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BECo. Ltr. #81-129

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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

License No. DPR-35
Docket No. 50-293

Further Information on Station Electric Distribution System Voltages

References:
1. Boston Edison Letter (G. C. Andognini) to NRC (D. L. Ziemann) dated November 15, 1976.
2. Boston Edison Letter (G. C. Andognini) to NRC (T. A. Ippolito) dated March 28, 1980.
3. Telecon with BECo & NRC Personnel on PNPS Electric Distribution, dated February 10, 1981.

Dear Sir:

In a telecon discussion on February 10, 1981, (Ref. 3), clarification was provided as to specific and/or alternative information which would be acceptable in order for your staff to complete its review of the Electric Distribution System Voltages at Pilgrim Station. As a result of this discussion, questions were formalized and transmitted by your letter dated February 12, 1981. Our response to those questions is presented as follows:

Question #1:

Per Guideline 1, Reference 4, submit an analysis for the 23kV connection (second offsite source) through the shutdown transformer to the Class IE buses.

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Response:

The normal operating range of Pilgrim Station's 23kV system voltage is between 23.4kV and 22.23kV (23.4kV + 0% - 5%). We have calculated and presented in Table 1, voltage profiles at the safety related buses for

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full load and no load conditions on the above 23kV system range. These calculations are extremely conservative in that (i) there is no credit taken for the capacitor bank on the primary side of the shutdown transformer (capacitor bank is installed to improve 23kV system voltage and minimize the effects of motor starting) (ii) we are assuming the shutdown transformer is supplying both the emergency buses (A5 & A6) simultaneously at full load. This would only occur with LOCA coincident with the loss of 345kV system, the failure of two (2) diesel generators to start and the vacuum breaker closed by-passing the subject capacitor bank. Although these conditions occuring simultaneously is extremely improbable, we feel the resulting analysis supports our contention that the 23kV system provides adequate power at acceptable voltages to the subject safety related equipment.

Question #2:

Provide the manufacturer's recommended minimum starting voltage for all Class IE loads.

Response:

Safety-related motor specifications for Pilgrim #1 require that all Class IE motors shall be capable of starting and accelerating the required loads with 80% rated nameplate voltage at the motor terminals. This results in the following voltage at the motor terminals:

a. 4000V motors connected to the 4160V safety-related buses require 3200V at the motor terminals for starting and accelerating.

b. 460V motors connected to the 480V safety-related buses require 368V at the motor terminals for starting and accelerating.

Our review of the manufacturer's recommended minimum starting voltage for Class IE load verified the above specification requirements.

Question #3:

Provide the voltage drops from the Class IE buses to the terminals of all Class IE loads for all cases analyzed.

(Telecon Clarification)

Envelope the "all Class IE loads for all cases analyzed" into worst case.

Response:

In Reference (1), Table 1 and Table 2 provide voltage profiles at the safety-related buses for the following cases:

a. When the station auxiliaries are supplied through the unit auxiliary transformer.

b. When the station auxiliaries are supplied through the startup transformer.

These voltages are calculated for normal operating ranges of 345kV grid system voltage with no load and full load conditions.

We have calculated the voltage drops from the Class IE buses to the terminals of Class IE loads. Voltage drops are given in the attached Table 2. Based on these voltage drops and voltage profiles given in Table 1 and Table 2 of Reference (1), we have calculated the voltages at the terminals of the safety-related loads for the worst case condition. Calculations verify that the voltages at the terminals of safety-related loads are within the operating ranges of the equipment.

Question #4:

Define the plant operating mode and the loading of the Class IE buses for the conditions identified as "Full Load" and "No Load" in Reference 2, Table 2.

(Telecon Clarification)

BECo can provide its own definitions for "full load" and "no load".

Response:

Full-Load LOCA condition with preferred offsite power (345kV) available. This means all RHR and Core Spray pumps are running and most of the station auxiliaries are connected.

No-Load Minimum loads required during refueling outage period when the station auxiliaries are supplied through the 345kV offsite power system.

Question #5:

Per Guideline 3, Reference 4, provide an analysis of the effect on all Class IE equipment when starting and running the largest non-Class IE load when the Class IE buses are heavily loaded during a LOCA. Also submit a transient analysis for bulk Class IE load starting (no sequential loading) during a LOCA. The analyses should confirm that the second-level of undervoltage protection relays do not drop out during these load starting conditions. The starting of the largest non-Class IE load will have an effect on the Class IE bus voltage regardless of the load location.

Response:

Case 1: Effect on all Class IE equipment when starting and running the largest non-Class IE load when the Class IE buses are heavily loaded during LOCA.

At Pilgrim Station Unit #1, the Class IE loads are connected to the "X" winding of the startup and unit auxiliary transformers. The largest non-IE load (Reactor Feedwater Pump, 5000 HP) is connected to the "Y" winding of the startup and unit auxiliary transformers. Startup and unit auxiliary transformers are three winding transformers. with one primary and two secondary windings (X and Y).

During the LOCA condition with 345 kV system available, the auxiliary loads are supplied through the startup transformer. In order to determine the effect of starting the largest non-IE load on Class IE buses, the equivalent circuit of the three winding startup transformer has been developed. (Please refer to: "Elements of Power Systems Analysis" by William D. Stevenson; Second Edition; Page 169.)

In Pilgrim Station #1, the largest non-IE load is the Reactor Feedwater Pump which has the following rating:

Rated HP - 5000 @ 4000V
Full Load Amp - 578 amps
Starting Current - 37555 amps
Starting KVA - 27.0 MVA

With the minimum voltage at the 4160V bus during LOCA condition, the voltage drop at the Class IE buses for starting the largest non-IE load on the Y winding of startup transformer is about 55V for less than 9 seconds. This voltage drop will not effect the Class IE systems and The second-level of undervoltage relays will not drop out.

Case 2: Transient analysis of bulk Class IE load starting during LOCA.

To analyze this condition, we have considered the simultaneous starting of all Class IE loads (RHR and Core Spray pumps) with Class IE buses fully loaded with a minimum voltage at the 345kV grid.

Due to starting of bulk Class IE loads during LOCA condition, the voltage drop at the 4160V safety-related buses will be about 300 volts for less than 6 seconds.

Due to the duration of this voltage drop, the second-level of undervoltage relays will not drop out during the starting of these loads.

This study verifies that the onsite distribution system in conjunction with offsite power sources has sufficient capacity and capability to automatically start, as well as operate, all required Class IE loads within their required voltage ratings. There will be no spurious tripping from the offsite sources due to:

(i) short-term voltage degradation of the offsite power source;

(ii) starting and running the largest non-class IE load when the Class IE buses are heavily loaded during LOCA;

(iii) starting of bulk Class IE loads during LOCA.

We trust this information is adequate to enable your staff to complete its review on this subject. However, should additional information or clarification be necessary, please feel free to contact us.

Very truly yours,

A.V. Morisi

Attachments:
Tables 1 and 2

Table #1
Pilgrim Station #600
Voltage Profiles at the Safety-Related Buses When
the Station Service is Supplied from Shutdown XFMR.
(23kV System)

	22.2 kV		23.4 kV	
Safety Related Bus	No Load	Full Load	No Load	Full Load
A5	3988 v.	3765 v.	4193 v.	3974 v.
A6	3988	3765	4193	3974
A7 B1, B6	472	438	499	463
B2	472	438	499	463
B15	469	430.5	494	456
B17	469	430.5	494	456
B10	470	437	494	462
B20	470	437	495	462
B14	470	433	494	458
B18	470	433	494	458

Full Load All RHR and Core Spray Pumps are running and load center transformers X21 and X22 are fully loaded.

No Load Load center transformers X21 and X22 are 50% loaded and no loads on A5 & A6 buses.

TABLE #2

VOLTAGE DROPS FROM CLASS IE BUSES
TO THE TERMINALS OF CLASS IE LOADS

FROM BUS	TO	VOLTAGE DROP (VOLTS)
A5	P-203A	5
A5	P-203C	4.9
A5	P-215A	5.1
A6	P-203B	2.3
A6	P-215B	2.2
B1	P-110A	7.5
B2	P-110B	7.2
B10	X19	5.4
B10	125V DC Backup Charger	5.7
B10	MO-4127	9
B10	MO-4126	11
B10	P-208C	14
B14	125V DC Charger "B"	18
B14	VGTF-201B	17
B14	V-EX-104B	8
B14	V-EX-210B	14
B14	P-202D	5
B14	P-202E	6
B14	P-202F	6
B14	P-208D	7.5
B14	P-208E	8
B14	P-141B	7
B14	MO-3806	4.4
B14	MO-3805	4.4
B15	125V DC Charger "A"	16
B15	V-EX-104A	8
B15	V-EX-210A	15
B15	P-202A	6
B15	P-202B	6.8
B15	P-202C	6.4
B15	P-208A	16
B15	P-208B	15
B15	P-141A	7
B15	MO-3801	5.2
B15	MO-3800	5.3
B17	C-103A	8.8
B17	V-AC-202B	9.1
B17	V-AC-202A	9.1
B17	V-AC0204A	13.6
B17	V-AC-204B	9.2
B17	MO-1400-3A	6.2
B17	MO-1400-4A	6.2
B17	MO-1400-24A	8.8
B17	MO-1400-25A	11.7
B17	MO-1001-7A	6.1
B17	MO-1001-7C	6.1
B17	MO-1001-18A	5.6
B17	MO-1001-23A	7.9
B17	MO-1001-26A	5.7

FROM BUS	TO	VOLTAGE DROP (VOLTS)
B17	MO-1001-16A	9
B17	MO-2301-4	7.9
B17	MO-1001-34A	6.8
B17	MO-1001-36A	5.9
B17	MO-1001-37A	5.8
B17	MO-1001-43C	6.2
B17	MO-4060B	5.7
B17	MO-4085A	5.9
B17	MO-4084	5.7
B17	VSF-103A	8.5
B17	Y3	5.6
B18	C104A	11.3
B18	V-AC-201B	8.8
B18	V-AC-201A	7.4
B18	V-AC-204C	8.2
B18	V-AC-204D	8.5
B18	MO-1400-3B	5.9
B18	MO-1400-4B	5.6
B18	MO-1400-24B	9.1
B18	MO-1400-25B	14
B18	MO-1001-7B	6
B18	MO-1001-7D	5.9
B18	MO-1001-18B	5.4
B18	MO-1001-23B	7.0
B18	MO-1001-26B	7.0
B18	MO-1001-16B	8.2
B18	MO-1301-16	5.5
B18	MO-1001-34B	7.8
B18	MO-1001-36B	5.7
B18	MO-1001-43B	5.8
B18	MO-1001-43D	5.8
B18	MO-4010A	5.6
B18	MO-4010B	5.6
B18	MO-4009A	5.5
B18	MO-4009B	5.3
B18	MO-4002	5.4
B18	MO-4087	5.3
B18	VSF-103B	9.8
B18	Y4	5.9
B20	MO-1001-29A	7.4
B20	MO-1001-29B	12.4
B20	MO-1001-28B	12.6
B20	MO-1001-19	5.8
B20	MO-1001-32	5.7
B20	MO-1001-50	7.7
B20	MO-1001-50	7.6
B20	MO-1001-63	5.6
B20	MO-1201-2	5.6
B20	MO-1201-80	6.0
B20	MO-220-1	5.4
B20	MO-2081	10.8
B20	MO-202-5A	8.6
B20	MO-202-6A	8.3

FROM BUS	TO	VOLTAGE DROP (VOLTS)
B20	MO-202-9A	5.5
B20	MO-202-4B	12.0
B20	MO-202-5B	8.7
B20	MO-202-6B	8.6
B20	MO-202-9B	5.5