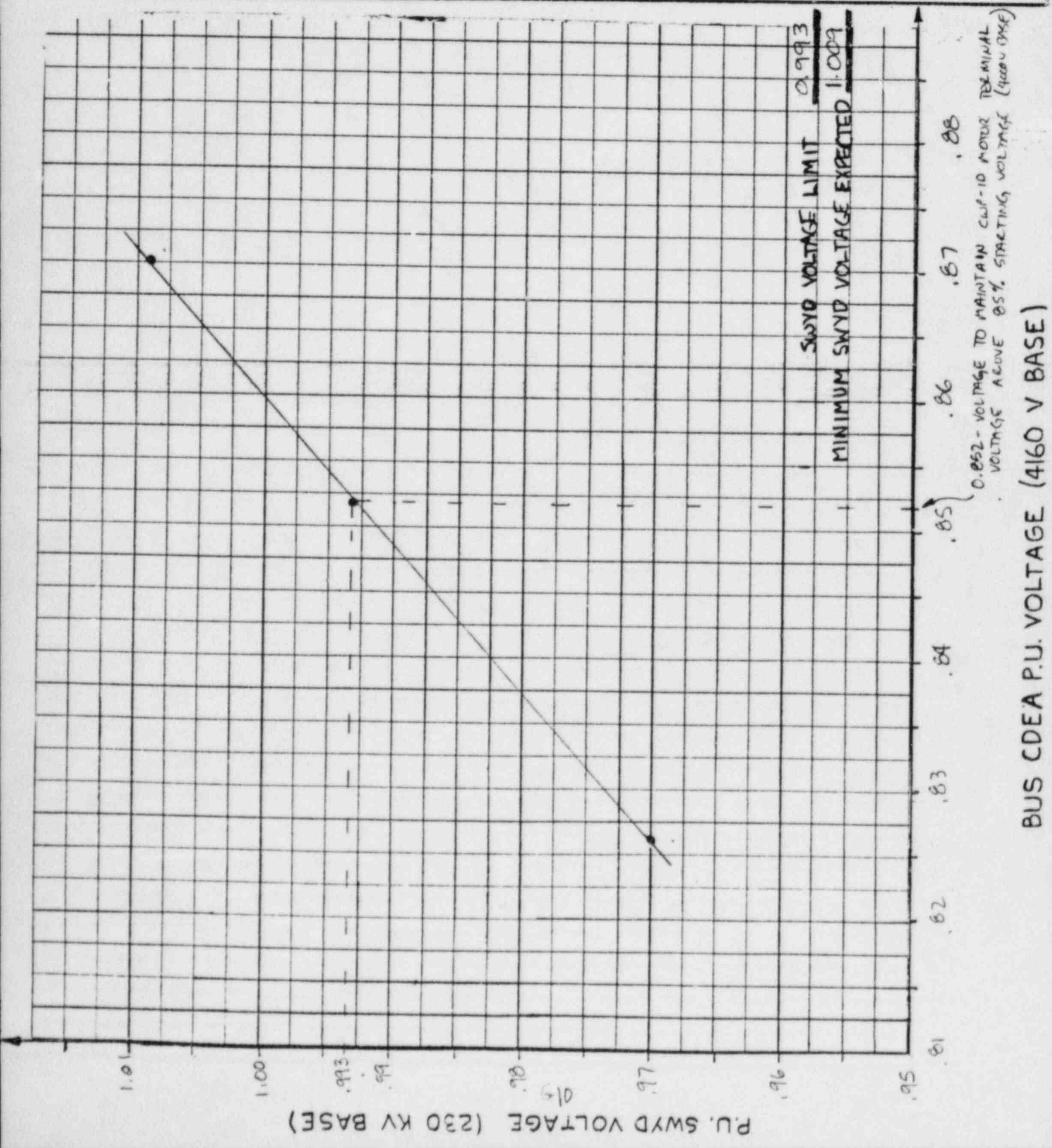
CDEA BUS VOLTAGE LIMIT $= 1.043(0.817) + (-0.0003) = \underline{\underline{0.852}}$

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-19-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT4 - 4TH CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/9/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-20-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1SAT5- FUEL POOL CLEANING PUMP 1A MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN FPCP-1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	FUEL POOL CLEANING PUMP 1A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8946	0.8606	0.8247
1.009	0.9405	0.9145	0.8764

85% MOTOR TERMINAL VOLTAGE ON 480V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8764 - 0.8247)$ $\quad m = \frac{0.039}{0.0517} = 0.754$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.754(0.8764) + b$ $\quad b = 0.348$

SWITCHYARD VOLTAGE LIMIT = $0.754(0.815) + 0.348 =$ 0.963

4160 V BUS CDEA VOLTAGE: $Y_{0.9405} - Y_{0.8946} = m(X_{0.9405} - X_{0.8946})$

$0.9405 - 0.8946 = m(0.8764 - 0.8247)$ $\quad m = \frac{0.0459}{0.0517} = 0.888$

$Y = mx + b$ @ 0.9405 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9405 = 0.888(0.8764) + b$ $\quad b = 0.162$

CDEA BUS VOLTAGE LIMIT = $0.888(0.815) + 0.162 =$ 0.886

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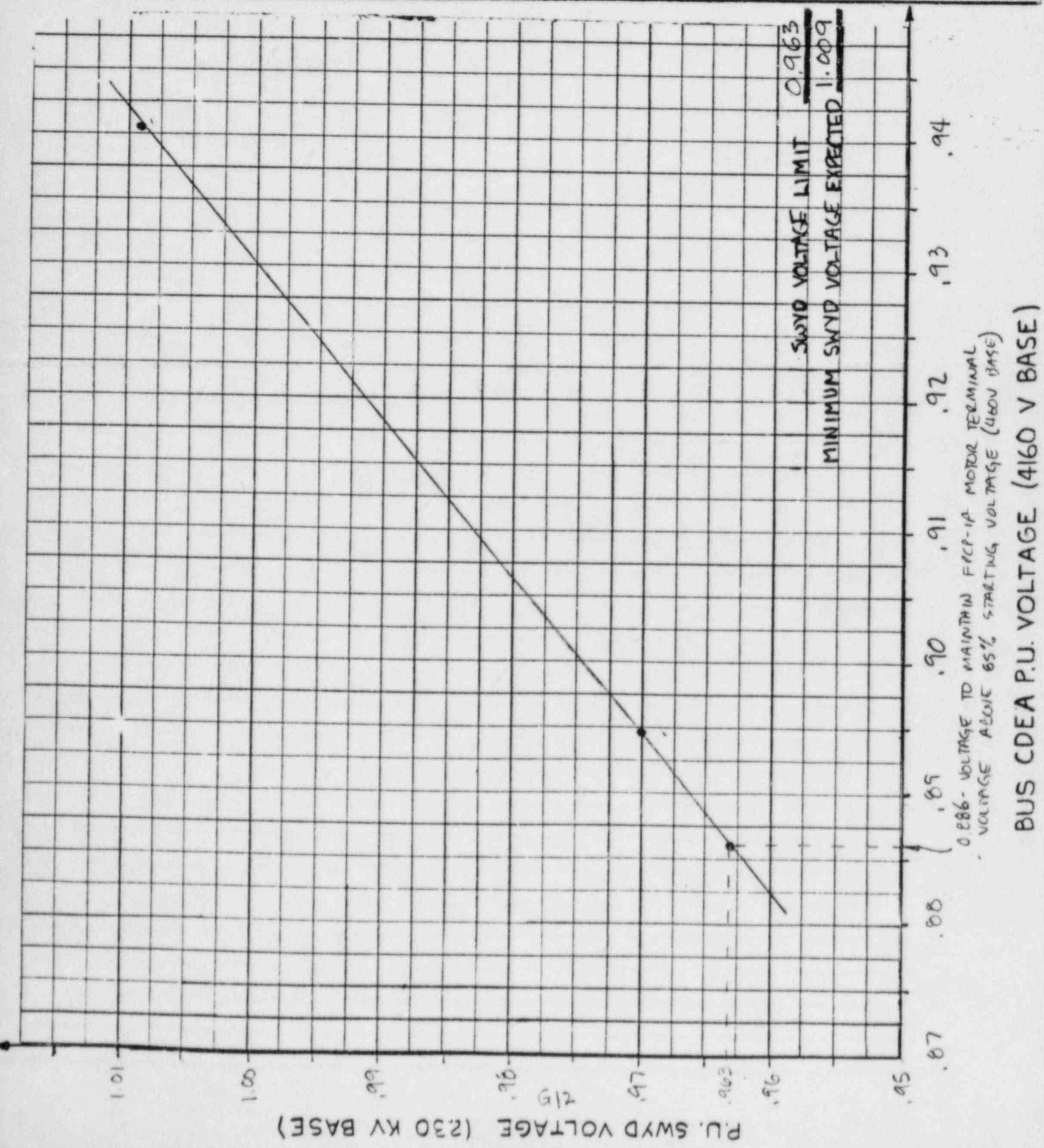
Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-20-F	
Checked by: J.A. Kowalchek	Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT5- FUEL POOL CLEANING PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 5/9/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-21-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT6 - FUEL POOL CLEANING PUMP 1B MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN FPCP-1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	FUEL POOL CLEANING PUMP 1B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8947	0.8535	0.8179
1.009	0.9407	0.9065	0.8687

85% MOTOR TERMINAL VOLTAGE ON A 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8687 - 0.8179)$ $m = \frac{0.039}{0.0508} = 0.768$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.768(0.8687) + b$ $b = 0.342$

SWITCHYARD VOLTAGE LIMIT = $0.768(0.815) + 0.342 =$ **0.968**

4160 V BUS CDEA VOLTAGE: $Y_{0.9407} - Y_{0.8947} = m(X_{0.9407} - X_{0.8947})$

$0.9407 - 0.8947 = m(0.8687 - 0.8179)$ $m = \frac{0.046}{0.0508} = 0.906$

$Y = mx + b$ @ 0.9407 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9407 = 0.906(0.8687) + b$ $b = 0.154$

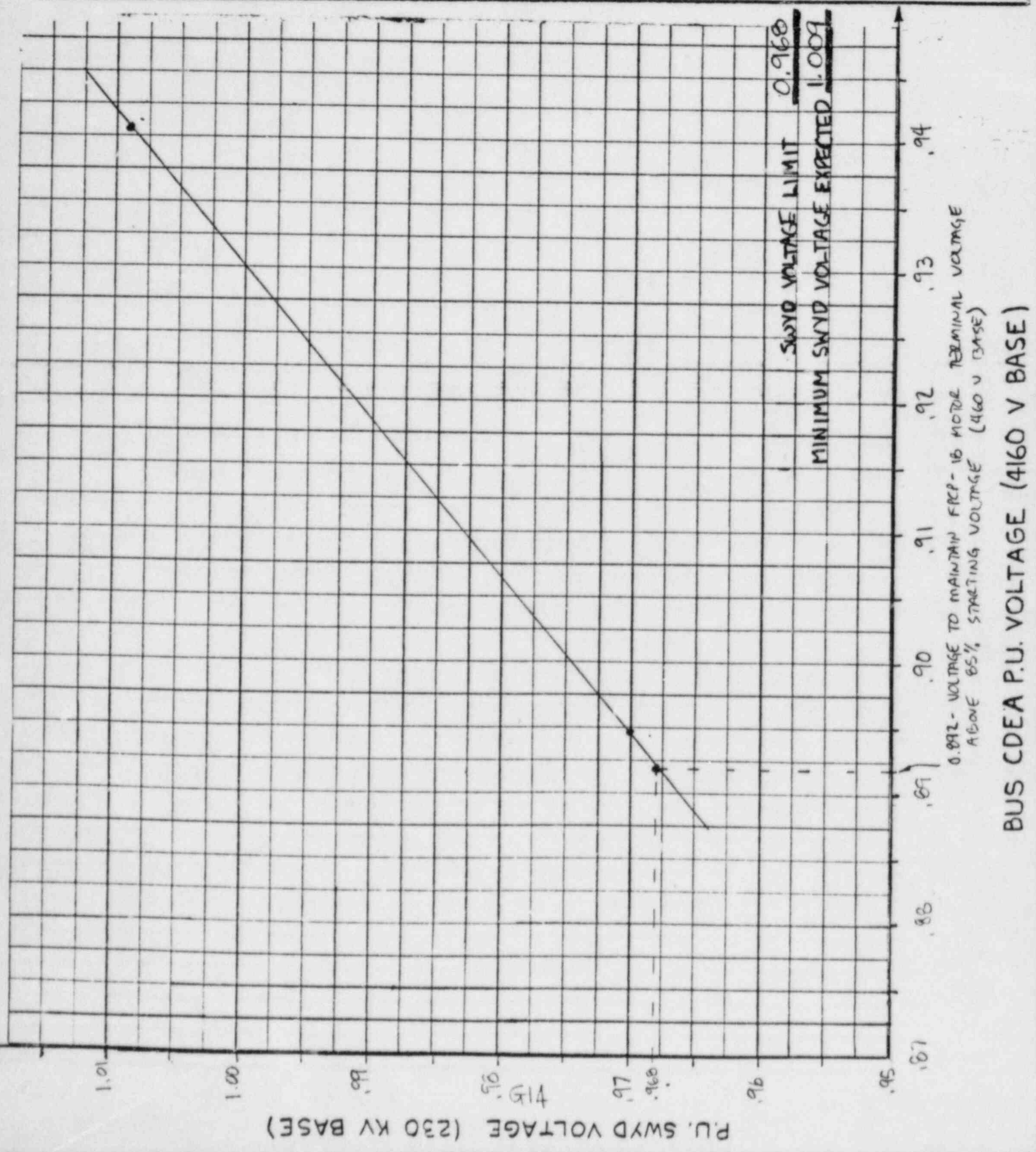
CDEA BUS VOLTAGE LIMIT = $0.906(0.815) + 0.154 =$ **0.892**

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-21-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAK No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT6 FUEL POOL CLEANING PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Young Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-22-F	
Checked by: J.A. Kowalchick Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT7- REACTOR RECIRC PUMP 1B MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN REACTOR RECIRC PUMP 1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000 V BASE)

SWYD. VOLTAGE	4160 V BUS 1B VOLTAGE	REACTOR RECIRC PUMP 1B MOTOR TERMINAL VOLTAGE 4000 V BASE	REACTOR RECIRC PUMP 1B MOTOR TERMINAL VOLTAGE 4160 V BASE
0.97	0.8162	0.8420	0.8096
1.009	0.8510	0.8779	0.8441

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8441 - 0.8096)$ $m = \frac{0.039}{0.0345} = 1.130$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 1.130(0.8441) + b$ $b = 0.055$

SWITCHYARD VOLTAGE LIMIT = $1.130(0.817) + 0.055 =$ <u>0.978</u>

4160 V BUS 1B VOLTAGE: $Y_{0.8510} - Y_{0.8162} = m(X_{0.8510} - X_{0.8162})$

$0.8510 - 0.8162 = m(0.8441 - 0.8096)$ $m = \frac{0.0348}{0.0345} = 1.009$

$Y = mx + b$ @ 0.8510 1B VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.8510 = 1.009(0.8441) + b$ $b = -0.0007$

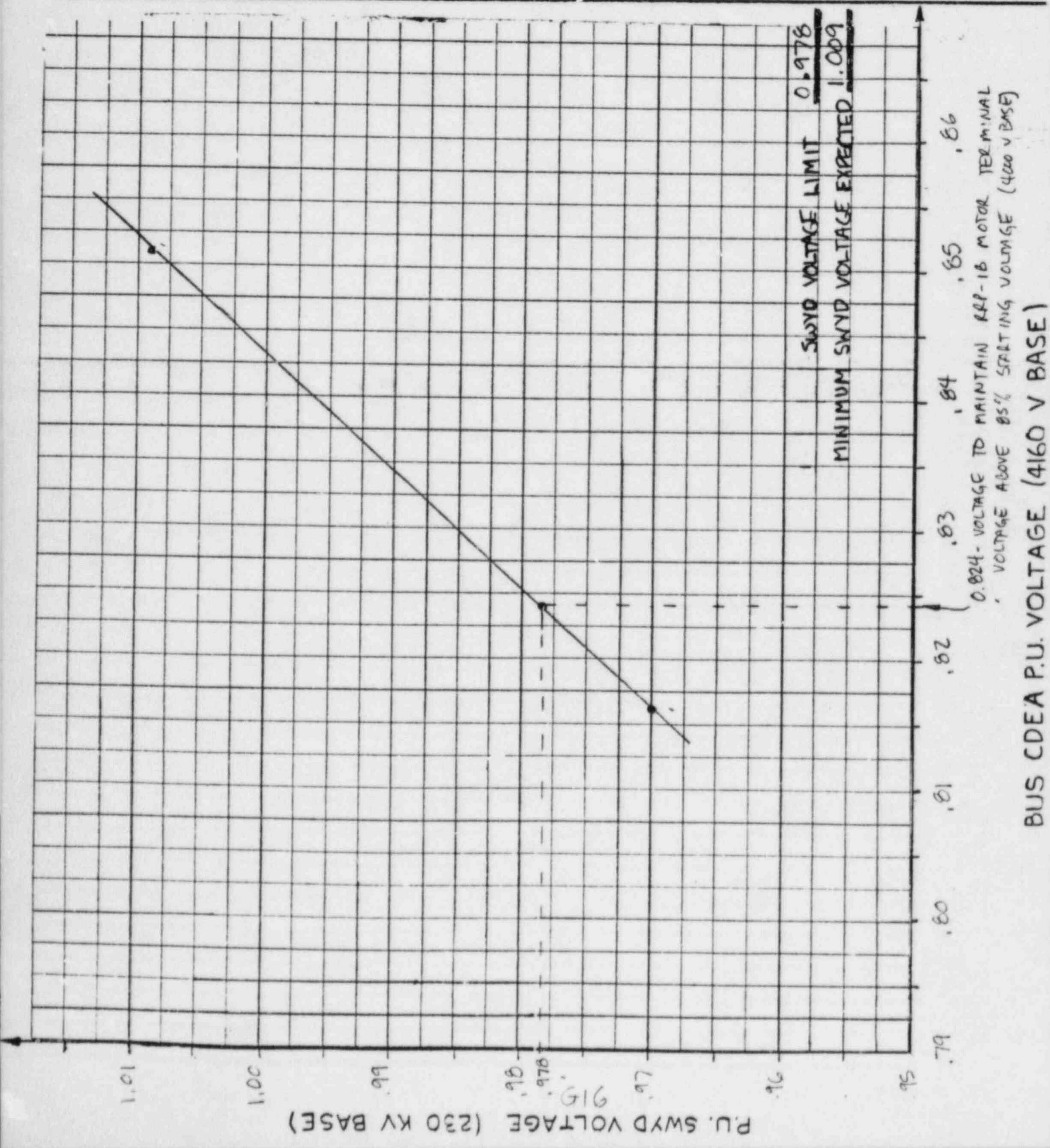
1B BUS VOLTAGE LIMIT = $1.009(0.817) + (-0.0007) =$ <u>0.824</u>

Computed by: DA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124 - E - 22 - F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT7- REACTOR RECIRC PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-23-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT8 - REACTOR BLDG. CLOSED COOLING WTR. PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN RBCCW PUMP 1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	REACTOR BLDG. CCW PUMP 1A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8944	0.8449	0.8097
1.009	0.9404	0.8971	0.8597

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8597 - 0.8097) \qquad m = \frac{0.039}{0.050} = 0.780$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.780(0.8597) + b \qquad b = 0.338$

SWITCHYARD VOLTAGE LIMIT = $0.780(0.815) + 0.338 = \underline{0.974}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9404} - Y_{0.8944} = m(X_{0.8597} - X_{0.8097})$

$0.9404 - 0.8944 = m(0.8597 - 0.8097) \qquad m = \frac{0.046}{0.050} = 0.920$

$Y = mx + b$ @ 0.9404 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9404 = 0.920(0.8597) + b \qquad b = 0.150$

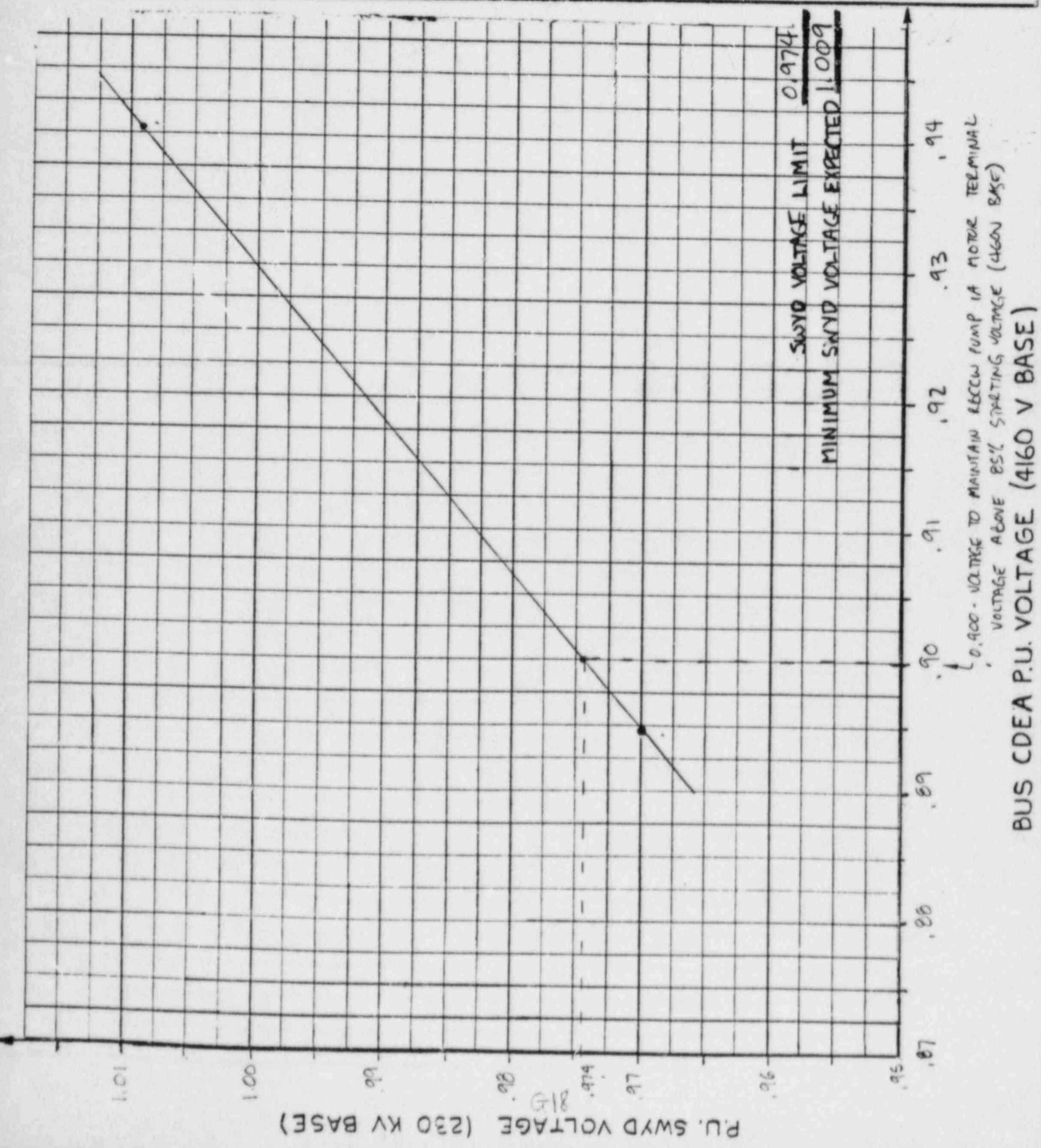
CDEA BUS VOLTAGE LIMIT = $0.920(0.815) + 0.150 = \underline{0.900}$

Computed by: J.A. Voano (signature) Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124 - E - 23 - F	
Checked by: J.A. Kowalczyk Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT8- REACTOR BLDG. CLOSED COOLING WTR. PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-24-F	
Checked by: J.A. Kowalchek	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1SAT9 - LOCA, BLOCK START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 480 V MCC CTO VOLTAGE ABOVE 70% CONTACTOR DROP-OUT VOLTAGE (480 V BASE)

SWYD VOLTAGE	4160 V BUS CDEA VOLTAGE	480 V MCC CTO VOLTAGE
0.930	0.7372	0.6529
0.965	0.7747	0.6980

SWITCHYARD VOLTAGE: $Y_{0.965} - Y_{0.930} = m(X_{0.965} - X_{0.930})$

$0.965 - 0.930 = m(0.6980 - 0.6529)$ $\qquad m = \frac{0.035}{0.0451} = 0.776$

$Y = mx + b$ @ 0.965 SWITCHYARD VOLTAGE:

$0.965 = 0.776(0.698) + b$ $\qquad b = 0.423$

SWITCHYARD VOLTAGE LIMIT = $0.776(0.70) + 0.423 = \underline{0.966}$

4160 V BUS CDEA VOLTAGE: $Y_{0.7747} - Y_{0.7372} = m(X_{0.7747} - X_{0.7372})$

$0.7747 - 0.7372 = m(0.6980 - 0.6529)$ $\qquad m = \frac{0.0375}{0.0451} = 0.832$

$Y = mx + b$ @ 0.7747 CDEA VOLTAGE (0.965 SWITCHYARD VOLTAGE):

$0.7747 = 0.832(0.6980) + b$ $\qquad b = 0.194$

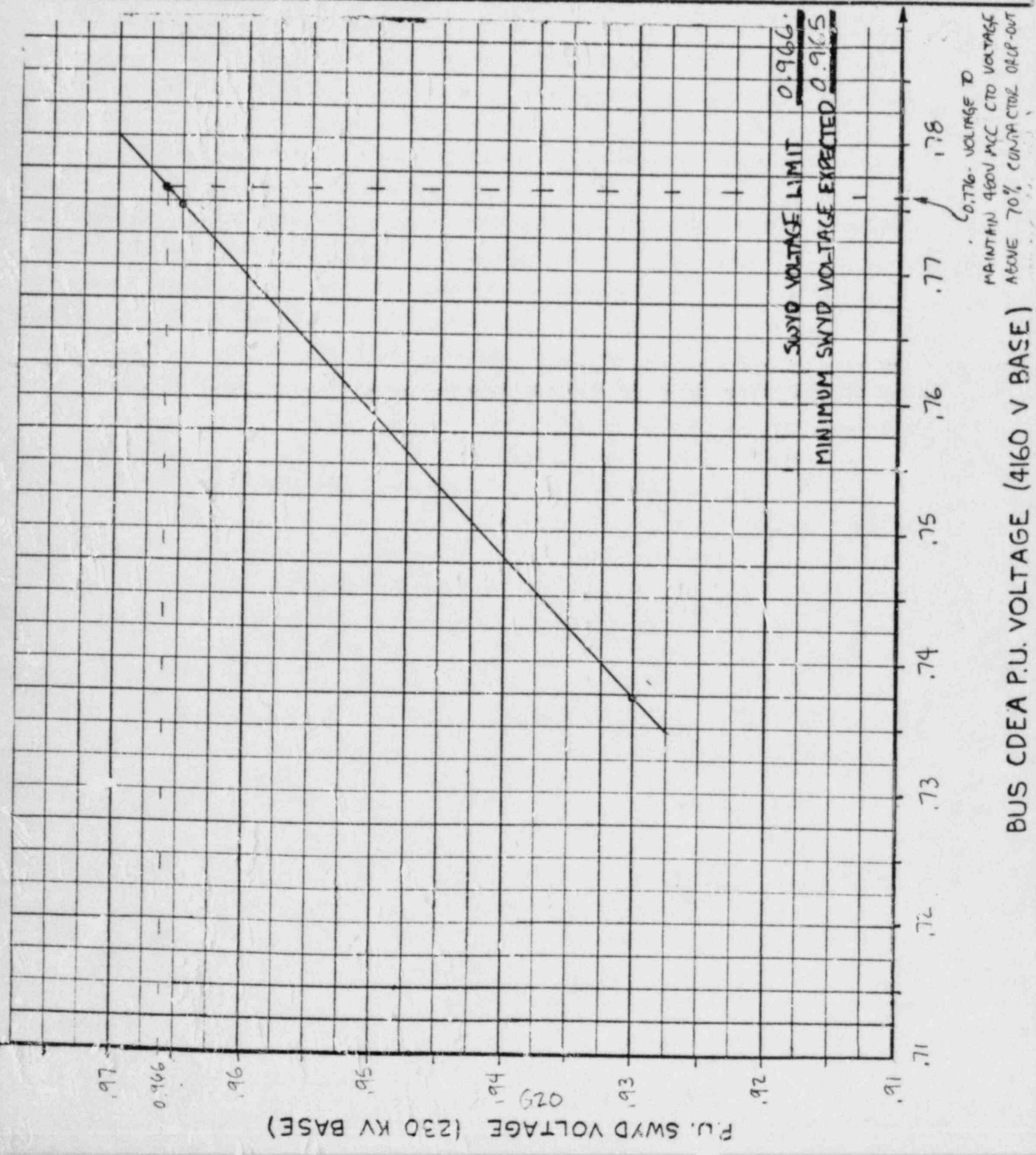
CDEA BUS VOLTAGE LIMIT = $0.832(0.70) + 0.194 = \underline{0.776}$

Computed by: JA Crane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-24-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT9 - LOCA, BLOCK STARTING

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-25-F	
Checked by: J.A. Kowalchek Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT10A-LOCA, SEQ. START: START 2 RHR PUMPS, 2 CSP'S OFF			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 480 V MCC CTO VOLTAGE ABOVE 70% CONTACTOR DROP-OUT VOLTAGE (480 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	480 V MCC CTO VOLTAGE
0.93	0.8042	0.7328
0.965	0.8434	0.7783

SWITCHYARD VOLTAGE: $Y_{0.965} - Y_{0.930} = M(X_{0.965} - X_{0.930})$

$0.965 - 0.930 = M(0.7783 - 0.7328)$ $M = \frac{0.035}{0.0455} = 0.769$

$Y = mx + b$ @ 0.965 SWITCHYARD VOLTAGE:

$0.965 = 0.769(0.7783) + b$ $b = 0.367$

SWITCHYARD VOLTAGE LIMIT = $0.769(0.70) + 0.367 =$ <u>0.905</u>

4160 V BUS CDEA VOLTAGE: $Y_{0.8434} - Y_{0.8042} = M(X_{0.7783} - X_{0.7328})$

$0.8434 - 0.8042 = M(0.7783 - 0.7328)$ $M = \frac{0.0392}{0.0455} = 0.862$

$Y = mx + b$ @ 0.8434 CDEA VOLTAGE (0.965 SWITCHYARD VOLTAGE):

$0.8434 = 0.862(0.7783) + b$ $b = 0.173$

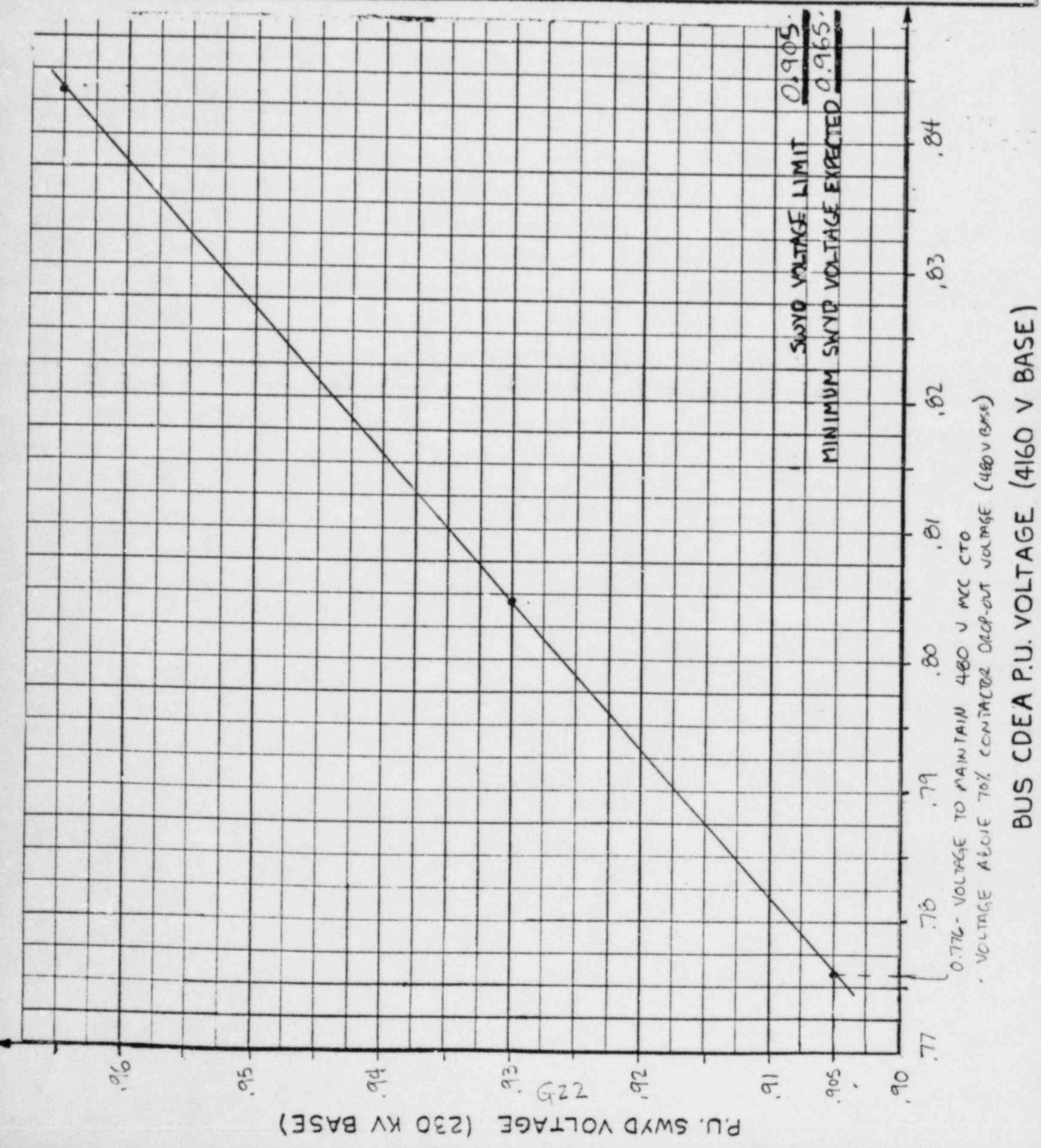
CDEA BUS VOLTAGE LIMIT = $0.862(0.70) + 0.173 =$ <u>0.776</u>

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124 - E - 35 - F	
Checked by: J.A. Kowalchuck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT KA - LOCA, SEQ. START: START 2 RHR PUMPS, 2 CSP'S OFF

Status: Prelim. ☐ Final ☒ Void ☐



G22

Computed by: JA Keane Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-26-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT10B - LOCA, SEQ. START - START 2 CSP'S, 2 RHR PUMPS RUNNING

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 480 V MCC CTO VOLTAGE ABOVE 70% CONTACTOR DROP-OUT VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	480 V MCC CTO VOLTAGE
0.930	0.7830	0.7078
0.965	0.8225	0.7541

SWITCHYARD VOLTAGE: $Y_{0.965} - Y_{0.930} = m(X_{0.965} - X_{0.930})$

$0.965 - 0.930 = m(0.7541 - 0.7078)$ $m = \frac{0.035}{0.0463} = 0.756$

$Y = mx + b$ @ 0.965 SWITCHYARD VOLTAGE:

$0.965 = 0.756(0.7541) + b$ $b = 0.395$

SWITCHYARD VOLTAGE LIMIT = $0.756(0.70) + 0.395 = \underline{0.924}$

4160 V BUS CDEA VOLTAGE: $Y_{0.8225} - Y_{0.7830} = m(X_{0.8225} - X_{0.7830})$

$0.8225 - 0.7830 = m(0.7541 - 0.7078)$ $m = \frac{0.0395}{0.0463} = 0.853$

$Y = mx + b$ @ 0.8225 CDEA VOLTAGE (0.965 SWITCHYARD VOLTAGE):

$0.8225 = 0.853(0.7541) + b$ $b = 0.179$

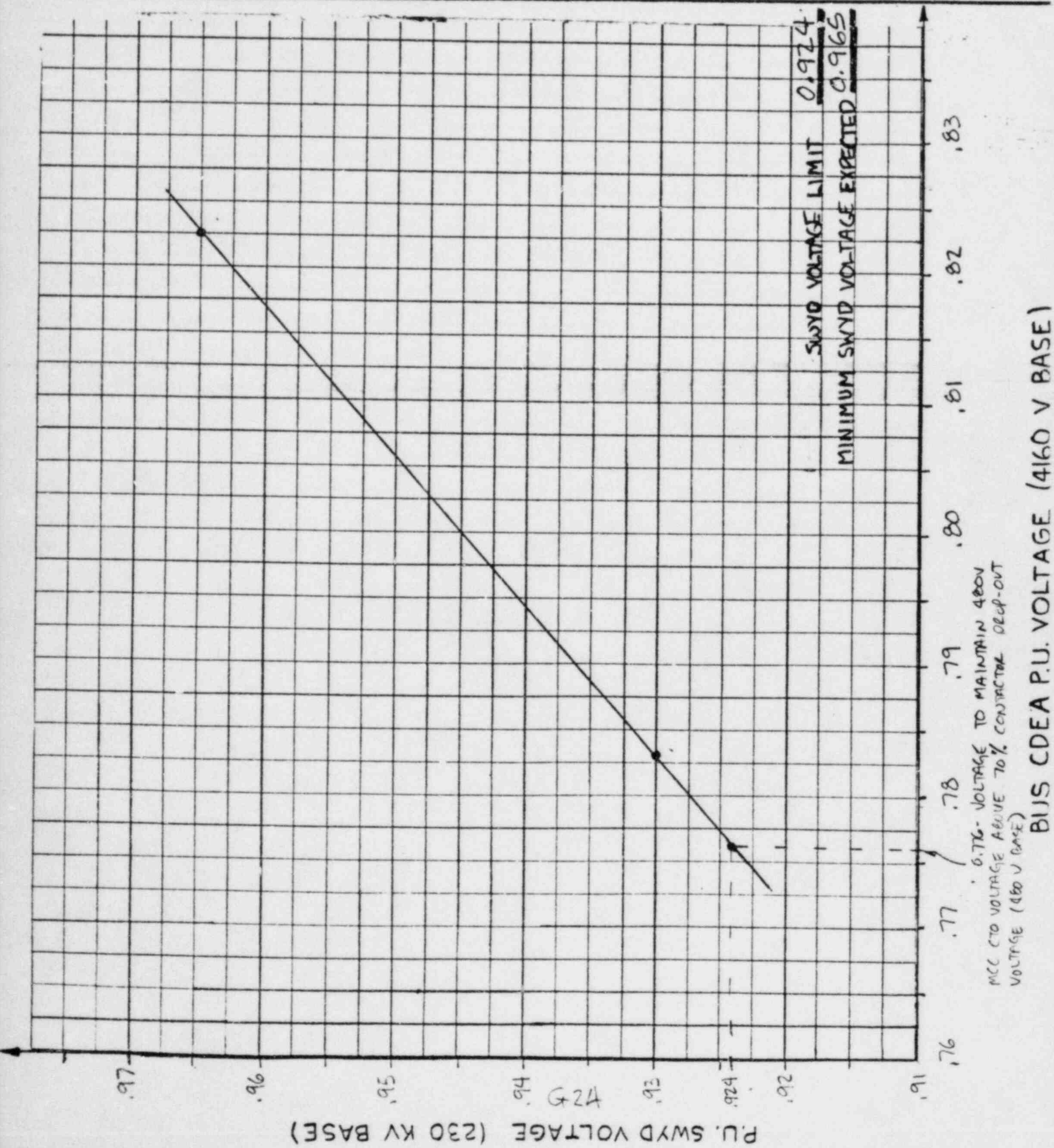
CDEA BUS VOLTAGE LIMIT = $0.853(0.700) + 0.179 = \underline{0.776}$

Computed by: J A Keane Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-26-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT10B - LOCA, SEQ. START - START 2 CSP'S, 2 RHR PUMPS RUNNING

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-27-F	
Checked by: J.A. Kowalchek	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1SAT11 - LOCA RUN				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 480 V MCC CTO VOLTAGE ABOVE 85% CONTACTOR PICK-UP VOLTAGE (480 V BASE)

SWYD VOLTAGE	4160 V BUS CDEA VOLTAGE	480 V MCC CTO VOLTAGE
0.940	0.8602	0.7977
0.989	0.9187	0.8642

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.8642 - 0.7977)$ $m = \frac{0.049}{0.0665} = 0.737$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.737(0.8642) + b$ $b = 0.352$

SWITCHYARD VOLTAGE LIMIT $= 0.737(0.85) + 0.352 = \underline{0.979}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9187} - Y_{0.8602} = m(X_{0.9187} - X_{0.8602})$

$0.9187 - 0.8602 = m(0.8642 - 0.7977)$ $m = \frac{0.0585}{0.0665} = 0.880$

$Y = mx + b$ @ 0.9187 CDEA VOLTAGE (0.989 SWITCHYARD VOLT.):

$0.9187 = 0.880(0.8642) + b$ $b = 0.158$

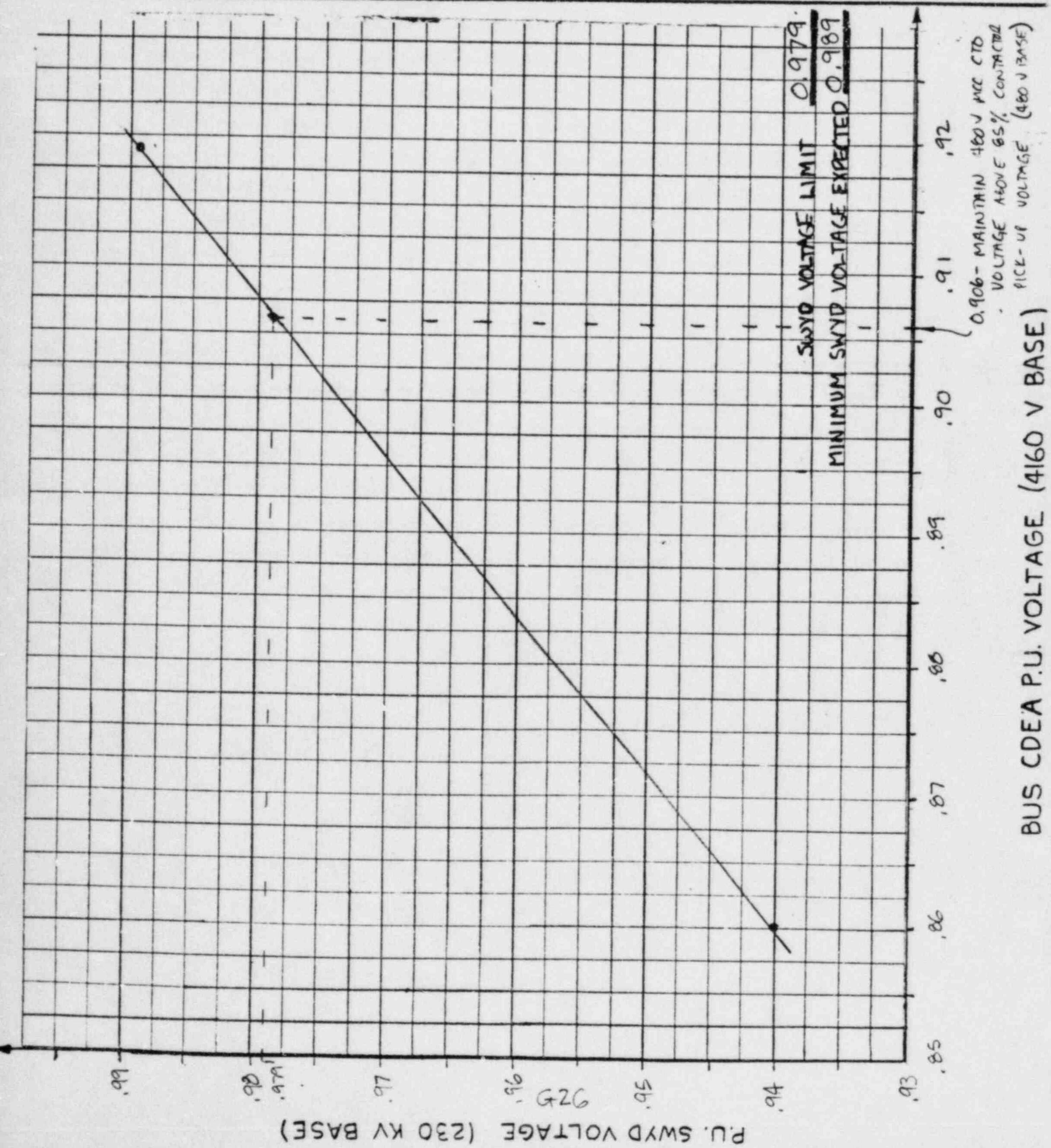
CDEA BUS VOLTAGE LIMIT $= 0.880(0.85) + 0.158 = \underline{0.906}$

Computed by: JA Keane Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-27-F
Checked by: J.A. Kowalcheck Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT11- LOCA RUN

Status: Prelim. ☐ Final ☒ Void ☐



G26

Computed by: JA Keane Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-28-F	
Checked by: J.A. Kowalchek Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 1 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT12 - LOCA RUN: 3RD CWP MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	CWP-1D MOTOR TERMINAL VOLTAGE 4000 V BASE	CWP-1D MOTOR TERMINAL VOLTAGE 4160 V BASE
0.940	0.8028	0.8008	0.7700
0.989	0.8577	0.8555	0.8226

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - Y_{0.940})$

$0.989 - 0.940 = m(0.8226 - 0.7700)$ $m = \frac{0.049}{0.0526} = 0.932$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.932(0.8226) + b$ $b = 0.222$

SWITCHYARD VOLTAGE LIMIT = $0.932(0.817) + 0.222 = \underline{0.983}$

4160 V BUS CDEA VOLTAGE: $Y_{0.8577} - Y_{0.8028} = m(X_{0.8577} - X_{0.8028})$

$0.8577 - 0.8028 = m(0.8226 - 0.7700)$ $m = \frac{0.0549}{0.0526} = 1.044$

$Y = mx + b$ @ 0.8577 CDEA VOLTAGE (0.989 SWITCHYARD VOLTAGE):

$0.8577 = 1.044(0.8226) + b$ $b = -0.001$

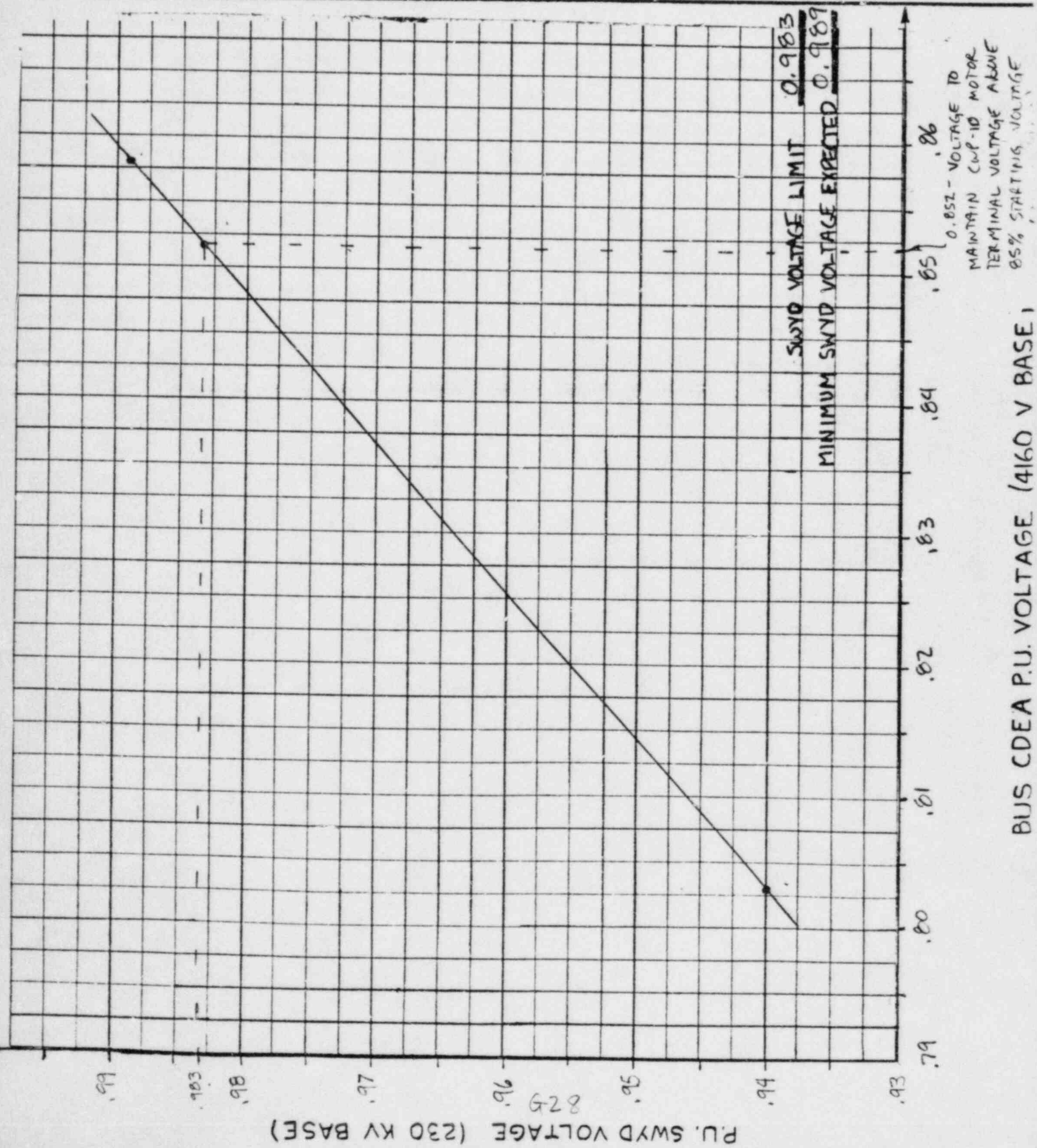
CDEA BUS VOLTAGE LIMIT = $1.044(0.817) + (-0.001) = \underline{0.852}$

Computed by: JA Keane Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-28-F
Checked by: J.A. Kowalcheck Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT12- LOCA RUN: 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G28

Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-29-F	
Checked by: J.A. Kowalchek	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	
Project Title: DSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1SAT13 - LOCA RUN: 4TH CWP MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000 V BASE)

SWYD. VOLTAGE	4160 V BUS COEA VOLTAGE	CIRCULATING WATER PUMP 1D MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.940	0.7911	0.7892	0.7588
0.989	0.8473	0.8452	0.8127

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.8127 - 0.7588)$ $m = \frac{0.049}{0.0539} = 0.909$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.909(0.8127) + b$ $b = 0.250$

SWITCHYARD VOLTAGE LIMIT $= 0.909(0.817) + 0.250 = \underline{\underline{0.993}}$

4160 V BUS COEA VOLTAGE: $Y_{0.8473} - Y_{0.7911} \; m(X_{0.8473} - X_{0.7911})$

$0.8473 - 0.7911 = m(0.8127 - 0.7588)$ $m = \frac{0.0562}{0.0539} = 1.043$

$Y = mY + b$ @ 0.8473 COEA VOLTAGE (0.989 SWITCHYARD VOLTAGE):

$0.8473 = 1.043(0.8127) + b$ $b = -0.0003$

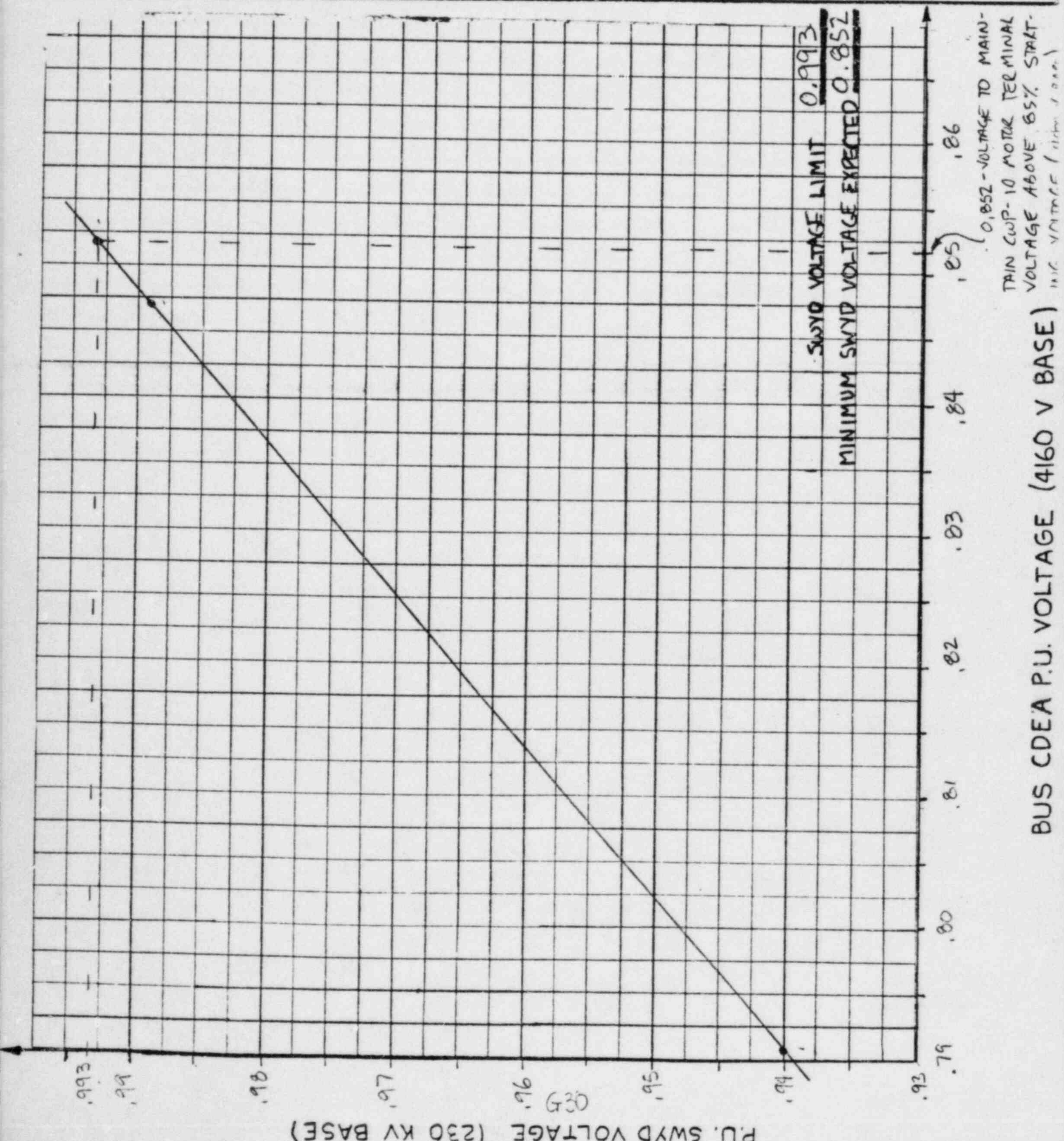
COEA BUS VOLTAGE LIMITS $= 1.043(0.817) + (-0.0003) = \underline{0.852}$

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-29-F	
Checked by: J.A. Kowalchick	Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT13 - LOCA RUN; 4TH CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keay Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-30-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AH-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT14 - LOCA RUN: STATOR COOLANT PUMP 1B MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN SCP-1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	STATOR COOLANT PUMP 1B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.940	0.8581	0.8349	0.8001
0.989	0.9165	0.9002	0.8627

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.8627 - 0.8001)$ $\quad m = \frac{0.049}{0.0626} = 0.783$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.783(0.8627) + b$ $\quad b = 0.314$

SWITCHYARD VOLTAGE LIMIT = $0.783(0.815) + 0.314 =$ <u>0.952</u>

4160 V BUS CDEA VOLTAGE: $Y_{0.9165} + Y_{0.8581} = m(X_{0.9165} - X_{0.8581})$

$0.9165 - 0.8581 = m(0.8627 - 0.8001)$ $\quad m = \frac{0.0584}{0.0626} = 0.933$

$Y = mx + b$ @ 0.9165 CDEA VOLTAGE (0.989 SWITCHYARD VOLTAGE)

$0.9165 = 0.933(0.8627) + b$ $\quad b = 0.112$

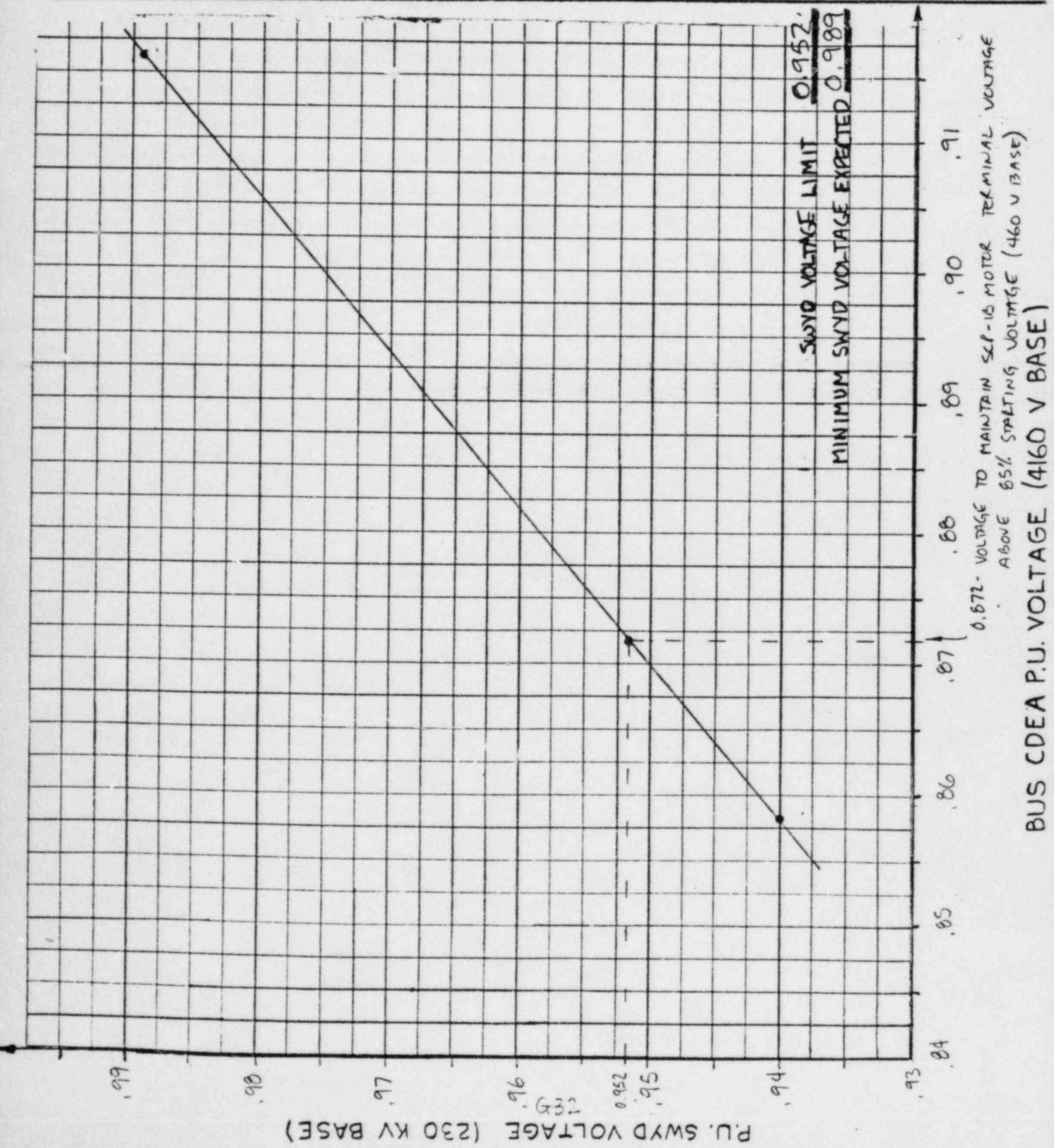
SWITCHYARD VOLTAGE LIMIT = $0.933(0.815) + 0.112 =$ <u>0.872</u>

Computed by: JA Keane	Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124 - E-30 - F	
Checked by: J.A. Kowalchek	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT14 - LOCA RUN; STATOR COOLANT PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G32

Computed by: JAKeane Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-31-F	
Checked by: J.A. Kowalchek Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT15- LOCA RUN: FUEL POOL CLEANING PUMP 1A MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN FPCP-1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160V BUS COEA VOLTAGE	FUEL POOL CLEANING PUMP 1A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.940	0.8582	0.8551	0.8195
0.989	0.9166	0.9210	0.8826

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.8826 - 0.8195)$ $m = \frac{0.049}{0.0631} = 0.777$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.777(0.8826) + b$ $b = 0.303$

SWITCHYARD VOLTAGE LIMIT = $0.777(0.815) + 0.303 =$ <u>0.936</u>

4160 V BUS COEA VOLTAGE: $Y_{0.9166} - Y_{0.8582} = m(X_{0.9166} - X_{0.8582})$

$0.9166 - 0.8582 = m(0.8826 - 0.8195)$ $m = \frac{0.0584}{0.0631} = 0.926$

$Y = mx + b$ @ 0.9166 COEA VOLTAGE (0.989 SWITCHYARD VOLTAGE):

$0.9166 = 0.926(0.8826) + b$ $b = 0.099$

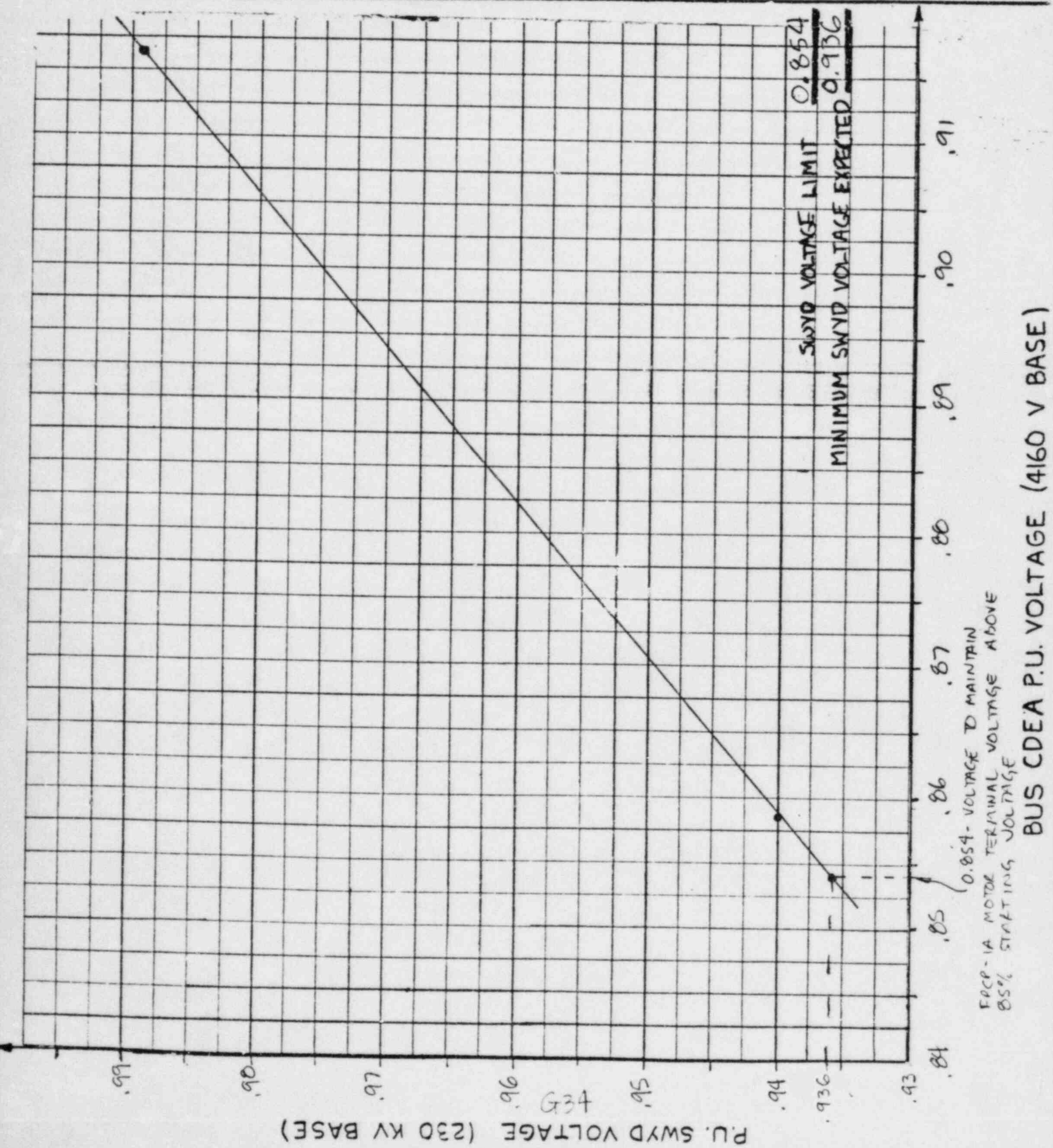
COEA BUS VOLTAGE LIMIT = $0.926(0.815) + 0.099 =$ <u>0.854</u>

Computed by: JA Keane Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124- E-31 -F
Checked by: J.A. Kowalcheck Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT15 - LOCA RUN; FUEL POOL CLEANING PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G34

Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-32-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1SAT16 - LOCA RUN; FUEL POOL CLEANING PUMP 1B MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN FPCP-1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160V BUS COEA VOLTAGE	FUEL POOL CLEANING PUMP 1B 460 V BASE	MOTOR TERMINAL VOLTAGE 460 V BASE
0.940	0.8584	0.8374	0.8025
0.989	0.9168	0.9029	0.8653

85% MOTOR TERMINAL VOLTAGE ON 480V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.8653 - 0.8025)$ $\qquad m = \frac{0.049}{0.0628} = 0.780$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 0.780(0.8653) + b$ $\qquad b = 0.314$

SWITCHYARD VOLTAGE LIMIT = $0.780(0.815) + 0.314 =$ <u>0.950</u>

4160 V BUS COEA VOLTAGE: $Y_{0.9168} - Y_{0.8584} = m(X_{0.9168} - X_{0.8584})$

$0.9168 - 0.8584 = m(0.8653 - 0.8025)$ $\qquad m = \frac{0.0584}{0.0628} = 0.930$

$Y = mx + b$ @ 0.9168 COEA VOLTAGE (0.989 SWITCHYARD VOLTAGE)

$0.9168 = 0.930(0.8653) + b$ $\qquad b = 0.112$

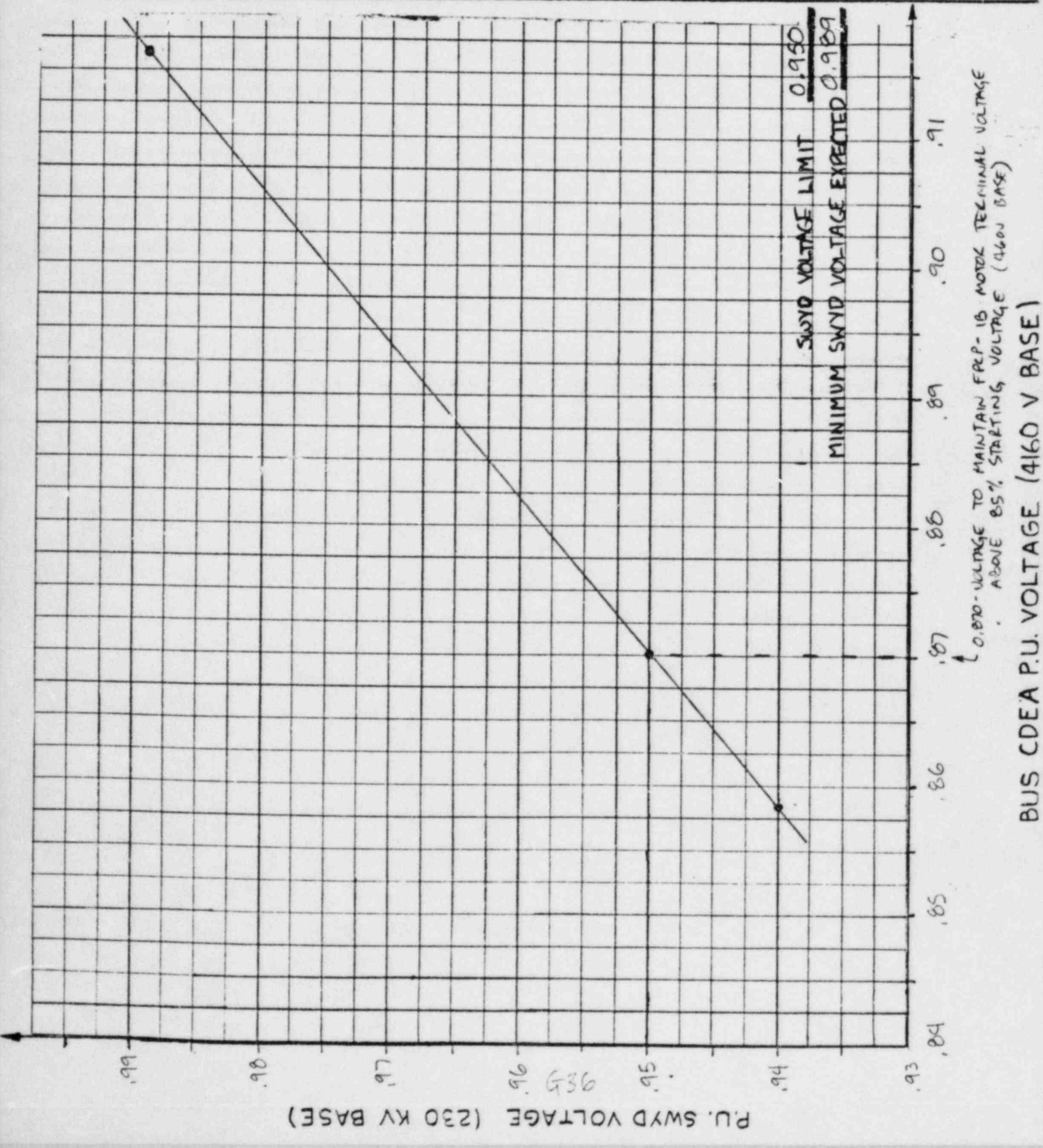
COEA BUS VOLTAGE LIMIT = $0.930(0.815) + 0.112 =$ <u>0.870</u>

Computed by: JA Keane Date: 5/15/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-32-F	
Checked by: J.A. Kowalcheck Date: 5/24/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT16 - LOCA RUN; FUEL POOL CLEANING PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G36

Computed by: JA Keane	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-33-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT17- LOCA RUN; TBCCW PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN TBCCW PUMP 1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	TURBINE BLDG. CLOSED COOL. WTR. PUMP MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.940	0.8559	0.7325	0.7020
0.989	0.9141	0.7830	0.7504

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.989 - 0.940 = m(0.7504 - 0.7020)$ $m = \frac{0.049}{0.0484} = 1.012$

$Y = mx + b$ @ 0.989 SWITCHYARD VOLTAGE:

$0.989 = 1.012(0.7504) + b$ $b = 0.230$

SWITCHYARD VOLTAGE LIMIT = $1.012(0.815) + 0.230 =$ **1.055**

4160 V BUS CDEA VOLTAGE: $Y_{0.989} - Y_{0.940} = m(X_{0.989} - X_{0.940})$

$0.9141 - 0.8559 = m(0.7504 - 0.7020)$ $m = \frac{0.0582}{0.0484} = 1.203$

$Y = mx + b$ @ 0.9141 CDEA VOLTAGE (0.989 SWITCHYARD VOLTAGE):

$0.9141 = 1.203(0.7504) + b$ $b = 0.011$

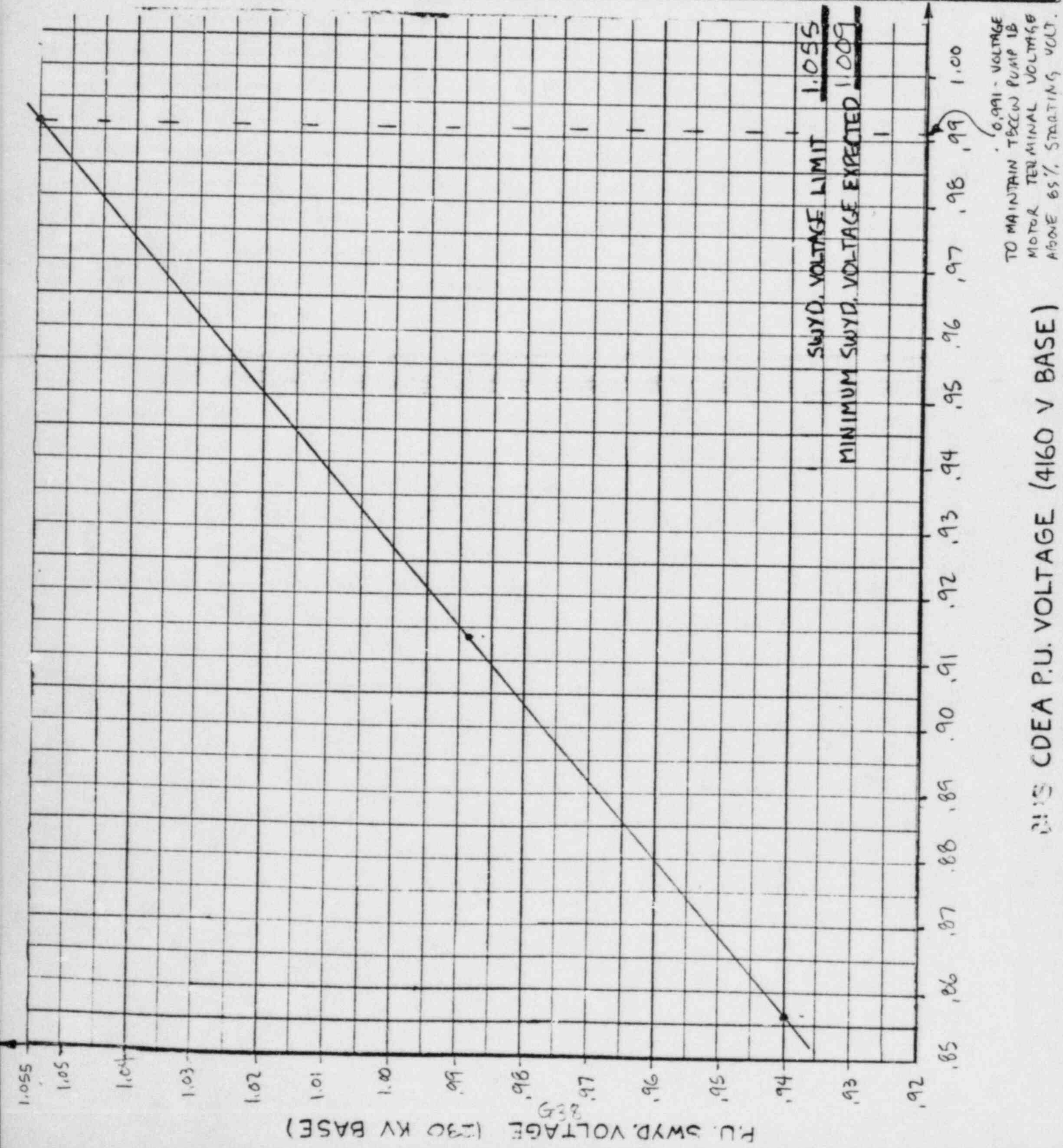
CDEA BUS VOLTAGE LIMIT = $1.203(0.815) + 0.011 =$ **0.991**

Computed by: JA Crane	Date: 5/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-33-F	
Checked by: J.A. Kowalczeck	Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT17- LOCA RUN; TBCCW PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/14/84	AROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-34-F	
Checked by: J.A. Kowalcheck	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT18- SCREEN WASH PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN SWP-1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEA VOLTAGE	SCREEN WASH PUMP 1A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.970	0.8896	0.7603	0.7286
1.009	0.9353	0.8064	0.7728

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.970} = m(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.7728 - 0.7286)$ $m = \frac{0.039}{0.0442} = 0.882$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.882(0.7728) + b$ $b = 0.327$

SWITCHYARD VOLTAGE LIMIT = $0.882(0.815) + 0.327 = \underline{1.046}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9353} - Y_{0.8896} = m(X_{0.9353} - X_{0.8896})$

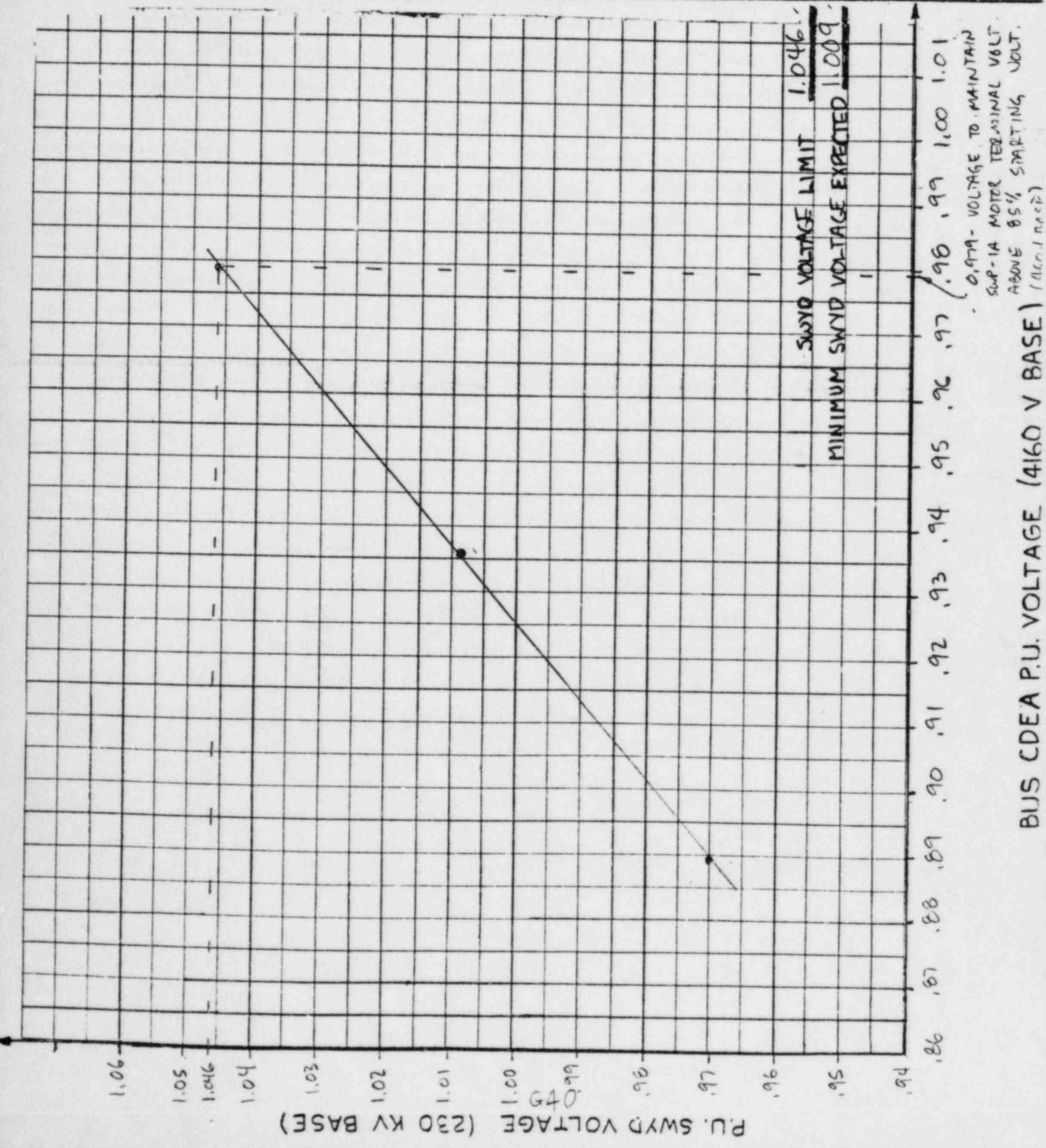
$0.9353 - 0.8896 = m(0.7728 - 0.7286)$ $m = \frac{0.0457}{0.0442} = 1.034$

$Y = mx + b$ @ 0.9353 CDEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9353 = 1.034(0.7728) + b$ $b = 0.136$

CDEA BUS VOLTAGE LIMIT = $1.034(0.815) + 0.136 = \underline{0.979}$

Computed by: DAKean Date: 5/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-34-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-S543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1SAT18 - SCREEN WASH PUMP 1A MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			



G40

Computed by: JA Keane	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-35F	
Checked by: J.A. Kowalchick	Date: 5/24/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SATA - TBCCW PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN TBCCW PUMP 1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE

SWYD. VOLTAGE	4160 V BUS COEA VOLTAGE	TURBINE BLDG. CLOSED COOL. WTR. PUMP MOTOR TERMINAL VOLT. 460 V BASE	480 V BASE
0.970	0.8921	0.7639	0.7321
1.009	0.9379	0.8037	0.7702

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.970} = m(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.7702 - 0.7321)$ $m = \frac{0.039}{0.0381} = 1.024$

$Y = mX + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 1.024(0.7702) + b$ $b = 0.220$

SWITCHYARD VOLTAGE LIMIT = $1.024(0.815) + 0.220 = \underline{1.055}$

4160 V BUS COEA VOLTAGE: $Y_{0.9379} - Y_{0.8921} = m(X_{0.9379} - X_{0.8921})$

$0.9379 - 0.8921 = m(0.7702 - 0.7321)$ $m = \frac{0.0458}{0.0381} = 1.202$

$Y = mX + b$ @ 0.9379 COEA VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9379 = 1.202(0.7702) + b$ $b = 0.012$

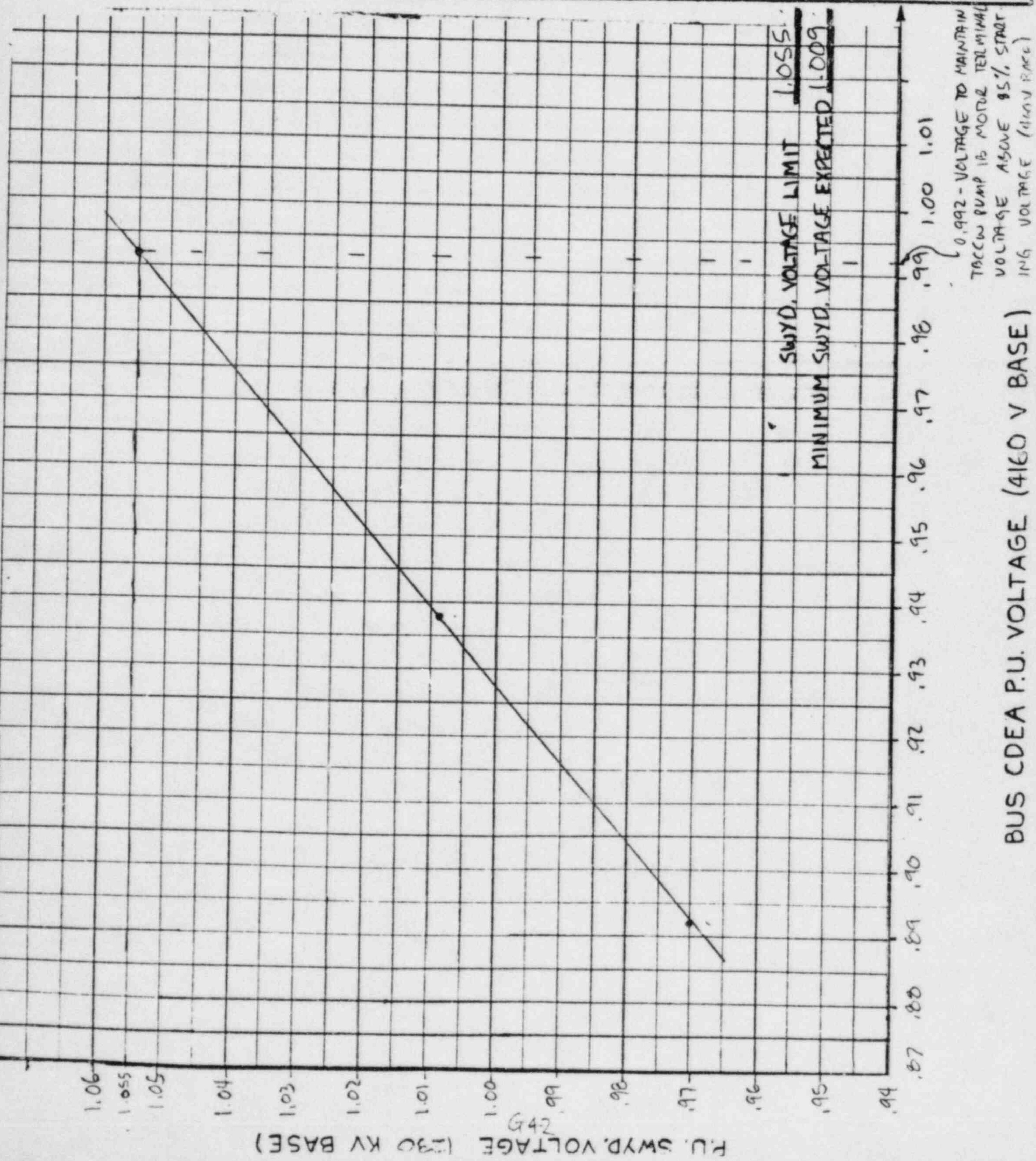
COEA BUS VOLTAGE LIMIT = $1.202(.815) + 0.012 = \underline{0.992}$

Computed by: JA Crane Date: 5/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-35-F	
Checked by: J.A. Kowalcheck Date: 5/24/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1SAT19 - TBCCW PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: J.A. Yeare Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-36-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AH-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT1 - FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 460V MOTOR TERMINAL VOLTAGE ABOVE 90% ON A 460 V BASE* (USE WORST CASE MCC: 1CA)

GEN. VOLTAGE	4160 V BUS CDEA VOLTAGE	MCC 1CA VOLTAGE 460V BASE	MCC 1CA VOLTAGE 480 V BASE	460 V MOTOR TERMINAL VOLTAGE 460V BASE	460 V MOTOR TERMINAL VOLTAGE 480 V BASE
0.97	0.9008	0.8879	0.8509	0.8613	0.8254
1.009	0.9438	0.9409	0.9017	0.9127	0.8745 (.8746)

* ASSUME A 3% VOLTAGE DROP ON A 460 V BASE FROM THE MCC TO THE MOTOR TERMINALS

90% MOTOR TERMINAL VOLTAGE ON A 480 V BASE = 0.863

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8745 - 0.8254)$ $m = \frac{0.039}{0.0491} = 0.794$ (.793)

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 0.794(0.8745) + b$ $b = 0.315$

GENERATOR VOLTAGE LIMIT = $0.794(0.863) + 0.315 =$ **1.000** (.999)

4160 V BUS CDEA VOLTAGE: $Y_{0.9438} - Y_{0.9008} = m(X_{0.9438} - X_{0.9008})$

$0.9438 - 0.9008 = m(0.8745 - 0.8254)$ $m = \frac{0.043}{0.0491} = 0.876$ (.876)

$Y = mx + b$ @ 0.9438 CDEA VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.9438 = 0.876(0.8745) + b$ $b = 0.178$ (.178)

CDEA BUS VOLTAGE LIMIT = $0.876(0.863) + 0.178 =$ **0.934** (.933)

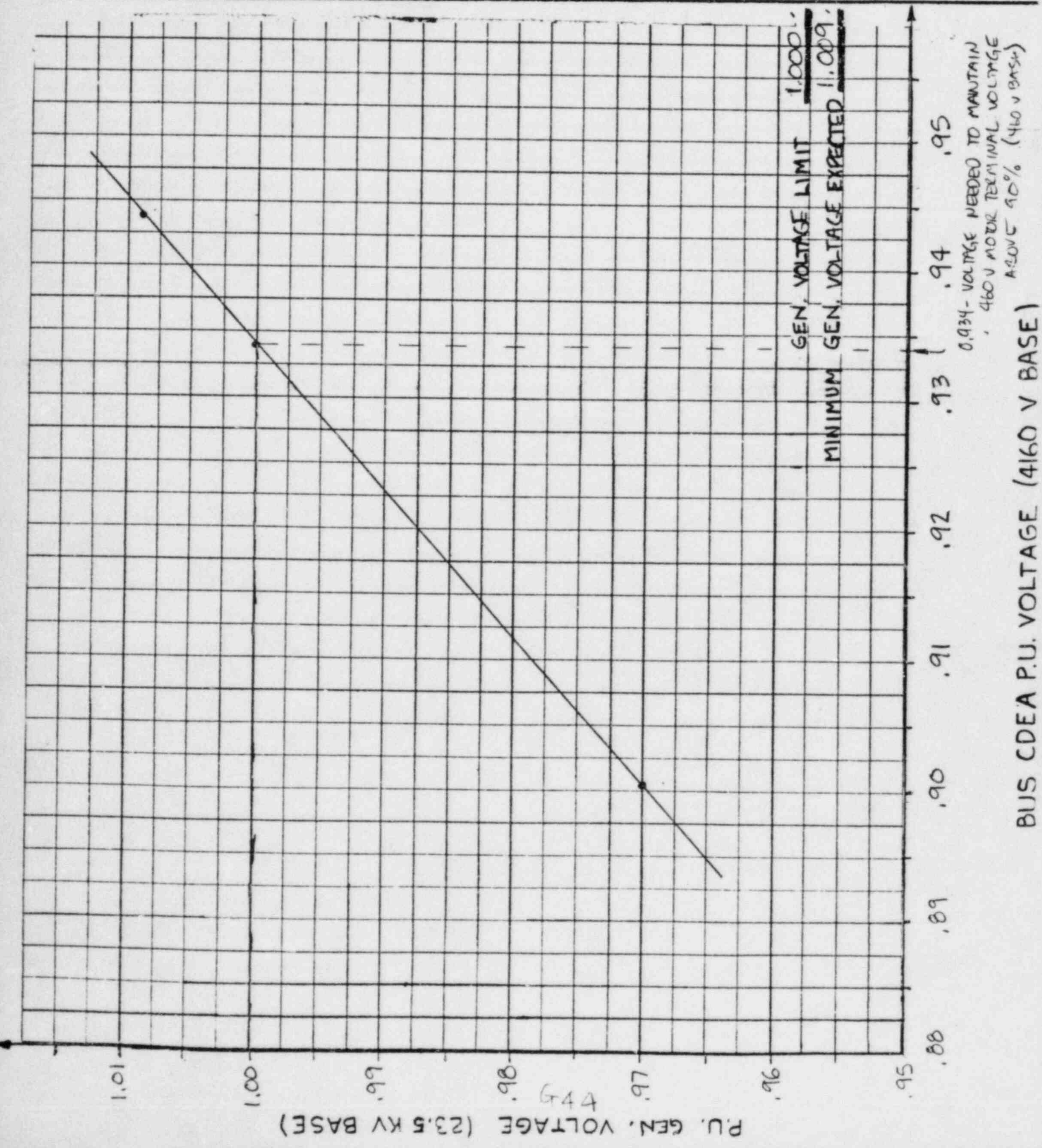
G43

Computed by: JAKeane	Date: 5/11/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124- E-36-F	
Checked by: J.A. Kowalchek	Date: 5/25/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AH-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT1- FULL LOAD OPERATION

Status: Prelim. ☐ Final ☒ Void ☐



G44

Computed by: J.A. Keane Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-37-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AH-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1UAT2- LIGHT LOAD CONDITION			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: LIMIT THE 460V MOTOR TERMINAL VOLTAGE TO 110% * (460 V BASE)

GEN. VOLTAGE	4160 V BUS CDEA VOLTAGE	480 V MCC 1TN VOLTAGE
1.000	0.9383	0.9393
1.038	0.9794	0.9850

* ASSUME NO VOLTAGE DROP FROM MCC TO MOTOR TERMINALS
110% MOTOR TERMINAL VOLTAGE ON 460 V BASE = 1.054

GENERATOR VOLTAGE: $Y_{1.038} - Y_{1.000} = m(X_{1.038} - X_{1.000})$

$1.038 - 1.000 = m(0.9850 - 0.9393)$ $m = \frac{.038}{0.0457} = 0.832$

$Y = mx + b$ @ 1.038 GENERATOR VOLTAGE:

$1.038 = 0.832(0.985) + b$ $b = 0.218$

GENERATOR VOLTAGE LIMIT = $0.832(1.054) + 0.218 = \underline{1.095}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9794} - Y_{0.9383} = m(X_{0.9794} - X_{0.9383})$

$0.9794 - 0.9383 = m(0.9850 - 0.9393)$ $m = \frac{0.0411}{0.0457} = 0.899$

$Y = mx + b$ @ 0.9794 CDEA VOLTAGE (1.038 GENERATOR VOLTAGE)

$0.9794 = 0.899(0.985) + b$ $b = 0.094$

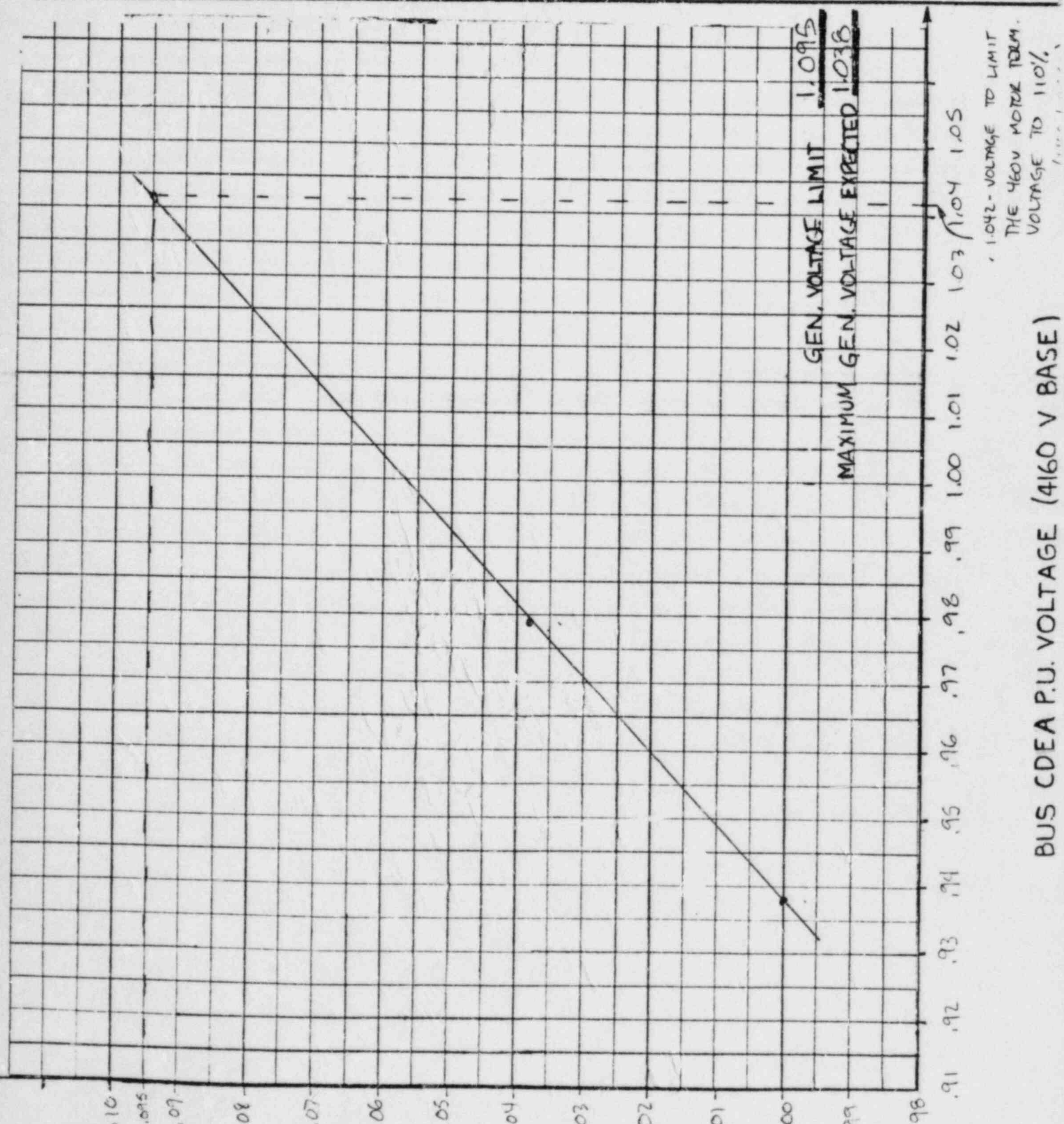
CDEA BUS VOLTAGE LIMIT = $0.899(1.054) + 0.094 = \underline{1.042}$

Computed by: JA Keare	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124- E-37-F	
Checked by: J.A. Kowalcheck	Date: 5/25/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT2- LIGHT LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



646

Computed by: JA Keane	Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-38-F	
Checked by: J.A. Kowalchek	Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT3 - 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000 V BASE)

GEN. VOLTAGE	4160 V BUS COEA VOLTAGE	CIRCULATING WATER PUMP 1D MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.97	0.8446	0.8425	0.8101
1.009	0.8847	0.8824	0.8485

85% MOTOR TERMINAL VOLTAGE ON 4160V BASE = 0.817

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.970 = m(0.8485 - 0.8101)$ $m = \frac{0.039}{0.0384} = 1.016$

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 1.016(0.8485) + b$ $b = 0.147$

GENERATOR VOLTAGE LIMIT = $1.016(0.817) + 0.147 =$ **0.977**

4160 V BUS COEA VOLTAGE: $Y_{0.8847} - Y_{0.8446} = m(X_{0.8847} - X_{0.8446})$

$0.8847 - 0.8446 = m(0.8485 - 0.8101)$ $m = \frac{0.0401}{0.0384} = 1.044$

$Y = mx + b$ @ 0.8847 COEA VOLTAGE (1.009 GENERATOR VOLTAGE);

$0.8847 = 1.044(0.8485) + b$ $b = -0.001$

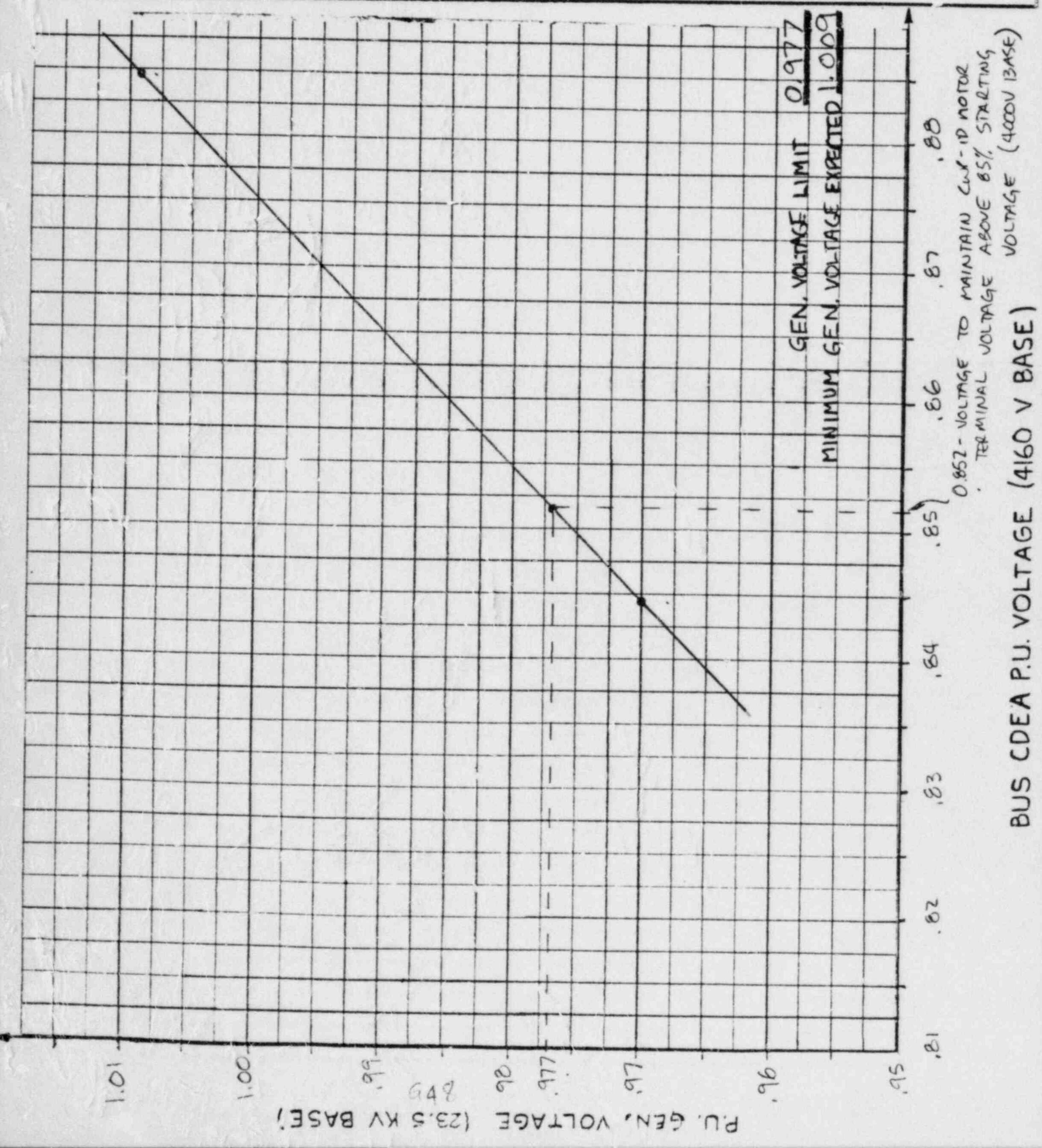
COEA BUS VOLTAGE LIMIT = $1.044(0.817) + (-0.001) =$ **0.852**

Computed by: JA Verne	Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-38-F	
Checked by: J.A. Kowalczyk	Date: 5/25/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AH-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT3 - 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Cerno Date: 5/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT/124-E-39-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-S543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 1UAT4- 4TH CWP MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN CWP-1D MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000 V BASE)

GEN. VOLTAGE	4160 V BUS COEA VOLTAGE	CIRCULATING WATER PUMP 1D 4000 V BASE	MOTOR TERMINAL VOLTAGE 4160 V BASE
0.970	0.8350	0.8329	0.8009
1.009	0.8758	0.8736	0.8400

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8400 - 0.8009)$ $m = \frac{0.039}{0.0391} = 0.997$

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 0.997(0.8400) + b$ $b = 0.171$ (.172)

GENERATOR VOLTAGE LIMIT = $0.997(0.817) + 0.171 = \underline{0.986}$ (.987)

4160 V BUS COEA VOLTAGE: $Y_{0.8758} - Y_{0.835} = m(X_{0.8758} - X_{0.835})$

$0.8758 - 0.8350 = m(0.8400 - 0.8009)$ $m = \frac{0.0408}{0.0391} = 1.044$ (1.043)

$Y = mx + b$ @ 0.8758 COEA VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.8758 = 1.044(0.8400) + b$ $b = -0.001$ (-.0003)

COEA BUS VOLTAGE LIMIT = $1.044(0.817) + (-0.001) = \underline{0.852}$ (.853)

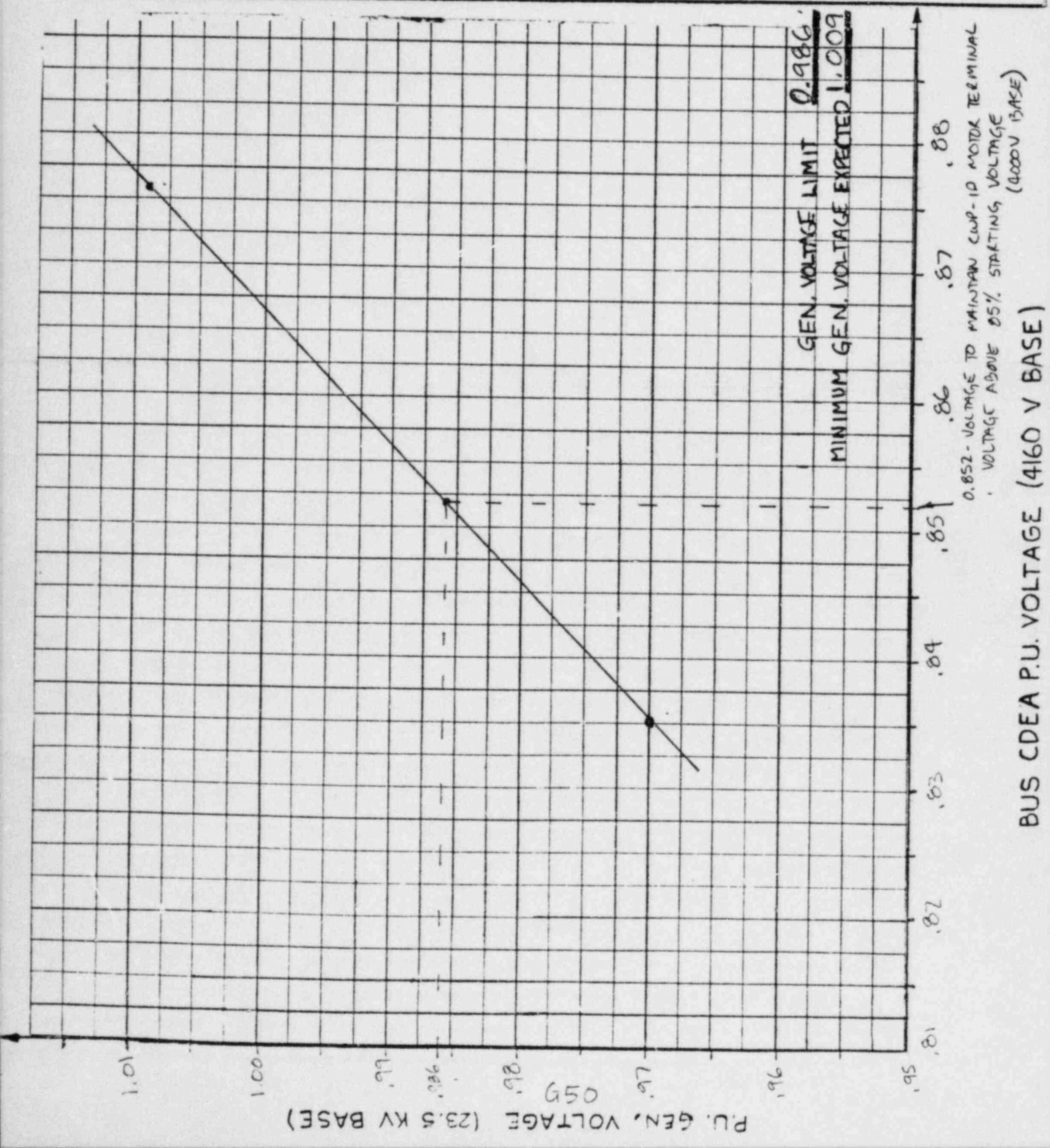
G49

Computed by: JA Keane Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-39-F	
Checked by: J.A. Kowalcheck Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT4- 4TH CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 5/11/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-40-F	
Checked by: J.A. Kowalchek	Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-S543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 1UATS - REACTOR RECIRC PUMP 1B MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN RRP-1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (4000V BASE)

GEN VOLTAGE	4160V BUS 1B VOLTAGE	REACTOR RECIRC PUMP 1B MOTOR TERMINAL VOLTAGE 4000 V BASE	REACTOR RECIRC PUMP 1B MOTOR TERMINAL VOLTAGE 4160 V BASE
0.970	0.8145	0.8402	0.8079
1.009	0.8477	0.8745	0.8409

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.970} = m\,(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.8409 - 0.8079)$ $\qquad m = \frac{0.039}{0.033} = 1.182$

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 1.182(0.8409) + b$ $\qquad b = 0.015$

GENERATOR VOLTAGE LIMIT = $1.182(0.817) + 0.015 =$ <u>0.981</u>

4160V BUS 1B VOLTAGE: $Y_{0.8477} - Y_{0.8145} = m(X_{0.8477} - X_{0.8145})$

$0.8477 - 0.8145 = m(0.8409 - 0.8079)$ $\qquad m = \frac{0.0332}{0.033} = 1.006$

$Y = mx + b$ @ 0.8477 1B VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.8477 = 1.006(0.8409) + b$ $\qquad b = 0.002$

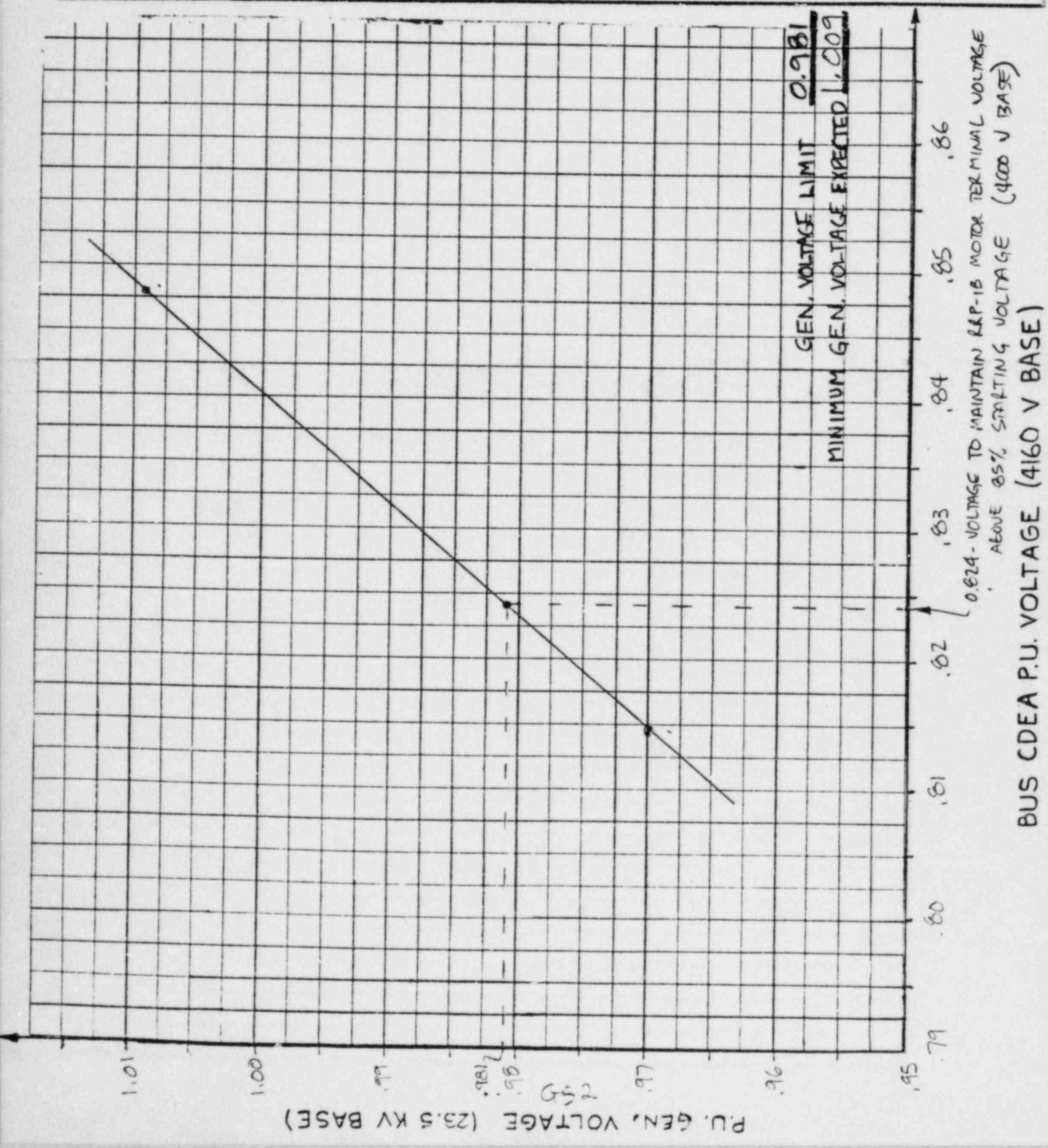
1B BUS VOLTAGE LIMIT = $1.006(0.817) + 0.002 =$ <u>0.824</u>

Computed by: JA Keane Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-40-F	
Checked by: J.A. Kowalchecik Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UATS-REACTOR RECIRC PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☐ Void ☐



Computed by: JA Keane Date: 5/11/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-41-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT6 - FUEL POOL CLEANING PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☐ Void ☐

LIMITING CONDITION: MAINTAIN FPCP-1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

GEN. VOLTAGE	4160V BUS CDEA VOLTAGE	FUEL POOL CLEANING PUMP 1A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.970	0.8990	0.8657	0.8296
1.009	0.9418	0.9160	0.8778

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.970} = m(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.8778 - 0.8296)$ $\quad m = \frac{0.039}{0.0482} = 0.809$

Y = mx + b @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.809(0.8778) + b$ $\quad b = 0.299$

GENERATOR VOLTAGE LIMIT = 0.809(0.815) + 0.299 = <u>0.958</u>

4160 V BUS CDEA VOLTAGE: $Y_{0.9418} - Y_{0.8990} = m(X_{0.9418} - X_{0.8990})$

$0.9418 - 0.8990 = m(0.8778 - 0.8296)$ $\quad m = \frac{0.0428}{0.0482} = 0.888$

Y = mx + b @ 0.9418 CDEA VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.9418 = 0.888(0.8778) + b$ $\quad b = 0.162$

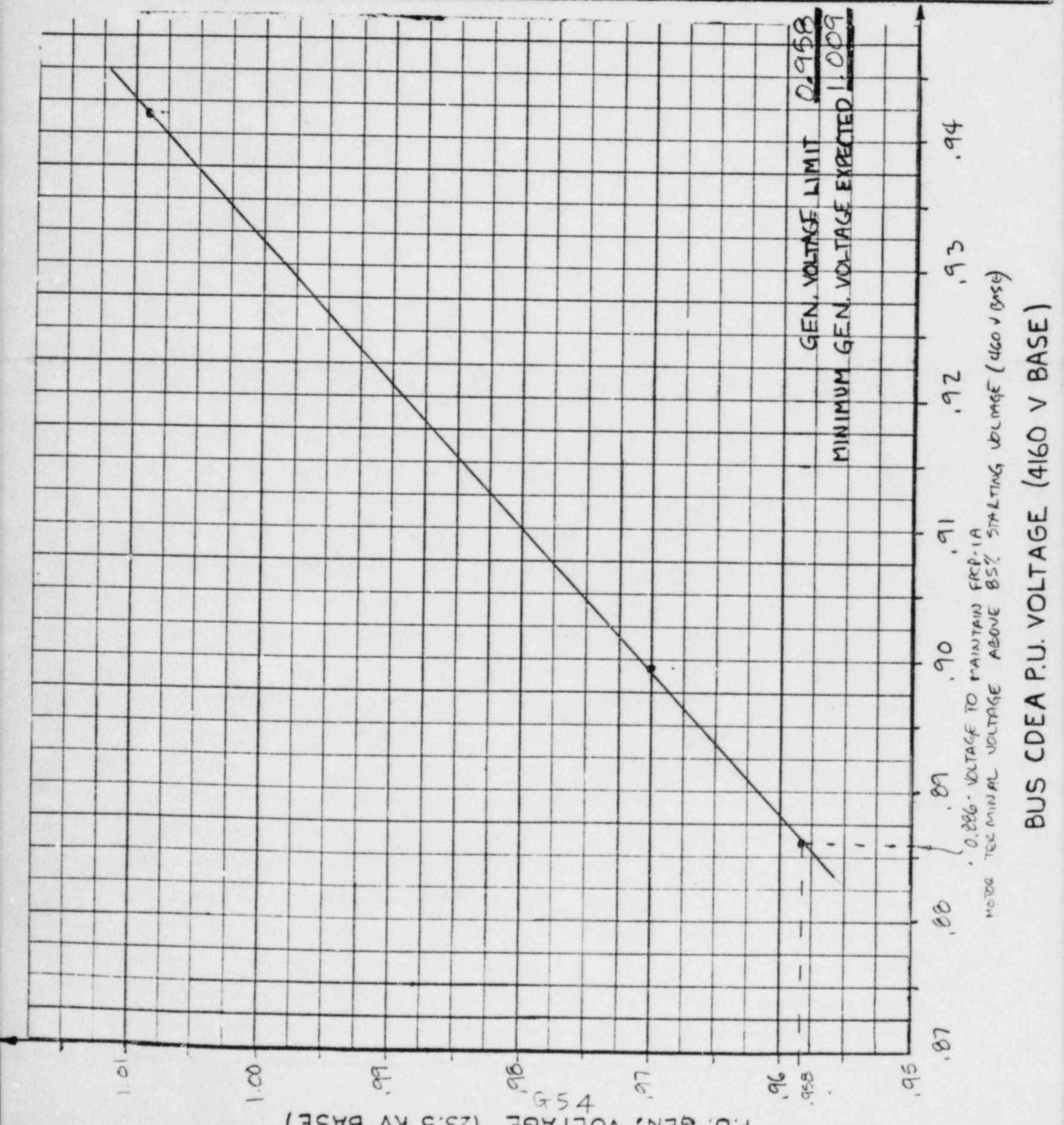
CDEA BUS VOLTAGE LIMIT = 0.888(0.815) + 0.162 = <u>0.886</u>

Computed by: JA Keane Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-41-F	
Checked by: J.A. Kowalcheck Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT6- FUEL POOL CLEANING PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G54

Computed by: JA Keane Date: 5/11/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-12-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT7 - FUEL POOL CLEANING PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN FPCP-1B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

GEN. VOLTAGE	4160 V BUS CDEA VOLTAGE	FUEL POOL CLEANING PUMP 1B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.970	0.8991	0.8586	0.8228
1.009	0.9419	0.9078	0.8700

85% MOTOR TERMINAL VOLTAGE ON 460 V BASE = 0.815

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.970} = m(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.8700 - 0.8228)$ $m = \frac{0.039}{0.0472} = 0.826$

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 0.826(0.8700) + b$ $b = 0.290$

GENERATOR VOLTAGE LIMIT = $0.826(0.815) + 0.290 = \underline{0.963}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9419} - Y_{0.8991} = m(X_{0.9419} - X_{0.8991})$

$0.9419 - 0.8991 = m(0.8700 - 0.8228)$ $m = \frac{0.0428}{0.0472} = 0.907$

$Y = mx + b$ @ 0.9419 CDEA VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.9419 = 0.907(0.8700) + b$ $b = 0.153$

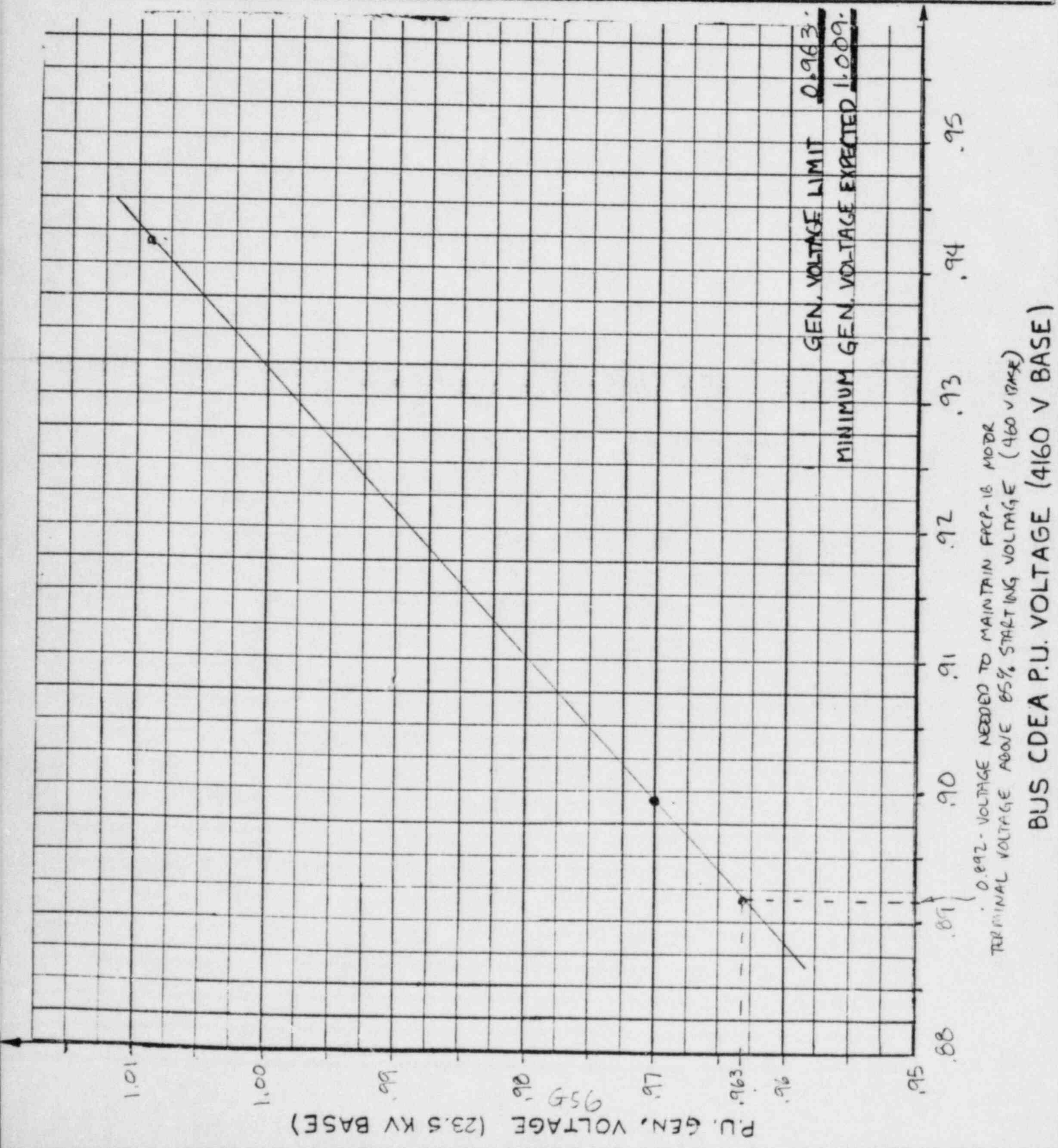
CDEA BUS VOLTAGE LIMIT = $0.907(0.815) + 0.153 = \underline{0.892}$

Computed by: JA Keare Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-42-F
Checked by: J.A. Kowalcheck Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UA17- FUEL POOL CLEANING PUMP 1B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 5/11/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-43-F	
Checked by: J.A. Kowalcheck Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 1 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNF-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT8 - RBCCW PUMP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN RBCCW PUMP 1A MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

GEN. VOLTAGE	4160V BUS CDEA VOLTAGE	REACTOR BLDG. CLOSED CLG. WTR. PUMP MOTOR TERMINAL VOLT. 460V BASE	480 V BASE
0.970	0.8988	0.8479	0.8126
1.009	0.9416	0.8965	0.8591

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

GENERATOR VOLTAGE: $Y_{1.009} - Y_{0.970} = m(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = m(0.8591 - 0.8126)$ $\quad m = \frac{0.039}{0.0465} = 0.839$

$Y = mx + b$ @ 1.009 GENERATOR VOLTAGE:

$1.009 = 0.839(0.8591) + b$ $\quad b = 0.288$

GENERATOR VOLTAGE LIMIT = $0.839(0.815) + 0.288 = \underline{0.972}$

4160 V BUS CDEA VOLTAGE: $Y_{0.9416} - Y_{0.8988} = m(X_{0.9416} - X_{0.8988})$

$0.9416 - 0.8988 = m(0.8591 - 0.8126)$ $\quad m = \frac{0.0428}{0.0465} = 0.920$

$Y = mx + b$ @ 0.9416 CDEA VOLTAGE (1.009 GENERATOR VOLTAGE):

$0.9416 = 0.920(0.8591) - b$ $\quad b = 0.151$

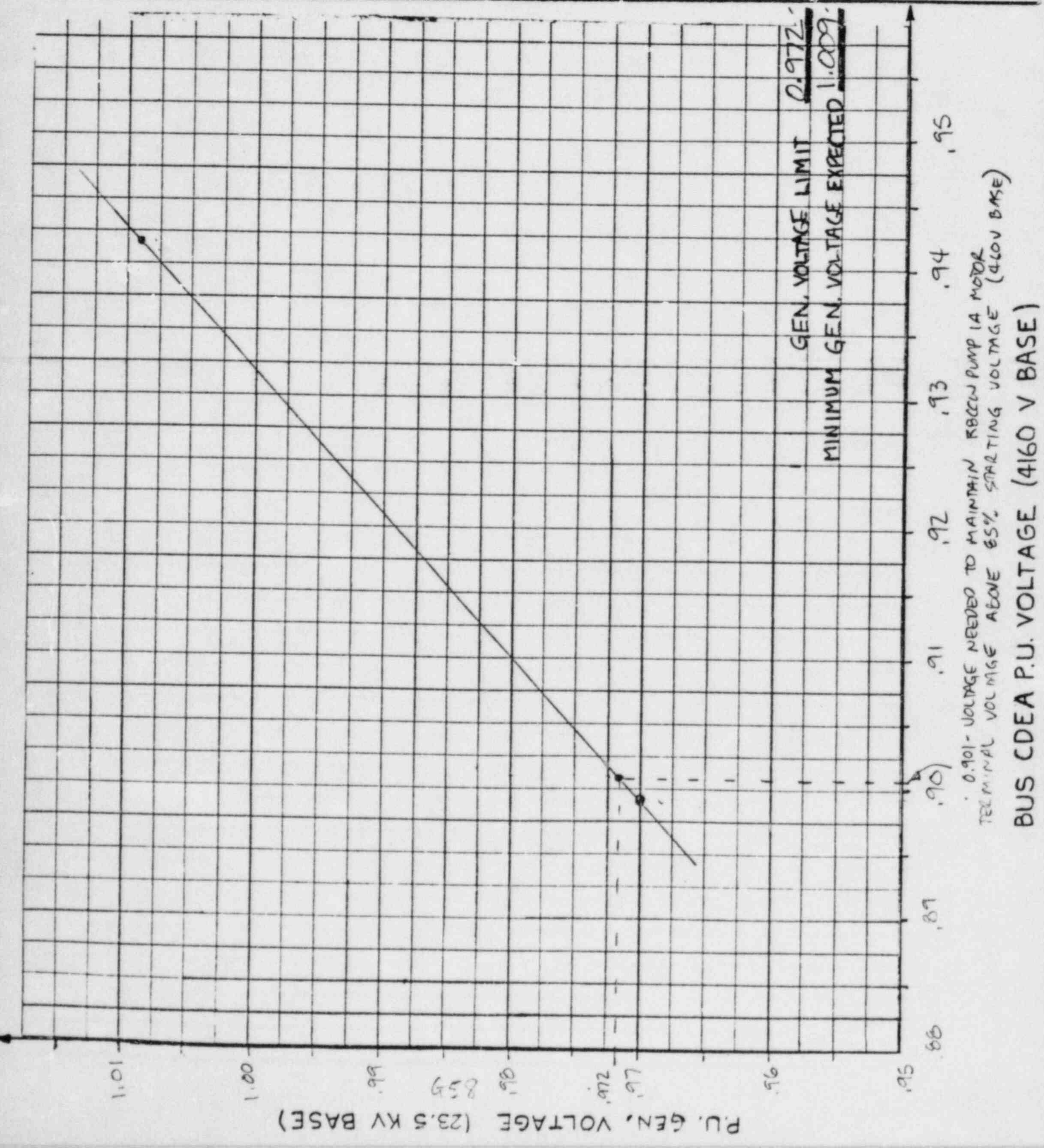
CDEA BUS VOLTAGE LIMIT = $0.920(0.815) + 0.151 = \underline{0.901}$

Computed by: JA Keane Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-43-F	
Checked by: J.A. Kowalcheck Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-S543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 1UAT8- RBCCW PUMP 1A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-44-F	
Checked by: J.A. Kowalchek	Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP-ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT1- FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN 460V MOTOR TERMINAL VOLTAGES ABOVE 90% ON 460V BASE (USE WORST CASE MCC: 2XH)

SWYD. VOLTAGE	4160 V BUS CDEB VOLTAGE	MCC 2XH VOLTAGE 480 V BASE	MCC 2XH VOLTAGE 460 V BASE	* 460V MOTOR TERMINAL VOLTAGE 480 V BASE	* 460V MOTOR TERMINAL VOLTAGE 460 V BASE
0.95	0.8684	0.8192	0.8548	0.7946	0.8292
1.009	0.9386	0.9017	0.9409	0.8747	0.9127

* ASSUMED A 3% VOLTAGE DROP ON A 460 V BASE FROM THE MCC TO THE MOTOR TERMINALS

90% MOTOR TERMINAL VOLTAGE ON A 460 V BASE = 0.863

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m\,(X_{1.009} - X_{0.95})$

$1.009 - 0.95 = m(0.8747 - 0.7946)$ $\quad m = \frac{0.059}{0.0801} = 0.737$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.737(0.8747) + b$ $\quad b = 0.364$

SWITCHYARD VOLTAGE LIMIT = $0.737(0.863) + 0.364 = \underline{1.000}$

4160 V BUS CDEB VOLTAGE: $Y_{0.9386} - Y_{0.8684} = m\,(X_{0.9386} - X_{0.8684})$

$0.9386 - 0.8684 = m(0.8747 - 0.7946)$ $\quad m = \frac{0.0702}{0.0801} = 0.8764$

$Y = mx + b$ @ 0.9386 CDEB VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9386 = 0.8764(0.8747) - b$ $\quad b = 0.172$

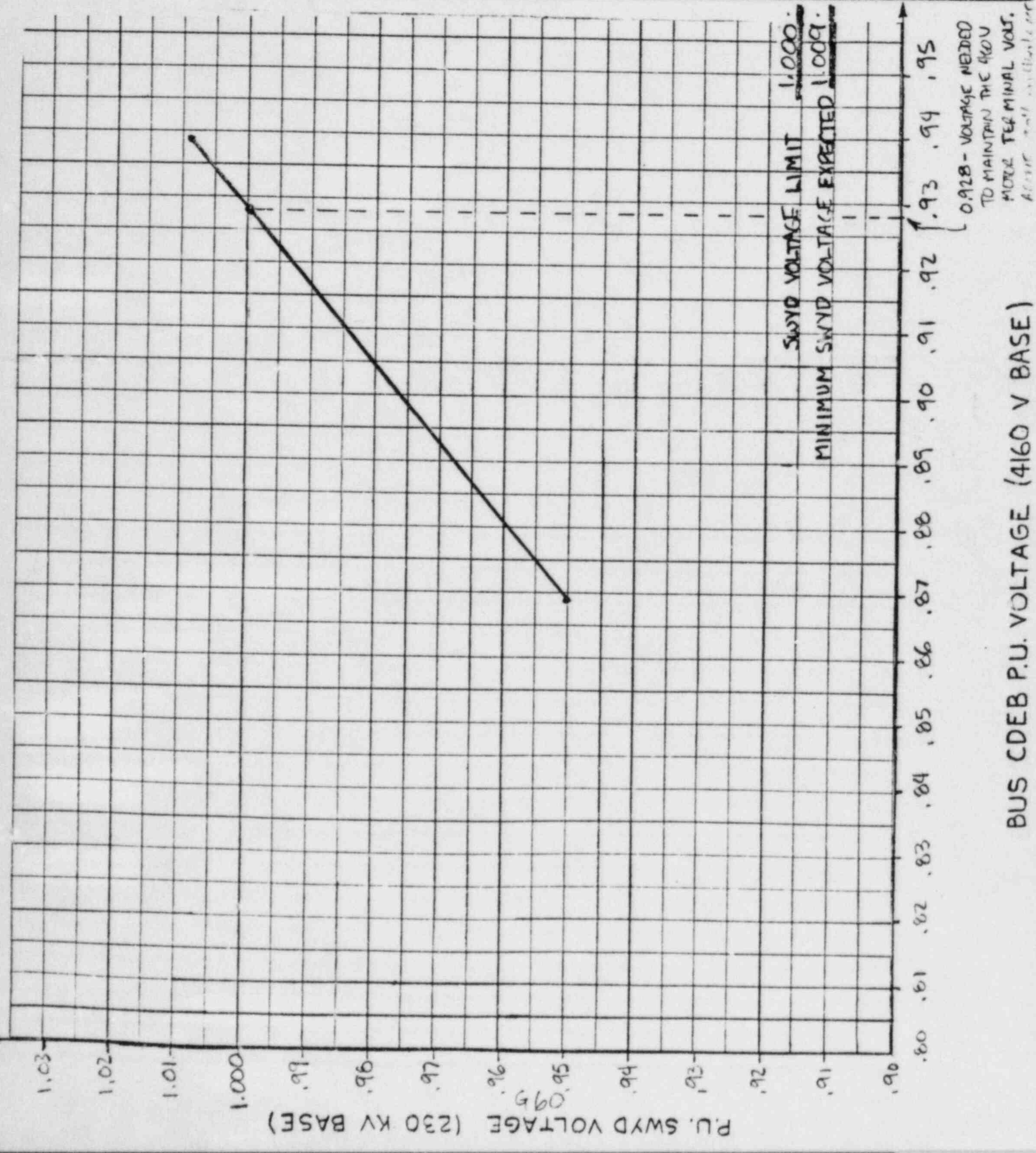
CDEB BUS VOLTAGE LIMIT = $0.8764(0.863) + 0.172 = \underline{0.928}$

Computed by: J.A. Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT-124-E-44 -F
Checked by: J.A. Kowalcheck Date: 4/13/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT1 - FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Coore	Date: 4/4/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-45-F	
Checked by: J.A. Kowalczek	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT2 - SHUTDOWN CONDITIONS				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE REQUIRED TO LIMIT THE 460 V MOTOR TERMINAL VOLTAGE TO 110% (460 V BASE)

SWYD VOLTAGE	4160 V BUS CDEB VOLTAGE	480 V MCC 2TE VOLTAGE
0.95	0.9548	0.9860
1.017	1.0250	1.0614

110% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 1.0542*

* ASSUME NO VOLTAGE DROP FROM MCC TO MOTOR TERMINALS

SWITCHYARD VOLTAGE: $Y_{1.017} - Y_{0.95} = m(X_{1.017} - X_{0.95})$

$1.017 - 0.95 = m(1.0614 - 0.9860)$ $\quad m = \frac{0.067}{0.0754} = 0.889$

$Y = mx + b$ @ 1.017 SWITCHYARD VOLTAGE:

$1.017 = 0.889(1.0614) + b \quad b = 0.073$

SWITCHYARD VOLTAGE LIMIT $= 0.889(1.0542) + 0.073 =$ <u>1.010</u>

4160 V BUS CDEB VOLTAGE: $Y_{1.025} - Y_{0.9548} = m(X_{1.025} - Y_{0.9548})$

$1.025 - 0.9548 = m(1.0614 - 0.9860)$ $\quad m = \frac{0.0702}{0.0754} = 0.931$

$Y = mx + b$ @ 1.025 CDEB VOLTAGE (0.996 SWITCHYARD VOLTAGE

$1.025 = 0.931(1.0614) + b \quad b = 0.037$

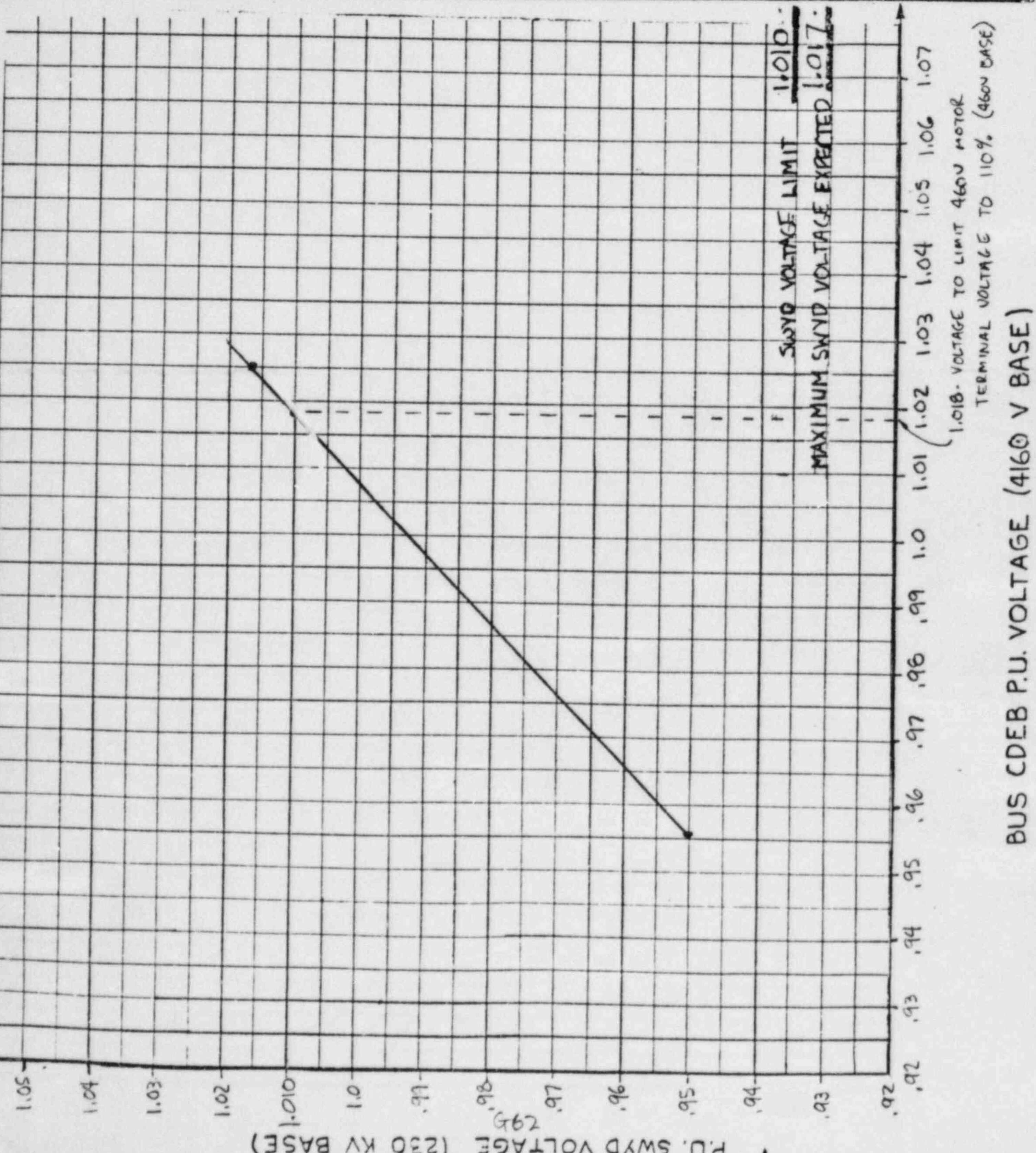
4160 V BUS CDEB VOLTAGE LIMIT $= 0.931(1.0542) + 0.037 =$ <u>1.018</u>

Computed by: J.A. Keane	Date: 4/4/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-45-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT2 - SHUTDOWN CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



G62

Computed by: JA Keane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-46-F	
Checked by: J.A. Kowalchegk	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT3 - 3RD CWP MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN THE 4000 V MOTOR TERMINAL VOLTAGE AT 85% (ON 4000 V BASE)

SWYD. VOLTAGE	4000 V CIRCULATING WATER PUMP MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.95	0.8095	0.7784
1.009	0.8751	0.8414

85% MOTOR TERMINAL VOLTAGE ON A 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$$1.009 - 0.95 = m(0.8414 - 0.7784)$$

$$m = \frac{0.059}{0.063} = 0.937$$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$$1.009 = 0.937(0.8414) + b$$

$$b = 0.221$$

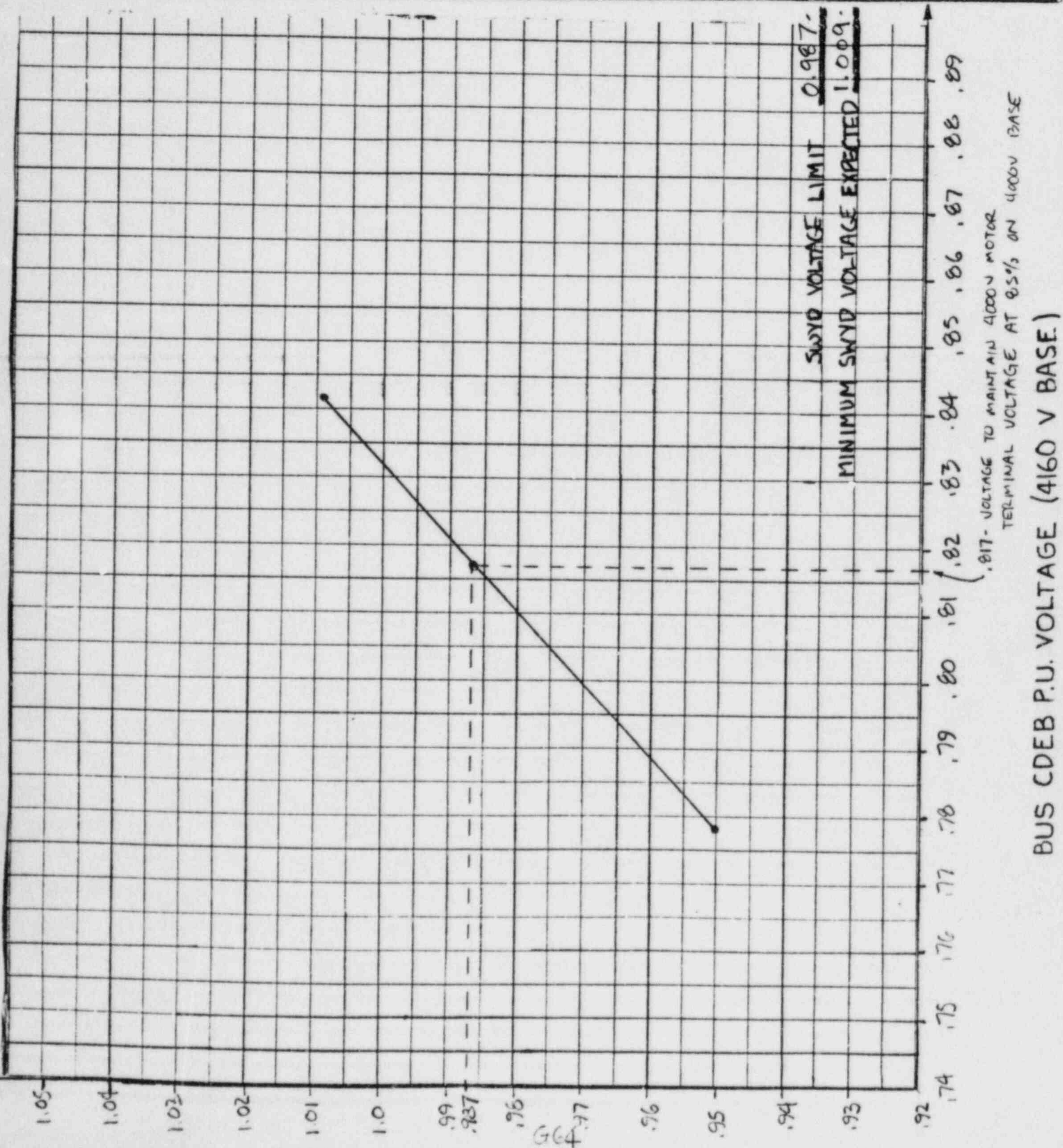
SWITCHYARD VOLTAGE LIMIT = $0.937(.817) + 0.221 =$ **0.987**

Computed by: JA Keane Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-46-F
Checked by: J.A. Kowalcheck Date: 5/1/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT3 - 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G64

Computed by: JA Keane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-47-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT4- 4TH CWP MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN THE 4000 V MOTOR TERMINAL VOLTAGE AT 85% (4000 V BASE)

SWYD VOLTAGE	4000 V CIRCULATING WATER PUMP MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.986	0.8408	0.8085
1.009	0.8666	0.8333

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$1.009 - 0.986 = m(0.8333 - 0.8085)$

$m = \frac{0.023}{0.0248} = 0.927$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE

$1.009 = 0.927(0.8333) + b$

$b = 0.237$

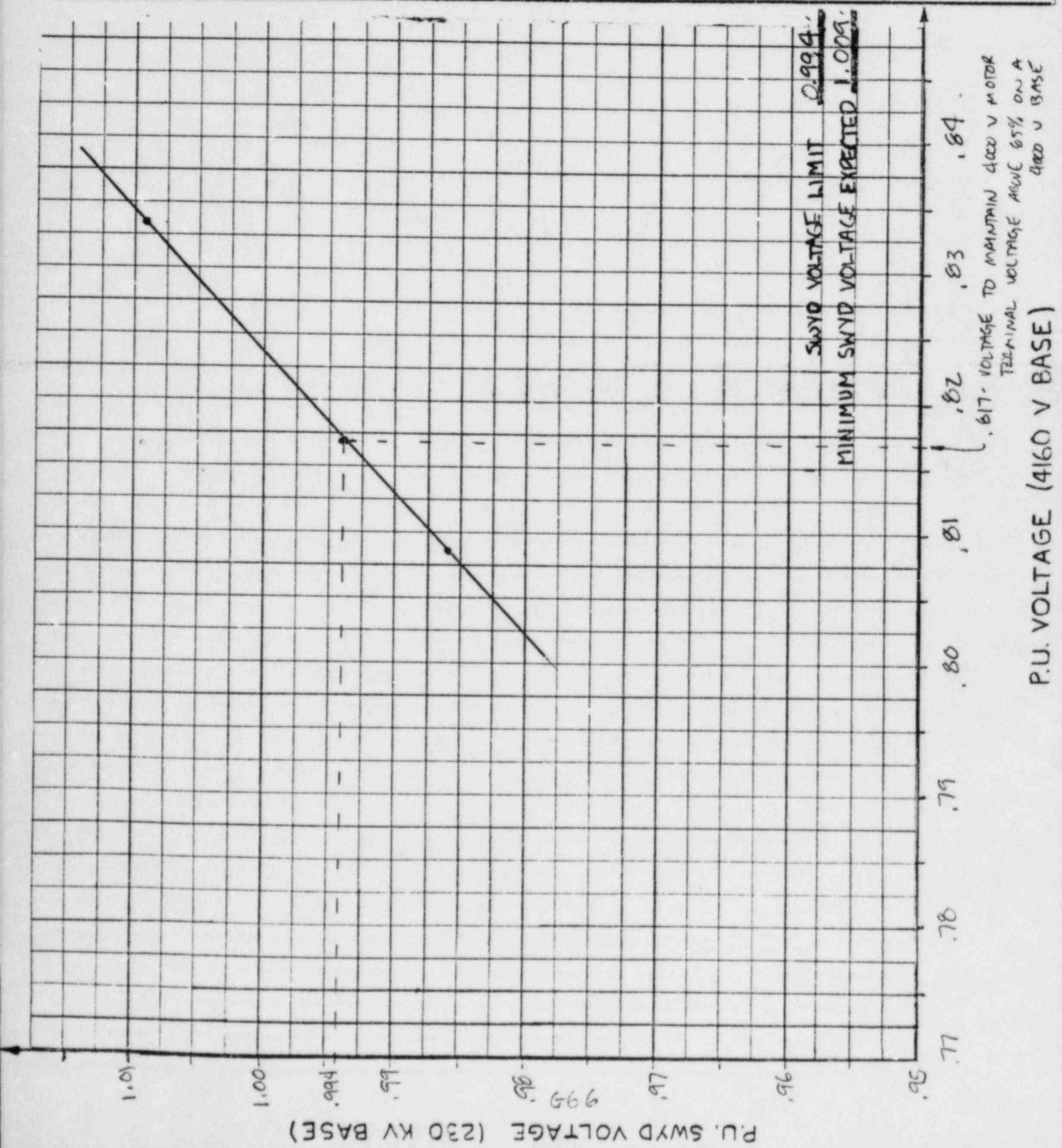
SWITCHYARD VOLTAGE LIMIT = $(0.927)(0.817) + 0.237$ **0.994**

Computed by: JA Cerne	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-47-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT4- 4TH CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-48-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT5- FUEL POOL CLEANING PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN 460 V MOTOR TERMINAL VOLTAGE AT 85% ON 460 V BASE

SWYD VOLTAGE	4160 V BUS CDEB VOLTAGE	460 V FUEL POOL CLEANING PUMP 2A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.95	0.8665	0.8365	0.8016
1.009	0.9365	0.9177	0.8795

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$1.009 - 0.95 = m(0.8795 - 0.8016)$ $m = \frac{0.059}{0.0779} = 0.757$

$Y = mX + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.757(0.8795) + b$ $b = 0.343$

SWITCHYARD VOLTAGE LIMIT = $(0.757)(0.815) + 0.343 = \underline{0.960}$

4160 V BUS CDEB VOLTAGE: $Y_{.9365} - Y_{0.8665} = m(X_{0.9365} - X_{0.8665})$

$0.9365 - 0.8665 = m(0.8795 - 0.8016)$ $m = \frac{0.0700}{0.0779} = 0.899$

$Y = mX + b$ @ 0.9365 CDEB VOLTAGE (1.009 SWITCHYARD VOLTAGE)

$0.9365 = 0.899(0.8795) + b$ $b = 0.146$

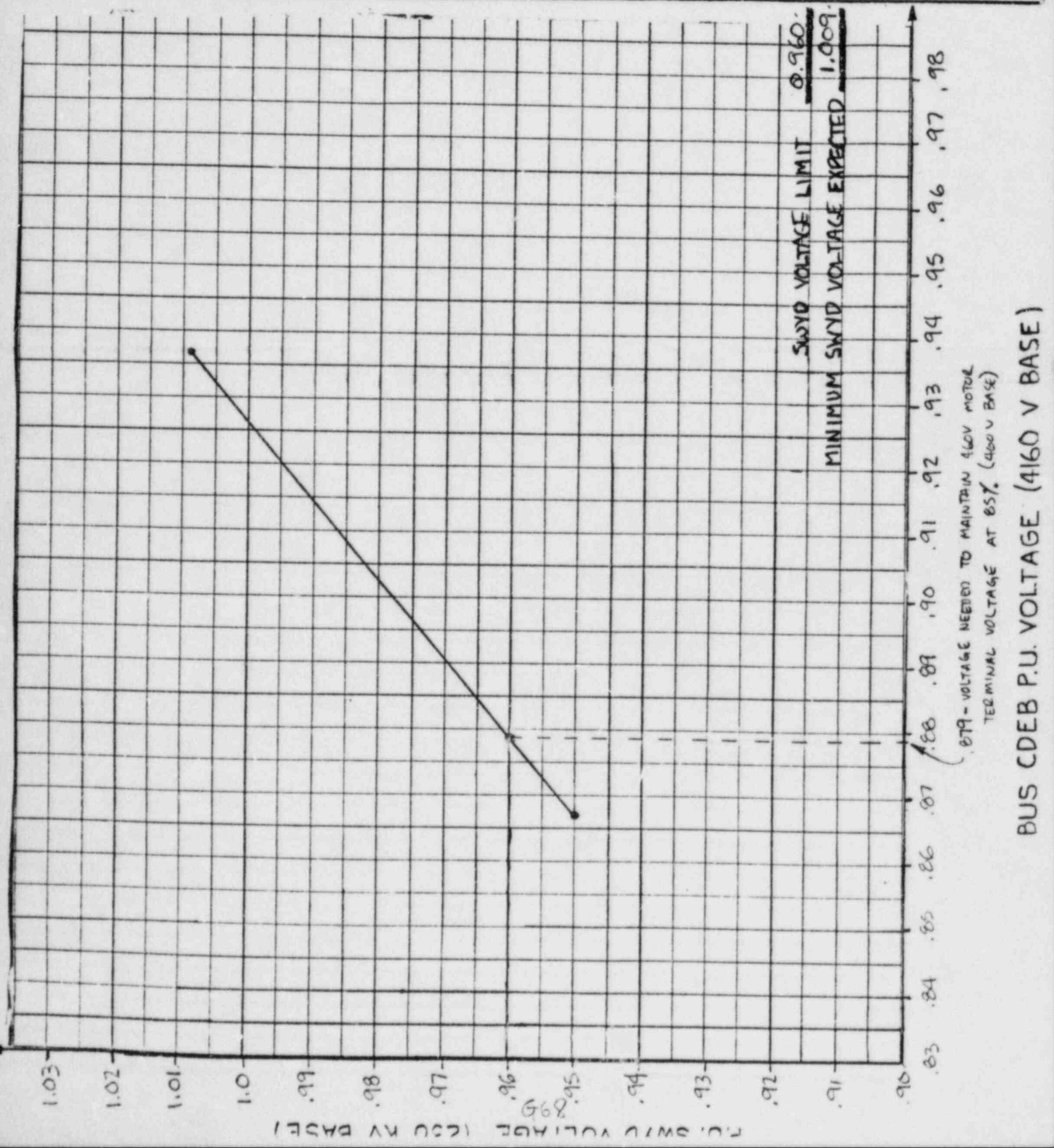
4160 V BUS CDEB VOLTAGE LIMIT = $0.899(0.815) + 0.146 = \underline{0.879}$

Computed by: JA Keane Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-48-F	
Checked by: J.A. Kowalchek 5/1/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SATS - FUEL POOL CLEANING PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Yeane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT 124-E-49-F	
Checked by: J.A. Kowalczeck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AW-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT6- FUEL POOL CLEANING PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN THE 460V MOTOR TERMINAL VOLTAGE AT 85% ON 460 V BASE

SWYD. VOLTAGE	4160 V BUS CDEB VOLTAGE	460 V FUEL POOL CLEANING PUMP 2B MOTOR TERMINAL VOLTAGE: 460 V BASE	480 V BASE
0.95	0.8666	0.8066	0.7730
1.009	0.9366	0.8870	0.8500

85% MOTOR TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$1.009 - 0.95 = m(0.8500 - 0.7730)$ $\quad m = \frac{0.059}{0.0770} = 0.766$

Y = mx + b @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.766(0.8500) + b$ $\quad b = 0.358$

SWITCHYARD VOLTAGE LIMIT = $(0.766)0.815 + 0.358 = \underline{0.982}$

4160 V BUS CDEB VOLTAGE: $Y_{0.9366} - Y_{0.8666} = m(X_{0.9366} - X_{0.8666})$

$0.9366 - 0.8666 = m(0.8500 - 0.7730)$ $\quad m = \frac{0.070}{0.0770} = 0.909$

Y = mx + b @ 0.9366 CDEB VOLTAGE (1.009 SWITCHYARD VOLTAGE)

$0.9366 = 0.909(0.8500) + b$ $\quad b = 0.164$

4160 V BUS CDEB VOLTAGE LIMIT = $0.909(0.815) + 0.164 = \underline{0.905}$

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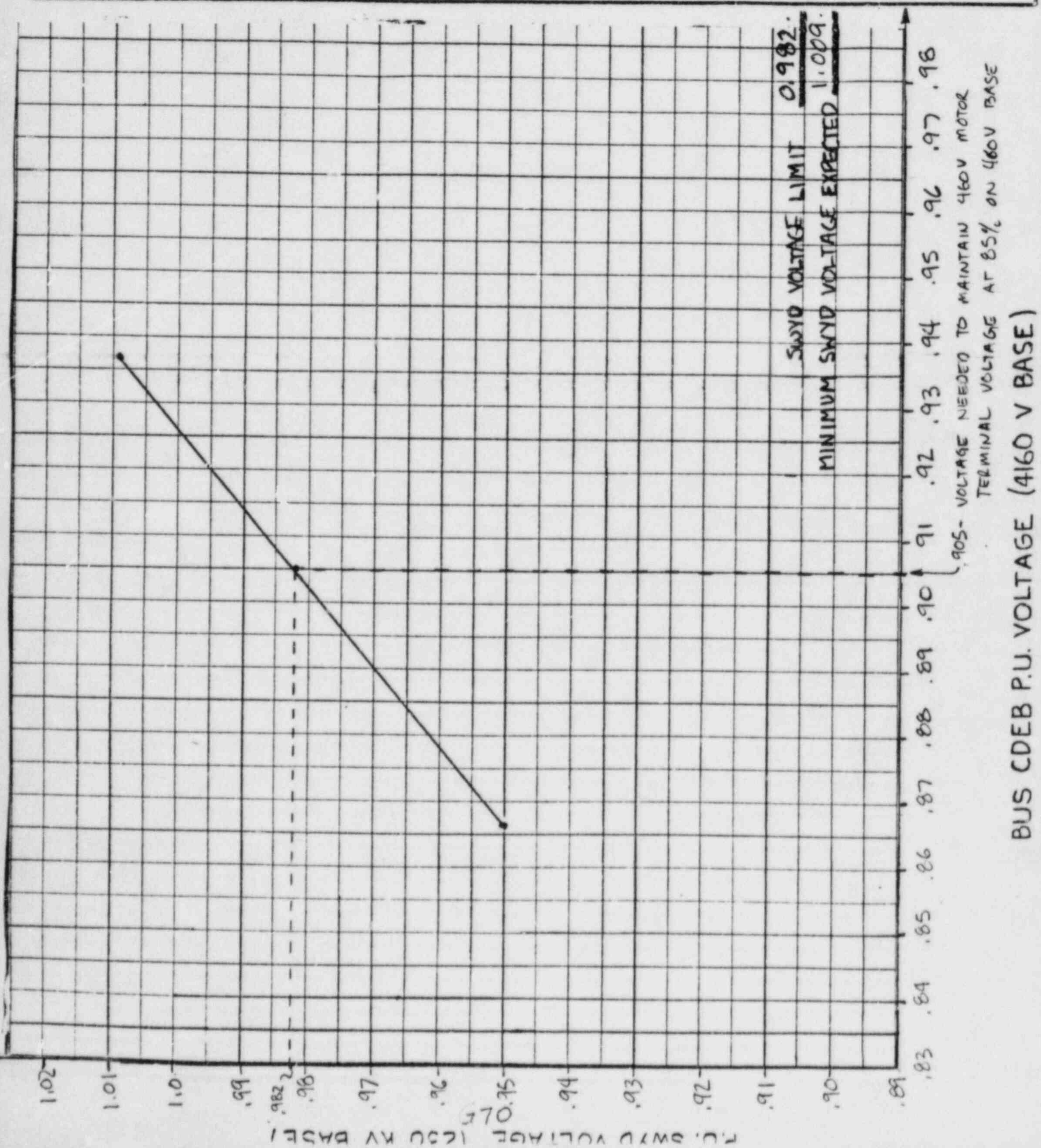
Computed by: JA Keane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-49-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AU-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT6- FUEL POOL CLEANING PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JAKeane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-50 -F	
Checked by: J.A.Kowalcheck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT7- REACTOR RECIRC PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE AT 85% ON 4000 V BASE

SWYD VOLTAGE	4000 V REACTOR RECIRC PUMP 2B MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.95	0.821	0.789
1.009	0.875	0.8412

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$1.009 - 0.95 = m(0.8412 - 0.789)$

$m = \frac{0.059}{0.0522} = 1.13$

$Y = mX + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 1.13(0.8412) + b$

$b = 0.058$

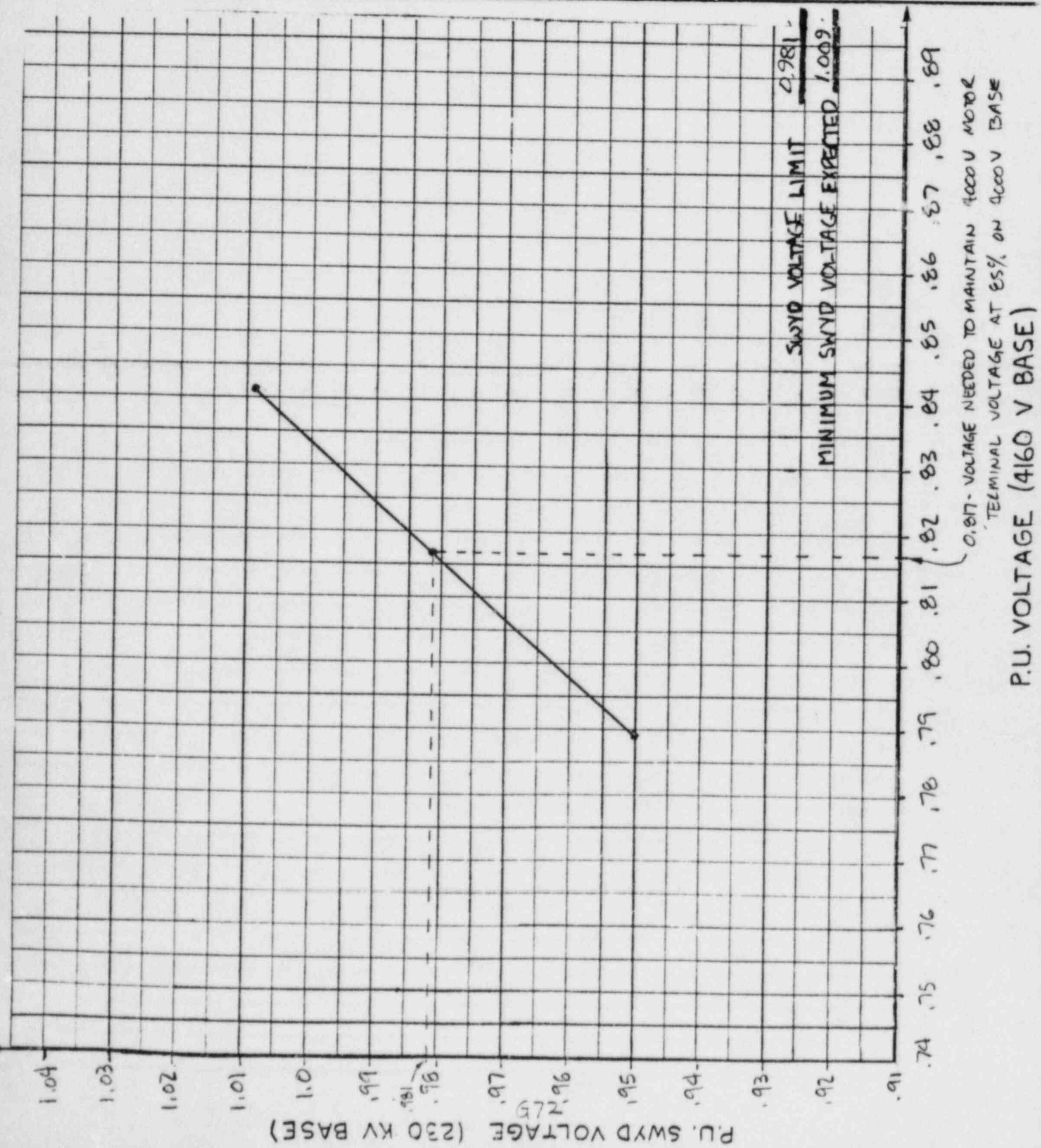
SWITCHYARD VOLTAGE LIMIT $= 1.13(0.817) + 0.058 = \underline{\underline{0.981}}$

Computed by: J.A. Keane	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-50-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT7- REACTOR RECIRC PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keene	Date: 4/5/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-51-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT8 - REACTOR BLDG. CLOSED COOLING WATER PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE AT 85% ON 460V BASE

SWYD VOLTAGE	4160 V BUS CDEB	REACTOR BLDG. CCW PUMP 2A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.95	0.8663	0.8211	0.7869
1.009	0.9363	0.8995	0.8620

85% TERMINAL VOLTAGE ON 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.95} = m(X_{1.009} - X_{0.95})$

$1.009 - 0.95 = m(0.8620 - 0.7869)$ $m = \frac{0.059}{0.0751} = 0.786$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.786(0.862) + b$ $b = 0.331$

SWITCHYARD VOLTAGE LIMIT = $0.786(0.815) + 0.331 = \underline{0.972}$

4160V BUS CDEB VOLTAGE: $Y_{0.9363} - Y_{0.8663} = m(0.8620 - 0.7869)$

$0.9363 - 0.8663 = m(0.862 - 0.7869)$ $m = \frac{0.070}{0.0751} = 0.932$

$Y = mx + b$ @ 0.9363 CDEB VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9363 = 0.932(0.862) + b$ $b = 0.133$

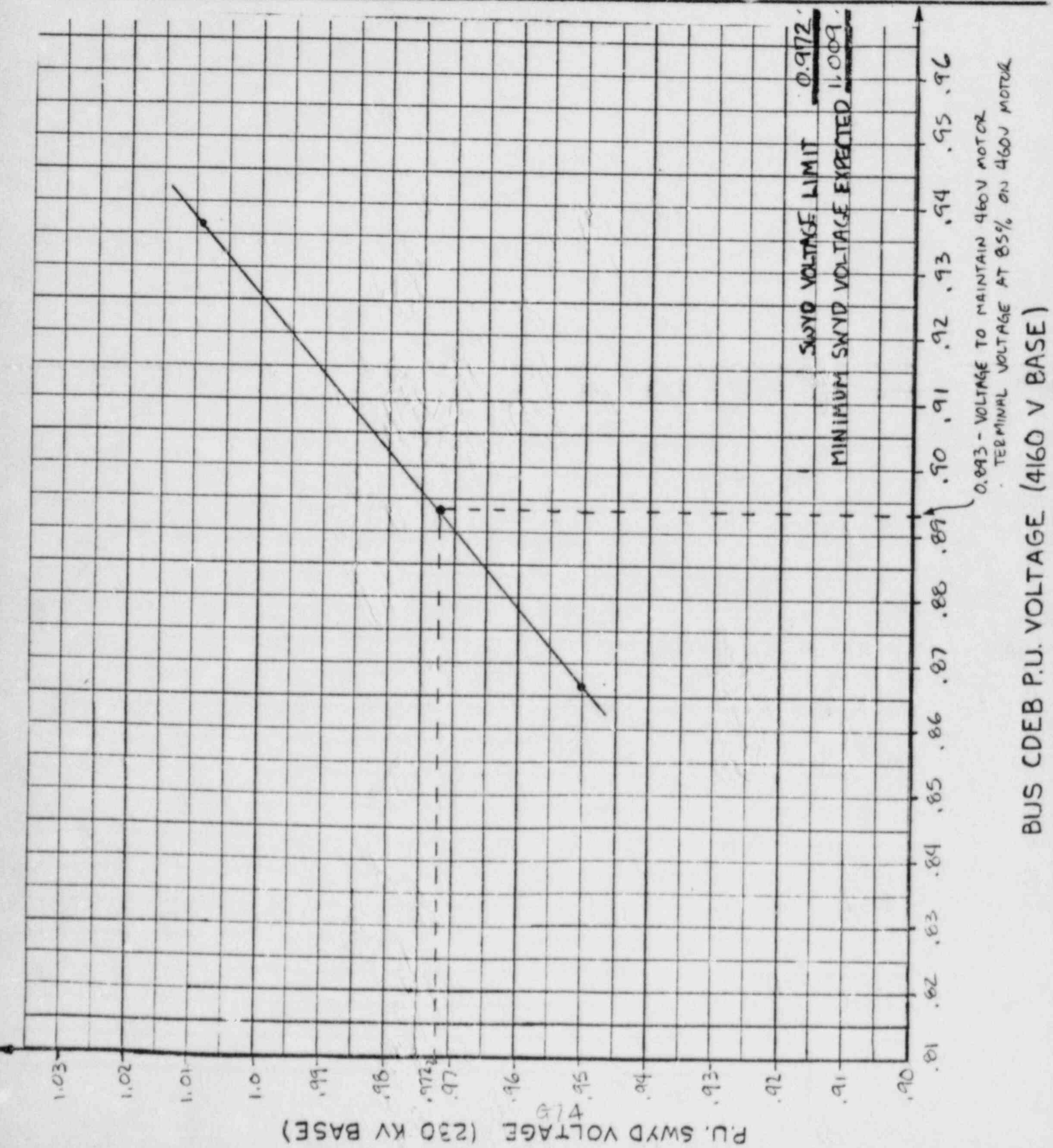
CDEB BUS VOLTAGE LIMIT = $0.932(0.815) + 0.133 = \underline{0.893}$

Computed by: J.A. Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT 124-E-51-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124		CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT8 - REACTOR BLDG. CLOSED COOLING WATER PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



674

Computed by: JA Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-52-F	
Checked by: J.A. Kowalcheck	Date: 5/1/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT9 - LOCA, BLOCK STARTING				
Status: Prelim. ☐ Final ☐ Void ☐				

LIMITING CONDITION: VOLTAGE NEEDED TO PREVENT 480 V CONTACTOR DROP-OUT AT MCC 2TM (0.70 ON 480 V BASE)

SWYD VOLTAGE	4160 V BUS CDEB VOLTAGE	480 V MCC 2TM VOLTAGE
0.965	0.7795	0.7409
1.00	0.8155	0.7773

SWITCHYARD VOLTAGE: $Y_{1.00} - Y_{0.965} = m(X_{1.00} - X_{0.965})$

$1.00 - 0.965 = m(0.7773 - 0.7409)$ $m = \frac{0.035}{0.0364} = 0.961$

$Y = mX + b$ @ 1.00 SWITCHYARD VOLTAGE:

$1.00 = 0.961(0.7773) + b$ $b = 0.253$

SWITCHYARD VOLTAGE LIMIT = $0.961(0.70) + 0.253 = \underline{0.926}$

4160V BUS CDEB VOLTAGE: $Y_{0.8155} - Y_{0.7795} = m(X_{0.8155} - X_{0.7795})$

$0.8155 - 0.7795 = m(0.7773 - 0.7409)$ $m = \frac{0.036}{0.0364} = 0.989$

$Y = mX + b$ @ 0.8155 CDEB VOLTAGE (1.00 SWITCHYARD VOLTAGE)

$0.8155 = 0.989(0.7773) + b$ $b = 0.047$

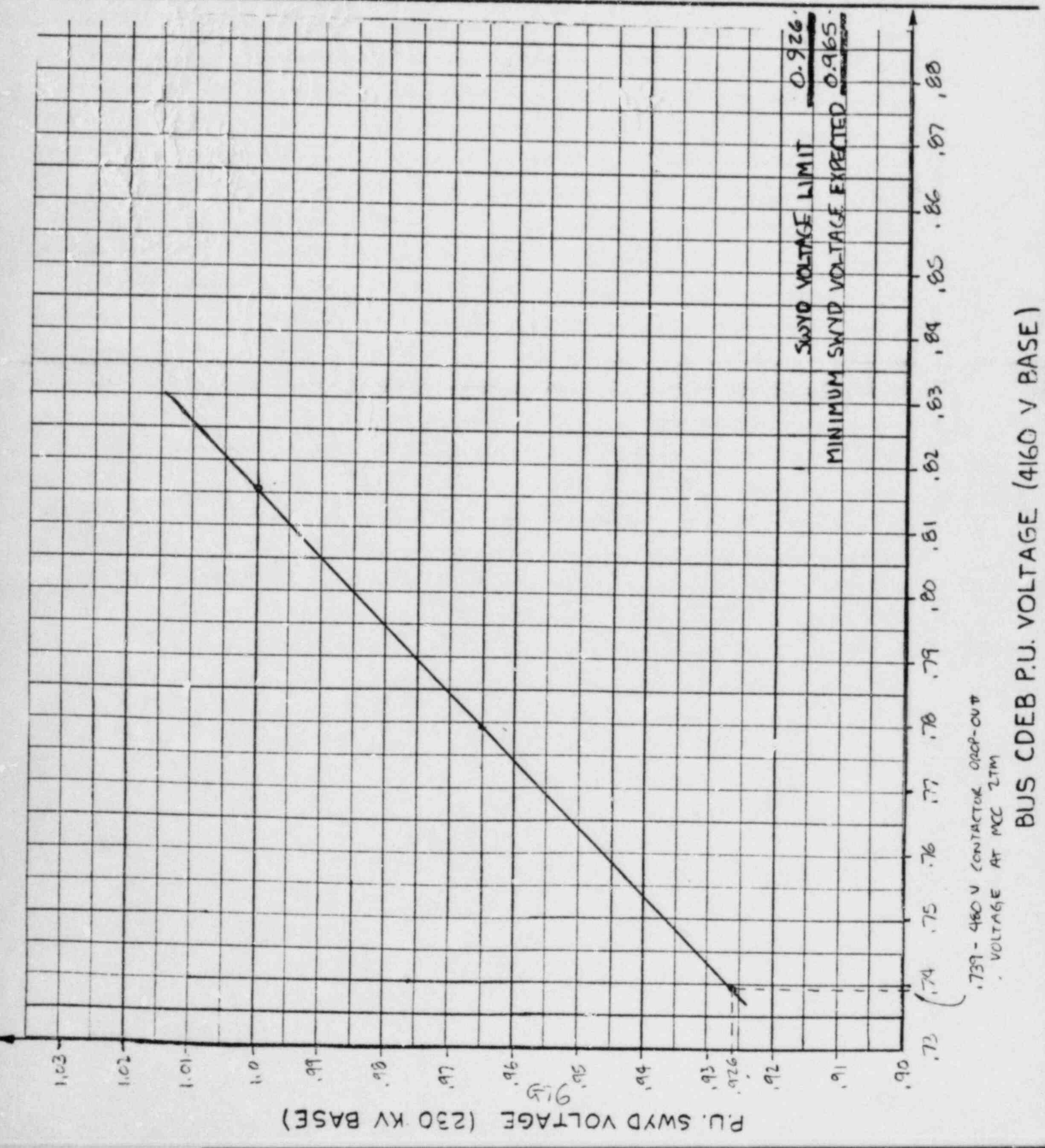
CDEB VOLTAGE LIMIT = $0.989(0.70) + 0.047 = \underline{0.739}$

Computed by: J.A. Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-52-F
Checked by: J.A. Kowalcheck Date: 5/1/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT9- LOCA, BLOCK STARTING

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT/24-E-53-F	
Checked by: J.A. Kowalcheck	Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT10A - LOCA, SEQ. START - START 2 RHR PUMPS; 2CSP'S OFF				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE TO PREVENT 480 V CONTACTOR DROP-OUT AT MCC 2TM (0.70 ON 480 V BASE)

SWYD. VOLTAGE	4160 V BUS COEB	480 V MCC 2TM
0.965	0.8469	0.8090
1.00	0.8849	0.8472

SWITCHYARD VOLTAGE: $Y_{1.00} - Y_{0.965} = m(X_{1.00} - X_{0.965})$

$1.00 - 0.965 = m(0.8472 - 0.8090)$ $\quad m = \frac{0.035}{0.0382} = 0.916$

$Y = mx + b$ @ 1.00 SWITCHYARD VOLTAGE:

$1.00 = 0.916(0.8472) + b$ $\quad b = 0.224$

SWITCHYARD VOLTAGE LIMIT $= 0.916(0.70) + 0.224 = \underline{0.865}$

4160 V BUS COEB VOLTAGE: $Y_{0.8849} - Y_{0.8469} = m(X_{0.8849} - X_{0.8469})$

$0.8849 - 0.8469 = m(0.8472 - 0.8090)$ $\quad m = \frac{0.038}{0.0382} = 0.995$

$Y = mx + b$ @ 0.8849 COEB VOLTAGE (1.00 SWITCHYARD VOLTAGE)

$0.8849 = 0.995(0.8472) + b$ $\quad b = 0.042$

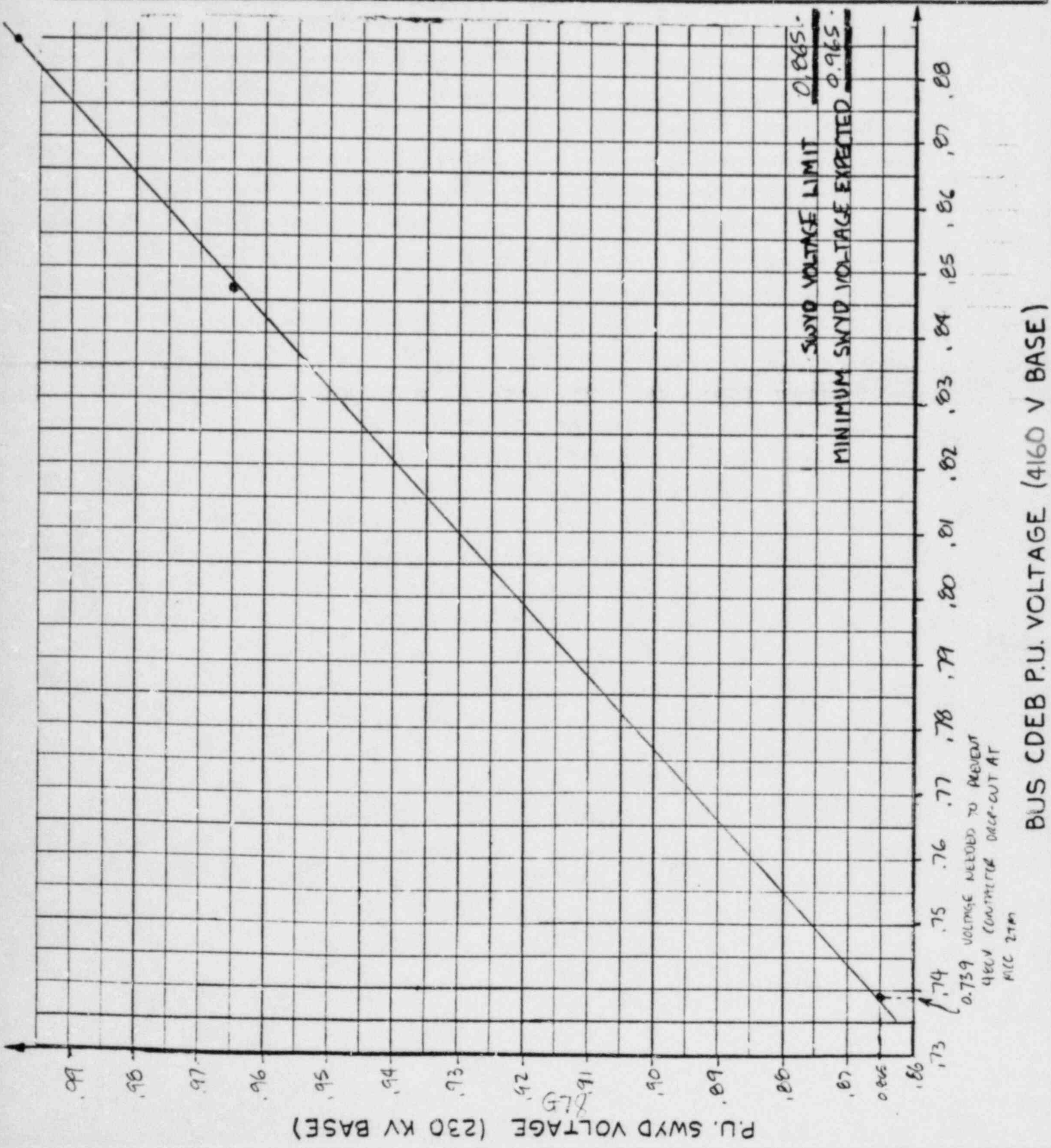
COEB VOLTAGE LIMIT $= 0.995(0.70) + 0.042 = \underline{0.739}$

Computed by: JAKeane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT-124-E-53-F	
Checked by: J.A. Kowalcheck Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT10A - LOCA, SEQ. START - START 2 RHR PUMPS; 2 CSI'S OFF

Status: Prelim. ☐ Final ☒ Void ☐



G78

Computed by: JA Keane	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-54-F	
Checked by: J.A. Kowalcheck	Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT10B - LOCA, SEQ. START - START 2 CSP'S; 2 RHRS RUNNING				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE NEEDED TO PREVENT 480 V CONTACTOR DROP-OUT AT MCC 2TM (0.70 ON 480 V BASE)

SWYD. VOLTAGE	4160 V BUS COEB VOLTAGE	480 V MCC 2TM VOLTAGE
0.965	0.8266	0.7885
1.00	0.8646	0.8268

SWITCHYARD VOLTAGE: $Y_{1.00} - Y_{0.965} = m(X_{1.0} - X_{0.965})$

$1.00 - 0.965 = m(0.8268 - 0.7885)$ $\qquad m = \frac{0.035}{0.0383} = 0.914$

$Y = mx + b$ @ 1.00 SWITCHYARD VOLTAGE:

$1.00 = 0.914(0.8268) + b$ $\qquad b = 0.244$

SWITCHYARD VOLTAGE LIMIT = $0.914(0.70) + 0.244 = \underline{0.884}$

4160 V BUS COEB VOLTAGE: $Y_{0.8646} - Y_{0.8266} = m(X_{0.8646} - X_{0.8266})$

$0.8646 - 0.8266 = m(0.8268 - 0.7885)$ $\qquad m = \frac{0.038}{0.0383} = 0.992$

$Y = mx + b$ @ 0.8646 COEB VOLTAGE (1.00 SWITCHYARD VOLTAGE):

$0.8646 = 0.992(0.8268) + b$ $\qquad b = 0.044$

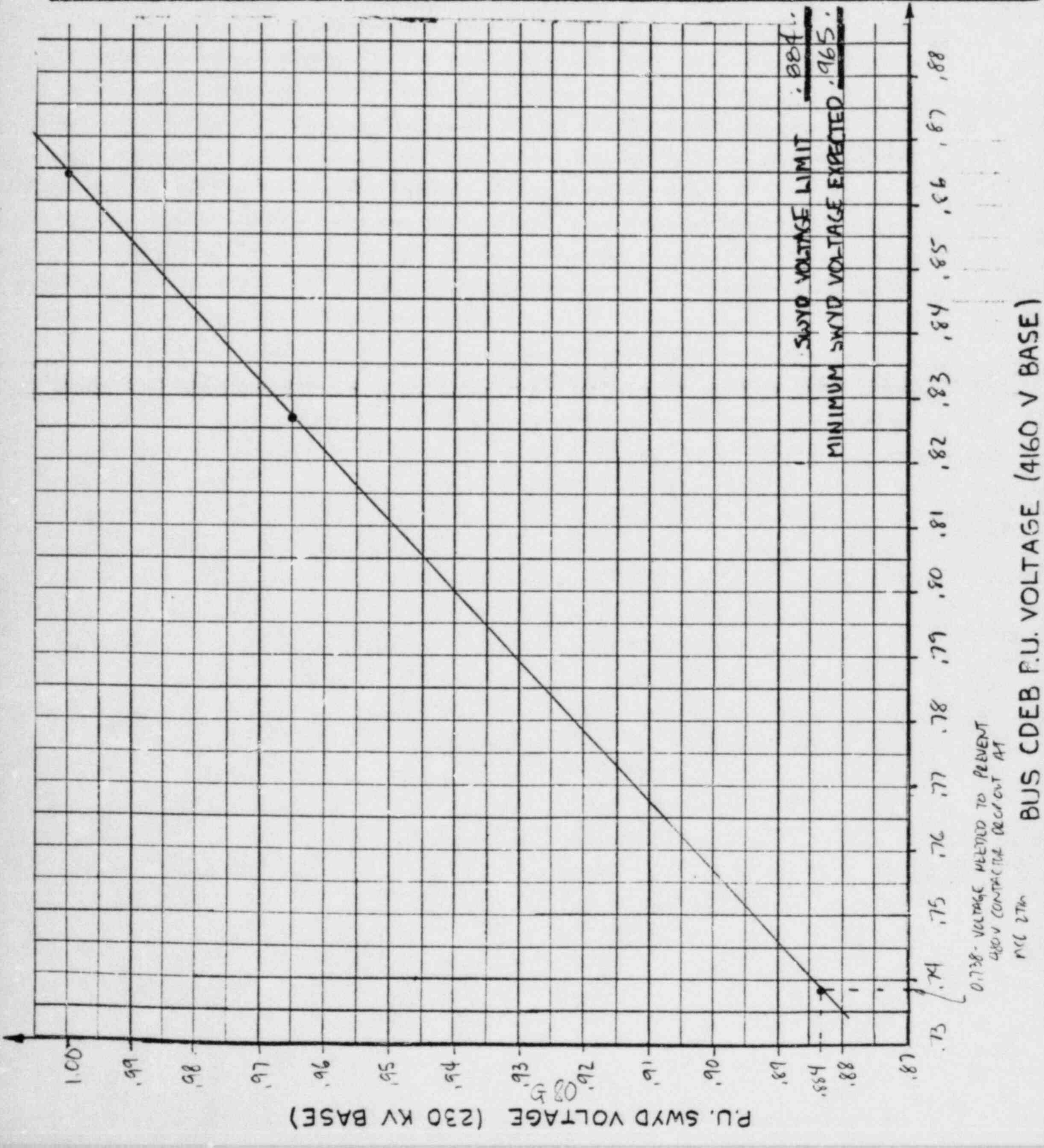
COEB VOLTAGE LIMIT = $0.992(0.70) + 0.044 = \underline{0.738}$

Computed by: DA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-54-F	
Checked by: J.A. Kowalchick Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT10B - LOCA, SEQ. START - START 2 CSP'S; 2 RHR PUMPS RUNNING

Status: Prelim. ☐ Final ☒ Void ☐



G80

Computed by: JA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-55-F	
Checked by: J.A. Kowalchek Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-ANS-543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SAT11- LOCA RUN			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 4160V BUS VOLTAGE ABOVE 89.5% 27DU RELAY SETTING

SWYD. VOLTAGE	4160V BUS COEB VOLTAGE
0.97	0.9011
0.991	0.9257

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$$0.991 - 0.97 = m(0.9257 - 0.9011)$$

$$m = \frac{0.021}{0.0246} = 0.854$$

$Y = mx + b$ @ 0.991 SWITCHYARD VOLTAGE:

$$0.991 = 0.854(0.9257) + b$$

$$b = 0.200$$

SWITCHYARD VOLTAGE LIMIT = $0.854(0.895) + 0.200 = \underline{0.964}$

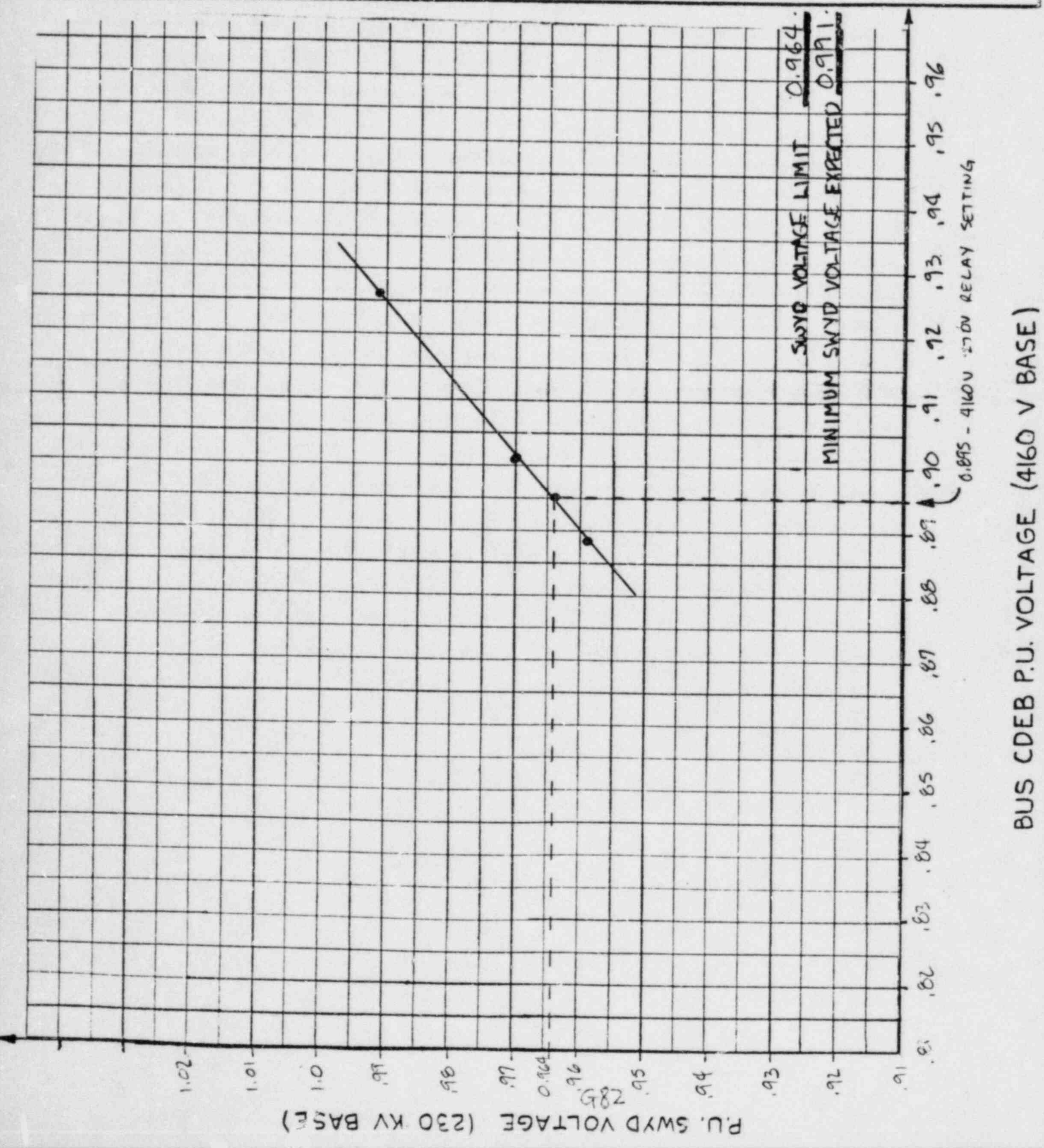
GS1

Computed by: J.A. Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT-124-E-55-F
Checked by: J.A. Kowalchick Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT11 - LOCA RUN

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-56-F	
Checked by: J.A. Kowalchek Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SAT:2 - LOCA RUN; START 3RD CWP MOTOR			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON 4000 V BASE

SWYD. VOLTAGE	4000 V CIRCULATING WATER PUMP 2B MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.97	0.8407	0.8084
0.991	0.8636	0.8304

85% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 0.817.

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$0.991 - 0.97 = m(0.8304 - 0.8084)$

$m = \frac{0.021}{0.022} = 0.954$

$Y = mX + b$ @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 0.954(0.8304) + b$

$b = 0.199$

SWITCHYARD VOLTAGE LIMIT = $0.954(0.817) + 0.199 = \underline{0.978}$

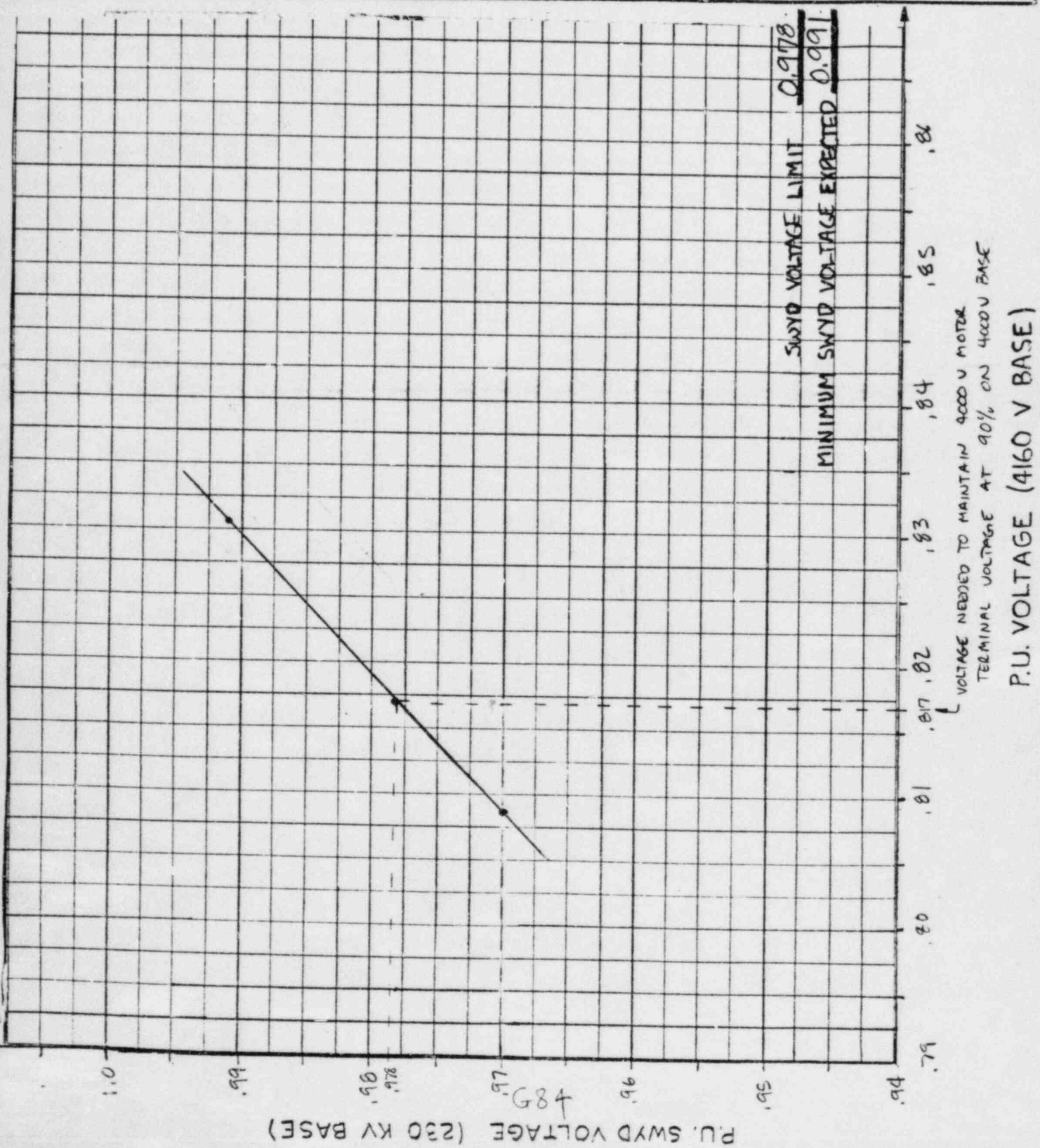
G83

Computed by: JA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-56-F
Checked by: J.A. Kowalczyk Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT12 - LOCA RUN; START 3RD CWP MOTOR

Status: Prelim. ☐ Final ☒ Void ☐



G84

Computed by: JA Veare Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-57-F	
Checked by: J.A. Kowalchek Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SAT13 - LOCA RUN; START 4TH CWP MOTOR			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE AT 85% ON 4000 V BASE

SWYD. VOLTAGE	4000 V CIRCULATING WATER PUMP 2B MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.978	0.8378	0.8056
0.991	0.8523	0.8195

85% TERMINAL VOLTAGE ON A 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.978} = m(X_{0.991} - X_{0.978})$

$0.991 - 0.978 = m(0.8195 - 0.8056)$

$m = \frac{0.013}{0.0139} = 0.935$

$Y = mx + b$ @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 0.935(0.8195) + b$

$b = 0.225$

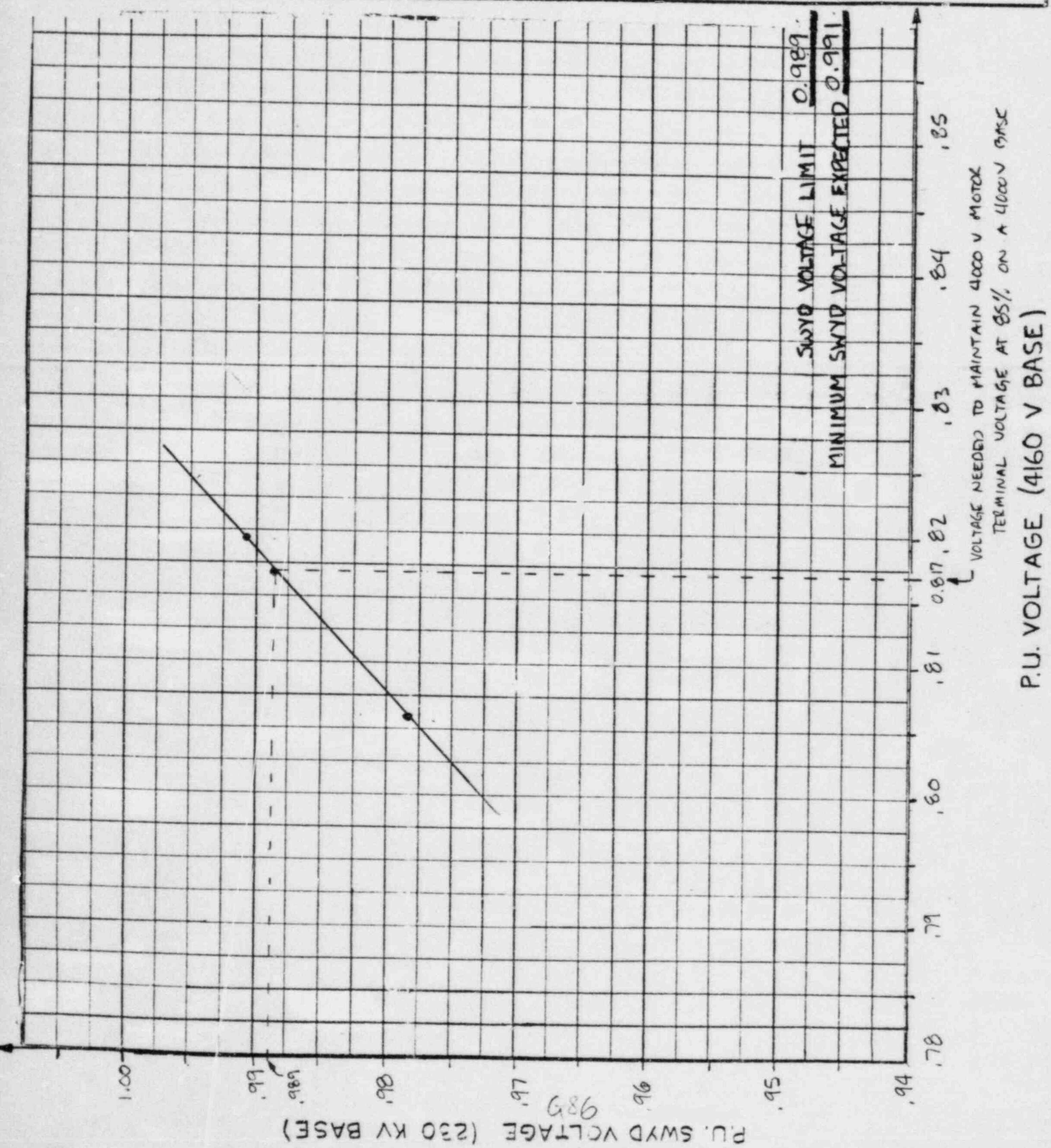
SWITCHYARD VOLTAGE LIMIT = $0.935(0.817) + 0.225 = \underline{0.989}$

Computed by: JA Veare Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-57-F
Checked by: J.A. Kowalcheck Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT13 · LOCA RUN; START 4TH CWP MOTOR

Status: Prelim. ☐ Final ☒ Void ☐



G86

Computed by: JA Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-58-F
Checked by: J.A. Kowalcheck	Date: 5/2/84		Pg. 1 of 2 — Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT14 - LOCA RUN; STATOR COOLANT PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON 460 V BASE

SWYD. VOLTAGE	4160 V BUS COEB VOLTAGE	460 V STATOR COOLANT PUMP 2B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8988	0.8843	0.8475
0.991	0.9232	0.9114	0.8734

85% TERMINAL VOLTAGE ON 480V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$0.991 - 0.97 = m(0.8734 - 0.8475)$ $\quad m = \frac{0.021}{0.0259} = 0.811$

Y = mx + b @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 0.811(0.8734) + b$ $\quad b = 0.283$

SWITCHYARD VOLTAGE LIMIT = 0.811(0.815) + 0.283 = **0.944**

4160 V BUS COEB VOLTAGE: $Y_{0.9232} - Y_{0.8988} = m(X_{0.9232} - X_{0.8988})$

$0.9232 - 0.8988 = m(0.8734 - 0.8475)$ $\quad m = \frac{0.0244}{0.0259} = 0.942$

Y = mx + b @ 0.9232 COEB VOLTAGE (0.991 SWITCHYARD VOLTAGE):

$0.9232 = 0.942(0.8734) + b$ $\quad b = 0.100$

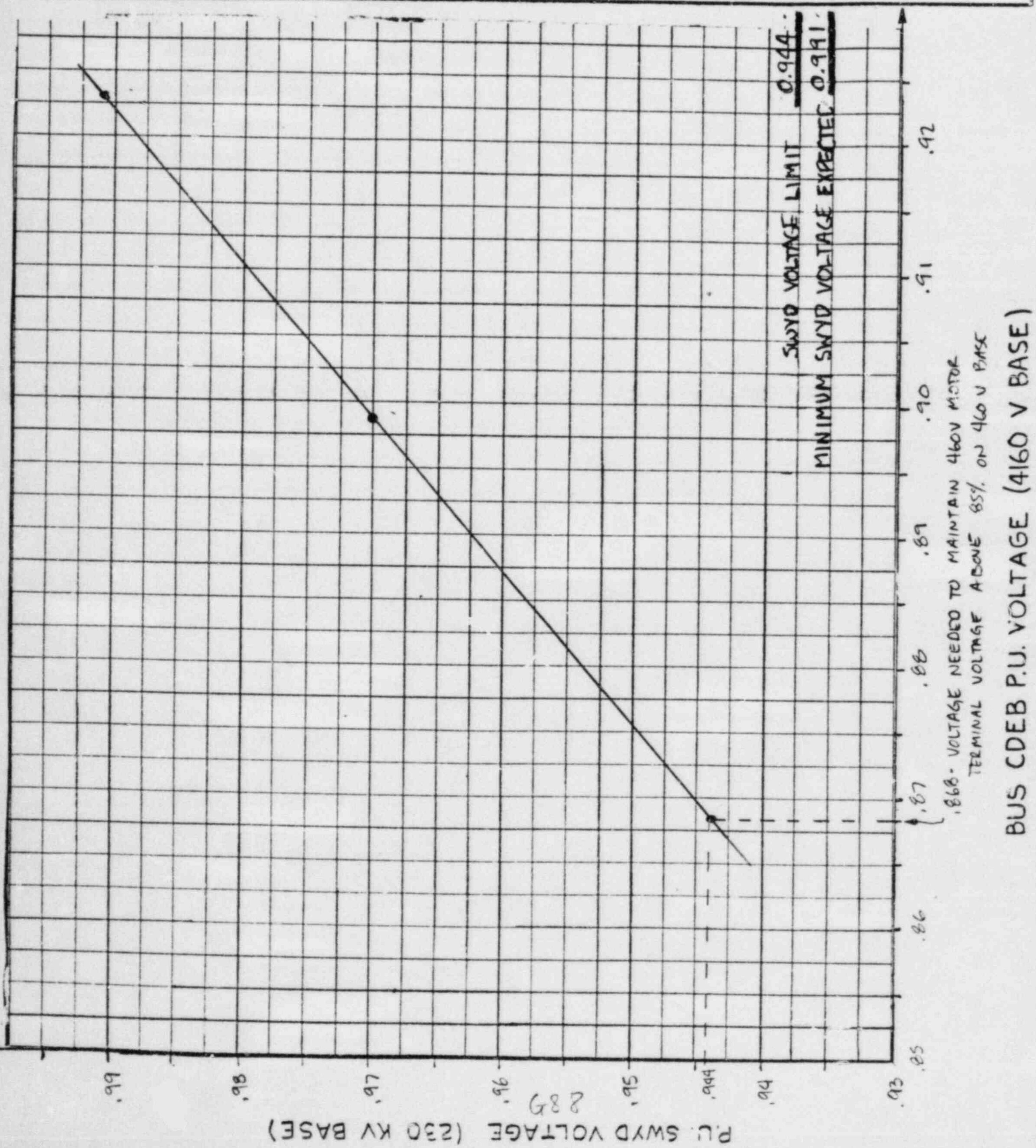
COEB BUS VOLTAGE LIMIT = 0.942(0.815) + 0.100 = **0.868**

Computed by: JA Keene Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-58-F
Checked by: J.A. Kowalcheck Date: 5/2/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT14 - LOCA RUN; STATOR COOLANT PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-59-F	
Checked by: J.A. Kovalchick Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SATIS-LOCA RUN; FPCP-2B MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON 460 V BASE

SWYD. VOLTAGE	4160 V BUS COEB VOLTAGE	460 V FUEL POOL CLEANING PUMP 2B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8992	0.8837	0.8469
0.991	0.9237	0.9103	0.8724

85% MOTOR TERMINAL VOLTAGE ON A 480V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$0.991 - 0.97 = m(0.8724 - 0.8469)$ $m = \frac{0.021}{0.0255} = 0.823$

$Y = mx + b$ @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 0.823(0.8724) + b$ $b = 0.273$

SWITCHYARD VOLTAGE LIMIT = $0.823(0.815) + 0.273 =$ <u>0.944</u>

4160 V BUS COEB VOLTAGE: $Y_{0.9237} - Y_{0.8992} = m(X_{0.9237} - X_{0.8992})$

$0.9237 - 0.8992 = m(0.8724 - 0.8469)$ $m = \frac{0.0245}{0.0255} = 0.961$

$Y = mx + b$ @ 0.9237 COEB VOLTAGE (0.991 SWITCHYARD VOLTAGE)

$0.9237 = 0.961(0.8724) + b$ $b = 0.085$

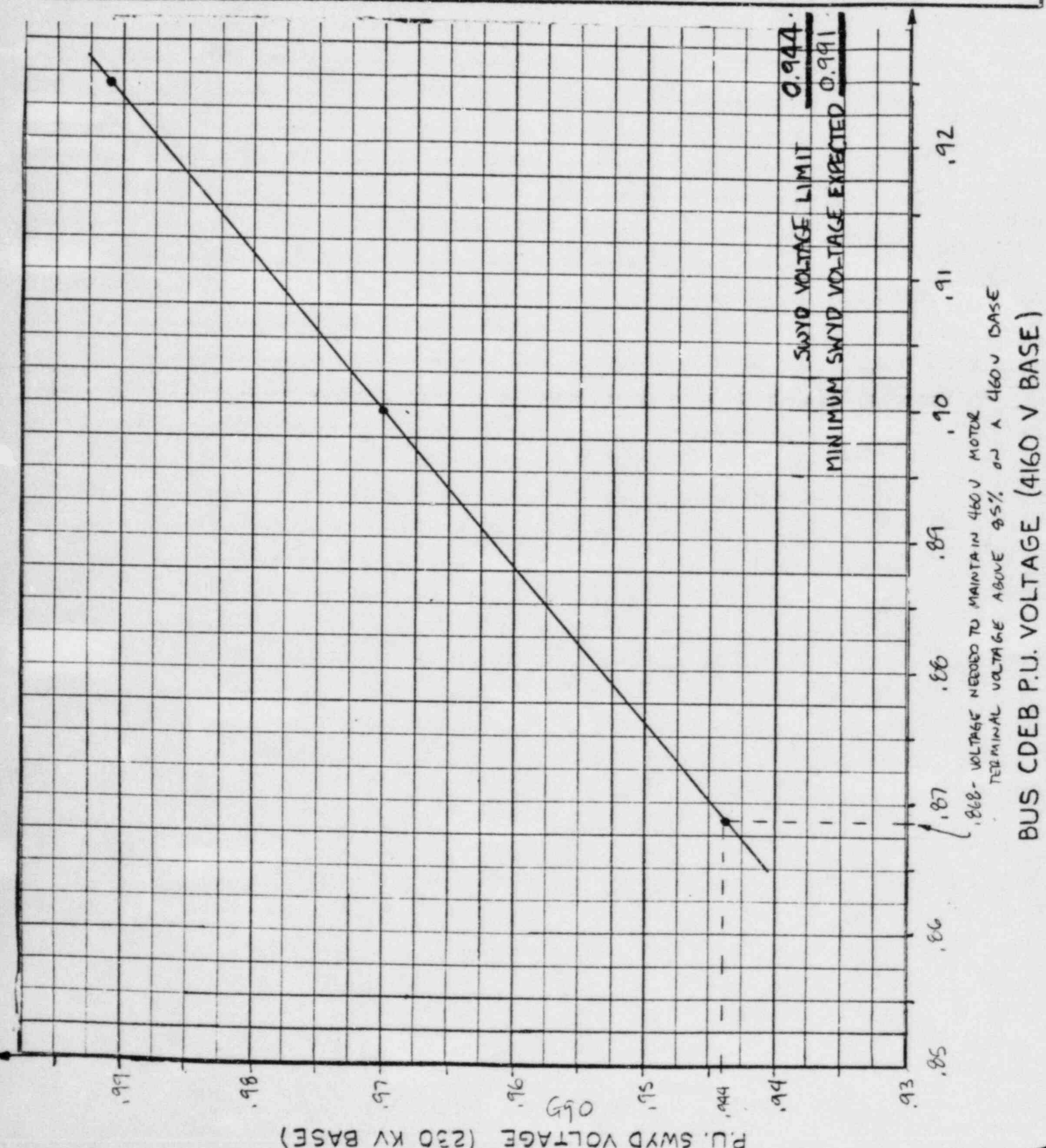
COEB BUS VOLTAGE LIMIT = $0.961(0.815) + 0.085 =$ <u>0.868</u>

Computed by: JA Keane	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-59-F	
Checked by: J.A. Kowalcheck	Date: 5/2/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SATIS- LOCA RUN; FPCP-2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: J A Kasse	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-60-F	
Checked by: J.A. Kowalcheck	Date: 5/2/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: NT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2SAT16- LOCA RUN; FPCP 2A MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 460 V BASE

SWYD. VOLTAGE	4160 V BUS COEB VOLTAGE	460 V FUEL POOL CLEANING PUMP 2A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8991	0.9054	0.8677
0.991	0.9236	0.9327	0.8938

85% TERMINAL VOLTAGE ON A 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$0.991 - 0.97 = m(0.8938 - 0.8677)$ $\quad m = \frac{0.021}{0.0261} = 0.805$

$Y = mx + b$ @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 0.805(0.8938) + b$ $\quad b = 0.271$

SWITCHYARD VOLTAGE LIMIT = $0.805(0.815) + 0.271 = \underline{\underline{0.927}}$

4160 V BUS COEB VOLTAGE: $Y_{0.9236} - Y_{0.8991} = m(X_{0.9236} - X_{0.8991})$

$0.9236 - 0.8991 = m(0.8938 - 0.8677)$ $\quad m = \frac{0.0245}{0.0261} = 0.939$

$Y = mx + b$ @ 0.9236 COEB VOLTAGE (0.991 SWITCHYARD VOLTAGE)

$0.9236 = 0.939(0.8938) + b$ $\quad b = 0.084$

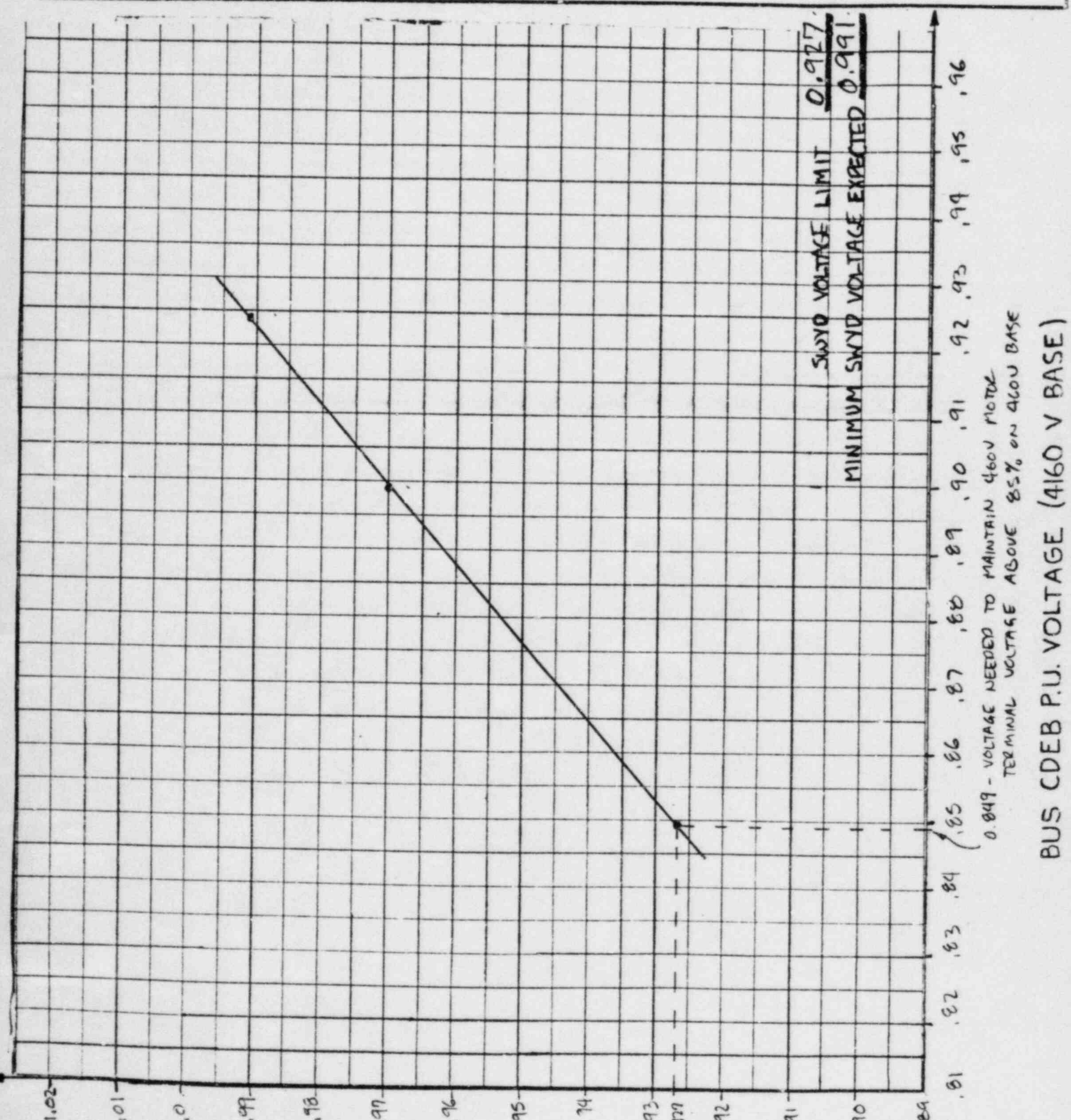
COEB BUS VOLTAGE LIMIT = $0.939(0.815) + 0.084 = \underline{\underline{0.849}}$

Computed by: JA Keane Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-60-F	
Checked by: J.A. Kowalcheck Date: 5/2/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AM-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT16- LOCA RUN; FPCP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G92

Computed by: JAYanne Date: 5/14/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-61-F	
Checked by: J.A. Kowalcheck Date: 5/25/84		Pg. 1 of 4	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SAT17- LOCA RUN; START TBCCW PUMP 2B MOTOR			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN TBCCW PUMP 2B MOTOR TERMINAL VOLTAGE ABOVE 85% STARTING VOLTAGE (460 V BASE)

SWYD. VOLTAGE	4160 V BUS CDEB VOLTAGE	TURBINE BLDG. CLOSED COOL. WTR. PUMP MOTOR TERMINAL VOLT. 460 V BASE	460 V BASE
0.97	0.8962	0.7616	0.7299
0.991	0.9206	0.7828	0.7502

85% MOTOR TERMINAL VOLTAGE ON 460 V BASE = 0.815

<u>SWITCHYARD VOLTAGE</u>: $Y_{0.991} - Y_{0.97} = m(X_{0.991} - X_{0.97})$

$0.991 - 0.97 = m(0.7502 - 0.7299)$ $m = \frac{0.021}{0.0203} = 1.035$

$Y = mX + b$ @ 0.991 SWITCHYARD VOLTAGE:

$0.991 = 1.035(0.7502) + b$ $b = 0.215$

SWITCHYARD VOLTAGE LIMIT = $1.035(0.815) + 0.215 = \underline{1.059}$

<u>4160 V BUS CDEA VOLTAGE:</u> $Y_{0.9206} - Y_{0.8962} = m(X_{0.9206} - X_{0.8962})$

$0.9206 - 0.8962 = m(0.7502 - 0.7299)$ $m = \frac{0.0244}{0.0203} = 1.202$

$Y = mX + b$ @ 0.9206 CDEA VOLTAGE (0.991 SWITCHYARD VOLTAGE):

$0.9206 = 1.202(0.7502) - b$ $b = 0.019$

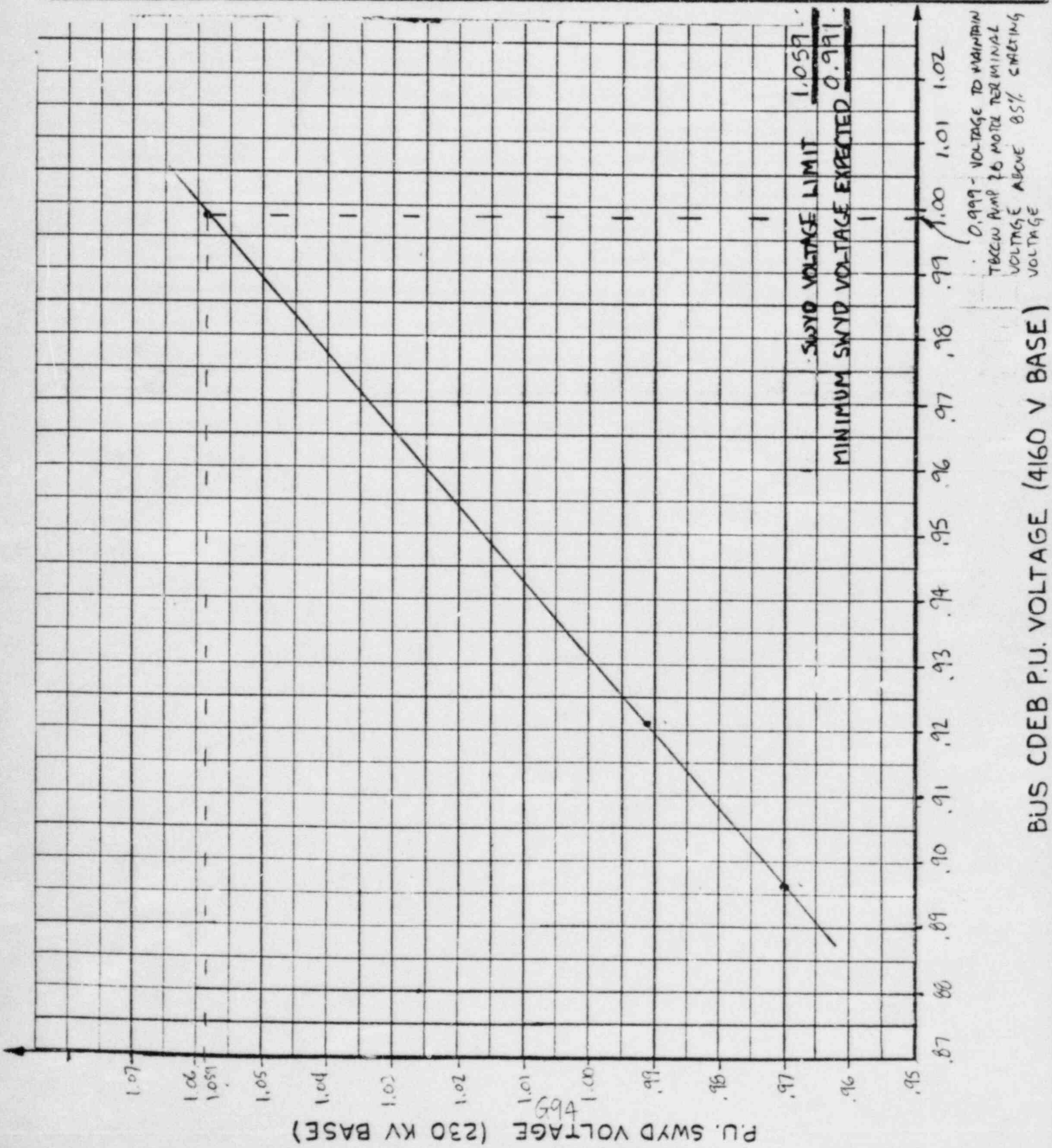
CDEA BUS VOLTAGE LIMIT = $1.202(0.815) + 0.019 = \underline{0.999}$

Computed by: JA Keene Date: 5/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-61-F	
Checked by: J.A. Kowalczewski Date: 5/25/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 4	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT17- LOCA RUN; TBCCW PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G94

Computed by: W K Russell Date: 4/6/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-61-F	
Checked by: J.A. Kowalcheck Date: 5/2/84		Pg. 3 of 4	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2SAT17 TBCCW-2B PUMP MOTOR START @ LOCA RUN			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION

VOLTAGE TO PREVENT CONTACTOR DROP OUT AT MCC 2TM (0.70 ON 480V BASE)

SWYD VOLTAGE	4160V BUS VOLTAGE	MCC 2TM VOLTAGE
0.970	0.8962	0.7593
0.991	0.9206	0.7804

SWYD VOLTAGE $Y_{0.991} - Y_{0.970} = m(X_{0.991} - X_{0.970})$

$0.991 - 0.970 = m(0.7804 - 0.7593)$

$m = 0.995$

$y = mx + b$ @ 0.991 SWYD VOLTAGE

$0.991 = (0.995)(0.7804) + b$

$b = 0.215$

SWYD VOLTAGE LIMIT $(0.995)(0.70) + 0.215 = \underline{0.912}$

4160V BUS VOLTAGE $Y_{0.9206} - Y_{0.8962} = m(X_{0.9206} - X_{0.8962})$

$0.9206 - 0.8962 = m(0.7804 - 0.7593)$

$m = 1.156$ $y = mx + b \Rightarrow 0.9206 = (1.156)(0.7804) + b$

$b = 0.0185$

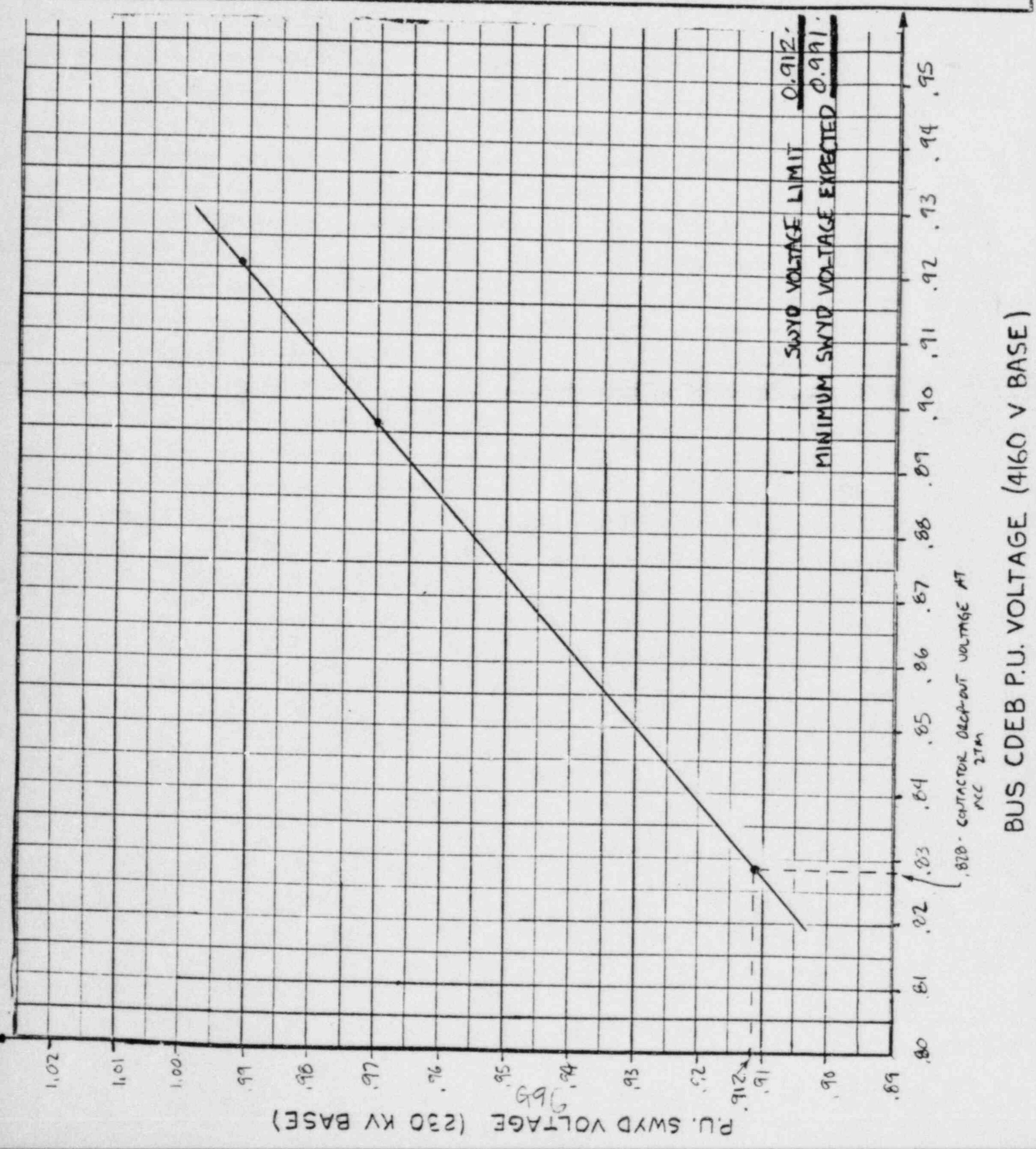
4160V BUS VOLTAGE LIMIT $(1.156)(0.70) + 0.0185 = \underline{0.828}$

Computed by: JACene	Date: 4/10/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-61-F	
Checked by: J.A. KOWALCHECK	Date: 5/2/84		Pg. 4 of 4	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2SAT17 - LOCA RUN; START TBCCW PUMP 2A

Status: Prelim. ☐ Final ☒ Void ☐



G96

Computed by: H.Q. Nguyen Date: 6-1-84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-62-F	
Checked by: J.A. Kowalcheck Date: 6-1-84		Pg. 1 of 2	Rev. 1
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP - Elec. Dist. Syst. study

Calculation Title: 2SAT18 - Screen wash pump 2B Motor start

Status: Prelim. ☐ Final ☒ Void ☐

limiting condition: Maintain SWP-2B motor terminal voltage above 85% starting voltage (460V base)

SWYD VOLTAGE	4160V BUS CDEB VOLTAGE	SCREEN WASH PUMP 2B MOTOR 460V BASE	TERMINAL VOLTAGE 480V BASE
0.970	0.8875	0.7573	0.7257
1.009	0.9332	0.7995	0.7662

85% MOTOR TERMINAL VOLTAGE ON 480V BASE = 0.815

SWYD VOLTAGE: $Y_{1.009} - Y_{0.970} = M(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = M(0.7662 - 0.7257) \Rightarrow M = 0.963$

$Y = MX + b$ @ 1.009 SWYD voltage

$1.009 = 0.963(0.7662) + b \Rightarrow b = 0.271$

SWYD voltage limit $= 0.963(0.815) + 0.271 = \underline{1.056}$

4160V BUS CDEB voltage: $Y_{0.9333} - Y_{0.8875} = M(X_{0.9333} - X_{0.8875})$

$0.9332 - 0.8875 = M(0.7662 - 0.7257) \Rightarrow M = 1.128$

$Y = MX + b$ @ 0.9332 CDEB voltage (1.009 SWYD voltage)

$0.9332 = 1.128(0.7662) + b \Rightarrow b = 0.069$

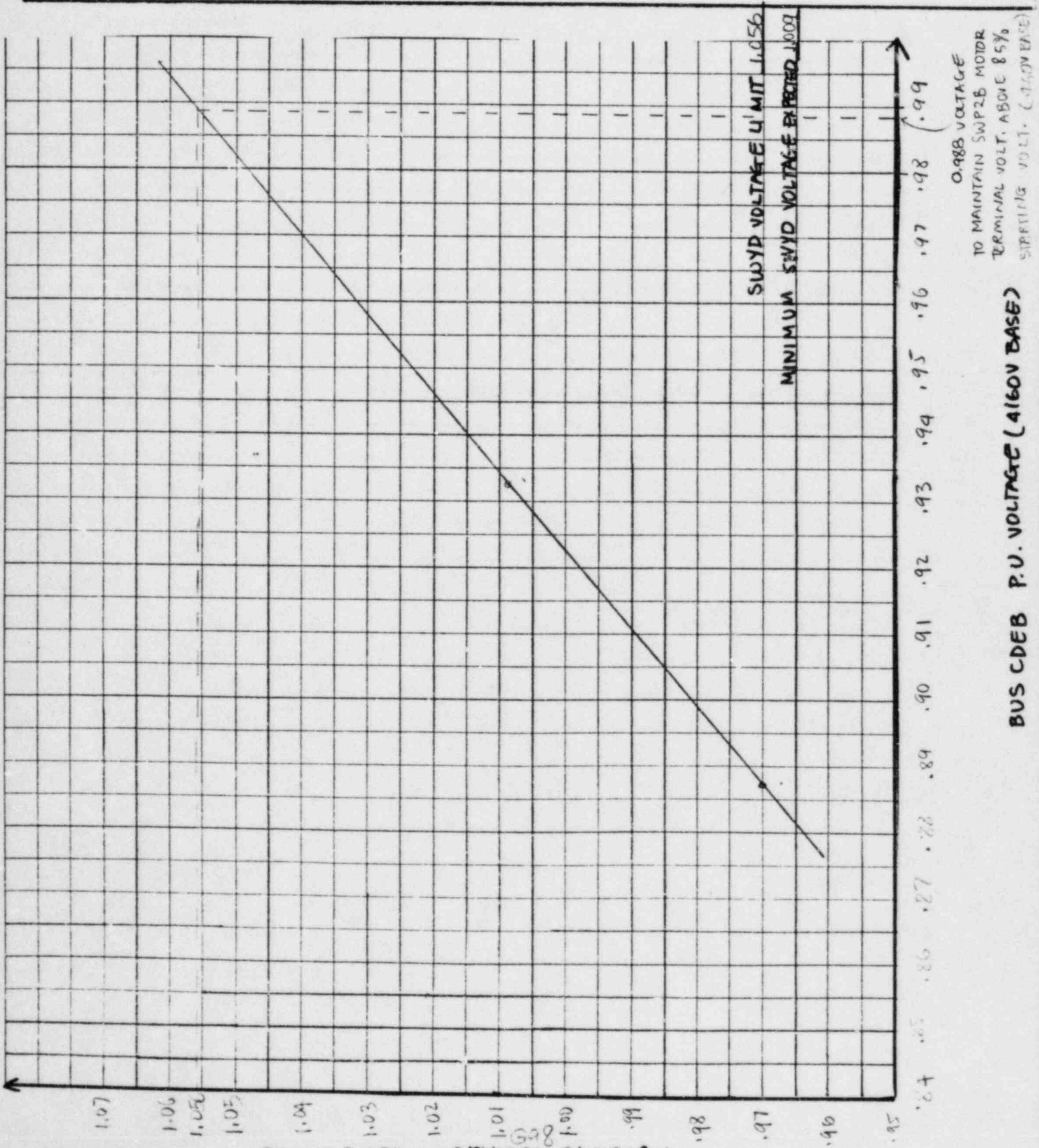
CDEB voltage limit $= 1.128(0.815) + 0.069 = \underline{0.988}$

Computed by: Ha Nguyen Date: 6-1-84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NTR4-E-62-F
Checked by: J.A. Kowalchek Date: 6-1-84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 1
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP Elec. Dist. Syst. Study

Calculation Title: 2SAT18 - SCREEN WASH PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: Ha Nguyen	Date: 6-1-84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-63-F	
Checked by: J.A. Kowalcheck	Date: 6-1-84		Pg. 1 of 2	Rev. 1
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP-Elec. Dist. Syst. Study				
Calculation Title: 2SAT19 - TBCCW - 2B pump motor start				
Status: Prelim. ☐ Final ☒ Void ☐				

Limiting condition: Maintain TBCCW pump 2B motor terminal voltage above 85% starting voltage (460V base)

SWYD VOLTAGE	4160V BUS CDEB VOLTAGE	TURB. BLD. CLOSED COOL. PMP 2B MOTOR TERM. VOLTAGE 460V BASE	480V BASE
0.970	0.8896	0.7560	0.7245
1.009	0.9354	0.7957	0.7625

85% motor terminal voltage on 480V base = 0.815

SWYD VOLTAGE $\quad Y_{1.009} - Y_{0.970} = M(X_{1.009} - X_{0.970})$

$1.009 - 0.970 = M(0.7625 - 0.7245) \Rightarrow M = 1.026$

$Y = Mx + b$ @ 1.009 SWYD VOLTAGE

$1.009 = 1.026(0.7625) + b \Rightarrow b = 0.227$

SWYD voltage limit $= 1.026(0.815) + 0.227 = \underline{1.063}$

4160V BUS CDEB VOLTAGE: $Y_{0.9354} - Y_{0.8896} = M(X_{0.9354} - X_{0.8896})$

$0.9354 - 0.8896 = M(0.7625 - 0.7245) \Rightarrow M = 1.205$

$Y = Mx + b$ @ 0.9354 CDEB voltage (1.009 SWYD voltage);

$0.9354 = 1.205(0.7625) + b \Rightarrow b = 0.017$

CDEB Bus voltage limit $= 1.205(0.815) + 0.017 = 0.999$

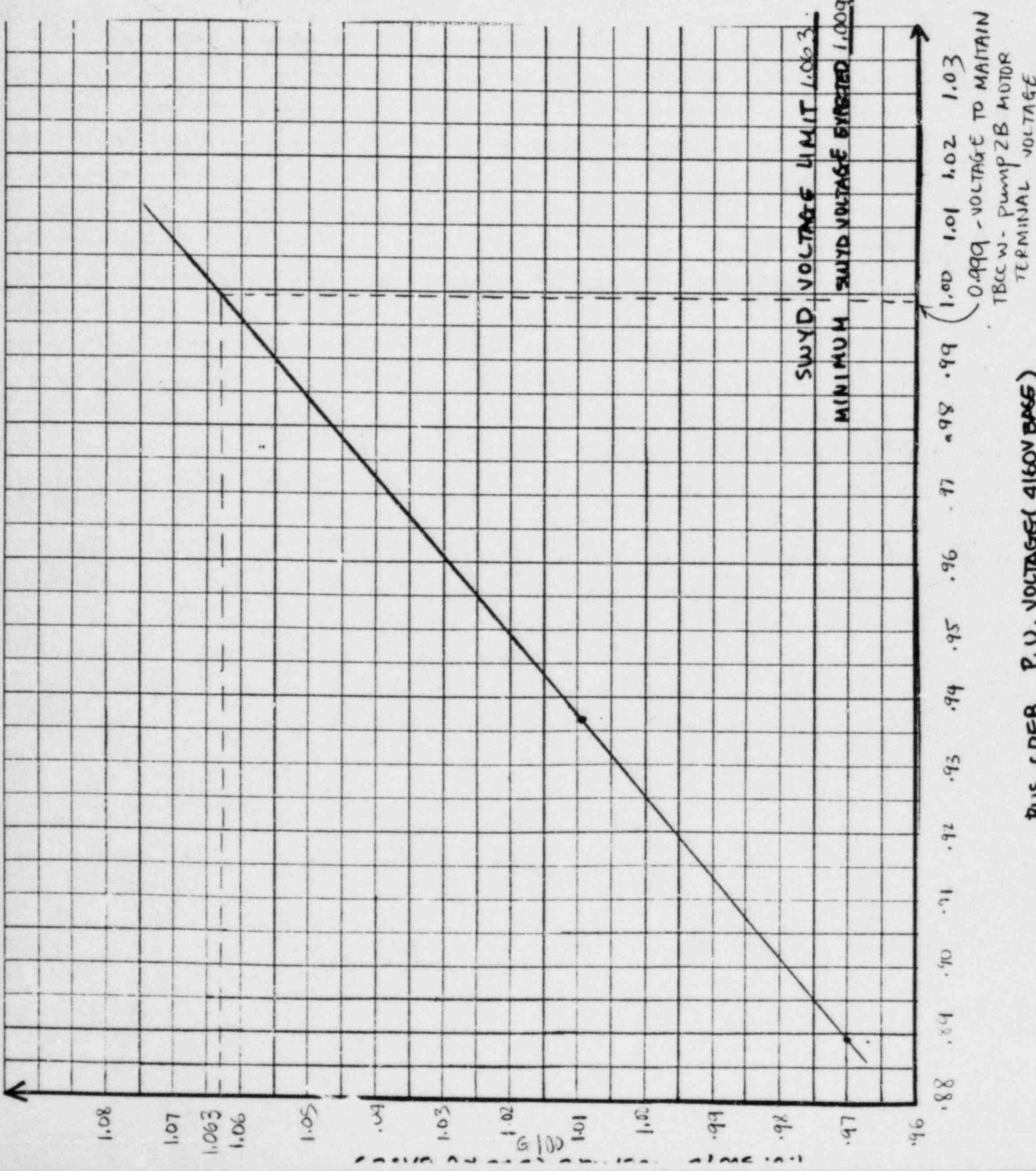
699

Computed by: Ha Nguyen	Date: 6-1-84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NTR4-E-63-F	
Checked by: J.A. Kowalcheck	Date: 6-1-84		Pg. 2 of 2	Rev. 1
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP Elec. Dist. Syst. study

Calculation Title: 2SAT19 - TBCCW - 2B pump motor start

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-64-F	
Checked by: J.A. Kowalchuck	Date: 4/27/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: ANT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT1 - FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: VOLTAGE NEEDED TO MAINTAIN 460V MOTOR TERMINAL VOLTAGE ABOVE 90% ON A 460 V BASE * (USE WORST CASE MCC: 2XH)

FPCP-2B ?

SWYD. VOLTAGE	4160V BUS CDEB VOLTAGE	MCC 2XH VOLTAGE 460 V BASE	MCC 2XH VOLTAGE 480 V BASE	460 V MOTOR TERMINAL VOLTAGE 460 V BASE	460 V MOTOR TERMINAL VOLTAGE 480 V BASE
0.97	0.8977	0.8910	0.8539	0.8643	0.8283
1.009	0.9407	0.9435	0.9042	0.9152	0.8771

* ASSUME A 3% VOLTAGE DROP ON A 460 V BASE FROM THE MCC TO THE MOTOR TERMINALS

90% MOTOR TERMINAL VOLTAGE ON A 480V BASE = 0.862

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8771 - 0.8283)$ $\quad m = \frac{0.039}{0.0488} = .799$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.799(0.8771) + b$ $\quad b = 0.308$

SWITCHYARD VOLTAGE LIMIT $= 0.799(0.862) + 0.308 = \underline{0.997}$

4160 V BUS CDEB VOLTAGE: $Y_{0.9407} - Y_{0.8977} = m(X_{0.9407} - X_{0.8977})$

$0.9407 - 0.8977 = m(0.8771 - 0.8283)$ $\quad m = \frac{0.043}{0.0488} = 0.881$

$Y = mx + b$ @ 0.9407 CDEB VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9407 = 0.881(0.8771) + b$ $\quad b = 0.168$

CDEB BUS VOLTAGE LIMIT $= 0.881(0.862) + 0.168 = \underline{0.927}$

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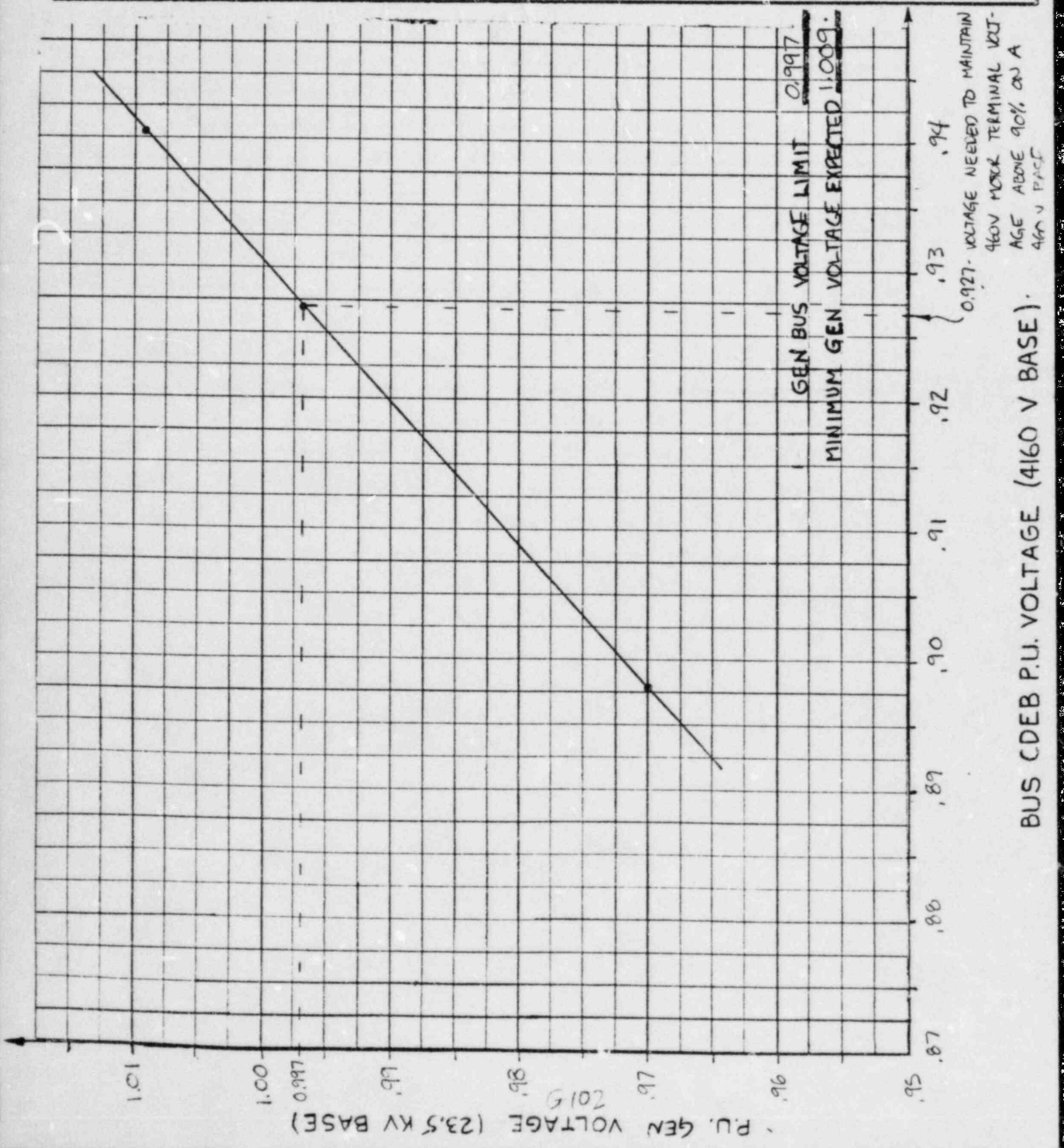
Computed by: JAKeane Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT-124-E-64-F
Checked by: J.A. Kowalcheck Date: 4/27/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT1- FULL LOAD CONDITION

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JAHeare	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-55-F	
Checked by: J.A. Kowalcheck	Date: 4/27/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2UAT2- LIGHT LOAD CONDITION				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: VOLTAGE NEEDED TO LIMIT THE 4000 V MOTOR TERMINAL VOLTAGE TO 110% ON A 4000 V BASE

SWYD. VOLTAGE	4160 V BUS 2B VOLTAGE
0.99	0.9912
1.017	1.0181

110% MOTOR TERMINAL VOLTAGE ON 4160 V BASE = 1.058*

* ASSUME NO VOLTAGE DROP FROM 4160 V BUS TO MOTOR TERMINALS

SWITCHYARD VOLTAGE: $Y_{1.017} - Y_{0.99} = m\,(X_{1.017} - X_{0.99})$

$1.017 - 0.99 = m(1.0181 - 0.9912)$ $\quad m = \frac{0.027}{0.0269} = 1.004$

$Y = mx + b$ @ 1.017 SWITCHYARD VOLTAGE:

$1.017 = 1.004\,(1.0181) + b$ $\quad b = -0.005$

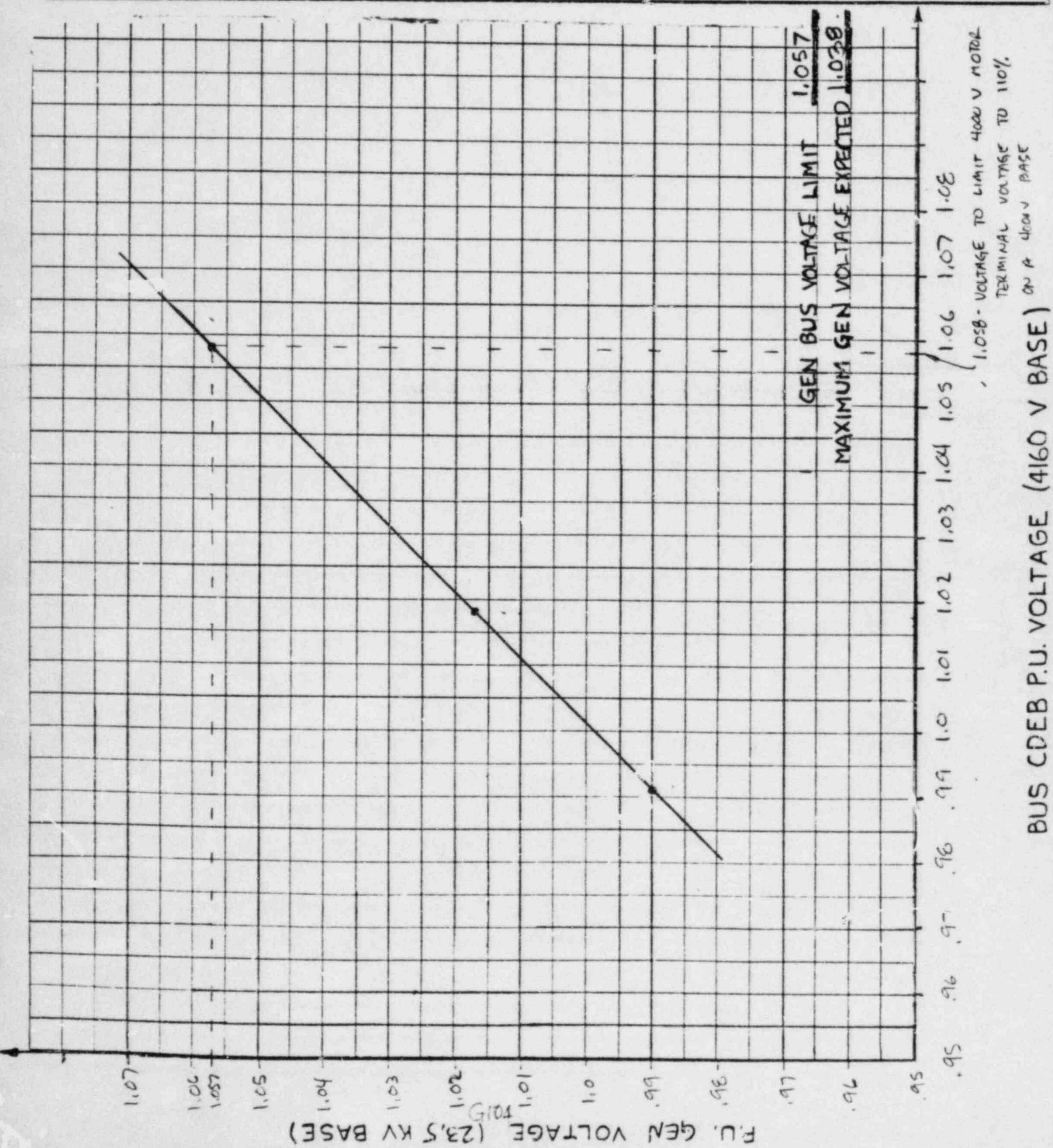
SWITCHYARD VOLTAGE LIMIT = $1.004(1.058) - 0.005 =$ <u>1.057</u>

Computed by: JA Kcase Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-65-F
Checked by: J.A. Kowalchek Date: 4/27/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT2 - LIGHT LOAD CONDITION

Status: Prelim. ☐ Final ☑ Void ☐



Computed by: JA Keane Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-66-F	
Checked by: J.A. Kowalchek Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN.5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY			
Calculation Title: 2UAT3 - 3RD CWP MOTOR START			
Status: Prelim. ☐ Final ☒ Void ☐			

LIMITING CONDITION: MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 4000V BASE

SWYD. VOLTAGE	4000 V CIRCULATING WATER PUMP MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.97	0.8[illegible]3	0.8080
1.009	0.8804	0.8465

85% MOTOR TERMINAL VOLTAGE ON A 4160 V BASE = 0.817

SWITCHYARD VOLTAGE = $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8465 - 0.808)$ $m = \frac{0.039}{0.0385} = 1.013$

$Y = mX + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 1.013(0.8465) + b$ $b = 0.151$

SWITCHYARD VOLTAGE LIMIT = $1.013(0.817) + 0.151 = \underline{0.979}$

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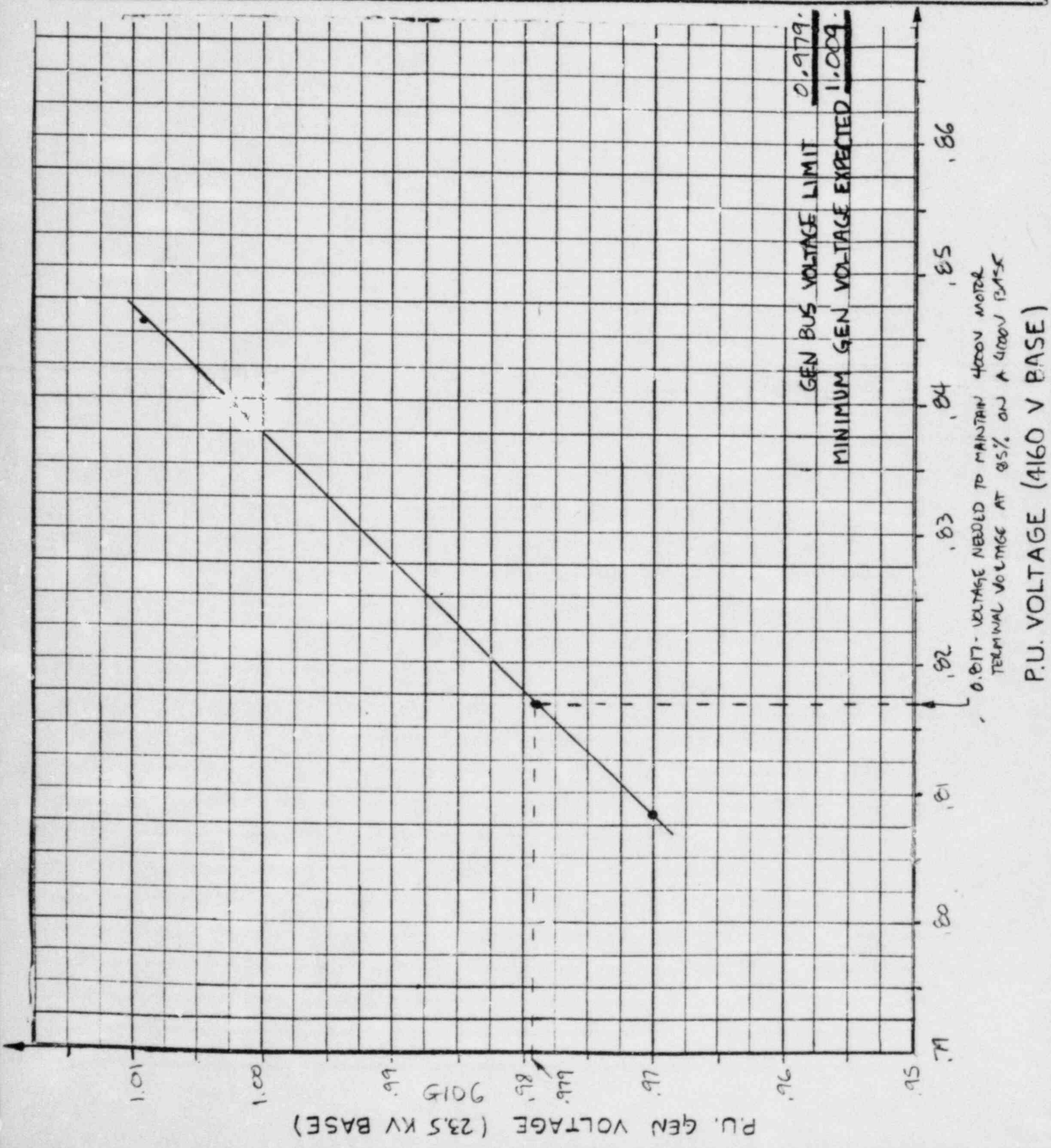
Computed by: JAKenne Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-66-F
Checked by: J.A. Kowalcheck Date: 4/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT3 - 3RD CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-67 F	
Checked by: J.A. Kowalcheck	Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM				
Calculation Title: 2UAT4 - 4TH CWP MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 4000 V BASE

SWYD. VOLTAGE	4000V CIRCULATING WATER PUMP 2B MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.979	0.8396	0.8073
1.009	0.8709	0.8374

85% MOTOR TERMINAL VOLTAGE ON A 4160 V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.979} = m(X_{1.009} - X_{0.979})$

$1.009 - 0.979 = m(0.8374 - 0.8073)$ $\quad m = \frac{0.030}{0.0301} = 0.997$

Y = mx+b @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.997(0.8374) + b$ $\quad b = 0.174$

SWITCHYARD VOLTAGE LIMIT = $0.997(0.817) + 0.174 = \underline{0.989}$

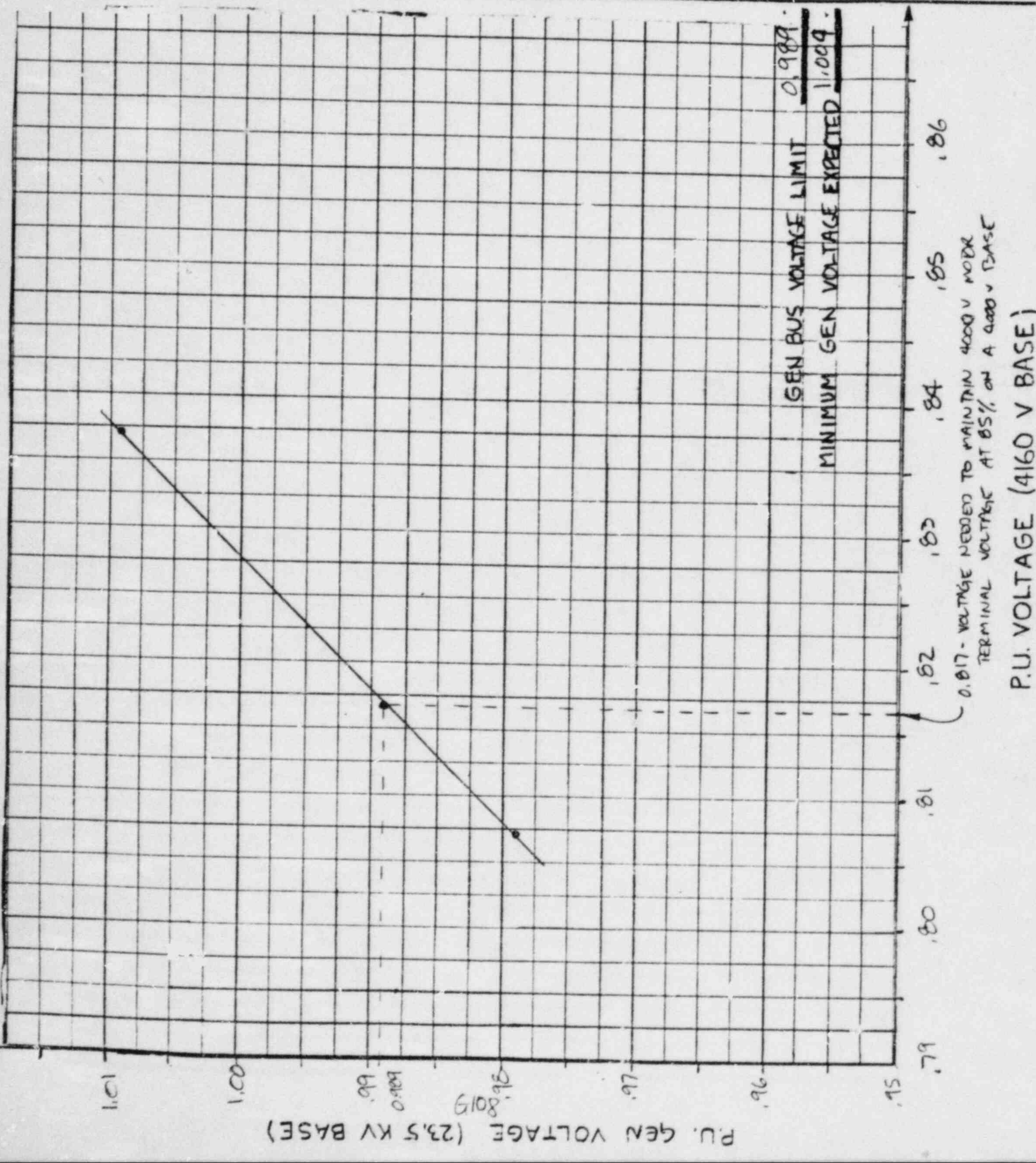
G107

Computed by: JA Keene	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-67-F	
Checked by: J.A. Kowalcheck	Date: 4/30/84		Pg. 2 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT4 - 4TH CWP MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: JA Keane	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-68-F	
Checked by: J.A. Kowalcheck	Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2UATS-REACTOR RECIRC PUMP 2B MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 4000 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 4000 V BASE

SWYD. VOLTAGE	4000 V REACTOR RECIRC PUMP 2B MOTOR TERMINAL VOLTAGE 4000 V BASE	4160 V BASE
0.97	0.8383	0.8061
1.009	0.8725	0.8389

85% MOTOR TERMINAL VOLTAGE ON A 4160V BASE = 0.817

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8389 - 0.8061)$ $\quad m = \frac{0.039}{0.0328} = 1.189$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE LIMIT:

$1.009 = 1.189(0.8389) + b$ $\quad b = 0.012$

SWITCHYARD VOLTAGE LIMIT $= 1.189(0.817) + 0.012 = \underline{0.983}$

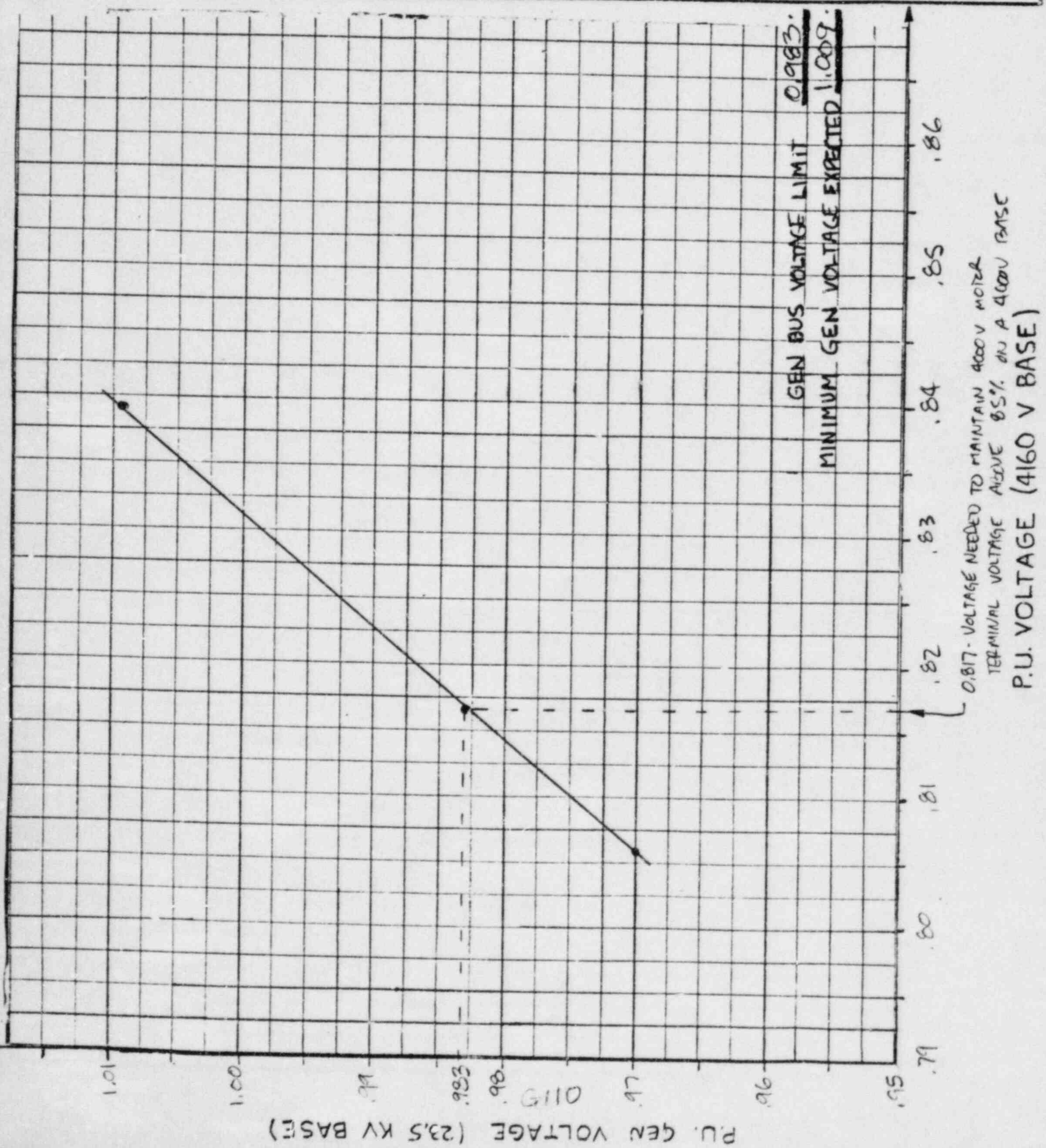
G109

Computed by: JA Glenn Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-68-F
Checked by: J.A. Kowalcheck Date: 4/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UATS - REACTOR RECIRC PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G110

Computed by: JA Crane	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT124-E-84-F	
Checked by: J.A. Kowalcheck	Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT6-FUEL POOL CLEANING PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 460V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 460V BASE

SWYD VOLTAGE	4160 V BUS COEB VOLTAGE	FUEL POOL CLEANING PUMP 2A MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8958	0.8712	0.8349
1.009	0.9387	0.9208	0.8824

85% MOTOR TERMINAL VOLTAGE ON A 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8824 - 0.8349)$ $m = \frac{0.039}{0.0475} = 0.821$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.821(0.8824) + b$ $b = 0.285$

SWITCHYARD VOLTAGE LIMIT = $0.821(0.815) + 0.285 =$ **0.954**

4160 V BUS COEB VOLTAGE: $Y_{0.9387} - Y_{0.8958} = m(X_{0.9387} - X_{0.8958})$

$0.9387 - 0.8958 = m(0.8824 - 0.8349)$ $m = \frac{0.0429}{0.0475} = 0.9032$

$Y = mx + b$ @ 0.9387 COEB VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9387 = 0.9032(.8824) + b$ $b = 0.1417$

COEB BUS VOLTAGE LIMIT = $0.9032(0.815) + 0.1417 =$ **0.878**

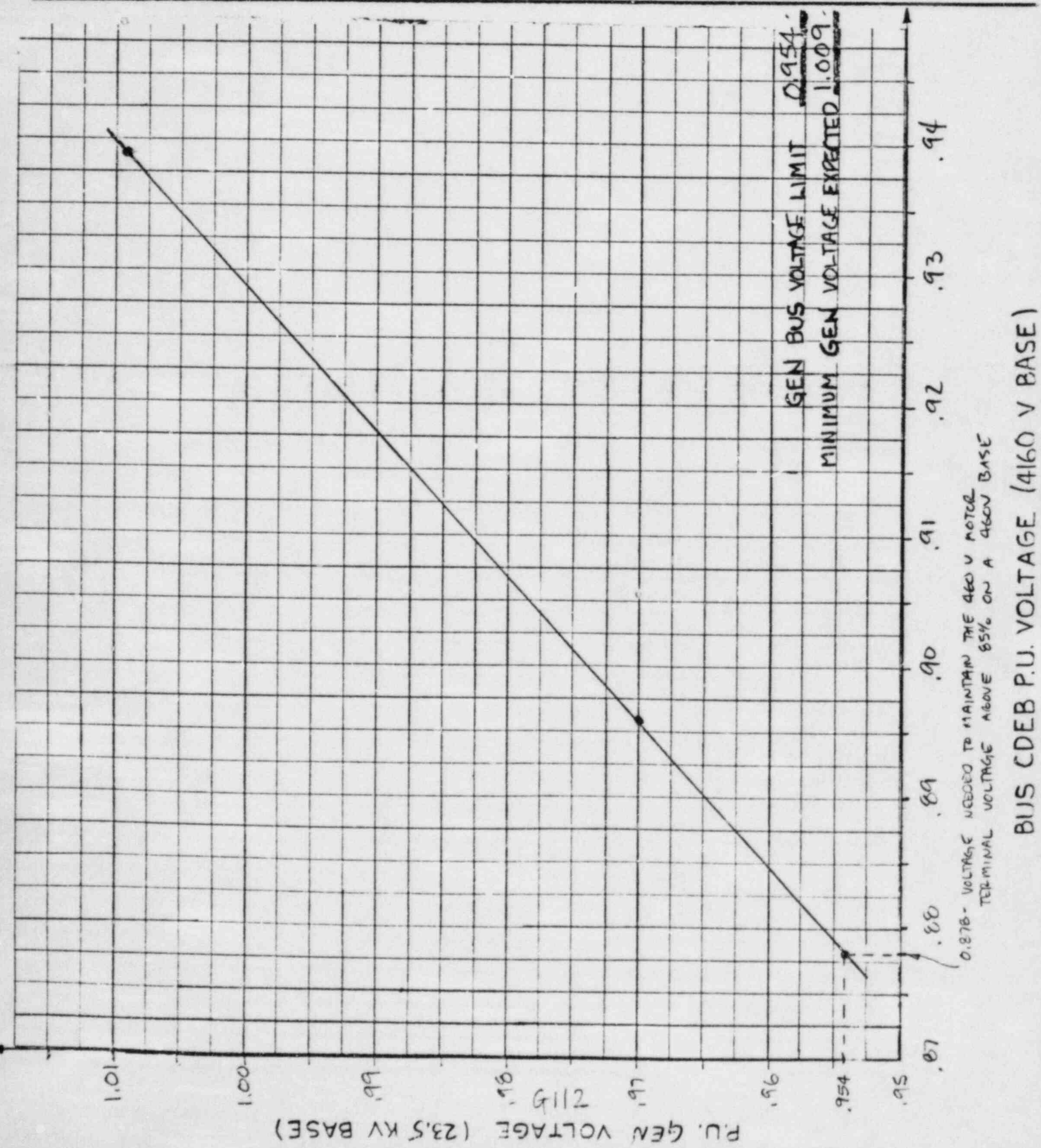
G111

Computed by: JA Keane Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation In: NT124-E-69-F	
Checked by: J.A. Kowalcheck Date: 4/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2	Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: ANT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT6 - FUEL POOL CLEANING PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



Computed by: J A Vxxx	Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NT-124-E-70-F	
Checked by: J.A. Kowalcheck	Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124			File: BNT-124-AN-5543	
Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY				
Calculation Title: 2UAT 7- FUEL POOL CLEANING PUMP 2B MOTOR START				
Status: Prelim. ☐ Final ☒ Void ☐				

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 460V BASE

SWYD. VOLTAGE	4160V BUS COEB VOLTAGE	460 V FUEL POOL CLEANING PUMP 2B MOTOR TERMINAL VOLTAGE 460 V BASE	480 V BASE
0.97	0.8959	0.8416	0.8065
1.009	0.9388	0.8907	0.8536

85% MOTOR TERMINAL VOLTAGE ON A 480 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8536 - 0.8065)$ $\quad m = \frac{0.039}{0.0471} = 0.828$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.828(0.8536) + b$ $\quad b = 0.302$

SWITCHYARD VOLTAGE LIMIT $= 0.828(0.815) + 0.302 = \underline{0.977}$

4160 V BUS COEB VOLTAGE: $Y_{0.9388} - Y_{0.8959} = m(X_{0.9388} - X_{0.8959})$

$0.9388 - 0.8959 = m(0.8536 - 0.8065)$ $\quad m = \frac{0.0429}{0.0471} = 0.911$

$Y = mx + b$ @ 0.9388 COEB VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9388 = 0.911(0.8536) + b$ $\quad b = 0.161$

COEB BUS VOLTAGE LIMIT $= 0.911(0.815) + 0.161 = \underline{0.903}$

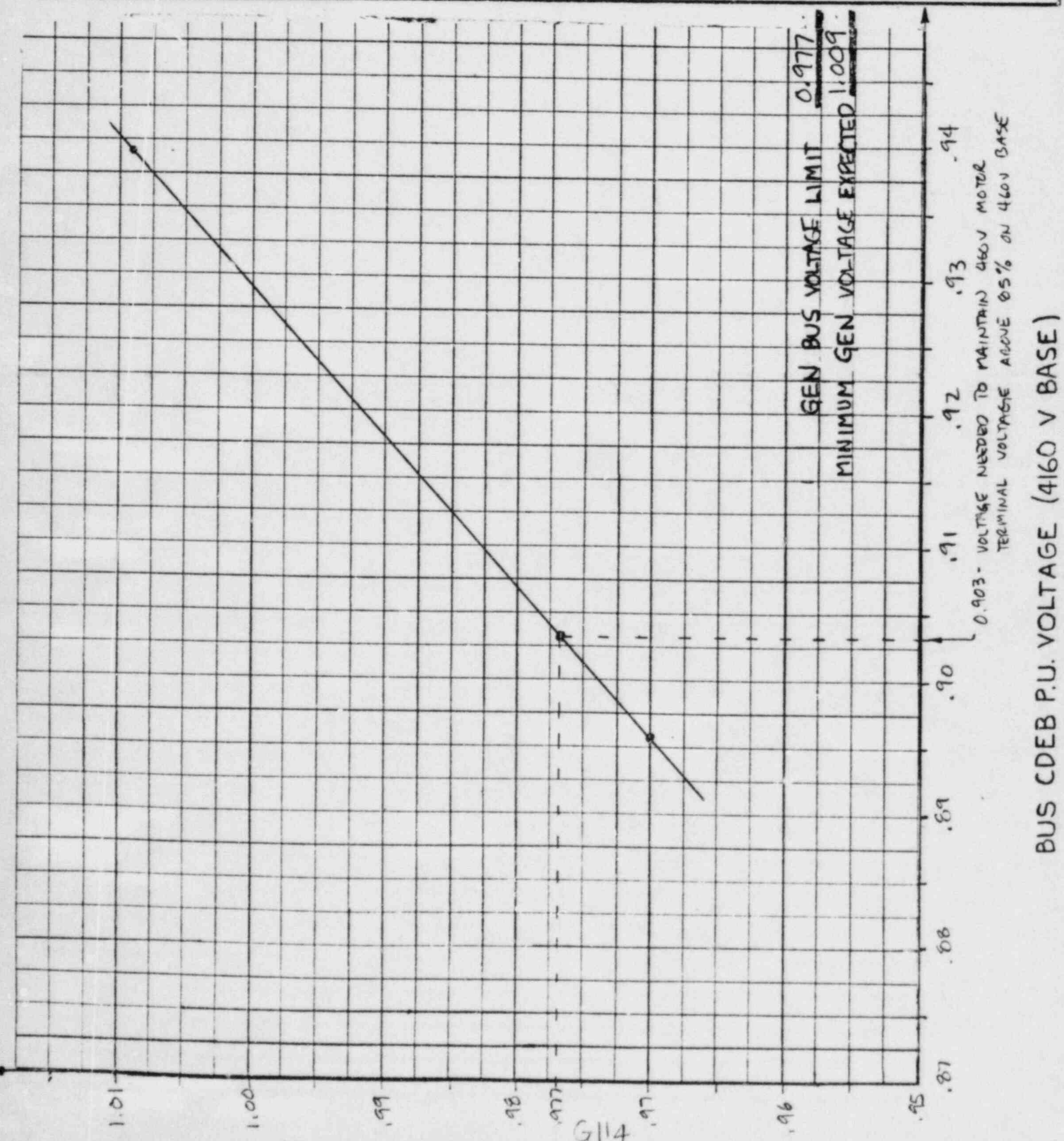
G113

Computed by: JA Kocne Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT124-E-70-F
Checked by: J.A. Kowalcheck Date: 4/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT7 - FUEL POOL CLEANING PUMP 2B MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



G114

Computed by: JA Keare Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY NUCLEAR PLANT ENGINEERING DEPARTMENT CALCULATION SHEET	Calculation ID: NI-124-E-71-F	
Checked by: J.A. Kowalcheck Date: 4/30/84		Pg. 1 of 2	Rev. 0
TAR No.: NT-124		File: BNT-124-AN-5543	

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT8 - REACTOR BLDG. CLOSED COOLING WATER PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐

LIMITING CONDITION: MAINTAIN 460 V MOTOR TERMINAL VOLTAGE ABOVE 85% ON A 460 V BASE

SWYD VOLTAGE	4160 V BUS COE3 VOLTAGE	460 V REACTOR BLDG. CLOSED COOL. WTR. PUMP 2A MOTOR TERM. VOLTAGE 460 V BASE	480 V BASE
0.97	0.8957	0.8541	0.8185
1.009	0.9386	0.9020	0.8644

85% MOTOR TERMINAL VOLTAGE ON A 460 V BASE = 0.815

SWITCHYARD VOLTAGE: $Y_{1.009} - Y_{0.97} = m(X_{1.009} - X_{0.97})$

$1.009 - 0.97 = m(0.8644 - 0.8185)$ $m = \frac{0.039}{0.0459} = 0.850$

$Y = mx + b$ @ 1.009 SWITCHYARD VOLTAGE:

$1.009 = 0.850(0.8644) + b$ $b = 0.274$

SWITCHYARD VOLTAGE LIMIT = $0.850(0.815) + 0.274 = \underline{0.967}$

4160 V BUS COE3 VOLTAGE: $Y_{0.9386} - Y_{0.8957} = m(X_{0.9386} - X_{0.8957})$

$0.9386 - 0.8957 = m(0.8644 - 0.8185)$ $m = \frac{0.0429}{0.0459} = 0.935$

$Y = mx + b$ @ 0.9386 COE3 VOLTAGE (1.009 SWITCHYARD VOLTAGE):

$0.9386 = 0.935(0.8644) + b$ $b = 0.130$

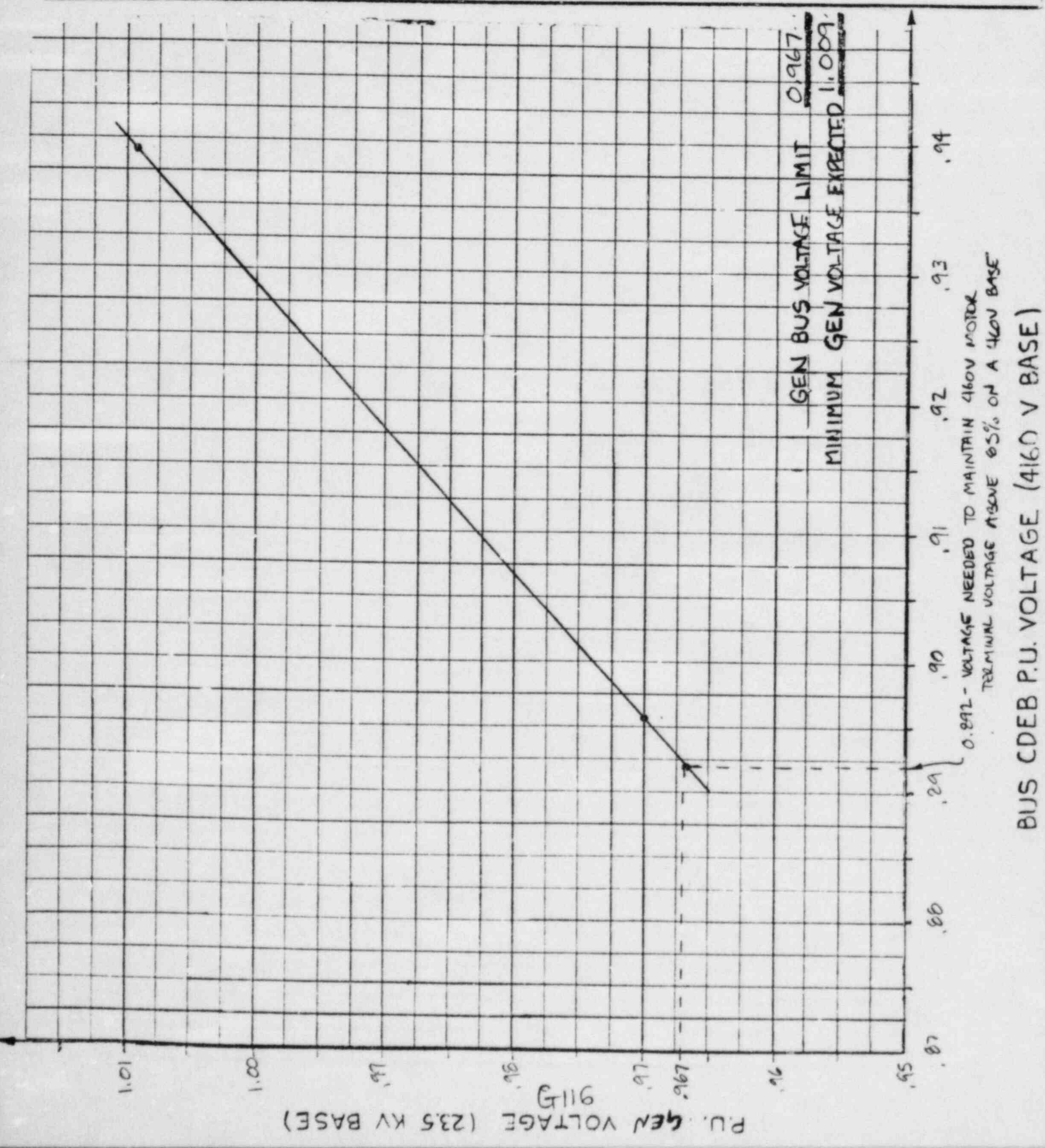
COE3 BUS VOLTAGE LIMIT = $0.935(0.815) + 0.130 = \underline{0.892}$

Computed by: JA Keane Date: 4/16/84	CAROLINA POWER & LIGHT COMPANY	Calculation ID: NT-124-E-71 -F
Checked by: J.A. Kowalcheck Date: 4/30/84	NUCLEAR PLANT ENGINEERING DEPARTMENT	Pg. 2 of 2 Rev. 0
TAR No.: NT-124	CALCULATION SHEET	File: BNT-124-AN-5543

Project Title: BSEP ELECTRICAL DISTRIBUTION SYSTEM STUDY

Calculation Title: 2UAT8- REACTOR BLDG. CLOSED COOLING WATER PUMP 2A MOTOR START

Status: Prelim. ☐ Final ☒ Void ☐



CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNITS 1 & 2

LOW VOLTAGE (208/120 VOLT) ELECTRICAL DISTRIBUTION SYSTEM STUDY

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