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United States Nuclear Regulatory Commission
Attention: Document Control Desk
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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
SUPPORTING INFORMATION FOR DEGRADED GRID VOLTAGE RELAY SETPOINT TECHNICAL SPECIFICATIONS CHANGE REQUEST SUBMITTED AUGUST 23, 1994

Gentlemen:

On August 23, 1994, Carolina Power & Light (CP&L) Company submitted a request for a Technical Specifications change for the degraded grid voltage relay setpoint. During a conference call between CP&L and NRC on February 21, 1995, NRC requested certain supporting information in support of the requested change. The information, contained in Engineering Evaluation EE107-CS-46, "Evaluation of Proposed Degraded Grid Voltage Relay Drop Out and Reset Setpoints," is enclosed.

Questions regarding this matter may be referred to Mr. K. R. Jury at (803) 857-1363.

Very truly yours,

R. M. Krich
Manager - Regulatory Affairs

Enclosures
c: Mr. S. D. Ebneter, Regional Administrator, USNRC, Region II
Ms. B. L. Mozafari, USNRC Project Manager, HBRSEP
Mr. W. T. Orders, USNRC Senior Resident Inspector, HBRSEP

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Enclosure 1
Affidavit

C. S. Hinnant, having been first duly sworn, did depose and say that the information contained in letter RNP-RA/95-0043 is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, contractors, and agents of Carolina Power & Light Company.

C S Hinnant

Anne H Shepherd

Notary (Seal)

My commission expires: November 18, 1996

ENCLOSURE 2
ENGINEERING EVALUATION

CAROLINA POWER & LIGHT COMPANY

P. O. BOX 1551
RALEIGH, NORTH CAROLINA 27602

ENGINEERING EVALUATION

EVALUATION OF PROPOSED DEGRADED GRID VOLTAGE RELAY DROP OUT AND RESET SETPOINTS

FOR

THE H. B. ROBINSON NUCLEAR PLANT

ANALYSIS I.D. EE107-CS-46

SAFETY CLASSIFICATION: (1E)

SEISMIC CLASSIFICATION: (N/A)

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LIST OF ABBREVIATIONS

BOP	Balance of Plant
BREF	Battery Room Exhaust Fan
DGVR	Degraded Grid Voltage Relay
EPDS	Emergency Power Distribution System
LOCA	Loss of Coolant Accident
SAT	Start Up Transformer
Tech Spec	Technical Specification
UAT	Unit Auxiliary Transformer

1.0 PURPOSE

As discussed in Attachment 0 of Reference 7.1, it appears that the basis for the existing Degraded Grid Voltage Relay (DGVR) nominal dropout setpoint of 415 +- 4 volts is based on contactor pick-up voltage requirements at the MCC level; this setpoint allows operation of continuous duty motor loads at less than minimum voltage rating for short periods of time, crediting operator response actions to increase system voltage (i.e., transfer of emergency bus loads to the Emergency Diesel Generators).

A higher DGVR nominal dropout setpoint of 430 +- 4 volts has been proposed to provide motor protection without relying on operator intervention. The higher dropout setpoint necessarily requires a higher reset setpoint. This study evaluates acceptability of the new DGVR dropout and reset values.

This study demonstrates the following:

That with the 115kV switchyard voltage at the minimum calculated value of 113.7kV (per attachment M of reference 7.1), under accident conditions, the following requirements will be met:

1. Adequate voltage will be available at the terminals of the motors which are being started during sequencing of loads, and
2. Transient voltages at the safety-related buses during load sequencing meet the required transient ride through voltage criteria, and
3. Adequate steady state voltage is available to emergency system loads after sequencing.
4. The secondary undervoltage relay (Degraded Grid Voltage Relay) will not trip, during sequencing,
5. The primary undervoltage relay will not trip,
6. Emergency equipment response times are not violated.

This study will also show that with the steady state voltage at the emergency buses at the minimum proposed Degraded Grid Relay dropout setpoint (plus a one volt margin) of 425 volts:

1. Adequate steady state voltage will be available at the terminals of continuous duty safety-related loads after the sequencing of loads is complete,
2. Adequate steady state voltage is available to ensure that all safety-related MCC contactors can pick up if required to do so,
3. The emergency bus circuit breakers and overload heaters will not trip, and

In addition, this study will also show that during normal plant operation the secondary undervoltage relay will not trip the normal

incoming E bus breaker due to transient undervoltage conditions resulting from large BOP motor starts

1.1 Overview

The function of the Degraded Grid Voltage Relays (DGVRs) is to monitor the E1 and E2 bus voltages and trip the normal incoming breaker on sustained undervoltage conditions. This prevents continuous operation of safety related loads at reduced terminal voltages. The DGVRs are electronic type relays with three independent settings:

1) the dropout or trip voltage setting,
2) the pickup or reset voltage setting (this setting is higher than the dropout setting), and
3) the time delay setting.

When the bus voltage reaches the dropout setting, the relay begins timing. Once the timer is initiated, the voltage must rise to above the pickup setting prior to timing out in order for the relay to reset, otherwise a trip signal will be generated.

This evaluation considers the effect on E bus voltages (and therefore to the operation of the DGVR) due to the sequencing of safety related motors, and due to worst case transients caused by large BOP motor starts to ensure that these motor starts do not cause the DGVR to time out.

The analysis will be conducted with additional loading modeled on the emergency power system which represents presently proposed load changes and an additional margin for future load additions. The minimum steady state terminal voltages for emergency power system loads will be determined with the E bus voltages at the minimum DGVR dropout setpoint and with the 115kV switchyard voltage at 113.7kV.

2.0 SUMMARY OF RESULTS

This evaluation shows the following:

1. Under accident conditions, with the 115kV switchyard voltage at 113.7kV, adequate voltage is available at the terminals of all safety related motors while starting during the sequencing of loads.

2. Voltages at safety related buses and MCCs during transient conditions meet the bus/MCC transient ride through voltage criteria and exceed the minimum required voltage criteria for safety related contactors. Therefore, control circuit contactors have adequate voltage to operate as required and running safety related motors will not stall.

3. With the minimum expected 115kV switchyard voltage available (per transmissions) large BOP motor starts or the sequencing of loads during an SI signal will not trip:

a. The degraded grid voltage relay, or

b. The primary undervoltage relay, or

c. The protective devices supplying safety related loads.

4. With the E bus voltage at 425.0 V, adequate steady state voltage exists at the terminals of continuous duty safety-related loads.

5. With the proposed DGVR setpoints, the existing limitations on the operation of the SWP A and SWP C motors can be lifted. Note that the existing limitations on the operation of the HVH 1 and HVH 4 motors <u>can not</u> be lifted.

6. Emergency equipment response times are not violated.

This evaluation shows that the proposed setpoints provide adequate protection against sustained undervoltages for the safety system loads without relying on operator intervention and without spurious separation of the safety system from the preferred source of power.

3.0 BASES AND ASSUMPTIONS

3.1 Based on the response to IRR RE/I-1750 (pg. A37), the proposed DGVR setpoints are as follows:

Nominal Setpoint: 430 +- 4 volts
Minimum Dropout Voltage: 426 volts
Maximum Reset Voltage: 436 volts
Minimum Time Delay: 9.5 seconds
Maximum Time Delay: 10.5 seconds
The relay reset time is 50ms per reference 7.10.

Note that for conservatism and to allow for a one volt Tech. Spec. margin, 425 volts will be used as the DGVR minimum dropout voltage.

3.2 It is assumed that all future load additions/changes to the EPDS will be engineered such that they can operate with the E bus voltages at the proposed minimum DGVR dropout setpoint (plus a one volt margin) of 425V. For the purposes of evaluating the operation of the DGVR, known proposed loading changes are included in the ASDOP/VDROP system models.

3.3 As demonstrated in attachment B of reference 7.1 the worst case (minimum) EPDS LOCA voltages occur when the entire plant loading is being fed from the SAT (note that feeding the entire plant loading from the UAT during a LOCA is not a realistic scenario and that the SAT feeding the entire plant loading envelopes both the split plant alignment and the fictitious UAT LOCA alignment). Therefore, this evaluation will assume that all plant loading is being supplied via the SAT, and all computer runs dealing with the safety system will use the LOCA loading database. Note that since the runs evaluating the E bus voltages due to BOP motor starts are during non-accident operation. Therefore, these runs use the SAT full power database.

3.4 To determine emergency power distribution system margin loading and for the transient ride through analysis, the lowest predicted 115kV switchyard voltage of 113.7kV is used (per attachment M of reference 7.1). This yields the highest currents and most conservative voltages.

3.5 For conservatism in calculating system voltages, it is assumed that the backup battery chargers A-1, B-1 and Instrument bus backup power supplies are operating in addition to their normally operating counterparts. When addressing E bus capacity, either the normal or backup load is considered to be operating, not both. In addition, this evaluation will determine applicable system voltages with the existing system loading plus documented proposed loading and an additional margin loading (see section 3.2 and 3.23).

3.6 Per reference 7.4, the primary undervoltage relay is set at 328 volts with a ±10 percent tolerance, and its operating time is ≤ 1 sec.

3.7 This calculation does not address voltage requirements for motor-operated valves.

3.8 Diesel generator breaker closing time is conservatively assumed to be 1 sec. maximum.

3.9 It is assumed that proposed changes to EPDS, as evaluated, in EE107-CS-08 (reference 7.2) will be installed as approved.

3.10 Since these motors could be running before an accident scenario and for conservatism in calculating motor voltages, the HVH 1, 2, 3, and 4 motors, the service water pump motors, and the service water booster pump motors are considered running in cases where they are not required to be started.

3.11 Per reference 7.6, SWBP A(B) will start concurrently with SWP A(C). Hence, SWBP A and B motors are considered starting concurrently with their associated SWP A and C motors, respectively (see section 3.10).

3.12 Per reference 7.7 the HVH 6A(6B) motors start/run concurrently with CSP A(B) and SIP A(B) motors, the HVH 7B(7A) motors start/run concurrently with the AFW A(B) motors and the HVH 8A(8B) motors start/run concurrently with the RHR A(B) motors. Since these motors also have a manual start capability, they will be considered running except when their parent motor is starting. Since the HVH 6A(6B) motors will be running when either the CSP or SIP motors are running, the HVH 6A(6B) motors will be considered as starting only when both the CSP A(B) motors and the SIP A(B) motors are starting.

3.13 Voltage/Time/Acceleration characteristics of the SWB pumps are assumed to be the same as the SW pumps. The characteristics given in reference 7.8 were based on assumed pump requirements. Based on actual test data, characteristics similar to SW pumps are considered more realistic. See attachment S of reference 7.1.

3.14 The CCW and CP pump motors do not receive an automatic start signal during an SI but can run during normal operation. Hence, these motors are modeled as running in all cases (reference 7.7).

3.15 Per Section 5.1.4 of reference 7.1, all E Bus motors except for the AFW and CP will accelerate at 75 percent voltage. The AFW and CP motors require 80 percent voltage to accelerate (note that the CP motor starting is not required to be considered based on section 3.14).

3.16 Per NEMA MG-1, section 20.45 (reference 7.12), motors are rated for continuous operation at terminal voltages from 90% to 110% of the nameplate voltage rating given a constant frequency of 60 Hz.

3.17 Per reference 7.9, the existing Emergency Load Sequencer Relays are set to accomplish breaker closure at the following nominal times.

SIP A & C:	5.0 sec.
RHR A & B:	15.0 sec.
SWP A & C:	20.0 sec.
SWP B & D:	25.0 sec.
HVH 1 & 3	30.0 sec.
HVH 2 & 4	35.0 sec.
AFW A & B:	39.5 sec.

These relays have a tolerance of ±0.5 seconds.

3.18 Operator restrictions exist (i.e., caution tags and control room standing memorandum) on the operation of SWP A(C) and HVH 2(4) such that each of these motors must either be kept running <u>or</u> its associated breaker racked out (see references 7.19 and 7.20). Note that these motors will be modeled as starting within their appropriate load block as shown in section 3.17 to provide a basis for removing/retaining the existing restrictions.

3.19 Per reference 7.15, the bus E1 and E2 undervoltage relays 2-17B and 2-27B are Agastat E7000 series time delay relays with a setting of 2.0 seconds. Per Reference 7.10, these relays have a tolerance of ±10 percent.

3.20 Unless otherwise noted, RNP-E-8.002 revision 2, (reference 7.1) forms the bases for the as-built plant configuration.

3.21 Per reference 7.7, the Containment Spray pumps (CSP) start randomly during load sequencing.

3.22 Motors/loads not specifically addressed are modeled per their respective load factors. Smaller motors are individually modeled in ASDOP so that they can be started if necessary. These loads are running if their applicable load factor is not zero.

3.23 For the purpose of calculating system voltages, approximate values for proposed loadings are included. In all other sections of this evaluation the existing as-built system configuration is evaluated (see section 3.2 and 3.20). Inclusion of these proposed loadings does not constitute an approval or an evaluation of the proposed loading changes. These changes are included only as a means of evaluating the proposed DGVR setpoints against the worst case as-built and proposed system loadings.

3.24 In order to improve the terminal voltages for the Battery Room Exhaust fans (BREF), there is a proposal to move the power feed for these motors

from MCCs 9 and 10 to MCCs 18 and 5. This document evaluates the proposed DGVR setpoints with these motors fed from the new MCCs (See Section 4.2.2). Engineering Evaluation EE107-CS-52, reference 7.23, evaluates the existing configuration for the BREFs with respect to the proposed DGVR setpoints.

4.0 DISCUSSION

4.1 Development of Computer Runs

To accomplish the objectives listed in section 1.0, the ASDOP computer program was used to predict the terminal voltages of safety system loads during steady state, motor starting and transient ride through conditions (see sections 3.20, 3.22 and 3.23).

The computer program VDROP was used to determine the minimum allowable voltage at the safety related buses under steady state and transient ride through conditions given the minimum terminal voltages required.

The computer runs in this evaluation were taken from reference 7.1 and modified as described in the following sections (referenced runs can be found in attachments B and C). See section 3.3 of reference 7.1 for a description of the programs used.

4.2 ASDOP Runs

The loading in the ASDOP databases from reference 7.1 was modified as shown below. Note that per section 3.23 the proposed DGVR setpoints are evaluated against the existing system plus approximate proposed loadings.

4.2.1 HVH Fan Motors

In order to model the starting of the HVH 6,7 and 8 fan motors, nodes 124, 125, 126, 137, 138, and 139 were added to the one line diagram (see pg. A4 and section 3.12). The loading, load factor, locked rotor currents and cable impedances were input into the program as shown in Table 1. The loading on MCCs 5 and 6 given in the runs from reference 7.1, was decreased by 10.8 hp each to account for the individual modeling of the HVH fans (loading determined from the Phoenix APR report pgs. A5-A12).

4.2.2 Battery Room Exhaust Fans

In response to design issue 92-03, there is a proposal to move the power feed for the Battery Room Exhaust fans (BREF) from MCCs 9 and 10 to MCCs 18 and 5 (see pg. A1-A3). The loading of the existing fans on MCCs 9 and 10 is 0.9 hp (1 hp and a 0.9 LF, as shown on pgs. A9, A10). Per page A2, the proposed fans will be approximately 5 hp each. Therefore, the loading on MCCs 9 and 10 was reduced by 0.9 hp and the loading on MCCs 5 and 18 was increased by 5 hp (see section 3.24).

4.2.3 Instrument Bus Upgrade Project

As part of project number 85-032, the following Instrument Bus upgrades

are being proposed (see IRR RE/I-1628 attachment D):

1. Replacement of the two existing 7.5kVA inverters feeding IB2 and 3 with two 15 kVA inverters with 480V input.

2. Replacement of the two existing 7.5kVA SOLA transformers feeding IBs 1 and 4 with two 15kVA line voltage regulators.

3. Replacement of the existing 120V alternate source from MCC-8 with four separate 15kVA line regulators supplied from MCC-3 and MCC-18.

4. Replacement of the existing circuit breakers in IB 1, 2, 3, 4, 7A, 7B, 9A and 9B.

Only proposed items 1 through 3 above will have an impact on main AC system loading. Therefore, based on the response to IRR RE/I-1628 (see attachment D), the following loading changes were included in the databases used in the ASDOP computer runs:

MCC5	+13.125kVA	MCC6	+24.375kVA
MCC18	+30kVA	MCC3	+30kVA

Note that these load changes are proposed changes and are subject to change.

4.2.4 Proposed Loading

The data bases were revised to include all applicable proposed loading that has not yet been installed. From engineering evaluation EE107-CS-08 R.1, reference 7.2, the only additional proposed/approved loading to the system under a LOCA condition is approximately 6.0kVA added to MCC21 (memo number ASD-R-267) and approximately 13.3kVA added to MCC15 (memo number ASD-R-555). The additional loading due to the refeed of battery chargers A-1 and B-1 is addressed in section 4.2.5.

4.2.5 Battery Charger Refeed

Memorandum number ASD-R-474 proposes to change the power feed of battery chargers A-1 and B-1 from MCC5 and MCC6 to MCC16 and MCC18. Since these chargers are presently fed from the same MCC as the primary chargers, reference 7.1 models the backup chargers as having a 0 equipment load factor. Hence, the loading on MCC5 and 6 was not changed. However, loading on MCC 16 and MCC 18 is increased for conservatism in calculating voltages (see section 3.5). The amount of loading change for the A-1, B-1 chargers is assumed to be 22.5kVA. This loading value is based on the following:

Per attachment D page D19 the chargers are assumed to draw no more than 123 amps dc continuous, or approximately 41% of the dc name plate rating. Per the Phoenix APR report (attachment A pgs A11 and A12), the existing A and B chargers are modeled as 45kW loads with 0.75 and 0.5 equipment load factors (ELF) respectively. Based on the above, the A-1 and B-1 chargers are assumed to have an ELF of 0.5 and therefore, will be modeled as 22.5kVA loads (45kW)(0.5) (assuming Kw=KVA). Note that this is an assumed envelope loading and represents the worst case

loading expected given the proposed data.

4.2.6 Service Water Pump Cable Impedances

EE107-CS-48 revision 0 (reference 7.5), shows that the increase in cable lengths for the service water pump motors impact the results calculated in reference 7.1. Therefore, the runs used in this evaluation have the service water pump cable impedances as calculated in EE107-CS-48 R.0 in lieu of those calculated in reference 7.1. For Service Water pump D two impedances are used: steady state/transient ride through and starting. These terms refer to the state of the motor (i.e. running or starting). Reference 7.5 calculates the impedance of the SWP D cable based on the temperature of the cable which is determined by the operating condition of the motor. For runs in which the SWP D motor is starting (CS46_213A and CS46_202A) the starting cable impedance is used. All other runs use the steady state/transient ride through cable impedance.

4.2.7 Margin Loading

In order to predict the worst case EPDS voltages and to ensure that this analysis remains valid for future load additions, the loading on MCCs 5,6,16 and 18 was increased such that both emergency buses are drawing the maximum allowable current (approximately 4000A based on emergency bus main breaker and bus duct ratings). For limiting criteria see attachment A of reference 7.1.

As noted in section 3.5, these runs consider redundant/backup loading as operating in order to predict system voltages. Since the redundant/backup loads are not operating at the same time as the normal supplies, the actual current drawn by the E buses is calculated by reducing the current shown in Run CS46_34A by the current corresponding to the Instrument bus backup power sources and the backup battery chargers (see below).

From run CS46_34A (nodes 500-51) the current drawn by bus E1 is 4030A. Per pg. D22, the redundant loading on train A is 22.5kVA (charger A1, which is fed from MCC16). Therefore, using the actual voltage at MCC16 (from run CS46_34A), the actual current drawn by bus E1 is:

4030A - 22.5kVA/(1.7321)(480 volts)(0.9142) =4000.4A.

From run CS46_34A (nodes 510-52) the current drawn by bus E2 is 4069A. Per pg. D22, the redundant loading on train B is 52.5kVA (charger B1, and Instrument bus 3 and 4 backup power supplies. Each is fed from MCC18). Therefore, using the actual voltage at MCC18 (from CS46_34A), the actual current drawn by bus E2 is:

4069A - 52.5kVA/(1.7321)(480 volts)(0.9148) = 4000.0A

Run CS46_34A models the system with all the changes noted in the previous sections and uses the switchyard voltage at 113.7kV (per section 3.4). Note that run CS46_34A includes the margin loading and that the above equations prove that this loading does load the respective E buses to approximately 4000 amps. Also, note that since the EPDS loads are assumed to be constant kVA loads, the amount of current drawn by the E buses is inversely proportional to the switchyard

voltage. Therefore, using the lowest calculated switchyard voltage results in the highest value of current for the redundant loads. Hence, the margin loading calculated above is conservative. The amount of margin loading added to each MCC was based on the amount of actual loading on the MCCs with more margin loading added to the MCCs having smaller as-built loadings. The actual loading changes are shown in Table 2.

Table 1
Summary of Node Changes to Databases used in Reference 7.1

EQUIPMENT/NODE (1)	HP (2)	LOAD FACTOR (3)	LOCKED ROTOR CURRENT (4)	Xd" (5)	CABLE IMPEDANCE (6)	
					R	X
HVH-6A/ 124	7.5	0.60	73.4	0.28	0.1434	0.0063
HVH-6B/ 137	7.5	0.60	68	0.28	0.3806	0.0167
HVH-7A/ 138	5.0	0.66	53	0.28	0.1103	0.0048
HVH-7B/ 125	5.0	0.66	53	0.28	0.2648	0.0116
HVH-8A/ 126	7.5	0.40	66	0.28	0.2923	0.0128
HVH-8B/ 139	7.5	0.40	48	0.28	0.1875	0.0082
SWP A 87 (7)	NO CHANGES				0.0128	0.0174
SWP B 88 (7)					0.0128	0.0174
SWP C 67 (7)					0.0130	0.0178
SWP D 68		STEADY STATE (8)			0.0166	0.0243
		STARTING (8)			0.0156	0.0243

Notes:

1) Node numbers refer to single-line diagram on page A4.

2) Horsepower values were taken from the B-190627 drawing R.12, reference 7.14.

3) Load factors are Summer Bus Design LOCA load factors and are taken from the Phoenix database revision date 4/27/92.

4) Locked rotor currents taken from RNP-E-2.019 R.1, reference 7.18.

5) Xd" values added for future only based on RNP-E-8.002 R.2 section 5.2.28.

6) Cable impedance values for the HVH motors was taken from Vdrop computer

runs, RNP-E-8.002 R.2 Attachment Z.

7) SWP A, B, and C cable impedance is taken from reference 7.5

8) Per reference 7.5 two sets of cable impedances for SWP D are used (one for steady state and one for motor starting).

4.3 Summary of Changes to ASDOP Model

Table 2
Summary of MCC Loading Changes

MCC	LOADING CHANGE	BASIS
MCC5/MCC6	-10.8 hp	HVH fans taken out of MCC lumped loading and represented by individual nodes. See section 4.2.1 and Table 1.
MCC5/MCC18	+5.0 hp	BREFs moved from MCC9 and MCC10 to MCC18 and MCC5. See section 4.2.2.
MCC9/MCC10	-0.9 hp	
MCC5	+13.125kVA	Instrument Bus Upgrade Project (see section 4.2.3 and attachment D)
MCC6	+24.375kVA	
MCC18	+30kVA	
MCC3	+30kVA	
MCC15	+13.3kVA	Loading increased due to pending (approved but not installed) load additions. See section 4.2.4.
MCC21	+6.0kVA	
MCC5	+3.875kVA	Increased loading to get 4kA on E1/E2. See section 4.2.7.
MCC16	+6.3kVA	
MCC6	+12.725kVA	
MCC18	+20.8kVA	
MCC16	+22.5kVA	Battery Charger A-1 and B-1 Refeed. See section 4.2.5
MCC18	+22.5kVA	

Table 2A
Existing and New Loading for MCCs in ASDOP Runs

MCC	EXISTING MOTOR LOADING in kVA (FROM RUN 34 OF RNP-E-8.002 R.2)	NEW MOTOR LOADING in kVA (ADDITION OF CHANGES FROM TABLE 2)
MCC3	87.9	147.9 (1)
MCC5	154.3	165.5
MCC6	101.2	127.5
MCC15	92.7	106.0
MCC16	56.2	85.0
MCC18	56.2	134.5
MCC21	14	20

(1) Although Table 2 shows that the loading on MCC3 should be increased by 30kVA, 60kVA was actually added. The additional loading is conservative (i.e., results in lower than actual voltages), and since it is added to the BOP system, it does not significantly impact the voltages on the safety system.

4.4 **VDROP Runs**

The VDROP runs in attachment C were used to determine the minimum steady state and transient ride through voltage criteria at the safety related buses given the required load terminal voltages. These runs were taken directly from reference 7.1 and modified as noted below. Refer to section 5.1.4 and attachment N of reference 7.1 for minimum allowable voltages and cable impedance information used in VDROP runs.

4.4.1 Per sections 4.2.2 and 4.2.5, the Battery Room Exhaust fans and the A-1 and B-1 battery chargers will be refed from alternate sources.

Although the refeed of the A-1 and B-1 battery chargers will be engineered to ensure that they can operate given the proposed DGVR setpoints (per section 3.2), these loads were modeled in the VDROP runs, in their existing configuration, to show that they receive adequate terminal voltages without implementing the proposed changes.

Per section 3.2, the proposed Battery Room Exhaust fan changes will be engineered such that they can operate given the proposed DGVR setpoints. Therefore, given that the terminal voltages of these loads is expected to be low (based on section 3.24), the BREFs were not modeled in the VDROP runs.

4.4.2 The impedances for the cables feeding CVT 1&2 from MCC 5 and 6 were

revised to reflect those used in RNP-E-1.005, attachment 1A pg. 3 (see pg. A23). These loads are single phase loads and the original database did not consider the impedance of the second wire in the cable.

4.4.3 Consistent with section 4.2.6 the impedance of the Service Water Pump motor cables was changed. Note that since the SWP D is considered to be running in all the VDROP runs, the steady state impedance is used.

5.0 Results

5.1 Starting Motor Terminal Voltages

Per section 3.21, the Containment Spray Pump may start at any time during load sequencing. Therefore, when evaluating the DGVR operation, the starting of any combination of motors shown in section 3.17 followed by the starting of the CSP or the starting of those motors concurrently with the CSP motor may cause the E bus voltage to decrease below the DGVR drop out setpoint and cause the DGVR relay to begin timing. If the E bus voltage does not recover to above the relay's reset setpoint within the minimum time delay, the relay will drop out.

This section considers the effects on E bus voltages of sequenced motor starting, and simultaneous or concurrent starting of the CS pump motor with each load block being sequenced onto the bus. Tables 3 and 4 show the condition (i.e. run, start or off) for each motor during each run.

The first seven runs consider the Containment Spray Pump (CSP) starting concurrently with each load block that is being sequenced onto the bus. These runs produce the lowest motor starting voltages, as well as the lowest bus transient voltages. The second set of eight runs considers each load block being sequenced onto the bus with the CSP running. In all runs the appropriate HVH motors (6,7, or 8) are running or starting depending on the state of their parent motor (see section 3.12). These runs use a 115kV switchyard voltage of 113.7kV per section 3.4. Although section 3.18 notes that the HVH 2(4) and SWP A(C) motors are either running or their associated breakers racked out, these motors are started in sequence per section 3.17 in order to determine whether the operating restriction noted in section 3.18 is still applicable.

Motor acceleration times are determined from the motor terminal voltages predicted in each of the referenced runs and from the graphs in attachment S of reference 7.1 (see pgs. A31-A36). The results are shown in Tables 5 and 6. The loading presented by the HVH 6, 7 and 8 fan motors is small, and should these motors accelerate slower that their parent motors, the affect on E bus voltages would be insignificant. Hence, the acceleration times for these motors are not calculated.

The voltages shown on Tables 3 and 4 are assumed present for the entire acceleration period of all motors, without crediting the voltage rise during acceleration or following the acceleration of the fastest motor during multiple motor starts.

TABLE 3
MOTOR STARTING VOLTAGES
SWITCHYARD VOLTAGE = 113.7kV
TRAIN A

RUN NO. CS46	CSP A (*)	SIP A (*)	RHR A (#)	SWP A	SWP B	SWB A	HVH 1	HVH 2	AFW A (@)	HVH 6A (*)	HVH 7B (@)	HVH 8A (#)
200	391.8	392.2	Off	Run	Run	Run	Run	Run	Off	402.0	Run	Run
201	389.4	Run	394.9	Run	Run	Run	Run	Run	Off	Run	Run	397.1
202	385.2	Run	Run	346.8	Run	371.3	Run	Run	Off	Run	Run	Run
202A	392.4	Run	Run	Run	353.3	Run	Run	Run	Off	Run	Run	Run
203A	387.5	Run	Run	Run	Run	Run	386.0	Run	Off	Run	Run	Run
203	387.3	Run	Run	Run	Run	Run	Run	389.6	Off	Run	Run	Run
63	385.9	Run	Run	Run	Run	Run	Run	Run	401.7	Run	395.4	Run
211	Run	403.5	Off	Run	Run	Run	Run	Run	Off	Run	Run	Run
212	Run	Run	406.1	Run	Run	Run	Run	Run	Off	Run	Run	408.9
213	Run	Run	Run	356.3	Run	381.7	Run	Run	Off	Run	Run	Run
213A	Run	Run	Run	Run	363.4	Run	Run	Run	Off	Run	Run	Run
214	Run	Run	Run	Run	Run	Run	396.9	Run	Off	Run	Run	Run
214A	Run	Run	Run	Run	Run	Run	Run	400.5	Off	Run	Run	Run
215	Run	Run	Run	Run	Run	Run	Run	Run	413.1	Run	407.2	Run
216	406.9	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run
31	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run

NOTE: Numerical entries represent starting motor terminal voltage with remaining motors in the specified mode.

(*),(#),(@) These motors start concurrently, see section 3.12.

TABLE 4

MOTOR STARTING VOLTAGES
SWITCHYARD VOLTAGE = 113.7kV
TRAIN B

RUN NO. CS46_	CSP B (*)	SIP C (*)	RHR B (#)	SWP C	SWP D	SWB B	HVH 3	HVH 4	AFW B (@)	HVH 6B (*)	HVH 7A (@)	HVH 8B (#)
200	392.4	393.6	Off	Run	Run	Run	Run	Run	Off	400.6	Run	Run
201	390.1	Run	396.5	Run	Run	Run	Run	Run	Off	Run	Run	401.1
202	386.0	Run	Run	347.1	Run	376.4	Run	Run	Off	Run	Run	Run
202A	394.3	Run	Run	Run	337.6	Run	Run	Run	Off	Run	Run	Run
203A	387.7	Run	Run	Run	Run	Run	395.9	Run	Off	Run	Run	Run
203	388.4	Run	Run	Run	Run	Run	Run	385.7	Off	Run	Run	Run
63	386.7	Run	Run	Run	Run	Run	Run	Run	402.5	Run	399.5	Run
211	Run	404.8	Off	Run	Run	Run	Run	Run	Off	Run	Run	Run
212	Run	Run	407.7	Run	Run	Run	Run	Run	Off	Run	Run	412.8
213	Run	Run	Run	356.6	Run	386.9	Run	Run	Off	Run	Run	Run
213A	Run	Run	Run	Run	347.2	Run	Run	Run	Off	Run	Run	Run
214	Run	Run	Run	Run	Run	Run	406.9	Run	Off	Run	Run	Run
214A	Run	Run	Run	Run	Run	Run	Run	396.4	Off	Run	Run	Run
215	Run	Run	Run	Run	Run	Run	Run	Run	413.9	Run	411.2	Run
216	407.6	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run
31	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run	Run

NOTE: Numerical entries represent starting motor terminal voltage with remaining motors in the specified mode.

TABLE 5

MOTOR STARTING VOLTAGES AND ACCELERATION TIMES
SWITCHYARD VOLTAGE = 113.7kV

TRAIN A

RUN NO. CS46_	STARTING MOTOR	MOTOR TERMINAL VOLTAGE (VOLTS) (1)	PERCENT OF RATING	ACCELERATION TIME (SEC.) (2)
200	CSP A SIP A	391.8 392.2	85.2 85.3	1.6 6.1
201	CSP A RHR A	389.4 394.9	84.7 86.0	1.6 1.4
202	CSP A SWP A SWB A	385.2 346.8 371.3	83.7 75.4 80.7	1.6 1.3 0.9
202A	CSP A SWP B	392.4 353.3	85.3 76.8	1.5 1.1
203A	CSP A HVH 1	387.5 386.0	84.2 83.9	1.6 7.2
203	CSP A HVH 2	387.3 389.6	84.2 84.7	1.6 6.9
63	CSP A AFW A	385.9 401.7	83.9 87.3	1.6 6.0
211	SIP A	403.5	87.7	5.5
212	RHR A	406.1	88.3	1.3
213	SWP A SWB A	356.3 381.7	77.5 83.0	1.0 0.8
213A	SWP B	363.4	79.0	0.9
214	HVH 1	396.9	86.3	6.5
214A	HVH 2	400.5	87.1	6.3
215	AFW A	413.1	89.8	5.0
216	CSP A	406.9	88.5	1.4

(1) Motor terminal voltage taken from applicable run in Table 3.

(2) Acceleration times taken from attachment S of reference 7.1

TABLE 6

MOTOR STARTING VOLTAGES AND ACCELERATION TIMES
SWITCHYARD VOLTAGE = 113.7kV

TRAIN B

RUN NO. CS46_	STARTING MOTOR	MOTOR TERMINAL VOLTAGE (VOLTS) (2)	PERCENT OF RATING	ACCELERATION TIME (SEC.) (3)
200	CSP B SIP C	392.4 393.6	85.3 85.6	1.5 6.0
201	CSP B RHR B	390.1 396.5	84.8 86.2	1.6 1.4
202	CSP B SWP C SWB B	386.0 347.1 376.4	83.9 75.5 81.8	1.7 1.3 0.9
202A	CSP B SWP D	394.3 337.6	85.7 73.4	1.5 1.4 (1)
203A	CSP B HVH 3	387.7 395.9	84.3 86.1	1.6 6.6
203	CSP B HVH 4	388.4 385.7	84.4 83.8	1.6 7.2
63	CSP B AFW B	386.7 402.5	84.1 87.5	1.6 5.5
211	SIP C	404.8	88.0	5.4
212	RHR B	407.7	88.6	1.3
213	SWP C SWB B	356.6 386.9	77.5 84.1	1.0 0.8
213A	SWP D	347.2	75.5	1.1
214	HVH 3	406.9	88.5	6.0
214A	HVH 4	396.4	86.2	6.6
215	AFW B	413.9	90.0	4.9
216	CSP B	407.6	88.6	1.4

(1) See section 5.1.1.

(2) Motor terminal voltage taken from applicable run in Table 3.

(3) Acceleration times taken from attachment S of reference 7.1 (pages A31-A36)

5.1.1 Analysis of Starting Motor Terminal Voltages

With the exception of SWP D, Tables 5 and 6 show that all emergency bus motors and the service water booster pump motors receive a terminal voltage greater than the minimum starting voltage required (75% of rated voltage for all motors except the AFW motor which requires 80% of rated voltage see section 3.15).

The SWP D starting terminal voltage of less than 75% rated voltage is acceptable based on the following:

The transient ride through terminal voltages for the SWP D motor is and 73.4% of rated voltage. This section will show that given the lower terminal voltage this motor can fully accelerate its respective load without motor stalling. For conservatism, the analysis will be done assuming 72.5% motor terminal voltage.

Page 6-48 of reference 7.21 indicates that, on average, the starting torque of a motor is proportional to the motor's terminal voltage raised to the power of 2.2. Pages A19 through A22 are vendor provided motor data sheets which show the Service Water pump motor torque, current and acceleration times for various terminal voltages. Page A14 summarizes the motor starting torque generated at 100%, 90%, 80% and 75% terminal voltages (these values are taken directly from reference 7.8). Given these data points and the above mentioned relationship an actual exponent value (rather than average) can be calculated which can then be used to calculate the motor starting torque at 72.5% terminal voltage. The exponent values using the known voltages and torques on page A14 were calculated from the following relationship:

$$Torque = Torque(rated\ voltage)\,[(Per\ Unit\ terminal\ voltage)]^{(exp)}$$

The exponent results are shown on page A14. A review of the calculated exponents shows that the exponent increases with decreasing terminal voltage. For the 90% to 80% interval the exponent increases by .03. For the 80% to 75% interval the exponent also increases by 0.03.

To calculate the torque at 72.5% terminal voltage an exponent of 2.41 is assumed. Given the increase in exponent values (0.03) for the known starting torques, 2.41 is the exponent value expected at 70% starting terminal voltage. Therefore, assuming an exponent of 2.41 for 72.5% of starting terminal voltage, yields a lower (more conservative) starting torque. Based on the above, the starting torque (0 rpm) at 72.5% starting terminal voltage is calculated as:

$$Torque(72.5\%) = Torque(100\%)\,[(.725)]^{2.41}$$

$$= (2234.67\ ft.\ lb)(.4607)$$

$$= 1029.50\ ft\ lb.$$

The values of motor starting torques for different rpm values are calculated using the same equation and are shown on page A15. For conservatism, the exponent value of 2.41 was assumed to be constant for all speeds. In actuality, as the motor approaches full speed the

exponent would decrease and the torque would be slightly higher.

Pages 6-37 and 6-38 of reference 7.21 give the equation for determining the acceleration time of a motor as:

$$Acceleration\ time,\ S = \frac{WK^2}{308}\frac{(rpmf-rpmi)}{(Tmavg-Tlavg)}$$

where:

WK^2 is the drive inertia.
308 is a constant
rpm_i, rpm_f are the initial and final speeds of the motor.
T_{mavg} is the motor average torque (within the subject rpm interval), and
T_{lavg} is the average load torque (within the subject rpm interval).

This equation applies only for small changes in motor speed during which the motor torque can be considered essentially constant. The variables in the above equation were determined from the data in reference 7.8 for 11 time intervals and are listed on page A16. Using 240 for the drive inertia value (pg. A19-22), an acceleration time for each interval was calculated and is listed on page A16.

Summing the acceleration times for each interval results in the total motor acceleration time of approximately 1.4 seconds. Pages A17 and A18 show the graphs of load torque vs motor torque given various terminal voltages.

5.1.2 Given a starting terminal voltage of 72.5% and based on section 5.1.1 the following conclusions can be made:

The SWP D motor develops sufficient torque to overcome motor/pump inertia and load torque and to accelerate the load to full speed in approximately 1.4 seconds.

The SWP D motor has sufficient break-away (locked rotor) torque to start the motor rotating from initial rest position (1029.5 ft-lb vs 0 ft-lb load torque).

Pull-up torque (minimum) is equal to locked rotor torque.

Break-down torque (maximum) occurs at 1110rpm and is approximately 126% of maximum load torque (which occurs near 1164rpm).

The acceleration time of these motors given a terminal voltage of 72.5% of rated voltage is approximately 1.4 seconds.

5.2 Motor and Load Block Acceleration Times

The motor acceleration times from Tables 5 and 6 are summarized below. Times shown are worst case between Trains A and B.

MOTOR ACCELERATION TIME (SEC)
MOTORS STARTING INDIVIDUALLY
(SWITCHYARD VOLTAGE = 113.7kV)

MOTOR	ACCELERATION TIME (s)
CSP A(B)	1.4
SIP A(C)	5.5
RHR A(B)	1.3
SWP A(C)	1.0
SWBP A(B)	0.8
SWP B(D)	1.1
HVH 1(3)	6.5
HVH 2(4)	6.6
AFW A(B)	5.0

TOTAL LOAD BLOCK ACCELERATION TIME (SEC)
MOTORS STARTING CONCURRENTLY WITH CSP
(SWITCHYARD VOLTAGE = 113.7kV)

STARTING LOAD BLOCK	ACCELERATION TIME FOR MOTOR WITH LONGEST ACCELERATION TIME(s)
SIP A(C)	6.1
RHR A(B)	1.6 (1)
SWP A(C) SWBP A(B)	1.7 (1)
SWP B(D)	1.5 (1)
HVH 1(3)	7.2
HVH 2(4)	7.2
AFW A(B)	6.0

(1) In these load blocks the Containment Spray Pump motor has the longest acceleration time of all the motors starting in that block.

5.3 Degraded Grid Voltage Relay Operation and Reset Capability

As noted in section 3.1, the following values will be used in determining the DGVR operation and reset capabilities.

Minimum Dropout Voltage: 425 volts
Maximum Reset Voltage: 436 volts
Minimum Time Delay: 9.5 seconds
Maximum Time Delay 10.5 seconds

During safety system motor starts the E Bus voltage may drop below the minimum DGVR dropout setting as shown by Table 7. When this occurs, the DGVR begins timing out. To avoid relay operation and to enable its timer

to reset, the E Bus voltage must rise above the maximum relay pickup value prior to timing out.

To determine the above it must be shown that whenever E bus motors are sequenced onto the bus (a load block starting concurrently with the CSP motor or a sequenced load block followed by the immediate starting of the CSP) resulting in the arming of the DGVR (i.e., E Bus voltage drops to or below the minimum dropout setting of 425 volts), the E Bus voltage will recover above the maximum reset value (436 volts) in less than 9.5 seconds. In order to show that the relay can reset, the emergency load sequencer relay settings, tolerances and the motor acceleration times must be considered.

Section 5.2 shows that no individual motor or single load block (any motor starting concurrently with CSP) has an acceleration time equal to or greater than 9.5 seconds. Therefore, no single load block will cause the DGVR to time out. The following paragraphs consider the impact of the Emergency Load Sequencer Relay (ELSR) settings and tolerances on E bus voltages during load sequencing.

Figures 1 and 2 are graphical representations of the E bus voltages verses time for the E bus motors being sequenced onto the bus using the data summarized in section 5.2. Figure 1 shows the acceleration times for each block starting simultaneously with the Containment Spray pump, and figure 2 shows the acceleration times for individual motor starts. Note that the times shown in figure 1 are the worst case (longest) acceleration times for any motor starting in the starting load block. In the case of runs CS46_201, 202 and 202A, the worst case acceleration time is that of the CSP. Each of these load blocks shows the acceleration time for the CSP although the CSP could start in only one of the load blocks shown.

Per section 3.17, the emergency load sequencing relays have a tolerance of +- 0.5 seconds. Figure 1 shows that given any combination of ELSR tolerances, there can be no overlapping of load blocks (with the exception of the HVH/HVH/AFW load blocks, see below). Hence, there can be no period of time in which the E bus voltage is below the maximum DGVR dropout setpoint (436 volts) for more than 9.5 seconds. Therefore, the DGVR will not trip due to load sequencing when the sequenced motors are starting concurrently with the CSP motor.

Figure 2 shows that given any combination of ELSR tolerances and a CSP acceleration time of 1.4 seconds per section 5.2, there can be no overlapping of load blocks (with the exception of the HVH/HVH/AFW load blocks, see below). Hence, there can be no period of time in which the E bus voltage is below the maximum DGVR dropout setpoint (436 volts) for more than 9.5 seconds. Therefore, the DGVR will not trip due to emergency load sequencing when the CSP motor is starting immediately after any sequenced motor.

Although both figures show an overlapping of load blocks during the HVH/HVH/AFW sequence, per section 3.18 the HVH 2/4 motors are either running or their associated breaker is racked out. Therefore, the sequencing of the HVH 2/4 block is not considered in the evaluation of the DGVR. Without the HVH 2/4 load block, and considering the ELSR tolerances and CSP starting acceleration as appropriate, Figures 1 and 2 show that there is sufficient interval between the HVH 1/3 and AFW A/B load blocks to permit the DGVR to reset. It should be noted that CS46_203 predicts the motor starting terminal voltages for the HVH 2/4 motors assuming that those motors are the only motors starting on the E bus and all other applicable motors are running (Table 3 and 4). Since

the HVH 1/3 motors would still be accelerating at the time when the HVH 2/4 motors are starting (see figures 1 and 2), the E bus voltage would be lower than that used in CS46__203 and the HVH 2/4 motor starting terminal voltages would be lower. Therefore, the starting motor terminal voltages and subsequent acceleration times for the HVH 2/4 motors are not applicable to the load sequenced case.

Since no single load block has an acceleration time equal to or greater than 9.5 seconds, and there is no overlapping of starting motor load blocks which would result in an E bus voltage equal to or lower than the maximum DGVR dropout setpoint (436 volts) for more than 9.5 seconds after the DGVR has been armed, the ELS relays are adequately set to support the capability of the DGVR to reset.

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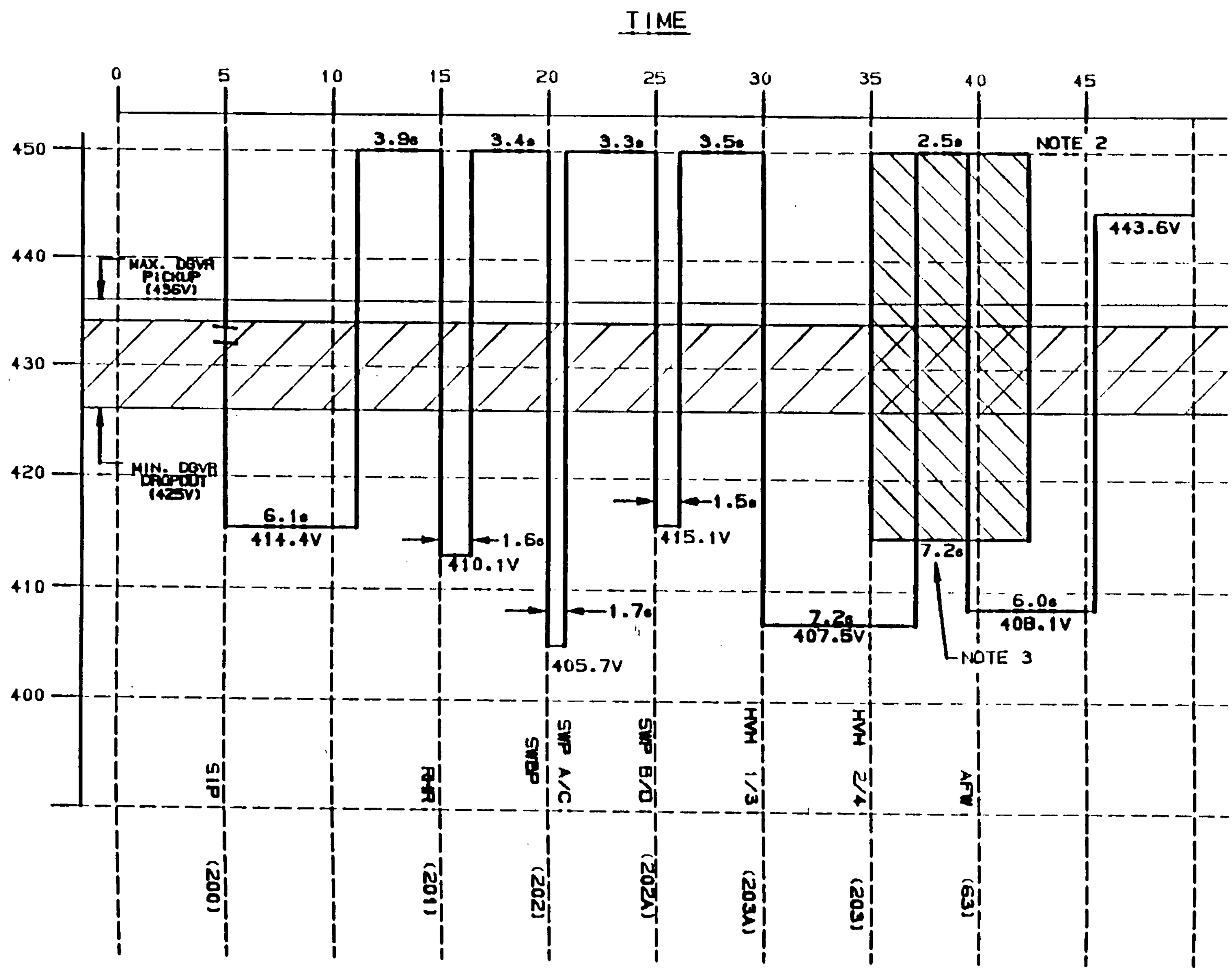

E-BUS VOLTAGE VS TIME DURING MOTOR SEQUENCING
(EACH BLOCK STARTS SIMULTANEOUSLY WITH CSP)

FIGURE 1

NOTES:

(1) NUMBERS IN PARENTHESES REPRESENT APPLICABLE ASDOP RUNS.

(2) RECOVERY VOLTAGE FOR EACH LOAD BLOCK SHOWN ABOVE ARE FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL RECOVERY VOLTAGES WOULD APPROACH STEADY-STATE VOLTAGE OF 443.6 WITH EACH ADDITIONAL LOAD BLOCK.

(3) [illegible]

E-BUS VOLTAGE VS TIME DURING MOTOR SEQUENCING
(CSP STARTS AFTER ACCELERATION OF ANY BLOCK)

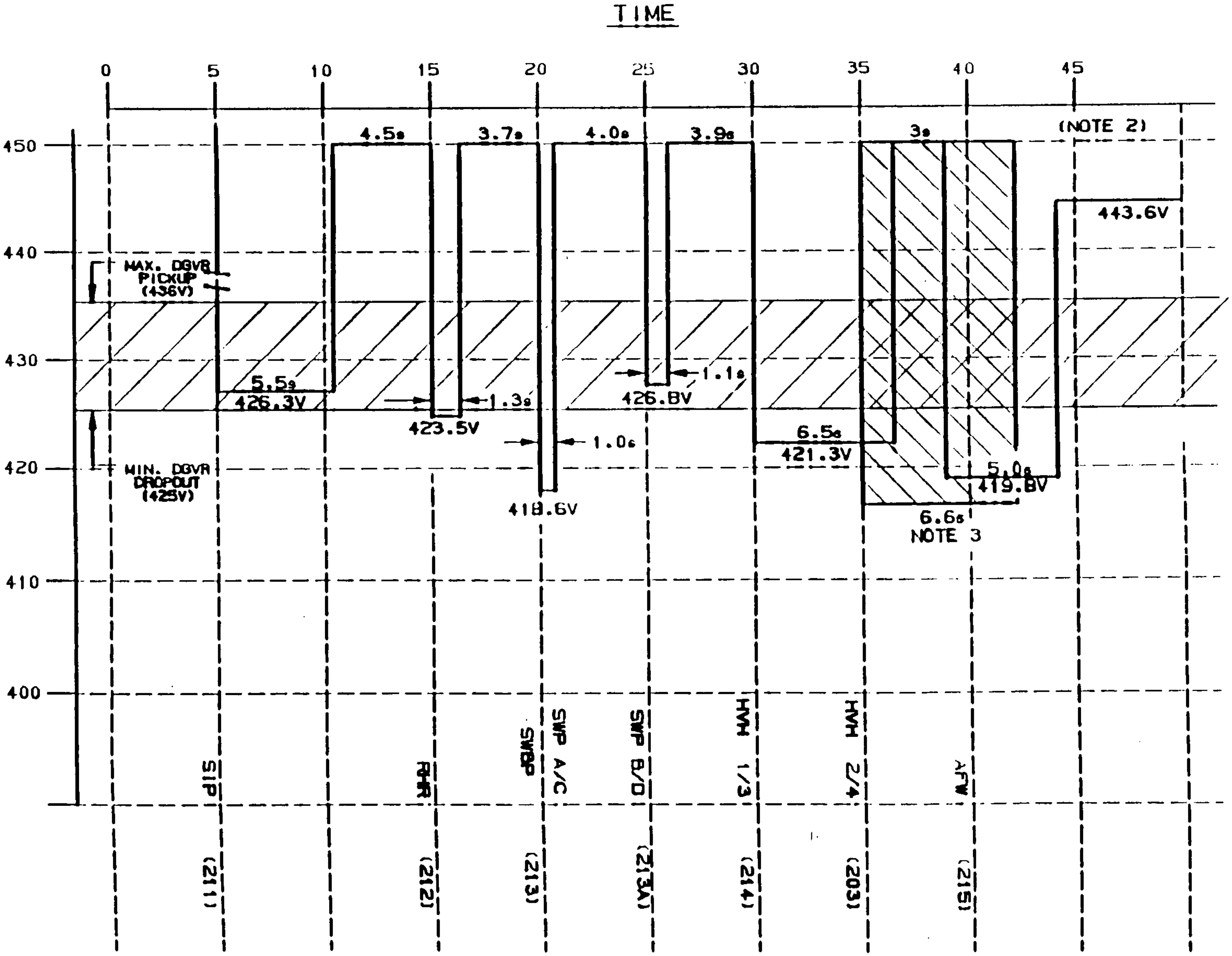

FIGURE 2

NOTES:

(1) NUMBERS IN PARENTHESES REPRESENT APPLICABLE ASDOP RUNS.

(2) RECOVERY VOLTAGE FOR EACH LOAD BLOCK SHOWN ABOVE ARE FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL RECOVERY VOLTAGES WOULD APPROACH STEADY-STATE VOLTAGE OF 443.6 WITH EACH ADDITIONAL LOAD BLOCK.

(3) VOLTAGE/ACCELERATION TIME FOR THIS BLOCK IS NOT APPLICABLE.

5.4 Bus Transient Ride Through Voltages During Load Sequencing

Table 7 shows the emergency bus transient ride through voltages during motor sequencing and the bus steady-state voltages following completion of the LOCA loading sequence with a switchyard voltage at 113.7kV (see run CS46_31). Voltages were taken from the referenced runs included in attachment B.

TABLE 7

BUS TRANSIENT RIDE THROUGH VOLTAGES
SWITCHYARD VOLTAGE = 113.7kV

CASE NO.	BUS E1	BUS E2	MCC 5	MCC 6	MCC 9	MCC 10	MCC 16	MCC 18
200	414.4	415.9	404.1	406.5	175.3	174.6	409.2	409.4
201	411.8	413.5	401.5	403.9	174.2	173.4	406.7	406.9
202	407.3	409.1	397.5	400.4	172.6	171.7	382.5	382.6
202A	415.1	417.9	405.6	409.4	176.5	175.2	409.9	411.5
203A	409.8	410.9	400.2	402.2	173.4	172.9	404.6	404.3
203	409.6	411.6	400.0	403.0	173.8	172.7	404.4	405.1
63	408.1	409.8	398.0	400.6	172.7	171.9	402.9	403.2
211	426.3	427.7	417.1	419.4	180.9	180.1	421.3	421.4
212	423.5	425.1	413.4	415.7	179.3	178.5	418.5	418.7
213	418.6	420.3	409.1	411.8	177.6	176.7	393.2	393.3
213A	426.8	429.7	417.6	421.4	181.8	180.4	421.9	423.4
214	421.3	422.4	412.0	413.9	178.5	178.0	416.3	415.9
214A	421.1	423.1	411.7	414.7	178.8	177.8	416.0	416.7
215	419.8	421.4	409.9	412.3	177.8	177.0	414.7	415.0
216	430.3	432.0	421.2	423.7	182.8	182.0	425.4	425.8
31	443.6	445.2	434.7	437.2	188.6	187.8	438.8	439.1

5.4.1 The lowest bus transient ride through voltages (from run CS46_202) were compared to the minimum allowable bus voltages as shown below. The first minimum allowable voltage column shows the transient ride through criteria based on load terminal voltage requirements from the transient VDROP run attachment C, pages C9-C16. The second column shows the minimum voltage criteria for safety related contactors from Table 3-2 of reference 7.1.

BUS TRANSIENT VOLTAGE

BUS	SWYD = 113.7kV	MIN. ALLOWABLE (1)	MIN. ALLOWABLE (2)
E1	407.3	361.6	-
E2	409.1	367.0	-

MCC 5	397.5	352.5	337.0
MCC 6	400.4	356.0	337.0
MCC 9	172.6	158.3	112.0
MCC 10	171.7	160.7	112.0
MCC 16	382.5	347.7	344.0
MCC 18	382.6	346.5	344.0

(1) Minimum transient ride through voltage criteria from transient VDROP run attachment C, pages C9-C16.

(2) Minimum voltage criteria for safety related contactors from Table 3-2 of reference 7.1.

5.4.2 The above indicate that the minimum allowable bus transient ride through voltages are not violated. Therefore, safety related control circuit contactors have adequate voltage to hold-in as required and running safety related motors will not stall. Furthermore, the E1 and E2 Bus voltages are much higher than the primary undervoltage relay setting of 328 ± 32.8 volts (section 3.6). Therefore, the primary undervoltage relay will not trip during the sequencing of emergency bus loads.

5.5 Bus and Equipment Steady-State Voltage with E Bus Voltage at Minimum Allowable DGVR Dropout Value (425 volts)

This section determines the steady state equipment terminal voltages that correspond to an E Bus voltage of 425V. ASDOP runs CS46_34B and CS46_34C (for train A and B respectively, see attachment B) show the emergency distribution system bus voltage levels with E1 and E2 bus voltages at the minimum DGVR dropout value of 425 volts (switchyard voltage for both runs was adjusted until E bus voltages were at 425 volts). The predicted MCC voltages were input into the steady state VDROP run as source voltages in order to determine the terminal voltage for safety system loads that are not individually modeled in the ASDOP model.

BUS Steady State Voltages

TRAIN A (Run CS46_34B) BUS	VOLTAGE	TRAIN B (Run CS46_34C) BUS	VOLTAGE
E1	425V	E2	425V
MCC5	415.8V	MCC6	416.6V
MCC10	179.6V	MCC9	179.7
MCC16	420.0V	MCC18	418.6V

5.5.1 Analysis of Safety Related Loads less than Rated Terminal Voltage

A review of the steady state VDROP run output shows that with the E buses at 425 volts, 22 safety related motors receive less than the minimum required steady state voltage (90% of rated), and one safety related power panel receives less than the minimum required steady state voltage (84% of rated).

Of the 22 motor loads receiving less than 90% terminal voltage, 18 receive a terminal voltage of 89.0% or higher of rated voltage (actual percentage of terminal voltage shown on pages C7 and C8). The following discussion demonstrates that operation of these motors at a higher temperature (resulting from the lower terminal voltage) is offset by operating the motors at lower than rated altitude.

Per NEMA MG-1.12.43 (reference 7.12) motors with a 1.0 service factor and class B insulation have a maximum allowable temperature rise rating of 80℃ over 40℃ ambient. Motors with a 1.15 service factor and class B insulation have a maximum allowable temperature rise rating of 90℃ over 40℃ ambient (at service factor load, and rated voltage). Consistent with section 4.2.1 of reference 7.7, it is assumed that these motors operate with a load factor equal to 90% of their service factor.

Therefore, the motor current at 89.0% terminal voltage is (1)(90)/(89) or 101.1% of rated current, for 1.0 service factor motors, and (115)(90)/(89) or 116.3% of rated current, for 1.15 service factor loads. The 1.0 service factor loads are drawing a current of 1.1% (101.1%-100%) above their maximum allowable, and the 1.15 service factor motors are drawing a current 1.3% (116.3%-115%) above their maximum allowable. Over a small increase in temperature, the resistance of the motor windings can be considered constant. Since power and therefore temperature, is proportional to the current squared (with constant resistance), the temperature rise can be calculate from:

$$Trise = (\text{actual current}/\text{rated current})^2 (\text{rated temperature rise})$$

Therefore, the temperature rise for the 1.0 service factor motors at 89% terminal voltage is:

$$Trise = (1.011)^2(80) = 81.8℃$$

and, the temperature rise for the 1.15 service factor motors at 89% terminal voltage is:

$$Trise = (1.013)^2(90) = 92.4℃$$

NEMA MG-1.14.04 indicates that the temperature rise ratings of motors are based on operation at altitudes of 3300 feet or less. For operation at altitudes greater than 3300 feet, it provides the following formula for calculating the permissible temperature rise:

$$Trise = T_{\text{RISE AT SEA LEVEL}} (1-(\text{Altitude} - 3300)/ 33000)$$

This accounts for the difference in air density (and resulting lower cooling effect) at higher elevations. Per reference 7.22, the elevation at the Robinson location is approximately 300 feet. Therefore, based on the above equation, the maximum Equivalent Temperature rise allowed is:

$Trise = (90)(1-(300-3300)/33000) = 98℃$ for a 1.15 service factor.

$Trise = (80)(1-(300-3300)/33000) = 87℃$ for a 1.0 service factor.

As shown above, a terminal voltage of 89% of rated results in a temperature rise that is lower than the maximum equivalent permissible rise at an elevation of 300 ft. Therefore, motor overheating will not occur.

The remaining four motors and one power panel are acceptable based on the following sections.

5.5.1.1 Service Water Pump D

Service Water Pump D receives 88.2% of rated voltage during steady state conditions with bus E2 at 425 volts. Per reference 7.14, this motor has a service factor of 1.15. NEMA MG-1.14.35 indicates that motors with a service factor of 1.15 can be operated at 1.15 times rated current given rated voltage and frequency, without exceeding the temperature limits of the motor windings. Therefore, assuming no variation in the motor efficiency or power factor between rated load and service factor load, the maximum current allowed (at rated voltage) at the service factor load is (1.15)(349A) = 401.4A. Where 349A is the rated full load current from reference 7.14 and 1.15 is the service factor.

At 88.2% rated terminal voltage the current drawn by SWP D would be (376A)(1.047)(0.9)/(0.882) = 401.7A. Where 376A is the FLC at 90% motor terminal voltage per reference 7.8, 1.047 is the equipment load factor from reference 7.7 and 0.882 is the per unit predicted terminal voltage from the steady state VDROP run. The predicted current at 88.2% terminal voltage exceeds the maximum allowable service factor current by 0.075%. As noted above this low voltage condition can only occur during a LOCA. Hence, there would be no abnormal degradation of this motors during normal conditions such as during power operation or shutdown. In addition, since it is expected that the switchyard voltage would recover within an hour or two after the initiation of a LOCA the amount of degradation to the motor due to operation at a current 0.075% higher than the service factor allows is considered to be negligible. In addition, based on the altitude analysis of the previous section, this motor would be operating at a temperature below the maximum equivalent allowable.

5.5.1.2 Power Panel 39

Power Panel 39 is fed from MCC10 via a constant voltage transformer. The minimum required voltage for this CVT is 84%. This is based on the transformer's input voltage requirements needed to regulate the transformer's output voltage at rated full load. The input voltage to the CVT that supplies PP-39 is 82.4% of rated. This is acceptable since the transformer is not fully loaded and partially loaded CVTs can withstand lower input voltages while maintaining their output voltages within specified limits. Per reference 7.2, the actual loading on this CVT is 0.61 kVA and the maximum permissible loading is 4.25 kVA or 0.85% of the transformer rating. Given the actual and envelope loading it is expected that the CVT can regulate its output given the 82.4% terminal voltage.

5.5.1.3 Instrument Air Dryers A and B

The voltage at the terminals of the Instrument Air Dryer motors is at least 85.6% of rated. This is acceptable since the instrument air dryers do not perform a safety related function (see ASD-R-570 pg. A24-A25).

5.5.1.4 Diesel Generator B Room Supply Fan HVS-6

As shown in the steady state VDROP run, the HVS-6 fan receives 88.5% of rated terminal voltage. Per reference 7.14, this motor has a service factor of 1.15. NEMA MG-1.14.35 indicates that motors with a service factor of 1.15 can be operated at 1.15 times rated full load current given rated voltage and frequency, without exceeding the temperature limits of the motor windings. This also means that a motor can be operated at degraded voltage without damage provided that the motor current drawn at that voltage is less than the product of full load current at rated voltage and the service factor.

Therefore, assuming no variation in the motor efficiency or power factor between rated load and service factor load, this motor can operate with a terminal voltage as low as 86.9% (1/1.15) of rated voltage without damage. It should be noted that per reference 7.7, the equipment load factor for this motor is 1.0. Since the predicted terminal voltage is higher than the minimum allowable, the motor will not be damaged due to the lower terminal voltage.

5.6 Bus and Equipment Steady-State Voltages with 115kV Switchyard Voltage at 113.7kV

5.6.1 The minimum bus steady-state voltages (taken from Run CS46_31, attachment B) with the switchyard voltage at its minimum expected voltage of 113.7kV, and the corresponding limiting values (taken from steady state VDROP run, attachment C) are as follows:

BUS	VOLTAGE	MIN. ALLOWABLE
E1	443.6	427.8
E2	445.2	432.9
MCC 5	434.7	420.3
MCC 6	437.2	423.2
MCC 9	**188.6**	188.7
MCC 10	**187.8**	188.1
MCC 16	438.8	416.2
MCC 18	439.1	415.2

As indicated above the steady-state voltages on Buses E1, E2, and MCCs 5, 6, 16, and 18 are higher than the minimum allowable voltages. The minimum allowable voltage criteria is exceeded on MCCs 9 and 10. A review of the steady state VDROP run shows that the limiting equipment on MCCs 9 and 10 is the Instrument Air Dryer motors. As noted in section 5.2.1.3. these motors do not perform a safety related function. Therefore, the slightly lower terminal voltages are acceptable. In addition, the terminal voltages for the other equipment on MCCs 9 and 10 are higher than the minimum allowable voltages listed above.

5.7 Emergency Equipment Response Times During LOCA Coincident with Degraded Grid Voltage

To determine the equipment response time the following tolerances/operating times are considered:

DGV Relay Time Setting: 10.0 + 0.5 seconds (section 3.1)

ELS Relay/Breaker Closing Time:	Setting + 0.5 seconds (section 3.17)
Loss of Voltage Relay:	1.0 seconds maximum (section 3.6)
Dead Bus Relay (2-17B):	2.0 + 0.2 seconds (section 3.19)
DG Breaker Closing Time:	1.0 seconds maximum (section 3.8)

EQUIPMENT RESPONSE TIMES DURING LOCA COINCIDENT WITH DEGRADED GRID VOLTAGE
(115kV Switchyard Voltage = 113.7kV)

T = 0	SI signal generated/load sequencing begins/DG starts/DGVR begins timing
T = 10.0	Diesel generator ready for load
T = 10.5	DGVR times-out/normal incoming breaker trips/loss of voltage relay begins timing
T = 11.5	Loss of voltage relay operates/dead bus relay begins timing
T = 13.7	Dead bus relay times out and provides DG breaker close permissive
T = 14.7	DG breaker closes/emergency bus power restored/CSP permitted to start when containment pressure reaches setpoint
T = 20.2	SIP A(C) starts
T = 30.2	RHR A(B) starts
T = 35.2	SWP A(C)/SWBP A(B) starts
T = 40.2	SWP B(C) starts
T = 45.2	HVH 1(3) starts
T = 50.2	HVH 2(4) starts See section 3.18.
T = 54.7	AFW A(B) starts
T = 60.7	AFW A(B) reaches full speed (6.0 seconds acceleration time)

Note: The AFW acceleration time shown above (6.0 seconds) is for simultaneous starting of the AFW and CSP when power is supplied from a degraded Switchyard voltage of 113.7kV. Since the above scenario assumes that the diesels are supplying power, the actual AFW acceleration time (due to higher terminal voltage) will be shorter.

The above response times are within postulated accidents response times identified in Chapter 15 of the UFSAR.

5.8 Effects of BOP Motor Starts on Degraded Grid Voltage Relay Setting

Since the DGVR trip setting is being increased, as compared to the existing setting, the relay becomes more susceptible to voltage transients. It must be shown that during normal plant operation large BOP motor starts, coincident with the starting of any safety-related motors on the E bus that could start automatically, will not drive the E bus voltage below the relay dropout setting for durations sufficient in length to result in tripping the E bus normal incoming breaker (i.e. greater than 9.5 seconds). The Reactor Coolant Pumps (RCPs) are known to create such transients and, as a result, during the starting of these pumps the DGVR output contacts must be blocked with a manual switch interlock (see section 4.2.1 #20 of reference 7.16).

ASDOP voltage drop runs completed for reference 7.1 indicate that the worst case voltage transients created by the starting of BOP motors, excluding the RCPs, occur when the Steam Generator Feedwater Pumps

(SGFPs), Circulating Water Pumps (CWPs) or Condensate Pumps (Cps) are started. These motors are required to operate during normal plant operation and do not start during an SI loading sequence.

During normal plant operation, the only E bus load that could start automatically without an SI signal present is the AFW pump. This pump starts due to low steam generator level. Since the most likely contributor to the low steam generator level is the loss of a SGFP, it is highly unlikely that the AFW would start at the same time as the SGFP. Therefore, the analysis will be limited to starting the CWP and CP in coincidence with the AFW pump and starting the SGFP alone. For conservatism, 112.8kV will be used as the 115kV switchyard voltage. Per attachment M of reference 7.1, this is the lowest expected 115kV switchyard voltage when starting an RCP during plant startup. ASDOP runs 362-364 model the above described scenarios, and are included in attachment C.

Runs 362 and 364 were taken from reference 7.1 and modified with the loading shown in Tables 1 and 2. Note that the loading in Tables 1 and 2 represent the proposed loading with LOCA load factors. It is assumed for this analysis that the proposed loads shown in Tables 1 and 2 do not have operating load factors that are different from their LOCA load factors. The results of runs CS46_362,_364 are summarized below:

CASE	START MOTOR	E BUS VOLTS	MOTOR VOLTS	PERCENT RATED	ACCEL TIME (SEC)
362	SGFP A	382	3434	85.9	4.5
	SGFP B	382	3443	86.1	4.5
363	CWP A	403	3728	93.2	3.3
	AFW A		397	86.3	6.2
	CWP B	405	3738	93.5	3.3
	AFW B		398	86.5	5.8
364	CP A	390	3672	91.8	3.4
	AFW A		384	83.5	7.4
	CP B	391	3685	92.1	3.3
	AFW B		384	83.5	7.0

The acceleration times for the 4kV motors shown above were extrapolated (on linear basis) from the data in Table 3-10 of reference 7.1. The acceleration times for the AFW motors are obtained from attachment S of reference 7.1.

The above indicate that even though the E Bus voltage drops to below the DGVR setting, it stays at this level for a time period less than the minimum relay reset time of 9.5 seconds. Therefore, the DGV relay will not operate to trip the bus incoming breaker during large BOP motor starts.

5.9 Effects of Voltage Transients on 480 V Emergency Bus Circuit Breakers

Table 7, ASDOP Run CS46_202, indicates that the lowest E Bus transient ride through voltages are 405.7 volts for train B and 405.9 volts for train A. Tables 5 and 6 indicate that the longest transient condition is 7.2 seconds (ASDOP Run CS46_203, Train B). This worst case voltage transient will be assumed to be present on the E bus when all E bus

loads are in steady state, run mode. The E bus load currents and main incoming breaker current at the reduced voltage are obtained from ASDOP Runs CS46_365 and CS46_366 (refer to attachment C) and are summarized below:

TRAIN A (RUN CS46_365)		TRAIN B (RUN CS46_366)	
BREAKER	AMPS	BREAKER	AMPS
MAIN	4396	MAIN	4450
MCC 5 & 16	805	MCC 6	486
AFW A	433	AFW B	434
CCW B	394	CCW C	394
CSP A	244	CSP B	244
RHR A	353	RHR B	353
CP B	175	CP C	175
SIP A	494	SIP C	494
SWP A	405	SWP C	423
SWP B	423	SWP D	437
HVH 1	338	HVH 3	336
HVH 2	337	HVH 4	338
		MCC 18	343

The load currents shown above were compared with each load's circuit breaker time-current characteristic curve of reference 7.13. These comparisons revealed that the breakers can tolerate the increased current, not only for the maximum transient duration of 7.2 seconds, but for at least 100 seconds. It should be noted that motor-locked rotor currents at the reduced voltage conditions are less than the locked rotor currents at rated voltage. Thus, since the breakers are set to allow motor starting at rated and maximum voltage conditions, there is no need to analyze motor starting at reduced voltage.

The Service Water Booster Pumps, powered by MCC starters, are protected by a molded case magnetic only circuit breaker in combination with a thermal overload relay. A typical Class 10 (fast acting) thermal overload relay requires approximately 10 seconds to trip at 600 percent of heater trip current rating. Since the increase in current due to the transient voltage discussed above will not approach this value (note that per Runs CS46_365 and CS46_366, the SWBPs are drawing rated current, 142 amps, with the upstream E buses at 405.7 and 405.9 volts), the relay will not trip.

5.10 Minimum Trip Times of Thermal Overload Relays for Safety Related Motors

The thermal overload relay settings for safety related continuous duty motors (MCC 5, 6, 9, 10, 16, 18) were evaluated to determine minimum trip times with the E bus voltages at the minimum DGVR dropout setpoint. The thermal protective devices for other constant kVA loads (e.g., battery chargers, constant voltage transformers) were also reviewed with the degraded voltage condition present. The minimum trip time was

calculated by comparing the adjusted current (rated current adjusted to terminal voltage) to the overload relay time-current characteristic curves included in attachment A (pgs A26 through A30). Per section 3.19, the load terminal voltages will be calculated with the E buses at the proposed minimum drop out setpoint of 425V. Terminal voltages were taken from the VDROP steady state run in attachment C.

The following table summarizes the results of the evaluation and indicates that the existing thermal protective devices (i.e., thermal overload relays, thermal magnetic breakers as applicable) will not cause tripping of the constant kVA loads supplied from these MCCs when minimum expected steady-state voltage is available. Note that per section 3.2 the existing protective devices/settings are evaluated.

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Minimum Trip Times for Safety Related Loads

MCC [1]	CMPT [1]	LOAD DESCRIPTION [1]	CURVE [2]	PROT. DEVICE [3]	OVERLOAD HEATER SET [3]	RATED AMPS [4]	RATED VOLTS [1]	TERMINAL VOLTS [5]	ADJUSTED CURRENT [6]	MINIMUM TRIP TIME (S)
MCC5	01D	EMERGENCY DIESEL AIR COMP. A	PTA 032480	FH37	115	7.1	460	414.9	7.9	∞
MCC5	01F	AIR HANDLING UNIT HVA-2	PTA 032480	FH42	115	11.2	460	411.1	12.5	∞
MCC5	02BL	CONST VOLT XFMR INSTR BUS 1	SC-4135-87	FD3020	-	11.7 [11]	450	403.8	13.0	∞
MCC5	02G	D. G. ROOM EXHAUST FAN HVE-18	PTA 032480	FH44	115	12	460	414.3	13.3	∞
				FH30	115	3.7	460	414.3	4.1	∞
MCC5	02M	EXHAUST FAN HVE-2A	PTA 012485	FH88	115	88	460	413.8	97.8	∞
MCC5	3B	BATTERY CHARGER A-1 (BACK-UP)	SC-4148-87	HFD3125	-	70	480	413.5	81.3	∞
MCC5	03D	DIESEL ROOM SUPPLY FAN HVS-6	PTA 032480	FH52	115	26	460	410.4	29.1	∞
MCC5	03G	BORIC ACID TRANS. PUMP A	PTA 012485	FH81	115	22	460	414.6	24.4	∞
MCC5	03M	CONTROL ROD DRIVE FANS HVH-5A	PTA 012485	FH86	115	73.5	460	410.3	82.4	∞
MCC5	04B	RHR PUMP AREA FAN HVH-8A	PTA 032480	FH41	115	10	460	410.8	11.2	∞
MCC5	04D	CHARCOAL FILTER BOOSTER FAN HVE-5A	PTA 032480	FH36	115	6.3	460	413.5	7.0	∞
MCC5	05J	AUX BLDG SUPPLY FAN HVS-1	PTA 012485	FH83	115	59	460	414.1	65.5	∞
MCC5	05M	INSTRUMENT AIR COMPRESSOR A (URM)	PTA 012485	FH86	115	73.0	440	414.2	77.5	∞
MCC5	06B	IODINE REMOVAL UNIT HVE-3 (URM)	PTA 032480	FH39	115	7.8	460	409.5	8.8	∞
MCC5	06F	SAFETY INJECT. PMP AREA FAN HVH-6A	PTA 032480	FH42	115	11.2	460	413.1	12.5	∞
MCC5	09BR	BATTERY CHARGER A	SC-4148-87	FD3125	-	92	440	412.8	98.1	∞
MCC5A1	01CR	CHARGING PUMP LEAK OFF	[13]	FD3010	-	5.2	440	414.4	5.5	∞
MCC5A2	03C	DIESEL FUEL OIL PUMP A	PTA 032480	FH16	115	0.95	440	415.4	1.0	∞
MCC5A2	04B	AUX FDW P AREA COOL UNIT HVH-7B	PTA 032480	FH38	115	7.2	460	412.6	8.0	∞
MCC5A2	04D	RADIATION MONITOR R-21	PTA 032480	FH30	100	3.4	460	414.3	3.8	∞
MCC6	02D	AUX FDW PUMP AREA FAN HVH-7A	PTA 032480	FH38	115	7.2	460	415.3	8.0	∞

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MCC [1]	CMPT [1]	LOAD DESCRIPTION [1]	CURVE [2]	PROT. DEVICE [3]	OVERLOAD HEATER SET [3]	RATED AMPS [4]	RATED VOLTS [1]	TERMINAL VOLTS [5]	ADJUSTED CURRENT [6]	MINIMUM TRIP TIME (S)
MCC6	02FL	CV XFMR FEEDER TO INST BUS NO 4	SC-4135-87	FD3020	-	11.7 [11]	450	412.4	12.8	∞
MCC6	03B	DIESEL GEN B AIR COMPRESSOR	PTA 032480	FH38	115	7.1	460	411.8	7.9	∞
MCC6	03D	DIESEL RM SUPPLY FAN HVS-5	PTA 032480	FH52	115	26	460	407.3	29.4	∞
MCC6	03G	INSTRUMENT AIR COMPRESSOR B (URM)	PTA 012485	FH83	115	73	460	412.3	81.4	510 [8]
MCC6	03M	EXHAUST FAN HVE-2B	PTA 012485	FH88	115	88	460	414.7	97.6	∞
MCC6	04M	CONTROL ROD DRIVE FANS HVH-5B	PTA 012485	FH85	115	72	460	414.7	79.9	∞
MCC6	05F	SFTY INJ PMP AREA COOL UNIT HVH-6B	PTA 032480	FH43	115	11.2	460	409.3	12.6	∞
MCC6	05H	CHARCOAL FILTER BOOSTER FAN HVE-5B	PTA 032480	FH36	115	6.3	460	414.9	7.0	∞
MCC6	06D	RHR PUMP AREA FAN HVH-8B	PTA 032480	FH40	115	9.3	460	413.7	10.3	∞
MCC6	07F	D.G. RM EXH FAN HVE-17	PTA 032480	FH44	115	12	460	410.1	13.5	∞
				FH30	115	3.3	440	410.1	3.5	∞
MCC6	09C	BORIC ACID TRANS. PMP B	PTA 012485	FH77	115	22	460	415.5	24.4	∞
MCC6	10C	STEAM DRIVEN FWR AUX OIL PP	PTA 032480	FH13	115	0.7	440	416.4	0.7	∞
MCC6	14M	BATTERY CHARGER B-1 (BACK-UP)	SC-4148-87	HFD3125	-	70	480	415.2	80.9	∞
MCC6A	01F	BATTERY CHARGER B	SC-4148-87	FD3125	-	92	440	414.9	97.6	∞
MCC6A	03B	RADIATION MONITOR R-20	PTA 032480	FH30	115	3.4	460	415.0	3.8	∞
MCC6A	03D	EMERG DIESEL FUEL OIL TRANSF PMP B	PTA 032480	FH16	115	0.95	440	415.9	1.0	∞
MCC6A	03F	IODINE REMOVAL UNIT HVE-4 (URM)	PTA 032480	FH38	115	7.0	460	414.0	7.8	∞
MCC9	02B	BATTERY ROOM EXHAUST FAN A HVE-8A	PTA 032480	FH32	115	4.2	208	177.7	4.9	∞
MCC9	02KR	FDR TO PP46 CV XFMR	SC-4137-87	FD3030	-	20.4 [12]	208	178.4	23.8	∞
MCC10	02F	BATTERY RM FAN B (HVE-8B)	PTA 032480	FH32	115	4.2	208	175.5	5.0	∞
MCC10	02BL	FEED TO PP39	SC-4137-87	FD3030	-	20.4 [12]	208	171.3	24.8	∞
MCC16F	02F	HVA-1A	PTA 032480	FH48	115	20	460	415.8	22.1	4500 [10]

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MCC [1]	CMPT [1]	LOAD DESCRIPTION [1]	CURVE [2]	PROT. DEVICE [3]	OVERLOAD HEATER SET [3]	RATED AMPS [4]	RATED VOLTS [1]	TERMINAL VOLTS [5]	ADJUSTED CURRENT [6]	MINIMUM TRIP TIME (S)
MCC16F	03M	SWB A	PTA 032480	FH26 [7]	100	142	460	417.8	156.3	∞
MCC16R	04H	HVE-19A	PTA 032480	FH40	115	9.7	460	417.9	10.7	1000 [9]
MCC16R	04M	WCCU-1A	PTA 012485	FH84	115	69.9	460	417.7	77.0	∞
MCC18F	02F	HVA-1B	PTA 032480	FH48	115	20	460	415.5	22.1	4500 [10]
MCC18F	03M	SWB B	PTA 032480	FH26 [7]	100	142	460	417.4	156.5	∞
MCC18R	04H	HVE-19B	PTA 032480	FH40	115	9.7	460	416.8	10.7	1000 [9]
MCC18R	04M	WCCU-1B	PTA 012485	FH84	115	69.9	460	416.7	77.2	∞

NOTES

[1] From reference 7.14.

[2] See attachment A pgs. A26-A30.

[3] From reference 7.17.

[4] Rated amps from reference 7.14 or measured amps from reference 7.18 (which ever is highest).

[5] Terminal volts are from steady state VDROP run (attachment C) and are based on E1/E2 voltage at 425 volts.

[6] Adjusted current = Rated current x (Rated Volts/Terminal Volts)

[7] Per CWDs sheets 845 and 846 the trip rating for SWB A & B was calculated by multiplying the nominal trip rating of the heater (2.95) times the current transformer rating (300/5) or 2.95 x 60 = 177 amperes.

[8] This compressor cycles (i.e. it is a non-continuous load). It should also be noted that the instrument air compressors are nonessential loads (the instrument air compressors are equipped with under voltage release mechanisms such that these loads are dropped on a loss-of-offsite power.). Therefore, it is not expected that the overload heater will cause tripping of the motor.

[9] Current was based on rated amps. Per reference 7.7, subcalc CPL-EB-202 & 203, the actual current draw would be 5.9 hp/7.5 hp x 11.4A or 8.97 amperes. The overload heater will not trip with this amount of current.

[10] Current was based on rated amps. Per reference 7.7, subcalc CPL-EB-200 & 201, the actual current draw would be 9.4 hp/15 hp x 23.5A at 14.7 amperes. The overload heater will not trip with this amount of current.

[11] Current values for Instrument Bus 1 (MCC5, cmpt 2BL) and Instrument Bus 4 (MCC6, cmpt 2FL) were obtained from Calculation RNP-E-1.003, Rev. 2 .

[12] Per reference 7.2, the enveloping kVA for PP39 and PP46 is 4.25 kVA on the secondary side of the transformer. The primary side current would be [4.25 kVA/ .120V] x 120V/208V = 20.43 amperes.

[13] At this time, there is no breaker curve available for the charging pump leak off breaker. However, per the steady state VDROP run the terminal voltage for this load is 414.4 volts or 90.1% of rated. Per reference 7.18 the current seen by the FD3010 breaker at rated voltage is 5.2 amps. Therefore, at 90.1% terminal voltage the current through this breaker is approximately (5.2 amps)/(0.901) = 5.77 amps. This value of current is well below the 10 amp thermal trip setting of this breaker. Hence, this breaker is not expected to trip given the degraded voltage at the emergency buses.

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6.0 Conclusion

The Degraded Grid Voltage Relay's primary function is to protect safety system loads from sustained undervoltages. This evaluation shows that the proposed setpoints provide adequate protection against sustained undervoltages for continuous duty safety system loads without relying on operator intervention and without spurious separation of the safety system from the preferred source of power. Therefore, the proposed DGVR setpoint changes are acceptable. In addition, the increased DGVR dropout setpoint increases the voltages available at the terminals of safety related motor operated valves. Hence, increasing the torque generated by these motors and improving their ability to operate when required.

7.0 References

7.1 CP&L calculation RNP-E-8.002 R.2 "AC Aux. Electrical Distribution System Voltage/Fault Current Study for H.B. Robinson Unit 2".

7.2 Engineering Evaluation EE107-CS-08 R.1 "Impact Load Changes will Have on As-built Calculations".

7.3 Not used.

7.4 Technical Specification Table 3.5-1.

7.5 Engineering Evaluation EE107-CS-48, R.0 "Evaluation of Increased Service Water Pump Cable Lengths".

7.6 Service Water and Service Water Booster Pump Control Wiring Diagrams B-190628, Sheets 831 (Rev. 14), 832 (Rev. 15), 833 (Rev. 14), 834A (Rev. 11), 834B (Rev. 8), 845 (Rev. 11), and 846 (Rev. 8).

7.7 Calculation RNP-E-7.002, R.3 "Emergency Equipment Load Factor Study".

7.8 Memorandum ASD-R-288, As-Built Load Data Sheets for LDS No. ASD-R-242, Rev. 1.

7.9 Memorandum ASD-R-270, As-Built Load Data Sheets for LDS No. ASD-R-255, Rev. 1.

7.10 Agastat E7000 Series Timing Relay Catalog.

7.11 ABB Instruction Bulletin IB 7.4.1.7-7, Issue D.

7.12 NEMA Standards Publication, No. MG-1 1987 Motors and Generators.

7.13 Calculations RNP-E-2.001 through RNP-E-2.008 and RNP-E-2.010 through RNP-E-2.013, Overcurrent Protection and Coordination Studies for Emergency Bus Breakers.

7.14 B-190627 drawing R.12, "Auxiliary Distribution System Load List and Front Views".

7.15 Drawing CP-380-5379-3238, R.20, "Safeguards System".

7.16 Operating Procedure OP-101 R.21, "RCP Running and Startup Procedures".

7.17 Drawing HBR2-10384, R.0 "Low Voltage Relay Settings".

7.18 CP&L Calculation RNP-E-2.019, R.0 "MCC 5,6,9 and 10 Protective Devices".

7.19 Operating Procedure for Containment Air Handling, OP-921 R.14.

7.20 Operating Procedure for Service Water System, OP-903 R.42.

7.21 EPRI, Power Plant Reference Series, Volume 6 Motors.

7.22 General Arrangement Drawings G190188 R.7 and G190191 R.11, "Reactor Aux. Building".

7.23 Engineering Evaluation EE107-CS-52, R.0 "Battery Room Exhaust Fan Motor Voltage Adequacy".