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SUBJECT: Forwards revision to Question 40.6 re degraded grid voltage, closing SER Outstanding Issue 49.

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May 15, 1981

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket Nos. 50-387
50-388

SUSQUEHANNA STEAM ELECTRIC STATION
SER OUTSTANDING ISSUE 49
ER 100450 FILE 841-2
PLA-781

Dear Mr. Youngblood:

Attached is a revision to Question 40.6 which addresses degraded grid voltage.

This revised response completes our action to close SER Outstanding Issue 49.

Very truly yours,

N. W. Curtis
Vice President-Engineering and Construction-Nuclear

CTC/mks

Attachment

cc: R. M. Stark - NRC

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QUESTION 040.6

Recent operating experience has shown that adverse effects on the safety-related power system and safety related equipment and loads can be caused by sustained low or high grid voltage conditions. We therefore require that your design of the safety related electrical system meet the following staff positions. Supplement the description of your design in the FSAR to show how it meets these positions or provide appropriate analyses to justify non-conformance with these positions.

(1) We require that an additional level of voltage protection for the onsite power system be provided and that this additional level of voltage protection shall satisfy the following criteria:

(a) The selection of voltage and time set points shall be determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels;

(b) The voltage protection shall include coincidence logic on a per bus basis to preclude spurious trips of the offsite power source;

(c) The time delay selected shall be based on the following conditions:

(i) The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the FSAR accident analyses;

(ii) The time delay shall minimize the effect of short duration disturbances from reducing the availability of the offsite power source(s); and

(iii) The allowable time duration of a degraded voltage condition at all distribution system levels shall not result in failure of safety systems or components;

1) The voltage sensors shall automatically initiate the disconnection of offsite power sources whenever the voltage set point and time delay limits have been exceeded;

2) The voltage sensors shall be designed to satisfy the applicable requirements of IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"; and

3) The Technical Specifications shall include limiting condition for operation, surveillance requirements, trip set points with minimum and maximum limits, and allowable values for the second-level voltage protection sensors and associated time delay devices.

(2) We require that the current system designs automatically prevent load shedding of the emergency buses once the onsite sources are supplying power to all sequenced loads on the emergency buses. The design shall also include the capability of the load shedding feature to be automatically reinstated if the onsite source supply breakers are tripped. The automatic bypass and reinstatement feature shall be verified during the periodic testing identified in Position 3.

In the event an adequate basis can be provided for retaining the load shed feature when loads are energized by the onsite power system, we will require that the setpoint value in the Technical Specifications, which is currently specific as "...equal to or greater than..." be amended to specify a value having maximum and minimum limits. Your bases for the selected setpoints and limits must be documented.

(3) We require that the Technical Specifications include a test requirement to demonstrate the full functional operability and independence of the onsite power sources at least once per 18 months during shutdown. The Technical Specifications shall include a requirement for tests: (1) simulating loss of offsite power; (2) simulating loss of offsite power in conjunction with a safety feature actuation signal; and (3) simulating interruption and subsequent reconnection of onsite power sources to their respective buses. Proper operation shall be determined by:

(a) Verifying that on loss of offsite power the emergency buses have been de-energized and that the loads have been shed from the emergency buses in accordance with design requirements.

(b) Verifying that on loss of offsite power the diesel generators start on the autostart signal, the emergency buses are energized with permanently connected loads, the auto-connected shutdown loads are energized through the load sequencer, and the system operates for five minutes while the generators are loaded with the shutdown loads.

(c) Verifying that on a safety features actuation signal (without loss of offsite power) the diesel generators

start on the autostart signal and operate on standby for five minutes.

(d) Verifying that on loss of offsite power in conjunction with a safety features actuation signal the diesel generators start on the autostart signal, the emergency buses are energized with permanently connected loads, the auto-connected emergency (accident) loads are energized through the load sequencer, and the system operates for five minutes while the generators are loaded with the emergency loads.

(e) Verifying that on interruption of the onsite sources the loads are shed from the emergency buses in accordance with design requirements and that subsequent loading of the onsite sources is through the load sequencer.

(4) The voltage levels at the safety-related buses should be optimized for the full load and minimum load conditions that are expected throughout the anticipated range of voltage variations of the offsite power source by appropriate adjustment of the voltage tap settings of the intervening transformers. We require that the adequacy of the design in this regard be verified by actual measurement and by correlation of measured values with analysis results. Provide a description of the method for making this verification; before initial reactor power operation, provide the documentation required to establish that this verification has been accomplished.

RESPONSE

I. Refer to Figures 8.3-1, 8.3-2, 8.3-3 and 8.3-15 for the following discussion on undervoltage detection and transfer logic.

The primary bus transfer on loss of offsite power is initiated at the 13.8 kV startup switchgear and at each Class 1E 4.16kV switchgear bus aligned to the lost offsite source. Refer to Subsection 8.3 for discussion on bus arrangement and the interconnection of the offsite power supplies and the on-site distribution system.

1. Each 13.8 kV startup bus is provided with an offsite power supply and the capability of connecting to the second offsite power supply by the closing of the 13.8 kV tie breaker (breaker 52-10502).

   The undervoltage detection system at each 13.8 kV switchgear bus consists of (1) incoming feeder (offsite power supply) undervoltage relays - device 27AI, (2) bus undervoltage relay - device 27A2, and (3) tie bus undervoltage relay - device 27A1.

   (a) Device 27AI-initiates tripping of the incoming feeder

   Device 27AI is an instantaneous plunger type relay with pickup setting at 93.6 volts (78% of the rated 120 volts). Two independent single phase relays are used to monitor the A-B and B-C phase voltages. The incoming breaker is tripped on coincidence logic of the two undervoltage relays at 91.7 volts with 30 cycle time delay.

   (b) Device 27A1-Provides the permissive for closing of tie breaker

   Device 27A1 is a long time induction disc type undervoltage relay set at 82 volts (68% of rated) and time dial 1/2. Two single phase relaysare provided for monitoring the availability of the alternate offsite power supply at the 13.8 kV level and provide a coincidence logic for the closing of the tie breaker.

   (c) Device 27A2 - initiates the bus transfer

   Device 27A2 is a 3 phase instantaneous plunger type relay with three full wave bridge rectifiers. The relay is set to drop out at 30 volts (25% of rated). Bus transfer is completed by the closing of the tie breaker (permissive by device 27A1).

2. Each 4.16 kV class 1E switchgear bus is provided with a preferred and an alternate (offsite) power supply and one diesel generator feeder as discussed in Subsection 8.3.1.3.

   The undervoltage detection and backup bus transfer on loss of offsite power or sustained degraded voltage on the bus is provided by (1) incoming feeder undervoltage relay-device 27AI, and (2) bus undervoltage relay - device 27A, and (3) degraded voltage protection relays devices 27B1, 27B2, 27B3, and 27B4. The devices settings for the Class IE bus undervoltage protection are summarized in the following Table 40.6-1.

(a) Device 27AI - provides the permissive for closing of the incoming breaker

Device 27AI is two single phase definite time delay relays set at 92% dropout voltage. These relays are used to monitor the availability of the offsite power supply at the class 1E 4.16 kV level.

(b) Device 27A - initiates the bus transfer

Device 27A is a 3 phase instantaneous plunger type relay with three full wave rectifiers. The relay is set to drop out at 18 volts or 15% of rated bus voltage. The 4.16 kV bus transfer is initiated with a time delay of 10 cycles by tripping of the preferred incoming feeder breaker. The transfer is completed if the alternate offsite power supply to this 4.16 kV bus is available (permissive by device 27AI). In case the alternate offsite power is not available, the standby diesel generator is initiated to start with a 0.5 second delay.

(c) Devices 27B1, 27B2, 27B3, and 27B4 - initiate bus transfer and undervoltage alarm. These undervoltage relays are solid-state, single phase with definite time delays (ITE 27D type definite long time).

The additional level voltage protection for each 4.16 kV Class IE bus is provided to assure that voltage levels at all Class IE distribution buses meet the minimum requirement of all safety related equipment to the extent practical.

In the event of loss of voltage on the 4.16 kV Class IE bus, the bus undervoltage relay (27A) initiates bus transfer per paragraph (b) above. In addition, relays 27B1, 27B2, 27B3, and 27B4 provide back up protection for alarms and initiating bus transfer.

If a degraded voltage condition occurs on the 4.16 kV Class IE bus, with no LOCA signal present (see Figure 8.3-15), which is below the setting of relays 27B1 and 27B2, an alarm (coincidence logic) will be initiated after 10 seconds. The relays will initiate the bus transfer after a 5 minute time delay during non-LOCA conditions. A LOCA signal bypasses the 5 minute time delay. The 10 second time delay is provided to preclude spurious alarms and trips for motor start transients. The

5 minute timer is provided for operators to initiate corrective actions during non-LOCA conditions. Relays 27B1 and 27B2 initiate an alarm when the diesel generator is supplying power but do not trip the diesel generator breaker.

In addition, relays 27B3 and 27B4 trip the offsite supply breakers after a time delay of 3 seconds when the bus voltage falls below their setting. These two relays are also connected in a coincident logic. Their setting is based on coordination with overcurrent relays to prevent false trips due to transient voltage dips from fault currents. These relays have no function when the diesel generator is supplying bus power.

If the alternate offsite power is not available, the emergency diesel generator will be started automatically with a 0.5 second delay and connected to the respective bus within 10 seconds per section 8.3.1.4.1.

II. (1) Selection of all voltage relay settings is based on the on-site distribution system load flow study and is verified by preoperational tests. The continuous operating voltage at each distribution voltage level is maintained at ± 10% of the rated voltage level over the entire transmission grid operating range.

Tripping of the offsite power supply at the 13.8 kV level is accomplished by a coincidence logic of two independent single phase undervoltage relays. The backup tripping of the same offsite power supply to the Class 1E 4.16 kV switchgear is provided by a 3 phase full wave rectifiers type undervoltage relay for minimizing nuisance tripping such as loss of a single control fuse in the detection circuit. The total time delay allowed by restarting (starting) of class 1E equipment after a DBA is 13 seconds as shown on Table 8.3-1. 10 seconds is reserved for diesel generator starting. Therefore, 3 seconds is allocated for voltage sensing and bus transfer. Pre-operating tests will verify that the time delay on the bus transfer does not exceed the allowable time.

As discussed in (I) of above, offsite power supply is automatically disconnected at the 13.8 kV level. This forces a loss of power to the 4 kV busses connected to the offsite supply and a 4 kV transfer to the alternate offsite supply, if available, or to the diesel generators. The undervoltage detection sensors and circuits are designed in accordance with IEEE std 279-1971.

(2) All loads on each 4.16 kV Class 1E switchgear bus except the 480 volt load center feeder are shed on loss of power to the bus. Once the bus is re-energized, the 4.16 kV Class 1E loads are loaded in accordance with the pre-set time delay. Load shedding and reloading of 4.16 kV class 1E loads are repeated as discussed above whenever the bus becomes de-energized.

(3) Refer to Chapter 16 for Technical Specification.

(4) Transformer tap settings are selected for optional operating voltage levels for all loading conditions under the anticipated voltage variation of the offsite power supplies. The continuous operating voltage at each level is maintained within ± 10% of rated. Pre-operational tests verify the actual voltage levels.

III. Relay Settings:

The function and settings of undervoltage relays are determined in consideration of the full load, minimum load, and the largest motor starting conditions that are expected throughout the anticipated range of voltage variations for the offsite power sources.

The settings of the degraded voltage protection relays are selected to prevent spurious trips of the offsite power supplies and to provide protection against damaging effects of degraded voltage. The settings are constrained by motor start transients and relay characteristics.

The following design criteria are used:

(1) The maximum allowable voltage at no load or the minimum load conditions is 110% of the motor rated voltage.

(2) The minimum voltage under the maximum running load condition is 90% of the bus rated voltage.

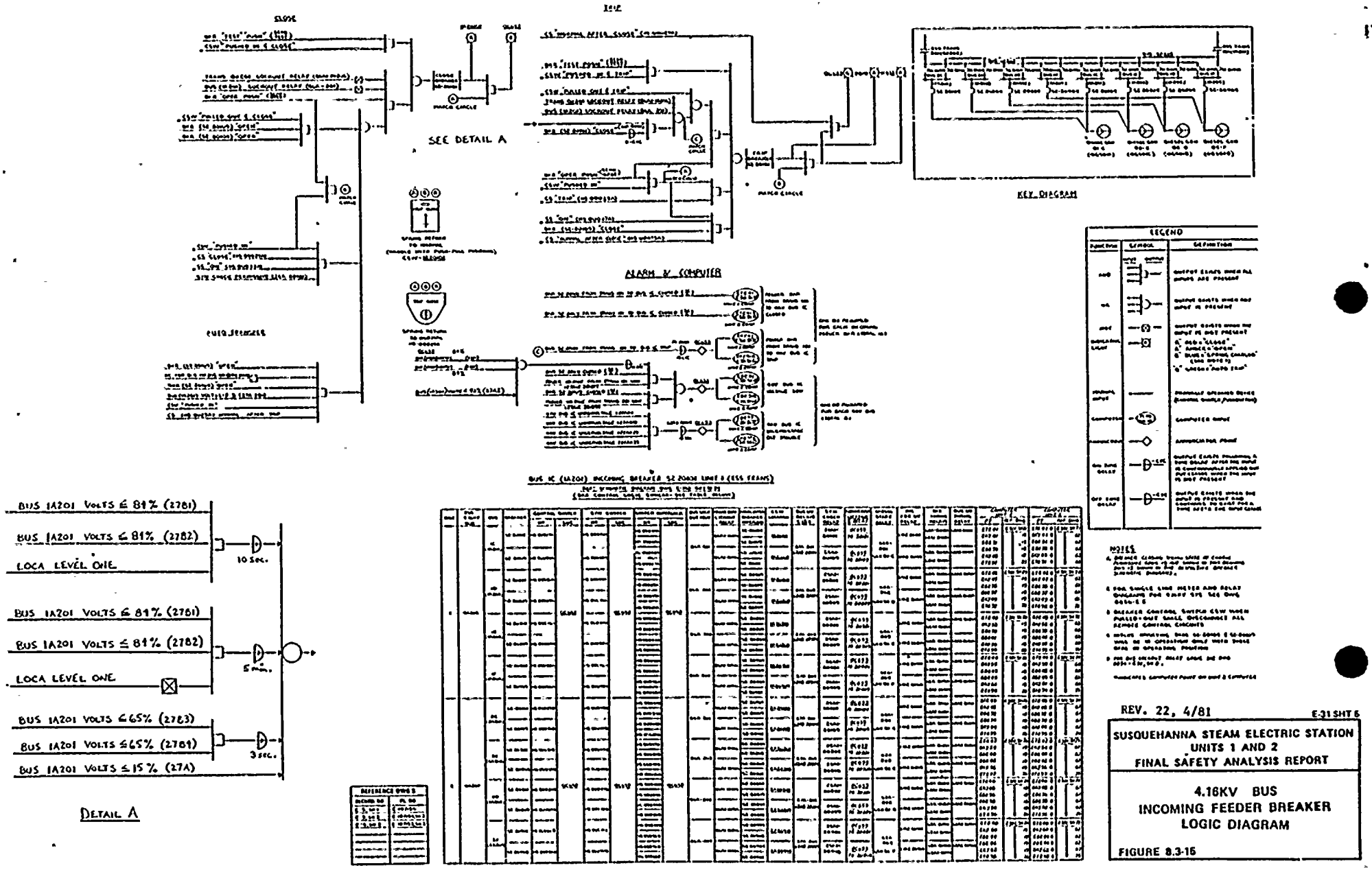
(3) The minimum starting voltage is 80% of motor rated voltage.

See Table 40.6-1.

TABLE 040.6

SETTING TABLE (4KV BUS)

Device No.	Function	Alarm	Voltage Setting	Time Setting
27AI (preferred)	Permissive to close the preferred power incoming Breaker.	Yes	92% dropout	1 sec.
27AI (alternate)	Permissive to close the alternate incoming Breaker	Yes	92% dropout	1 sec.
27A	Initiate bus transfer Trip the incoming closed breaker	Yes	15%	10 cycles
59/27	Bus over/under voltage (alarm only & located in load center)	Yes	110%/90%	10 sec.
27B1 27B2	Undervoltage alarm and initiate bus transfer with time delay relays.	Yes	84% dropout	10 sec.
27B1X 27B2X	Time delay relays with 27B1 & 27B2 to initiate bus transfer.	No	-	5 min.
27B3 27B4	Initiate bus transfer on LOCA condition	No	65% dropout	3 sec.



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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

4.16KV BUS
INCOMING FEEDER BREAKER
LOGIC DIAGRAM

FIGURE 8.3-16