Omaha Public Power District

1623 HARNEY ■ OMAHA, NEBRASKA 68102 ■ TELEPHONE 536-4000 AREA CODE 402

July 2, 1981

Mr. Robert A. Clark, Chief
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Operating Reactors Branch No. 3
Washington, D.C. 20555

Reference: Docket No. 50-285

Dear Mr. Clark:

The Commission's letter dated May 13, 1981, forwarded questions regarding the adequacy of Fort Calhoun Station's electrical distribution system voltages. Omaha Public Power District's response to those questions are attached.

Sincerely,

W. C. Jones
Division Manager
Production Operations

WCJ/KJM/TLP:jmm

Attachment

cc: LeBoeuf, Lamb, Leiby & MacRae
1333 New Hampshire Avenue, N.W.
Washington, D.C. 20036

A001
s 1/1

Attachment

Question

(A) Tables 1 and 2 of attachment 9 provide transient voltage values during the sequenced starting of the engineered safeguard loads on buses 1A3 and 1A4.

1. What are the final (steady-state) voltages at the 4160V and 480V buses, the 4160V, 4000V, and 460V motor terminals, and the 460V motor starters when all safeguard loads are operating for Cases 4, 5, and 6 of Table 1 and Cases 3, 4, 5, and 6 of Table 2?

2. What are the lowest 4160V bus transient voltages for Cases 4, 5, and 6 of Tables 1 and 2, attachment 9?

Response

The intent of question (A), part 1., is apparently to determine if the 161 kV tap setting on the 161/4.16 kV transformers would adversely affect the steady-state voltages after all the engineered safeguard loads have started and become operable. With this understanding, it is then apparent that, if the worst case motor terminal voltage exceeds minimum operating limits, then all the other cases would also be acceptable. This is what is shown in tables provided by enclosure 1, where the worst case was taken to be the motor which provides the largest load and cable impedence. For Table 1, the worst case gave a per unit value of 0.7494 which is 75% of 480 volts which exceeds the minimum acceptable level of 70% of 480 volts at the motor terminals.

Question

(B) The voltages at buses 1A3 and 1A4 in Tables 1, 2, and 3 of attachment 5 appear to be based on transformers T1A3 and T1A4 set on the 165kV tap (see sheet 2). What will the voltages be at buses 1A3 and 1A4 in Tables 1, 2, and 3 if the transformers are on the 161kV tap?

Response

Some load flows were run to examine the effect of changing the taps on the house service transformers at Fort Calhoun from 165 kV to 161 kV. Of primary interest is the power flowing through the generator auxiliary transformer when its secondary is tied to the secondary of the house service transformer. This is a condition that exists momentarily during the normal transfer of station service loads between the 161 kV and the 22 kV sources. Buses 1A2 and 1A4 were used in this analysis because they are more heavily loaded than buses 1A1 and 1A3. Enclosure 2, column V1A2, V1A4, demonstrates this effect.

Cases were run with the 22 kV bus voltage at .955 per unit (21.01 kV) and at 1.023 per unit (22.5 kV). The transmission system used in the model was 1978 summer peak load conditions, both with the system intact and with an outage of

Response (Continued)

the Raun 345/161 kV transformer. Previous investigations have shown this transformer outage causes the greatest difference in the voltage phase angle between the 22 kV and 161 kV buses at Fort Calhoun.

Under the conditions studied, the 161 kV tap caused a slight decrease in the transformer MVA loading. In all cases, the loading on the generator auxiliary transformer (22 kV/4160V) was between 25 and 30 MVA.

For the case where 161 kV is transferred to 165 kV directly, it was determined that voltages were higher for the 161 kV tap. Column V1A1 of enclosure demonstrates this effect and it is expected that the same effect would be seen for all buses.

Question

(C) The FSAR and attachment 6 indicate that provisions exist to start up the plant from the 345kV source. Can this source be used to safely shut the plant down under LOCA conditions if the 161kV source is not available? If so, how soon would the 345kV source be available?

Response

Yes. If the 161 kV source were not available and a LOCA were to occur, the operator would open the motor operated disconnect switch DS-T1 (generator disconnect switch), and close the two 345 kV breakers 3451-4 and 3451-5. The time required would be the time necessary for the equipment to operate.

Question

(D) What is the service factor for the 4160V, 4000V, and the 460V safeguards motors?

Response

Enclosure 3 provides a partial listing of motor service factors. Additional investigation is required for the remaining motors and this information will be provided by August 15, 1981.

Question

(E) The NRC letter of August 8, 1979, requires a test be performed to verify your analytical results. The latest guidelines required that this test should be performed by:

(a) Loading the station distribution buses including all Class 1E buses down to the 120/208V level, to at least 30%,

(b) Recording the existing grid and Class 1E bus voltages and bus loading down to the 120/208 volt level at steady state conditions and during the starting of both a large Class 1E and non-Class 1E motor (not

Question (Continued)

(Note) To minimize the number of instrumented locations (recorders), during the motor starting transient tests, the bus voltages and loading need only be recorded on that string of buses which previously showed the lowest analyzed voltages.

(c) Using the analytical techniques and assumptions of the previous voltage analyses and the measured existing grid voltage and bus loading conditions recorded during conduct of test, calculate a new set of voltages for all Class 1E buses down to the 120/208 volt level.

(d) Compare the analytical derived voltage values against the test results.

With good correlation between the analytical results and test results, the test verification requirement will be met. That is, the validity of the mathematical model used in performance of the analysis will have been established. In general, the test results should be within ± 3% of the analytical results; however, the difference between the two when subtracted from or added to should never provide values that would allow operation of the Class 1E equipment outside of rated voltage ranges.

Please provide a test description and date by when test results will be available.

Response

During 1978, the District did some testing to verify the electrical distribution system voltages. The 1978 test data is still being evaluated to determine the correlation to present guidelines, and determine further testing.

The District expects to provide our response by August 31, 1981.

GSE-B-2-2 FORM REVISION 01 DATE AUG 01 1975 TASK NO. FC-77-40	PREPARED BY ____ CHECKED BY ____ APPROVED ____ REV. ____ DATE ____	TRANSFORMER TAP CHANGE DESIGN DESCRIPTION SH. ____ CONT. ON SH. ____ OMAHA PUBLIC POWER DISTRICT GENERATING STA. ENG.

TABLE - 1 (STEADY STATE)

(BUS 1A4)

CASE	SYSTEM CONDITIONS				STEADY STATE VALUE OF VOLTAGE AT BUS/ MOTOR TERMINALS. (B - BUS VOLTAGE M - MOTOR TERM VOLTAGE)																	
					GROUP 1										GROUP 2						GROUP3	
	SYSTEM VOLTAGE (SEE NOTE 2)	LOADING NORMAL/STARTUP	TRANSF. TIA-4 TAPS	TRANSF. TIA-4 A,B,C TAPS	LPSI PUMP 300 HP (BUS 1A4)		RAW WATER PUMP 200 HP (BUS 1A4)		COMP CLG WATER PUMP 250 HP BUS 1B4A		CONTAINMENT SPRAY PUMP 300 HP BUS 1B4B		HIGH PRESSURE SAFETY INJ. PUMP 300 HP BUS 1B4C		CONTAINMENT AIR FAN 125HP BUS 1B4S		CONTAINMENT SPRAY PUMP 300HP BUS 1B3S		CHARGING PUMP 75 HP BUS 1B4C		RAW WATER PUMP 200 HP BUS 1A4		CHARGING PUMP 75HP BUS 1B4S		CONTAINMENT AIR FAN 250HP BUS 1B4C	
					B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
①	161	N	165/4.16	4.16/0.48																						
②	161	S	165/4.16	4.16/0.48																						
③	161x 0.945	N	16 / 4.16	4.16/0.48																						
④	161x 0.945	N	161/4.16	4.16/0.48	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
⑤	161	S	161/4.16	4.16/0.48	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
⑥	161x 0.945	S	161/4.16	4.16/0.48	0.8119	NR	0.8119	NR	NR	NR	NR	NR	0.7708	0.7494	NR	NR	NR	NR	0.7708	NR	0.8119	NR	NR	NR	0.7708	NR

VOLTAGE BASE FOR CASE 1, 2, 3: 165, 4.16, 0.48

VOLTAGE BASE FOR CASE 4, 5, 6: 161, 4.16, 0.48

ABBREVIATIONS.

NR - CALCULATIONS NOT REQD.

N - NORMAL LOADING 8 MW @ 0.865 pf.

S - OUTAGE LOADING 17.9 MVA @ 0.8 pf

NOTES:

These voltages are steady-state values with all motors operating, (Groups 1, 2 and 3), as requested in Question (A) part (1).

NOTE: (1) Calculations were performed for worst conditions only, if for obvious reasons it was evident that a particular condition will have no problem, no calculations were done. Such cases in this table are marked "NR".

(2) 161 KV is normal minimum system voltage. In outage condition, with one transmission line out of service, this can go down to (0.945 x 161) KV.

TABLE -2 (STEADY STATE)

(BUS 1A3)

CASE	SYSTEM CONDITIONS: SYSTEM VOLTAGE (SEE NOTE 2)	LOADING NORMAL / STARTUP	TRANSF. T1A-4 TAPS	TRANSF. T1A-4 A,B,C TAPS	GROUP 1: LPSI PUMP 300 HP (BUS 1A3) B	M	RAW WATER PUMP 200 HP (BUS 1A3) B	M	COMP CLG WATER PUMP 250 HP BUS 1B3B B	M	CONTAINMENT SPRAY PUMP 300 HP BUS 1B3C B	M	HIGH PRESSURE SAFETY INJ. PUMP 300 HP BUS 1B3A B	M	GROUP 2: CONTAINMENT AIR FAN 125 HP BUS 1B3C B	M	HPSI PUMP 300 HP 1B3A-4A B	M	CHARGING PUMP 75 HP BUS 1B3A B	M	COMP. CLG WATER PUMP BUS 1B3C B	M	GROUP 3: RAW WATER PUMP 200 HP BUS 1A3 B	M	CONTAINMENT AIR FAN 250 HP BUS 1B3A B	M
1	161	N	165/4.16	4.16/0.48																						
2	161	S	165/4.16	4.16/0.48																						
3	161	10.7 MW @ 0.85 pf	16 / 4.16	4.16/0.48	0.922	NR	0.922	NR	0.8759	0.8685	0.8497	NR	0.8547	NR	0.8497	NR	0.8547	NR	0.8547	NR	0.8497	NR	0.922	NR	0.8547	NR
4	161 x 0.945	N	161/4.16	4.16/0.48	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
5	161 x 0.945	5.5 MW @ 0.85 pf	161/4.16	4.16/0.48	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6	161 x 0.945	7.2 MW @ 0.85 pf	161/4.16	4.16/0.48	0.8868	NR	0.8868	NR	NR	NR	0.8107	0.7882	0.8161	NR	0.8107	NR	0.8161	0.8151	0.8161	NR	0.8107	NR	0.8668	NR	0.8161	NR

STEADY STATE VALUE OF VOLTAGE AT BUS/ MOTOR TERMINALS. (B - BUS VOLTAGE M - MOTOR TERM VOLTAGE)

VOLTAGE BASE FOR CASE 1, 2 165, 4.16, 0.48

VOLTAGE BASE FOR CASE 3, 4, 5, 6 161, 4.16, 0.48

ABBREVIATIONS.
NR - CALCULATIONS NOT READ
N - NORMAL LOADING 3.5 MW @ 0.85 pf.
S - START UP LOADING

NOTES:

These voltages are steady-state values with all motors operating, (Groups 1, 2 and 3), as requested in Question (A), part (1).

NOTE: (1) Calculations were performed for worst conditions only, if for obvious reasons it was evident that a particular condition will have no problem, no calculations were done. Such cases in this table are marked "NR".
(2) 161 KV is normal minimum system voltage. In outage condition, with one transmission line out of service, this can go down to (0.945 x 161) KV.

GSE-B-2-2 FORM
REVISION 01
DATE AUG 01 1975
TASK NO FC-77-40

PREPARED BY ____
CHECKED BY ____
APPROVED ____
REV. ____ DATE ____

TRANSFORMER TAP CHANGE DESIGN DESCRIPTION
SH ___ CONT. ON SH ___

OMAHA PUBLIC POWER DISTRICT
GENERATING STA ENG.

Enclosure 1

GSE-B-2-2 FORM
REVISION 01
DATE AUG 01 1975
TASK NO FC-[illegible]

PREPARED BY ______
CHECKED BY ______
APPROVED ______
REV. ____ DATE ______

TRANSFORMER TAP CHANGE DESIGN DESCRIPTION
SH. ___ CONT. ON SH. ___

OMAHA PUBLIC POWER DISTRICT
GENERATING STA. ENG.

TABLE - 1 (TRANSIENT

(BUS 1A4)

CASE	SYSTEM CONDITIONS				TRANSIENT VALUE OF VOLTAGE AT BUS/ MOTOR TERMINALS. (B - BUS VOLTAGE M - MOTOR TERM VOLTAGE)																							
					GROUP 1										GROUP 2								GROUP 3					
	SYSTEM VOLTAGE (SEE NOTE 2)	LOADING NORMAL / STARTUP	TRANSF. T1A-4 TAPS	TRANSF. T1A-4 A,B,C TAPS	LPSI PUMP 300 HP (BUS 1A4)		RAW WATER PUMP 200 HP (BUS 1A4)		COMP CLG WATER PUMP 250 HP BUS 1B4A		CONTAINMENT SPRAY PUMP 300 HP BUS 1B4B		HIGH PRESSURE SAFETY INJ. PUMP 300 HP BUS 1B4C		CONTAINMENT AIR FAN 125HP BUS 1B3B		CONTAINMENT SPRAY PUMP 300HP BUS 1B3B		CHARGING PUMP 75 HP BUS 1B4C		RAW WATER PUMP 200 HP BUS 1A4		CHARGING PUMP 75 HP BUS 1B4B		CONTAINMENT AIR FAN 250HP BUS 1B4C	
					B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
1	161	N	165/4.16	4.16/0.48																						
2	161	S	165/4.16	4.16/0.48																						
3	161 x 0.945	N	16 / 4.16	4.16/0.48																						
4	161X 0.945	N	161/4.16	4.16/0.4	0.8507																					
5	161	S	161/4.16	4.16/0.48	0.8559																					
6	161X 0.945	S	161/4.16	4.16/0.48	0.7924																					

VOLTAGE BASE FOR CASE
1, 2, 3   165, 4.16, 0.48
VOLTAGE BASE FOR CASE
4, 5, 6   161, 4.16, 0.48

ABBREVIATIONS.
NR - CALCULATIONS NOT READ
N - NORMAL LOADING
8 MW @ 0.865 pf.
S - OUTAGE LOADING
17.9 MVA @ 0.8 pf

CONCLUSIONS.

Question (A), part (2) asks for the lowest 4160 v bus transient. As expected it occurs under outage condition with start-up loading (Case 6), as 0.7924 pu. which is 79% of 4160 v.

NOTE: (1) Calculations were performed for worst conditions only, if for obvious reasons it was evident that a particular condition will have no problem, no calculations were done. Such cases in this table are marked "NR".

(2) 161 KV is normal minimum system voltage. In outage condition, with one transmission line out of service, this can go down to (0.945 x 161) KV.

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PREPARED BY ______
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APPROVED ______
REV. ____ DATE ______

TRANSFORMER TAP CHANGE DESIGN DESCRIPTION
SH. ___ CONT. ON SH. ______

OMAHA PUBLIC POWER DISTRICT
GENERATING STA. ENG.

TABLE - 2 (TRANSIENT)

(BUS 1A3)

CASE	SYSTEM CONDITIONS				TRANSIENT VALUE OF VOLTAGE AT BUS/ MOTOR TERMINALS. (B - BUS VOLTAGE M - MOTOR TERM VOLTAGE)																					
					GROUP 1										GROUP 2								GROUP 3			
	SYSTEM VOLTAGE (SEE NOTE 2)	LOADING NORMAL /STARTUP	TRANSF. TIA-4 TAPS	TRANSF. TIA-4 A,B,C TAPS	LPSI PUMP 300 HP (BUS 1A3)		RAW WATER PUMP 200 HP (BUS 1A3)		COMP CLG WATER PUMP 250 HP BUS 1B3B		CONTAINMENT SPRAY PUMP 300 HP BUS 1B3C		HIGH PRESSURE SAFETY INJ. PUMP 300 HP BUS 1B3A		CONTAINMENT AIR FAN 125HP BUS 1B3C		HPSI PUMP 300 HP 1B3A-4A		CHARGING PUMP 75 HP BUS 1B3A		COMP. CLG. WATER PUMP BUS 1B3C		RAW WATER PP. 200 HP BUS 1A3		CONTAINMENT AIR FAN 250HP BUS 1B3A	
					B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
①	161	N	165/4.16	4.16/0.48																						
②	161	S	165/4.16	4.16/0.48																						
③	161	10.7 MW @ 0.85 pf	16 / 4.16	4.16/0.48																						
④	161 x 0.945	N	161/4.16	4.16/0.48	NR																					
⑤	161 x 0.945	5.5 MW @ 0.85 pf	161/4.16	4.16/0.48	NR																					
⑥	161 x 0.945	7.2 MW @ 0.85 pf	161/4.16	4.16/0.48	0.8552																					

VOLTAGE BASE FOR CASE
1, 2 165, 4.16, 0.48

VOLTAGE BASE FOR CASE
3, 4, 5, 6 161, 4.16, 0.48

ABBREVIATIONS.
NR - CALCULATIONS NOT REQ'D
N - NORMAL LOADING 3.5 MW @ 0.85 pf.
S - START UP LOADING

CONCLUSIONS.

Lowest 4160 v bus transient = 0.8552 p.u. since Case 6 is taken as worst case.

NOTE: (1) Calculations were performed for worst conditions only, if for obvious reasons it was evident that a particular condition will have no problem, no calculations were done. Such cases in this table are marked "NR".

(2) 161 KV is normal minimum system voltage. In outage condition, with one transmission line out of service, this can go down to (0.945 x 161) KV.

Base MVA => 100 MVA.

1978 Summer Peak Load Conditions

Combined load on buses 1A2 and 1A4 18.88 MVA at .86 power factor

Plant generator output 480 MW

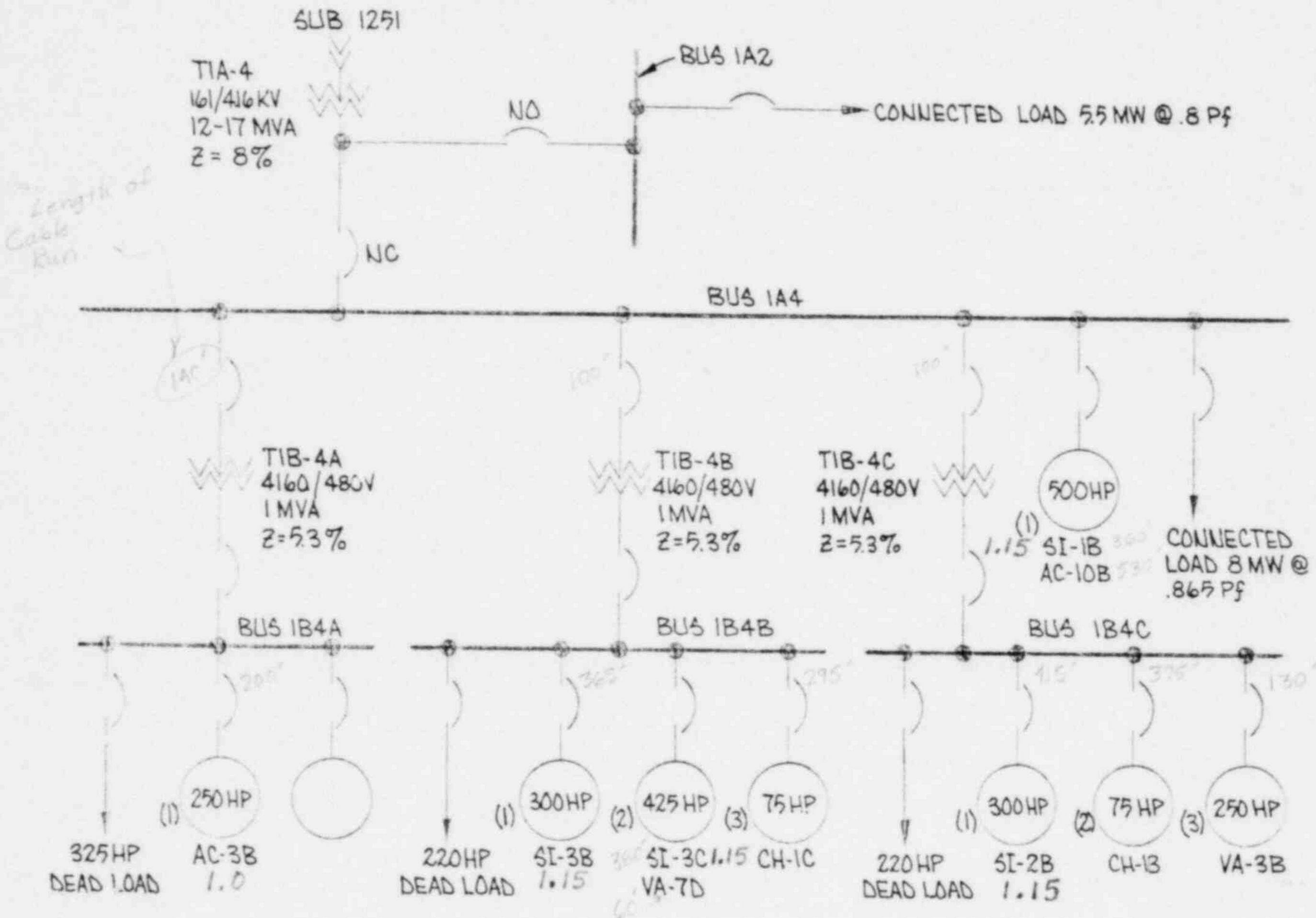
House Service Transf. tap (kV)	V 22 kV 22 kV base	V 161 kV 161 kV base	Flow 22 kV to 1A4 MW	MVA	V 1A2, V 1A4 4160V base	V 1A1 4160V base	V 1A3 4160V base	Raun 345/161 Transf. Status
165	1.023/-13.7°	1.020/-24.7°	25.86+j 9.94	27.7	.973/-20.9°	1.013/-14.7°	.980/-25.9°	in
161	1.023/-13.7°	1.019/-24.7°	26.0+j 7.82	27.2	.983/-20.9°	1.013/-14.7°	1.004/-25.8°	in
165	.955/-13.0°	1.010/-24.7°	25.13+j 5.14	25.6	.928/-20.9°	.944/-14.1°	.970/-26.0°	in
161	.955/-13.0°	1.008/-24.7°	25.28+j 3.18	25.5	.938/-20.9°	.944/-14.1°	.993/-25.9°	in
165	1.023/-13.3°	1.021/-25.4°	27.60+j 10.24	29.44	.972/-21.0°	1.013/-14.3°	.981/-26.6°	out
161	1.023/-13.3°	1.019/-25.4°	27.78+j 8.12	28.94	.983/-21.0°	1.013/-14.3°	1.004/-26.6°	out
165	.955/-12.5°	1.010/-25.5°	26.79+j 5.45	27.34	.927/-21.0°	.944/-13.7°	.970/-26.8°	out
161	.955/-12.5°	1.009/-25.5°	26.97+j 3.50	27.20	.937/-21.0°	.944/-13.7°	.994/-26.7°	out

Here it is shown that the voltage at Buses 1A3 and 1A4 will always be higher with the tap at 161 kV, than with the tap at 165 kV.

Ken Birt - OPPD
June 14, 1978

GSE-B-2-2 FORM REVISION 01 DATE AUG 01 1975	PREPARED BY CHECKED BY APPROVED REV. ___ DATE ___	Motor Terminal Voltage Calculations SH 2 CONT ON SH 3
TASK NO FC-77-40		OMAHA PUBLIC POWER DISTRICT GENERATING STA ENG

1) One Line Diagram: (Refer to Fig. 8.4-1 FSAR)



(1) - 1st Group of Sequence Starting Motors

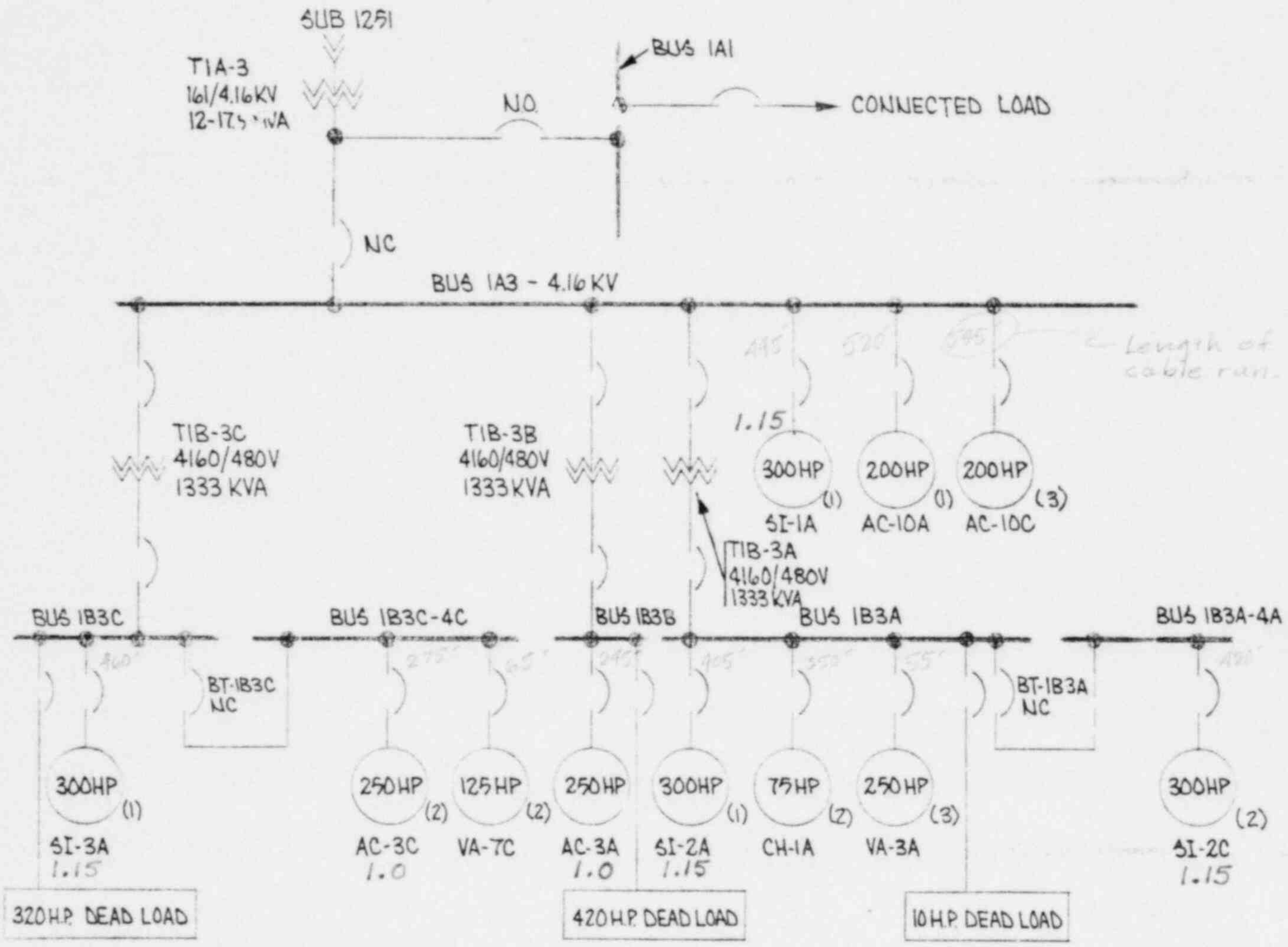
(2) - 2nd Group of Sequence Starting Motors

(3) - 3rd Group of Sequence Starting Motors

Service Factors in green.

GSE-B-2-2 FORM REVISION 01 DATE AUG 0 1 1975	PREPARED BY CHECKED BY APPROVED REV. DATE	Motor Terminal Voltage Calculations SH 2 CONT ON SH 3
TASK NO		OMAHA PUBLIC POWER DISTRICT GENERATING STA ENG

1) One Line Diagram: (Refer to Fig. 8.4-1 FSAR)



(1) - 1st Group of Sequence Starting Motors

(2) - 2nd Group of Sequence Starting Motors

(3) - 3rd Group of Sequence Starting Motors

Service Factors in green.