CON EDISON CALCULATION/ANALYSIS COVER SHEET

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Equip.Type	038	ELECTRICAL SUPPLY
Structure	08	CONTROL BUILDING
Structure	25	PRIMARY WATER STORAGE TANK
System	77	138 KVAC ELECTRICAL
System	80	480 VOLT ELECTRICAL
System	81	6.9 KVAC ELECTRICAL

Preparer/Date (Print/Sign)	Reviewer/Date (Print/Sign)	Approval/Date (Print/Sign)	Rev.No.	Supercedes	Confirm. Required?
KENNETH CHAN Kenneth Chan 1/21/93	ANDY CHAN Andy Chan 1/22/93	Roger Sullivan Roger Sullivan 1/22/93	0	EGP-00024-00	No.

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CON EDISON CALCULATION/ANALYSIS

Description of Change Sheet

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SUMMARY OF DEGRADED VOLTAGE STUDY

I) INTRODUCTION

During the 1993 Refueling Outage, modifications will be implemented in connection with the degraded voltage study. The enhancement will provide greater margin to insure the safety-related equipment operation. In addition, as part of the Motor Operated Valve Upgrade Program, MOV(s) will be upgraded, based on a MOV analysis that uses a higher degraded voltage setpoint.

Modification Procedure No. EGP-91-06786-E Revision 0 and 1. will replace the degraded undervoltage relays and change the setpoint from 403VAC +/-5 volts to 421VAC +/-6 volts; this will increase the margins between the minimum starting voltage and the minimum voltage due to degraded conditions at the 480VAC safeguard motor terminals.

Modification Procedure No. EGP-92-07762-E Revision 0 will enhance the 480VAC Safety Buses 2A, 3A, 5A and 6A voltage level through a faster load tap changer response by lowering

the 138/6.9kV offsite supply Station Auxiliary Transformer (SAT) load tap changer (LTC) initial time delay from 45 seconds to 2 seconds and by reducing the transferred AC load to the offsite bus after the unit trip through the automatic tripping of 6.9kV Condensate Pump No. 23 following a unit trip.

Modification Procedure No. FEX-92-08169-E will upgrade MOV(s) based on the new degraded voltage relay setpoints when required.

II) OBJECTIVE

Based on the 1993 enhancements and the new degraded voltage relay setpoints, this analysis will demonstrate the following:

o Basis for new degraded voltage relay setpoint

o With the new degraded voltage relays setpoint, under the normal offsite voltage conditions 136kV to 142kV, the

480VAC buses will not be degraded to a level that would initiate an unnecessary transfer to the emergency onsite power supply during normal plant operation, unit trip or accident conditions.

- For the worst case 138kV offsite power degradation which is well beyond the Electric Planning Extreme Contingency Analysis and the New York Power Pool Design Criteria, the 480VAC buses will transfer to the emergency onsite power supply, as designed.

III) DEGRADED VOLTAGE MODIFICATION ENHANCEMENTS

Due to the higher degraded voltage setpoint, enhancements are being made to preclude any unnecessary transfers to the onsite emergency power supply. These changes are covered under modification Procedure EGP-91-06786-E, (IP2 SV Relay Replacement) and EGP-92-07762-E, (IP2 Degraded Voltage Circuit Modification). Modification EGP-91-06786-E provides for the replacement of the existing Westinghouse SV relays with ABB Type 27N high accuracy relays and for the associated setpoint changes. Modification EGP-92-07762-E

provides for the reduction of the time delay for the Station Auxiliary Transformer LTC and for the automatic tripping of Condensate Pump No. 23 on a unit trip. Tripping of the condensate pump will reduce the load that is transferred from the unit supply (Unit Auxiliary Transformer) to the offsite supply (Station Auxiliary Transformer). This modification provides for the quicker recovery of the 6.9kV and 480V bus voltages following an offsite power grid disturbance and for a reduction of the voltage drop through the Station Auxiliary Transformer and associated cable and switchgear, thus reducing the voltage drop the LTC must quickly compensate for. Both modifications will be performed during the 1993 refueling outage.

IV) MOTOR OPERATED VALVES

Presently a study is being conducted by B&W Nuclear Services in response to Generic Letter 89-10 to determine the minimum required voltage at the MOV terminals. The minimum acceptable voltage at the MOV terminal will determined by the B&W analysis. A comparison will be made between the required voltage and the degraded voltage relay setpoints to

determine whether MOV(s) have to be upgraded. Modifications will be performed for those MOV's identified by the B&W analysis which do not have adequate motor terminal voltage during starting conditions.

V) <u>BASIS FOR DEGRADED UNDERVOLTAGE SETPOINT</u>

To increase the margin of motor starting voltage, the degraded voltage relays setpoints will be changed from the present setpoint value of 403V +/-5V to 421V +/-6V via modification procedure EGP-91-06786-E, Revision 1.

The setpoint value was chosen with an enhanced margin of safety above the minimum required bus voltage (415VAC, see Calc. EGE-00001-00) to start and run the 480V safeguard motors, with an upper bound to preclude spurious transfers to the diesel generators for system fluctuations and to account for relay drift and tolerances and for the tolerances of the potential transformers. The setpoint range is based upon the actual operating characteristics of the ABB Type 27N relays which will be used in the degraded voltage protection circuits.

VI) MINIMUM VOLTAGE REQUIREMENTS FOR CLASS 1E MOTORS

In order to determine the voltage requirements for Class 1E safety-related motors, an analysis was performed by the Rotating Machinery Subsection of Electrical Engineering. The analysis consisted of determining the minimum required voltage at the motor terminals to start the motor by using the latest EPRI recommended calculation method and actual motor and pump curves. (See Calculation EGE-00001-00). In addition, the calculation also determined the minimum voltage level required at the 480V supply buses (2A, 3A, 5A, 6A), taking into consideration the voltage drop of the power cable. Based on the results of the above calculation, it was determined that the 250 HP Component Cooling Pump Motors were the bounding motors in terms of maximum required terminal voltage. This corresponds to 415VAC at the 480V Safety Related Buses (2A, 3A, 5A, 6A).

VII) OFFSITE POWER SYSTEM DISTURBANCE (Offsite Power-138kV)

Under the normal operating conditions, Con Edison system voltages are maintained within the specified range as

described in EO-4000, Rev 04, "System Operating Manual No. 5" and are as follows:

Substation	Minimum Voltage	Maximum Voltage
138-kV	136-kV	142-kV
345-kV	340-kV	359-kV

For this range of offsite power grid voltage variations the 480V bus voltages must not be reduced to a level which would initiate an unnecessary transfer to the emergency onsite power during normal plant operations, unit trip or accident condition.

For this analysis, the voltage used was based on the Electric Planning Department study which simulated the loss of Indian Point No. 2. In order to simulate the degraded voltage scenario, pre-contingency voltages for the IP2 offsite supply from the Buchanan 138-kV substation were intentionally scheduled at their minimum design level (136kV) to achieve the lowest voltage condition resulting

from this system disturbance. The 138-kV offsite voltage after the loss of IP2 is 0.958 pu (132.20-kV).

Immediately after this contingency, System Operations at the Energy Control Center is required to restore the 138-kV system to the value 0.985 pu minimum as defined in EO-4000-4 and in accordance with the "Standards For Planning and Operating The New York Power Pool Bulk Power System", 0.95 pu minimum. This can be accomplished by System Operations at the Energy Control Center who would control the Buchanan North 345/138-kV Transformer TA5's tap changer via the supervisory system (System Operation Computer Control System known as SOCCS). In addition, the IP2 Station Auxiliary Transformer LTC would automatically adjust the voltage on the 6.9kV and 480V buses. As a result, the amount of time that the offsite grid voltage would be degraded to the extent that there would be a transfer to emergency onsite power is minimal. Offsite power remains the preferred power source by design, and a transfer to emergency onsite power is designed to occur only for sustained degraded conditions which would reduce the margin for the 480V safeguard motors below the enhanced acceptable levels.

For offsite grid voltages which fall below the above range, the offsite grid voltage is considered to be degraded, and if the degraded voltage setpoint is reached and sustained for the Technical Specification time delay, the 480V buses will be transferred to emergency onsite power by design.

A) LOCA ANALYSIS

To evaluate the effects of the degraded voltage on the various safety-related motors, a case study was performed for the plant LOCA scenario mode (when the offsite power is initially at 136kV) using EBASCO's computerized program, Electrical System Management Software (ESMS), dated 12/31/89, with a database updated to reflect the installed 1991 outage modifications. This model reflects the electrical distribution system of the 6.9kV and 480V buses at IP2. The program was written and QA verified by EBASCO Services Incorporated. This case scenario assumes no voltage adjustment by the System Operator via the SOCCS supervisory panel. The program is limited in its capability

to fully model the load tap changer. To compensate for the program's inability to model the LTC for the 43MVA, 138/6.9kV Station Auxiliary Transformer, the transformer's winding ratio was manually varied to simulate LTC movements. The SAT is a Westinghouse unit with a URT type LTC. Modification EGP-92-07762-E will reduce the time delay for operation of the first tap by lowering the transformer's SVR relay raise and lower time delay from 45 seconds to 2 seconds and will provide for the automatic tripping of the 6.9kV Condensate Pump No. 23 via the auxiliary relays 86X-1/P and 86X-1/BU. (These relays will be actuated by the 86/P and 86/BU relays which also actuate the fast bus transfer) These modifications will improve the bus voltage levels on the 6.9kV and 480V buses. After the initial time delay, the time required for the load tap changer to change from one position to the next is one (1) second. For conservatism, this analysis will use two (2) seconds as the mechanical operation time to change from one position to the next as the worst case assumption.

In actual operating circumstances after the system disturbances, the LTC will either automatically adjust the

voltage back to approximately 7.05kV or be operated manually via the Central Control Room. In addition the System Operator will restore the 138-kV system voltage via the SOCCS supervisory panel manually to maintain the specified operating voltage (136-kV to 142-kV).

LOCA CONCLUSION

The results of the LOCA case scenario with the automatic load sequencing of safety related loads as per Reference 9. are shown in Figures 1 and 2. These figures represent the load profiles for the 480V Buses 5A and 6A and illustrates that during motor starting transients the voltage on the bus will drop to a level below the proposed degraded voltage setpoint (Bus 5A - 403VAC. starting Safety Injection Pumps Nos. 21, 22, 23, Bus 6A - 398VAC. starting Auxiliary Feedwater Pumps Nos. 21, 23). However. the bus voltage after the motor(s) has started will recover to a steady state voltage above the reset value of the degraded undervoltage relays within the acceptable time frame (10 seconds with SI) as designed (Bus 5A - 438VAC. Bus 6A - 434VAC). These figures also demonstrate that the

safety-related motors will be able to start and continue to operate under the LOCA scenario and not transfer to the emergency onsite power. After the completion of the SI loading sequence, the steady state voltage on the 480VAC Bus 5A and 6A will be 441V and 434V respectively.

The worst case 480V bus loading occurs on Buses 5A and 6A. Therefore, this analysis does not include the load profiles for Buses 2A and 3A since these are not the bounding cases.

Table 1 lists the safety related equipment, desired terminal starting voltage, desired voltage at bus and the voltage prior and after starting of the subject motor per the SI loading sequence.

Table 2 lists the attachments numbers of the EBASCO computer printouts for selected cases with corresponding SAT LTC secondary winding ratio's and the selected motor(s) to be started.

Table 3 lists the safety related motor starting sequence and their respective starting times from the initiation of bus sequence signal.

FASTBUS TRANSFER ANALYSIS

We have also evaluated the effects of a Unit trip resulting in a fastbus transfer of loads from the Unit Auxiliary Transformer supply to the Station Auxiliary Transformer supply during normal plant conditions. This case scenario assumes no voltage adjustment by the System Operator via the SOCCS supervisory panel. During a non SI condition, the degraded undervoltage relays actuate a Agastat timer (set at 180 seconds) which in turn trips its respective 480V breaker in the event that the degraded voltage relays do not reset within the 180 seconds. The time delay allows for the voltage fluctuations on the 138-kV offsite system and normal plant load variations to stabilize to prevent an inadvertent transfer to the emergency onsite power supply.

FIGURE 1

BUS 5A VOLTAGE PROFILE

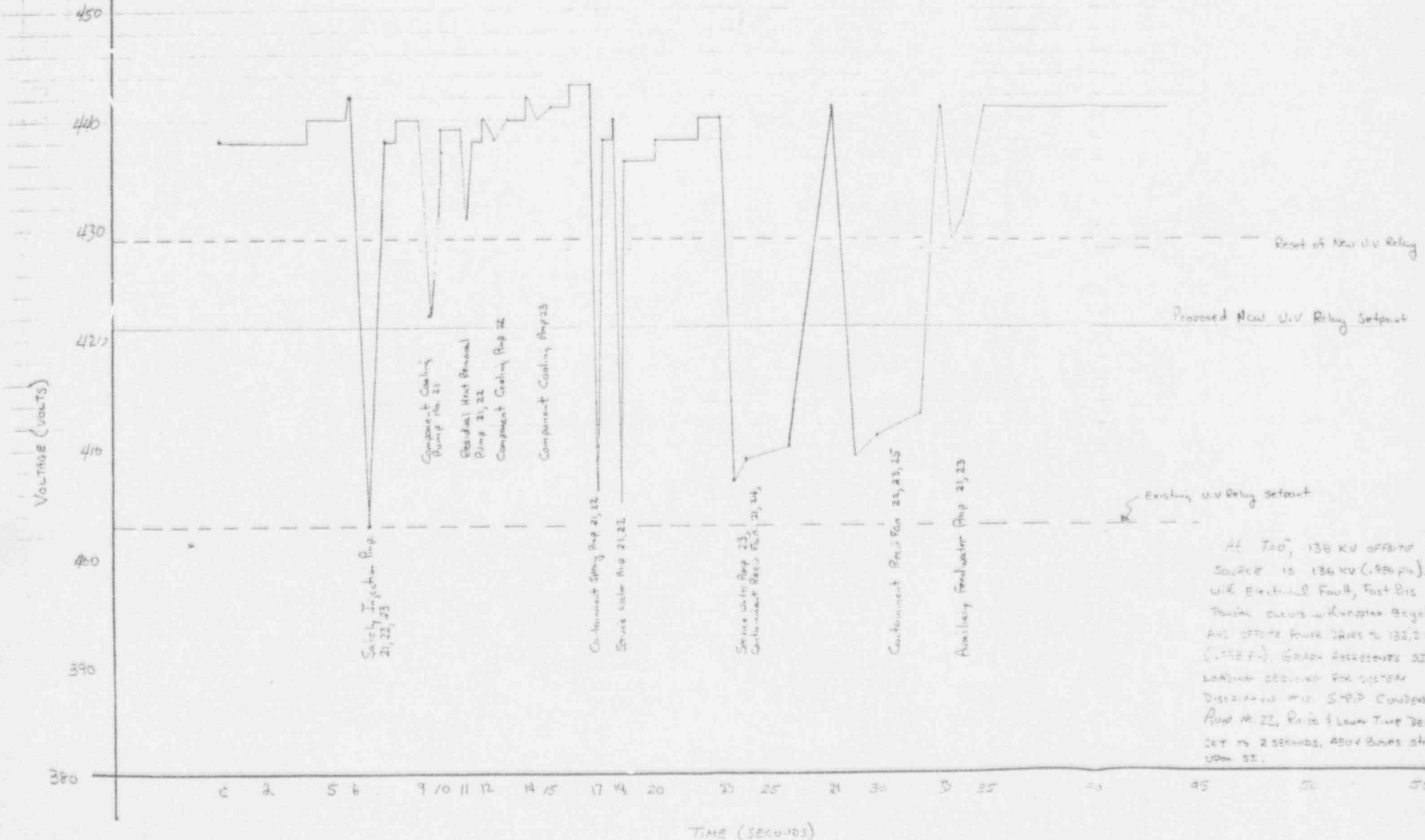
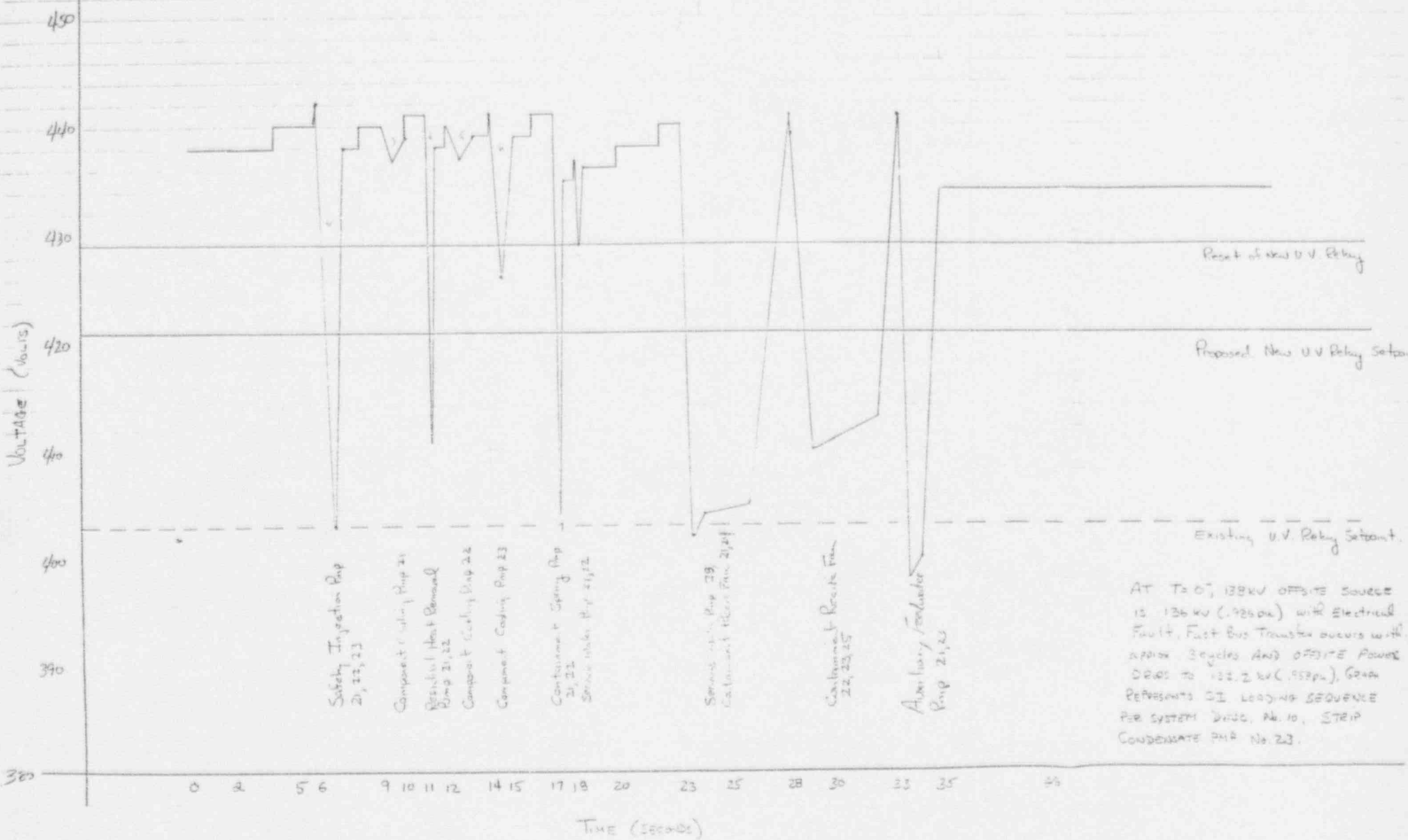


Figure 2
Bus 6A Voltage Profile



Mod. No. EGP-91-06786-E, Rev 1
Calc. No. EGP-00110-00

TABLE 1

o IP2 in operation, Offsite power at 136kV (0.985pu)
o Loss of IP-2, the Offsite power drops to 132kV (0.958pu)
° SWP 21, 22, 23 assumed to be on essential header

MOTOR DESCRIPTION	480V SUPPLY BUS	DESIRED MOTOR TERMINAL STARTING VOLTAGE	DESIRED VOLTAGE AT BUS (V)	DEGRADED BUS VOLTAGE LOCA MODE	
				PRIOR	AFTER
CONTAINMENT SPRAY PUMP (21)	5A	313	337	443	438
CONTAINMENT SPRAY PUMP (22)	6A	313	338	441	435
SAFETY INJECTION PUMP (21)	5A	343	365	442	438
SAFETY INJECTION PUMP (22)	2A	343	367	442	437
SAFETY INJECTION PUMP (23)	6A	343	365	442	438
CONTAINMENT RECIRCULATION FAN (21)	5A	313	354	440	435
CONTAINMENT RECIRCULATION FAN (22)	5A	313	356	441	437
CONTAINMENT RECIRCULATION FAN (23)	2A	313	359	448	443
CONTAINMENT RECIRCULATION FAN (24)	3A	313	362	449	445
CONTAINMENT RECIRCULATION FAN (25)	6A	313	370	441	437
LO HEAD SI RECIRCULATION PUMP (21)	5A	312	358	* *	* *
LO HEAD SI RECIRCULATION PUMP (22)	6A	312	357	* *	* *
SERVICE WATER PUMP (21)	5A	*	*	440	436
SERVICE WATER PUMP (22)	2A	323	357	444	439
SERVICE WATER PUMP (23)	6A	323	358	440	435
SERVICE WATER PUMP (24)	5A	323	361	* *	* *
SERVICE WATER PUMP (25)	3A	*	*	* *	* *
SERVICE WATER PUMP (26)	6A	323	361	* *	* *
AUXILIARY FEEDWATER PUMP (21)	3A	370	397	453	447
AUXILIARY FEEDWATER PUMP (23)	6A	370	395	441	434
COMPONENT COOLING PUMP (21)	5A	369	403	440	437
COMPONENT COOLING PUMP (22)	2A	369	415	442	439
COMPONENT COOLING PUMP (23)	6A	369	411	441	439
RESIDUAL HEAT REMOVAL PUMP (21)	3A	333	365	444	441
RESIDUAL HEAT REMOVAL PUMP (22)	6A	333	362	441	438

Note: Loss of IP2, fastbus transfer, automatic stripping of the 480V buses, the bus voltage will drop to the following values:

Bus 2A-438V

Bus 3A-438V

Bus 5A-438V

Bus 6A-438V

* SWP 21 and 25 are electrically and mechanically interchangeable with the other SWP's motors

** Not required during injection mode

TABLE 2

ATTACH #	PAGE #	CASE #	SAT WINDING RATIO	REMARKS
LOCA-1	155, 156	1	(N) 7073	Normal precontingency condition
LOCA-2	155	2	(N) 7073	T=0+, IP2 unit trip coincident with SI
LOCA-3	155	2	(R1) 7105	LTC changing position
LOCA-4	155, 156, 167	2	(R2) 7137	Starting SI-21 (5A) , SI-22 (2A), SI-23 (6A)
LOCA-5	155	3	(R3) 7169	Starting CCP-21 (5A)
LOCA-6	155, 167	4	(R4) 7202	Starting RHR-21 (3A), RHR-22 (6A)
LOCA-7	167	5	(R5) 7234	Starting CCP-22 (2A)
LOCA-8	156	6	(R6) 7267	Starting CCP-23 (6A)
LOCA-9	155, 156	7	(R7) 7299	Starting CS-21 (5A), CS-22 (6A)
LOCA-10	155, 156, 167, 168	8	(R8) 7331	Starting SWP-21 (5A), SWP-22 (2A),
LOCA-11	155, 156	8	(R9) 7363	LTC changing position
LOCA-12	155, 156, 168, 169	9	(R10) 7395	Starting SWP-23 (6A), CRF-21 (5A), CRF-24 (3A)
LOCA-13	155, 156, 168	9	(R11) 7428	LTC changing position
LOCA-14	155, 156, 168	9	(R12) 7460	LTC changing position
LOCA-15	155, 156, 169	10	(R13) 7493	Starting CRF-22 (5A), CRF-23 (2A), CRF-25 (6A)
LOCA-16	156, 157, 169	10	(R14) 7525	LTC changing position
LOCA-17	157, 169, 170	11	(R15) 7558	Starting ABFP-21 (3A), ABFP-23 (6A)
LOCA-18	155, 156, 168, 169,	11	(R16) 7590	LTC changing position

TABLE 3, SI STARTING TIME FROM INITIATION OF BUS SEQUENCE SIGNALS (SECONDS)

MOTOR DESCRIPTION	BUS 5A	BUS 2A	BUS 3A	BUS 6A
SAFETY INJECTION PUMP (21)	3			
SAFETY INJECTION PUMP (22)		3		
SAFETY INJECTION PUMP (23)				3
COMPONENT COOLING PUMP (21)	6			
RESIDUAL HEAT REMOVAL PUMP (21)			8	
RESIDUAL HEAT REMOVAL PUMP (22)				8
COMPONENT COOLING PUMP (22)		9		
COMPONENT COOLING PUMP (23)				11
CONTAINMENT SPRAY PUMP (21)	14			
CONTAINMENT SPRAY PUMP (22)				14
SERVICE WATER PUMP (21)	15			
SERVICE WATER PUMP (22)		15		
SERVICE WATER PUMP (23)				20
CONTAINMENT RECIRCULATION FAN (21)	20			
CONTAINMENT RECIRCULATION FAN (24)			20	
CONTAINMENT RECIRCULATION FAN (22)	25			
CONTAINMENT RECIRCULATION FAN (23)		25		
CONTAINMENT RECIRCULATION FAN (25)				25
AUXILIARY FEEDWATER PUMP (21)			30	
AUXILIARY FEEDWATER PUMP (23)				30

NOTES: Time = 3 seconds, Sequence initiated

B) FASTBUS TRANSFER CONCLUSION

For the computer model of the fastbus transfer, the precontingency condition SAT LTC is in the neutral position (N-7073V at no load). At the T=0+, the moment when the fastbus transfer occurs, the voltage on the 480V Bus 5A drops to 408VAC, below the degraded undervoltage setpoint. However, the setpoint of the Agastat timer is 180 seconds and during this time the SAT LTC will be changing tap positions from the precontingency LTC position (neutral) to the upper most tap position (R16-7590V) within 35 seconds. This takes into consideration the 2 second initial time delay for the first load tap changer operation and the 2 second time delay to change from one tap position to the next due to the mechanical mechanism of the tap changer. The load profile for the fastbus transfer is shown in Figure 3.

This load profile of the 480V Bus 5A represents the worst case bounding condition in terms of voltage levels for the safety related buses. Therefore, this analysis does not include the load profiles for the 480V Buses 2A, 3A and 6A

since these are not the bounding cases. The EBASCO program was run for the Neutral (7073V) and the R16 (7590V) tap positions. The bus voltages with the SAT LTC in the neutral (N-7073V) and the upper most tap position (R16-7590V) are as follows:

<u>CASE Ia:</u> Attachment #FBT-1, Page 155, 156, 171

Fastbus Transfer - loads supplied from 138kV system immediately after transfer of loads (Degraded Voltage Scenario - 0.958 pu). SAT LTC position (N-7073V)

Bus 2A - 416V

Bus 3A - 414V

Bus 5A - 408V

Bus 6A - 410V

CASE Ib:

Attachment #FBT-2, Page 155, 166

Fastbus Transfer - loads supplied from 138kV system 35 seconds after transfer and SAT LTC moving to raise voltage (Degraded Voltage Scenario - 0.958 pu), SAT LTC position (R16-7590V)

Bus 2A - 447V

Bus 3A - 445V

Bus 5A - 440V

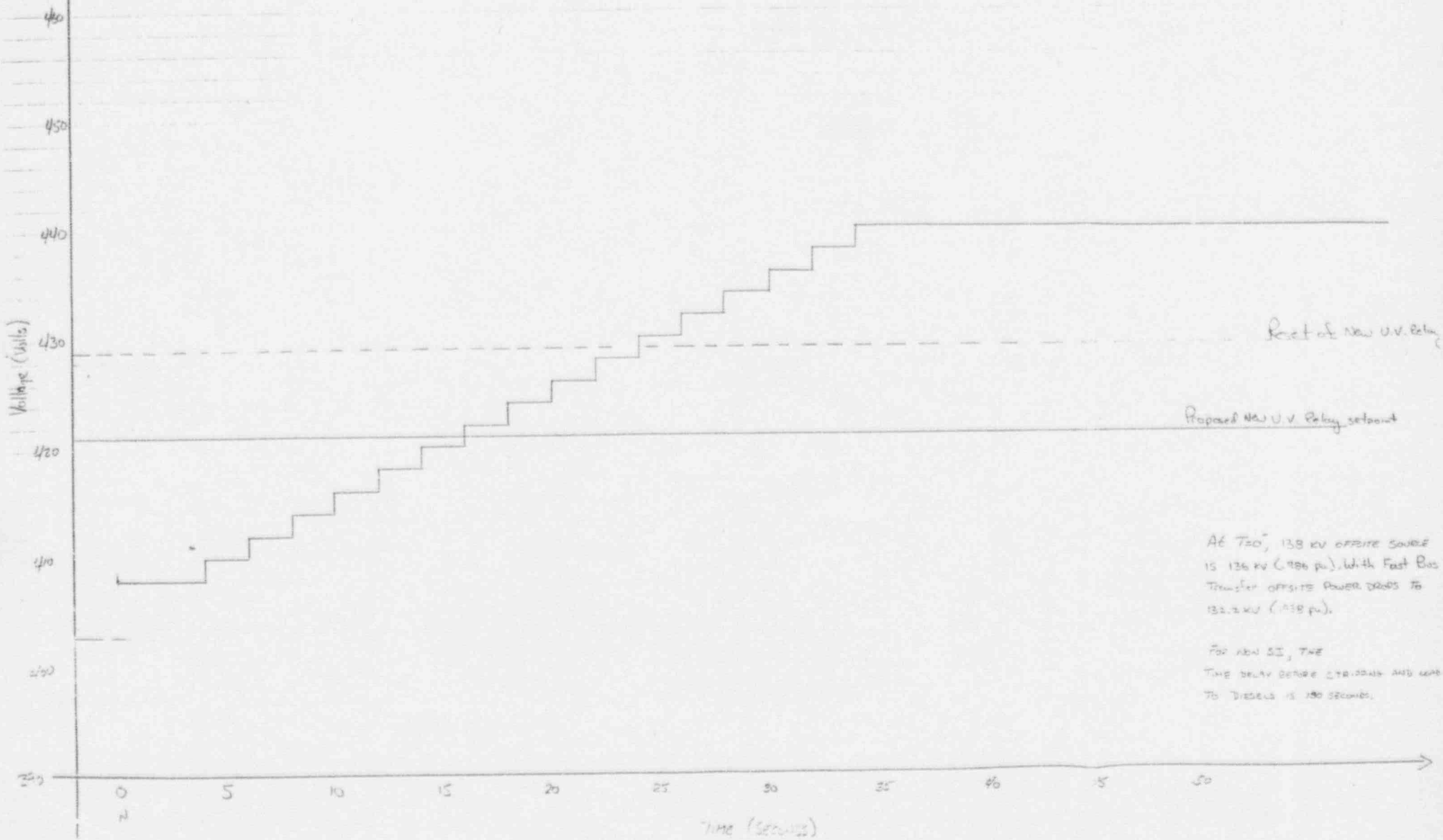
Bus 6A - 442V

C) NORMAL PLANT MODE ANALYSIS

During normal plant conditions at IP2, the 6.9kV Buses 1 - 4 are supplied via the Unit Auxiliary Transformer and Buses 5 and 6 are supplied via the Station Auxiliary Transformer. As part of the normal plant mode scenario, this analysis will assume the 0.958pu (132.2kV) value that was defined for the loss of IP2 by the Electric Planning Department. This is a conservative assumption, since the the normal operating range of the 138kV offsite power supply as defined by EO-4000-4 is in the range of 136kV - 142kV. The

FIGURE 3

FAST BUS TRANSFER, NO SI, BUS 5A



precontingency voltages for the IP2 offsite supply from the Buchanan 138kV Substation were intentionally scheduled at their minimum design level (136kV) to achieve the lowest voltage resulting from the above system disturbance.

Special cases were run for the Component Cooling Pumps, which are the bounding motor cases. For each special case studied, the voltage level at the motor terminals and at the supply 480V safety buses was analyzed prior, during, and after bounding motors were started. These cases were run assuming no voltage adjustment by the System Operator via the SOCCS supervisory panel or any adjustment by the 138/6.9kV Station Auxiliary Transformer LTC.

NORMAL PLANT MODE CONCLUSION

For the computer model of the Normal Plant Mode, the precontingency SAT LTC position is neutral (N-7073V). Our results for the starting of the bounding case motors indicates that the voltage on the 480V buses will be high enough to start and operate the equipment. Listed below are the results of our case scenario.

CASE IIa: Attachment #NB-1, Page 88

Normal-Plant loads supplied from 138kV system (Degraded Voltage Scenario - 0.958 pu); Starting 480V Motor on Bus 5A (Component Cooling Pump #21)

	Prior	During	After	Min. Desired Voltage
Bus (V)	463	445	460	403
Motor Terminals (V)	0	407	453	369

CASE IIb: Attachment #NB-1, Pages 97, 98

Normal-Plant loads supplied from 138kV system (Degraded Voltage Scenario - 0.958 pu); Starting 480V Motor on Bus 6A (Component Cooling Pump #23)

	Prior	During	After	Min. Desired Voltage
Bus (V)	465	447	462	411
Motor Terminals (V)	0	400	453	369

D) PLANT STARTUP MODE

During the startup condition, the source of power for the plant auxiliary loads is the 138kV switchyard via the Station Auxiliary Transformer. The 6.9kV Buses 1 and 2 are tied to the 6.9kV Bus 5 and buses 3 and 4 are tied to bus 6 and supplied via the Station Auxiliary Transformer. (See assumption under the Normal Plant Mode pertaining to the 138kV offsite power system disturbance.)

PLANT STARTUP MODE ANALYSIS

For the computer model of the Plant Startup Mode, the precontingency SAT LTC position is R16-7590V. Our results for the starting of the bounding case motors indicates that the voltage on the 480V buses will be high enough to start and operate the equipment. Listed below are the results of our case scenario.

CASE IIIa: Attachment #PSU-1, Page 155

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.958 pu); Starting 480V Motor on Bus 5A (Component Cooling Pump #21)

	Prior	During	After	Min. Desired Voltage
Bus (V)	446	427	443	403
Motor Terminals (V)	0	391	435	369

CASE IIIb: Attachment #PSU-1, Page 204

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.958 pu); Starting 480V Motor on Bus 2A (Component Cooling Pump #22)

	Prior	During	After	Min. Desired Voltage
Bus (V)	454	436	451	415
Motor Terminals (V)	0	388	441	369

CASE IIIc: Attachment #PSU-1, Page 175

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.958 pu); Starting 480V Motor on Bus 6A (Component Cooling Pump #23)

	Prior	During	After	Min. Desired Voltage
Bus (V)	447	429	444	411
Motor Terminals (V)	0	384	434	369

VIII) WORST CASE DEGRADED VOLTAGE ANALYSIS

For the worst case Indian Point degraded voltage study, the voltage used was based on the Electric Planning Department study which simulated the worst case possible scenario for transmission degraded voltage conditions. The Planning study was conducted to determine the impact on the IP2 138-kV offsite power sources at the Buchanan Substation during various system disturbances. In order to simulate the worst possible degraded voltage scenario, pre-contingency voltages at the Buchanan Substation were intentionally scheduled at their minimum design level to

achieve the lowest voltage condition resulting from various disturbances.

The worst case 138-kV degradation would result from the loss of Millwood 345/138-kV Transformer TA1 and Millwood 345/138-kV Transformer TA2 coincident with the loss of Feeder 96951 and the Peekskill Refuge Generating Unit out of service. The minimum 138-kV offsite grid voltage for this contingency is 0.912 pu (125.86-kV).

The worst case 138-kV offsite power degradation used for this part of the study are well beyond the Electric Planning Extreme Contingency Analysis, the New York Power Pool Design Criteria, and the System Operation projected extreme contingencies. The worst case disturbance is highly unlikely to occur.

The computer modeling of the IP2 electrical distribution system is based upon the various system configurations at which the IP2 station operates. The case studies that are addressed in the degraded voltage study are as follows:

I. Load supplied from 138/6.9kV System (Normally-Fed from 138/6.9kV SAT).

II. Plant startup (Normally-Fed from 138/6.9kV SAT).

The voltage analysis program calculates the voltage profile for the buses and motor terminals before, during and after selected motors are started.

To evaluate the effects of the worst case degraded voltage on the various safety-related motors, case studies were performed for the normal plant and plant start-up modes. These cases were run assuming no voltage adjustment by the System Operator via the SOCCS supervisory panel or any adjustment by the Station Operator of the 138/6.9kV transformer's LTC. Special cases were run for the Component Cooling Pumps, which are the bounding motor cases. For each special case studied, the voltage level at the motor terminals and at the supply 480V safety buses was analyzed prior, during, and after bounding motors were started.

Our results indicate that the bounding case motors will start and continue to operate under the normal plant and

plant startup modes for the projected worst case degraded voltage condition (0.912pu). However, it should be noted that in the startup mode even though the bounding motors can start and operate, the bus voltages before and after the motors have started are below the proposes degraded undervoltage setpoint (421VAC +/-6 volts) and will transfer to the emergency onsite power supply. Based on values obtained in the Plant Startup Mode analysis, we conclude that during a LOCA or Fastbus transfer with the worst case offsite degradation, the 480V bus voltage will drop below the proposed degraded voltage setpoint and the 480V buses will transfer to the emergency onsite power supply. This will ensure the integrity of the safety related equipment and when called upon to start and continue to operate, they will.

The bus voltages for the bounding case motors are summarized below.

During the plant startup mode, the IP2 Operators are controlling the startup of the plant under controlled conditions. This meaning that the operators are selectively

starting essential equipment to start in order to support the operation of plant. In actual operating circumstances the IP2 Operators are monitoring the bus voltage prior to starting of selected motors. In the event that the voltage on the buses are below the specified operating range, the SAT LTC will adjust the voltage automatically or manually via the Central Control Room to within an acceptable value. In the event that additional voltage is required, the IP2 Operators will request the operators at the Buchanan Substation to raise the 138kV offsite power supply voltage.

CASE IVa: Attachment #NB-2, Page 88

Normal-Plant loads supplied from 138kV system (Degraded Voltage Scenario - 0.912 pu); Starting 480V Motor on Bus 5A (Component Cooling Pump #21)

	Prior	During	After	Min. Desired Voltage
Bus (V)	439	421	436	403
Motor Terminals (V)	0	385	428	369

CASE IVb: Attachment #NB-2, Pages 101, 102

Normal-Plant loads supplied from 138kV system (Degraded Voltage Scenario - 0.912 pu); Starting 480V Motor on Bus 6A (Component Cooling Pump #23)

	Prior	During	After	Min. Desired Voltage
Bus (V)	441	423	438	411
Motor Terminals (V)	0	379	428	369

CASE Va: Attachment #PSU-2, Pages 155, 156

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.912 pu); Starting 480V Motor on Bus 5A (Component Cooling Pump #21)

	Prior	During	After	Min. Desired Voltage
Bus (V)	415	398	412	403
Motor Terminals (V)	0	364	403	369

CASE Vb: Attachment #PSU-2, Page 226

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.912 pu); Starting 480V Motor on Bus 2A (Component Cooling Pump #22)

	Prior	During	After	Min. Desired Voltage
Bus (V)	424	407	421	415
Motor Terminals (V)	0	362	410	369

CASE Vc: Attachment #PSU-2, Pages 184, 185

Plant Startup Mode, loads supplied from 138kV system (Degraded Voltage Scenario - 0.912 pu); Starting 480V Motor on Bus 6A (Component Cooling Pump #23)

	Prior	During	After	Min. Desired Voltage
Bus (V)	417	399	413	411
Motor Terminals (V)	0	357	403	369

IX) Summary

Our analysis of the LOCA (supplied from 138kV offsite power supply), Fastbus Transfer, Normal Plant Mode and Plant Startup Mode scenarios concludes that Indian Point No. 2 will not transfer to the emergency onsite power supply with the projected 0.958 pu (132.2kV) offsite power disturbance resulting in the loss of IP2. The voltage levels on the 480V Safety Related Buses (2A, 3A, 5A, 6A) will be higher than the proposed degraded undervoltage relay setpoint (421VAC +/-6 volts) for the case scenarios modeled in this analysis. In addition, the 480V Safety related Buses will be high enough for the safety related 1E motors to start and operate prior to any system voltage corrective action by the Senior System Operator via the SOCCS supervisory system. The 138kV offsite power supply remains the preferred source by design, and a transfer to the emergency onsite power is designed to occur for offsite grid voltages which fall below the acceptable values as defined in EO-4000, Rev 4 and if the degraded voltage setpoint is reached and sustained for the Technical Specification time delay.

Under the worst offsite disturbance, (0.912 pu on the 138kV offsite power system which is well beyond the Electric Planning Extreme Contingency Analysis, the New York Power Pool Design Criteria and the System Operating projected extreme contingencies.), the degraded AC voltage is high enough under the Normal Plant and Plant Startup modes for the safety-related 1E motors to start and continue to operate prior to any system voltage corrective action by the Senior System Operator or the automatic LTC of the Station Auxiliary Transformer. In the Plant Startup Mode, even though the bounding motors can start and operate, the bus voltage before and after the motors have started are below the proposed degraded voltage setpoint and will transfer the 480V buses to the emergency onsite power supply. The proposed degraded undervoltage setpoint, will increase the margin between the required bus voltage and the available bus voltage for the Component Cooling Pumps to ensure the integrity of the safety related equipment. This will ensure the operability of safety related equipment when called upon to operate.

In the improbable event that the system disturbance caused AC degraded voltage level lower than our projections, the degraded undervoltage protection relays will transfer the 480V safety related buses off the 138kV offsite AC source and reconnect to the emergency onsite power supply at IP2.

CON EDISON CALCULATION/ANALYSIS SHEET	CALCULATION No. EGP-00110-00	REVISION 0	PAGE 40 OF 40
PREPARER/DATE KENNETH CHU 1/4/93	REVIEWER/DATE ANDY CHAN 1/22/93		CLASS CLASS A,1E
SUBJECT/TITLE SUMMARY OF DEGRADED VOLTAGE STUDY			PROJECT No. 06786-91
			MOD No. - REV EGP-91-06786-E 1

REFERENCES:

1) EBASCO Letter to Mr. R. Sullivan, "Verification Of EBASCO Supplied Computer Program", dated June 28, 1991

2) Con Edison Calc. No. EGE-00001-00, 480 Volt Motor Undervoltage Starting & Acceleration Times

3) Con Edison Calc. No. SGX-00013-00, Setpoint Change For Undervoltage Relays on 480 Volt Buses 2A, 3A, 5A, And 6A

4) Indian Point Station Unit 2, System Operating Procedure 27.1.4, Rev. 3, "6900 Volt System"

5) Con Edison System Operating Manual No. 5, EO-4000-4 dated June 1988

6) Indian Point Station Unit 2, System Description No. 27.1, "Electrical Systems" Rev. 3, February 1981

7) Planning Study Memo from G. Jee to R.K. Sullivan, dated 4/17/91

8) Indian Point Station Unit 2, System Description No. 27.1, "Electrical Systems" Rev. 3, February 1981

9) Indian Point Station Unit 2, System Description No. 10.0, "Engineered Safeguards System", Rev. 4, February 1981

10) Planning Study Memo from F. Elmi to A. Chan, dated 7/17/92

11) ABB Power T&D Company fax from C. Librizzi to D. Brown, dated 1/20/93

12) Con Edison H.T. Oper. Dia. 138/345 System Ties, Rev 298.

13) Westinghouse Electric Corporation Calc. No. WCAP-12556, Documentation Book For The Emergency Diesel Generator Loading Study

14) Degraded Voltage Analysis Attachments: LOCA-1, LOCA-2, LOCA-3, LOCA-4, LOCA-5, LOCA-6, LOCA-7, LOCA-8, LOCA-9, LOCA-10, LOCA-11, LOCA-12, LOCA-13, LOCA-14, LOCA-15, LOCA-16, LOCA-17, LOCA-18, FBT-1, FBT-2, NB-1, PSU-1, NB-2 and PSU-2