DOCKET NO. 50-336

ATTACHMENT 3

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

1362 245

NOVEMBER, 1979

7911200

476

MILLSTONE UNIT NO. 2

In Reference (1), NNECO was asked to review the adequacy of the offsite power supplies for each of our operating nuclear power facilities. The following discussions will relate our response to the three areas of concern identified in Reference (1). In reviewing this response, it would be helpful for the reader to refer to the attached sketch of the auxiliary bus system for this unit.

QUESTION (1)

"Determine analytically if, assuming all onsite sources of AC power are not available, the offsite distribution system and the onsite distribution system is of sufficient capacity and capability to automatically start as well as operate all required safety loads, within their required voltage ratings in the event of (1) an anticipated transient (such as unit trip) or (2) an accident (such as a LOCA) regardless of other actions the electric power system is designed to automatically initiate and without the need for manual shedding of any electric loads".

RESPONSE

Capacity - The maximum loading for the preferred offsite power supply would occur when RSST-2 is carrying all the Millstone Unit 2 normal auxiliary loads and the LOCA loads. This total load amounts to 27.31 MVA on the 6.9 KV winding and 13.95 MVA on the 4.16 KV winding. These levels correspond to a one percent overload of the 6.9 KV winding

1362 246

and a load on the 4.16 KV winding which is 22 percent below the rating of the winding. The one percent overload on the 6.9 KV winding is acceptable since it is offset by the relatively light loading of the 4.16 kV winding.

The alternate offsite supply for Millstone Unit 2 is the Reserve Station Service Transformer for Unit 1 (RSST-1). The maximum loading for this supply (as identified in the response for Unit 1) would occur when RSST-1 is carrying all the Millstone Unit 1 normal auxiliary loads, the Unit 1 LOCA loads, and the loads necessary to maintain Millstone Unit 2 in a shutdown mode. This total load amounts to 19.05 MVA on the 4.16 kV "X" winding and 20.60 MVA on the 4.16 kV "Y" winding. The "X" winding load is 28% below the rating of the "X" winding, and the "Y" winding load is 23% above the rating of the "Y" winding. The magnitude of the overload is lessened by the relatively light loading of the "X" winding. At the voltage levels identified in the discussion of undervoltages (below), the RSST-1, will be able to support this loading condition. Also, this loading condition will exist for only a short time (approximately 15 minutes) following a LOCA due to the operator's removal of nonsafeguards loads from the auxiliary busses.

<u>Voltage Capabilities</u> - In determining the voltage limits of the supplies to the auxiliary systems, NNECO used calculated typical voltage drops of ten volts for 480-volt running loads, 50 volts for 480-volt starting loads, 20 volts for 4.16 KV running loads, 100 volts for 4.16 KV starting loads, 20 volts for 6.9 KV running loads, and 100 volts for 6.9 KV starting loads. These values have not been verified by test, however,

they are considered to be conservative for our purpose and represent the worst case conditions.

Overvoltage - Working within the maximum allowable 345 KV supply voltage (362 KV), NNECO has identified three system conditions which could result in exceeding the ten percent overvoltage capability of the motors on the 480-volt busses. The maximum allowable 480 volt bus voltage is 516 volts (ten percent overvoltage on the 460-volt motors plus ten-volt cable drop) and the system conditions which reach this limit are as follows:

a. With the unit shutdown and the Normal Station Service Transformer (NSST-2), supplied from the main generator step-up, carrying minimum station auxiliary load (4.38 MVA), we reach 516 volts on the 480-volt busses when the 345 KV switchyard voltage is at or above 355.4 KV.

b. With the unit shutdown and the Reserve Station Service Transformer (RSST-2) carrying minimum station auxiliary load (4.38 MVA) we reach 516 volts on the 480-volt system when the 345 KV switchyard voltage is at or above 355.7 KV.

c. With the unit fully loaded and the NSST-2 carrying normal station auxiliary load (39.07 MVA), we reach 516 volts on the 480-volt system when the generator voltage is at or above 24.52 KV.

To eliminate the possibility of these overvoltages going unnoticed, NNECO will add overvoltage monitors to these busses which will alarm when an overvoltage situation exists. The station operator will then request system voltage adjustments such that the 480-volt bus voltages will maintain a level below the 516 volt maximum. Depending on the connection of the station auxiliaries, these would include adjustments to the 345 KV transmission system voltage, the Unit 2 generator voltage, or starting of some highly inductive loads. If these adjustments are not available for voltage correction, the emergency onsite power supplies (except in case "C") would be used to carry the station auxiliary loads (separated from the transmission system).

These overvoltage situations are limited by the 480-volt bus voltages. However, less limiting overvoltages can occur on the 6.9 KV and 4.16 KV busses for the same system configurations identified above (a, b, & c). Therefore, overvoltage monitors will also be added to the 6.9 KV and 4.16 KV busses to alarm when the bus voltages exceed their limits (7.26 KV and 4.42 KV respectively).

Undervoltage - During normal operation of the plant, NNECO must maintain at least 5960 volts on the 6.9 KV busses for operation of the 6.6 KV motors, at least 3620 volts on the 4.16 KV busses for operation of the 4 KV motors, and at least 424 volts on the 480-volt busses for operation of the 460-volt motors. These normally operating loads will ride through temporary voltage dips due to motor starts provided the voltage doesn't fall below the dropout level of the motor contactors (less than 50% of the voltage rating of the motors).

When the auxiliary busses are supplied from the preferred offsite supply (RSST-2), our analyses have demonstrated that no undervoltage condition exists until the transmission system voltage drops below 328 KV. Since this is the administrative minimum for the transmission system, it is unlikely to be reached under any but the most remote circumstances. If, for any reason, when operating on the RSST-2, the voltage on the 4.16 KV emergency busses falls below the accepted minimum of 3640 volts (level required to maintain 424 volts on the 480-volt busses) the level two undervoltage detection scheme will transfer the safeguards busses to the onsite power supplies.

If the alternate offsite supply (RSST-1) is carrying the Unit 2 shutdown loads, the worst case loading occurs when RSST-1 has to carry the Unit 1 normal auxiliary loads and the starting of the Unit 1 LOCA loads. This results in a switchyard voltage requirement of 341.2 KV due to the start capability of the Unit 1 LOCA loads. Since this mode of operation is extremely rare and a 341.2 KV minimum would be severely limiting, we propose to implement an appropriate Millstone Unit 1 administrative procedure if we have the need to use RSST-1 as the Unit 2 alternate offsite supply. This administrative procedure will include selection of a second level 2 undervoltage scheme which will be calibrated for a setpoint equivalent to 342 KV.

QUESTION (2)

The adequacy of the onsite distribution of power from the offsite circuits shall be verified by test to assure that analysis results are valid. Please provide: (1) a description of the method for performing this verification, and (2) the test results.

RESPONSE

It is not practical or reasonable to test station auxiliary equipments at a time when their bus voltages would be at a minimum due to a low voltage condition on the transmission system. Therefore, we propose to verify the appropriateness of our analyses by comparing calculated and measured bus voltages for specific loading conditions on the station auxiliary system. Substantiating the accuracy of the analysis for these specific loading conditions will demonstrate the accuracy of the analyses for other postulated loadings of the station auxiliary system at other voltage conditions.

Method - NNECO's calculation method utilizes station loading to calculate bus voltages on the load side of a transformer for the expected range of voltages on the high side of the transformer. To verify the accuracy of our calculation method (for steady state conditions) we have measured the loads on each of the busses in the station auxiliary system. At the same time, we also measured the auxiliary bus voltages in the station and the voltages of the offsite supplies to the auxiliary busses. (All measurements taken with QA calibrated meters). Using the measured loads on the auxiliary busses, and the known offsite supply voltage, we calculated (using the computerized transformer voltage drop calculation method discussed above) the expected bus voltages for each bus in the onsite distribution system. Errors between the measured and calculated voltages for the Millstone 2 steady state test all range from -0.86 to +0.51 percent. Table 1 identifies these results.

The major difference between the steady state calculation and the motor start calculation is the inclusion of the constant impedance model for the motor start. Using a portable oscillograph to monitor the bus voltage at the bus supplying the Service Water Pump C motor, the main generator voltage, voltages at selected 480-volt busses, and the current to the motor, the service water pump C motor was started. These values were compared with the calculated values using the station loading which existed just prior to the start of the motor. The calculated motor impedance was used to determine the expected bus voltages on the onsite distribution system. Errors between the calculated and measured voltages for the motor start test for Unit 2 range from -1.21 to +0.77 percent. Table 2 identifies these results.

Test Results

Table 1 - Steady-State Case

Location	Calculated V	Measured V	Error
Generator	23,520 V.*	23,520 V.	-
Bus 25A	6,752 V.	6,726 V.	+0.39%
Bus 25B	6,752 V.	6,756 V.	-0.06%
Bus 24A**	4,070 V.	4,049.5V.	+0.51%
Bus 24B**	4,070 V.	4,102 V.	-0.78%
Bus 22A	483.1V.	484.8V.	-0.35%
Bus 22B	483.1V.	483.2V.	-0.02%
Bus 22C	488.6V.	490.8V.	-0.45%
Bus 22D	487.1V.	488.8V.	-0.35%
Bus 22E	484.6V.	488.8V.	-0.86%
Bus 22F	484.6V.	486.8V.	-0.45%

Table 2 - Motor Starting Case

Location	Calculated V	Measured V	Error
Generator	23,520 V.*	23,520 V.	-
Bus 24B**	3,996 V.	3,965.5V.	+0.77%
Bus 22B	474.4V.	474.4V.	0%
Bus 22D	478.4V.	481.6V.	-0.66%
Bus 22F	474.4V.	481.2V.	-1.21%

*We start with the "calculated" generator voltage matching the measured generator voltage.

**Bus voltages for busses 24C and 24D were measured at busses 24A and 24B respectively (these busses are connected to each other). This was done so that any mistake by the test personnel would not cause a misoperation of the LNP circuit.

1362 253

These test results demonstrate the accuracy of the calculations employed in our analyses and show that the calculation method is applicable for all station loading conditions considered in our analyses. Differing bus configurations, bus loadings, or supply voltages will not adversely affect the accuracy of the model, and, therefore, we can take full credit in using these results to establish the expected bus voltages under all analyzed conditions.

QUESTION (3)

You are expected to review the electric power systems of your nuclear station to determine if there are any events or conditions which could result in the simultaneous or consequential loss of both required circuits to the offsite network to determine if any potential exists for violation of GDC-17 in this regard.

RESPONSE

NNECO's review of the electric power systems, which are shown on the attached sketch, has revealed one event which could result in the simultaneous loss of both required circuits from the offsite network.

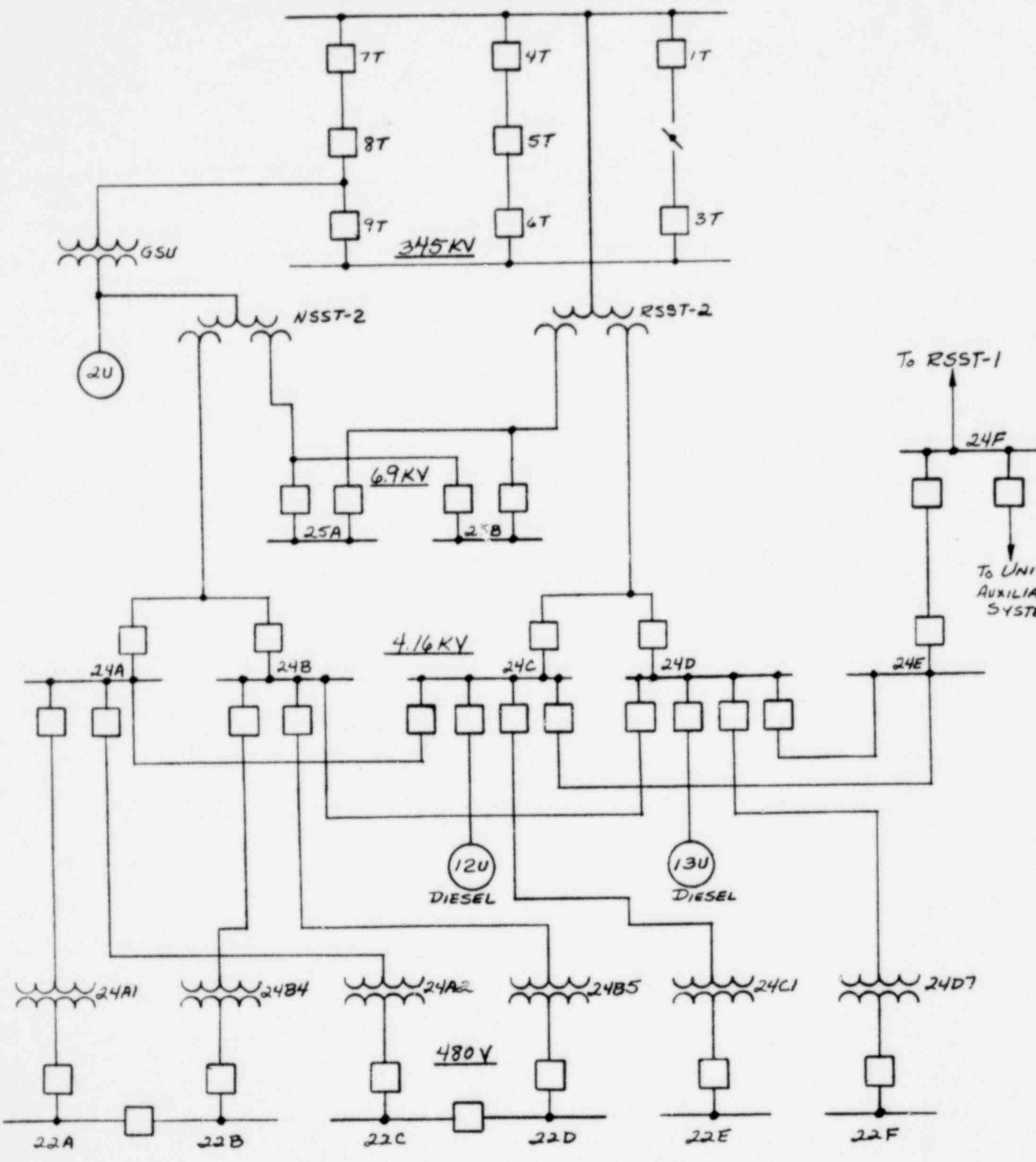
The event in question, is the failure of 345 KV circuit breaker 1T, which is part of the offsite power system. This failure would cause automatic tripping of 345 kV bus A which supplies RSST-2 and automatic tripping of 345 KV breaker 3T which will remove RSST-1 from service. Thus both required circuits to the offsite network are lost since RSST-2 and RSST-1 are respectively the preferred and alternate offsite circuits for Millstone Unit 2.

The design of breaker 1T control and protection systems incorporates separate and independent equipment which is powered from redundant 125V. D.C. supplies. The object of this design feature is to minimize the possibility of breaker failure to trip occurring as a result of a control or protective relay malfunction. We have, therefore, concluded that this event does not violate GDC-17 since we consider the design of breaker 1T minimizes to the extent practical the likelihood of its failure and a switchyard common to both offsite power circuits is permissible.

1362 255

Millstone Unit 2

Auxiliary Bus System



1362 256