REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

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FACIL:50-261 H. B. Robinson Plant, Unit 2, Carolina Power and Ligh 05000261
AUTH.NAME AUTHOR AFFILIATION
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RECIP.NAME RECIPIENT AFFILIATION
VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Provides addl info re adequacy of electrical distribution voltage sys,per 840119 request.Criteria used in selecting undervoltage & overvoltage alarm setpoints for 115-KV grid voltage discussed.

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MAR 9 1984

Director of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
REQUEST FOR ADDITIONAL INFORMATION
ADEQUACY OF STATION ELECTRICAL DISTRIBUTION VOLTAGE SYSTEM

Dear Mr. Varga:

SUMMARY

By letter dated January 19, 1984, you requested that Carolina Power & Light Company (CP&L) provide additional information regarding the adequacy of the electrical distribution voltage system at H. B. Robinson Steam Electric Plant (HBR2) in order to complete your evaluation of the electric distribution system. The purpose of this letter is to provide the additional information requested.

BACKGROUND

Carolina Power & Light Company was requested by an NRC letter dated August 8, 1979, to review the adequacy of the HBR2 electrical distribution voltage system. The review included determining the capability of the offsite and onsite systems to automatically start and operate during an anticipated transient or accident, and determining any situation which would cause the loss of both required circuits from the offsite network to the onsite distribution system. After reviewing CP&L's submittals dated October 5, 1979, July 23, 1980, October 14, 1982 and March 23, 1983, NRC identified four open items that required resolution prior to concluding that HBR2's electrical distribution system was adequate to maintain the voltage within the design limits of the required Class 1E equipment.

DISCUSSION

The first open item was a request for the setpoints and alarm procedures on the 115 KV system under and overvoltage monitors. The low and high alarm setpoints are 110.4 KV (0.96 p.u.) and 117.3 (1.02 p.u.) KV, respectively, as presented in the setpoint analyses (Attachment 1). Upon receipt of the annunciator alarms, operators will take appropriate action per HBR2 plant operating procedures. (Appropriate instructions will be incorporated by the end of the current steam generator replacement outage.)

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In the second item, NRC requested FSAR and Technical Specification (TS) revisions on backfeeding through the main and unit auxiliary transformers to the Class 1E buses. Backfeeding the E1 and E2 safety related buses through the main and unit auxiliary transformer will only occur during cold shutdown when no other power sources are available, unless nuclear safety considerations require it to be done during hot shutdown. Changes to the FSAR will be included in its annual update. The changes to the TS will be requested by May 1984. In addition, the requirement to be in cold shutdown prior to backfeeding the safety-related buses through the main and unit auxiliary transformer has been added to the HBR2 operating procedure.

The third open item involves ensuring that the degraded grid protection scheme is reinstated following bypassing during RCP starting. NRC expressed its safety concerns about the administrative controls CP&L currently implements in a conference call on February 13, 1984. Subsequent to that discussion, CP&L has made plans to install an indicator in the control room during the next scheduled outage of sufficient duration following the current replacement outage that will inform the operators that the trip circuits are in the bypass mode.

The final open item was your request for the results of CP&L's tests verifying the estimated acceleration times of the starting loads used in the voltage profile analysis. The results of the in-house tests on steam generator feedwater pumps A and B, auxiliary feedwater pumps A and B and service water booster pumps A and B, conducted at HBR2 on August 27 and 28, 1983, are provided in Attachment 2. These tests confirm the estimated acceleration times used in the report, "Supplemental Information for Degraded Grid Voltage Analysis" forwarded to you March 23, 1983. Therefore, conclusions reached in the study remain valid.

PREVIOUS COMMITMENTS

In the letter dated October 14, 1982, CP&L committed to make tap setting changes on station service transformers 2A, 2B, 2C and 2D to ensure conservatisms made in the marginal voltage analysis. The tap setting changes on 2A, 2B and 2C have been performed by increasing the secondary voltage at the safety buses by 2.5 percent. The new voltage ratios are 4160V to 492V. The tap change to 2D was not performed since this transformer only supplies loads on 480V Bus 4, which cannot be cross-connected to Emergency Bus 1 and 2, or to 480V Buses 1, 2A, 3B and 3. Therefore, transformer 2D does not supply any safety-related loads. In addition, the voltage readings taken on 480V Bus 4 are currently at an acceptable level. Because a tap setting change on 2D would result in excessive voltage, it will remain at its original voltage ratio of 4160V to 480V.

In the March 23, 1983 letter, CP&L also committed to install an undervoltage and overvoltage alarm to monitor the 115 KV system voltage. This alarm has been installed and appropriate instructions will be incorporated into the HBR2 plant operating manual by the end of the current steam generator replacement outage.

CONCLUSION

Based on the information provided above and pending approval of the requested TS changes to be submitted to NRC by May 1984, CP&L believes that the offsite and onsite electrical distribution system at HBR2 is adequate to meet the requirements of General Design Criteria 17 and that this issue should be closed for HBR2. If you have any further questions, please contact a member of our Nuclear Licensing Staff.

Yours very truly,

A. B. Cutter, Vice President
Nuclear Engineering & Licensing

CGL/ccc (9595CGL)
Attachments

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. G. Requa (NRC)
Mr. Steve Weise (NRC-HBR)

ATTACHMENT 1

UNDERVOLTAGE AND OVERVOLTAGE ALARM SETPOINTS ANALYSIS

INTRODUCTION

In a letter to the NRC (LAP-83-62 from L. W. Eury to S. A. Varga), dated March 23, 1983, CP&L made a commitment to install undervoltage and overvoltage alarms to monitor the 115 kv system voltage. These alarms would be installed in the HBR-2 Control Room prior to start-up following the next refueling outage. In addition, the letter stated that, "In conjunction with this modification, studies will be performed to determine the alarm setpoints."

As a result of these studies, low and high alarm setpoints of 0.96 pu (110.4kv) and 1.02 pu (117.3kv), respectively, have been established.

The purpose of this report is to summarize the results of the studies related to this subject and to explain the criteria used in selecting the undervoltage and overvoltage alarm setpoints for the 115 kv grid voltage. In the above letter, CP&L stated that the results of these studies would be provided to the NRC within 60 days after start-up following the next refueling outage.

DISCUSSION

The analysis of each case in the following section is based on information contained in the following previously submitted Ebasco reports. Information for Cases A, B, and C, respectively, can be found in these references:

Reference 1: Supplemental Information for Degraded Grid Voltage Analysis; September 1982; Section 5.10, Pp. I-17 and I-18. (October 14, 1982 letter from L. W. Eury to S. A. Varga)

Reference 2: Supplemental Information for Degraded Grid Voltage Analysis; March 1983; Response to Question No. 9, Pp. 11, 15, and 16. (March 23, 1983 letter from L. W. Eury to S. A. Varga)

Reference 3: Supplemental Information for Degraded Grid Voltage Analysis; September 1982; Section 5.4, Pp. I-10 and I-11. (October 14, 1982 letter from L. W. Eury to S. A. Varga)

The above reports demonstrated that the voltage on safety-related buses would be maintained within recommended limits, regardless of the operating condition of the plant as long as the 115 kv switchyard was maintained within the operating range of 0.97 pu to 1.01 pu.

The reports also showed that certain bus voltages could degrade to a level below the recommended minimum if the 115 kv switchyard voltage fell to a level of 0.95 pu. Likewise, certain bus voltages would rise to a level above the recommended maximum, if the switchyard voltage rose to a level of 1.06 pu. The latter case would be especially true under conditions of minimum plant load. Since the 115 kv switchyard per-unit values of 0.95 and 1.06 are

outside of the maintained voltage schedule, these conditions were not viewed as significant. However, since the undervoltage situation is applicable under any plant condition, it received immediate attention; and the primary side of the 4160V/480V Station Service Transformers were lowered by one tap. This has the effect of increasing the nominal voltage on the 480V system by 2 1/2 percent. This is the arrangement assumed under Reference No. 2.

The report revealed a second problem involving the Start-Up Transformer (SUT). This transformer is especially important since all power is supplied through it to Unit 2 during shutdown conditions. In addition, certain safety-related buses are always fed by the SUT. The primary connection for the SUT is to the 115 kv west bus. The report showed that since the HBR-2 operators did not have any direct knowledge of the 115 kv bus voltage level, they had no way of knowing the primary voltage on the SUT at any time.

In order to alleviate this problem, CP&L proposed to install alarms in the HBR-2 Control Room which would alert the operators to an over or undervoltage condition on the 115 kv west bus. The setpoints for these alarms must be between the extremes of normal operation, and the over and undervoltage levels which would lead to high or low-voltage conditions on the safety-related buses. Setpoints are proposed which are outside of the normal operating conditions by a value of 0.01 per unit. Based on 1.0 pu being equivalent to 115 kv, the low alarm setpoint would be 0.96 pu (110.4 kv) and the high alarm setpoint would 1.02 pu (117.3 kv).

Each case in the following section shows the expected voltages on selected safety-related buses at the proposed alarm setpoints. Note that the high alarm setpoint calculations are shown at 1.05 pu. This compensates for the 2 1/2 percent tap change described above. This is a very conservative action since the tap change is not likely to cause a full 3 percent increase in the 480V bus voltage levels.

These case studies show that at the alarm setpoints selected, the safety-related bus voltages will not fall or rise to levels outside the manufacturer's recommended limits with one exception. In this exception (see "Case C"), the predicted bus voltage on Bus E2 is 516 Volts, given that Unit 2 is in a condition of minimum load (such as in a cold-shutdown) and that the switch-yard voltage is at a "high setpoint" level of 1.02 pu (117.3 kv). (Note that the "high" setpoint of 1.05 pu which is analyzed is a conservative way of compensating for the station service transformer tap change). We feel that this exception is insignificant for the following reasons:

1. The predicted bus voltage (516V on Bus E2) is less than 2 percent above the manufacturer's recommended maximum for continuous motor operation.

2. Voltage drop between the bus and connected motors is not considered.

3. This condition will only be possible during periods of minimum plant load coincident with high switchyard voltage.

With implementation of the under and overvoltage alarms, the HBR2 operators are given sufficient warning of an "out-of-limit" condition before a serious condition develops. Upon receipt of this alarm, operators will take appropriate action per HBR2 operating procedures.

ANALYSIS

Case A: Steady-State Conditions at Full Power[1]

The steady-state voltage studies for H. B. Robinson Unit No. 2 were conducted to determine the minimum voltages which could be expected on the major on-site electrical buses during steady-state power operations as the grid voltage was varied from 0.95 pu to 1.06 pu of 115 kv. The following conditions were assumed to exist during the conduct of this study:

1. The plant is assumed to be operating at 100 percent power.

2. All electrical loads which are required by the unit are supplied from the 115 kv grid via the Start-up Transformer.

3. All running electrical loads are assumed to be in continuous operation (i.e., no equipment starts or stops).

4. The tap changes on the station service transformers are not considered.

The calculated bus voltages during steady-state operation of the plant are as tabulated below:

115KV Switchyd. Vltg.(PU)	4160-Volt Bus		480-Volt Bus					208-Volt Bus	
	1/2	3/4	E1	E2	SHDN	MCC5	MCC6	MCC9	MCC10
0.95	3903	3917	421	419	421	418	416	178	179
1.00	4138	4151	450	448	450	447	445	191	192
1.06	4417	4429	484	483	484	481	480	206	206

This information is presented graphically in Figures 1, 2A, 2B, and 3. (Only Bus E1 and MCC6 are shown on Figure 2B since they establish the range within which all of the other 480V bus values fall).

Because of the linear relationship of these values, the bus voltages at various switchyard per-unit values can be predicted. The following table shows the interpolated bus voltages for switchyard per unit values of 0.96 and 1.05:

PU	4160-Volt Bus		480-Volt Bus			280-Volt Bus	
	1/2	3/4	E1	E2	MCC6	MCC9	MCC10
0.96	3944	3960	427	425	422	181	182
1.05	4368	4389	479	477	474	203	204

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[1] See Reference No. 1 in Discussion

(9611CGL/cfr)

The results tabulated above show that during steady-state operation, if the switchyard voltage is maintained between the limits shown, all of the buses are maintained above the manufacturers' recommended minimum voltage, and below the recommended maximum voltage, for continuous motor operation.

(NOTE: Due to the previously discussed tap change on the Station Service Transformers, the above voltages are nominally 2-1/2 percent low. This should compensate for any voltage drop between the power buses and the motors.)

Case B: LOCA Conditions[2]

Computer models of the September 1982 Report Study - 3X (Appendix D) and Study - 3Y (Appendix E) were modified incorporating the following conditions (modified computer models for this study are included in Appendix 7, 8, and 9 of the March 1983 report):

1. Load shedding of buses after initiation of a LOCA (loads shown under shaded area of Sketch CAR 2762 E4, Sheets 1 and 2).

2. Using the 4160/480-volt transformer tap change (4056-volt tap).

3. Using actual observed load currents for large pumps as reported in the 1976 report and actual observed load currents for the auxiliary feedwater pump and service water booster pumps as recorded during an in-plant test (September 1982 report).

4. All AC electrical loads which are required to support the loss of coolant accident mode are being supplied from the 115 kv switchyard via the start-up transformer.

5. The Post Turbine Trip 115 kv switchyard voltage is assumed to be at 0.97 pu.

The analysis presented in the March 1983 report demonstrated that the worst case contractor dropout voltages would not be approached under any of the postulated conditions. The following tables (Tables 7 and 8 from the March 1983 report) show the minimum steady-state voltage (425V) and the minimum transient voltage (396V) reached by either emergency bus under LOCA conditions.

[2]See Reference No. 2 in Discussion.

TABLE 7

30 Seconds After LOCA Signal
Component Cooling Pump C Actuated
(Case 7)

	Minimum Voltage		
	Steady State		Transient
Plant Buses	Before Starting	After Starting	
480V Bus El	434	434	434
480V Bus E2	430	425	396
480V Shutdown Bus	435	430	402
480V MCC 5	425	425	425
480V MCC 6	421	416	386
208 MCC 9	181	178	165
208 MCC 10	182	182	182

TABLE 8

35 Seconds After LOCA Signal
Recirculation Cooling Unit 4 Actuated
(Case 8)

	Minimum Voltage		
	Steady State		Transient
Plant Buses	Before Starting	After Starting	
480V Bus El	434	429	404
480V Bus E2	425	425	425
480V Shutdown Bus	430	430	430
480V MCC 5	425	420	394
480 MCC 6	416	416	416
208 MCC 9	178	178	178
208 MCC 10	182	180	169

Of special interest are the minimum levels reached under the same conditions given a switchyard voltage at the undervoltage alarm point (0.96 pu). The above tables show that the minimum steady-state voltage is much closer to the second level trip setting (412 ± 1V for 10 ± 0.5 seconds) than the minimum transient voltage is to the first level trip setting (328 ± 1V for 0.75 ± 0.25 seconds). Consequently, it is only necessary to predict the minimum steady-state voltage which results from the degradation of the 115 kv switchyard voltage to the "LO" alarm point (0.96 pu).

The dotted line representing "Case B" on Figure 2A shows the predicted minimum steady-state voltage for Bus E2, under LOCA conditions, for a range of 115 kv grid voltage levels. This figure shows that a minimum value 418 volts is predicted for a 115 kv switchyard per - unit valve of 0.96. (Note: Although we would expect that the slope for "Case B" on Figure 2A would be very close to the slope of "Case A", we assumed a flatter slope which would result in a conservative prediction. A slope of 0.7 was selected which is consistent with other CP&L studies of Plant Distribution System behavior during LOCA conditions.)

This value is well above the second level trip setting of 412 volts for the emergency buses. In conclusion, this information, along with that presented in the March 1983 report shows that Buses E1 and E2 will not experience separation from their respective power sources during a LOCA.

Case C: Steady-State Conditions at Minimum Load[3]

Using minimum plant load connected to the start-up transformer for maximum grid voltage (1.06 pu), the following maximum expected voltages at the buses were calculated.

Load	Maximum Steady-State Bus Voltage
480-Volt Bus E2	521
480-Volt MCC6	515
208-Volt MCC9	220

Since "X" winding of the Start-up Transformer has more connected and assumed more running load under cold shutdown conditions, only the "Y" winding was only analyzed (Calculation No. 8 of the September 1982 report).

Note that the analysis given below, and the figures referenced, refer to a high-alarm setpoint of 1.05 pu rather than the actual setting of 1.02 pu. As previously stated, this is a conservative means of com-pensating for the Station Service Transformed tap change which is not reflected in the figures shown above.

[3]See Reference No. 3 in Discussion.

The maximum operating voltage for 460 and 200-volt rated motors is 506 and 220 volts, respectively, or ± 10 percent of nameplate. This condition is exceeded by 15 volts or 2.9 percent on 480-Volt Box E2. However, as shown on Figure 2B, if the maximum grid voltage is limited to a per-unit value of 1.05, then the maximum predicted voltage for Bus E2 is 516 volts. This exceeds the recommended maximum operating voltage by less than 2 percent and, therefore, is not considered significant. The corresponding maximum value for 208-volt MCC9 (at a 115 kv grid per-unit value of 1.05 as shown on Figure 3) is 218 volts, which is within the recommended maximum of 220 volts. (Note: For Figures 2B and 3, a slope of 0.9 was assumed for "Case C" which is consistent with other CP&L studies of Plant Distribution System behavior during periods of minimum load.)

ATTACHMENT 2

PUMP MOTOR ACCELERATION TEST RESULTS

BY JAK DATE 2/22/84 SUBJECT 115KV UNDER/OVER VOLTAGE SHEET NO. 1 OF 4
CHKD. BY .... DATE .... A[illegible]RM SET-POINT EVALUATION JOB NO. ....

CASE A

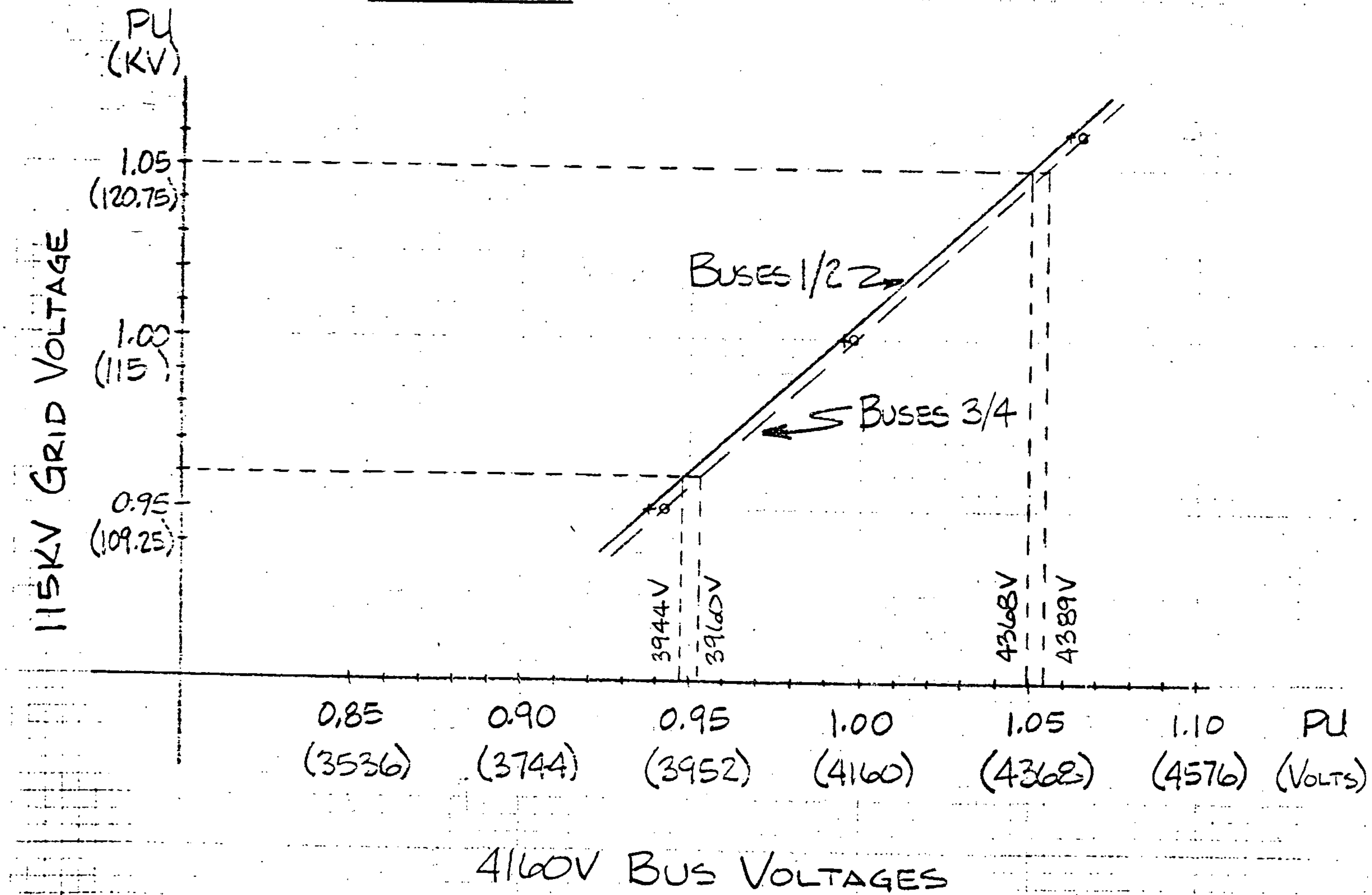

FIGURE 1

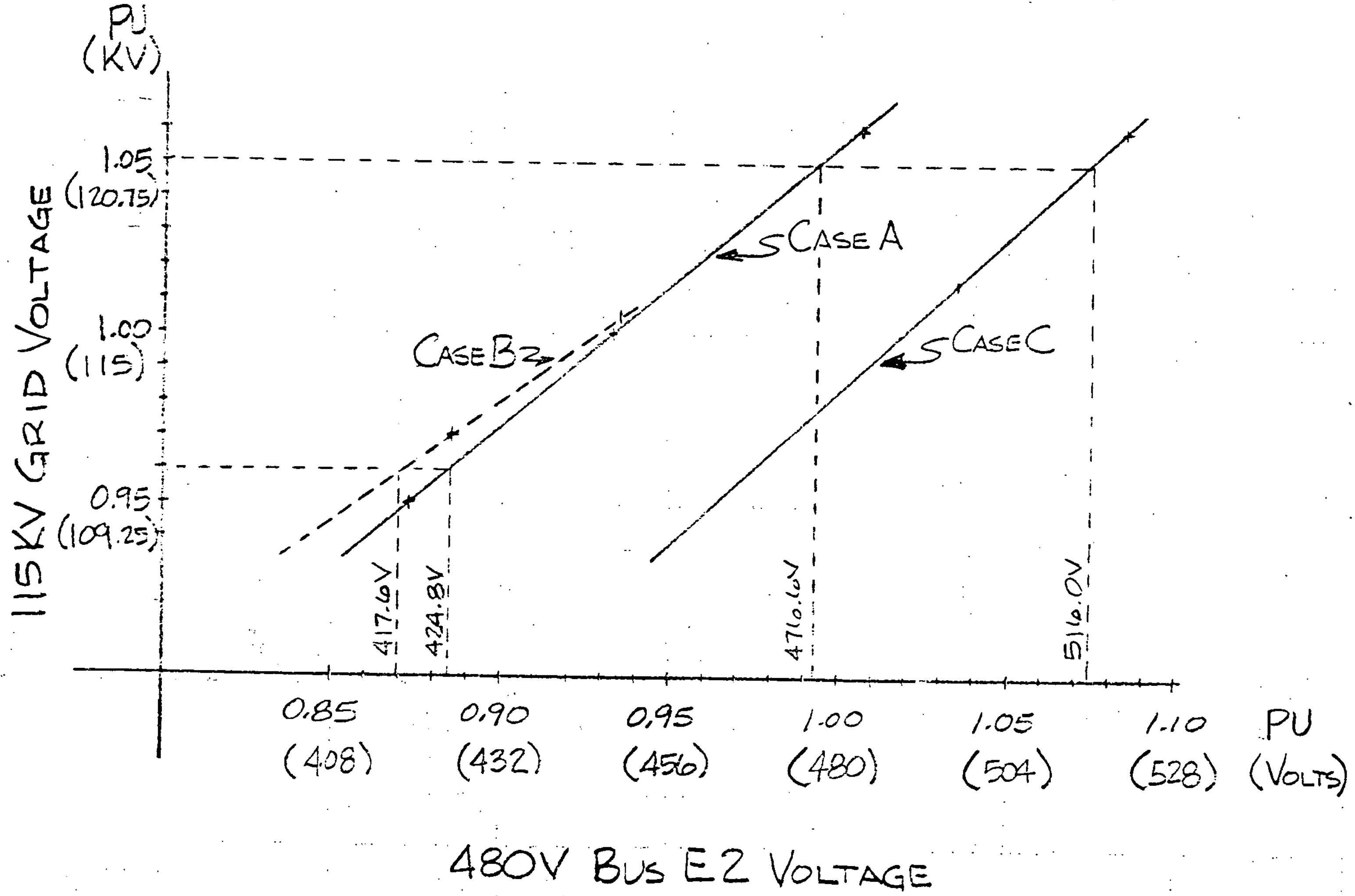
PU
(KV)
115KV GRID VOLTAGE
1.05
(120.75)
1.00
(115)
0.95
(109.25)
CASE A
CASE B
CASE C
417.6V
424.8V
476.6V
516.0V
0.85
(408)
0.90
(432)
0.95
(456)
1.00
(480)
1.05
(504)
1.10
(528)
PU
(VOLTS)
480V BUS E2 VOLTAGE

FIGURE 2A

BY JAL DATE 2/22/84 SUBJECT 115KV UNDER/OVER VOLTAGE ALARM SET-POINT EVALUATION SHEET NO. 3 OF 4
CHKD. BY DATE JOB NO.

CASE A

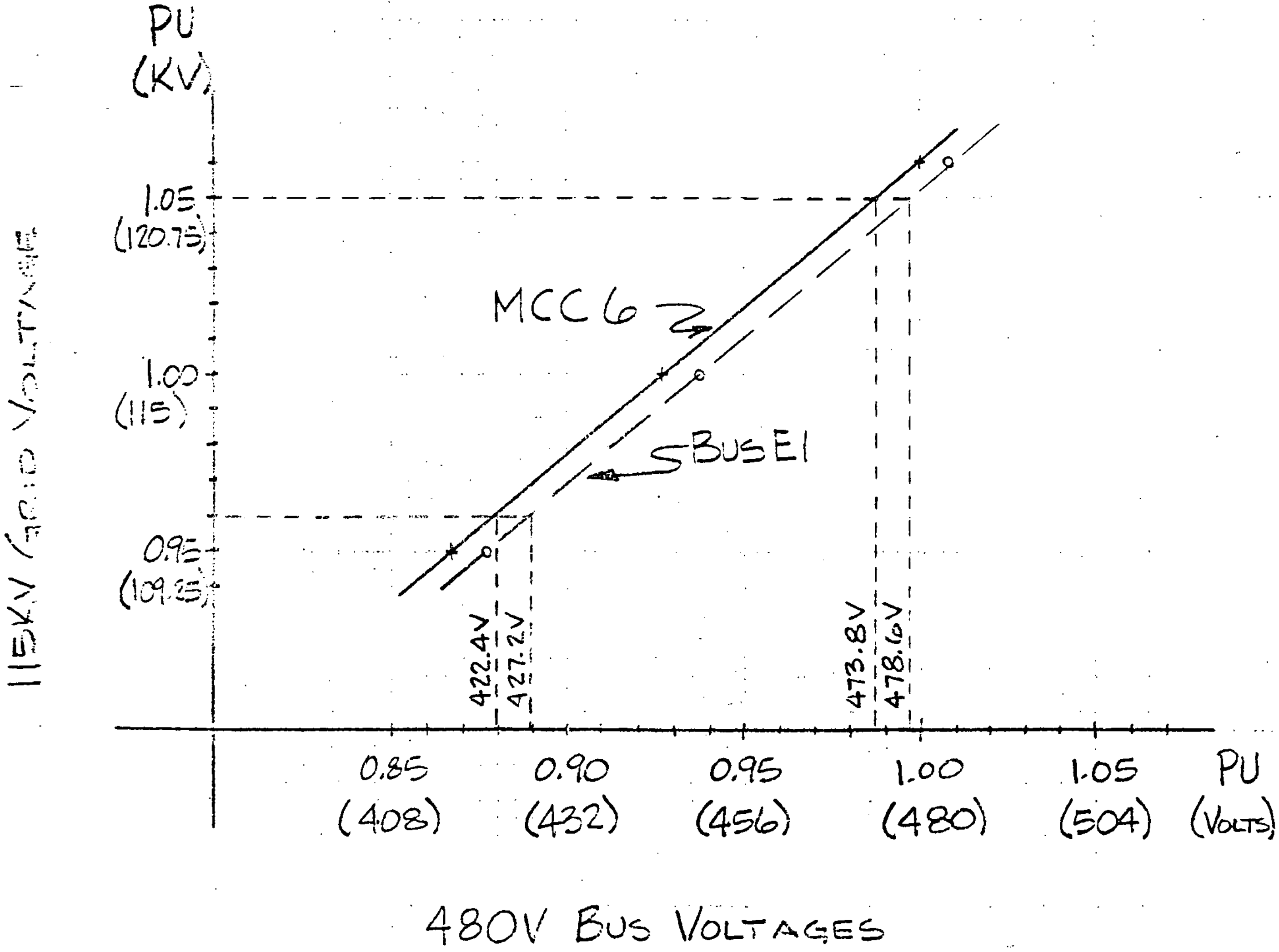

FIGURE 2B

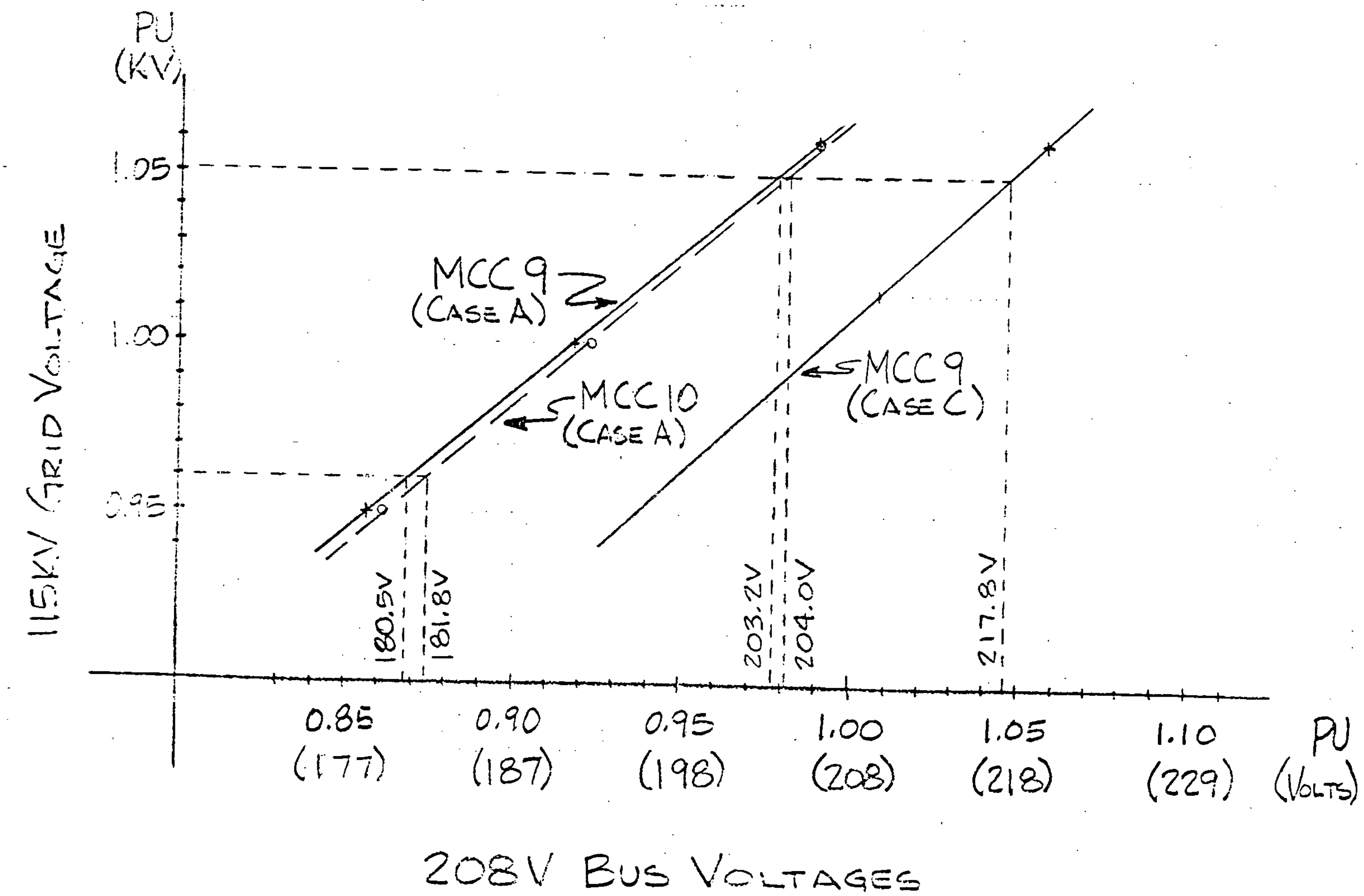
PU
(KV)
1.05
1.00
0.95
115KV Grid Voltage
MCC 9
(Case A)
MCC 10
(Case A)
MCC 9
(Case C)
180.5V
181.8V
203.2V
204.0V
217.8V
0.85
(177)
0.90
(187)
0.95
(198)
1.00
(208)
1.05
(218)
1.10
(229)
PU
(Volts)
208V Bus Voltages

FIGURE 3

ATTACHMENT 2

PUMP MOTOR ACCELERATION TEST RESULTS

PUMP MOTOR ACCELERATION TEST RESULTS

	Driven Equipment	Motor Size in Hp	Acceleration Time/Seconds	Bus Voltage	Test Date	Estimated Acceleration Time in March 1983 Report/Seconds
1.	Steam Generator Feedwater Pump A	6000	4.61	4100	8/28/83	≤ 7
2.	Steam Generator Feedwater Pump B	6000	4.32	4150	8/28/83	≤ 7
3.	Auxiliary Feedwater Pump A	350	2.33	480	8/27/83	≤ 5
4.	Auxiliary Feedwater Pump B	350	2.32	460	8/27/83	≤ 5
5.	Service Water Booster Pump A	150	0.50	*480	8/27/83	≤ 4
6.	Service Water Booster Pump B	150	0.48	*480	8/27/83	≤ 4

* Source voltage at 480 volt Bus E1 and E2.