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TO: R.W.REID

FROM: CAROLINA PWR & LIGHT CO.
RALEIGH,N.C.
E.E. UTLEY

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PROP

INPUT FORM

DESCRIPTION

LTR. RE. THEIR 10/12/~~77~~ 76 LTR. AND OUR 8/12/76 LTR...
RESPONSE TO SPECIFIC QUESTIONS OF ENCLOSURE 2 OF OUR REFERENCED LTR.CONCERNING THE EFFECTS OF DEGRADED GRID VOLTAGE ON UNIT OPERATION...

(5P)
(1 SIGNED CY. RECEIVED)

PLANT NAME: H.B. ROBINSON# 2

ENCLOSURE

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ACKNOWLEDGED

FOR ACTION/INFORMATION — SAB 3/2/77

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Carolina Power & Light Company

February 17, 1977

FILE: NG-3514(R) SERIAL: NG-77-097

Mr. Robert W. Reid, Chief
Operating Reactors Branch No. 4
Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

H. B. ROBINSON UNIT NO. 2
LICENSE NO. DPR-23
DOCKET NO. 50-261
EFFECTS OF DEGRADED GRID VOLTAGE ON UNIT OPERATION

Dear Mr. Reid:

Our letter of October 12, 1976, provided partial response to your letter of August 12, 1976, requesting information on the vulnerability of the H. B. Robinson Unit No. 2 facility to degraded grid voltage conditions of a similar nature to the ones experienced on Millstone Unit 2. We are now able to provide a complete response to your request for information as the voltage drop analysis for our facility has been completed by Ebasco Services, Inc.

The following are responses to specific questions of Enclosure 2 of your letter. The responses are numbered the same as the questions of Enclosure 2.

1a. Response is given in our letter of October 12, 1976.

1b. The normal operating range of the grid system voltage and the corresponding voltage values at the safety-related busses are as follows for the condition noted:

Status	Grid Voltage	Corresponding Voltage at
Full Load	.95 - 1.06 per Unit (PU) (115 KV Nominal)	Bus E1 = 433 - 495 Bus E2 = 426 - 488 MCC 5 & 5A = 430 - 492 MCC 6 & 6A = 423 - 486

1c. The voltage profiles at the safety-related busses for the full-load and no-load conditions on the system and the corresponding range of grid voltage are as follows:

A. Status: Full Load - Voltage given in response to 1b.

B. Status: No Load*

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Grid Voltage .95 - 1.06 PU

Corresponding Voltage at

Bus E1 = 479 - 534
Bus E2 = 479 - 534
MCC 5 & 5A = 479 - 534
MCC 6 & 6A = 479 - 534

*Note: The computer program study utilizes lightly loaded conditions (a more realistic loading) and no-load conditions at the 4KV and 480V busses.

The no-load voltages listed above are based on the no-load 4KV bus voltage transformed to safety busses assuming no transformer regulation. The following results were obtained for a light-load condition:

Status: Light Load

Grid Voltage - .95 - 1.06 PU

Voltage at - Bus E1 = 468 - 524
Bus E2 = 474 - 530
MCC 5 & 5A = 461 - 517
MCC 6 & 6A = 468 - 524

The worst case limiting condition on voltage degradation is the pick-up voltage of the load control starter. This voltage has been determined by the Ebasco study based on the characteristics of the starter. If the control transformers (CT's) are replaced with CT's of different rating as per recommendations of Section 4, the worst case pick-up voltage of 404 volts at the busses is not violated at any condition of bus loading or normal grid voltage swing. The drop-out voltage of the starter, approximately 291 volts, is not approached under any condition of loading or normal grid voltage swing regardless of the control transformer size.

1d. A computer study was performed which varied generator voltage (22KV) over a range of .95 to 1.05 PU. This study indicated the voltage values at Bus E1 and MCC 5 and 5A. Since Bus E2 and MCC 6 and 6A are never connected to the auxiliary transformer, the analysis of the voltage on these busses has already been presented in Responses 1b. and 1c.

The following are voltage values at Bus E1 and MCC 5 and 5A for the voltage swing described above:

Generator Voltage - .95 - 1.05 PU

Voltage at E1 = 444 - 507
MCC 5 & 5A = 441 - 504

Again, it is noted that the pick-up voltage (404V) and the drop-out voltage (291V) of the load control starter are not violated during this voltage swing. For low-voltage trip, see the following response.

1e. The safety-related, under-voltage relays are located at Busses E1 and E2. The trip setpoint is 328 volts. Although original design documents do not reveal the basis for the trip point selection, the value was apparently chosen to allow starting of the larger (6000 hp) motors under minimum system or generator voltage and also to be above the worst case contactor drop-out voltage, 291 volts.

1f. The voltage at the safety-related busses corresponding to maximum grid voltage is given in Response 1b. above. The grid voltage that corresponds to the undervoltage trip setpoint (328 volts on safety busses) is approximately .85 PU (97.8KV) for the x winding (for Bus E1) and .84 PU (96.6KV) for the y winding (for Bus E2).

1g. Attachment 1 to this letter lists the criteria used to establish the system constraints during various plant operating conditions. This criteria is utilized to establish constraints for both safety and nonsafety-related loads. In addition, criteria is established for both transient and continuous operation. From this criteria the following definition of voltage range has been developed for continuous operation of safety-related and nonsafety-related components:

1. System Voltage

   .95 PU to 1.06 PU (109.2KV to 121.9KV)

2. Generator Voltage

   .95 PU to 1.05 PU (20.9KV to 23.1KV)

In this range of operation, the components will operate continuously in the performance of their design function. In addition, this range of operation will assure the capability of all safety-related loads, including related control circuitry and instrumentation, to perform their safety function.

It is noted that periodic operation of motors outside of the lower and upper voltage limits of 414V and 506V will not create any detrimental conditions or operating restrictions; however, the operator should take corrective action as recommended in Section 4. In addition, transient conditions that would be experienced during large motor starting could cause operation of motors outside of the voltage limits. If the transient persists, then the same recommendation applies as given above.

Based on the results of computer programs and miscellaneous calculations, it can be demonstrated that no safety-related starter contactor will drop out under the system or generator conditions analyzed. It can be further demonstrated that under steady state conditions, assuming recommended changes in control transformer sizes are made per Section 4, all safety-related contactors will pick up.

1h. Response is given in our letter of October 12, 1976.

2. Response is given in our letter of October 12, 1976.

3. Response is given in our letter of October 12, 1976.

4. Recommendations:

The control transformer analysis performed by Ebasco indicates that the transformer impedence is the predominant factor in determining the available voltage at the starter contactor coil. Utilizing information provided by Westinghouse, it was determined that changing the control transformers from 50 VA to 150 VA for starter Sizes 1 and 2 and from 150 VA to 300 VA for starter Sizes 3 and 4 results in a lessening of the motor control center voltage requirements necessary for proper operation of the system. Therefore, the allowable voltage range for the grid and main generator is increased. Pursuant to this recommendation, we have purchased the required control transformers for MCC's 5, 5A, 6, and 6A. A modification document has been prepared to install the control transformers and preparations are being made to install them upon receipt of compatible fuses recommended by Westinghouse.

As previously noted, it is important that the operator be made aware of voltage conditions which exceed equipment limitations. Based on this requirement, it is recommended by the Ebasco study that an undervoltage and overvoltage relay be added to each of the safety-related power centers (E1 and E2). The output of each of these relays should be paralleled into a timing relay (15 seconds to allow for large motor starting) and resultant pick up alarmed

to the operator as "abnormal safety Bus voltage." This would allow the operator to take the necessary corrective actions to remedy the situation.

Pursuant to this recommendation, we will purchase the necessary equipment and develop the required modification documents for implementation.

The degraded system voltage study has established that if the recommended modifications are implemented, then all safety-related loads will start and operate properly above .95 PU of nominal grid voltage (115KV). It should be noted that safety-related loads can be started and operated even below .95 PU of nominal grid voltage. However, since we have already established an interim measure for initiating corrective voltage restoration action at .95 PU of nominal grid voltage, we intend to maintain this same procedure on a permanent basis. The procedure is as described in our October 12, 1976, letter whereby the diesel generators are required to supply the emergency busses if grid voltage drops below .95 PU. This procedure will provide adequate protection in the unlikely event that the 115 KV bus voltage should fall below .95 PU of nominal voltage due to system conditions.

Very truly yours,

E. E. Utley
Senior Vice President
Power Supply

WH:jfc

cc: Mr. W. G. McDonald
Mr. E. Volgenau

ATTACHMENT 1

The following criteria will be used to establish the system constraints during various plant operation conditions:

EQUIPMENT	NAMEPLATE RATING	VOLTAGE CONSTRAINTS CONTINUOUS	VOLTAGE CONSTRAINTS TRANSIENT	REMARKS
Motors	4.0 KV	± 10% (3600 to 4400 V)	-15% starting (3400 volts) -30% running voltage drop (2800 volts)	These are the values assumed for all motors except for those supplied by the NSS. For NSS motors, it is assumed that starting voltage should not be less than 80% (3200 volts). This same characteristic is assumed for the feedwater pump.
	460 V	± 10% (414 to 506 V)	-25% starting (345 volts)-30% running voltage drop (322 volts)	These values are assumed for all safety-related 460 V Motors.
Station Service	4.16 KV	+10% (4576)-no load +5% (4368)-loaded	+10%(4576)	This is industry standard for upper limit of voltage at rated frequency. Also, should the tap setting of the transformer be varied from 4.16 KV, the +10% constraint is applied to the new tap setting.
Transformers	480 V	+10% (528)-no load +5% (504)-loaded	+10% (528)	
Contactors		Required Pickup Voltage*	Does not go below drop-out voltage	These voltages are at the starter terminals. The corresponding voltages at the MCC's are included in the Degraded System Voltage Study.
	Size 1	92 Volts	64 Volts	
	Size 2	95 Volts	53 Volts	
	Size 3	91 Volts	72 Volts	
	Size 4	91 Volts	72 Volts	

*Westinghouse A/200 contactor data dated 9/20/66