DOCKET NO. 50-245

ATTACHMENT 2

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

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NOVEMBER, 1979

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MILLSTONE UNIT NO. 1

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 power 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-1 is carrying all the Millstone Unit 1 normal auxiliary loads, the LOCA loads and the loads necessary to maintain Millstone Unit 2 in a shutdown mode (RSST-1 being the alternate offsite supply for Unit 2). This total load amounts to 19.05 MVA on the 4.16 KV

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"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 (ratings are based on the 65°C temperature rise). The magnitude of this overload is lessened by the relatively light loading of the "X" winding. At the voltage level 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.

The Millstone Unit 1 alternate offsite supply (SDT-1) is fed from a 23 KV feeder which originates at Flanders 11Y Substation. The 23/4.16 kV transformer (SDT-1) is intended to carry a load equivalent to that of one division of ECCS loads (2.9 MVA). Since these loads are manually connected, no potential exists for overloading of SDT-1.

Voltage Capabilities - In determining the voltage limits of the supplies to the auxiliary systems, we 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, and 100 volts for 4.16 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), we have 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 494 volts (ten percent overvoltage on the 440-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-1), supplied from the main generator step-up, carrying minimum station auxiliary load (3.33 MVA), we reach 494 volts on the 480-volt system when the 345 KV switchyard voltage is at or above 361.8 KV.

b. With the unit shutdown and the Reserve Station Service Transformer carrying minimum station auxiliary load (3.33 MVA) we reach 494 volts on the 480-volt system when the 345 KV switchyard voltage is at or above 353.0 KV.

c. With the unit fully loaded and the NSST-1 carrying normal station auxiliary load (34.7 MVA), we reach 494 volts on the 480-volt system when the generator voltage is at or above 25.1 KV. Voltages of this magnitude would be highly unlikely because 25.2 KV is the maximum allowable generator terminal voltage.

d. With the emergency diesel loads being carried by the alternate offsite supply (SDT-1), we reach 494 volts on the 480-volt system when the 23 KV feeder voltage goes to 23.85 KV.

To eliminate the possibility of these overvoltages going unnoticed, we 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 494 volt maximum. Depending on the connection of the station auxiliaries, these would include adjustments to the 345 KV transmission system voltage, the Unit 1 generator voltage, the voltage at Flanders 11Y Substation, 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).

As a result of our analyses, we have determined that no overvoltage conditions can occur on the 4.16 KV busses.

Undervoltage - During normal operation of the plant, NNECO must maintain at least 3620 volts on the 4160-volt busses for operation of the 4 KV motors and at least 416 volts on the 480-volt busses to insure positive operation of the contactors for the 440 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 contactors (less than 50% of the voltage rating of the motors).

Excluding the use of RSST-1 as the alternate offsite supply for Unit 2, the worst case loading of the Millstone Unit 1 station auxiliaries occurs when all of the normal station loads as well as the LOCA loads are running. During this condition, in order to maintain 416 volts on the 480-volt busses, we must operate the 345 KV switchyard at 335.7 KV or higher. This case is more limiting than starting the LOCA loads because of the reduced voltage start capability of the LOCA loads.

Previous low voltage considerations on the auxiliary bus system had identified a 343 KV minimum switchyard voltage. This limit was selected to assure starting of the LOCA loads, including the reduced voltage start capability of these motors. However, the previous limit was determined by using a constant current representation of a motor start, whereas a more accurate model for motor starts would be constant impedance. Using this model, the switchyard voltage requirement for starting of the LOCA loads drops to 334.3 KV. NNECO plans to reset the voltage sensors of the Level 2 undervoltage scheme to reflect the change in the switchyard limit from 343 KV to 336 KV to incorporate the limit identified in the previous paragraph.

Considering the situation where RSST-1 is carrying the Unit 2 shutdown loads (as the Unit 2 alternate offsite supply) the worst case auxiliary bus system voltage occurs when attempting to start the Millstone Unit 1 LOCA loads. This results in a switchyard voltage requirement of 341.2 KV. Since this mode of operation is extremely rare and a 341.2 KV minimum would be severely limiting compared to the 336 KV limit discussed above, NNECO plans to implement the 341.2 KV limit administratively 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.

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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 the bus voltages are at their minimum due to low voltage conditions on the transmission system. Therefore, NNECO will 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 1 steady-state test range from -0.41 to +2.31 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 Core Spray Pump B motor, the main generator voltage, voltages at selected 480-volt busses, and the current to the motor, the core spray pump 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 1 range from 0 to +0.17 percent. Table 2 identifies these results.

Test Results

Table 1 - Steady-State Case

Location	Calculated V	Measured V	Error
Generator	23,880 V.*	23,880 V.	-
Bus 14A	4,040 V.	3,986.5V.	+1.34%
Bus 14B	4,040 V.	4,000.5V.	+0.31%
Bus 14C**	3,988 V.	3,930.5V.	+1.46%
Bus 14D**	3,988 V.	3,930.5V.	+1.46%
Bus 12C	460.7V.	454.4V.	+1.39%
Bus 12D	461.7V.	463.6V.	-0.41%
Bus 12E	465.7V.	455.2V.	+2.31%
Bus 12F	460.6V.	453.2V.	+1.63%

Table 2 - Motor Starting Case

Location	Calculated V	Measured V	Error
Generator	23,800 V.*	23,800 V.	-
Bus 14E	3,853 V.	3,846.5V.	+0.77%
Bus 12E	445.6V.	445.6V.	0%
Bus 12F	444.4V.	444.4V.	0%

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

**The voltages on busses 14E and 14F are the same as those on 14C and 14D respectively, and therefore, were not measured.

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.

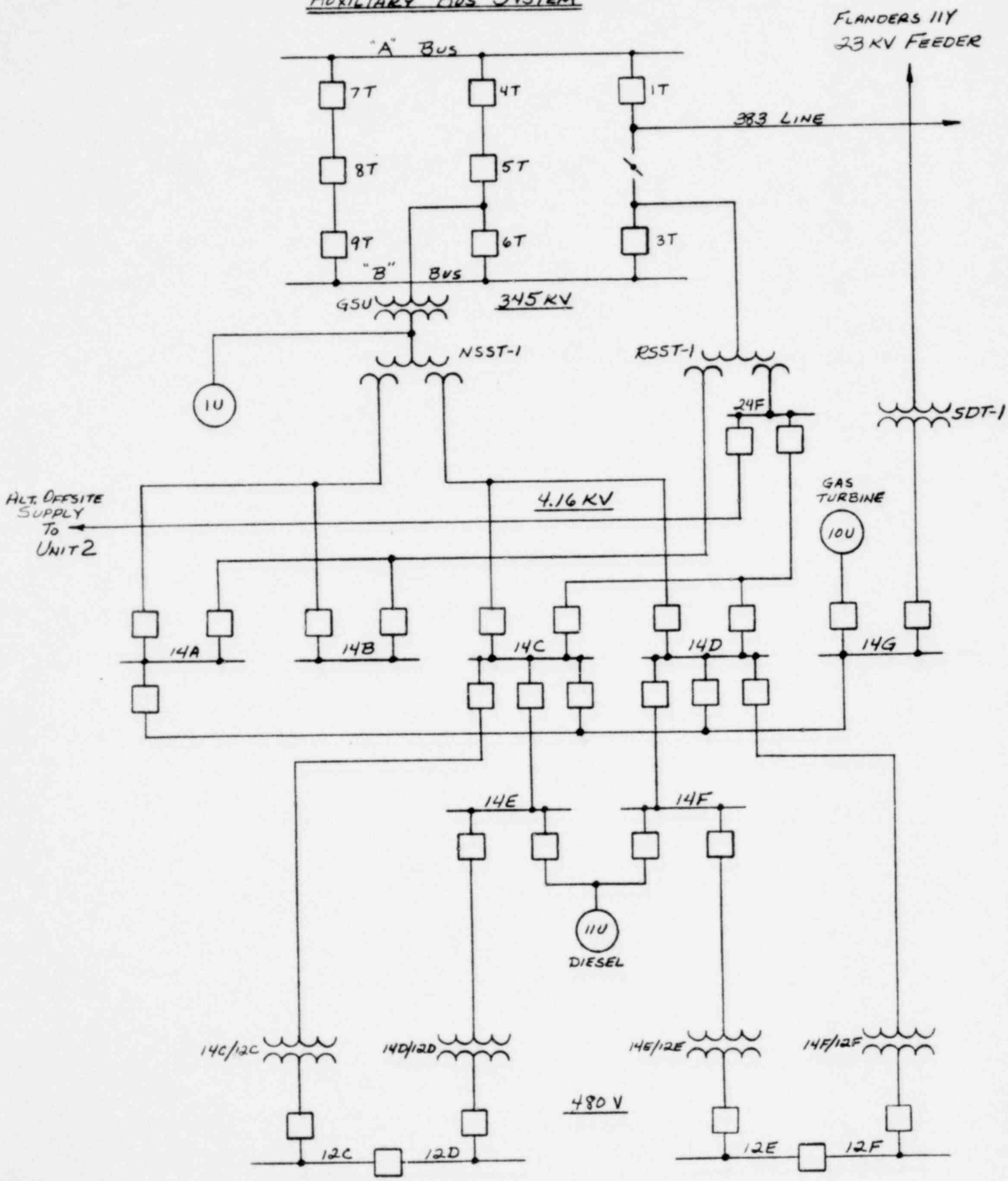
The event involves the failure of a particular span of 345 KV transmission line 383 which passes over the 23 KV feeder originating at Flanders 11Y Substation. If it is postulated that the span, in failing, falls on the 23 KV circuit, then by protective relay action 345 KV circuit breakers 1T and 3T will be tripped and the 23 KV circuit removed from service.

These actions, as can be seen from the attached sketch, remove both required circuits from the offsite network.

For this event, electrical isolation of the 383 line and restoration of the RSST-1 345 KV circuit can be accomplished by operator action in a time equal to or less than that required to secure the delayed access circuit. We have, therefore, concluded that, since this event presents a situation no worse than that associated with the permanent loss of the immediate access circuit (RSST-1), and since the probability of occurrence is extremely remote, no violation of GDC-17 exists for this event.

Millstone Unit 1

Auxiliary Bus System



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