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March 3, 1992

Dr. Thomas E. Murley, Director
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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Document Control Desk

Subject: Dresden Nuclear Power Station Units 2 and 3
Second-Level Undervoltage (Degraded Voltage)
Setpoints for 4 kV Safety Buses
NRC Docket Nos. 50-237 and 50-249

References:
(a) CECo-NRR-Region III teleconference on January 24, 1992.
(b) CECo-NRR-Region III teleconference on January 31, 1992.
(c) CECo-NRR-Region III teleconference on February 27, 1992.

Dear Dr. Murley:

As a result of the Electrical Distribution System Functional Inspection (EDSFI) at Dresden Station, Commonwealth Edison Company (CECo) has determined new second-level undervoltage (degraded voltage) setpoints for the station's 4 kV safety buses. In the referenced teleconferences, CECo presented those actions taken to support the implementation of the new setpoints. This letter documents the information presented in those teleconferences.

Please contact this office should further information be required.

Respectfully,

Milton H. Richter
Nuclear Licensing Administrator

Enclosure: Dresden Station Second-Level Undervoltage (Degraded Voltage) Setpoint

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ENCLOSURE

DRESDEN STATION

SECOND-LEVEL UNDERVOLTAGE (DEGRADED VOLTAGE) SETPOINT

INTRODUCTION

During the Electrical Distribution System Functional Inspection (EDSFI) at Dresden Station, Commonwealth Edison Company (CECo) was requested to verify that the existing second-level undervoltage (degraded voltage) setpoint for the station's safety-related 4160 volt buses (4 kV safety buses) was sufficient to ensure adequate voltage to start and operate all Class 1E equipment. CECo performed a preliminary calculation of auxiliary power system voltages for Dresden Unit 2 Division II utilizing the Unit 2 Emergency Diesel Generator Cooling Water Pump (DGCWP) as the limiting Class 1E load. This load path was selected since: 1) existing auxiliary power system calculations (prior to the EDSFI) had shown that Unit 2 Division II was the highest loaded division; 2) the scope of the review activities for the EDSFI inspection team concentrated on Unit 2 Division II; and 3) the Unit 2 DGCWP was the largest electrical load on the 480 volt Motor Control Center (MCC) with the lowest projected voltage. The preliminary calculations determined that the minimum 4 kV safety bus (bus 24-1) voltage necessary to start and operate the Unit 2 DGCWP to be above the existing second level relay setpoint.

Based on these preliminary results, compensatory measures were developed to ensure the availability of the Unit 2 DGCWP. These compensatory measures, which applied to both units (Units 2 and 3) for consistency, were discussed with NRC personnel (NRR and Region III) on August 1, 1991, and incorporated into a Dresden Operating Order. As a result of a Unit 3 scram on August 17, 1991, additional compensatory measures were implemented (Reference 1). These measures were subsequently incorporated into station procedures (DOA-6500-07 and DOA-6500-08).

A baseline critical voltage calculation was completed for Unit 2 Division II in November 1991. This calculation, which was based on updated loading tables and cable length values, determined that the required critical voltage at safety bus 24-1 would be greater than 4000 volts to ensure the starting and operation of the limiting safety-related loads (Unit 2 DGCWP, Control Room HVAC Train 'B' Air Filtration Unit heater, Containment Cooling Service Water (CCSW) Cubicle Cooler "C" and "D" Fans). The results of this calculation confirmed that a reduction of the critical voltage at safety bus 24-1 would be required in order to restore the automatic second-level undervoltage (degraded voltage) function.

Critical voltage calculations were subsequently performed for the electrical divisions on both units (Units 2 and 3). While these calculations were being performed, both units at Dresden Station were in extended outages (Unit 2 in a forced outage, Unit 3 in a refueling outage). During those outages, CECo pursued actions which would: 1) reduce the critical voltage at the 4 kV safety buses for all divisions; and 2) support the restoration of the automatic second-level undervoltage (degraded voltage) function prior to the startup of each unit. This document presents a summary of those activities (previously discussed with NRC personnel in References 2, 3, and 4).

It should be noted that at this time Unit 2 has returned to service (on February 6, 1992) while Unit 3 is currently scheduled to remain in its refueling outage (Fall 1991 refueling outage) until March 24, 1992.

CRITICAL VOLTAGE REDUCTION

In order to reduce the critical voltage for the 4 kV safety buses, CECo implemented modifications which would reduce the voltage drop to those 480 volt MCCs which supply critical safety-related loads. These modifications involved the installation of: 1) larger feed cables to the 480 volt MCCs which supply the DGCWPs; and 2) an automatic trip of the non-essential loads from the 480 volt switchgear upon a LOCA start signal for the diesel generator (high drywell pressure or low-low reactor water level).

Cable Replacement/Installation

In order to reduce the cable impedance (and resultant voltage drop) between the 480 volt switchgear (28, 29, 38, 39) and the 480 volt MCCs which supply the DGCWPs, larger feed cables were installed for each division as reflected in the following table.

Unit	Division	Feed Cable Replaced	Cable Size
2	I	SWGR 28 to MCC 28-3	from 350 MCM (single cable) to 500 MCM (two cables in parallel)
2	II	SWGR 29 to MCC 29-2	from 350 MCM (single cable) to 500 MCM (two cables in parallel)
3	I	SWGR 38 to MCC 38-3	from 500 MCM (single cable) to 500 MCM (two cables in parallel)
3	II	SWGR 39 to MCC 39-2	from 350 MCM (single cable) to 500 MCM (two cables in parallel)

These cable replacements were completed prior to the startup of Unit 2 from its Fall 1991 forced outage (note, Unit 3 currently remains in its Fall 1991 refueling outage).

Load Shed

Modifications were also implemented to automatically trip the following non-essential loads from 480 volt switchgear 28, 29, 38 and 39 upon a LOCA start signal for the diesel generator (+2 psig drywell pressure or - 59 inches reactor water level).

- Drywell Coolers
- South Turbine Building Vent Fans
- Recirculation MG Set Vent Fans
- Condensate Storage Tank Heaters

These modifications lowered the total current through the unit substation transformers (4160 volts to 480 volts) located between the 4 kV safety buses and 480 volt switchgears, thereby reducing the voltage drop in the transformers. The modifications were completed prior to the startup of Unit 2 from its Fall 1991 forced outage (note, Unit 3 currently remains in its Fall 1991 refueling outage).

Since the load shed modifications are unit specific (that is, the load shed only occurs on that unit which experiences the diesel generator start signal), the control circuit logic associated with the transfer of the power feeds for the Diesel Generator 2/3 auxiliaries is being modified. Currently, the Diesel Generator 2/3 auxiliaries (DGCWP, Vent Fan, Fuel Oil Transfer Pump) normally receive power from Unit 2 MCCs 28-1 and 28-3, and will only transfer to the alternate Unit 3 sources (MCCs 38-1 and 38-3) upon a loss of voltage on the Unit 2 power sources. The control logic will be modified to initiate a transfer from the normal power sources (MCCs 28-1 and 28-3) to the alternate power sources (MCCs 38-1 and 38-3) upon a LOCA signal on Unit 3 or the closing of the Diesel Generator 2/3 output breaker to Unit 3 (onto bus 33-1). Should the Diesel Generator 2/3 output breaker close to Unit 2 (onto bus 23-1), the logic will transfer the auxiliaries back to the normal power sources (MCCs 28-1 and 28-3). The modification protects the Diesel Generator 2/3 auxiliaries from a degraded power source by ensuring that the power source utilized will have benefited from the load shed or is being fed from the diesel generator itself. Since the normal power source for the Diesel Generator 2/3 auxiliaries is from Unit 2, this modification is only required to support the startup of Unit 3. The modification will be implemented prior to the completion of the current Unit 3 refueling outage (startup is currently scheduled for March 24, 1992).

RESTORATION OF SECOND-LEVEL UNDERVOLTAGE FUNCTION

In addition to the modifications implemented to reduce the critical voltage for the 4 kV safety buses, CECo pursued the following to restore the automatic second-level undervoltage function for each unit prior to startup:

- completion of the critical voltage calculations for each division;
- equipment testing, evaluations and modifications to support the critical voltage calculations;
- setpoint methodology development and setpoint determination;
- review of minimum switchyard voltage projections; and
- administrative actions to maintain safety bus voltage.

Critical Voltage Calculations

Critical voltage calculations for the 4 kV safety buses (which included starting and running case analyses) have been completed for each division. These calculations were based on the loading conditions during a small break LOCA scenario (with off-site power available), which requires the highest loading condition on the 4 kV safety buses. The calculations also credit the completion of the previously discussed modifications (feed cable replacement and load shed modifications). The limiting critical voltage value for each division, which resulted from running case analyses, is presented in the following table. It was determined from these calculations that the resultant critical voltage from the running case analyses bounded the critical voltage from the starting case analyses.

Unit	Division	4 kV Safety Bus	Critical Voltage (Volts)	Limiting Load
2	I	23-1	3784	Unit 2/3 DGCWP
2	II	24-1	3762	Unit 2 DGCWP
3	I	33-1	3832	Unit 2/3 DGCWP
3	II	34-1	3792	Unit 3 Diesel Generator Vent Fan

These critical voltage calculations were supported by the testing of the Unit 3 DGCWP to determine an adequate starting voltage for the motor. The details of that testing are described later in this section. Additionally, based on the limiting critical voltage values, several loads on each unit would experience a voltage level below the value recommended by NEMA or the vendor. An evaluation has been performed for each of these loads to determine the impact of the lower voltages. The results of those evaluations are also discussed later in this section (and in Attachment 'B').

DGCWP Testing

In order to support the critical voltage calculations, CECo requested a minimum starting voltage requirement for the DGCWP motor from the pump vendor (Chempump Division of Crane Company). The pump vendor provided a minimum starting voltage requirement of 85% of the motor's 460 volt rating (391 volts). This vendor recommendation was based on engineering judgment since: 1) a motor torque-speed characteristic curve applicable to this pump was not available; and 2) a motor of the same design was not available for testing. As a result, in order to determine a minimum starting voltage, CECo performed testing of the Unit 3 DGCWP (in the as-installed configuration) to obtain a torque-speed characteristic curve for the motor. The details of the starting voltage evaluation (assumptions, methodology, derived torque-speed characteristic curve, available torque) are presented in Attachment 'A'. Additionally, an evaluation of the testing is provided in Attachment 'B'.

The results from the testing determined that a motor starting voltage of 70% of rated (322.0 volts) was adequate for the Unit 3 DGCWP. These results were also determined to be applicable for the Unit 2 and Unit 2/3 DGCWPs since: 1) the modifications performed by the pump vendor on each motor were standard practice (see Attachment 'B'); and 2) the in-service DGCWPs were supplied to CECo by the same purchase order (delivered in 1973). The minimum DGCWP motor starting voltages which were utilized for the performance of the critical voltage calculations are presented below:

- Unit 2/3 DGCWP - Unit 2 Division I - 80.6% of rated (370.6 volts);
- Unit 2 DGCWP - Unit 2 Division II - 80.9% of rated (372.3 volts);
- Unit 2/3 DGCWP - Unit 3 Division I - 76.0% of rated (349.6 volts); and
- Unit 3 DGCWP - Unit 3 Division II - 74.5% of rated (342.7 volts).

As indicated previously, the limiting critical voltage values for each division were determined from running case analyses, which bounded the voltage requirements to assure successful starting. The limiting critical voltage value for each unit was used as a basis for the new second-level undervoltage relay setpoint. Therefore, the voltage available for starting the DGCWPs at the new setpoint will be greater than the values indicated above.

Equipment Evaluations

As indicated previously, at the limiting critical voltage values, several safety-related loads on each unit would experience a voltage level below the value recommended by NEMA or the vendor. The affected components are presented below.

- Unit 2 DGCWP
- Unit 2/3 DGCWP
- Unit 3 DGCWP
- CCSW Cubicle Cooler "A" and "B" Fans for Unit 2
- CCSW Cubicle Cooler "C" and "D" Fans for Unit 3
- 125 and 250 Volt Battery Chargers for Units 2 and 3
- Five (5) 120 Volt Size 2 Starter Contactors for MOV applications on each unit (Units 2 and 3)

Attachment 'B' presents the evaluation performed on each component.

It should be noted that at the critical voltage value for Unit 2 Division II, the ability of the Control Room HVAC Train "B" Air Filtration Unit heater to perform its intended function (prevention of moisture buildup in the charcoal absorbers) is only assured during winter conditions when there is a lower moisture content in the air. To ensure the operability of the Air Filtration Unit at the limiting critical voltage value during summer conditions, the existing heater (9 kW rating) will be replaced (by a larger heater -12 kW rating) by March 31, 1992.

Setpoint Methodology/Setpoint Determination/Switchyard Voltage Projections

To support the implementation of the new second-level undervoltage (degraded voltage) setpoint at each unit, CECo performed the following:

- the replacement of the existing second-level undervoltage relays at each 4 kV safety bus;
- the development of the setpoint methodology;
- the determination of the new setpoints; and
- a review of minimum switchyard voltage projections.

The existing second-level undervoltage relays have been replaced with new relays (ABB Model 27N). The new relays, which have an improved design tolerance and "pick-up to drop-out" ratio, were installed to minimize the reset voltage level. The new relays have a design tolerance of approximately 1.0 percent and a "pick-up to drop-out" ratio of 0.5 percent. These new relays were installed during the Fall 1991 forced outage for Unit 2, and the current Fall 1991 refueling outage for Unit 3.

The methodology utilized for the determination of the second-level undervoltage setpoints is presented in Attachment 'C'. The methodology established a total setpoint error associated with the potential transformer and the second-level undervoltage relay. The total setpoint error was determined through the summation of the total random and non-random errors, with the random errors being combined utilizing the "square root of the sum of the squares" methodology. The elements considered for the determination of the total setpoint error included: 1) the accuracy of the potential transformer (as assigned by the manufacturer); 2) the reference accuracy of the relay (repeatability at constant temperature and control voltage); 3) the temperature and control voltage effects on relay repeatability; 4) the relay setting tolerance; and 5) the calibration instrument error for the relay. The relay has been qualified for humidity variation, seismic events, radiation exposure, and pressure variation; therefore, it was concluded that these conditions would not affect the functional capability of the relay.

Only one second-level undervoltage relay setpoint was determined for each unit. The new relay setpoint was determined by adding the total negative setpoint error to the largest (limiting) critical voltage (for that unit), thus ensuring that protection is provided for each division. The following table presents the new second-level undervoltage relay setpoint, and the potential minimum and maximum trip voltages, for each unit.

Unit	Max. 4kV Safety Bus Critical Voltage (Volts)	Relay Setting (Volts)	Min. Relay Trip Voltage (Volts)	Max. Relay Trip Voltage (Volts)	Max. Relay Reset Voltage (Volts)
2	3784	3820 ± 7	3784	3891	3911
3	3832	3870 ± 7	3832	3940	3959

In conjunction with the setpoint determination, CECo evaluated the anticipated 4 kV safety bus voltages based on minimum switchyard voltages during transmission system emergency conditions. This evaluation was performed to ensure that the new second-level undervoltage setpoints would not result in the unnecessary removal of the safety buses from the off-site power source.

The most limiting condition predicted for both units is a summer transmission system load of 18,500 MW (5% above the largest summer load experienced to date) coupled with the two transmission system outages (e.g., generator, transformer, or line) which would have the largest impact on switchyard voltage. For this limiting condition, the Unit 2 switchyard (rated 138 kV) would be at a voltage of 134 kV, and the Unit 3 switchyard (rated 345 kV) would be at 344 kV. The evaluation of 4 kV safety bus voltage was performed assuming a steady state simulation of the following loading cases for the Reserve Auxiliary Transformer (RAT) and the Unit Auxiliary Transformer (UAT).

- Case 1 - Normal Loads + LOCA Loads on RAT with Switchyard Bus Tie Open
- Case 2 - Normal Loads + LOCA Loads on RAT with Switchyard Bus Tie Closed
- Case 3 - Normal Loads only on RAT with Switchyard Bus Tie Open
- Case 4 - Normal Loads evenly split between UAT and RAT with Switchyard Bus Tie Open (Normal Configuration during Full Power Operation)

The results of the evaluation, coupled with the new second-level undervoltage relay setting, are presented in the following table.

Unit	4 kV Division	Bus	Relay Setting (Volts)	Estimated 4 kV Safety Bus Voltage (Volts) Case 1	Case 2	Case 3	Case 4
2	I	23-1	3820±7	3845	3994	3875	3976
2	II	24-1	3820±7	3840	3990	3875	4018
3	I	33-1	3870±7	3929	3982	3954	4062
3	II	34-1	3870±7	3924	3977	3949	4050

The 4 kV safety bus voltage levels (Case 1) are projected to remain above the nominal second level undervoltage relay trip setpoints at the expected minimum switchyard voltage for each unit (Unit 2 - 134 kV, Unit 3 - 344 kV). The bus voltage levels will increase when the switchyard bus tie is closed (Case 2). Historical data over the past three years indicates that the lowest voltage level in the Dresden 138 and 345 kV switchyards has not decreased below the expected minimum switchyard voltage. It should also be noted that at the new second level undervoltage relay setpoint, the maximum trip and reset voltage levels are above the lowest expected voltage levels on the 4 kV safety buses; however, this situation is mitigated by the "two-out-of-two" taken once logic for the undervoltage trip, which would necessitate both relays at a safety bus to initiate above the nominal trip setting. Additionally, closure of the switchyard bus tie raises the voltage at the safety bus above the maximum trip and reset voltages for the relay.

The new second-level undervoltage setpoint for Unit 2 (3820±7 volts) was implemented prior to unit startup from the Fall 1991 forced outage. The new setpoint for Unit 3 (3870±7 volts) has been implemented to support unit startup from the current Fall 1991 refueling outage.

Administrative Actions

In addition to the new second-level undervoltage setpoint, CECo is implementing administrative actions (in Operating Abnormal Procedures DOA-6500-07 and DOA-6500-08) in the event safety bus voltage decreases below 4000 volts. The procedures provide actions (e.g., notification of load dispatcher, removal of third circulating water pump from service, closure of switchyard tie breakers, adjustment of VARs) which may be taken to improve the switchyard and safety bus voltages. Additionally, the procedures prevent the initiation or continuation of any surveillances which: 1) starts LPCI, Core Spray or the Diesel Generators; or 2) tests the high drywell pressure switches (+2 psig) or low-low reactor water level switches (-59 inches). Finally, in the event operation of the CCSW pumps is required, guidance on the starting sequence (non-vault CCSW pumps started first) and operation of those pumps is provided. DOA-6500-07, which is applicable to Unit 2, was revised for implementation prior to unit startup from the Fall 1991 forced outage. DOA-6500-08, which is applicable to Unit 3, will be revised prior to unit startup from the Fall 1991 refueling outage.

It should be noted that in an effort to improve the accuracy and readability of the control room indication for safety bus (4 kV) voltage, modifications were initiated to replace the current analog voltmeter for each unit with a digital voltmeter. The digital voltmeter for Unit 2 was installed during the Fall 1991 forced outage, while the Unit 3 voltmeter will be installed during the current Fall 1991 refueling outage.

REFERENCES

1) M. Richter (CECo) letter to U.S. Nuclear Regulatory Commission, "Additional Information Regrading the Dresden Station Electrical Distribution System Functional Inspection", dated August 26, 1991.

2) CECo/NRR/Region III teleconference regarding Dresden Station second-level undervoltage (degraded voltage), dated January 24, 1992.

3) CECo/NRR/Region III teleconference regarding the second-level undervoltage (degraded voltage) setpoint for Dresden Unit 2, dated January 31, 1992.

4) CECo/NRR/Region III teleconference regarding the second-level undervoltage (degraded voltage) setpoint for Dresden Unit 3, dated February 27, 1992.

ATTACHMENT B

EQUIPMENT EVALUATIONS FOR UNITS 2 AND 3

At the limiting critical voltage value for the 4160 Volt safety busses on each unit (Unit 2 - 3784 Volts, Unit 3 - 3832 Volts), the following safety related loads would experience a terminal voltage below the vendor recommendations or NEMA criteria:

- Unit 2, 2/3, 3 DGCWP's
- CCSW Cubicle Cooler A and B Fans for Unit 2
- CCSW Cubicle Cooler C and D Fans for Unit 3
- 125 and 250 Volt Battery Chargers (both units)
- Five (5) 120 Volt Size 2 Starter Contactors on each unit (used for MOV's)

CECo has performed an assessment of this condition to evaluate the performance of each component. A summary of these assessments follows.

<u>Diesel Generator Cooling Water Pump Minimum Starting Voltage</u>

The purpose of this assessment is to evaluate the voltage available for starting the Diesel Generator Cooling Water Pumps (DGCWP). The critical voltage calculations used to determine the second level undervoltage relay setpoint have determined that the running case bounds the starting case when field testing data is used as an acceptance criteria for starting the DGCWP's. The starting analysis utilized a minimum terminal voltage for the DGCWP's as shown in the table below. At this point, another load becomes the critical load for the starting case, but the calculated critical voltage on the 4160 Volt safety bus is still bounded by the run condition.

DGCWP	Unit	Division	Available Terminal Voltage	Percent of Rated Voltage
2	2	II	372.3	80.9%
3	3	II	342.7	74.5%
2/3	2	I	370.6	80.6%
2/3	3	I	349.6	76%

The vendor of the DGCWP's, Chempump Division of Crane Company, does not specify a minimum starting voltage requirement. In response to a request by CECo for a minimum starting voltage requirement, the vendor responded that the motor was guaranteed to start and run at 90% of the 460 Volt rating (or 414 Volts) and may not start if the line voltage dips by more than 15% (85% of rated or 391 Volts). However, the minimum starting voltage recommendation was based on engineering judgment, and no actual testing was performed under degraded voltage conditions (under 90% of rated voltage). The vendor was unable to provide a motor torque-speed characteristic curve applicable to this pump. This specific motor is no longer used by Crane, and they no longer have one available for testing.

Crane obtained a standard motor for each of Dresden's DGCWP's. The pump vendor modified each motor to allow for use in a submerged location. To accomplish this, the vendor machined the rotor to increase the air gap and installed a liner in the motor. This liner protects the windings from moisture, thus creating a submersible combination pump/motor in a common enclosure. An integral water cooling jacket was also provided with the housing. Machining the rotor and providing a custom enclosure is standard practice for the vendor. The pumps were supplied to CECo in 1973.

CECo performed a test of the Unit 3 DGCWP to obtain the torque - speed characteristic curve by developing an analytical model of the motor. Torque - speed curves would normally be obtained using a dynamometer. Due to the design of the DGCWP, the motor shaft can not be connected to a dynamometer. Dynamometer testing may also result in motor failure. Therefore, this method of testing was impractical for the Dresden DGCWP.

Alternate analytical methods are available to determine torque - speed characteristics of induction motors. Generally, these methods are not used by manufacturers as potentially destructive dynamometer testing of redundant motors is more economical than the engineering effort required to develop the analytical model. For the Dresden DGCWP, developing an analytical model of the motor based on test data was the only possible alternative. The test measured the three phase currents and voltage values from the initial inrush current until reaching a steady state value, indicating that the motor had started. Current and potential transformers were installed in the motor circuit to allow the use of a digital fault recorder to obtain the required data. The DGCWP was then started in accordance with normal station operating procedures. The testing accurately monitored the motor and pump as it is installed in the plant with the actual mechanical load applied to the pump impeller (cooling water flow to the Unit 3 diesel generator).

An analytical model of the motor was developed and benchmarked against the test data for validity. This type of motor model accurately represents the motor speed - torque curve, the changing rotor impedance with time and allows assessment of machine capability in response to available voltage. Additionally, the model can be used to predict motor behavior under all conditions, and is independent of starting voltage actually present during the test. The minimum starting voltage required to start and accelerate the motor was then calculated from the motor analytical circuit model. The assumptions, methodology and the torque - speed curve developed are documented in Attachment A.

Two requirements must be met at the minimum acceptable starting voltage. Adequate torque must be provided at reduced voltage and the protective devices must not trip on overcurrent before the inrush current drops to the steady state value. The torque - speed curve determined by the testing shows that the motor will successfully start at 70% of rated voltage. The overload relay will not trip during a degraded voltage start, and the maximum current drawn by the motor is below the trip curve of the breaker.

The motor develops adequate breakdown and pull-up torque at 70% of rated voltage to assure successful starting. The critical factor in this application, by the test data, is net accelerating torque available. A minimum value of 25% of load torque must be provided to accelerate the load in a reasonable time (approximately 50 lb.-ft. in this application). An accelerating torque of 73.8 lb.-ft. is available at 70% voltage, providing a conservative margin in the calculated result. This will accelerate the pump to operating speed in 1.65 seconds.

At locked rotor current, the overload relay will trip in 13 to 21 seconds, assuring that the thermal rating of the motor is not compromised. As the motor will start in less than two seconds, the overload will not trip the motor under starting conditions at 70% of rated voltage. The maximum current will be drawn when the motor starts under the highest expected voltage, which causes a locked rotor current of 626 Amperes at 110% of rated voltage. The 200 Amp TFJ breaker will take 27 seconds to trip at this current.

Therefore, at 70% of rated voltage or greater, the motor has adequate torque to start and no undesired protective trip will occur.

<u>CCSW Cubicle Cooler Fans</u>

The Containment Cooling Service Water (CCSW) System provides long term decay heat removal. This system has a total of four pumps. Only one CCSW pump is required for the containment cooling safety function. CCSW pumps A and B are powered from ESS Division I and pumps C and D are Division II. Two of the CCSW pumps, B and C, are located in vaults to provide protection against local flooding. Each of these two pumps have four cooler fans fed by the respective divisional power source as shown in the following table. CCSW Pumps A and D are not in vaults. Consequently, these pumps do not require cooler fans.

CCSW Pump	ESS Division	In Vault?	CCSW Cubicle Cooler Fans
A	Division I	No	None
B	Division I	Yes	A Fan 1, A Fan 2, B Fan 1 and B Fan 2
C	Division II	Yes	C Fan 1, C Fan 2, D Fan 1 and D Fan 2
D	Division II	No	None

The degraded voltage analysis used an acceptance criteria for terminal voltage for the CCSW Cubicle Cooler fans of 414 Volts for running conditions (90% of rated, based on NEMA) and 391 Volts (85% of rated) for starting. The starting value was based on conservative engineering judgment, rather than a vendor value. No information on the minimum starting voltage has been located, either as a stated value from the vendor or a torque - speed curve applicable to these motors. The voltage available to the one division of these fans is adequate for starting and running these motors at the new second level undervoltage relay setpoint for each unit (Division II fans - C and D - on Unit 2, Division I fans - A and B - on Unit 3). However, setting the relay to assure starting of the other division cooler fans (A and B on Unit 2, C and D on Unit 3) would result in an unacceptably high relay setpoint. Since the cooler fans only support operation of the CCSW Pumps in vaults, the containment cooling function is still available (this function requires only one pump as indicated above).

For the loss of all four CCSW Pumps, and a resultant loss of the containment cooling function, the simultaneous events of flood, LOCA and degraded voltage with off site power available must occur, plus a single failure of a loss of the division with adequate voltage to start the fans. This event is not considered to be credible, as it is estimated to be on the order of 9.9×10^{-12} per year (not considering the loss of one division). Therefore, the potential low voltage on the cooler fans of one division is not a concern.

<u>125 and 250 Volt Battery Chargers</u>

The nominal rating of the battery chargers is 480 Volts, not 460 Volts as most motors. Therefore, to meet the NEMA criteria of 90% voltage, 432 Volts is required at the charger terminals. Further, the manufacturer of the chargers (Power Conversion Products) has a published specification of 130 Volts ±1% output voltage from no load to 200 Amperes with an input of 480 Volts +15, -10% (values are for the 125 Volt charger; the 250 Volt charger has the same specification except for a nominal output voltage of

260). To assure 432 Volts to the chargers would require an unacceptable setpoint for the Second Level Undervoltage Relay, as a higher relay setpoint would trip the preferred power source when it is still capable of supplying the critical loads. This would challenge the diesel generators unnecessarily. Therefore, the higher relay setpoint is unacceptable, both from an operating perspective and considering overall plant safety.

The worst case battery charger is 125 V Battery Charger 3 which has 410.9 Volts at the terminals during steady state LOCA conditions (after all required motors have been started) with Summer aux power system loading. All other chargers have greater than 415V available.

The effect on the charger output at 410.9 Volts (85.6% of 480 Volt rating) has been assessed and CECo has concluded that there would be less than a 6% reduction in output voltage. This would be sufficient to prevent a discharge of the batteries. The charger maximum current output capability is also reduced; however, with off-site power available the load demand on the DC system would be less than the design basis loading (e.g. fewer breaker and solenoid operations; inverters remain on AC power). Therefore the small reduction in charger output is acceptable. Additionally it should be noted that the batteries were sized based on a loss of off site power with no credit from the battery chargers.

<u>120 Volt Starter Contactors</u>

Five safety related 120 Volt starter contactors on Dresden Unit 2 do not meet the vendor stipulated minimum voltage requirement of 75% of the 120 Volt rating at the critical voltage required for running continuous duty motors (DGCWP, etc.; the new second level relay setpoint). These contactors control motor operated valves required for LPCI injection. These valves are:

Reactor Recirculation Pump 2A Discharge Valve, 2-202-5A
Reactor Recirculation Pump 2B Discharge Valve, 2-202-5B
LPCI Injection Valve 2A, 2-1501-22A
LPCI Injection Valve 2B, 2-1501-22B
LPCI Full Flow Test Valve 2C, 2-1501-38B

There are also five safety related 120 Volt contactors on Dresden Unit 3 which do not meet the above criteria at the critical voltage level. These contactors perform the same functions on Unit 3 as the Unit 2 contactors listed above. These valves are:

Reactor Recirculation Pump 3A Discharge Valve, 3-202-5A
Reactor Recirculation Pump 3B Discharge Valve, 3-202-5B
LPCI Injection Valve 3A, 3-1501-22A
LPCI Injection Valve 3B, 3-1501-22B
LPCI Full Flow Test Valve 3A, 3-1501-38A

The valve with the lowest available voltage, LPCI Injection Valve 3A (3-1501-22B), has 68.47% of rated voltage available at the contactor at the minimum trip point of the new degraded voltage relay. Raising the relay setpoint to meet the conservative vendor voltage requirement for these contactors would result in an unacceptable relay setpoint as discussed above.

The contactors for the valves listed above were replaced during the fall 1991 outages (Unit 2 forced outage, Unit 3 refueling outage) with safety-related, environmentally qualified General Electric (GE) Series 300 contactors. CECo has tested the minimum pickup of a 300 Series contactor. The test data shows that the GE Series 300 contactor minimum pickup is 58% of rated voltage when new. The GE value for pickup of 75% is to allow aging over the useful life of the device (40 years) and to provide a margin for conservatism.

The minimum expected voltage on the safety related 4160 Volt busses under worst case loading conditions (small break LOCA with off site power available immediately following a trip from 100% power) is adequate to assure contactor operation through the spring. This is an extreme condition which would only occur at the highest off site power system loading condition with two transmission system contingencies and a LOCA on Unit 2. CECo is a summer peaking utility, and the highest off site power system loading condition occurs on the hottest day of the year. Lower loading conditions of both the transmission system and the station auxiliary power system will provide higher available voltage during Spring, 1992.

Based on; 1) the qualified GE Series contactor design which assures 75% voltage pickup at the end of its 40 year life; 2) the demonstrated 58% of rated pickup voltage of a new Series 300 contactor through testing; 3) the installation of new Series 300 contactors in all of the safety related size two starters; and 4) the minimum expected voltages during the Spring 1992 time period, all contactors will properly perform their safety function.

Modifications will be completed by March 31, 1992 to assure that there is adequate voltage for contactor pickup at the new second level relay setpoint.