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FROM: METR
METROPOLITAN EDISON CO.
READING, PA.
R.C. ARNOLD

DATE OF DOCUMENT 9-16-76

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DESCRIPTION
LTR. RE OUR 8R12-76 LTR.....TRANS THE FOLLOWING,

PLANT NAME: THREE MILE ISLAND #1

ENCLOSURE
RESPONSE TO QUESTIONS CONCERNING THE PLANT OPERATION AND EQUIPMENT FAILURES DURING A DEGRADED GRID VOLTAGE........

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September 16, 1976
GQL 1313

RECEIVED SEP 22 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Director of Nuclear Reactor Regulation
Attn: R. W. Reid, Chief
Operating Reactors Branch #4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station Unit 1 (TMI-1)
Docket Number 50-289
Operating License DPR-50

Enclosed please find responses to questions forwarded by your letter of August 12, 1976, concerning plant operation and equipment failures during a degraded grid voltage.

Sincerely,

Signed: R. C. ARNOLD
R. C. Arnold
Vice President

RCA:JJM:eg

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9601

1a. Describe the plant conditions under which the plant auxiliary systems (safety related and nonsafety related) will be supplied by offsite power. Include an estimate of the fraction of normal plant operating time in which this is the case.

The plant auxiliary systems are fed by two full size auxiliary transformers which are connected to different 230 kv busses and provide a source of power for startup, shutdown, and after shutdown requirements. Each of the auxiliary transformers has two isloated secondary windings, one at 6900 volts and one at 4160 volts.

The 230 kv substation incorporates a breaker-and-a-half scheme for high reliability and is connected to the existing Metropolitan Edison Company 230 kv transmission network by three circuits, two full capacity circuits going north to Middletown junction on separate double circuit towers and one-half capacity circuit going south to Jackson single circuit towers. TMI Unit 1 generates electric power at 19 kv which is fed through an isolated phase bus to the unit main transformer bank where it is then stepped up to 230 kv transmission voltage and delivered to the substation.

In view of the above, the plant auxiliary system (safety-related and non-safety related) are normally supplied by offsite power 100% of the time.

1b. The voltage used to describe the grid distribution system is usually a "nominal" value. Define the normal operating range of your grid system voltage and the corresponding voltage values at the safety related busses.

The nominal value of the grid voltage is 230 kv. The normal operating range of the grid voltage is 232 to 236 kv. The corresponding voltage values at the safety related busses on full load are the following:

Grid voltage	232 kv	236 kv
4160 v Bus (1D or 1E)	3999.7 v	4071.9 v
480 v Bus 1P	445.7	453.9 v
480 v Bus 1R	448.6	456.9 v
480 v Bus 1S	446.9	455.2 v
480 v Bus 1T	450.7	459.0 v

1c. The transformers utilized in power systems for providing the required voltage at the various system distribution levels are normally provided with taps to allow voltage adjustment. Provide the results of an analysis of your design to determine if the voltage profiles at the safety related busses are satisfactory for the full load and no load conditions on the system and the range of grid voltage.

There are five fixed 230 kv voltage taps at the auxiliary transformers. The are 218.5 kv, 224.24 kv, 230 kv, 235.75 kv, and 241.5 kv. The present

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tap setting is at 230 kv and voltage profiles for this tap setting at the safety related busses for the full auxiliary load and no-load conditions on the system and the range of grid voltage indicated in 1b above are as follows:

Bus	Full Load		No Load	
230 v	232 kv	236 kv	232 kv	236 kv
4160 v	3999.7 v	4071.9 v	4196.2 v	4268.5
480 v (1P)	445.7 v	453.9 v	484.2 v	492.5
480 v (1R)	448.6 v	456.9 v	484.2 v	492.5
480 v (1S)	446.9 v	455.2 v	484.2 v	492.5
480 v (1T)	450.7 v	459.0 v	484.2 v	492.5

The voltage profiles at the safety related busses for the other tap settings have also been calculated and are found to be satisfactory for the full load and no load conditions on the system and the range of grid voltage.

1d. Assuming the facility auxiliary loads are being carried by the station generator, provide the voltage profiles at the safety busses for grid voltage at the normal maximum value, the normal minimum value, and at the degraded conditions (high or low voltage, current, etc.) which would require generator trip?

Based on Penn-Jersey Matrix (PJM) criteria, the maximum limit of 230 kv grid voltage is 241.5 and the minimum limit is 218.5 kv. The degraded voltage condition which requires a generator trip is an overvoltage condition which is 118% of 230 kv or 271.8 kv. Assuming the station auxiliary loads are being carried by the station generator only, the voltage profiles at the safety busses for grid voltage at the normal maximum value, the normal minimum value and at the degraded conditions which would require generator trip are the following:

Bus	Normal Minimum	Normal Maximum	Degraded Maximum
230 kv	218.5	241.5	271.8 kv
4160 v	3756.25	4171.07	4717.9
4480 v (1P)	417.87	465.28	527.9
480 v (1R)	420.68	468.25	531.1
480 v (1S)	419.05	466.51	529.2
480 v (1T)	422.79	470.39	533.2

1e. Identify the sensor location and provide the trip setpoint for your facility's loss of Offsite Power (undervoltage trip) instrumentation. Include the basis for your trip setpoint selection.

Undervoltage tripping relays are included in each of the 4160 volt E.S. busses 1D and 1E and the 480 volt busses 1P, 1R, 1S, and 1T. Undervoltage trip setpoints are as follows:

Bus	Setpoints
4 kv	3588 volts
480 v	410 volts

The undervoltage relays on the E.S. switchgear have been set to operate at a point such that there will be no detrimental conditions on the system. The contacts on the 4 kv system are set to close at a slower rate than the 480 volts system due to a problem that arose during preoperational testing. During the "loss of offsite power" test, the 480 volt undervoltage relays did not trip before the 4 kv relays, thus exceeding diesel generator block-1 loading conditions. In order to rectify the problem, the 4 kv relays were set to operate at a slower rate than the 480 volt system, but still within a tolerance acceptable to operate a motor under slight undervoltage conditions.

The original and present basis for the undervoltage trip setpoints is to maintain the bus voltage above motor starting voltage.

1f. Assuming operation on offsite power and degradation of the grid system voltage, provide the voltage values at the safety related buses corresponding to the maximum value of grid voltage and the degraded grid voltage corresponding to the undervoltage trip setpoint.

The voltage values at the safety related busses corresponding to the maximum value of grid voltage (241.5kv), and the degraded grid voltage corresponding to the undervoltage trip setpoint (209 kv corresponding to 4 kv undervoltage trip setting of 3588 volts) are as follows:

Bus	Voltage	
230 kv	209 kv	241.5 kv
4160 v	3588	4171
480 v (1P)	399	465
480 v (1R)	401	468
480 v (1S)	400	466
480 v (1T)	404	470

1g. Utilizing the safety related bus voltage values identified in (f), evaluate the capability of all safety related loads, including related control circuitry and instrumentation, to perform their safety functions. Include a definition of the voltage range over which the safety related components, and nonsafety components, can operate continuously in the performance of their design function.

At the safety-related bus voltage values identified in (f) above, corresponding to the maximum grid voltage (241.5 kv), there is no problem as far as operation of safety-related equipment is concerned.

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However, at the safety-related bus voltage values corresponding to the degraded grid voltage viz., 209.19 Kv, one could hypothesize a situation wherein the 480 V bus undervoltage trip devices trip all 480 V E-S/Non E-S loads off the 480 volt busses, but because of the inherent time lag built into the 4 kv undervoltage trip relays described in "Basis for Undervoltage Trip Settings" in le above, the 4 kv bus might not clear and a further hypothesis of an E-S signal appearing during such conditions might result with the 480 volt E-S motors not being available until the 4 kv bus clears.

However, the above is a highly improbable situation since with only one of 3-230 kv lines available for plant operation and TMI Unit 1 not on line, the grid voltage is expected to be about 95.6% of nominal, viz., 219.88 kv and it has to be pointed out that the reactor may not be made critical with less than two 230 kv lines in service nor may operations be continued with only one 230 kv line in service unless Unit 1 generator is carrying its own auxiliaries (TMI-1 Technical Specifications, para. 3.7.2).

Therefore, the degradation of grid voltage to that corresponding to the undervoltage trip setpoint is an extremely unlikely situation in view of the facts mentioned in the previous paragraph and this would probably be a gradual change which can be responded to by proper operator action. The safety-related bus voltages corresponding to a degraded grid voltage of 219.88 kv (approximately 220 kv) are the following:

Buss	Voltage
230 Kv	220 Kv
4160 v	3783.29 v
480 v (1P)	420.96 v
480 v (1R)	423.78
480 v (1S)	422.14
480 v (1T)	425.89

All safety-related equipment including control circuitry and instrumentation have been designed to operate satisfactorily at the above reduced bus voltages.

Tests made at TMI-1 on starters/contactors supplying power to three phase 480 volt ES equipment have shown that they operate satisfactorily to a voltage of 384 volts and minimum pickup values have ranged from 241 volts to 336 volts and dropout values have ranged from 140 to 261 volts.

1h. Describe the bus voltage monitoring and abnormal voltage alarms available in the Control Room.

There are voltmeters on each of the 4160 and 480 volt busses. Also, potential transformer alarms (indicating one out of three undervoltage relays has operated) and undervoltage alarms on the 4160 and 480 volt busses are available in the Control Room.

2. The functional safety requirement of the undervoltage trip is to detect the loss of offsite (preferred) power system voltage and initiate the necessary actions required to transfer safety related busses to the onsite power system. Describe the load shedding feature of your design (required prior to transferring to the onsite [diesel generator] systems) and the capability of the onsite systems to perform their function if the load shedding feature is maintained after the diesel generators are connected to their respective safety busses. Describe the bases (if any) for retention or reinstatement of the load shedding function after the diesel generators are connected to their respective busses.

   The loss of AC power from the auxiliary transformers will result in undervoltage relay action on the 4 kv engineered safeguards busses 1D and 1E. The operation of the 4 kv bus undervoltage relays will result in tripping of all motors connected to the busses except for the engineered safeguards block-1 loads. The 4 kv feeders to the 480 volt unit substations are not tripped by 4 kv bus undervoltage, however, the 480 volt unit substation busses have their own undervoltage relays which will trip all 480 volt motors connected to their respective busses.

   The load shedding feature in <u>not</u> maintained after the diesel generators are connected to their respective safety busses and therefore this part of the question is <u>not</u> applicable to TMI-1.

3. Define the facility operating limits (real and reactive power, voltage, frequency and other) established by the grid stability analyses cited in the FSAR. Describe the operating procedures or other provisions presently in effect for assuring that your facility is being operated within these limits.

   The facility operating limits established by the grid stability analyses are not cited in the FSAR. However, there is a generator trip on overvoltage at 118% of 230 kv nominal voltage at 60 Hz. Also there is an underfrequency trip which trips the generator at 57.5 Hz.

4. Provide a description of any proposed actions or modifications to your facility based on the results of the analyses performed in response to items 1-3 above.

   As a result of the above analyses, it is concluded that no modifications to the Class 1E distribution system at TMI-1 is required.