Consumers Power Company

General Offices: 212 West Michigan Avenue, Jackson, Michigan 49201 • Area Code 517 788-0550

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August 29, 1980

Director, Nuclear Reactor Regulation
Att Mr Dennis M Crutchfield, Chief
Operating Reactors Branch No 5
US Nuclear Regulatory Commission
Washington DC 20555

DOCKET 50-155 - LICENSE DPR-6 -
BIG ROCK POINT PLANT - RESPONSE
TO GENERIC ISSUES - ADEQUACY OF
STATION ELECTRIC DISTRIBUTION
SYSTEM VOLTAGES

NRC letter dated August 8, 1979, cited an event that occurred at the Arkansas Nuclear One station which raised two generic concerns. The NRC staff's concerns pursuant to this event involve the acceptability of the voltage conditions on the station electric distribution system with regard to both (1) potential overloading due to transfers of either safety or nonsafety loads, and (2) potential starting transient problems.

Consumers Power Company has determined analytically that, assuming all on-site sources of ac power are not available, the off-site power system and on-site distribution system are of sufficient capacity and capability to automatically start, as well as operate, all required safety loads. Specific results of this analysis are presented in the Attachment I response to Enclosure 2 of the August 8, 1979 letter. Test verification of the analytical results was performed on June 26, 1980. Attachment II provides a summary of the test and its results.

Big Rock Point began operation prior to the issuance of General Design Criterion 17 (GDC-17) and, as identified in our docket letter dated February 19, 1980, does not meet all of its requirements. With respect to the off-site power system, Big Rock Point does have two sources of off-site power as identified in Attachment I. Specific areas of noncompliance with GDC-17 are the secondary sides (2,400 V) of the two off-site transmission circuits which are connected to one 2,400 V switchgear bus that supplies power to a single 480 V load center which, in turn, supplies a single safety-related motor control center resulting in a lack of redundancy in the on-site ac distribution system. Also, lack of redundancy in on-site power sources exists in the form of one set of emergency power supply batteries (except for the Reactor

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Depressurization System where redundancy is provided) and the single emergency diesel generator (note that an auxiliary diesel generator is available, if required). Consumers Power Company has previously identified these problems and will pursue resolution of them through our participation in the NRC Systematic Evaluation Program in which Big Rock Point is involved.

David P Hoffman (Signed)

David P Hoffman
Nuclear Licensing Administrator

CC Director, Region III, NRC
NRC Resident Inspector - Big Rock Point

Attachments 7 Pages

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ATTACHMENT I

Response to Enclosure 2 of NRC Letter Dated August 8, 1979

GUIDELINES FOR VOLTAGE DROP CALCULATIONS

Guideline 1

Separate analyses should be performed assuming the power source to safety buses is (a) the unit auxiliary transformer, (b) the startup transformer, and (c) other available connections to the off-site network one by one assuming the need for electric power is initiated by (1) an anticipated transient (eg, unit trip), or (2) an accident, whichever presents the largest load demand situation.

Response

The attached single-line diagram, Figure 1, shows that the 2,400 V bus can be supplied from the generator, a 138 kV line or a 46 kV line. Two different motor start-ups were investigated to determine which load demand situation results in the worst voltage conditions. The first case, maximum loading but not required for accident operation, requires starting a reactor feed pump on the 2,400 V bus while connected to the 138 kV source. The 138 kV line is the source for all start-ups. In this analysis, the grid voltage was depressed to 0.95 per unit and a starting power factor of 0.25 was assumed. The analysis showed an instantaneous per unit voltage drop of 0.7978 (2,400 V bus), 0.7663 (LC2), and 0.7657 (2A and 2B buses).

The second case, maximum loading required for accident operation, requires starting the electric fire pump on the 2B bus from the 46 kV source. In this analysis, the grid voltage was again depressed to 0.95 per unit and a starting power factor of 0.25 was assumed. The analysis showed an instantaneous per unit voltage drop of 0.9447 (2,400 V bus), 0.8247 (LC2), and 0.8163 (2B bus).

Guideline 2

For multi-unit stations, a separate analysis should be performed for each unit assuming (1) an accident in the unit being analyzed and simultaneous shutdown of all other units at that station, or (2) an anticipated transient in the unit being analyzed (eg, unit trip) and simultaneous shutdown of all other units at that station, whichever presents the largest load demand situation.

Response

The Big Rock Point Plant is a single-unit station; therefore, this guideline does not apply.

Guideline 3

All actions the electric power system is designed to automatically initiate should be assumed to occur as designed (eg, automatic bulk or sequential loading or automatic transfers of bulk loads from one transformer to another). Included should be consideration of starting of large nonsafety loads (eg, condensate pumps).

Response

All protective circuitry is assumed to operate as designed. The plant is not designed to perform such functions as automatic bulk or sequential loading or automatic transfers of bulk loads from one transformer to another.

The starting of the plant's largest motor, the reactor feed pump, was considered and the results are shown in the response to Guideline 1, above.

Guideline 4

Manual load shedding should not be assumed.

Response

Voltage drop calculations for the Big Rock Point Plant do not assume manual load shedding.

Guideline 5

For each event analyzed, the maximum load necessitated by the event and the mode of operation of the plant at the time of the event should be assumed in addition to all loads caused by expected automatic actions and manual actions permitted by administrative procedures.

Response

These assumptions were used in the voltage drop calculations shown in the response to Guideline 1, above.

Guideline 6

The voltage at the terminals of each safety load should be calculated based on the above listed considerations and assumptions and based on the assumption that the grid voltage is at the "minimum expected value." The "minimum expected value" should be selected based on the least of the following:

a. The minimum steady-state voltage experienced at the connection to the off-site circuit.

b. The minimum voltage expected at the connection to the off-site circuit due to contingency plans which may result in reduced voltage from this grid.

c. The minimum predicted grid voltage from grid stability analysis (eg, load flow studies).

In the report to NRC on this matter, the licensee should state planned actions, including any proposed "Limiting Conditions for Operation" for Technical Specifications, in response to experiencing voltage at the connection to the off-site circuit which is less than the "minimum expected value." A copy of the plant procedure in this regard should be provided.

Response

As stated in the response to Guideline 1, our analysis is performed assuming that the grid voltage is 0.95 per unit. This is the "minimum expected value" of the predicted grid voltage.

Consumers Power Company does not intend to include any "Limiting Conditions for Operations" for the Technical Specifications in response to experiencing voltage at the connection to the off-site circuit which is less than the "minimum expected value." The second level of Undervoltage Protection Modification, which is presently being engineered and will be installed during the next refueling outage, will protect the safety equipment from sustained undervoltage conditions which may result from voltages lower than the "minimum expected value." This second level of undervoltage protection provides a built-in "Limiting Condition for Operation."

Guideline 7

The voltage analysis should include documentation for each condition analyzed, of the voltage at the input and output of each transformer and at each intermediate bus between the connection to the off-site circuit and the terminals of each safety load.

Response

The conditions which were analyzed are stated in the response to Guideline 1. Our computer program provides values for voltage on the input and output for each transformer and intermediate bus, but these will not be itemized here. The only important values are itemized in the response to Guideline 1. These are the terminal voltages that the loads must operate at, not the intermediate bus voltages.

Guideline 8

The analysis should document the voltage setpoint and any inherent or adjustable (with nominal setting) time delay for relays which (1) initiate or execute automatic transfer of loads from one source to another, (2) initiate or execute automatic load shedding, or (3) initiate or execute automatic load sequencing.

Response

The plant schemes are not designed to initiate or execute automatic load sequencing. Automatic transfer of loads from one source to another is assumed to occur. The voltage setpoint and time delay settings for the second level of undervoltage protection relays were obtained from the Undervoltage Protection Modification.

Guideline 9

The calculated voltages at the terminals of each safety load should be compared with the required voltage range for normal operation and starting of that load. Any identified inadequacies of calculated voltage require immediate remedial action and notification of NRC.

Response

The second level of undervoltage protection will prevent the safety load terminal voltages from dropping below the required range for normal operation and starting of that load. Inadequate voltages will be eliminated by the second level of undervoltage protection.

Guideline 10

For each case evaluated, the calculated voltages on each safety bus should be compared with the voltage time settings for the undervoltage relays on these safety buses. Any identified inadequacies in undervoltage relay settings require immediate remedial action and notification of NRC.

Response

The voltage time settings for the second level of undervoltage relays were initially chosen as a result of our voltage drop calculations. The load configuration has not changed since these calculations were made so there is no need to reevaluate the settings.

Guideline 11

To provide assurance that actions taken to assure adequate voltage levels for safety loads do not result in excessive voltage, assuming the maximum expected value of voltage at the connection to the off-site circuit, a determination should be made of the maximum voltage expected at the terminals of each safety load and its starting circuit. If this voltage exceeds the maximum voltage rating of any item of safety equipment, immediate remedial action is required and NRC shall be notified.

Response

This determination was made as a result of the NRC's letter dated June 3, 1977. Consumers Power Company reported this determination in our letter dated June 14, 1978.

Guideline 12

Voltage time settings for undervoltage relays shall be selected so as to avoid spurious separation of safety buses from off-site power during plant start-up, normal operation and shutdown due to start-up and/or operation of electric loads.

Response

The values for voltage time settings for the second level of undervoltage relays were addressed in our letter dated June 14, 1978. Setting selection involved consideration of avoiding spurious separations and protection of safety loads from sustained undervoltage.

Guideline 13

Analysis documentation should include a statement of the assumptions for each case analyzed.

Response

All major assumptions are itemized in the response to Guideline 1.

ATTACHMENT II

Test Verification of Analytical Model for
Determination of Voltage Drops

Introduction

NRC letter dated August 8, 1979 required verification of analytical models used for determination of voltage drops by test to assure than analysis results are valid.

Method of Testing

The analytical model of the Big Rock Point Plant was verified by starting the 440 V 100 hp fire pump fed from the 2B bus while the plant was operating at full capacity. A simplified one-line diagram of the Big Rock Point Plant, Figure 1, is attached for reference. This loading condition is considered to be the maximum loading required for accident operation. Precision oscillographs were installed to monitor critical voltages and current during prestart and start-up.

Test Results

A complete set of voltage, power and current readings were taken prior to the starting of the fire pump. Special CTs and PTs were installed at several locations to monitor the 480 V 2A-2B current, voltage and watts, and the LC1-2A current and watts. The 480 V 2B bus voltage dropped from 456 V to 419 V during the fire pump start-up. The motor locked rotor current was 741 amps and normal running current 123 amps at 456 V.

Description of Analytical Model

The analytical tool used to model the Big Rock Plant is the P1161 computer program (ASDOP) obtained from Duke Power Company and adapted to the Consumers Power Company Time Sharing Option (TSO) network. The program is also used extensively on all other Consumers Power Company power plants (fossil as well as nuclear). The program has load flow, motor starting and three-phase short circuit capability for various plant operating contingencies. All induction motors and static loads are modeled down to the 480 V level.

Computer Simulation of Fire Pump Start-Up

Prestart conditions were first input into the P1161 computer model of the plant. Once the prestart conditions were properly input, simulation of the fire pump start-up was executed. Comparison of the 480 V 2B bus before and during start-up can be summarized as follows:

	Oscillograph	P1161 Simulation	V	± %
Prestart	456	464	+8	+1.75
Start-Up	419	420	+1	+.24

Comparison of the oscillograph and computer simulated values of Bus 2B voltages indicates only a small difference. This verifies the accuracy and validity of the computer model for both load flow and motor start-up conditions for the Big Rock Point Plant.

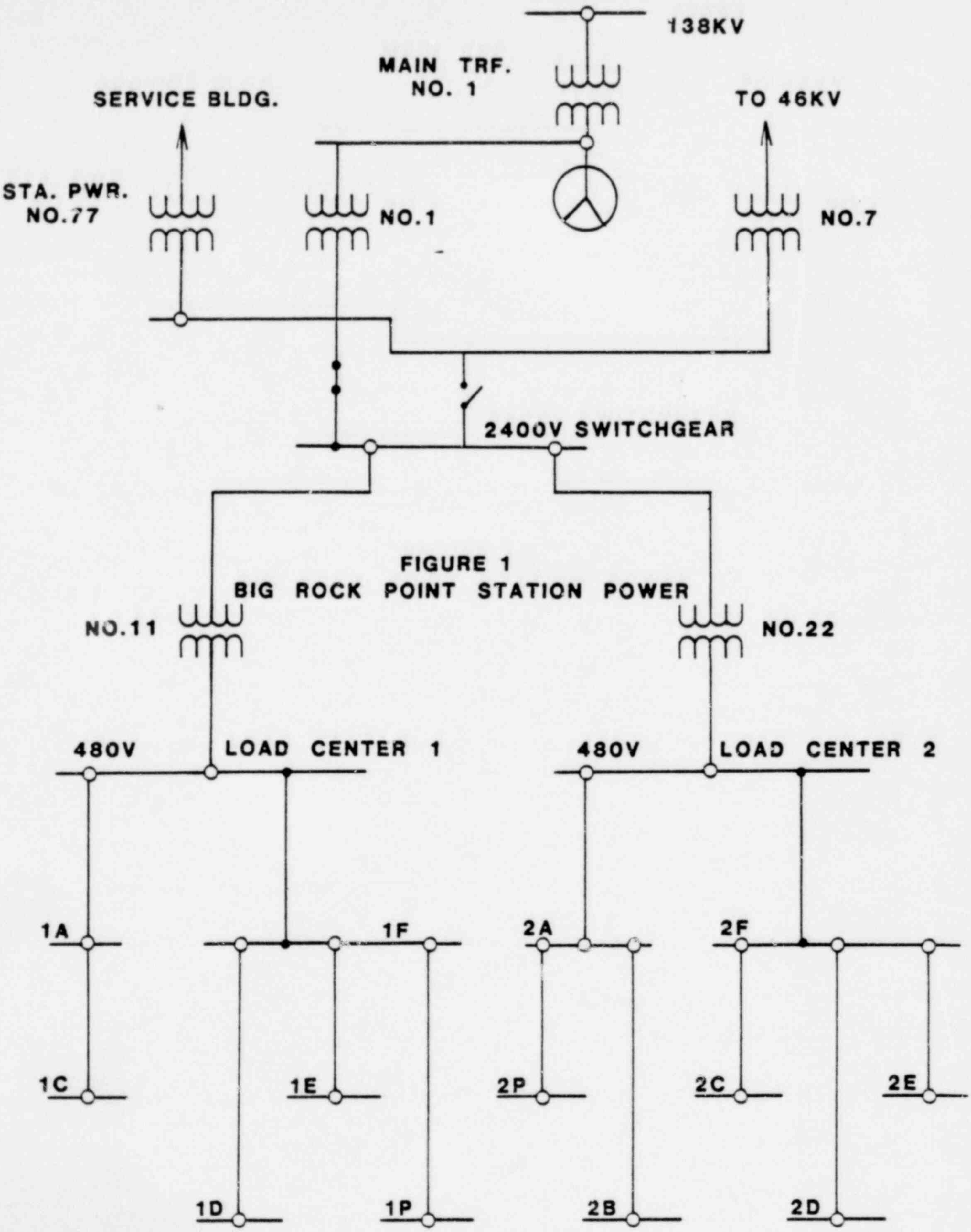

FIGURE 1
BIG ROCK POINT STATION POWER