Adequacy of Station Electric Distribution System Voltages

Commonwealth Edison Company

Zion Station
Quad Cities Station
Dresden 2/3

December 14, 1979

In the November 1, 1979 submittal on the adequacy of "Station Electric Distribution System Voltages", it was stated that further information on corrective measures for the Zion 480 volt low voltage condition, a further analysis of the slight high voltage condition on the 480 volt buses and a test verifying the validity of the computer program used to determine the auxiliary power voltages would be submitted at a later date.

Accordingly, an analysis of the corrective measure for resolving the Zion low voltage condition, test results for a Zion voltage test, and an analysis of the high voltage on the 480 volt buses at Dresden 2/3, Quad Cities and Zion follow in this report.

Low Voltage on 480 Volt Buses - Zion Station

In the November 1, 1979 submittal on the adequacy of "Station Electric Distribution System Voltages", it was indicated that the calculated voltage on two of the three 480 volt Engineered Safety Feature buses at Zion Station was slightly low for the minimum expected grid voltage of 343 KV when the auxiliary power system is loaded with its maximum expected load plus the load of the Engineered Safety Features.

C.E.Co. has evaluated this low voltage condition and proposes to remedy the condition by load shedding. The load shedding will consist of automatically tripping one Circulating Water Pump and two Condensate Booster Pumps for a total of 9500 horsepower. The load shedding will occur for a unit trip if the 480 volt bus voltage reaches about 440 volts. The exact voltage level at which load shedding will occur will be determined after the voltage sensing relay type has been selected. Neither a unit trip alone nor a low bus voltage alone will result in load shedding.

Exhibit 1 indicates the expected 480 volt bus voltages when load shedding is included in the voltage analysis for the minimum expected grid voltage and the maximum expected auxiliary power system loading.

Test Results - Zion Station

The results of the computer program used to analyze the Zion auxiliary power systems have been verified by test. Accurate measurements of the bus voltages and loads on the auxiliary power system were made on November 14, 1979. At the time that the measurements were taken, both Zion units were shut down.

The measured loads were entered into the computer program and the voltages were computed by the computer. A comparison of the measured voltages with the voltages calculated by the computer for Units 1 and 2 are shown on Exhibits 2 and 3 respectively.

The 345 KV bus voltage was 345 at the beginning of the test on Unit 1 and had increased to 348 KV by the time all Unit 1 measurements had been completed. The 345 KV bus voltage was 348 KV during the entire time that measurements were being made on Unit 2.

The voltage calculations for Unit 1 were based on a grid voltage of 348 KV. Exhibit 2 indicates that the calculated voltage data agrees well with the measured data. The initial measured grid voltage (345 KV) is about 1% lower than the final measured grid voltage (348 KV). If the worst case was assumed, that is, a measured voltage of 345 KV, and the calculation was based on 348 KV, the largest % difference between calculated and measured voltage would only be about 1%. This difference can be considered to be within instrument accuracy.

Calculations for Unit 2 (Exhibit 3) give agreement within about 0.6% of the measured voltages.

The close agreement between these measured versus calculated voltage values verifies that the results of the voltage analyses for Zion Station are valid.

High Voltage on 480 Volt Buses

In the November 1, 1979 submittal on the adequacy of "Station Electric Distribution System Voltages", it was indicated that the calculated no-load voltages on the 480 volt Engineered Safety Feature buses are slightly high for the maximum expected grid voltages at Dresden 2/3, Quad Cities and Zion Stations. That is, the calculated no-load voltages on the 480 volt buses exceeded the nominal equipment ratings (460 volts) by slightly more than 10%.

The no-load voltages do not take into account the volt drop across the 4 KV to 480 volt transformers and associated leads or the voltage drop in the leads from 480 volt buses to the equipment being supplied with power.

In order to evaluate overvoltages at the 480 volt bus under light load conditions, the actual loading on the auxiliary power system at Zion Station was measured with both Zion units shut down. The shutdown loads for Units 1 and 2 are shown on Exhibits 4 and 5 respectively. These loadings were used to calculate the various bus voltages using the maximum expected grid voltage of 354 KV. The highest voltage observed was 510 volts (110.9% of 460 volts) on Bus 138. This voltage would be decreased further if the voltage drop in the cable supplying the equipment is taken into account. Adding required ESF loads or any other loads necessary for operating will result in decreasing the 480 volt bus voltages even further.

Based on the above analysis of maximum voltage conditions occurring at light loads on the auxiliary power system at Zion Station, it is our conclusion that the safety loads at Zion Station will not be subjected to unacceptable overvoltages.

Also based on the above analysis, it is our conclusion that safety loads at Dresden and Quad Cities Stations will not be subjected to unacceptable overvoltages. As soon as the buses are loaded even slightly, there is enough voltage drop in the supply transformers and the associated cable to the equipment that the highest expected voltages at the equipment terminals will be very close to 110%.

Exhibit 1

480 Volt ESF Bus Voltages

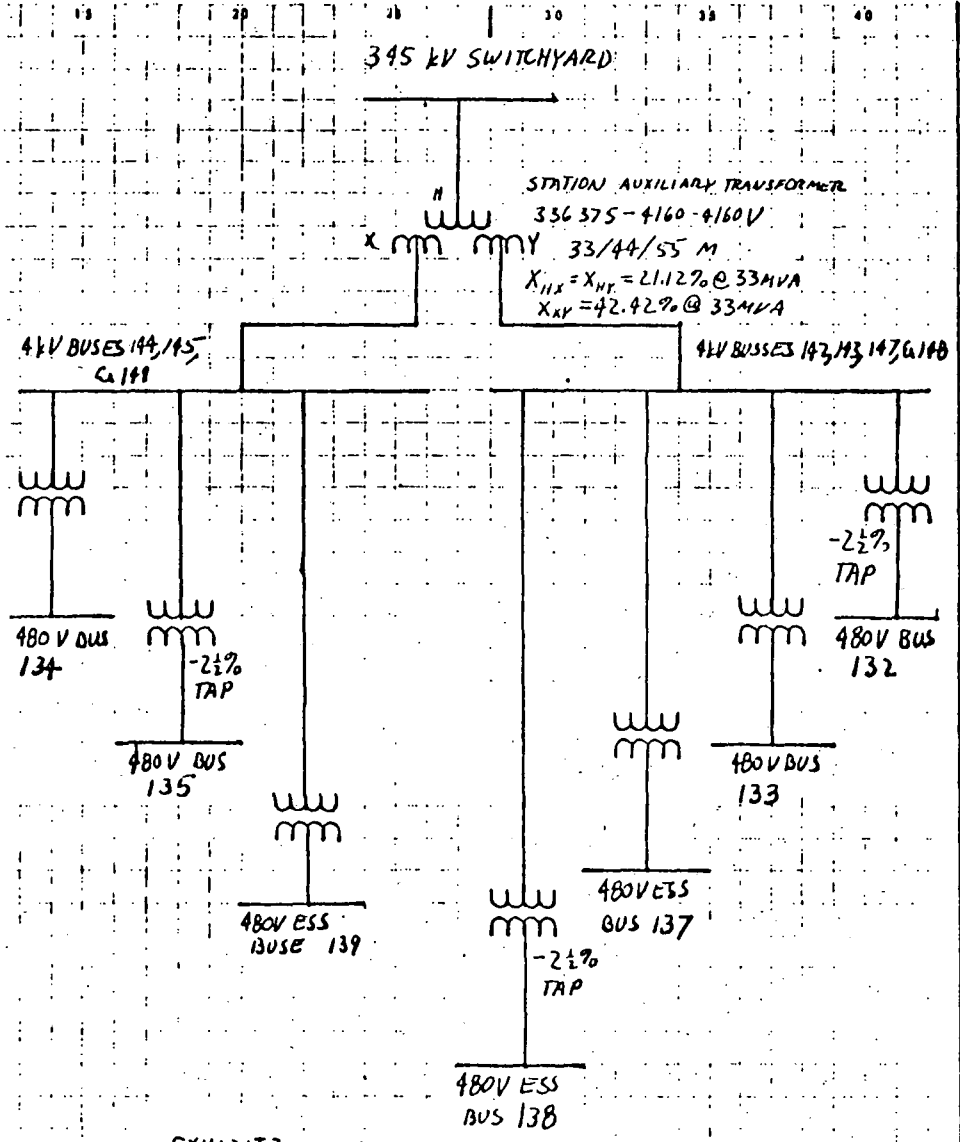
Corrective Measure

Zion Station

	Load Shedding 2-CBP & 1-CWP* Only
480V ESS Bus 137	
Coincident kVA	878
Volts	426
% of 480V	88.8
% of 460V	92.6
480V ESS Bus 138	
Coincident kVA	1437
Volts	420
% of 480V	87.5
% of 460V	91.3
480V ESS Bus 139	
Coincident kVA	832
Volts	435
% of 480V	90.6
% of 460V	94.6

*CBP - Condensate Booster Pump
CWP - Circulating Water Pump

CALCULATED VOLTAGE	MEASURED VOLTAGE	% DIFFERENCE
348 000	344,960	
4256	4270	-0.33
487	487.73	-0.15
488	492.26	-0.87
482	480	0.42



CALCULATED VOLTAGE	MEASURED VOLTAGE	% DIFFERENCE
348,000	344900	
4253	4268.8	-0.37
489	487.73	0.26
496	496.36	-0.07
489	487.73	0.26
500	497.3	0.54

EXHIBIT 2
VALIDATION OF COMPUTER PROGRAM - UNIT 1

SARGENT LUNDY

Client COMMONWEALTH EDISON CO.	Prepared by W G BLOETHE	Date 12-6-78	Calc. No.
Project ZION	Reviewed by	Date	Rev. Date
Proj. No. 6030-33 Equip. No.	Approved by	Date	Page 1 of 1

Calcs. For VALIDATION OF EASY ZION UNIT 1
Safety-Related ☒ Non-Safety-Related

CALCULATED VOLTAGE 345 000	MEASURED VOLTAGE 348 000	% DIFFERENCE
4256	4279.3	
486	488.67	
496	497.47	
477	480.1	

345 kV SWITCHYARD

STATION AUXILIARY TRANSFORMER
336375-4160-4160V
33/47/55 MVA
X_{HX} = 20.64% @ 33 MVA X_{HY} = 20.68% @ 33 MVA
X_{XY} = 40.94% @ 33 MVA

4kV BUSES 244, 245, CA241

4kV BUSSES 242, 243, 247, CA248

480 V BUS 234

-2½% TAP

480V BUS 235

480V ESS BUS 239

480V ESS BUS 238

480V ESS BUS 237

-2½% TAP

480V BUS 233

480V BUS 232

CALCULATED VOLTAGE 348 000	MEASURED VOLTAGE 348000	% DIFFERENCE
4245	4265.3	-0.48
478	481.7	-0.77
498	500.9	-0.58
488	490.67	-0.54
485	488.1	-0.64

EXHIBIT 3
VALIDATION OF COMPUTER PROGRAM - UNIT 2

SARGENT LUNDY

Client COMMONWEALTH EDISON CO
Project ZION
Proj. No. 6030-33 Equip. No.

Prepared by W G BLOETHE Date 12-6-79
Reviewed by Date
Approved by Date

Calcs. For VALIDATION OF EASY - ZION UNIT 2
Safety-Related X Non-Safety-Related

Calc. No
Rev. Date
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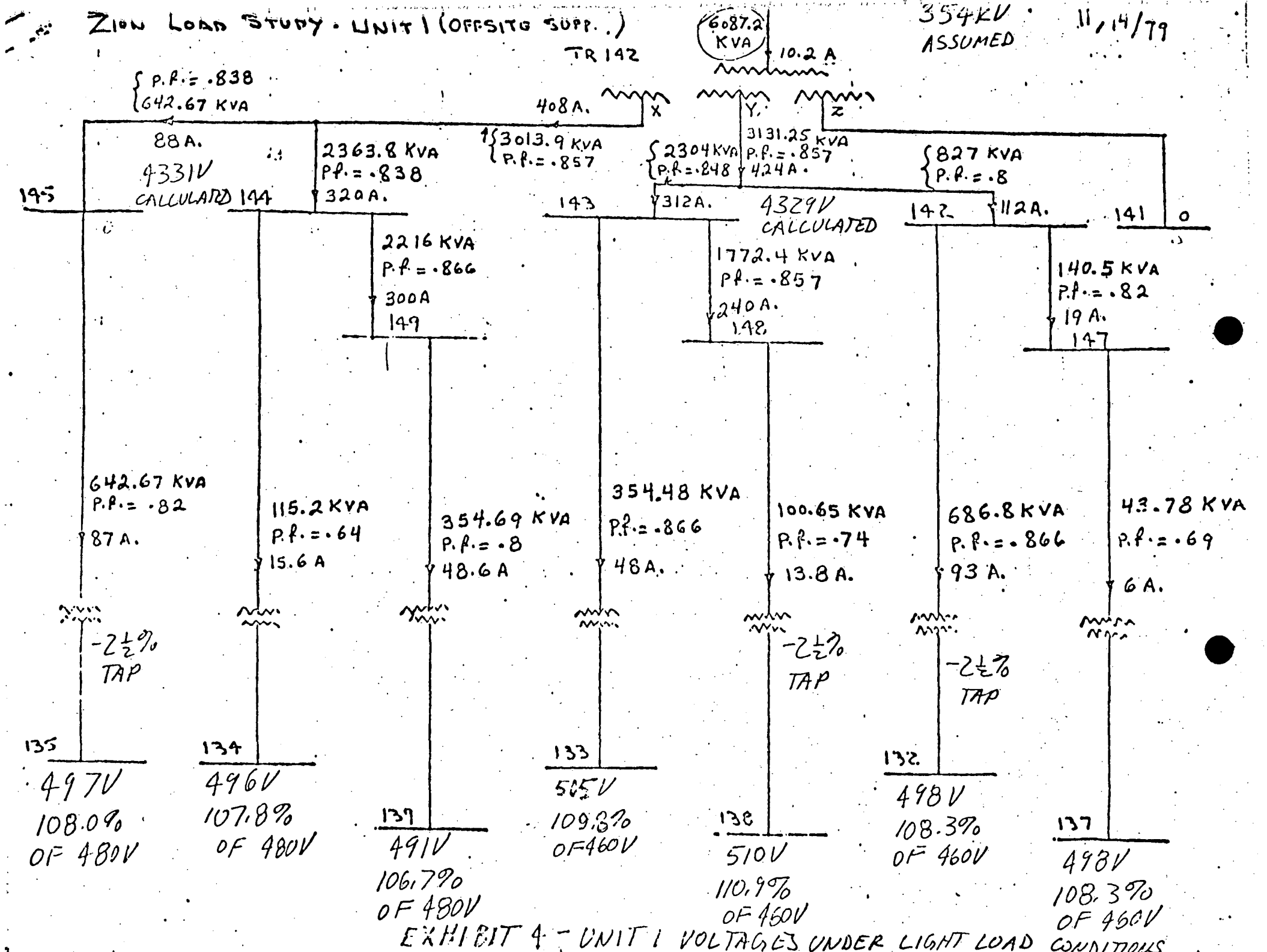

EXHIBIT 4 - UNIT 1 VOLTAGES UNDER LIGHT LOAD CONDITIONS

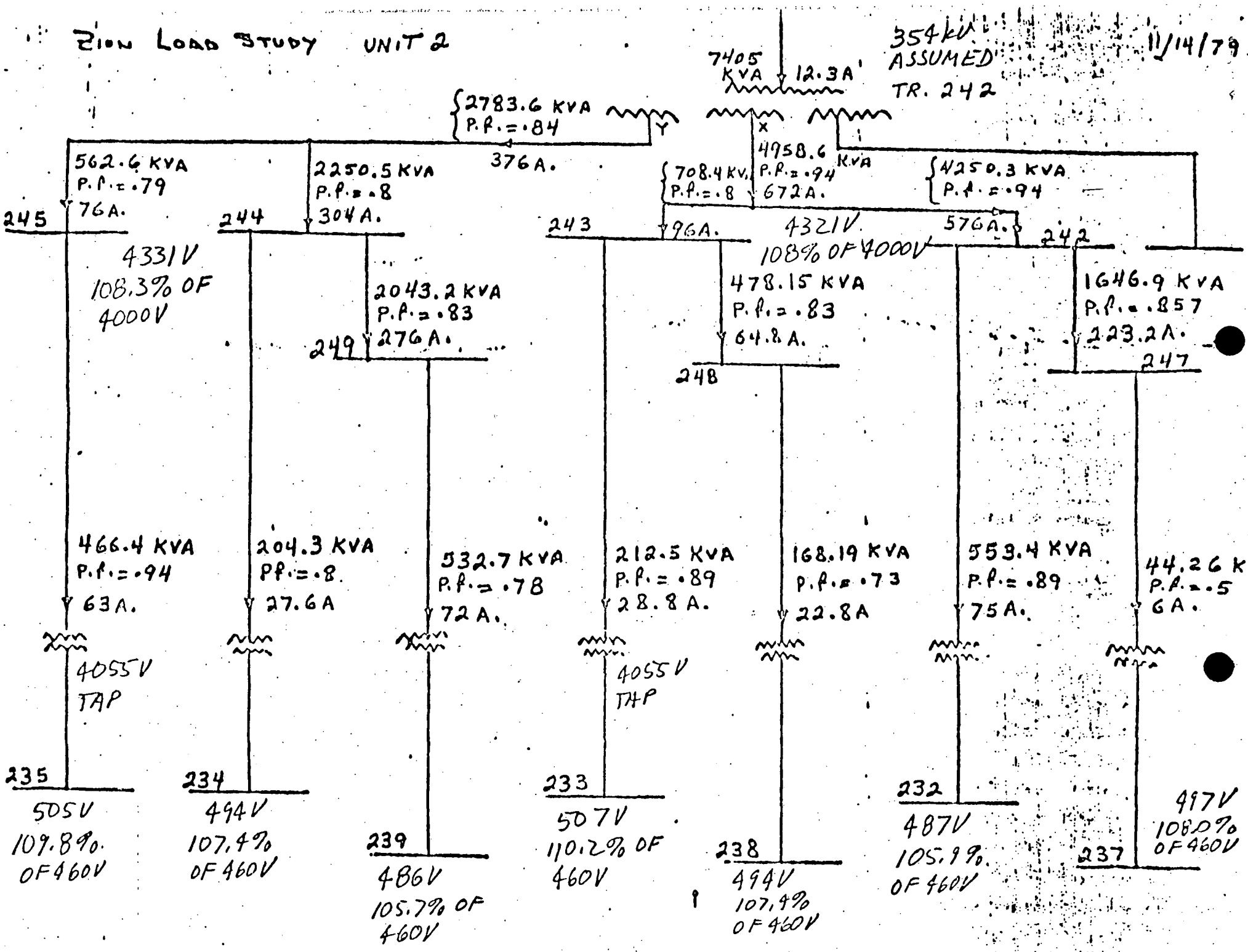

EXHIBIT 5 - UNIT 2 VOLTAGES UNDER LIGHT LOAD CONDITIONS