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SUBJECT: Responds to NRC 881031 request for addl info re adequacy of station electrical distribution sys voltages.Project to ensure ampacity rating of cables scheduled for completion in Second Quarter 1992.

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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
ADEQUACY OF STATION ELECTRICAL DISTRIBUTION SYSTEM VOLTAGES

Gentlemen:

In accordance with your letter of October 31, 1988, this submittal provides Carolina Power & Light Company's (CP&L) response to the information requested regarding the adequacy of the Station Electrical System Voltages at the H. B. Robinson Steam Electric Plant, Unit No. 2. The enclosure to this letter provides:

A. The results of the analysis (RNP-E-8.002) performed to document the capability of the Off-Site Power System to support the electrical power system for the various modes of plant operation, including analyzed accidents.

B. A discussion of the system implemented at H. B. Robinson for assuring adequate voltages are available to support the safety-related electrical system (degraded grid voltage relay and Operating Procedures).

The electrical design basis reconstitution effort often includes the continuing reconstitution of selected electrical calculations in support of the plant design basis. The results of the analysis submitted herein are based on the reconstituted design basis, database, and information available at this time. As this program continues and additional calculations are completed, the analysis will be revised accordingly if required. Furthermore, the analysis will be modified when changes are warranted based on future plant modifications.

The analysis to assure adequacy of the emergency diesel generators is currently being revised to incorporate additional scenarios identified during the design basis reconstitution project. Therefore, the final results of this task are not currently available. Upon completion of this effort, the results will be provided. Completion is currently scheduled for the fourth quarter, 1991.

The project to assure the ampacity rating of cables is still ongoing and the results are not currently available. Upon completion of this project, the results will be provided. Completion is currently scheduled for the second quarter, 1992.

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The entire study of the electrical system voltages is a living calculation which is maintained at the CP&L Corporate Office. If the NRC staff wishes to perform an in-depth review, CP&L believes that a working meeting at the Corporate Office, similar to that held in October 1988, would be the most effective mechanism. If you have any questions regarding this matter or desire to set up a meeting, you may contact Mr. R. W. Prunty at (919) 546-7318.

Yours very truly,

S. D. Floyd

S. D. Floyd
Manager
Nuclear Licensing Section

JSK/jbw (1173RNP)

Enclosure

cc: Mr. S. D. Ebneter
Mr. L. Garner (NRC-HBR)
Mr. R. Lo

ENCLOSURE

A. AC SYSTEM VOLTAGE STUDIES
(WITH OFF-SITE POWER AVAILABLE)

To assure voltage adequacy, voltages were studied for the following conditions:

1. Steady-State Low Voltage
2. Steady-State High Voltage
3. Transient Ride-Through Voltages (transient voltage dips due to motor starting elsewhere in the distribution system)
4. Motor Starting Voltages (voltage at motor terminals)

For each of these conditions, the following plant operating scenarios were considered to determine the 'worst case' scenario for each condition:

1. Full power
2. Start-up, system fed from Start-Up Transformer (SUT)
3. Cold shutdown, system fed from SUT
4. Cold shutdown, system fed from Unit Auxiliary Transformer (UAT)
5. Hot shutdown, system fed from SUT
6. LOCA (injection phase), single bus, system fed from SUT
7. LOCA (large break recirculation phase), single bus, system fed from SUT
8. LOCA (small break recirculation phase), single bus, system fed from SUT

To evaluate the acceptability of the voltages generated by the studies, voltage criteria were established. The criteria were established by determining the limiting component at each bus. Components considered included continuously operating motors, static loads, transformer limitations, voltage relay settings, control circuits powered from the bus, and breaker/bus ratings.

The results of these studies as related to the safety systems are as follows:

I. Steady-State Low Voltage

Based on a review of the scenarios listed, it was concluded that the 'worst case' enveloping scenario for the steady-state low voltage on the emergency power system would be a LOCA (recirculation phase) with the system fed from the 115 kV switchyard via the SUT at the lowest predicted switchyard voltage of 113.7 kV.

The following conservatisms/conditions were assumed during the conduct of this study:

1. The switchyard voltage used in the steady-state low-voltage calculation is 113.7 kV, the lowest voltage to which the system is expected to drop upon loss of plant generation. This is conservative, as no credit is taken for grid voltage recovery during the event. Some recovery would be expected due to equipment on the transmission system responding to the drop in grid voltage.

2. No credit is taken for manual load shedding.

3. Non-safety loads that may come on automatically are modeled as operating.

4. The emergency power system is conservatively modeled with both trains loaded to a level commensurate with that which would be expected with the opposite train unavailable. This results in a conservatively high estimation of the voltage drop through the system.

The calculated safety bus voltages under this scenario and the above conditions are as follows:

BUS NAME	BUS RATING (V)	STEADY-STATE VOLTAGES PREDICTED (V)	CRITERIA* (V)
E1	480	444	428
E2	480	446	428
MCC 5	480	436	420
MCC 6	480	439	423
MCC 16	480	440	419
MCC 18	480	442	419
MCC 9	208	189	189
MCC 10	208	188	190
PP 60	208/120	189	184
PP 62	208/120	190	184

*The criteria were established by determining the limiting component at each bus. Components considered included continuously operating motors, static loads, transformer limitations, voltage relay settings, control circuits powered from the bus, and breaker/bus ratings.

As shown above, with the switchyard at the lowest predicted voltage, continuous-duty safety-related equipment will operate within the manufacturers' recommended voltage range (with the exception of Battery Room Exhaust Fan B fed from MCC 10, which has been evaluated as acceptable [89 percent voltage vs. rated 90 percent voltage]); safety-related MCC control circuits will function properly; and spurious separation of the emergency power system from the off-site source will not occur.

II. Steady-State High Voltage

During full-power operation, safety-related busses E2, MCCs 6, 18, and 9 and power panel 62 are supplied from the 115 kV switchyard via the start-up transformer. Busses on the opposite train are supplied from the generator via the unit auxiliary transformer.

Based on a review of the scenarios listed, it was found that the worst case high voltages would occur on the busses connected to the start-up transformer during normal full-power operation with the switchyard at its maximum scheduled voltage of 117.5 kV.

BUS NAME	BUS RATING (V)	STEADY-STATE VOLTAGES PREDICTED (V)	STEADY-STATE VOLTAGES CRITERIA* (V)
E2	480	506	506
MCC 6	480	505	506
MCC 18	480	506	506
MCC 9	208	218	229
PP 62	208/120	217	220

*The criteria were established by determining the limiting component at each bus. Components considered included continuously operating motors, static loads, transformer limitations, voltage relay settings, control circuits powered from the bus, and breaker/bus ratings.

Actual voltages are expected to be lower than the above predicted voltages due to conservatisms in the high-voltage analysis, such as disregarding cable voltage drop and the use of the 'spare' start-up transformer impedance, which is lower than that of the installed transformer.

It has been identified that voltages higher than predicted are occurring in the switchyard under conditions of light loading on the CP&L system. To mitigate overvoltages on the safety system, procedures have been put in place to transfer loads, thereby reducing bus voltages, when these light loading periods occur.

III. Transient Ride-Through Voltages

Based upon the scenarios listed, an analysis was conducted to determine which safety motors, upon starting, will most impact bus voltages. The worst case scenario was determined to be a LOCA condition with the plant distribution system fed from the 115 kV switchyard via the SUT and the switchyard at its minimum predicted voltage of 113.7 kV. Service Water Pumps B and C, the Service Water Booster Pumps, and Containment Spray Pumps A and B starting simultaneously represent the worst case starting motors. (Service Water Pump and Service Water Booster Pump starting are initiated at the same time. The Containment Spray Pump, which has a random start, was assumed to start simultaneously with the Service Water Pump and the Service Water Booster Pump).

The following conservatisms/conditions were assumed during the conduct of this study:

1. The switchyard voltage used in the calculation is 113.7 kV, the lowest voltage to which the system is expected to drop upon loss of plant generation. This is conservative, as no credit is taken for system recovery during the event. Some recovery would be expected due to equipment on the transmission system responding to the drop in grid voltage.

2. No credit is taken for manual load shedding.

3. Non-safety loads that may come on automatically are modeled as operating.

4. The emergency power system is conservatively modeled with both trains loaded to a level commensurate with that which would be expected with the opposite train unavailable. This results in a conservatively high estimation of the voltage drop through the system.

5. These motors are modeled as starting simultaneously, resulting in conservatively low voltages. In actuality, some delay between starting times would be expected. This is especially true of the Containment Spray Pump, which is started by process signals rather than the sequencer.

6. During operation, some of the Service Water Pumps and one Service Water Booster Pump would be running and would therefore not need to be started upon initiation of an accident. The conservative approach of the analysis, assuming these pumps are off prior to the accident, results in a conservatively low voltage.

The results of this study are as follows:

BUS NAME	BUS RATING (V)	STEADY-STATE VOLTAGES PREDICTED (V)	STEADY-STATE VOLTAGES CRITERIA* (V)
E1	480	408	363
E2	480	410	362
MCC 5	480	399	352
MCC 6	480	403	355
MCC 16	480	384	351
MCC 18	480	385	351
MCC 9	208	173	158
MCC 10	208	172	159
PP 60	208/120	165	156
PP 62	208/120	165	156

*The criteria were established by determining the limiting component at each bus. Components considered included continuously operating motors, static loads, transformer limitations, voltage relay settings, control circuits powered from the bus, and breaker/bus ratings.

As shown, safety system voltages will be adequate during the starting of the safety-related motors.

IV. Motor Starting Voltages

Worst case motor starting voltages (voltages at the motor terminals) will occur during LOCA Injection with the plant distribution system fed from the 115 kV switchyard via the SUT. The switchyard voltage is assumed to be at the minimum predicted voltage of 113.7 kV. Each bus was examined for the limiting motor(s) on that bus. Considerations for determining the limiting motor(s) included locked rotor current of the motor, motor starting voltage requirements, and feeder cable length and size. To envelope all equipment fed from the bus, all motors, including non-safety, were considered. The Containment Spray Pump, which is a random start motor, was assumed to start concurrently with the limiting motor(s).

1. The switchyard voltage used in the calculation is 113.7 kV, the lowest voltage to which the system is expected to drop upon loss of plant generation. This is conservative, as no credit is taken for system recovery during the event. Some recovery would be expected due to equipment on the transmission system responding to the drop in grid voltage.

2. No credit is taken for manual load shedding.

3. Non-safety loads that may come on automatically are modeled as operating.

4. The emergency power system is conservatively modeled with both trains loaded to a level commensurate with that which would be expected with the opposite train unavailable. This results in a conservatively high estimation of the voltage drop through the system.

5. The starting motor(s) is modeled as starting simultaneously with the Containment Spray Pump, resulting in conservatively low voltages. In actuality, some delay between starting times would be expected. This is especially true of the Containment Spray Pump, which is started by process signals rather than the sequencer.

Based on the above considerations, the following cases were identified as potential 'worst case' and examined:

BUS	LIMITING MOTOR (MOTOR BEING STARTED[(1)])
E1 or E2	Auxiliary Feedwater Pumps (AFW)
E1 or E2	Service Water Pumps (SWP)[(2)]
MCC 5 or MCC 6	Exhaust Fans HVE-2
MCC 5 or MCC 6	Control Rod Drive Fans HVH-5
MCC 9 or MCC 10	Instrument Air Dryers (IAD)
MCC 16 or MCC 18	Service Water Booster Pumps (SWBP)[(2)]

NOTES:

(1) Containment Spray Pump (CSP) is considered to be starting concurrently in all cases. See text.

(2) Service Water Pumps and Service Water Booster Pumps are considered to be starting concurrently. See discussion under "Transient Ride-Through Voltages."

The calculated motor terminal voltages under these scenarios and the above conditions are as follows:

MOTOR NAME	MOTOR TERMINAL VOLTAGES	
	PREDICTED[1] (V)	CRITERIA (V)
CSP[2]	386	345
AFW	403	368
SWP	348	345
SWBP	370	345
IAD	179	166
HVE	397	368
HVH	392	368

NOTES:

(1) Voltage represents the lower of the Train A or Train B predicted voltages.

(2) Voltage represents lowest of six cases described above.

As shown above, with the switchyard at the lowest predicted voltage, continuous-duty safety-related motors will have adequate terminal voltage to assure the capability of the motor to start.

B. Degraded Grid Voltage

The degraded grid voltage relays are presently set to disconnect the 480 V emergency busses from the off-site power distribution system and transfer these busses to their associated emergency diesel generators at 415 ± 4 V. Evolving from the design basis reconstitution efforts for the Electrical Power Distribution System (EPDS), it has been determined that the voltage setting of the degraded grid voltage relays is based on contactor pick-up voltage requirements at the MCC level. This allows operation of continuous-duty motors at less than minimum rating (typically 90 percent of nameplate rating) for short periods of time, crediting operator response actions to ensure voltage restoration of the emergency power distribution system (reference CP&L to NRC letters GD-79-222 and NG-77-097, dated 1-24-79 and 2-17-77, respectively).

Operator intervention is initiated by two methods: (1) switchyard voltage alarm actuation and (2) notification from the load dispatcher. The voltage alarm is set at 115 kV ± 1 kV, which is substantially higher than the analyzed limit for maintaining minimum rated voltage at safety-related motors (108.7 kV for normal operation and 110.9 kV for accident loading). Following alarm actuation or notification from the load dispatcher, the operator is procedurally required to monitor the 480 V emergency bus voltage and transfer the busses to their respective diesel generators should the voltage continue to decrease to the analyzed limit.

To alleviate the need for operator intervention, consideration is being given by our current analysis to increasing the degraded grid voltage relay setting. To this end, plant modification 1043 replaced the old ITE type 27D relays with more accurate ABB type 27N undervoltage relays during Refueling Outage No. 13. The 27D relays could not support a setpoint increase due to the wide pickup to dropout ratio which they exhibited. Should our ongoing analyses conclude that a setpoint change is appropriate, a Technical Specification Change Request will be submitted.

For conservatism, however, the studies conducted for the current analysis consider manufacturer's specified voltage range for motors (typically rated ± 10 percent) in establishing steady-state voltage criteria.