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DESCRIPTION:	ENCLOSURES:
Ltr re our 7-26-74 ltr.......furnishing info concerning reactor building spray pump motors..... W/Attached calculations analyzing the starting voltage drop of the reactor building spray pump motors...........	

PLANT NAME: Three Mile Island Unit # 1

FOR ACTION/INFORMATION 9-20-74 AB

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METROPOLITAN EDISON COMPANY

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September 13, 1974
GQL 0326

Mr. A. Schwencer, Chief
Light Water Reactors Branch 2-3
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Schwencer:

Subject: Three Mile Island Unit 1
Docket No. 50-289
Operating License No. DPR-50
Reactor Building Spray Pump Motors

Reference: AEC Letter Dated July 26, 1974 from
Mr. A. Schwencer to Mr. R. C. Arnold

1485 238

In response to your letter of July 26, 1974 questioning the ability of the Reactor Building Spray Pump Motors to accelerate under degraded off-site power conditions, we submit the attached five pages of calculations analyzing the starting voltage drop of the Reactor Building Spray Pump Motors.

As noted in your letter, the Engineered Safeguard sequencing will be initiated from the off-site power system, if available. The reasoning behind this design feature is the strength of the off-site power system. Another point to note in the ES sequencing on off-site power, is the time available for the spray pump to accelerate. When ES sequence is actuated with off-site power, the block loading sequence starts immediately without encountering the delay necessary for the diesel to start and come up to speed. The spray pumps, starting in block 4, will receive a start signal in approximately 18 seconds. The FSAR requires the spray pumps to be up to speed 37.5 seconds after the ES condition. Therefore, on off-site power, the Reactor Building Spray Pumps have approximately 19 seconds to accelerate. (As you will see from the voltage drop calculation, the spray pump will accelerate at a near normal rate.)

The voltage drop calculations are self explanatory but certain criteria and assumptions will be briefly summarized. Per the AEC guidelines of its July 26, 1974 letter, the maximum system impedance was determined. A second condition was maximum transformer loading when starting the spray pumps. The transformer loading used was an actual recorded reading while TMI Unit 1 was supplying load to the system. (The reactor output at the time of the reading was near 100%). These two conditions used together leads to an extremely

9571

conservative situation. A second degree of conservatism is the requirement that the infinite bus is required to be located "somewhere" on the system, connected to the TMI substation via an impedance.

Finally, under the conditions described above, the voltage drop at the motor terminals could drop to a value of 96.88% of motor nameplate voltage rating. This value is well within acceptable limits, since the motor manufacturer has stated that at 90% of motor nameplate voltage rating, the motor will accelerate to full load in 6.0 seconds.

In addition to the conditions analyzed in this letter, an additional system condition is being investigated. This condition would involve the simultaneous loss of lines and off-system generating units which support the 230 KV voltage at TMI, and although highly improbable, could produce a 230 KV bus voltage at TMI of approximately 95% of normal. Although rough calculations for this condition show acceptable spray pump acceleration time, we are proceeding to analyze this case in depth and we will provide your office with the results as a supplement to this report on September 30, 1974.

If we can be of further assistance, please feel free to contact us.

Very truly yours,

R. C. Arnold
R. C. Arnold
Vice President

RCA:tas

1485 237

cc: George F. Trowbridge, Esq.
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GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.	CLIENT: Metropolitan Edison	FILING CODE
	PROJECT: Three Mile Island Unit 1	W.O. 4192 / PAGE 1 of 5
SYSTEM/EQUIPMENT: Bldg Spray Pump	CALCULATION APPLICABLE TO: Starting Voltage Drop	ENGINEER: P. J. Shoppen Jr / DATE 9-5-74
		REVIEWED BY / DATE

Base MVA - 15
Base Voltage - 4160
Base Amperes - 2081.85
Base Ohms - 3.46

System Infinite Bus
232.76 KV (See Calculation Pg 4)

Max. System Impedance
0.0057 + j 0.0574 Ω on 100 MVA Base

Transformer Impedance
0.0376 + j 0.0754 Ω on 15 MVA Base

Bus Resistance
2.41×10^{-6} Ω/ft 316 ft

Cable Impedance
0.050 + j 0.0323 Ω/1000 ft 400 ft

Bldg Spray Pump Motor
Starting Current 231 Amps
@ 0.20 pf (assumed)

Transformer Loading: Turb Plt Bus 1A - 900 A
" " " 1B - 700 A
Eng. Safeguard 1E - 200 A
Total 1800 A

High Side pf - 0.87

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	PROJECT: Three Mile Island Unit 1	W.O. 4192	PAGE 2 OF 5
SYSTEM/EQUIPMENT: Bldg Spray Pump	CALCULATION APPLICABLE TO: Starting Voltage Drop	ENGINEER: R.J. [illegible] DATE 5-9-74	
		REVIEWED BY DATE	

System Impedance Converted To 15MVA Base

$$(0.0057 + j0.0574)\ {}^{15}/_{100} = 8.55 \times 10^{-4} + j0.00861$$

Per Unit Ohms - Bus

$$(2.41 \times 10^{-6})(316)/3.46 = 7.61 \times 10^{-4}/3.46$$

$$= 0.00022$$

Per Unit Ohms - Cable

$$\left[(0.050 + j0.0323)\ {}^{400}/_{1000}\right]/3.46$$

$$(0.02 + j0.01292)/3.46$$

$$= 0.00578 + j0.00373$$

Total Per Unit Impedance From System To The Motor

System	0.000855	+ j 0.00861
Transformer	0.0376	+ j 0.0754
Bus	0.00022	
Cable	0.00578	+ j 0.00373
Total	0.0445	+ j 0.0877

1485 242

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Load Current

$I_L = (900+700+200)(0.87 - j0.494)/2081.85$

$= (1800)(0.87 - j0.494)/2081.85$

$= (1566 - j884.2)/2081.85$

$= 0.7522 - j0.4271$

Motor Starting Current

$I_M = 231(0.20 - j0.98)/2081.85$

$= (46.2 - j226.38)/2081.85$

$= 0.0222 - j0.1087$

Total Current

$I = I_L + I_M$

$= (0.7522 - j0.4271) + 0.0222 - j0.1087$

$= 0.7744 - j0.5358$

GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.	CLIENT: Metropolitan Edison	FILING
	PROJECT: Three Mile Island	W.O. 4192 / PAGE 4 OF 5
SYSTEM/EQUIPMENT: Bldg Spray Pump	CALCULATION APPLICABLE TO: Starting Voltage Drop	ENGINEER: [signature] DATE 9-5-74
		REVIEWED BY / DATE

System Voltage Will Be Constant At The Infinite Bus. Worst Case Voltage Is Given At TMI Unit 1 Substation At 230.92 KV. To Arrive At Infinite Bus Voltage, The System Voltage Drop Must Be Calculated.

System Voltage Drop (V_{SD})

$$I Z_{sys} = (0.7744 - j0.5358)(0.00085 + j0.0086)$$

$$= (0.0006 - j0.00045 + j0.0066598 - j^2 0.0046078)$$

$$= (0.0052 + j0.0062)$$

$$= \left| \sqrt{0.000027 + 0.0000384} \right|$$

$$= \left| \sqrt{0.0000654} \right.$$

$$= 0.00809$$

System Voltage

$$V_S = V_{(AT\ TMI)} + V_{SD}$$

$$= 1.004 + 0.008$$

$$= 1.012$$

1485 244

$$V_S = 1.012\ (230\ KV)$$

$$= 232.76\ KV$$

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GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.	CLIENT: Metropolitan Edison	FILING CODE	
	PROJECT: Three Mile Island	W.O. 4192	PAGE 5 OF 5
SYSTEM/EQUIPMENT: Bldg Spray Pump	CALCULATION APPLICABLE TO: Starting Voltage Drop	ENGINEER [signature] DATE 9-5-74	
		REVIEWED BY	DATE

Total Voltage Drop

$$IZ = (0.7744 - j0.5358)(0.0445 + j0.0877)$$

$$= (0.0345 - j0.0238 + j0.0679 - j^2 0.0470)$$

$$= 0.0815 + j0.0441$$

Voltage At Motor Terminals

$$V_s - IZ$$

$$1.012 - (0.0815 + j0.0441) =$$

$$0.9305 - j0.0441$$

$$= \left|\sqrt{0.8658 + 0.0019}\right| = \left|\sqrt{0.8677}\right|$$

$$= 0.9315$$

Percentage of Motor Nameplate Voltage Rating At Motor Terminals

$$0.9315 \left(\frac{4160}{4000}\right) 100$$

$$= 96.88\ \%$$

1485 245

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