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License Number NPF-3

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Document Control Desk
Washington, DC 20555-0001

Subject: Davis-Besse Nuclear Power Station
License Amendment Application to Change Design Requirements for Emergency Diesel Generators (License Amendment Request No. 03-0017)

Ladies and Gentlemen:

Pursuant to 10 CFR 50.90, the following amendment is requested for the Davis-Besse Nuclear Power Station, Unit 1 (DBNPS). The proposed amendment would change the facility as described in the DBNPS Updated Safety Analysis Report (USAR) to modify the design requirements for the emergency diesel generators (EDGs). Specifically, the proposed amendment would allow a departure from the regulatory position of Safety Guide 9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," for the frequency and voltage transient during the EDG automatic loading sequence. NRC Regulatory Guide 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," (November 2000) endorses Revision 1 of Nuclear Energy Institute (NEI) 96-07, "Guidelines for 10 CFR 50.59 Implementation," (November 2000) as providing methods acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59. In addressing 10 CFR 50.59(c)(2)(ii), NEI 96-07 provides guidance that a license amendment is required prior to departing from a commitment to an acceptance criteria contained in a Regulatory Guide. The proposed amendment does not involve a change to any Operating License Condition or Technical Specification. Enclosure 1 to this letter contains the technical analysis of the proposed changes and the proposed no significant hazards consideration.

A review of data collected from EDG testing has identified that EDG voltage and frequency dropped below the criteria specified in the USAR during automatic load sequencing. An

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evaluation of the condition determined that it did not affect the operability of the EDGs. This proposed amendment would resolve the EDGs' non-conformance to USAR requirements. Approval of the proposed amendment is requested by October 28, 2004, to support final corrective action for this non-conforming condition. Once approved, the amendment shall be implemented within 120 days.

The proposed changes have been reviewed by the DBNPS onsite review committee and offsite review committee.

Should you have any questions or require additional information, please contact Mr. Gregory A. Dunn, Manager - Regulatory Affairs, at (419) 321-8450.

The statements contained in this submittal, including its associated enclosures and attachments, are true and correct to the best of my knowledge and belief. I am authorized by the FirstEnergy Nuclear Operating Company to make this request. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: May 3, 2004

By: [signature]
Mark B. Bezilla, Vice President - Nuclear

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Enclosures

cc: Regional Administrator, NRC Region III
J. B. Hopkins, NRC/NRR Senior Project Manager
D. J. Shipley, Executive Director, Ohio Emergency Management Agency, State of Ohio (NRC Liaison)
C. S. Thomas, NRC Region III, DB-1 Senior Resident Inspector
Utility Radiological Safety Board

Docket Number 50-346
License Number NPF-3
Serial Number 3006
Enclosure 1

DAVIS-BESSE NUCLEAR POWER STATION
EVALUATION
FOR
LICENSE AMENDMENT REQUEST NUMBER 03-0017

(39 pages follow)

DAVIS-BESSE NUCLEAR POWER STATION
EVALUATION
FOR
LICENSE AMENDMENT REQUEST NUMBER 03-0017

Subject: License Amendment Application to Change Design Requirements for Emergency Diesel Generators

1.0 DESCRIPTION

This is a request to amend the Davis-Besse Nuclear Power Station (DBNPS), Unit Number 1 Facility Operating License Number NPF-3.

NRC Regulatory Guide 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," (November 2000) endorses Revision 1 of Nuclear Energy Institute (NEI) 96-07, "Guidelines for 10 CFR 50.59 Implementation," (November 2000) as providing methods acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59. In addressing 10 CFR 50.59(c)(2)(ii), NEI 96-07 provides guidance that a license amendment is required prior to departing from a commitment to acceptance criteria contained in a Regulatory Guide.

Section 8.3.1.1.4.1, "Emergency Diesel Generators," of the DBNPS Updated Safety Analysis Report (USAR) specifies requirements for Emergency Diesel Generator (EDG) voltage and frequency response during automatic loading. The USAR requirements for EDG voltage and frequency response during loading were derived from Regulatory Position 4 of NRC Safety Guide 9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," which states:

> Each diesel generator set should be capable of starting and accelerating to rated speed, in the required sequence, all the needed engineered safety feature and emergency shutdown loads. At no time during the loading sequence should the frequency and voltage decrease to less than 95 percent of nominal and 75 percent of nominal, respectively. During recovery from transients caused by step load increases or resulting from the disconnection of the largest single load, the speed of the diesel generator set should not exceed 75 percent of the difference between nominal speed and the overspeed trip set point or 115 percent of nominal, whichever is lower. Voltage should be restored to within 10 percent of nominal and frequency should be restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval.

The USAR provides an allowed exception from this regulatory position by stating that there may be a voltage dip below 75 percent of normal lasting for a few cycles during the first step in the required loading sequence due to the essential unit substation transformer excitation inrush. A review of data collected from Emergency Diesel Generator (EDG) testing has identified that EDG voltage and frequency did not meet the criteria specified in the USAR and in Safety Guide 9 during the first step of automatic load sequencing for a loss of offsite power (LOOP) with a Safety Features Actuation System (SFAS) signal present. Analysis has identified that the criteria specified in the USAR and in Safety Guide 9 are also not met for the steps in the automatic loading sequence following a LOOP-only without an SFAS signal present. This proposed amendment would resolve the EDGs' non-conformance to the USAR description. The proposed amendment would change the facility as described in the USAR to modify the design requirements for the EDGs related to the voltage and frequency response during the EDG loading sequence. The proposed amendment would allow a departure from the regulatory position of Safety Guide 9 for the frequency and voltage transient during the EDG automatic loading sequence. The proposed amendment does not involve a change to any condition of the Operating License or to any Technical Specification.

2.0 PROPOSED CHANGE

The proposed amendment would change the facility as described in the USAR to modify the design requirements for the emergency diesel generators. The proposed changes are shown on the marked-up USAR pages in Attachment 1. The proposed changes affect USAR Sections 3D.2.9, "Safety Guide 9 - 'Selection of Diesel Generator Set Capacity for Standby Power Supplies' (March 1971);" 8.1.5, "Design Bases;" and 8.3.1.1.4.1, "Emergency Diesel Generators."

The proposed changes would:

- Modify the existing exception to Safety Guide 9 for the frequency and voltage requirements of Regulatory Position 4 for the first step in the automatic loading sequence following a LOOP with an SFAS signal present. Specifically, the proposed change would allow a frequency dip to less than 95 percent of nominal and a voltage dip to less than 75 percent of nominal during the first step of the loading sequence.
- Modify the existing exception to Safety Guide 9 for the frequency and voltage requirements of Regulatory Position 4 for the first and second steps in the automatic loading sequence following a LOOP-only without an SFAS signal present. Specifically, the proposed change would allow a frequency dip to less than 95 percent of nominal and a voltage dip to less than 75 percent of nominal during the first and second steps of the loading sequence.
- Specify the calculated largest voltage and frequency dip exceeding the Safety Guide 9 criteria for which the EDGs and onsite power system have been evaluated.
- Explicitly incorporate part of Regulatory Position 4 of Safety Guide 9 into the USAR. The USAR will be revised to specifically require that voltage be restored to within 10 percent of nominal and frequency be restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval.

The revisions to the USAR text are discussed below.

<u>USAR Section 3D.2.9, "Safety Guide 9 - 'Selection of Diesel Generator Set Capacity for Standby Power Supplies' (March 1971)"</u>

USAR Section 3D.2.9 states:

> This system electrical design as described in Subsection 8.3.1.1.4.1 incorporates the requirements of this Safety Guide.

The proposed change would revise this section to state:

> This system electrical design as described in Subsection 8.3.1.1.4.1 incorporates the requirements of this Safety Guide except as noted in Subsection 8.3.1.1.4.1.

USAR Section 8.1.5, "Design Bases"

USAR Section 8.1.5 states, in part:

> The design documents that are implemented in the design of the electrical systems are listed below:

Document No.	Title	Approval Date
.		
.		
Safety Guide 9	Selection of Diesel Generator Set Capacity for Standby Power Supplies	3-10-71

USAR Section 8.1.5 would be revised to add a note that modifies the Safety Guide 9 entry in the table. The note would state, "Except as noted in Section 8.3.1.1.4.1."

USAR Section 8.3.1.1.4.1, "Emergency Diesel Generators"

USAR Section 8.3.1.1.4.1 states, in part:

> Each of the two emergency diesel generators has the capability to:
>
> .
>
> .
>
> b. Start and accelerate to rated speed in the required sequence its dedicated dedicated [sic] engineered safety features loads. At no time during the loading sequence, will the frequency and voltage decrease to less than 95 percent of nominal and 75 percent of nominal, respectively, except that during the first step in the required loading sequence, there may be a voltage dip below 75 percent of normal lasting for a few cycles due to the essential unit substation transformer excitation inrush.

This text would be revised to state:

> b. Start and accelerate to rated speed in the required sequence its dedicated engineered safety features loads. At no time during the loading sequence, will the frequency and voltage decrease to less than 95 percent of nominal and 75 percent of nominal, respectively, except that during the first step in the loading sequence with an SFAS signal present and during the steps in the loading sequence without an SFAS signal present, there may be a voltage dip and a frequency dip below these levels. This is an exception to Safety Guide 9. It has been determined that voltage could dip as low as 59% of nominal and frequency could dip as low as 88% of nominal during the first step in the loading sequence with an SFAS signal present. For the loss of offsite power only case, it has been determined that voltage could dip as low as 70% of nominal and frequency as low as 90% of nominal during the first load step, and the voltage could dip as low as 69% of nominal for the second load step. Voltage will be

> restored to within 10 percent of nominal and frequency will be restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval.

USAR Section 8.3.1.1.4.1 further states:

> The generator reactances, excitation system, and regulator response time are such that adequate voltage is provided to meet automatic loading requirements in accordance with AEC Safety Guide 9.

This sentence would be revised to state:

> The generator reactances, excitation system, and regulator response time are such that adequate voltage is provided to meet automatic loading requirements in accordance with AEC Safety Guide 9, except as noted above.

Summary

In summary, the proposed amendment would allow a change to the facility as described in the DBNPS Updated Safety Analysis Report (USAR) to modify the design requirements for the emergency diesel generators (EDGs). The proposed amendment would allow a departure from the regulatory position of Safety Guide 9 for the frequency and voltage transient during the EDG automatic loading sequences. The proposed amendment does not involve a change to any Operating License Condition or Technical Specification.

3.0 BACKGROUND

A review of data collected from Emergency Diesel Generator (EDG) testing has identified that EDG voltage and frequency dropped below the criteria specified in the USAR and in Safety Guide 9 during the first step of automatic load sequencing for a loss of offsite power (LOOP) with a Safety Features Actuation System (SFAS) signal present. Analyses have identified that the criteria specified in the USAR and in Safety Guide 9 are not met for the steps in the automatic loading sequence following a LOOP either with or without an SFAS signal present. These conditions were entered into the DBNPS Corrective Action Program. This proposed amendment would resolve the EDGs' non-conformance to USAR requirements by modifying the USAR to accept the identified EDG condition as-is. In addition to this proposed amendment, other corrective actions to improve the EDG voltage and frequency response are being considered. These include (1) upgrading the existing static exciter and voltage regulator, (2) adding a frequency interlock as a closure permissive of the EDG output breaker or incorporating a time delay to the existing voltage interlock, (3) moving loads from SFAS load step 1 to other load steps, (4) upgrading the existing governor control system, and (5) delaying briefly the start of the service water pump or component cooling water pump following a LOOP-only.

The emergency diesel generators are part of the onsite electrical power systems. The onsite power systems are described in USAR Section 8.3, "Onsite Power Systems." The onsite electrical distribution systems include the 13.8 kV, the 4160 V, and low voltage distribution systems.

Two redundant emergency diesel generator units, one connected to each of two essential 4160 V busses, are provided as onsite standby power sources to supply their respective essential busses upon loss of the normal and the reserve power sources. As required by procedure, the minimum indicated voltage setpoint for the EDG voltage regulators is 4200 V. For the purposes of this evaluation, this is considered to be nominal voltage. The nominal speed for the EDGs is 900 rpm, which corresponds to a nominal frequency of 60 Hz. Essential bus load shedding and isolation, bus transfer to the emergency diesel generator, and pickup of critical loads is automatic.

If loss of offsite power is confirmed, by loss of voltage at either essential 4160 V bus (i.e., the bus voltage drops below the undervoltage setpoint for a time period greater than the time delay setpoint), the following will occur:

1. Bus load breakers on the affected bus, except the breakers supplying power to the 480V essential unit substation supply breakers, makeup pump breakers, and component cooling pump breakers, will be tripped.
2. Both source breakers will be tripped and the bus will be isolated.
3. The associated emergency diesel generator set will be started, if not already running.
4. When the emergency diesel generator reaches approximately 95 percent of its nominal voltage, the corresponding emergency diesel generator breaker will close, energizing the 4160 V and 480 V essential busses.

5a. In case the safety features actuation system (SFAS) has been tripped, the engineered safety features loads will be automatically energized according to the predetermined loading sequence. The automatic loading sequence for the case where an SFAS signal is present consists of five load steps in five-second intervals.

5b. In case the SFAS has not been tripped, the emergency diesel will be loaded manually; except that in any case, the previously running component cooling water pumps, previously running makeup pump, and the essential 480 V busses will be started/energized as soon as the EDG output breaker closes. In addition, the component cooling water pump in standby, and the service water pumps will start at approximately 21 seconds following EDG output breaker closure.

4.0 TECHNICAL ANALYSIS

4.1 Affected Design Functions

The proposed change affects the design requirements for the EDGs. The effects of the proposed change on the capability of the EDGs, the onsite electric power system, and essentially powered equipment to perform their required safety functions have been evaluated. The design basis function of the EDGs can be stated as follows:

> In the event normal onsite ac power sources and offsite circuits are lost, the emergency diesel generators shall provide a source of electric power to essential loads to ensure that

> the specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. Following a loss-of-coolant accident, the emergency diesel generators shall be available to ensure that core cooling, containment vessel integrity, and other essential safety functions are maintained.

The design basis function of the onsite power system can be stated as follows:

> The onsite electric power system, assuming a loss of offsite power, shall provide sufficient capacity and capability to provide a source of electric power to essential loads to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

The EDGs and onsite power system provide a support function to equipment that perform the following essential station functions: (1) Emergency Core Cooling, (2) Containment Cooling, (3) Containment Isolation, (4) Emergency Ventilation, (5) Safe Shutdown, and (6) Containment Vessel Combustible Gas Control.

4.2 EDG Frequency and Voltage Transient Response

Automatic starting and loading of an EDG occurs when a loss of voltage is detected on its corresponding essential 4160 V bus. The automatic loading sequence varies depending on the presence or absence of a safety features actuation system (SFAS) signal. Analyses of the EDG voltage and frequency response were performed for the Loss of Offsite Power (LOOP) coincident with a Loss of Coolant Accident (LOCA) and for LOOP-only (no LOCA).

Transient analysis computer models of the DBNPS EDGs and loads for the LOOP concurrent with LOCA (LOOP/LOCA) and LOOP-only loading sequences were developed using MATLAB and Simulink. These modeled the diesel engine, the engine speed control governor and actuator, the generator and excitation system, and the 4160 V and 480 V loads that are automatically connected to the EDG during each scenario. Verification of the model was performed by comparing the model results to known surveillance test results. This model was used to develop the bounding voltage and frequency responses for the EDGs. The summary of the voltage and frequency responses are shown in Table 1 for the LOOP/LOCA and in Table 2 for the LOOP-only scenario.

As shown in Table 1, at no time during the LOOP/LOCA loading sequence, except during Load Step 1, does the generator frequency or voltage decrease to less than 95 percent of nominal or 75 percent of nominal, respectively. This Safety Guide 9 requirement is met for all load steps in the LOOP/LOCA sequence except for Load Step 1.

Table 1. Bounding Model Results for the LOOP/LOCA Case

Parameter	Load Step				
	1	2	3	4	5
Minimum Resulting Voltage, V	2500	3357	3580	3296	3714
75% of Nominal Voltage	3150	3150	3150	3150	3150
Time to Recover to 90% Nominal Voltage, sec	1.4	1.4	0.7	1.3	0.3
Minimum Frequency, Hz	52.9	58.9	59.4	58.6	59.2
95% of Nominal Frequency	57	57	57	57	57
Time to Recover to 98% Nominal Frequency, sec	1.8	N/A	N/A	0.3	N/A

Notes:

1. Model voltage results based on: (a) nominal voltage of 4200 V, which is the minimum allowable voltage set point based on Davis-Besse Systems Procedure DB-OP-06316, "Diesel Generator Operating Procedure," Rev. 11 and (b) voltage at breaker closure of approximately 3952 V.
2. Based on nominal voltage of 4200 V, 75 percent nominal is 3150 V and 90 percent nominal is 3780 V.
3. Model frequency results based on: (a) nominal frequency of 60 Hz, which is the nominal frequency set point given in Davis-Besse Systems Procedure DB-OP-06316 and (b) frequency at breaker closure of approximately 56.3 Hz, based on the SFAS test results for EDG-1 and EDG-2.
4. Based on nominal frequency of 60 Hz, 95 percent nominal is 57 Hz and 98 percent nominal is 58.8 Hz.

As shown in Table 2, for Load Step 1 of the LOOP-only sequence, the generator frequency and voltage decrease to less than 95 percent of nominal and 75 percent of nominal, respectively. For Load Step 2 of the LOOP-only sequence, the generator voltage decreases to less than 75 percent of nominal.

Table 2. Bounding Model Results for the LOOP-Only Case

Parameter	Load Step	
	1	2
Minimum Resulting Voltage, V	2950	2907
75% of Nominal Voltage	3150	3150
Time to Recover to 90% Nominal Voltage, sec	1.1	1.7
Minimum Frequency, Hz	54.1	58.0
95% of Nominal Frequency	57	57
Time to Recover to 98% Nominal Frequency, sec	1.5	1.0

For both the LOOP/LOCA and LOOP-only sequences, voltage is restored to within 10 percent of nominal and frequency is restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval. This Safety Guide 9 requirement is met for all load steps. No other Safety Guide 9 or DBNPS USAR requirements are affected by the proposed change. Therefore, the evaluations that follow, except those in Section 4.7, are limited to the effects of the frequency and voltage dips during Load Step 1 of the LOOP/LOCA sequence and both load steps of the LOOP-only sequence.

4.3 Effects on Emergency Diesel Generators

The EDGs are not adversely affected by the momentary voltage and frequency dips below USAR criteria that occur during automatic load sequencing. By design, the equipment operates at reduced frequency and voltage for short periods during each start. The generator field is excited (flashed) at 400 rpm (~27 Hertz). After the field is flashed, the EDG takes approximately three to four seconds to reach rated speed, i.e., 900 rpm (60 Hertz). Throughout the acceleration from 400 to 900 rpm, the generator and excitation system are operating at reduced voltage and frequency on the generator armature (stator) winding. In addition, SFAS testing has demonstrated that the engine, governor, and generator and excitation system are capable of operating reliably with the reduced voltage and frequency below nominal for momentary periods. A more detailed discussion for the excitation and voltage regulating system and governor control is provided below.

4.3.1 Excitation and Voltage Regulating System

Each EDG is provided with a solid state excitation and voltage regulating system of the saturable current potential transformer type. The exciter is of the static type having fast response characteristics and reliability for allowing the startup of a heavy load in parallel with a running load. The voltage regulator is a static type with silicon type rectifiers and provides the necessary excitation control to maintain the adjusted generator voltage with the generator operating at loads ranging from zero up to and including its overload capacity at rated power factor and frequency.

The components of the excitation and voltage regulating system have been evaluated for the momentary voltage dip during EDG loading. The momentary voltage dip below the Safety Guide 9 criteria does not prevent the excitation and voltage regulating system from performing its safety function. Relaying and other components required for successful automatic loading of the EDG are not prevented from performing their required functions by the low voltage condition.

The components of the excitation and voltage regulating system have been evaluated for the momentary frequency dip during EDG loading. The low frequency condition does not detract from the voltage regulator's ability to produce maximum signals for excitation, since it attempts to raise voltage, regardless of frequency, throughout the transient. In addition, the low frequency condition will not damage or adversely affect the voltage regulator and excitation system.

As discussed above, the momentary voltage and frequency dips during automatic EDG loading do not prevent the excitation and voltage regulating system from performing its safety function. Furthermore, the capability of the excitation and voltage regulating system to perform acceptably has been demonstrated by satisfactory completion of testing in accordance with Technical Specification Surveillance Requirement 4.8.1.1.2.d.2. Therefore, the impact of the proposed change to the EDG design requirements on the EDG excitation and voltage regulating system is acceptable.

4.3.2 Governor Control

Each EDG is provided with a Woodward EGB-13C governor/actuator with a Woodward EGA electronic controller to control the speed of the engine.

The components of the governor control have been evaluated for the momentary voltage dip during EDG loading. As the voltage to the EGA controller is reduced so is the output of its power supply, which is a zener diode clamped power supply, +18Vdc / -18Vdc. This will have no effect on the operation of the control because both positive and negative voltage supplies decrease and increase together. The low voltage condition is also sensed by the load sensor. However, during automatic load sequencing, the EDG operates in single-unit-isochronous mode. The load sensor is not active in the single-unit-isochronous mode. Therefore, the low voltage condition will not affect the load sensor. The low voltage condition does not damage or adversely affect any components in the EGA controller circuitry because high electrical stresses are not imposed by this condition.

The components of the governor control have been evaluated for the momentary frequency dip during EDG loading. The low frequency condition is sensed by the speed sensing circuit (in this device frequency is analogous to speed). This signal causes an upset to the summing junction in the EGA control circuit. As speed increases to the desired value, the summing junction is satisfied and speed is controlled to the set point (nominally 900 RPM). The low frequency condition does not adversely affect either this circuit, as its function is to control frequency (or speed), or any control components.

As discussed above, the momentary voltage and frequency dips during automatic EDG loading do not prevent the EDG governor from performing its safety function. Furthermore, the capability of the governor to perform acceptably has been demonstrated by satisfactory completion of testing in accordance with Technical Specification Surveillance Requirement 4.8.1.1.2.d.2 (simulation of a LOOP in conjunction with a SFAS test signal). Therefore, the impact of the proposed change to the EDG design requirements on the EDG governor is acceptable.

4.4 Effect on Connected Loads

Loads that may be powered by an EDG during a LOOP/LOCA or LOOP-only scenario are documented in DBNPS Calculation C-EE-015.03-008, Rev. 3, "AC Power Distribution System Analysis – Electrical Transient Analysis Program." The essential loads include heaters, motors, battery chargers, and rectifiers. These connected loads will not be damaged from the brief voltage and frequency dips because of their short duration. Each of these load types is discussed below.

4.4.1 Heaters

Heaters are resistive loads, which draw less current with lower voltages. While they will be less effective for the short duration at reduced voltage, there will be no damage. Since these loads are resistive, the low frequency will have no adverse effect on the equipment. Therefore, the impact of the proposed change to the EDG design requirements on the essentially powered heaters is acceptable.

4.4.2 Motors

While the voltage and frequency dips will result in reduced performance, there will be no damage to the motors. Induction motors with a fixed resistance rotor have a starting current which varies directly with the impressed voltage (Reference "American Electricians Handbook", Eleventh Edition, McGraw Hill, Section 7-150). The voltage dips will cause reduced current so a current overload is not a concern. If the voltage did not recover relatively quickly (i.e., within about two seconds) and the motors failed to accelerate, this would expose the motors to extended periods of starting currents, which could be of concern. However, this is not a concern for the following reasons: (a) for the worst case dip, the voltage recovers to 90 percent (3780 V) of its nominal value (4200 V) within approximately 1.7 seconds so the start of essential motors is not significantly delayed and (b) the essential motors were designed to start with a reduced voltage of 70% of nominal. The effect of the slight delay in motor acceleration on the performance of essential load safety functions is addressed in Section 4.7.

The essential motors were designed to start at 70 percent of nominal voltage. The essential motors also were designed so that they will not stall (i.e., will "ride through") during momentary voltage dips provided that their terminal voltage is greater than 65 percent of nominal voltage.

The momentary frequency dips will not cause any damage to the motors. If the frequency did not recover relatively quickly (i.e., within about two seconds) the steady-state rotational speed of the motor would be decreased, which could impact the ability of the driven load to perform its safety function. However, the frequency recovers quickly, i.e., within two seconds. Therefore, the steady-state operating speed of the motors will not be adversely affected. The impact of the proposed change to the EDG design requirements on the EDG essentially powered motors is acceptable. The effect of the slight delay in motor acceleration on the performance of essential load safety functions is addressed in Section 4.7 of this document.

The historical reliability of the Component Cooling Water pump motors was examined to determine if the reduced voltage and frequency condition during surveillance testing had resulted in premature aging of the motors. This review identified no premature aging of the equipment.

4.4.3 Battery Chargers

If there is a loss of voltage, a relay contact in the input to the charger will open, protecting the battery charger. When the voltage is restored the battery charger will recover, closing this relay contact. The batteries will supply the required DC for the period when the battery charger is unavailable.

The frequency dips occur at the same time as the voltage dips and the battery may be supplying loads at this time. Frequency dips alone are unlikely to reduce charger output requiring the battery to carry any of the load, and no long term adverse effect is expected on the charger due to these frequency dips. This is because the charger components, including regulator boards, power electronics, and filter capacitors, would typically be the same if these chargers were designed for sustained 50 Hz operation. The charger power transformers may have increased heating due to sustained low frequency operation, however, the short duration of the dips would result in a negligible change in transformer temperature. The impact of the proposed change to the EDG design requirements on the battery chargers is acceptable.

4.4.4 Rectifiers

The rectifiers are very similar in design to the chargers. No damage to the rectifiers is expected from the minor dips in voltage and frequency because if the input AC voltage dips sufficiently, the DC feed from the battery charger or batteries will take over. The rectifiers will carry the load as soon as the voltage recovers. For the worst case duration of the voltage dip, the EDG voltage recovers to 90 percent (3780 V) of its nominal value (4200 V) within approximately 1.7 seconds. The impact of the proposed change to the EDG design requirements on the rectifiers is acceptable.

4.5 Effect on Protective Relays

The relays that are active during EDG emergency starting and loading were evaluated to ensure that sufficient margin exists in the relay settings to enable them to function as designed and that the relays will not inadvertently operate due to the voltage and frequency response of the EDGs during automatic load sequencing.

In general, protective relay setting criteria provide sufficient margin to allow for expected voltage and current variations to prevent nuisance tripping. The EDG transient loading calculation shows the bus voltage dips below the rated starting voltage of the motors during the first load step of the LOOP/LOCA scenario for a short period. In evaluating the protective relays that respond to voltage and current, it was assumed conservatively that the essential motors would stall during the period the voltage dips below 90% of nominal voltage. The calculation also shows, however, that the voltage recovers quickly and the motor terminal voltages will rise to a value that will enable them to start within the remaining duration of the load step.

During the first step in a loading sequence, the EDG will initially see no load followed by sudden application of motor loads plus non-motor and static loads. The motor loads represent the dominant load in this case. Motor loads appear as a constant impedance to the system upon starting. Thus, as the voltage drops, the individual motor starting currents and the total motor starting current drop proportionally. The overcurrent relays have inverse time-current characteristics. Thus as voltage goes down, the relay response time increases. This has a compensating effect that helps the overcurrent relays allow for the voltage dip and motor starting condition. Relays that respond to voltage were evaluated to verify either the voltage setpoint will not be exceeded, or if exceeded, that sufficient time delay will exist so they will not operate due to the transient.

While protective relay setting criteria allow for expected variations in voltage and current, they generally assume normal frequency variations in the power system will be within a range of ± 5 percent of nominal, or 57 to 63 Hz. The frequency during Load Step 1 of the LOOP/LOCA case is below 57 Hz for approximately 1.1 seconds with a minimum calculated value of 52.9 Hz. Therefore, this evaluation addresses the potential effects of this momentary reduced frequency on the relays and the instrument transformers that supply the AC signals to the relays.

The EDG has numerous relays which provide protection of the EDG during testing. However, during emergency operation (i.e., a loss of essential bus voltage or an SFAS level 2), controls limit the EDG trips to the generator differential relay (87/DG) and engine overspeed trip relay. The voltage-controlled time overcurrent relay (51V-2) is also not bypassed and will trip the EDG output breaker due to fault on the essential bus. The evaluation below includes only those relays that are not bypassed during emergency operation of the EDG.

4.5.1 4160 V Protective Relays and Instrument Transformers

4.5.1.1 Potential Transformers (PTs)

PT ratio and accuracy are impacted by three main factors that are affected by voltage and frequency variations: flux density, excitation current, and series impedance. Flux density in a transformer is directly proportional to the Volts per Hertz (V/Hz) ratio. During the EDG voltage and frequency dips, the V/Hz ratio will be less than normal, resulting in lower than normal flux density. Excitation current will also be lower than normal because both flux density and the applied voltage will be lower than normal. In addition, the series reactance of the transformer (and the total reactance of connected inductive loads) will be less than normal at the lower frequencies. The net effect is that the PT secondary voltage may be slightly higher for the given primary voltage during the dip than it would be at the normal 60 Hz values of PT flux density, excitation current, and series impedance. Thus, 4160 V undervoltage relays will not see voltages lower than expected at 60 Hz at their input terminals due to the reduced frequency effects on the PT circuits.

4.5.1.2 Current Transformers (CTs)

CT ratio and accuracy will not be affected by the reduced voltages, since CTs measure current only. At lower frequencies, the core flux density of CTs used for relaying are higher than at 60 Hz for a fixed level of primary current, resulting in higher than normal excitation current and some additional error in the CT secondary current. However, CTs used for relaying are designed to provide acceptable performance and accuracy over a very wide range of currents, from normal levels through maximum calculated fault levels. In this case, the CT primary currents will be less during the voltage dip than if normal voltages were applied and much less than during fault conditions. Also, at the reduced frequency, the reactance of the CT conductors and connected inductive loads will be less, reducing the CT load burden somewhat. The net effect is an acceptable CT error during the momentary dip that will not impact the performance of the 4160 V relays that respond to current.

4.5.1.3 Induction Disk Overcurrent Relays

All 4160 V relays discussed below, including the voltage-controlled time overcurrent relay, are electromechanical induction disk type with inverse time-current characteristics. Studies by the protective relay industry indicate that the pickup of induction disk type overcurrent relays is relatively flat from 60 Hz down to approximately 50 Hz and then increases at lower frequencies. Therefore, the momentary frequency dip during Load Step 1 of either sequence will have no significant impact on the performance of the 4160 V overcurrent relays. The effects of the voltage dip are addressed below for each overcurrent relay. The discussion below refers to Train 1 (C Bus) components. Effects on Train 2 (D Bus) components have been evaluated and are similar to those on Train 1.

Relay 87DG: This is the EDG differential protection relay (ABB Model SA-1) which is operated by the differential current between the generator line side and the ground side. Voltage changes in the range of voltages evaluated here will not have any adverse effect on the amount of differential current. The differential relay does not have any voltage input from the generator output. Accordingly, there is no impact from the voltage dip. The frequency response curve shows that the SA-1 relay becomes less sensitive at frequencies below 60 Hz, so there is no adverse impact from the frequency dip. Therefore, the EDG differential protection relay will not misoperate during EDG load sequencing. (Reference Calculation C-EE-024.01-002).

Relay 51V-2/DG: This is a type COV-9 voltage-controlled time overcurrent (phase overcurrent) relay that provides backup protection for the generator and system from damage due to phase faults that are not cleared by primary relays and associated breakers. The relay has a voltage controlled overcurrent unit set to begin timing when voltage drops below 2800 V primary (that is, 80 V secondary). (Reference Calculation C-EE-024.01-002).

During Load Step 1 of the LOOP/LOCA load sequencing, the EDG transient loading calculation shows that the minimum voltage dip at the 4160 V Essential Bus is 2500 V with recovery to 3780 V (90% of nominal voltage) in 1.4 seconds. These calculations also show that the maximum current during Step 1 is less than 900 A. Conservatively assuming the voltage remained at the minimum value of 2500 V for 1.5 seconds, the 51V-2/DG relay operate time at 900 A would be 16 seconds which yields a minimum relay operating margin of 14.5 seconds. For Steps 2 – 5 of the LOOP/LOCA sequence and both steps of the LOOP-only sequence, the worst case voltage dip is 2907 V which is above the relay voltage setpoint (2800 V). Therefore, the 51V-2/DG relay will not inadvertently trip during EDG load sequencing. (Reference Calculation C-EE-024.01-002).

Relay 50/51 on Breaker AC1CE11 (AC1CE12): The 4160 V feeder breaker to 4160/480V Transformer CE1-1 (CE1-2) has type CO-11 phase overcurrent relays with a long time delay trip unit and a short time delay trip unit. The relay setpoints were based on conservative load assumptions to ensure there will be no nuisance trips during expected starting and steady state conditions.

A review of the relay setpoint calculations shows that the minimum margin between the relay time-current curve and the calculated starting current (demand load) profile is approximately 9 seconds. This starting load profile assumes the motors have adequate voltage to begin accelerating immediately. However, the EDG dynamic calculations show that for a worst case voltage dip at the 4160 V bus of 2500 V (Step 1), the voltage at the motor terminals will be <70% of rated motor starting voltage. For conservatism, the motors were assumed to be completely stalled for 1.5 seconds. This effectively adds 1.5 seconds to the starting load profile durations. The EDG transient loading calculation shows the bus voltage will rise above 4160 V within this time and remain above 4160 V for the duration of Step 1. Thus, the minimum margin between the relay time-current curve and the calculated starting current (demand load) profile in the relay calculation would be 9 – 1.5 = 7.5 seconds. Furthermore, additional margin is assured because the starting demand load profile assumed in the relay calculation is conservative when compared to the estimated starting demand load profile for EDG load sequencing (see discussion for Breaker BCE11/BCE12 below). Therefore, Breaker ACE11 (ACE12) phase overcurrent relays will not inadvertently trip due to the EDG load sequencing. (Reference Calculations C-EE-004.01-038 and C-EE-004.01-039).

<u>Relay 50/51 on Breaker AC113 (AC108)</u> Breaker AC113 (AC108) for Component Cooling Water (CCW) Pump MP0431 (MP0433) has COM-5 phase overcurrent relays with three units: a CO(51) time - overcurrent unit which alarms at 1.25 to 1.5 times full load amps, a ITH(50) high dropout instantaneous unit set at 2 to 3 times full load amps and a IIT(50) instantaneous trip unit set at 2 times locked rotor amps. For the breaker to trip, both the CO(51) and ITH(50) must trip or the IIT(50) trip.

For a worst case voltage dip at the 4160 V bus of 2500 V (Step 1 of LOOP/LOCA sequence), the voltage at the motor terminals will be less than 70 percent of rated motor starting voltage. For conservatism, the motor was assumed to be completely stalled for 1.5 seconds. The EDG transient loading calculation shows the bus voltage will rise to greater than 4160 V within this time and remain above 4160 V for the duration of Step 1. Thus, motor voltage will remain above rated terminal voltage for the remainder of Step 1 (approximately 3.5 seconds). Average voltage, and hence, motor starting current, will be between 100 percent and 110 percent of rated motor voltage for this period. At 100 percent of rated voltage or higher, the motor will accelerate to rated speed within 2 seconds based on the motor starting curves. Thus, total CCW Pump motor starting time for Step 1 should be ≤ 3.5 seconds. At 100 percent of rated starting current (332 A) for the motor, the relay operating time is approximately 8.4 seconds. At 110 percent of rated starting current (1.1 x 332 A = 365 A), the relay operating time is approximately 8 seconds. This yields a worst case relay operating time margin of 4.5 seconds (8 – 3.5 seconds). Therefore, CCW Pump motor phase overcurrent relays will not inadvertently trip due to the EDG load sequencing. (Reference Calculations C-EE-004.01-005 and C-EE-004.01-007) For Load Step 2 of the LOOP-only case, the voltage will not drop below 70% of the CCW pump motor namplate voltage.

<u>Breaker AC105</u>: Breaker AC105 for Make-Up Pump Motor MP371A has a COM-5 overcurrent relay with three units: a CO(51) time - overcurrent unit which alarms at 1.25 to 1.5 times full load amps, a ITH(50) high dropout instantaneous unit set at 2 to 3 times full load amps and a IIT(50) instantaneous trip unit set at 2 times locked rotor amps. For the breaker to trip both the CO(51) and ITH(50) must trip or the IIT(50) trip. Using the same approach as for the CCW Pump motor phase overcurrent relays:

> For a worst case voltage dip at the 4160 V bus of 2500 V (Step 1 of the LOOP/LOCA sequence), the voltage at the motor terminals will be less than 80 percent of rated motor starting voltage. For conservatism, the motor was assumed to be completely stalled for 1.5 seconds. The EDG transient loading calculation shows the bus voltage will rise to greater than 4160 V within this time and remain above 4160 V for the duration of Step 1. Thus, motor voltage will remain above rated terminal voltage for the remainder of Load Step 1 (approximately 3.5 seconds). Average voltage, and hence, motor starting current, will be between 100 percent and 110 percent of rated motor voltage for this period. At 100 percent voltage or higher, the motor will accelerate to rated speed within 1 second based on the motor starting curves. Thus, total Make-Up Pump motor starting time for Step 1 should be ≤ 2.5 seconds. At 100 percent of rated starting current (336 A) for the motor, the relay operating time is approximately 5.4 seconds. At 110 percent of rated starting current (1.1 x 336 A = 370 A), the relay operating time is approximately 5.2 seconds. This yields a worst case relay operating time margin of approximately 2.7

seconds. Therefore, Make-Up Pump motor phase overcurrent relays will not inadvertently trip due to EDG load sequencing. (Reference Calculation C-EE-004.01-013)

Breaker AC107 (AC109): Breaker AC107 (AC109) for Service Water Pump Motor MP0031 (MP0033) has a COM-5 overcurrent relay with three units: a CO(51) time - overcurrent unit which alarms at 1.25 to 1.5 times full load amps, a ITH(50) high dropout instantaneous unit set at 2 to 3 times full load amps and a IIT(50) instantaneous trip unit set at 2 times locked rotor amps. For the breaker to trip, both the CO(51) and ITH(50) must trip or the IIT(50) trip.

The SW pump does not start until Load Step 4 of the LOOP/LOCA sequence and Load Step 2 of the LOOP-only sequence, so it does not see the voltage dip during the first load steps. For the remaining load steps, the voltage does not drop below 70 percent of the motor nameplate voltage. The margins for motor starting between 70 percent and 100 percent terminal voltage are addressed in the existing phase overcurrent relay calculations and are adequate. Therefore, SW Pump motor phase overcurrent relays will not inadvertently trip during EDG load sequencing. (Reference Calculations C-EE-004.01-001 and C-EE-004.01-003)

The same reasoning applies to Breakers AC111 for HPI Pump Motor MP0581 and AC112 for the Decay Heat Pump Motor MP0421. These pumps start in Load Steps 2 and 3 of the LOOP/LOCA Sequence, respectively. (Reference Calculations C-EE-004.01-009 and C-EE-004.01-011) For these and subsequent load steps, the voltage does not drop below 70 percent of the motor nameplate voltage. These pumps do not start during the LOOP-only sequence.

50GS Ground Fault Relays: A number of 50GS ground fault relays are used in the 4160 V power system. No ground faults are postulated to occur as a result of these voltage and frequency dips and the dips will not be misinterpreted by the relays as a ground fault. Therefore, no inadvertent operations of the 50GS relays will occur.

59% Undervoltage Relay 27C1. The 59% undervoltage relays are solid state relays of type ABB27N. The analytical limit for relay dropout was selected as the minimum voltage calculated for the design basis LOOP/LOCA loading sequence (i.e., 2500 V during the first load step). The maximum allowable pickup set point was then determined, accounting for measurement uncertainty and drift.

The ABB27N undervoltage relay is dual rated for both 50 Hz and 60 Hz applications. However, the relay is normally calibrated using a 60 Hz test source for use on a 60 Hz system. The potential for the relay to inadvertently operate during the Load Step 1 frequency dips was evaluated. FENOC and ABB performed independent tests on two different ABB27N relays to check the relay performance at frequencies between 50 and 60 Hz after being calibrated at 60 Hz. The tests yielded similar results that show the relay undervoltage setpoint does not increase above the 60 Hz setpoint over the 50 to 60 Hz range. Furthermore, as noted earlier, the potential transformers will not produce a voltage error during the dip that would cause lower voltage at the relay than at 60 Hz (for a given primary voltage). Therefore, the 59% undervoltage relay will not inadvertently trip during EDG load sequencing.

Degraded Voltage Relays 27A. The EDG voltage and frequency dips that occur during automatic load sequencing will not adversely impact the degraded voltage relays that are installed on the 4160 V essential busses C1 and D1. The relays are type ABB27N. The safety function of the degraded voltage relays is to separate the offsite power source from the essential busses. The degraded voltage relays have a 7.5 second time delay which is significantly greater than the duration of the EDG voltage and frequency dips.

The following corresponding 4160 V protective relaying calculations were reviewed to verify similar results for EDG 1-2:

- C-EE-024.01-002, EDG 1-2
- C-EE-004.01-032 (C-EE-004.01-033), Breaker AD1DF11 (AD1DF12) for 4160/480V Transformer DF1-1 (DF1-2)
- C-EE-004.01-006 and C-EE-004.01-008, Breaker AD113 (AD108) for CCW Pump MP0432 (MP0433)
- C-EE-004.01-014, Breaker AD105 for Make-Up Pump Motor MP372A
- Calculations C-EE-004.01-002 and C-EE-004.01-004, Breaker AD107 (AD109) for Service Water Pump Motor MP0032 (MP0033)
- C-EE-004.01-010, Breaker AD111 for HPI Pump MP0582
- C-EE-004.01-012, Breaker AD112 for Decay Heat Pump MP0422

4.5.2 480 V Protective Relays

SST Trip Devices: G.E. Type SST solid state overcurrent trip devices are used for overcurrent protection on the 480 V breakers. The time-current curves for the SST devices indicate the curves apply at both 50 Hz and 60 Hz. Therefore, the momentary frequency dip during Load Step 1 of either sequence will have no significant impact on the performance of the 480 V overcurrent trip devices. Voltage and current impacts on these devices during the EDG loading sequence are addressed for each breaker below.

Breaker BCE11 (BCE12): The 480 V incoming breakers to Bus E1 have a GE SST overcurrent trip device with a long time delay trip unit set at 2080 A (1.43 times calculated full load amps) and a short time delay trip unit set at 8000 A (1.2 times the calculated starting current or demand load in the relay calculations). The trip device (relay) setpoints were based on conservative load assumptions to ensure there will be no nuisance trips during expected starting and steady state conditions. The 200 hp Containment Spray pump and 40 hp Containment Air Cooler (CAC) fan make up a significant portion of the initial starting demand load assumed in the relay calculations. However, these two loads do not start until Load Step 5 during EDG load sequencing.

The load demand profile assumed in the relay setpoint calculations is conservative when compared to an estimated load demand profile for Bus E1 during EDG load sequencing. The maximum estimated load demand for Bus E1 due to in-rush and motor starting is less than 3600 A during EDG sequencing. This maximum load demand for Bus E1 will have a duration of less than 10 seconds. If the current remained at 3600 A, the trip device would operate in approximately 35 seconds. This yields a relay operating time of 25 seconds (35 – 10 seconds) at the maximum load demand.

The average estimated load demand for Bus E1 during EDG load sequencing is less than 2500 A for a period of approximately 35 seconds (20 seconds for the timing to the fifth load step plus 15 seconds for the CAC fan to accelerate). After this period, load falls below the trip device long time pickup value. At 2500 A, the trip device would operate in approximately 70 seconds. This yields a relay operating time margin of 35 seconds (70 – 35 seconds) at the average load demand. Thus, the addition of a short delay (less than 1.4 seconds) in acceleration of the starting motors due to the EDG Step 1 voltage dip will still yield adequate margin with the BCE11 (BCE12) trip device. Therefore, the Breaker BCE11 (BCE12) overcurrent trip device will not trip due to EDG load sequencing. (Reference Calculations C-EE-005.01-037 and C-EE-005.01-040)

Breaker BE106. The feed to MCC E12A has a GE SST overcurrent trip device with a long time delay trip unit set at 600 A (1.12 times calculated full load amps) and a short time delay trip unit set at 3600 A (1.7 times calculated starting current or demand load). The trip device (relay) setpoints were based on conservative load assumptions to ensure there will be no nuisance trips during expected starting and steady state conditions.

The load demand profile assumed in the relay setpoint calculation is conservative when compared to an estimated load demand profile for EDG load sequencing. The estimated EDG worst case load demand for MCC E12A during sequencing is less than 2000 A (occurs during Load Step 1 of LOOP/LOCA sequence), which is comparable to that assumed in the relay calculation. At 2000 A, the trip device would operate in approximately 65 seconds. The 480 V starting motors will accelerate to normal speed and MOVs will complete their strokes within this time. The addition of a short delay (less than 1.4 seconds) in acceleration of the starting motors due to the EDG Step 1 voltage dip will still yield a significant margin with the BE106 trip device. Therefore, the Breaker BE106 overcurrent trip device will not trip due to EDG load sequencing. (Reference Calculation C-EE-005.01-030)

Breaker BE109. The feed to MCC E12B has a GE SST overcurrent trip device with a long time delay trip unit set at 540 A (1.6 times calculated full load amps) and a short time delay trip unit set at 2160 A (approximately 10 times calculated starting current or demand load). The trip device (relay) setpoints were based on conservative load assumptions to ensure there will be no nuisance trips during expected starting and steady state conditions.

The load demand profile assumed in the relay setpoint calculation is conservative when compared to an estimated load demand profile for EDG load sequencing. The estimated EDG worst case load demand for MCC E12B during sequencing is less than 200 A (occurs during Load Step 1), which is comparable to that assumed in the relay calculation. At 200 A, the trip device would operate in approximately 75 seconds. The 480 V starting motors will accelerate to normal speed, and MOVs will complete their strokes within this time. The addition of a short delay (less than 1.4 seconds) in acceleration of the starting motors due to the EDG Step 1 voltage dip will still yield a significant margin with the BE 109 trip device. Therefore, the Breaker BE109 overcurrent trip device will not trip due to EDG load sequencing (Reference Calculations C-EE-015.03-008 and C-EE-005.01-101).

Breaker BE110 (BE105). The feed to Containment Air Cooler (CAC) Fan MC0011 (MC0013), has a GE SST overcurrent trip device with a long time delay trip unit set at 480 A (2 to 3 times full load amps) and an instantaneous trip unit set at 3840 A (2 times Locked Rotor Amps). This motor is sequenced on during Load Step 5 of the LOOP/LOCA sequence. The EDG transient analysis shows that for Load Step 5, voltage at the 4160 V bus does not fall below 3700 V (minimum analyzed voltage). Review of the relay calculation coordination curve indicates there is significant time margin to accommodate an increase in low speed starting time due to a voltage dip, even if the motor is stalled for several seconds before the voltage recovers to a value at which the motor would begin accelerating. Therefore, the Breaker BE110 (BE105) overcurrent trip device will not trip due to EDG load sequencing. (Reference Calculations C-EE-005.01-022 and C-EE-005.01-024)

Breaker BE111. The feed to Containment Spray Pump Motor MC0011, has a GE SST overcurrent trip device with a long time delay trip unit set at 600 A (2 to 3 times full load amps) and an instantaneous trip unit set at 4800 A (2 times Locked Rotor Amps). This motor is sequenced on during Load Step 5 of the LOOP/LOCA sequence. The EDG transient analysis shows that for Load Step 5, voltage at the 4160 V bus does not fall below 3700 V (minimum analyzed voltage). Review of the relay calculation coordination curve indicates there is significant time margin to accommodate an increase in low speed starting time due to a voltage dip, even if the motor is stalled for several seconds before the voltage recovers to a value at which the motor would begin accelerating. Therefore, the Breaker BE111 overcurrent trip device will not trip due to EDG load sequencing. This motor also has an overload relay in the low speed circuit, but it is used for indication only (does not trip). (Reference Calculation C-EE-005.01-003)

Breaker BE107. The feed to MCC E11A has a GE SST overcurrent trip device with a long time delay trip unit set at 600 A (3 times full load amps) and a short time delay trip unit set at 3600 A (1.15 times calculated starting current or demand load). The trip device (relay) setpoints were based on conservative load assumptions to ensure there will be no nuisance trips during expected starting and steady state conditons.

The load demand profile assumed in the relay setpoint calculation was compared to an estimated load demand during EDG load sequencing. The estimated EDG worst case load demand during load sequencing occurs during Load Step 1 and is less than 1000 A for MCC E11A, which is well below that assumed in the relay calculation. At 1000 A, the trip device would operate in approximately 120 seconds. It is reasonable to assume that 480 V starting motors will accelerate to normal speed and MOVs will complete their strokes within approximately 20 seconds. Thus, the addition of a short delay (less than 1.4 seconds) in acceleration of the starting motors due to the EDG Step 1 voltage dip will still yield a significant margin with the BE107 trip device. Therefore, the Breaker BE107 overcurrent trip device should not trip during EDG load sequencing. (Reference Calculation C-EE-005.01-028)

Breaker BE118. The feed to MCC E16A has a GE SST overcurrent trip device with a long time delay trip unit set at 600 amps and a short time delay trip unit set at 3600 A.

The estimated load demand profile for EDG load sequencing is less than 1000 A for MCC E16A. At 1000 A, the trip device would operate in approximately 120 seconds. It is reasonable to assume that 480 V starting motors will accelerate to normal speed within a few seconds under normal conditions (no MOVs or fans start during sequencing). Thus, the addition of a short delay (less than 1.4 seconds) in acceleration of the starting motors due to the EDG Step 1 voltage dip will still yield a significant margin with the BE118 trip device. Therefore, the Breaker BE118 overcurrent trip device should not trip during EDG load sequencing. (Reference Calculation C-EE-005.01-029)

The following corresponding 480V protective relaying calculations were reviewed to verify similar results for EDG 1-2:

- C-EE-005.01-034 (C-EE-005.01-035), Breaker BDF11 (BDF12) - 480V Incoming breakers to Bus F1
- C-EE-005.01-023 and C-EE-005.01-025, Breaker BF110 (BF105) - Feed to Containment Air Cooler (CAC) Fan MC0012 (MC0013)
- C-EE-005.01-004, Breaker BF111 – Feed to Containment Spray Pump Motor MC0012
- C-EE-005.01-031, Breaker BF114 - Feed to MCC F12A
- C-EE-005.01-027, Breaker BF115 - Feed to MCC F11A
- C-EE-005.01-032, Breaker BF118 - Feed to MCC F16A
- C-EE-005.01-101, Breaker BF107 - Feed to MCC F12B

Breaker BF113. Bus F1 provides an alternative feed to MCC F13. The normal feed to this MCC is F7, which is a non-essential MCC. The loads on MCC F13 are not critical for safe shutdown or accident mitigation (e.g., turbine generator turning gear, turbine generator turning gear oil pump, boric acid heat tracing). Therefore, the trip device margin was not evaluated for this breaker.

The LOOP-only transient has lower loading because certain SFAS equipment is not energized. Therefore, the above discussion on 480 V protective relays for the LOOP/LOCA transient conservatively envelopes the LOOP-only transient.

4.6 Motor Control Circuits

Control of 4160 V and 480 V switchgear loads will not be adversely affected by the voltage and frequency dips, since the control circuits for these loads are powered from the 125VDC system. The 480 V MCC motor control circuits for the essential loads could be affected by the voltage dips, since these control circuits are powered from 480-120 VAC control power transformers (CPTs). The 480 V MCC motor control circuits were reviewed to verify that the voltage dips will not adversely affect the essential 480 V MCC loads. The results of this review are discussed in detail below. Additionally, the historical reliability of the 480 V contactors was examined to determine if the reduced voltage and frequency condition during surveillance testing had resulted in premature aging of the contactors. This review identified no premature aging of the equipment.

4.6.1 Voltage Required for Pickup

The minimum 4160 V bus voltage necessary to assure that the 480 V contactors will pick up was determined for the AC system analysis based on Calculation C-EE-006.01-027 and bench testing of the bounding circuit configuration. These values are used as design input to Calculation C-EE-015.02-008, Revision 3, which concludes that a minimum analyzed voltage, i.e., at 3700 V at C1 and D1 busses, all of the contactors have adequate voltage for pickup.

During Load Steps 1, 2, 3, and 4, the voltage drops below 3700 V for the initial part of the load step. The majority of the 480 V loads start during Load Step 1. The pickup of the 480 V contactors may be delayed for loads starting in Load Step 1. However, the transient analysis shows that the voltage recovers to 3700 V in 1.3 seconds. Accordingly, the 480 V contactors will pickup as required following the initial voltage dip in Load Step 1. The potential for drop out of these contactors during subsequent load steps is discussed below, in the next section. The impact of the delayed pickup on required SFAS response times is discussed below in Section 4.7.

Similarly, for the pickup of contactors for loads which start during Load Steps 2, 3, and 4 may be delayed because the 4160 V bus voltage briefly drops below 3700 V. However, the voltage recovers to greater than 3700 V, and the contactors will pickup as required following the initial voltage dip. The potential for drop out of these contactors during subsequent load steps is discussed below, in the next section. The impact of the delayed pickup on required SFAS response times is discussed below in Section 4.7.

Size 1 starters are used for SFAS valves powered from 240 V busses YE2 and YF2. Their control circuits are encompassed by the Calculation C-EE-006.01-027. The impact would be the same as for the 480 V loads and these impacts are also addressed below in Section 4.7.

The Containment Air Cooling (CAC) Fan contactors are size 4. These loads are started in Load Step 5. Since the minimum voltage for Load Step 5 is 3714 V and the voltage recovers to nominal voltage (4200 V or greater), the pickup of the CAC Fans contactors will not be impacted during EDG transient load sequencing.

4.6.2 Voltage Required for Dropout

Once the 480V motor starter contactor is pulled in, more significant voltage drops must be present to cause dropout. Revision 3 of Calculation C-EE-006.01-027 indicates that the highest MCC bus voltage required to assure that the control circuits have sufficient voltage to prevent dropout (i.e., that they stay held-in) is 292 V. Revision 3 of Calculation C-EE-015.03-008 indicates that during the inrush associated with the block loading of the SFAS accident loads (analysis case ST1a), the maximum voltage drop from the essential 480 V switchgear busses E1 and F1 to the MCCs is less than 15 V. Accordingly, the 480 V switchgear bus voltage required to prevent dropout of the control circuit contactors and auxiliary relays is:

$V_{480\text{-Holdin}} = 292 + 15 = 307$ V

The turns ratio of the 4160 V to 480 V unit substation transformers feeding essential switchgear busses E1 and F1 is 4055 V : 480 V, which does not account for the voltage drop across the transformer impedance. Calculation C-EE-015.03-008 indicates that during the inrush associated with the block loading of the SFAS accident loads, that there is approximately 490 V of voltage drop across the transformer impedance on the high-side of the transformer. Calculation C-EE-015.03-008 also indicates the maximum cable voltage drop between the unit substation transformers and the 4160 V busses is 0.1 percent (or 4.16 V). Accordingly, the 4160 V bus voltage at busses C1 and D1 required to prevent dropout of the control circuit contactors and auxiliary relays is:

$V_{4160\text{-Holdin}} = 307 \times (4055 / 480) + 490 + 4.16 = 3088$ V

Therefore, as long as the voltage at the 4160 V bus remains above 3088 V, the MCC control circuit contactors will not dropout. The design basis LOOP/LOCA analysis indicates that the 4160 V bus voltage will remain above 3088 V for all but the first load step. Since it is already assumed that the 480 V loads do not pickup on the first load step until the voltage recovers to above 3700 V, dropout is not an issue during the first load step. During the remaining load steps, the voltage remains above 3088 V and the 480 V loads will not dropout.

As discussed above in the LOOP/LOCA evaluation, the contactors may initially be delayed until sufficient voltage is achieved. As discussed above, the required hold-in voltage for the contactors for the SFAS circuits is 307 V. The lowest 480 V switchgear bus voltage for LOOP-only is 343 V, which is sufficient for the SFAS circuits and provides sufficient voltage margin to address the non-SFAS circuits.

4.6.3 SFAS Signal Seals-In Required Loads

Although not predicted to occur, even if the 480V motor contactors were to dropout during a load step, the voltage would recover to nominal within two seconds and the contactors would pick back up, as long as the SFAS actuation signal was still applied. The elementary diagrams for the 480 V loads actuated by SFAS were reviewed to confirm that the SFAS signal, if active, would allow the contactors to pickup after voltage returns to a sufficient voltage. This review confirmed that all of the 480 V SFAS actuated loads are adequately "sealed-in" by the SFAS signal.

For loads that start during the first load step, the SFAS signal is applied throughout the load sequencing. However, loads that are started during the second through fifth load steps initially have the SFAS signal "blocked" by the sequencer until the proper load step. At the load step time, the sequencer un-blocks the SFAS signal for three (3) seconds and then blocks the SFAS signal again until the end of load sequence. This is done to prevent a large load from starting concurrently with another load.

There are a few 480 V loads that are started after the first load step. These loads include:

- MV-HP2A, B, C, and D - High Pressure Injection Valves
- MV-2733 and 2734 – Decay Heat Pump Suction Valve from BWST

- MC1-1, 2, and 3 – Containment Air Cooler Fans
- MP56-1 and 2 - Containment Spray Pumps

The HPI valves have a timer included in their starting circuit to seal-in the start signal even if the SFAS signal is then blocked by the sequencer. The DH pump suction valves receive an SFAS signal. However these valves are normally in the correct position and do not have a required response time requirement specified in the DBNPS Technical Requirements Manual. Finally, the CAC fans and containment spray pumps do not start until the fifth and final load step, so there will be no additional sequencing voltage transients after these fans are started.

Therefore, the voltage and frequency dips will not adversely impact the performance of the 120 V AC control circuits for the 480 V loads for the following reasons:

- Contactors will pick up since voltage recovers to an adequate value within two seconds. There may be a time delay for the start of these loads.
- Contactors will not drop out because the voltage dips remain above the maximum dropout voltage for the contactors after the first load step.

4.7 Response Time of Essential Loads

For Mode 1 through 4 the SFAS functions defined in Section 3.3.2.1 and Table 3.3-3 of the DBNPS Technical Specifications are required to be operable. The response times for loads with Technical Specification response time requirements could be impacted by the voltage dips. First, as discussed above, 480 V loads could be delayed in starting due to the voltage required by the motor starter contactors. Second, if the voltage drops below the analyzed condition for the load, the load may not be able to perform its function for the time period of the degraded voltage condition.

During the recent EDG testing, the voltage and frequency were outside prescribed limits for approximately 1 second during the first load step only. Thereafter, the EDG governor and voltage regulator adequately controlled frequency and voltage within the prescribed USAR limits for the subsequent load steps and during steady state loading. This condition did not prevent successful completion of surveillance test acceptance criteria. The loads monitored during the surveillance tests started within the time criteria specified in DBNPS Technical Requirements Manual Table 3.3-5.

The actual response times during an accident condition could be slower than those determined from the latest SFAS surveillance tests because the voltage and frequency transients are expected to be worse. To evaluate the impact of the design basis LOOP/LOCA analysis results to the measured response times, a "penalty" time was calculated for each load and added to the measured response time. This adjusted response time was then compared to the Technical Specification-required response times. For the LOOP-only case, there are no required SFAS response times.

The penalty time was calculated using the design basis LOOP/LOCA analysis results and the minimum analyzed voltage for successful operation of the essential loads. Based on calculation C-EE-015.03-008, Revision 3, the minimum analyzed voltage evaluated for operation of the essential loads is at a degraded voltage of 3700 V at the 4160 V bus. Essential 4 kV and large essential 480 V motors are not penalized unless the voltage drops below 70 percent, since the safety related motors at the DBNPS were designed to start at 70 percent voltage and ride through unless voltage drops below 65 percent. Only during the first load step does the 4160 V bus voltage drop below 70 percent; therefore, only the CCW pump motor is penalized for response time since it is the only large motor with a response time requirement to start during the first load step. In all cases, the minimum analyzed voltage, i.e., 3700 V was used to calculate the penalty times since all the SFAS loads are operable at the minimum analyzed voltage.

For each voltage dip during which time a load is operating, the penalty time was calculated as the time during which the voltage is below the minimum analyzed voltage described above plus the expected model uncertainty for response time. The response times for the SFAS loads were measured during the SFAS tests and, as such, the surveillance test response times already accounted for the voltage dips that occurred during the tests. Accordingly, the time measured in the SFAS tests when the voltage was below the minimum analyzed voltage was deducted from the calculated time obtained from the LOOP/LOCA analysis results. The incremental time of the LOOP/LOCA analysis over the SFAS tests thus obtained are the penalty times. The penalty times calculated using the described approach assume that the SFAS test response times were measured while the loads were supplied with a minimum voltage equal to the minimum analyzed voltage for the load. Furthermore, the calculation of penalty times using the described approach also assumes that the load completely stalls during this period. Therefore, this approach for determining the penalty time is quite conservative. There is sufficient response time margin to account for the expected design basis LOOP/LOCA voltage responses. Table 3 summarizes the response time penalties calculated for each load step.

Table 3. Response Time Penalties

	Calculated Penalty Time					
Load Step:	**1**	**2**	**3**	**4**	**5**	**Total**
Time Below Minimum Analyzed Voltage (sec)	**0.5**	**0.6**	**0.5**	**0.7**	**0**	**2.3**

4.8 <u>Summary</u>

The proposed change affects the design requirements for the EDGs. The impact of the proposed change on the capability of the EDGs, the onsite electric power system, and essentially powered equipment to perform their required safety functions has been evaluated. The proposed change does not prevent the successful performance of the design basis functions of the affected systems and components. Therefore, the health and safety of the public will not be endangered by operation in the proposed manner.

5.0 REGULATORY SAFETY ANALYSIS

5.1 No Significant Hazards Consideration

The proposed amendment would allow a change the facility as described in the Davis-Besse Nuclear Power Station (DBNPS) Updated Safety Analysis Report (USAR) to modify the design requirements for the emergency diesel generators (EDGs). The proposed amendment would allow a departure from the regulatory position of Safety Guide 9 for the frequency and voltage transient during automatic loading of the EDGs. The proposed amendment does not involve a change to the DBNPS Technical Specifications or to the Operating License conditions.

An evaluation has been performed to determine whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The proposed amendment alters the design requirements for the Emergency Diesel Generators (EDGs). Specifically, the proposed amendment affects the requirements for EDG voltage and frequency response following a loss of offsite power. The EDGs function to mitigate the consequences of accidents when offsite power is not available. The EDGs are not an initiator of any analyzed accident.

   The effect of this change on the capability of the EDGs, the onsite electric power system, and essentially powered equipment to perform their required safety functions has been evaluated, and the proposed change does not significantly impact the capability of these systems to perform their required accident mitigation functions. No previously analyzed accident scenario is affected by the proposed change.

   The proposed change does not affect the initiation of any analyzed accident. The accident mitigation functions for affected equipment are maintained. Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

Response: No.

The proposed amendment affects the USAR requirements for EDG voltage and frequency response following a loss of offsite power. The effect of this change on the capability of the EDGs, the onsite electric power system, and essentially powered equipment to perform their required safety functions has been evaluated, and the proposed change does not significantly impact the capability of these systems to perform their required safety functions. The assumptions of the current accident analyses are maintained and no new or different accident initiators are created. Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

The proposed amendment affects the USAR requirements for EDG voltage and frequency response following a loss of offsite power. The effect of this change on the capability of the EDGs, the onsite electric power system, and essentially powered equipment to perform their required safety functions has been evaluated, and it is concluded the proposed change does not impact the capability of these systems to perform their required safety functions. However, since the proposed change does make changes to the controlling values for EDG voltage and frequency transient response that are less restrictive than those presently described in the USAR, this is considered a reduction in a margin of safety.

The magnitude of voltage and frequency drops which would result in failure of the EDGs, the onsite power system, or essentially powered equipment have not been determined due to the limitations of the transient assessment model and the nonlinear phenomena associated with that postulated failure. However, based on (1) a computer model and testing of the diesel engine, engine speed control governor and actuator, the synchronous generator and excitation system that demonstrate the EDGs are capable of starting, accelerating, and carrying the required loads, (2) a comprehensive evaluation of the impact of the transient voltage and frequency response on plant equipment and safety functions, (3) the momentary duration of the voltage and frequency dips, and (4) based on engineering judgement, the proposed change is not considered to have a significant effect on the margin of safety. Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, it is concluded that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is acceptable.

5.2 Applicable Regulatory Requirements/Criteria

Design requirements for the DBNPS electrical power systems are specified in USAR Section 3D.1.13, "Criterion 17 - Electric Power Systems." USAR Section 3D.1.13 states, in part:

> An onsite electric power system and an offsite electric power system are provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) is to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

Safety Guide 9 specified an acceptable basis for the selection of diesel generator sets of sufficient capacity and margin to implement these requirements.

The proposed amendment would revise the DBNPS USAR to identify an exception to Safety Guide 9 for the frequency and voltage requirements of Regulatory Position 4 for the automatic loading sequence. The technical analysis provided in Section 4.0 of this application demonstrates that the revised USAR requirements will continue to assure that the capacity and capability of the EDGs and the onsite power systems are sufficient to assure safe plant operation. Although the proposed amendment alters the criteria for acceptable EDG performance, the proposed amendment does not alter the principal design requirements for the EDGs and the onsite power systems.

The proposed amendment would also revise the USAR to specify the calculated limiting voltage and frequency dip for which the EDGs and onsite power system have been evaluated. The values being added are those that were used to support the technical analysis in Section 4.0 of this application. This change will assure that changes in EDG performance from that assumed in the evaluations in support of this amendment are properly addressed. Inclusion of these values in the DBNPS USAR will assure potential future changes include proper consideration of 10 CFR 50.59 requirements.

The proposed amendment would revise the USAR to explicitly incorporate the part of Regulatory Position 4 of Safety Guide 9 that states that voltage be restored to within 10 percent of nominal and frequency be restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval. This change is being made to clearly state that this position of Safety Guide 9 continues to be a design basis requirement.

The changes being made by the proposed amendment do not affect the DBNPS's compliance with any requirement of Title 10 of the Code of Federal Regulations or the DBNPS Technical Specifications. The proposed changes have been evaluated to assure continued compliance with the DBNPS principal design criteria. Therefore, the proposed amendment is acceptable.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

6.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 REFERENCES

1. DBNPS Operating License NPF-3, Appendix A Technical Specifications through Amendment 262.
2. DBNPS Updated Safety Analysis Report through Revision 23.
3. NRC Safety Guide 9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," March 1971.
4. *American Electricians Handbook*, Eleventh Edition, McGraw Hill, Section 7-150, page 7-72.
5. IEEE C37.102-1995, "Guide for AC Generator Protection."
6. System Description SD-002, "Safety Features Actuation (SFAS)."
7. DBNPS Technical Requirements Manual, Revision 19.

8. Calculation C-EE-004.01-001, "Protective Relay Setpoints for Service Water Pump Motor 1-1 (AC107)," dated May 12, 1998.
9. Calculation C-EE-004.01-002, "Protective Relay Setpoints for Service Water Pump Motor 1-2 (AD107)," dated May 12, 1998.
10. Calculation C-EE-004.01-003, "Protective Relay Setpoints for Service Water Pump Motor 1-3 (AC109)," dated October 27, 1992.
11. Calculation C-EE-004.01-005, "Protective Relay Setpoint for: Component Cooling Water Pump Motor 1-1 (AC113)," dated April 28, 1998.
12. Calculation C-EE-004.01-006, "Protective Relay Setpoint for Component Cooling Water Pump Motor 1-2 (AD113)," dated November 23, 1993.
13. Calculation C-EE-004.01-007, "Protective Relay Setpoint for Component Cooling Water Pump Motor 1-3 (AC108)," dated October 27, 2003.
14. Calculation C-EE-004.01-009, "Protective Relay Setpoint for High Pressure Injection Pump Motor 1-1 (AC111)," dated February 28, 2003.
15. Calculation C-EE-004.01-010, "Protective Relay Setpoint for High Pressure Injection Pump Motor 1-2 (AD111)," dated June 21, 1991
16. Calculation C-EE-004.01-011, "Protective Relay Setpoints for Decay Heat Pump Motor 1-1 (AC112)," dated April 9, 2001.
17. Calculation C-EE-004.01-012, "Protective Relay Setpoints for Decay Heat Pump Motor 1-2 (AD112)," dated September 26, 1991.
18. Calculation C-EE-004.01-013, "Protective Relay Setpoint for Makeup Pump Motor 1-1," dated June 4, 1992.
19. Calculation C-EE-004.01-014, "Protective Relay Setpoint for Makeup Pump Motor 1-2 (BKR AD105)," dated May 12, 1998.
20. Calculation C-EE-004.01-032, "Protective Relay Setpoint for Incoming to Transformer DF1-1 (BKR. AD1DF11)," dated October 23, 1992.
21. Calculation C-EE-004.01-033, "Protective Relay Setpoint for Incoming to Transformer DF1-2 (BKR. AD1DF12)," dated May 12, 1998.
22. Calculation C-EE-004.01-038, "Protective Relay Setpoint for: Incoming to Transformer CE1-1 (BKR. AC1CE11)," May 12, 1998.
23. Calculation C-EE-004.01-039, "Protective Relay Setpoint for: Incoming to Transformer CE1-2 (BKR. AC1CE12)," October 23, 1992.
24. Calculation C-EE-005.01-003, "Protective Relay Setpoint Calculation for Containment Spray Pump Motor 1 (BE111)," dated September 18, 2003.
25. Calculation C-EE-005.01-004, "Protective Relay Setpoint Calculation for Containment Spray Pump Motor 2 (BF111)," dated September 21, 2003.
26. Calculation C-EE-005.01-022, "Protective Relay Setpoint Calculation for Containment Air Cooler Fan 1-1 (BE110)," dated March 1, 1999.
27. Calculation C-EE-005.01-023, "Protective Relay Setpoint Calculation for Containment Air Cooler Fan 1-2 (BE110)," dated March 1, 1999
28. Calculation C-EE-005.01-024, "Protective Relay Setpoints Calculations for Containment Air Cooler Fan 1-3 (BE105)," dated March 1, 1999.

29. Calculation C-EE-005.01-025, "Protective Relay Setpoint Calculation for Containment Air Cooler Fan 1-3 (BE105)," dated March 1, 1999.
30. Calculation C-EE-005.01-027, "Protective Relay Setpoint Calculation for Incoming to MCCF11A (BKR BF115)," dated November 10, 2003.
31. Calculation C-EE-005.01-028, "Protective Relay Setpoint Calculation for Incoming to MCCE11A (BKR BF107)," dated October 2, 1997.
32. Calculation C-EE-005.01-029, "Protective Relay Setpoint Calculation for Incoming to MCCE16A (BKR BE118)," dated December 18, 1990.
33. Calculation C-EE-005.01-030, "Protective Relay Setpoint Calculation for Incoming to MCC312A (BKR BE106)," dated November 9, 2003.
34. Calculation C-EE-005.01-031, "Protective Relay Setpoint Calculation for Incoming to MCCF12A (BKR BE114)," dated July 26, 2003.
35. Calculation C-EE-005.01-032, "Protective Relay Setpoint Calculation for Incoming to MCCF16A (BKR BE118)," dated January 28, 1991.
36. Calculation C-EE-005.01-034, "Protective Relay Setpoints Calculations for Incoming to Bus FA (BKR BDF11)," dated February 8, 1991.
37. Calculation C-EE-005.01-035, "Protective Relay Setpoint Calculation for Incoming to Bus F1 (BKR DF12)," dated January 4, 1991.
38. Calculation C-EE-005.01-037, "Protective Relay Setpoints Calculations for Incoming to Bus E1 (BKR BCE11)," dated February 8, 1991.
39. Calculation C-EE-005.01-040, "Protective Realy Setpoint Calculation for Incoming to Bus E1 (BKR BCE12)," dated January 4, 1991.
40. Calculation C-EE-006.01-026, "Voltage Drop for GL 89-10 Valve Operators," dated December 10, 2003.
41. Calculation C-EE-006.01-027, "Safety-Related Motor Contactor Control Circuit Voltage Drop," dated December 8, 2003.
42. Calculation C-EE-015.03-008, "AC Power Distribution System Analysis – Electrical Transient Analysis Program," dated December 9, 2003.
43. Calculation C-EE-024.01-002, "Protective Relay Setpoints for the Emergency Diesel Generator 1-1 (AC101)," dated March 19, 2003.
44. Calculation C-EE-024.01-003, "Protective Relay Setpoints for The Emergency Diesel Generator 1-2 (AD101)," dated March 19, 2003.
45. MPR-2594, "Davis-Besse Emergency Diesel Generator Transient Response Evaluation," Revision 1, January 2004.

8.0 ATTACHMENTS

1. Proposed Mark-Up of Updated Safety Analysis Report Pages