SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT ☐ 6201 S Street, Box 15830, Sacramento, California 95813; (916) 452-3211

August 1, 1980

Director of Nuclear Reactor Regulation
Attention: Mr. Robert W. Reid, Chief
Operating Reactors, Branch 4
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket No. 50-312
Rancho Seco Nuclear Generating Station,
Unit 1
Adequacy of Station Electrical Distribution
System Voltage

Dear Mr. Reid:

There have been a number of letters and telephone conversations between the District and the NRC concerning the adequacy of the Rancho Seco Safety Grade Electrical Distribution System since the off site degraded voltage condition at Millstone Unit No. 2 during July, 1976. In the various letters and telephone conversations, the District has reported the results of analyses and made design commitments. Over the past four years, the NRC has clarified their position on certain items which have required the District to perform additional analyses and make new design commitments. Also, the District has made major modifications and is planning future modifications to the electrical distribution system that has required additional analyses and new design commitments.

The number of letters and telephone conversations that describe the District's proposed modifications have become so numerous that the staff and the District are not communicating effectively. To resolve this problem, the District is resubmitting in their entirety, our responses to your letters of June 3, 1977 and August 8, 1979. These responses have been revised to indicate:

(a) All commitments made to the NRC.
(b) All modifications that have been performed.
(c) All proposed modifications.
(d) All proposed technical specifications and operating procedure changes.

Enclosures I and II of this letter contain all the information required for an evaluation of the District's existing and proposed distribution system. They supersede all other transmittals on this item. Revisions from our previous response are indicated by a line in the margin with a revision number next to it.

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The District is planning to implement all the proposed modifications during the 1981 refueling outage, scheduled for June 1, 1981.

It will require nine months of engineering to complete the design. The material required to implement the task have lead times as long as 9 - 12 months. Therefore, to be able to implement the modification during the June, 1981 refueling outage, the District must have all NRC comments resolved and the design approved by September 30, 1980.

If you have any questions on this item, please do not hesitate to contact me.

Sincerely,

John J. Mattimoe

John J. Mattimoe
Assistant General Manager
and Chief Engineer

Enclosure

Enclosure I

SACRAMENTO MUNICIPAL UTILITY DISTRICT

RANCHO SECO NUCLEAR GENERATING
STATION, UNIT NO. 1

RESPONSE TO:

NUCLEAR REGULATORY COMMISSION
REQUEST TO REVIEW
THE
ADEQUACY OF STATION ELECTRIC
DISTRIBUTION SYSTEM VOLTAGES
(LETTER FROM WILLIAM GAMMILL
TO POWER REACTOR LICENSEES
DATED AUGUST 8, 1979)

Issued: October 17, 1979
Revision 1: August 1, 1980

ENCLOSURE I

PART A

GENERAL RESPONSE TO
WILLIAM GAMMILL TO POWER REACTOR
LICENSEES' LETTER DATED AUGUST 8, 1979

The following is the revised text of the October 17, 1979 letter to William Gammill, NRC's Acting Assistant Director for Operating Reactors Projects, from John J. Mattimoe, SMUD's Assistant General Manager and Chief Engineer.

The August 8, 1979, letter from the NRC to all Power Reactor Licensees (except Humbolt Bay) requested:

1. A verification by analysis of the capacity and capability of Rancho Seco's offsite power system and the onsite electrical distribution system.

2. A verification, by test, of the adequacy of Rancho Seco's offsite power system and the onsite electrical distribution system.

3. A review of Rancho Seco's electrical power supply system to determine if there are any conditions which could result in the simultaneous or consequential loss of both required circuits to the offsite network to determine if any potential exists for violation of GDC-17 in this regard.

4. Immediate remedial action and prompt notification of the Commission with written followup in the event of a violation or potential violation of GDC-17 or voltage requirements of safety loads.

The responses to these requests are listed below:

1. The analysis of Rancho Seco's offsite power system and the onsite electrical distribution system demonstrates that the District's existing systems are adequate. To achieve this adequacy, it was necessary to change the loading sequence of the diesel generator room supply and exhaust fans from Block Two to Block Three. The setpoint on the inverse-time undervoltage relays was raised to 3744V (90 percent of 4160V) to assure equipment protection. Special orders have been issued to the plant operators to describe operator actions at degraded voltage conditions (Reference SO 5-79).

Subsequent analysis, taking into account proposed relay type changes and accuracy considerations discussed in Enclosure II, have determined that the 1
modifications listed below should be implemented.

a. Set undervoltage relay dropout at 3771V (91 percent of 4160V).

b. Set overvoltage relay pickup at 4580V.

c. Limit plant operation if the switchyard voltage is less than 218kV.

d. Block automatic condensate pump starting on a turbine trip to assure that safety equipment terminal voltage does not dip below the minimum required.

Since the normal switchyard voltage range is 221kV to 239kV, neither the setpoints nor operational limits will be affected by normal voltage variations. The voltage dip during condensate pump starting, although 1
undesired, does not prevent the safety equipment from performing their required functions since the dip is of a short duration.

A discussion of each modification is included in the response to guidelines contained in Enclosure I, Part B. The applicable guideline for each modification is listed below:

Modification	Reference Guideline
a	10
b	11
c	6, 9 and 10
d	9

1

The above modifications insure the adequacy of the Rancho Seco offsite power system and the onsite electrical distribution system to supply safety-related loads under the conditions described in Enclosure I, Part B.

The capacity of the transformers to continuously carry the expected load demand is illustrated in Sketches 2-7 of Enclosure I, Part B. 1

2. The District's method of determining the adequacy of the offsite power system and onsite electrical system is based on a combination of test data and analysis.

The load data for the Class 1E 4.16-kV system and safety motors greater than 60 hp was based on actual field measurements (under simulated accident conditions, if applicable). The impedance data for transformers was based on factory test results.

If test data was not available, the data used in the analysis was based on conservative engineering assumptions. Refer to Enclosure I, Part B 1
Response to Guideline 13 for a discussion of the assumptions made in the analysis. The analytical results were obtained using a computer load flow program. The program has been checked to verify its accuracy. It solves nodal admittance network equations by the accelerated Gauss-Seidel method.

A single full scale system test will not provide sufficient data to justify or verify the analytical methods and assumptions used in the analysis. It is not practical and in some cases not possible to simultaneously produce, in a test, all the conservative assumptions made in the analysis. Listed below are three examples of assumptions made in the analysis that are impractical to implement in a test:

a. The analysis assumes 214kV in the Rancho Seco switchyard. The normal operating voltage range for the switchyard is 1
221kV to 239kV. The District cannot lower the switchyard

voltage to 214kV without seriously affecting the grid. Simulation of a degraded switchyard voltage condition by raising the startup transformer taps is not feasible since the transformers are already operating at the maximum tap setting. 1

b. The analysis assumes full operating load on the non-Class IE buses. The test would have to be run with the unit shut down. In this condition it is not possible to obtain full load on the non-safety related equipment. For example, the condensate pumps would be operating at miniflow conditions instead of rated flow and load assumed in the analysis.

c. The analysis assumes all safety related loads are operating at maximum design conditions encountered during a loss of coolant accident (LOCA). The upper dome air circulators and the reactor building emergency air coolers would be operating during a test at loads less than the load assumed in the analysis since the reactor building atmosphere would not be at a LOCA condition.

Therefore, it is not practical to perform a test at the conditions assumed in the analysis. The use of a proven computer program with actual measured test data combined with conservative assumptions provide the District with assurance that the offsite power system and onsite distribution systems are adequate.

3. The District has completed a review of Rancho Seco's electrical power supply for compliance to GDC-17. The cases analyzed indicated that the District's electrical power supply system is in compliance with GDC-17. 1

1

For information on the analysis performed for compliance to GDC-17 refer to Enclosure I, Part C. 1

4. The District has implemented loading sequence changes, relay setpoint changes and issued special orders.

The modifications proposed (a thru d) will be implemented after the District receives NRC approval and the new relay types are installed. 1

Enclosure I, Part B is the District's response to the Guidelines contained in Enclosure 2 of William Gammill to Power Reactor Licensee's letter dated August 8, 1979.

Enclosure I, Part C is an evaluation of the District's offsite power supply system for compliance to GDC-17. 1

ENCLOSURE I

PART B

RESPONSE TO GUIDELINES LISTED
IN ENCLOSURE 2 NRC'S
WILLIAM GAMMILL TO POWER
REACTOR LICENSEES, LETTER DATED
AUGUST 8, 1979

Listed below is a response to each guideline listed in Enclosure 2 "Guidelines for Voltage Drop Calculations" of NRC's, William Gammill to Power Reactor Licensees, letter dated August 8, 1979.

GUIDELINE #1

Separate analyses should be performed assuming the power source to safety buses is (a) the unit auxiliary transformer; (b) the start-up transformer; and (c) other available connections to the offsite network one by one assuming the need for electric power is initiated by (1) an anticipated transient (e.g., unit trip) or (2) an accident, whichever presents the largest load demand situation.

RESPONSE TO GUIDELINE #1

The Rancho Seco electrical power system is described by the attached single line diagram (Sketch 1).

The District's analysis was performed assuming the power source for the safety buses was obtained with the following plant configurations. (Case 1 is the normal operating configuration).

Case	Description	Reference Sketches	
1A	Bus 4A on start-up transformer #1	2	
1B	Bus 4B on start-up transformer #2	3	
2	Buses 4A and 4B on start-up transformer #1	4	
3	Buses 4A and 4B on start-up transformer #2	5 & 8-14	1
4A	Bus 4A on start-up transformer #2	6	
4B	Bus 4B on start-up transformer #1	7	

Sketches 2-7 illustrate the steady-state condition immediately following completion of automatic load sequencing due to safety features actuation. Starting conditions are illustrated for Case 3 only which, due to the heavy loading on start-up transformer #2, represents the limiting case. Sketches 8-13 illustrate the minimum system voltages occurring during automatic load sequencing and Sketch 14 illustrates the minimum system voltages that could occur should the largest 4.16-kV load, a condensate pump, be manually started after completion of automatic load sequencing. 1

The unit auxiliary transformers are not an available source for the safety buses as indicated by Sketch 1; the above cases are all the connections available to the safety buses from the offsite network. 1

The transient assumed in the analysis is a loss of coolant accident (LOCA) with the reactor at 100-percent power coincident with a turbine-generator trip and a safety features actuation signal (SFAS) to both redundant safety systems. This transient produces the maximum load on the start-up transformers.

A turbine-generator trip will place non-safety buses 6A and 6B on start-up transformer #1 and non-safety buses 4C, 4D, 4E1 and 4E2 on start-up transformer #2.

GUIDELINE #2

For multi-unit 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.

RESPONSE TO GUIDELINE #2

This guideline is not applicable to Rancho Seco. Rancho Seco is a single unit station.

GUIDELINE #3

All actions the electric power system is designed to automatically initiate should be assumed to occur as designed (e.g., automatic bulk or sequential loading or automatic transfers of bulk loads from one transformer to another). Included should be consideration of starting of large non-safety loads (e.g., condensate pumps).

RESPONSE TO GUIDELINE #3

The District's analysis assumed the following automatic actions occur coincident with the LOCA/turbine-generator trip:

(a) Buses 6A and 6B transfer from unit auxiliary transformer #1 to start-up transformer #1. 1

(b) Buses 4C, 4D, 4E1 and 4E2 transfer from unit auxiliary transformer #2 to start-up transformer #2.

(c) Heater drain pumps trip due to loss of net positive suction head. 1

(d) The safety buses are sequentially loaded. The loading sequence is indicated in Table 1. Time zero is when the SFAS signal is received.

Large non-safety loads are not started coincident with the event. Automatic starting of the condensate pump, for example, is blocked on a turbine trip. 1

GUIDELINE #4

Manual load shedding should not be assumed.

RESPONSE TO GUIDELINE #4

Manual load shedding was not assumed in the District's analysis.

GUIDELINE #5

For each event analyzed, the maximum load necessitated by the event and the mode of operation of plant at the time of event should be assumed in addition to all loads caused by expected automatic actions and manual actions permitted by administrative procedures.

RESPONSE TO GUIDELINE #5

The event the District analyzed provided the maximum load on the start-up transformers.

The analysis assumed automatic starting of safety equipment due to an SFAS signal. The safety equipment automatic loading sequence is indicated in Table 1. 1

It was assumed that the train B auxiliary feedwater pump was manually started simultaneously with the automatically started Train A auxiliary feedwater pump during the fourth automatic sequential loading block. Manual starting is an action permitted by operating procedures. 1

GUIDELINE #6

The voltage at the terminals of each safety load should be calculated based on the above listed considerations and assumptions and based on the assumption that the grid voltage is at the "minimum expected value". The "minimum expected value" should be selected based on the least of the following:

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

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

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

In the report to NRC on this matter the licensee should state planned actions, including any proposed "Limiting Conditions for Operation" for Technical Specifications, in response to experiencing voltage at the connection to the offsite circuit which is less than the "minimum expected value". A copy of the plant procedure in this regard should be provided.

RESPONSE TO GUIDELINE #6

The "minimum expected value" of the grid voltage is 214kV and is based on the minimum steady-state voltage experienced at the connection to the offsite circuit. The value of the voltages at the safety buses and at the most distant (electrically) load during this condition is shown on Sketches 2 through 14 for the cases the District analyzed.

Refer to Attachment 1 of Enclosure II for a description of "Limiting Conditions for Operation" being considered for inclusion in the Technical Specifications.

The District will modify operating procedures to incorporate
the operating constraints described in Attachment 1 of Enclosure II when 1
the proposed design, and proposed technical specifications are approved
by the NRC and the relays described in Enclosure II are installed.

Special orders have been issued to the plant operators to described operator action at degraded voltage conditions when the switchyard voltage is less than 216kV. The special order is available for review at Rancho Seco.

GUIDELINE #7

The voltage analysis should include documentation for each condition analyzed of the voltage at the input and output of each transformer and at each intermediate bus between the connection to the offsite circuit and the terminals of each safety load.

RESPONSE TO GUIDELINE #7

Sketches 2-14 indicate the voltages at each intermediate bus 1
between the connection to the offsite circuit and the terminals of the
safety loads with the lowest steady-state voltage.

GUIDELINE #8

The analysis should document the voltage setpoint and any inherent or adjustable (with nominal setting) time delay for relays which (1) initiate or execute automatic transfer of loads from one source to another; (2) initiate or execute automatic load shedding; or (3) initiate or execute automatic load sequencing.

RESPONSE TO GUIDELINE #8

The District has overvoltage and undervoltage trip relays which will (1) initiate an automatic transfer of the safety buses from the offsite power source to the diesels and (2) initiate automatic load shedding. Automatic load sequencing is initiated by an SFAS signal and not by the voltage relaying.

The setpoint for the undervoltage relay is documented in the response to Guideline #10.

The setpoint for the overvoltage relay is documented in the response to Guideline #11.

GUIDELINE #9

The calculated voltages at the terminals of each safety load should be compared with the required voltage range for normal operation and starting of that load. Any identified inadequacies of calculated voltage require immediate remedial action and notification of NRC.

RESPONSE TO GUIDELINE #9

The District compared the calculated terminal voltages to that required for normal operation and starting of each safety load. The analysis identified inadequacies. To correct the inadequacies, the following modifications were implemented.

1. Automatic sequential loading of the diesel-generator supply and exhaust fans was changed from Block 2 to Block 3 (Table 1). This change assured that an acceptable level of terminal voltage would be available for all safety motors being started.

2. Special order 5-79 was issued to describe operator actions when the switchyard voltage is less than 216kV.

   The analysis demonstrated that for this voltage level, or 1
   higher, the terminal voltage at any safety motor would never be less than its minimum required starting voltage.

Subsequent analyses, taking into relay accuracy considerations discussed in Enclosure II, demonstrate that reactor operation can only be permitted down to 218kV. These analyses also assumed that automatic condensate pump starting is blocked on a turbine trip. Only automatic starting is blocked, the pumps continue to operate if they have been running prior to the event; all studies conservatively assumed that the condensate pumps were running at normal operating load. Condensate pump starting concurrent with automatic starting of safety equipment could cause the safety equipment terminal voltage to dip below the minimum required voltage during the condensate pump starting interval.

The justification for each type of load to operate at the calculated voltages indicated on sketches 2 through 14 is given below. This analysis assumes that the modification blocking auto starting of the condensate pumps has been implemented. 1

Motors - The voltage data shown on sketches 2-7 show that some safety-related motors could be operating below the nominal 90-percent minimum steady-state voltage stipulated by NEMA MG 1. Generally, the

motors operating below this voltage are driving loads that are less than their nameplate horsepower. The District has performed an analysis that indicates continuous operation at the voltage indicated is practical with no net loss in motor life since the increased heating effects due to the reduced voltage are offset by the lighter than nameplate load. For exceptions, where the motors are operating at a high load demand factor, motor life will be expended at a greater rate. However, this increased rate is acceptable since the total life expended is negligible due to the limited time of operation anticipated at the reduced voltage level. (E.g.: For a fully loaded motor with Class B insulation, the life expended during 1
4-hours of operation - actual duration of the degraded voltage condition experienced - at 85-percent voltage is equivalent to 9 hours of operation at 90-percent voltage*.)

The District's safety-related motors were qualified to start at 75 percent of rated voltage. Sketches 8-14 show that voltage above this 1
value will be available during starting periods and the motors will start.

<u>Motor-Operated Valves</u> - Motor-operated valves are capable of operating properly down to at least 368V (.80 of 460V) which is below the 1
minimum voltage calculated for the valve motors.

<u>Battery Chargers</u> - The battery chargers were factory tested at rated load, at 140VDC, with an input voltage of 432 volts (.94 of 460V). The District has performed additional tests to verify that the battery chargers can operate at the minimum calculated voltage of 387 volts (.84 of 1
460V).

<u>Heat Tracing System</u> - The heat tracing system for the safety-related pipes, tanks and valves containing boric acid consists of strip-type resistance heating tape, transformers, and thermostats. At the calculated minimum voltage (394V) the heat tracing system is capable of 1
providing sufficient heat to maintain the temperature above crystallization for the expected (4 hr.) duration.

<u>MCC Control Circuits</u> - The District has verified by field test that the components in the control circuits of the MCC's can be operated at the minimum calculated voltage.

<u>Overcurrent Protection</u> - The switchgear overcurrent protective 1
devices have been analyzed to verify that tripping of safety-related loads will not occur. Analysis of MCC overload protection is still being performed.

<u>GUIDELINE #10</u>

For each case evaluated the calculated voltages on each safety bus should be compared with the voltage-time settings for the undervoltage relays on these safety buses. Any identified inadequacies in undervoltage relay settings require immediate remedial action and notification of NRC.

*This analysis assumes that for each 10°C temperature rise, life is 1
expended at twice the rate.

RESPONSE TO GUIDELINE #10

In the October 17, 1979 analysis report, the District compared
the voltage-time settings of the undervoltage relays with the voltage 1
requirements of the safety equipment. This comparison identified a potential inadequacy. The District changed the undervoltage relay setpoint from
85 to 90 percent of 4160V to correct the inadequacy. 1

Subsequent analyses, taking into account proposed undervoltage relay type changes and accuracy considerations to implement NRC's position 1 (see Enclosure II), ongoing power system modifications and proposed modifications, indicate that an increase in the undervoltage relay setting to 3771V (0.91 of 4160V), which is equivalent to a switchyard voltage of 216 kV, is desirable.

With this setting and the switchyard at 214 kV the steady state voltages on the 4160 volt buses 4A and 4B will be less than the relay setpoint. (Refer to Sketches 2 through 7 for steady state voltages). The analysis indicates that 214 kV is the minimum experienced voltage and the minimum voltage that the offsite power system is capable of supplying the onsite distribution system. However, the proposed relay setting is justifiable when the ±1 percent relay tolerance is considered. The table below indicates the relay setpoint, dropout voltage limits based on the relay tolerance and the equivalent switchyard voltage.

	4160 Volt Bus Voltage	Switchyard Voltage	
			1
Maximum Dropout Voltage	3827 (.92 of 4160)	218 kV	
Setpoint	3771 (.91 of 4160)	216 kV	
Minimum Dropout Voltage	3731 (.90 of 4160)	214 kV	

The proposed relay setpoint provides adequate protection for safety equipment since the minimum dropout voltage is equal to the minimum voltage the equipment is qualified to operate at. The setpoint will not cause spurious inadvertent operation since the maximum dropout voltage is below the normal operating voltage range.

GUIDELINE #11

To provide assurance that actions taken to assure adequate voltage levels for safety loads do not result in excessive voltage, assuming the maximum expected value of voltage at the connection to the offsite circuit, a determination should be made of the maximum voltage expected at the terminals of each safety load and its starting circuit. If this voltage exceeds the maximum voltage rating of any item of safety equipment immediate remedial action is required and NRC shall be notified.

RESPONSE TO GUIDELINE #11

The District has performed a review of data on voltage in the Rancho Seco switchyard. Based on this review, the maximum expected switchyard voltage is 239kV. For the existing transformation ratios (Sketches 2-7) and assuming a no load condition, the maximum voltage is on the 4.16-kV system and on the 480-V system. This voltage is equal to or less than the maximum voltage rating of any safety equipment except the 460-V motors and motor-operated valves (MOV's).

An analysis for each type of safety-related equipment is listed below. 1
This analysis was based on the maximum steady-state voltage allowed (4626V) by the overvoltage protection relays since this voltage is higher than the maximum expected voltage and represents the permissible extreme.

Motors & Motor-Operated Valves - The 4160-volt motors are designed to operate at a maximum voltage of volts which is less than the maximum calculated voltage of 4626 volts (111 percent of 4160V). The 460-volt motors and motor-operated valves have a maximum voltage rating which is less than maximum calculated voltage of 521 volts (113 percent of 460V).

Operation of the motors and motor-operated valves at these voltages is acceptable for the following reasons:

a. Operation at the maximum expected switchyard voltage is an extreme condition that is only expected to occur on rare occasions and for short durations. (Note - Operating time of MOV's during this condition is further limited by their inherent short-time operating duty.)

b. The maximum calculated voltage condition conservatively assumes that there is absolutely no auxiliary load operating (i.e: no voltage drop) when the maximum expected switchyard voltage occurs. 1

c. The maximum calculated voltage condition conservatively assumes operation at two-percent above the maximum expected voltage (i.e., it allows for relay inaccuracy).

d. The motors and motor-operated valves will be operating at less than 110 percent of rated voltage when equipment operation is initiated by an SFAS due to voltage drop in the electrical system.

e. The maximum voltages calculated will produce a torque that is only slightly greater than the torque that would be produced at the nominal maximum voltage of 110 percent. However, due to voltage drop during starting and operation of a motor, the maximum voltage at the terminals of the motor and the increase in torque will be reduced. The MOV circuits have minimal voltage drop during starting and operation. Therefore, it is possible for the MOV's to produce a slightly greater torque than that produced at 110-percent voltage. However, operation of the MOV is limited by a torque switch. Therefore, the excessive torque is not applied to the valve and operation during the overvoltage condition is acceptable.

f. The motor manufacturers contacted did not expect any adverse effect to their equipment due to the slight overvoltage levels being considered. Operating instructions published by one motor manufacturer* indicate the following characteristics for operation of their motors above rated voltage.

Percent of Rated Voltage	Percent of Full Load Efficiency	Percent Current	Percent Torque	Full Load Temp. Rise	1
100	100	100	100	-	
110	101.5-102	93	121	(-)3 to (-)4°C	
120	100+	89	144	(-)5 to (-)6°C	

From the above data, it is indicated that motors are not particularly sensitive to overvoltage. Efficiency at 120-percent voltage, for example, is even better than at rated voltage.

g. Overvoltage alarm relaying is being added to the 480-V safety buses to alert the operator should an unusual overvoltage condition (greater than 110 percent of 460V) occur.

Battery Chargers - The battery chargers are qualified to operate at full load with a maximum input voltage of 528 volts (114 percent of 460V) which is above the maximum calculated voltage of 521 volts. 1

Heat Tracing System - The heat tracing system for the safety-related pipes, tanks, and valves containing boric acid consists of strip type resistance heating tape, transformers and thermostats. All of this equipment should be capable of operating at the maximum calculated voltage 1 of 521 volts.

MCC Control Circuits - The control voltage for each 480-volt MCC feeder circuit is obtained from a feeder line tap through a 480 to 120 volt stepdown control power transformer. The maximum voltage rating for the most limiting component is 132 volts. The maximum calculated voltage on 1 the component is 130 volts which is less than the maximum voltage rating.

*Installation, Operation and Care of "Duty Master" Nuclear Service Class IE Integral Horsepower Induction Motors, Reliance Electric Instruction Manual 1 B-3645, December, 1977.

Overvoltage Relay Setpoint - In case the maximum calculated voltage is exceeded the analysis indicates that the District's overvoltage relay should be set at 4580 volts (110 percent of 4160V) which, assuming a no load condition, corresponds to a maximum of 112 percent of 460 volts on the 480-V system. This setpoint is equivalent to a voltage of 242kV in the switchyard. With this setpoint, the relay will protect the safety-related equipment. The relay is set a higher voltage than the maximum expected voltage and will not cause spurious trips. It has a definite time delay set at 3 seconds and operates in series with an external time delay relay set at 0.5 seconds. 1

GUIDELINE #12

Voltage-time settings for undervoltage relays shall be selected so as to avoid spurious separation of safety buses from offsite power during plant startup, normal operation and shutdown due to startup and/or operation of electric loads.

RESPONSE TO GUIDELINE #12

The setting for the undervoltage relay was selected to assure protection of the safety equipment as explained in the response to Guideline #10. The setting selected avoids spurious separation of the safety buses from offsite power during plant startup, normal operation and shutdown due to starting and/or operation of loads providing the switchyard voltage is above 218kV. This level is below the 221-kV voltage defined as the normal minimum voltage for the switchyard. 1

GUIDELINE #13

Analysis documentation should include a statement of the assumptions for each case analyzed.

RESPONSE TO GUIDELINE #13

For the cases analyzed the District's assumptions have been included. The following statements describe the general assumptions used in the computer analysis.

a. The computer modeled running loads and motors as having a constant volt-ampere characteristic.

b. Starting motors are modeled as having a constant impedance characteristic.

c. The load data for the non-Class IE 4.16-kV system (and subsystems) and safety motors greater than 60 hp was based on actual field measurements (under simulated accident conditions, if applicable); for other loads, field test data, manufacturers' data and typical motor/load data were utilized.

d. Impedance data for transformers was based on the actual nameplate or test report data. 1

e. Impedance data for bus duct was based on manufacturers published data.

f. Impedance of cables was modeled for Class IE 4160-480V transformer primary and secondary cables, MCC feeders and worst-case loads. Other loads were lumped together at their supply point. 1

g. Cable impedance was calculated based on the actual cable length pulled and cable type. 1

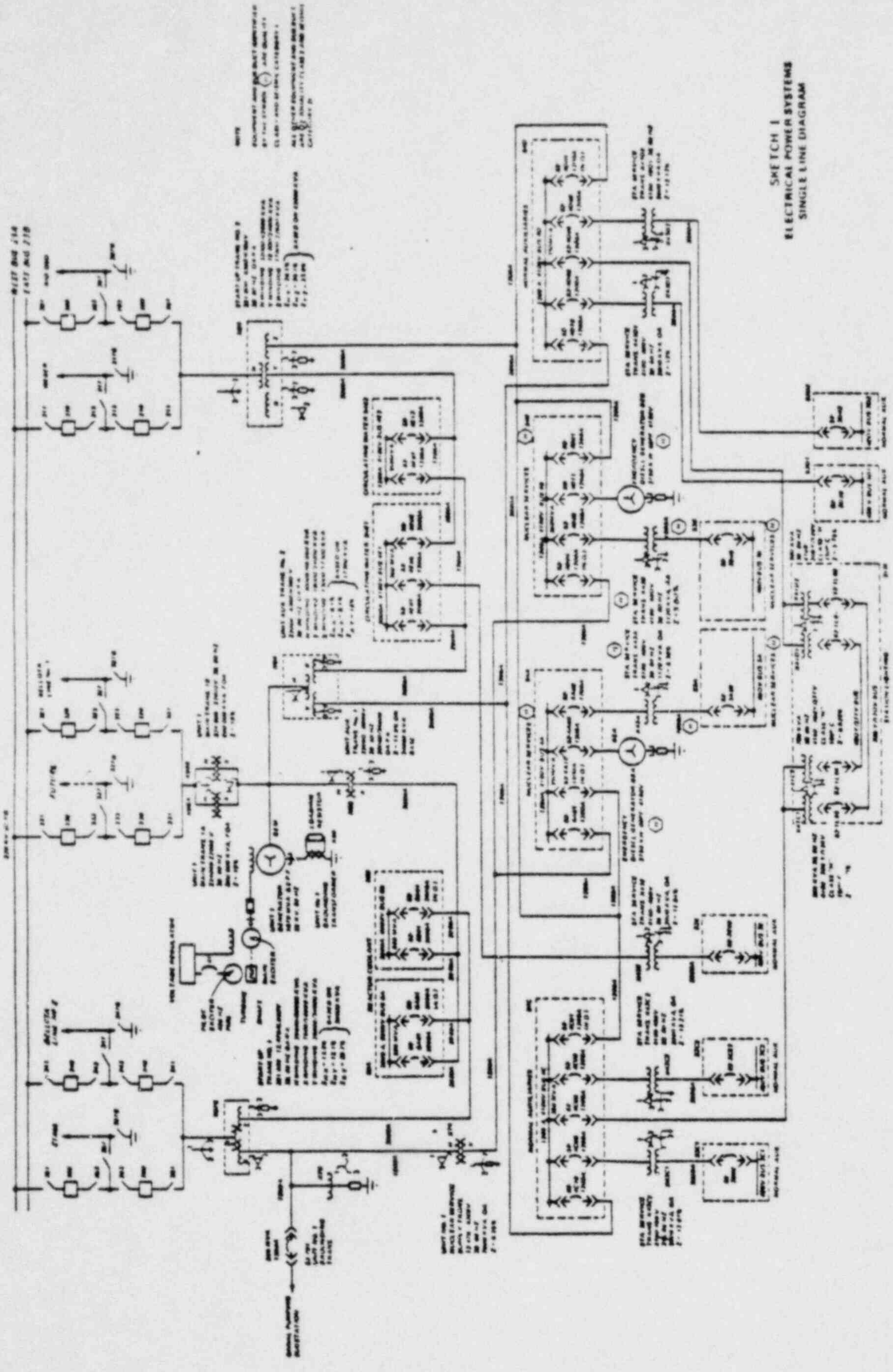
h. The impedance of switching equipment (switchgear, breakers, etc.) is negligible and was not included.

TABLE 1

NUCLEAR SERVICE BUS (EACH) AUTOMATIC LOADING SEQUENCE

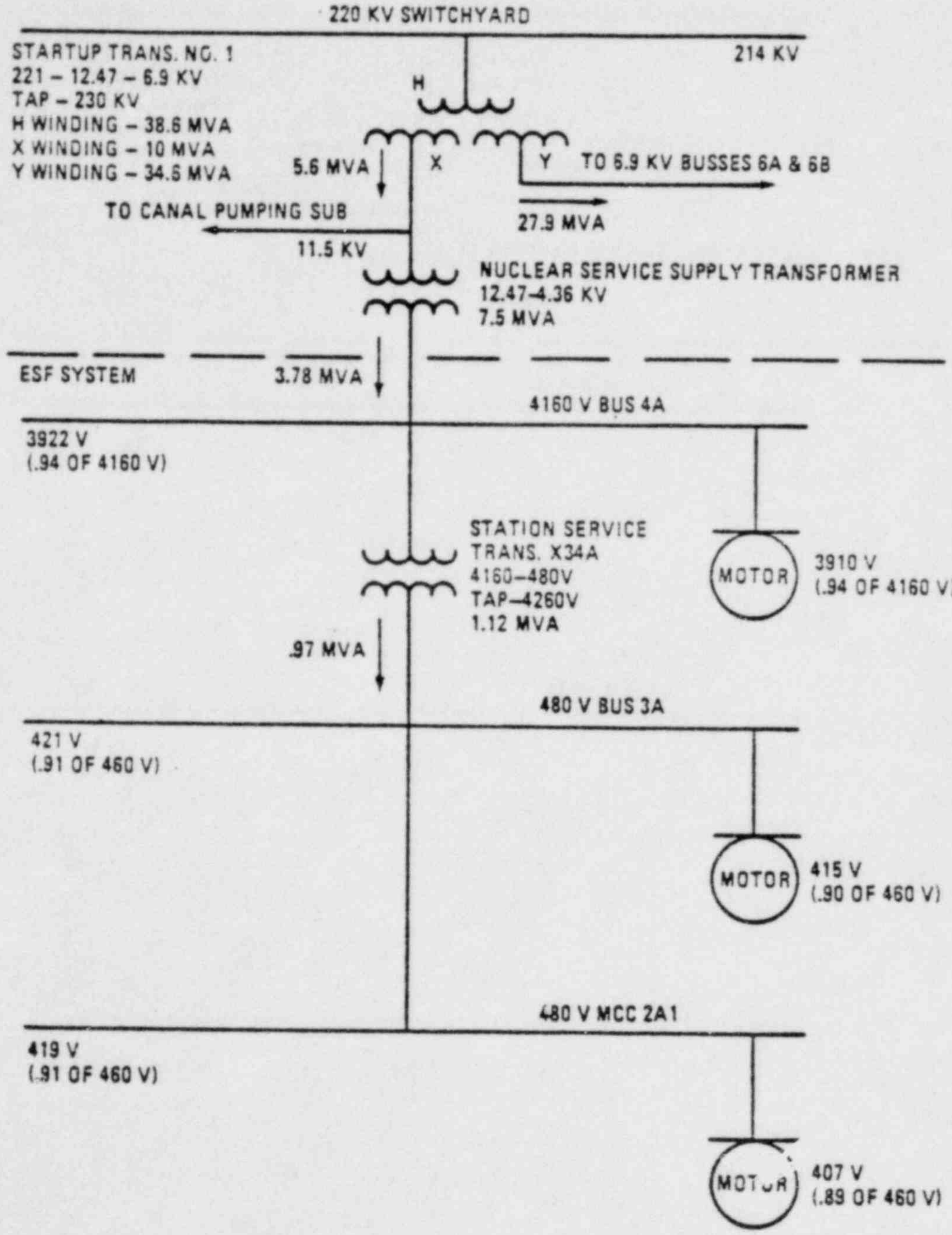
Offsite Power System Loading Sequence	Quantity	Acc. Time Sec.	Description	
				1
Block 1 - Energize at:				
0 + 0 sec	1	0.9	Decay heat pump (low pressure inj.)	
	2	5.3	Reactor Building upper dome air circulators	
	1	1	Motor control center (miscellaneous load)	1
0 + 3 sec*	1	0.7	Makeup pump (high pressure inj.)	
Block 2 - Energize at:				
0 + 16 sec	2	4.2	Reactor Building Emergency air cooler	
	1	0.6	Nuclear service cooling water pump	1
Block 3 - Energize at:				
0 + 26 sec	1	0.6	Nuclear service raw water pump	
	2	5.8	Diesel generator room supply and exhaust fans	
Block 4 - Energize at: 0 + 36 sec	1	3	Auxiliary Feedwater Pump (Train A only)	1
Block 5 - Energize at:				
0 + 300 sec	1	0.5	Reactor Building spray system including pump	

*Start of the make-up pump (high pressure inj.) is delayed 3 seconds to allow its bearing lube oil flow to get started.



SKETCH 1
ELECTRICAL POWER SYSTEMS
SINGLE LINE DIAGRAM

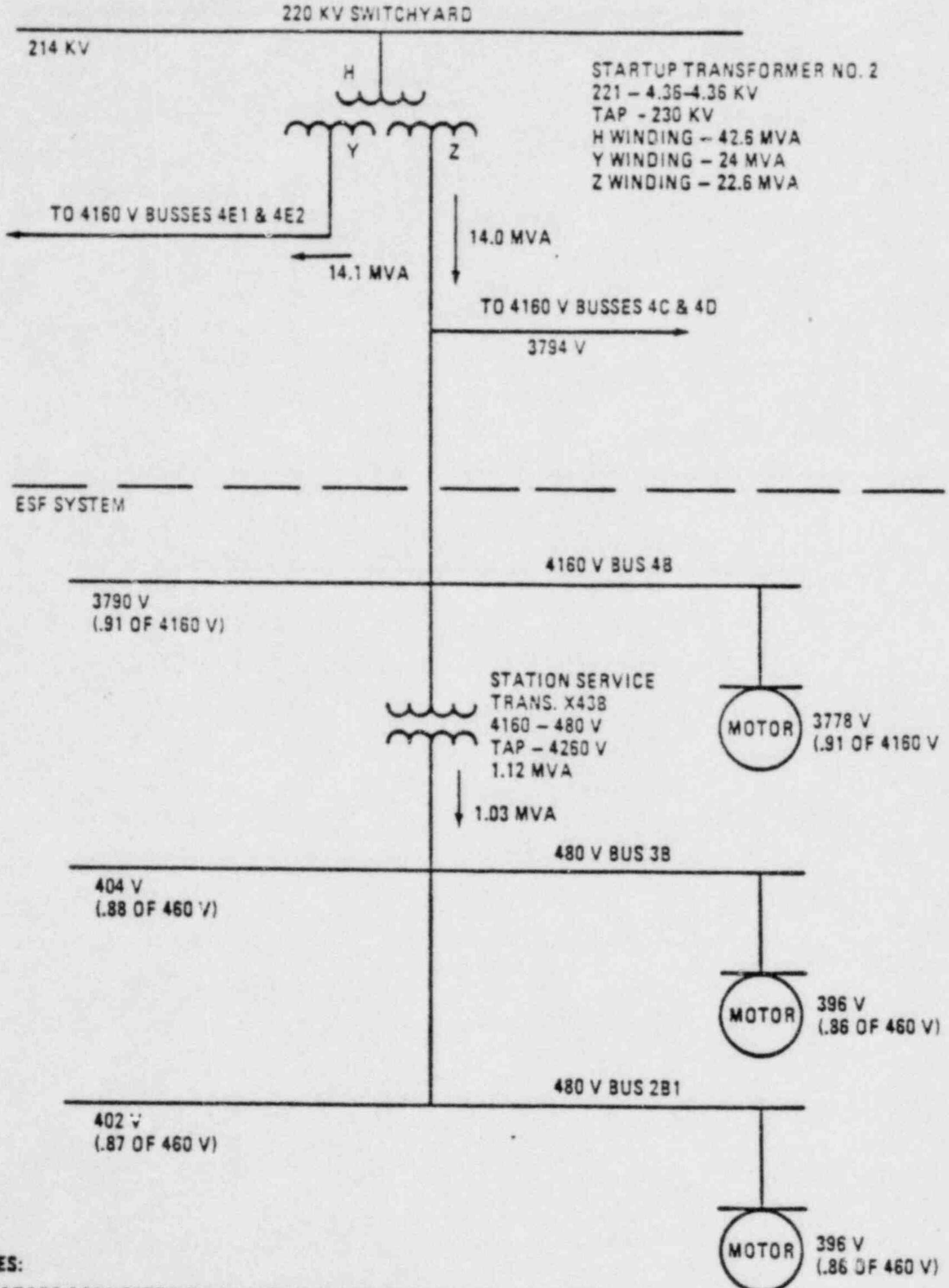
CASE 1A
BUS 4A ON STARTUP TRANSFORMER NO. 1
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



NOTES:

1. MOTORS CONNECTED TO A 4160V BUS ARE RATED 4160V. THE 480V SYSTEM MOTORS ARE RATED 460V.
2. THE MOTORS SHOWN ARE ELECTRICALLY THE MOST DISTANT MOTORS FROM THE BUSSES SHOWN. ALL OTHER MOTORS ON THESE BUSSES WILL OPERATE AT A VOLTAGE BETWEEN THAT OF THE BUS, AND THAT OF THE MOST DISTANT MOTOR.

CASE 1B
BUS 4B ON STARTUP TRANSFORMER NO. 2
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



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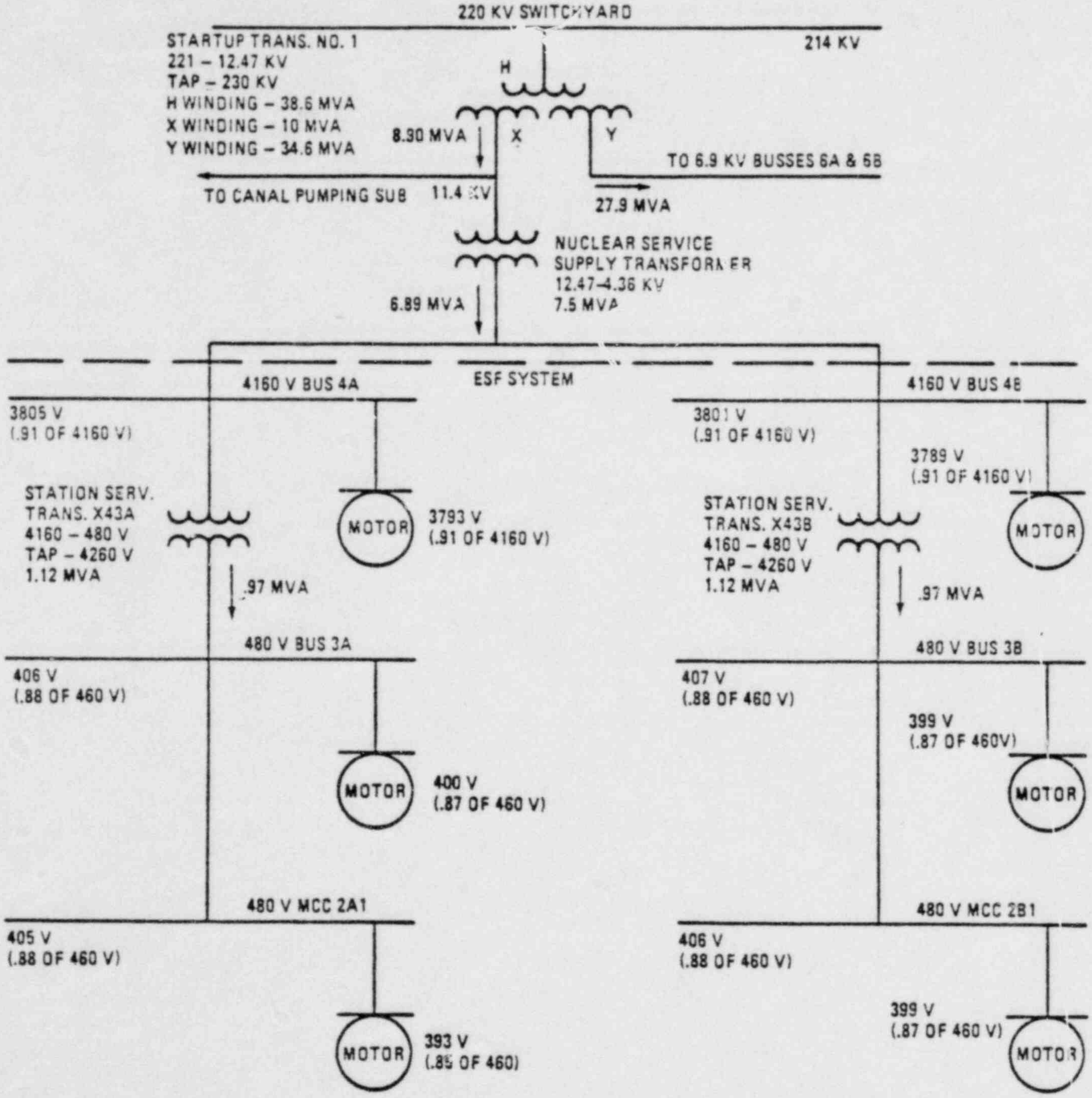
CASE 2
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 1
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



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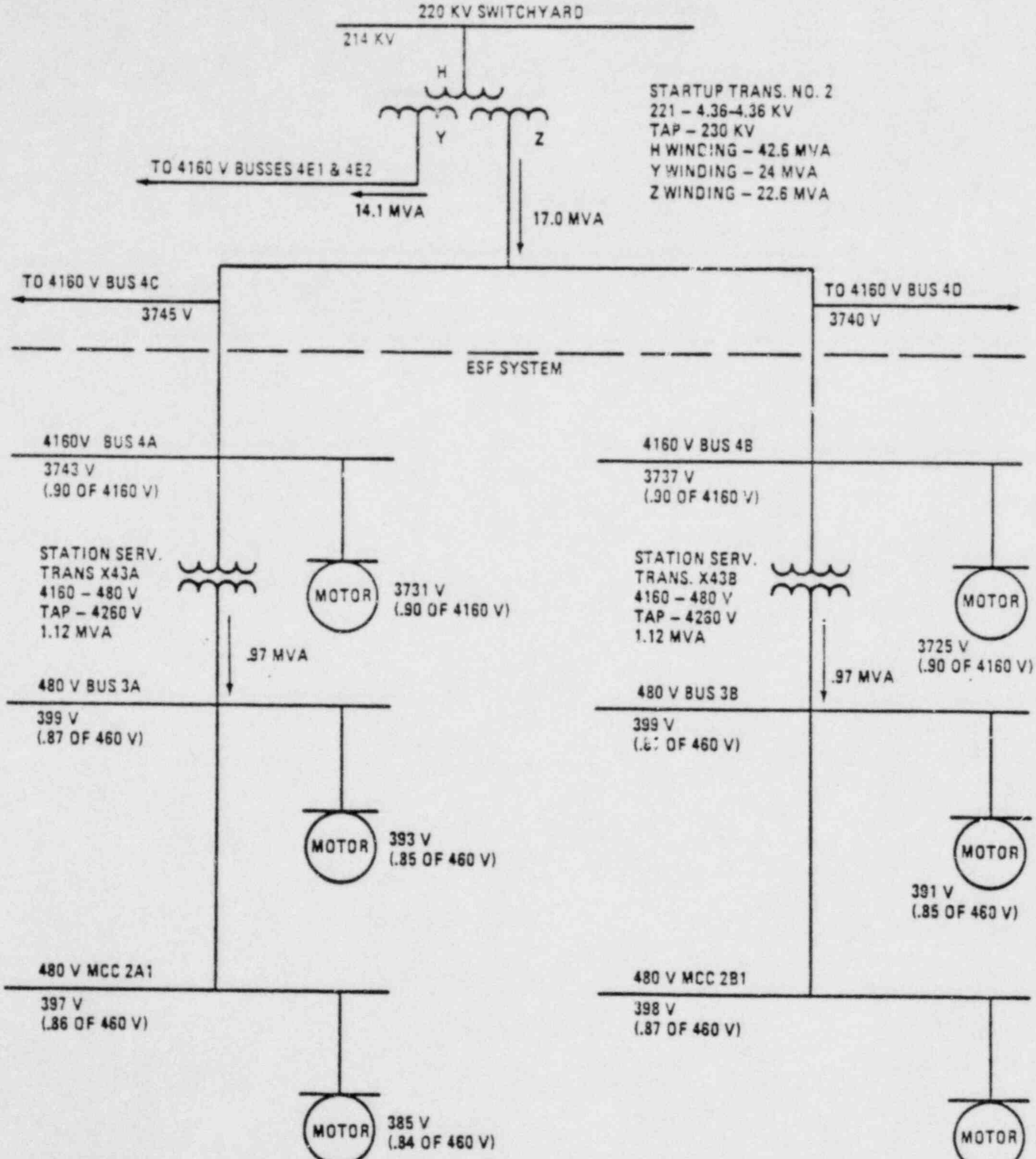
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



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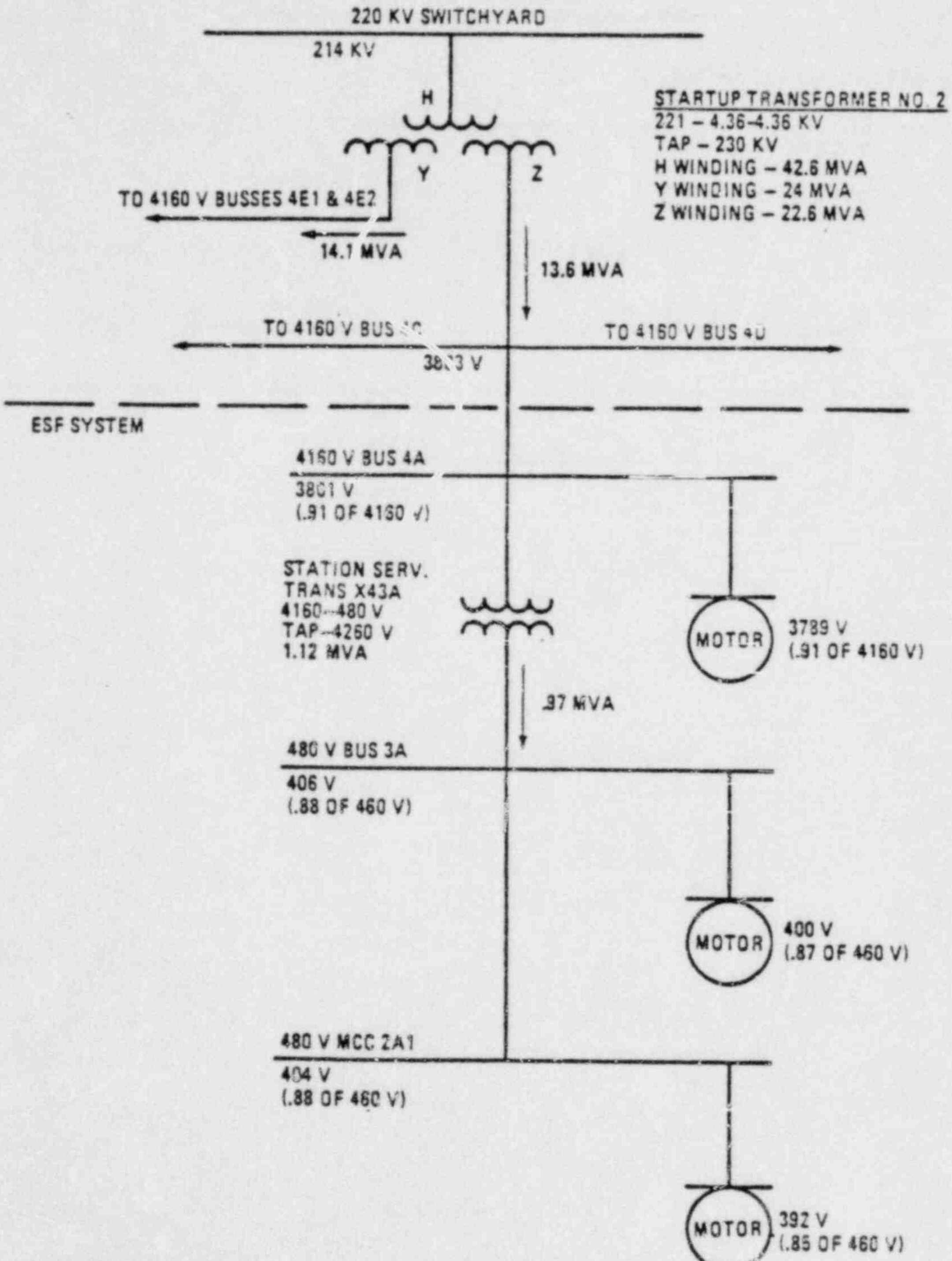
CASE 4A
BUS 4A ON STARTUP TRANSFORMER NO. 2
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



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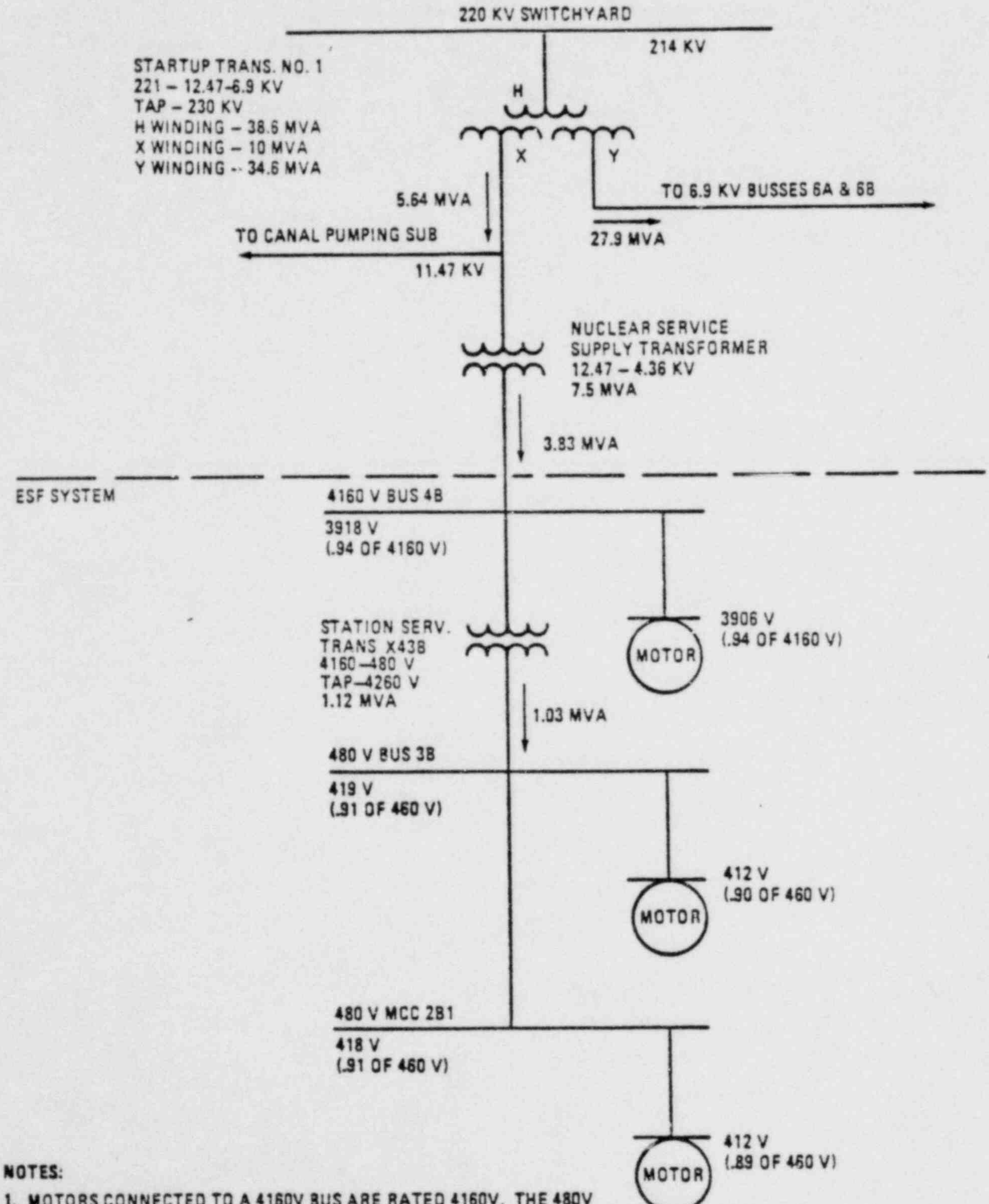
CASE 4B
BUS 4B ON STARTUP TRANSFORMER NO. 1
STEADY STATE AFTER SEQUENTIAL LOADING
214 KV SWITCHYARD VOLTAGE



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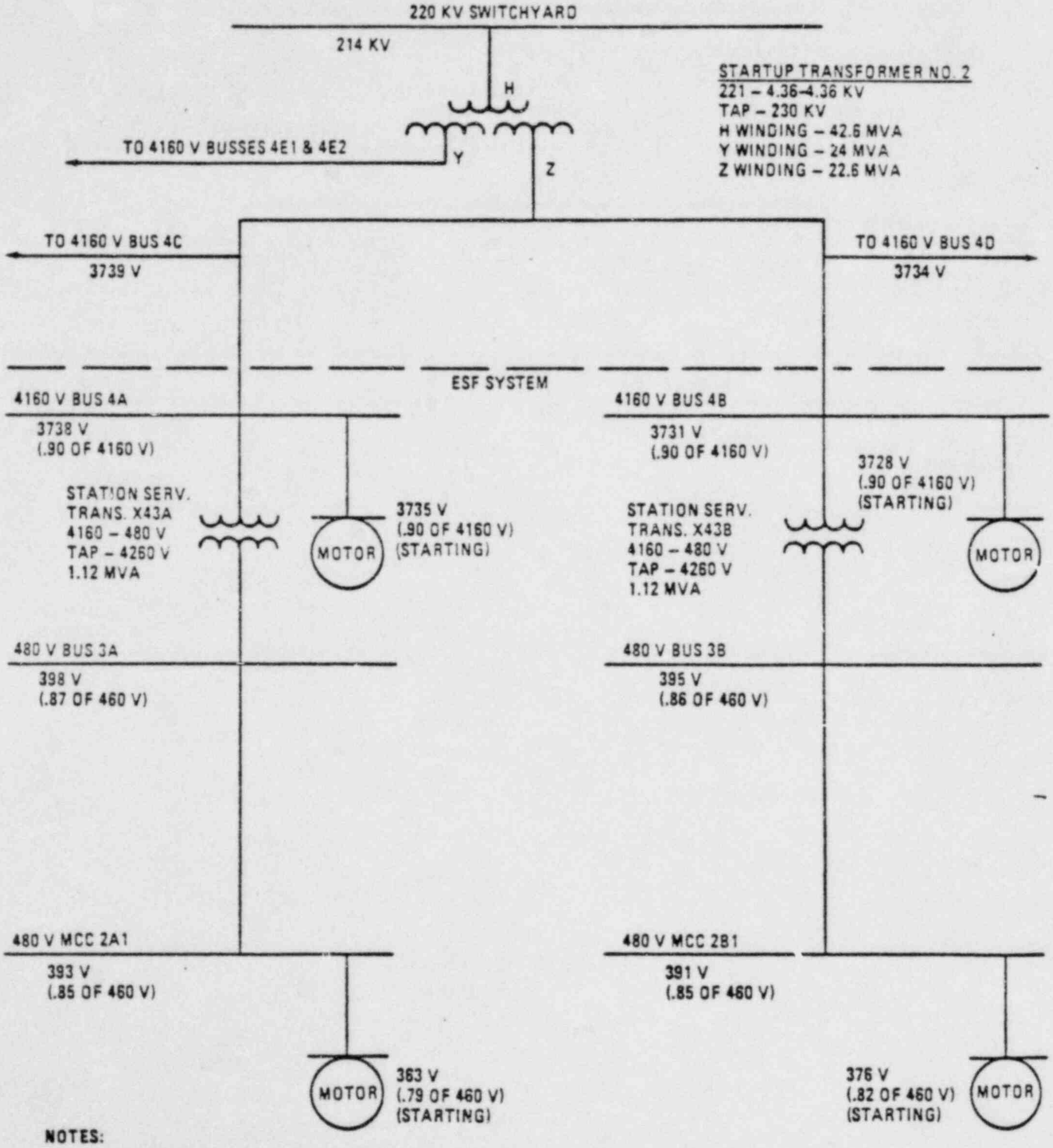
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 1., T = 0 SEC.)
START DECAY HT REMOVAL PP, RB UPPER DOME FANS AND MISCELLANEOUS MCC LOADS



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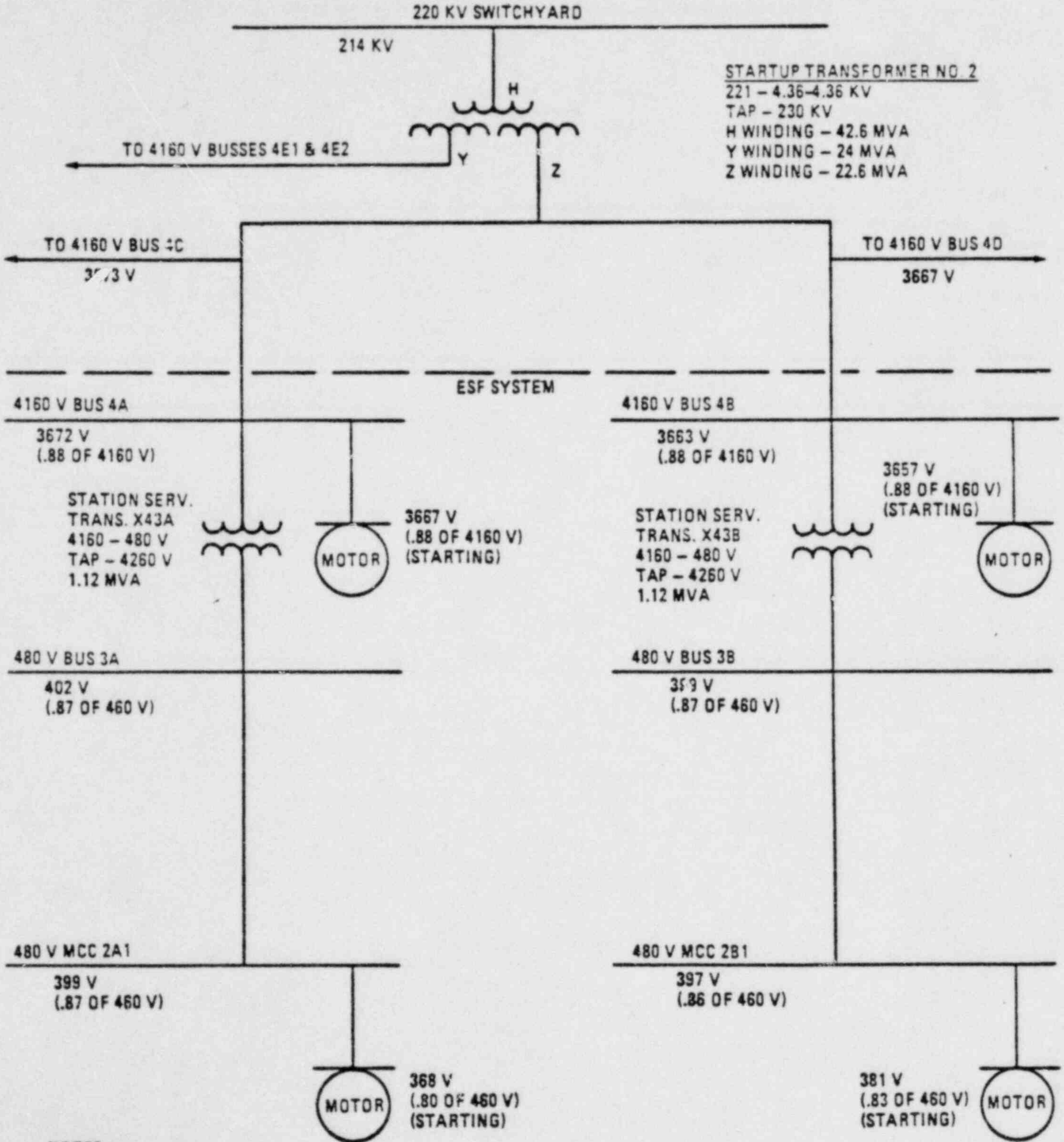
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 1., T = 3 SEC.)
START HP INJECTION PP, THE RB DOME FANS CONTINUE STARTING



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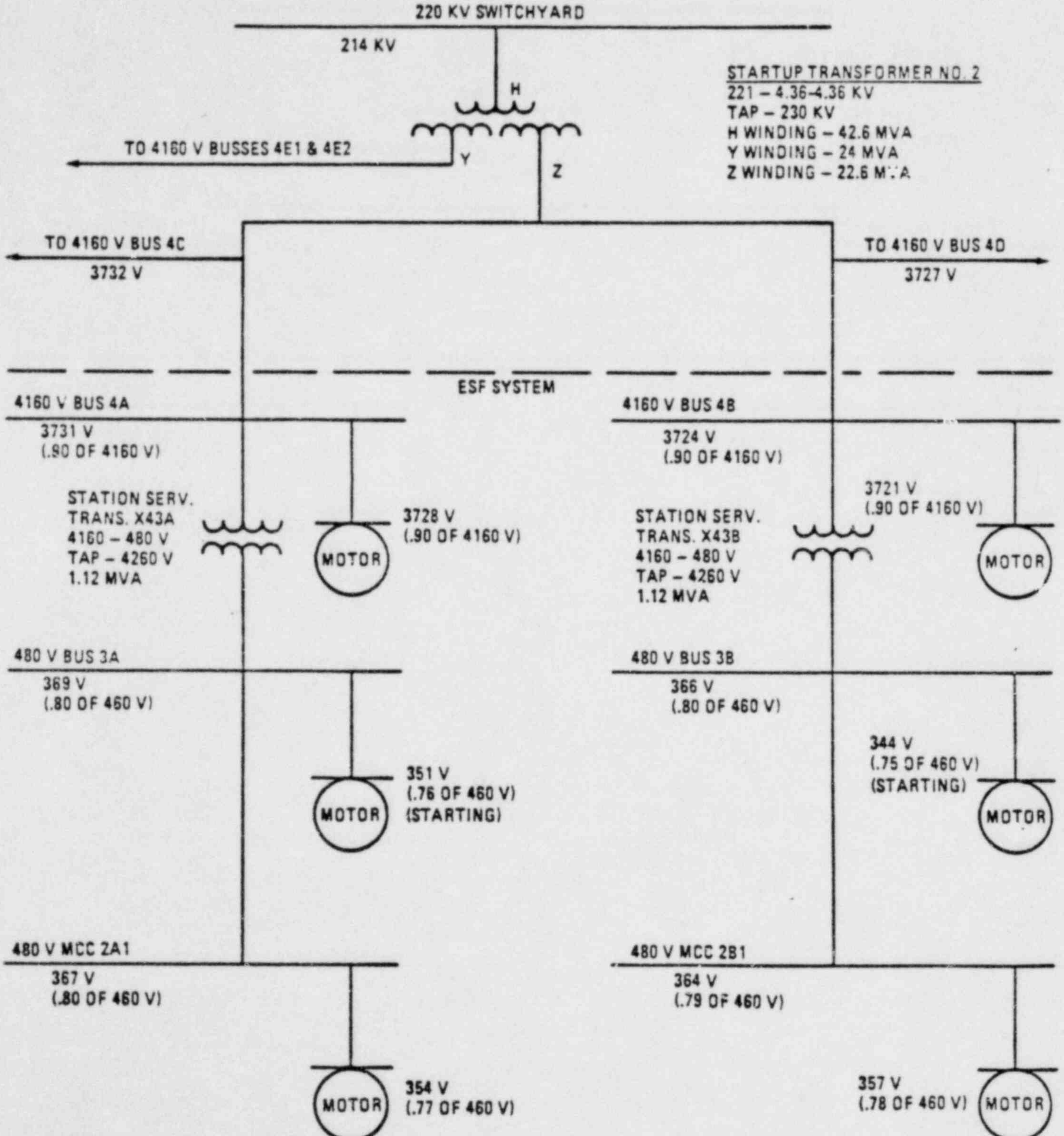
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 2., T = 16 SEC.)
START NUCLEAR SERVICE AIR COOLERS AND NUCLEAR SERVICE COOLING WATER PUMPS



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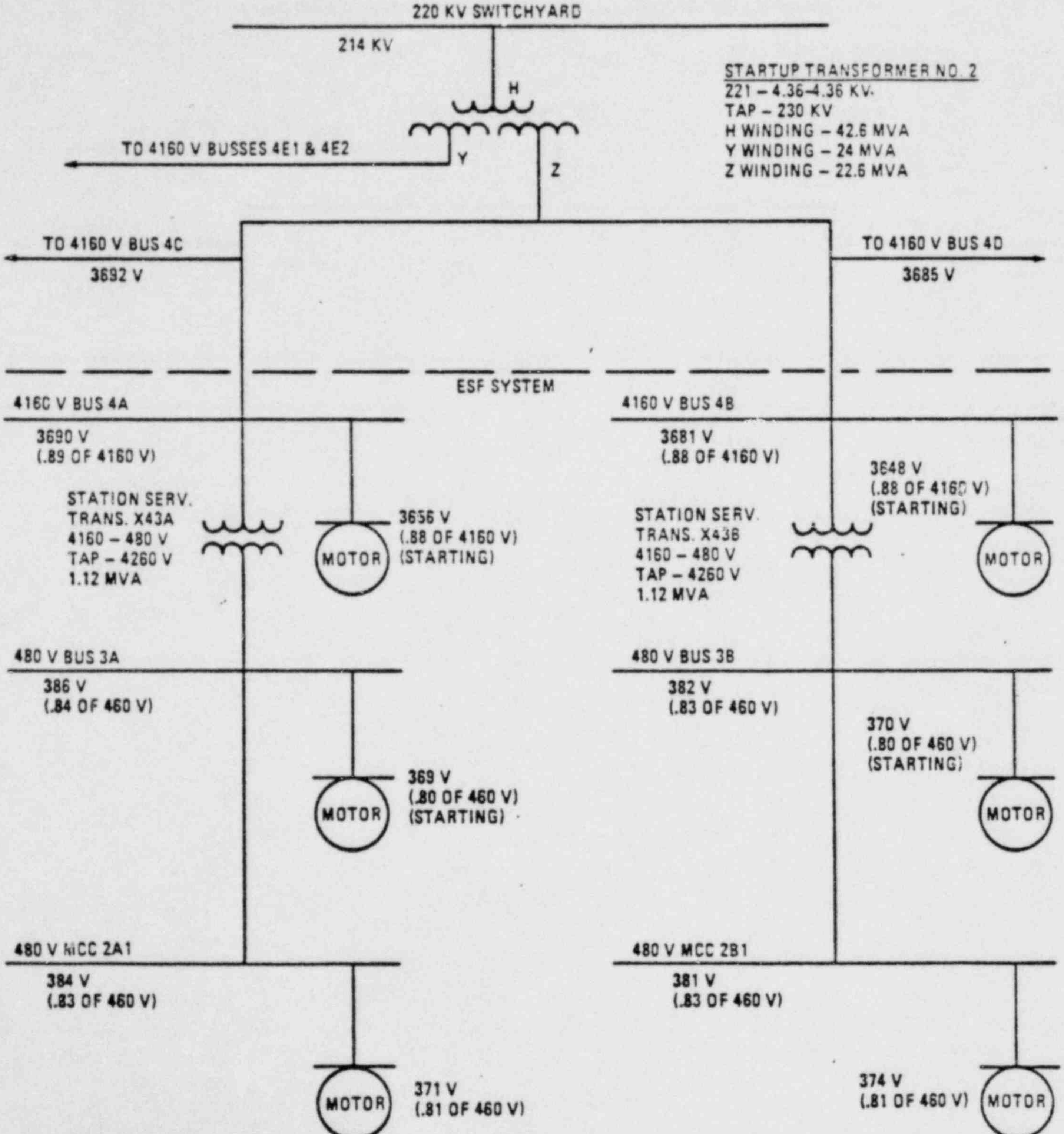
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 3., T = 26 SEC.)
START THE NUCLEAR SERV RAW WATER PUMPS AND THE DIESEL-GENERATOR ROOM VENT FANS



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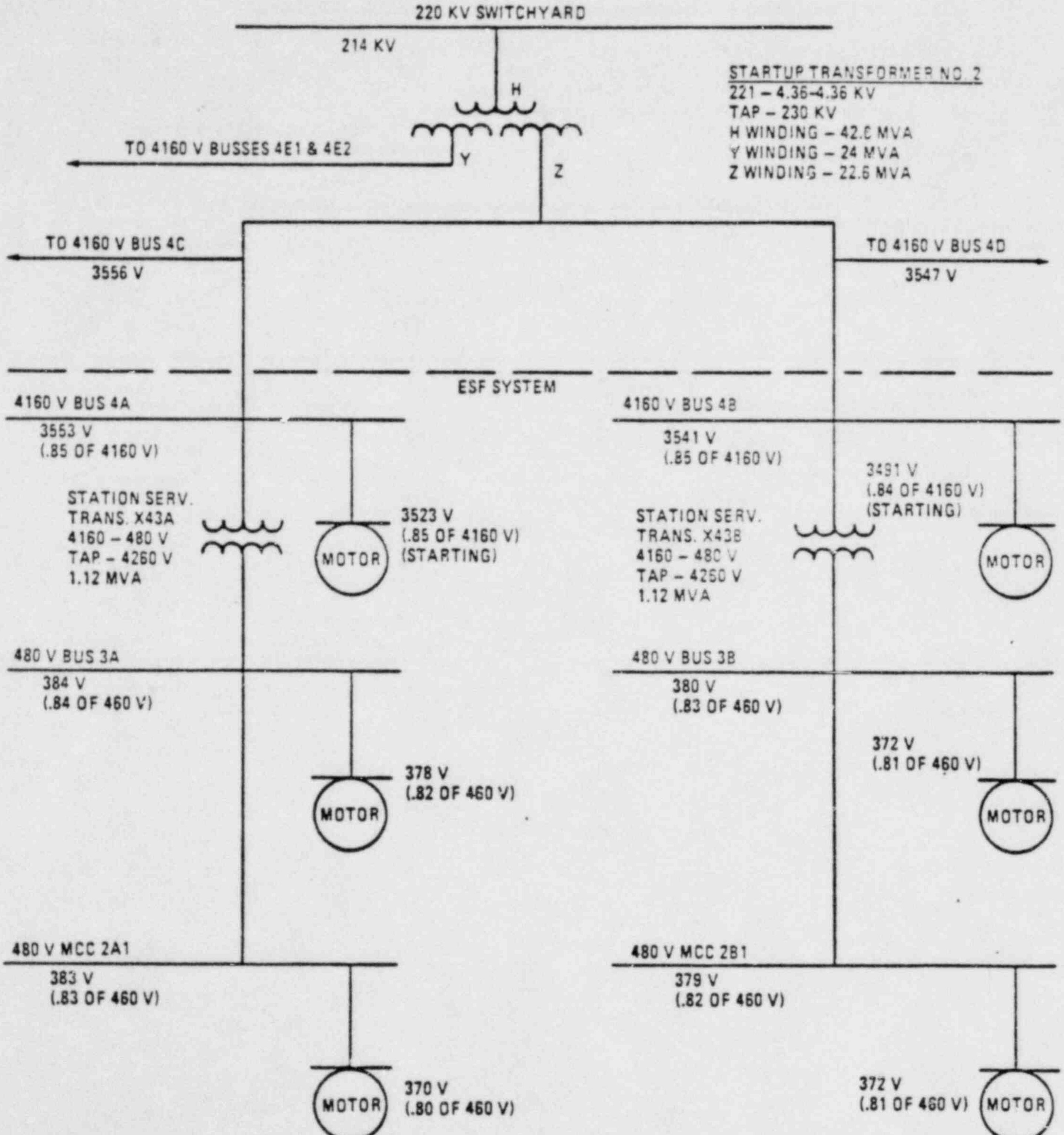
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 4., T = 36 SEC.)
START AUX FEED WATER PUMPS



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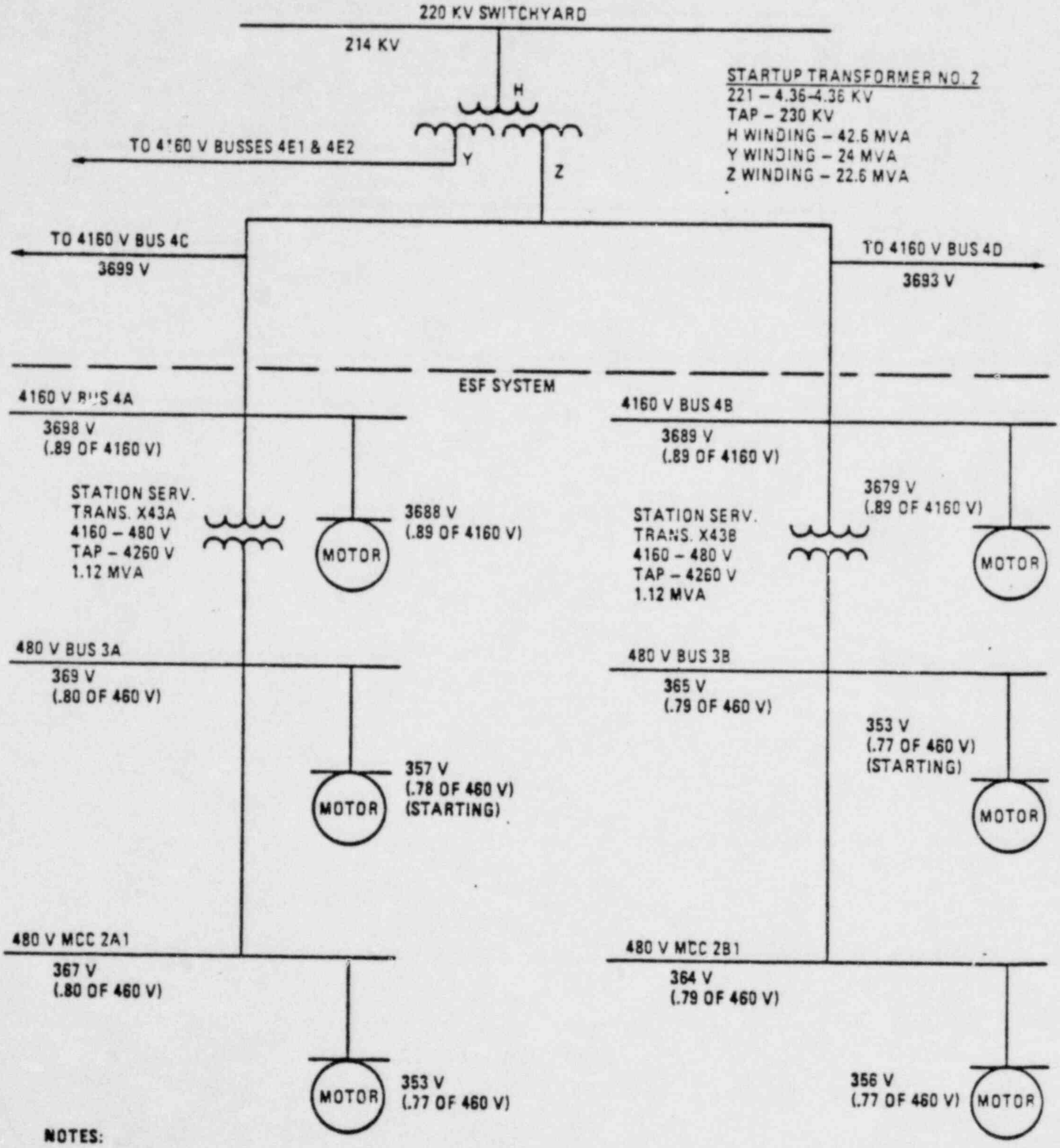
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING BLOCK LOADING OF EMERGENCY BUSSES
(BLOCK 5., T = 300 SEC.)
START REACTOR BUILDING SPRAY PUMP



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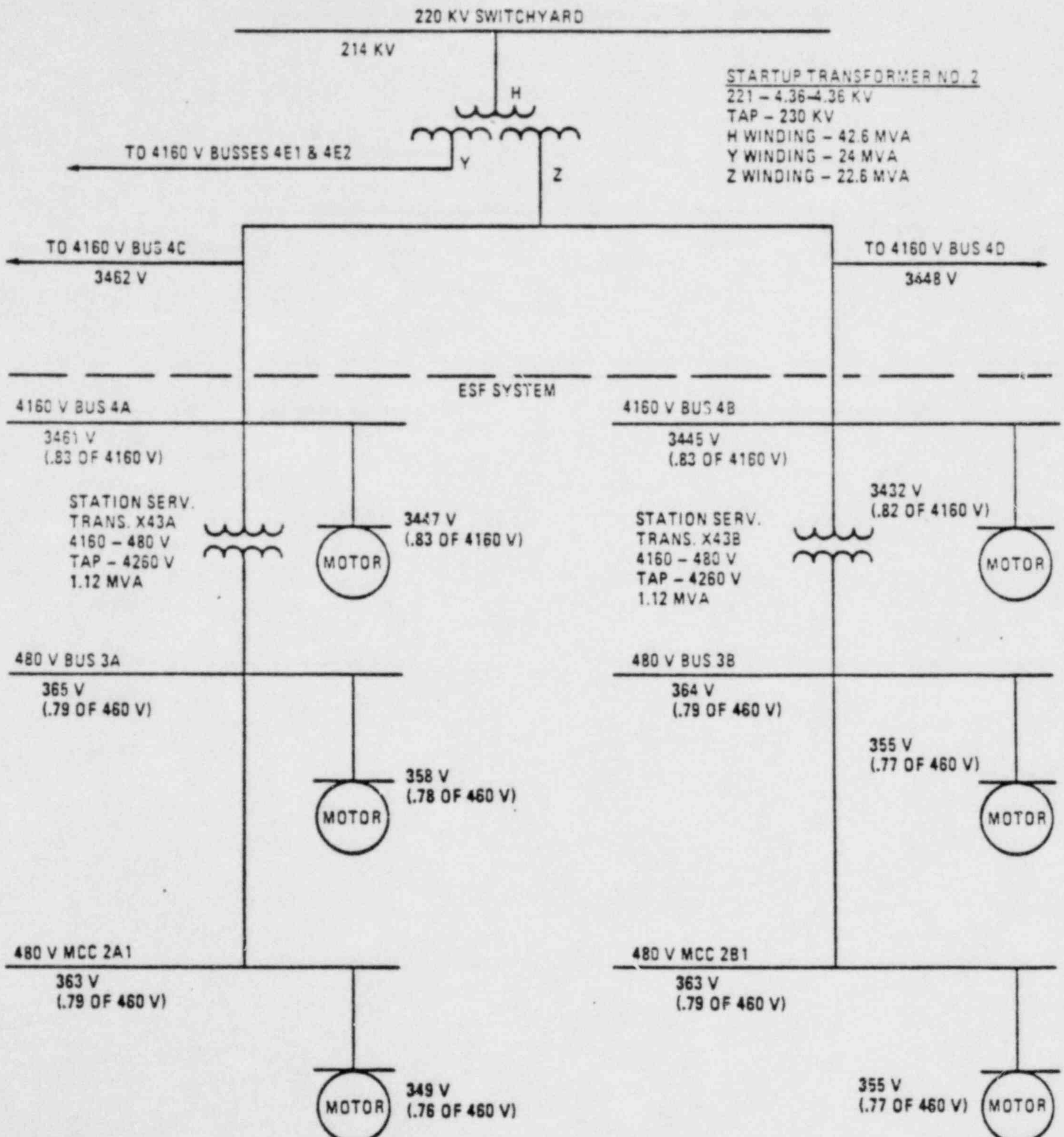
CASE 3
BUS 4A & 4B ON STARTUP TRANSFORMER NO. 2
VOLTAGE DURING START OF CONDENSATE PUMP



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3. CONDENSATE PUMP STARTING TIME IS LESS THAN 2 SECONDS.

ENCLOSURE I

PART C

Evaluation of the Rancho Seco Offsite
Power System for Compliance
to General Design Criterion 17
(Refer to NRC Letter
William Gammill to Power Reactor
Licensees Dated August 8, 1979)

The NRC's August 8, 1979, letter to all Reactor Licensees (except Humbolt Bay) requested the District

> "To review the electric power systems of your nuclear station to determine if there are any events or conditions which could result in the simultaneous or consequential loss of both required circuits to the offsite network to determine if any potential exists for violation of GDC-17 in this regard."

The District has completed a review of the electrical power system for Rancho Seco and has determined that the District's electrical power supply system is in compliance with GDC-17. The basis for this conclusion is contained in what follows. 1

The power distribution system from the transmission network to the onsite safety related electrical distribution system consists of:

a. Five overhead lines

b. Start-up transformers #1 and #2 and the nuclear service transformers.

c. Bus duct from the start-up transformers to the onsite safety related electrical distribution system.

d. Protective relays, circuit breakers, control panels, batteries, and power and control cables associated with the operation of the distribution system.

The following assumptions were made by the District in determining events which could result in simultaneous or consequential loss of both required circuits. (For a one line diagram of the Rancho Seco distribution system refer to Sketch 1.)

a. All switchyard breakers are closed and in service.

b. All five lines that connect the switchyard to the transmission system are in service.

c. Safety Bus 4A is connected to start-up transformer #1.

d. Safety Bus 4B is connected to start-up transformer #2.

e. Only a single event or failure is assumed to occur unless it could be deominstrated that the single event could lead to multiple failures.

Based on the following assumptions, the District has analyzed the following events to determine if they could cause loss of both required circuits.

FIRE

It is possible for a single fire either in a control cabinet, cable tray or conduit to involve the control circuits for all the circuit breakers required for both offsite sources, and cause the circuit breakers to trip. However, this loss of power would only be temporary since the required circuit breakers can be quickly closed manually without any electrical power.

The District has minimized to the extent practical the likelihood of this event by:

1. Using flame retardant cable for all cable between the plant and switchyard.

2. Installing a fire detection and suppression system in the plant and switchyard where the circuits of concern are routed.

3. Providing a manual method of choosing the circuit breakers.

Therefore, this event is not a violation or potential violation of GDC-17.

SEISMIC EVENT

A design basis earthquake may cause the loss of both offsite sources. However, the District has designed and located equipment so as to minimize to the extent practical the likelihood of loss of both required circuits during a seismic event by including a seismic load in the design of supports for equipment required to be in service to provide offsite power. Therefore, loss of both required offsite power sources during an earthquake is not a violation or potential violation of GDC-17.

RANDOM SINGLE FAILURES

The District has analyzed the power distribution system from the transmission system to the onsite safety electrical distribution system for single failures that can cause loss of both required offsite circuits. The review indicated that there are no single failures that can cause the loss of both required offsite sources. This analysis included the following items. 1

a. Short circuits

b. Breaker failures

c. Switchyard battery failure

d. Relay failures

e. Transformer failures

f. Lightning strikes

TOWER FAILURES

The District has analyzed the transmission system for compliance with GDC-17 and determined that there is no single tower failure that could cause the loss of all offsite power. Therefore, failure of a transmission tower is not a violation or potential violation of GDC-17. 1

Enclosure II

SACRAMENTO MUNICIPAL UTILITY DISTRICT

RANCHO SECO NUCLEAR GENERATING
STATION, UNIT NO. 1

RESPONSE TO:

NUCLEAR REGULATORY COMMISSION
REQUEST FOR INFORMATION
REGARDING ENCLOSURE 1 OF NRC TO SMUD LETTER
DATED JUNE 3, 1977 TITLED
SAFETY EVALUATION AND STATEMENT OF STAFF
POSITIONS RELATIVE TO THE EMERGENCY POWER
SYSTEMS FOR OPERATING REACTORS

Issued: July 19, 1977
Revision 1: August 1, 1980

Listed below is a response to each position listed in Enclosure 1 "Safety Evaluation and Statement of Staff Positions Relative to the Emergency Power Systems for Operating Reactors" of NRC's Robert W. Reid to J. J. Mattimore, letter dated June 3, 1977.

POSITION 1: SECOND LEVEL UNDEROROVER VOLTAGE PROTECTION WITH A TIME DELAY

We require that a second level of voltage protection for the onsite power system be provided and that this second level of voltage protection shall satisfy the following criteria.

a) The selection of voltage and time set points shall be determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels;

b) The voltage protection shall include coincidence logic to preclude spurious trips of the offiste power source;

c) The time delay selected shall be based on the following conditions:

   (1) The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the FSAR accident analyses;

   (2) The time delay shall minimize the effect of short duration distribances from reducing the availability of the offsite power source(s); and

   (3) The allowable time duration of a degraded voltage condition at all distribution system levels shall not result in failure of safety systems or components;

d) The voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the voltage set point and time delay limits have been exceeded;

e) The voltage monitors shall be designed to satisfy the requirements of IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"; and

f) The Technical Specification shall include limiting condtions for operation, surveillance requirements, trip set points with minimum and maximum limits, and allowable values for the second-level voltage protection monitors.

RESPONSE TO POSITION 1

The second level of voltage protection for the onsite power system is not necessary since equivalent protection is afforded by a single inverse time-undervoltage relay type.

a) The selection of voltage and time settings was determined by analysis of the voltage requirements of the safety-related loads. The undervoltage relay settings are analyzed in the response to Guideline #10 of Enclosure I. The overvoltage relay settings are analyzed in the response to Guideline #1 of Enclosure I.

b) A scheme incorporating coincidence logic is proposed to preclude spurious trips of the offsite power system. The circuit proposed in shown in Figure 1.

Three potential transformers will be used to monitor the bus voltage. Each potential transformer will monitor a different line-to-line voltage. Connected to the secondary of each potential transformer (PT) will be an undervoltage relay, overvoltage relay and a voltmeter.

The contacts from the undervoltage and overvoltage relays are connected such that if either relay is removed, an alarm will be received in the control room on the plant annunciator and plant computer. A normally-closed contact from the overvoltage relay and a normally-opened contact from the undervoltage relay on the same PT are connected in series to operate an auxiliary relay (4AUL1, 4AUL2 and 4AUL3). The auxiliary relays are deenergized for either an undervoltage or overvoltage condition. The contacts from the auxiliary relays are arranged in a two-out-of-three logic. This logic string is used to operate an existing time delay energize-deenergize relay (62A). A time delay close (TDC) contact from this relay is used to initiate bus load shedding and diesel starting in the existing scheme.

The 62B relay is a time delay on energizing relay that prevents an accidental bus unloading when the logic circuit is initially energized. The 125V dc to terminals 7 and 8 on the overvoltage and undervoltage relays is the control power to the relays.

c) The time delay setting was based on thefollowing conditions:

(1) The undervoltage relay will trip in less than one second on a complete loss of voltage (see Figure 2). This, combined with the 62A relay definite time delay, is appreciably less than 5-second maximum delay shown in the FSAR. Time requirements for overvoltage trip delay are not addressed in the FSAR.

(2) The time delays selected have been analyzed to verify that short-duration disturbances caused by motor starting and short circuits will not cause inadvertent disconnection of the offsite power source.

(3) The time duration that a degraded voltage condition is allowed to persist before tripping of the voltage relays has been analyzed to verify that failure of safety system or components will not occur.

d) The voltage monitors will automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits have been exceeded.

e) The voltage monitors were designed to satisfy the requirements of IEEE 279 except independence between channels of the same train is not provided since the sensing and protective action functions relate only to that train. However, independence is provided between redundant portions of the safety systems (i.e.: between Train A and Train B) in accordance with the requirements for independence established in IEEE 603.

f) Technical Specifications will be revised to include limiting conditions for operation, surveillance requirements, trip set points with maximum and minimum limits, and allowable values. Refer to Attachment 1 for a description of the Technical Specification modifications being considered by the District.

POSITION 2: INTERACTION OF ONSITE POWER SOURCES WITH LOAD SHED FEATURE

We require that the current system designs automatically prevent load shedding of the emergency buses once the onsite sources are supplying power to all sequenced loads on the emergency buses. The design shall also include the capability of the load shedding feature to be automatically reinstated if the onsite source supply breakers are tripped. The automatic bypass and reinstatement feature shall be verified during the periodic testing identified in Position 3.

In the event an adequate basis can be provided for retaining the load shed feature when laods are energized by the onsite power system, we will require that the setpoint value in the Technical Specifications, which is currently specified as "...equal to or greater than..." be amended to specify a value having maximum and minimum limits. The licensees' bases for the setpoints and limits selected must be documented.

RESPONSE TO POSITION 2

The existing Rancho Seco design complies with this position; consequently, no changes are necessary.

The existing scheme functions as follows:

1. After exceeding the voltage setpoint a contact of the 62A relay closes energizing a set of load shedding relays.

2. The load shedding relays perform the following functions:

   A. Trip the normal offsite supply breaker to the safety features ·160 volt buses.

   B. Trip the load breakers on the 4160 volt buses.

   C. Set up the load sequencing timing circuit.

   D. Start the emergency diesel generato::s.

3. When the diesel driven generator reaches the required voltage, its circuit breaker will automatically close connecting it to the 4160 volt bus, and the step loading sequence will automatically commence if a safety features actuation signal exists.

4. An auxiliary "b" contact from the generator circuit breaker opens to disable the load shedding feature of the circuit. Consequently, the voltage sensing relay cannot re-initiate the load shedding feature of the scheme so long as the generator circuit breaker remains closed.

5. Should the gene·ator circuit breaker be opened for any reason the load shedding and loading sequences would be re-initiated as described in Items 2 and 3 above.

POSITION 3: ONSITE POWER SOURCE TESTING

We require that the Technical Specifications include a test requirement to demonstrate the full functional operability and independence of the onsite power sources at least once per 18 months during shutdown. The Technical Specifications shall include a requirement for tests: (1) simulating loss of offsite power in conjunction with a safety injection actuation signal; and (2) simulating interruption and subsequent reconnection of onsite power sources to their respective buses. Proper operation shall be determined by:

a) Verifying that one loss of offsite power the emergency buses have been de-energized and that the loads have been shed from the emergency buses in accordance with design requirements.

b) Verifying that on loss of offsite power the diesel generators start from ambient condition on the autostart signal, the emergency buses are energized with permanently connected loads, the autoconnected emergency loads are energized through the load sequencer, and the system operates for five minutes while the generators are loaded with the emergency loads.

c) Verifying that on interruption of the onsite sources the loads are shed from emergency buses in accordance with design requirements and that subsequence loading of the onsite sources is through the load sequencer.

RESPONSE TO POSITION 3

Refer to Attachment 1 for a description of the Technical Specification modifications being considered by the District.

FIGURE 1
4160-V NUCLEAR SERVICE BUS
PROPOSED VOLTAGE PROTECTION SCHEME MODIFICATION

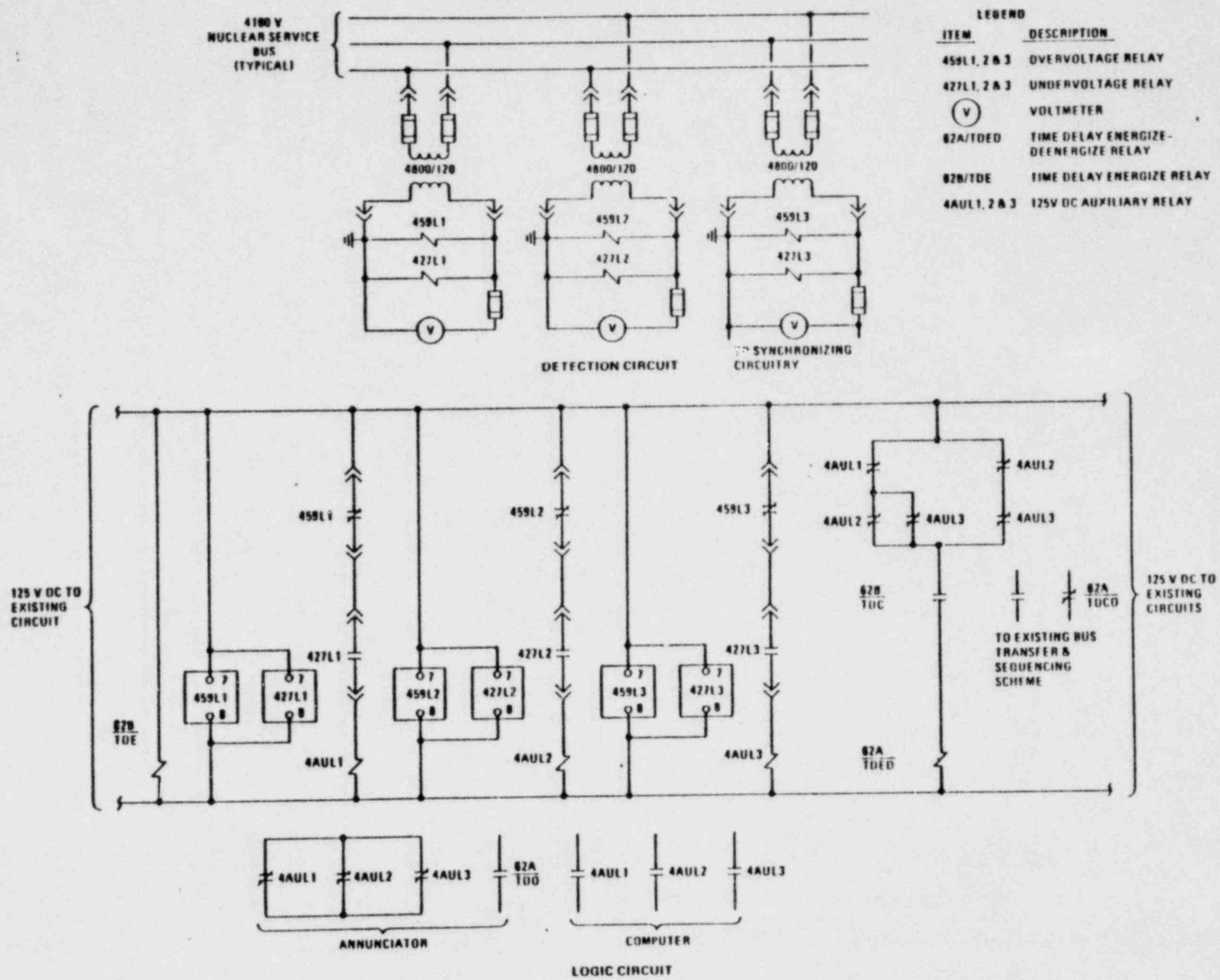
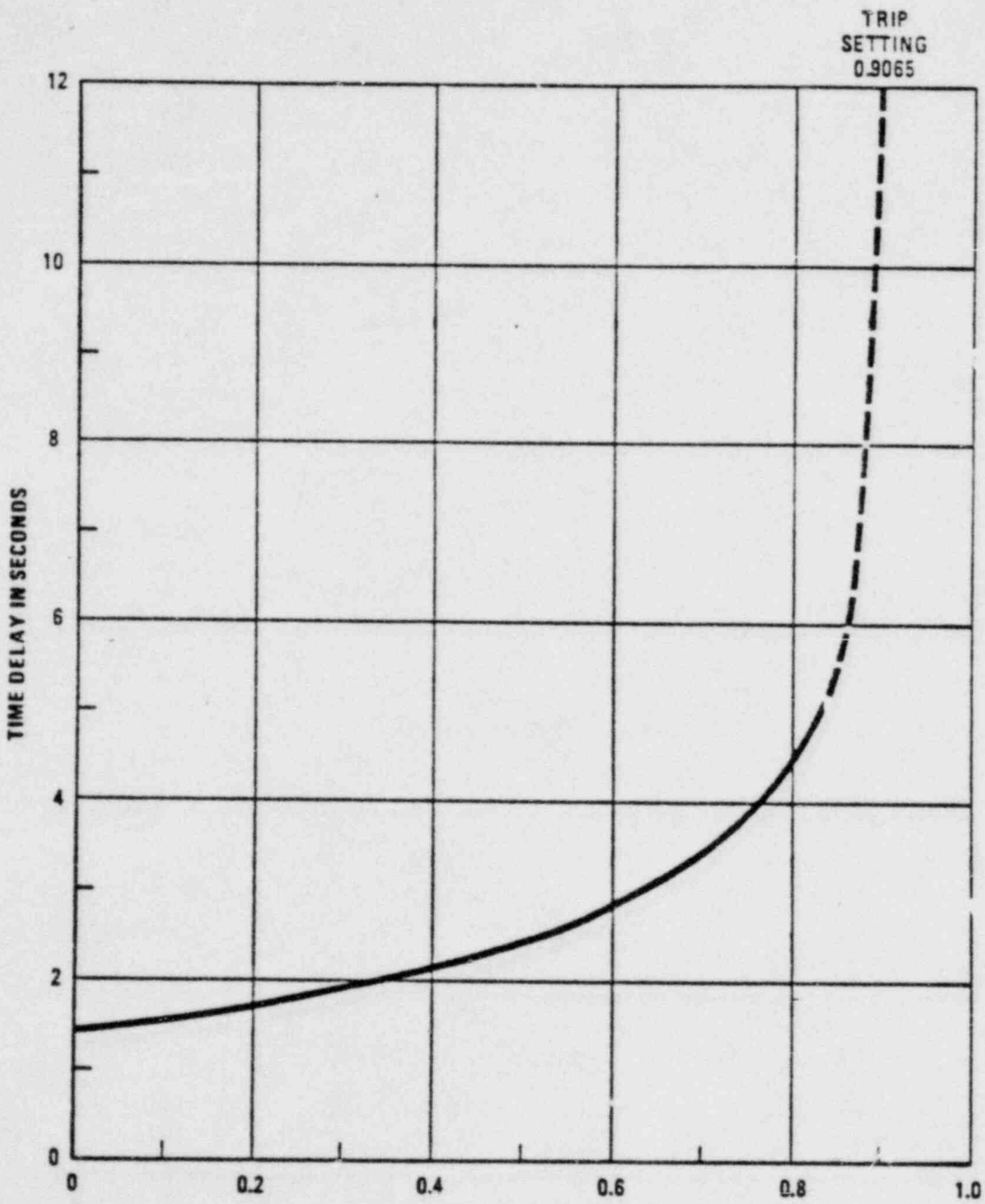


FIGURE 2
UNDERVOLTAGE RELAY
TIME-VOLTAGE CHARACTERISTIC



NOTE: AN EXTERNAL TIME DELAY RELAY (62A) SET AT 0.5 SECOND OPERATES IN SERIES WITH THIS RELAY.

TECHNICAL SPECIFICATION MODIFICATIONS

The modifications described herein have been drafted in response to NRC positions and guidelines. They are being considered by the District for inclusion in the Technical Specifications and are submitted to the NRC for preliminary review. Upon NRC approval of the voltage protection system modifications, a proposed Technical Specification change will be submitted for NRC approval.

3. LIMITING CONDITIONS FOR OPERATION

3.7 AUXILIARY ELECTRICAL SYSTEMS

Specification

3.7.1 The reactor shall not be brought critical unless the following conditions are met:

Add paragraph 3.7.1 (I) as follows:

I. The switchyard voltage is 218 kV or above.

3.7.2 The reactor shall not remain critical unless all of the following requirements are satisfied.

Add paragraph 3.7.2 (H) as follows:

H. If the switchyard voltage is below 218 kV for less than 24 hours, no corrective action is required. After 24 hours, if the voltage has not increased above 218 kV, both diesel generators will be started, connected to the nuclear service buses, and the startup transformers removed from the nuclear service buses. Switchyard voltage above 218 kV will allow unrestricted plant operation.

Add paragraph 3.7.4 as follows:

3.7.4 The voltage protection system trip setting shall be as stated in Table 3.7.1.

Add paragraph 3.7.5 as follows:

3.7.5 Voltage Protection System Limiting Conditions

A. Startup and operation are not permitted unless the minimum requirements and action statements of Table 3.7.5 are met.

B. In the event the number of protective channels falls below that listed in Table 3.7.5, the plant will be brought to a hot shutdown within 48 hours.

Bases

Add the following paragraph to Bases

The voltage protection system is designed to isolate the nuclear service buses from the startup transformers when the bus voltage exceeds the allowable operating limits of the equipment. The allowable operating range for the 4160-V nuclear service buses is 3731 to 4626 volts and 397 to 521 volts for the 480-V nuclear service buses. This corresponds to a switchyard voltage range of 214 to 244kV. This range of switchyard voltage encompasses the normal operating range of 221 to 239kV.

TABLE 3.7.1

VOLTAGE PROTECTION SYSTEM RELAY TRIP VALUES

	Trip Value	Time Delay
Undervoltage	(Note 2)	
a. Dropout	3771 $\pm$ 38V	Note 1
b. 75-percent of 4160V	3120 $\pm$ 31V	1.9 $\pm$ 0.2s
c. Complete loss	0	1.5 $\pm$ 0.2s
Overvoltage	4580 $\pm$ 46V	3.0 $\pm$ 0.3s

Note 1 - Dropout voltage is calibrated with relay on its minimum time dial settings.

Note 2 - The relay voltage values shown have been converted by the PT ratio (40:1) for review convenience.

TABLE 3.7.5

Functional Unit	Total Number of Channels	Channels to Trip	Minimum Channels OPERABLE	Action (Note 1)
Undervoltage	3/Bus	2/Bus	2	A
Overvoltage	3/Bus	2/Bus	2	A

Action Statements

Action A - With the number of OPERABLE channels one less than the Total Number of Channels operation may proceed provided both of the following conditions are satisfied:

a. The inoperable channel is placed in the tripped condition within one hour.

b. The Minimum Channels OPERABLE requirement is met; however, one additional channel may be bypassed for up to 2 hours for surveillance testing.

Note 1: The above table is not applicable when the plant is in cold shutdown.

4. SURVEILLANCE STANDARDS

4.1 OPERATIONAL SAFETY REVIEW

TABLE 4.1-1

INSTRUMENT SURVEILLANCE REQUIREMENTS

Add item 48 to Table 4.1-1.

Channel Description	Check	Test	Calibrate	Remarks
48. Voltage Protection	S			Compare voltmeter readings
a. Undervoltage		R	R	
b. Overvoltage		R	R	
c. Time Delay		R	R	

S = Each Shift
M = Monthly
R = Once during the refueling interval

4.6 EMERGENCY POWER SYSTEM PERIODIC TESTING

Specification

Substitute 4.6.2 with the following:

4.6.2 During each refueling interval, a test of the diesel generators and emergency start circuits shall be performed to verify that these emergency power sources and associated equipment are operable by:

A. Simulating a loss of offsite power in conjunction with a safety injection actuation signal, and:

1) Verifying deenergization of the nuclear services buses and operation of the load shedding circuitry.

2) Verifying the diesel starts from ambient condition on the auto-start signal and energizes the nuclear services buses, and by verifying proper operation of the automatic load sequencing circuitry. The diesel generators will be operated for at least 5 minutes in this condition.

3) Verifying that on diesel-generator trip, the load shedding circuitry operates properly and the diesel restarts on the auto-start signal, and by verifying proper operation of the automatic load sequencing circuitry. The diesel generator will be operated for at least 5 minutes in this condition.

B. Load testing the diesel generators to SFAS capacity.