DOCKET NO. 50-213

ATTACHMENT 1

# HADDAM NECK PLANT

# ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

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## HADDAM NECK PLANT

In Reference (1), Connecticut Yankee Atomic Power Company (CYAPCO) 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 preferred offsite power supply for the Haddam Neck Plant consists of two 17.3-MVA transformers (389 and 399). In the normal configuration, maximum loading for each of these transformers occurs when each is carrying its normal station load, a reactor coolant pump, and its associated LOCA loads. This load amounts to 14.9 MVA which is approximately 14 percent below the transformer nameplate rating of 17.3 MVA.

If one of these transformers is out of service, the remaining transformer becomes the alternate offsite supply. The maximum loading for either alternate offsite supply (389 or 399) occurs when all of the normal station auxiliary loads as well as two divisions of LOCA loads and two reactor coolant pumps are running on the one remaining transformer. This load amounts to 29.8 MVA and exceeds the transformer nameplate rating of 17.3 MVA by 72 percent (the protective relays will not trip for this level of overload). This transformer will experience a two percent loss of life if this loading is maintained for a period of one hour. However, approximately 15 minutes after a LOCA, the operator will remove those nonsafeguards loads which are not required to maintain the plant in a safe shutdown. This will bring the transformer loading down to a level within the nameplate capability of the transformer. The ability of the transformer to provide sufficient voltage to the auxiliary busses during this overload condition is discussed in a later paragraph.

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 - Reference (2) addressed the overvoltage capabilities of the auxiliary bus system at the Haddam Neck Plant. Attachment 1 of Reference (2) stated that "the 480-volt buses could be subjected to overvoltages during no-load conditions and during periods of minimum load conditions.....The no-load case is not considered to be a realistic condition as the station service buses are never completely unloaded. Additionally, the likelihood of overvoltage conditions on the 480-volt buses is small because it requires the coincidence of minimum load conditions, such as during a plant refueling outage, and a transmission system voltage very near its normal maximum value of 117 KV. Even then, the magnitude of the overvoltage, about 1-1/2% of the limiting equipment's nameplate rating, is small. In order to alert the station operator to any possible overvoltage condition, overvoltage alarm relays will be added to each of the 480-volt buses. The relays will have a setpoint below the limiting continuous overvoltage of the equipment, and will act to initiate operator action to eliminate the overvoltage condition.

Operator action can include starting additional loads, reconfiguration of the bus systems to provide additional voltage drops and a request to the System Operations Supervisor for a system voltage reduction. The basis for limiting automatic action to alarming only is that small magnitude, short-time overvoltages are not a threat to equipment reliability.

During the same system conditions for possible overvoltage on the 480-volt busses, it is also possible to experience similar overvoltages on the 4.16-KV busses. As in the case of the 480-volt busses, overvoltage alarms will be added to the 4.16-KV busses. The same operator action described in the quote from Reference (2) will be effective in eliminating the overvoltage condition on the 4.16-KV busses.

Until such time as the overvoltage alarms can be installed on the 4.16-KV and 480-volt busses, these overvoltage conditions will be controlled administratively.

Undervoltage - During normal operation of the plant, we must maintain at least 3,620 volts on the 4.16-KV busses for operation of the 4-KV motors and at least 406 volts on the 480-volt busses for operation of the 440-volt motors. These normally connected loads will ride through temporary voltage dips due to motor starts provided the voltage doesn't fall below the dropout level of the contractor (less than 50% of the voltage rating of the motors).

Our analyses have identified two separate worst case conditions for undervoltage performance of the auxiliary bus system at the Haddam Neck Plant. These are:

a. Starting of the containment air recirculating fans during sequencing of the LOCA loads while the station auxiliary busses are supplied by both offsite supplies (389 and 399).

b. Starting of the containment air recirculating fans during sequencing of the LOCA loads while the station auxiliary busses are supplied by only one offsite supply (389 or 399).

These cases assume no manual disconnection of any nonsafeguards loads. The conditions described in "a" above require a transmission system voltage on the 115-KV bus at the Haddam Neck Plant of 106.0 KV to assure starting of all LOCA loads (requirement includes the 80% start capability of all LOCA loads and the appropriate cable drop for each LOCA load). The conditions described in "b" above require a transmission system voltage on the 115-KV bus at the Haddam Neck Plant of 110.8 KV to assure starting of all LOCA loads.

Recognizing these two different limits, we propose to install two level 2 undervoltage monitoring schemes to detect each condition. The "a" scheme will reflect the 106.0 KV limit when two offsite supplies are in service and the "b" scheme will reflect the 110.8 KV limit when only one offsite supply is in service. We had previously proposed to install one undervoltage monitoring scheme which was described in reference (3). The proposed action to be taken upon operation of either scheme "a" or scheme "b" is the same as that proposed in reference (3). Until such time as these schemes can be implemented, these limits will be administratively imposed. If these limits are exceeded, the operator will be required to notify the System Operations Supervisor and request them to restore the voltage to at least the level identified by these limits.

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, CYAPCO will verify the adequacy of our analyses by comparing the calculated and measured bus voltages for a specific loading condition on the station auxiliary system. Proving the accuracy of the analysis for this specific loading condition demonstrates the accuracy of the analyses for any postulated loading of the station auxiliary system.

Method - Our 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 voltage for the Haddam Neck Plant steady state test range from -0.58 to -2.56 percent. Table 1 identifies these results.

Previous calculations, verified by test at Millstone Units 1 and 2 had already demonstrated the model accuracy for motor starting conditions. It was, therefore, considered unnecessary to repeat the test at the Haddam Neck Plant in order to verify calculational accuracy. Test 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.

The results of the motor start tests at Millstone Units 1 and 2 are included in the test results summarized below. The motor tested at Millstone Unit 1 was the Core Spray Pump B motor. At Millstone Unit 2, the Service Water Pump C motor was tested. Errors between the calculated and measured voltages for the motor start test for Unit 1 ranged from 0 to +0.17 percent. For Unit 2, the errors ranged from -1.21 to +0.77 percent. Table 2 identifies the test results for both of the motor start tests.

## Test Results

### Table 1 - Steady-State Case

| Location | Calculated V | Measured V | Error |
|---|---|---|---|
| 115 KV Bus | 111,900 V* | 111,900 V | - |
| Bus 1-2 (8) | 4,186 V | 4,210.5 V | - 0.58% |
| Bus 1-3 (9) | 4,171 V | 4,207 V | - 0.86% |
| Bus 1-4 | 475.5 V | 482.2 V | - 1.39% |
| Bus 1-5 | 470.5 V | 482.9 V | - 2.56% |
| Bus 1-6 | 471.5 V | 482.9 V | - 2.36% |
| Bus 1-7 | 469.5 V | 480.8 V | - 2.35% |

### Table 2 - Motor Starting Case

MP-1; Core Spray Pump B

| Location | Calculated V | Measured V | Error |
|---|---|---|---|
| Generator | 23,880 V* | 23,880 V | - |
| Bus 14E | 3,853 V | 3,846.5 V | + 0.17% |
| Bus 12E | 445.6 V | 445.6 V | 0% |
| Bus 12F | 444.4 V | 444.4 V | 0% |

MP-2; Service Water Pump C

| Location | Calculated V | Measured V | Error |
|---|---|---|---|
| Generator | 23,520 V* | 23,520 V | - |
| Bus 24B** | 3,996 V | 3,965.5 V | + 0.77% |
| Bus 22B | 474.4 V | 474.4 V | 0% |
| Bus 22D | 478.4 V | 481.6 V | - 0.66% |
| Bus 22F | 475.4 V | 481.2 V | - 1.21% |

1362 229

*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 Loss of Normal Power circuit.

These test results demonstrate the accuracy of the calculation employed in our analyses and show that the calculation method is applicable for all station loading conditions considered in our analyses. Therefore, we can take full credit in using these results to establish the expected bus voltages under all analyzed conditions.

## QUESTION (3)

You are requested 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

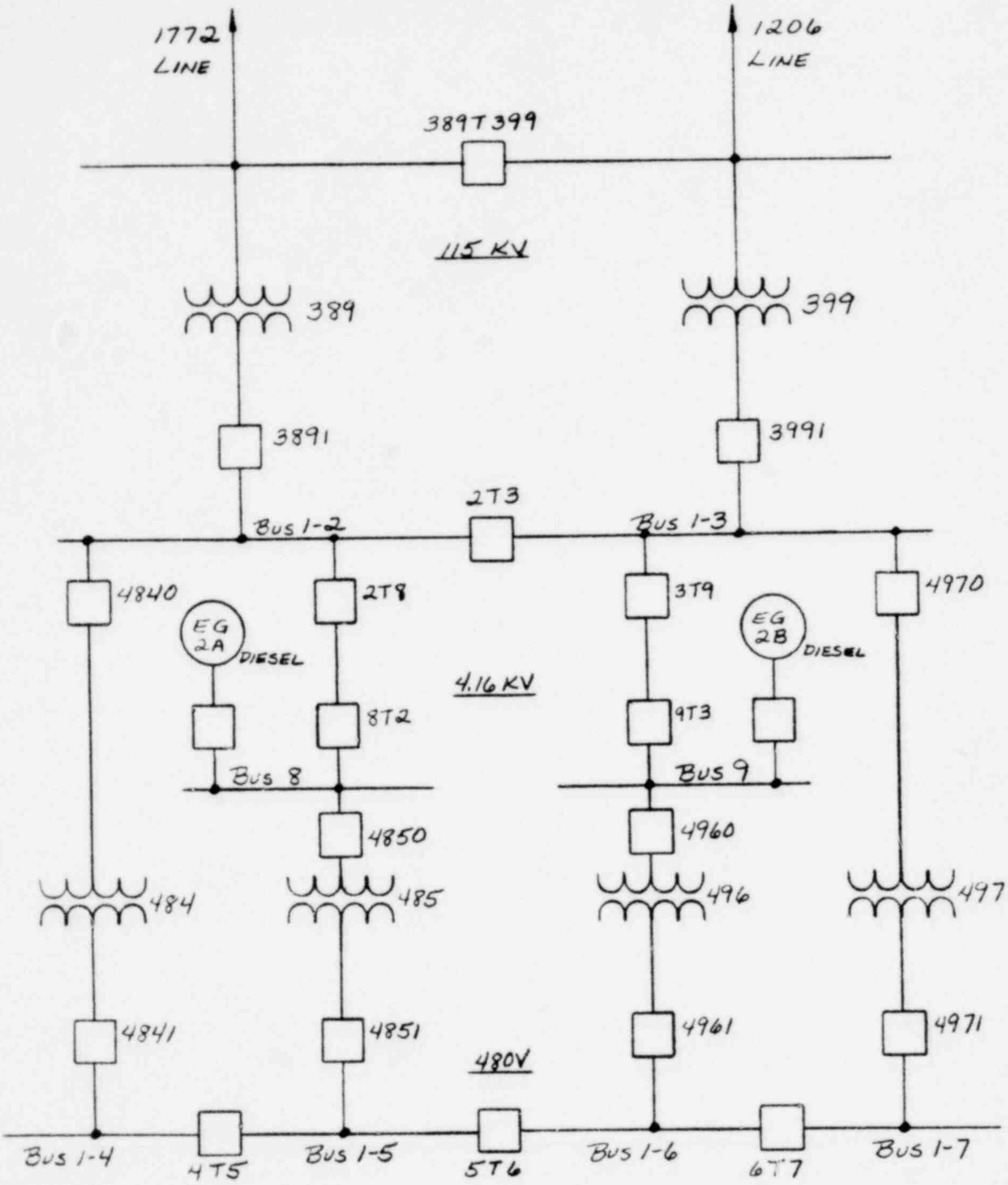
Our review of the electric power systems, which are shown on the attached sketch, has revealed two events, each of which could result in the simultaneous loss of both required circuits from the offsite network.

1) The failure of 4,160 V tie breaker 2T3, which for the purpose of GDC-17 review is considered part of the onsite electric power system, will cause the loss of both circuits from the offsite network as a consequence of automatically clearing buses 1-2 and 1-3 to isolate the fault. This failure does not cause loss of the redundant onsite power supplies nor does it prevent these power sources from supplying all segments of the redundant safety-related onsite distribution systems. We have, therefore, concluded that no potential violation of GDC-17 exists for this event since the single failure of breaker 2T3 does not affect either of the redundant onsite electric power systems.

2) In the unlikely event that 115-KV breaker 389T399, which is part of the offsite power system, were to fail, it would cause automatic tripping of 115-KV lines 1206 and 1772 which constitute the two offsite circuits to the plant. The design of breaker 389T399 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 389T399 minimizes to the extent practical the likelihood of its failure and a switchyard common to both offsite power circuits is permissible.

# CONNECTICUT YANKEE

# AUXILIARY BUS SYSTEM



1362 232