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July 17, 1980

Docket Nos. 50-348
50-364

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. A. Schwencer

RE: Joseph M. Farley Nuclear Plant - Units 1 and 2
Degraded Electrical Power Grid Conditions

Gentlemen:

Enclosed is the additional information you requested by telephone from out staff on June 26, 1980, concerning the subject of degraded electrical power grid conditions for Farley Units 1 and 2. Specifically provided, as part of the enclosure, is information that supplements that previously submitted by our letter dated January 15, 1979 regarding our assessment of NRC Staff Positions 1, 2, and 3 as outlined in your letter dated November 27, 1978. Also included is our response to NRC Staff Position 4 regarding transformer voltage tap settings as related to voltage variations from the offsite power source which is in addition to the information requested by your November 27, 1978 letter. The enclosed responses were discussed with your staff and agreed upon in a meeting held with the NRC on July 16, 1980.

Should you have any further questions, please advise.

Yours very truly,

F. L. Clayton

F. L. Clayton, Jr.

FLCJr/TNE:aw

Enclosures

cc: Mr. R. A. Thomas
Mr. G. F. Trowbridge
Mr. L. L. Kintner, W/Enclosures
Mr. W. H. Bradford
Mr. Ed Reeves, W/Enclosures

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ENCLOSURE

POSITION 1:

In regard to NRC Position 1, the NRC has requested APCo to demonstrate for a degraded voltage condition that the time delay chosen does not exceed the maximum time delay assumed in the accident analyses. The following response will demonstrate for a degraded voltage condition that the existing Degraded Grid Voltage Relay and Loss of Voltage Relay settings meet the response times assumed in the FSAR Accident Analyses for the Engineered Safety Features Systems. Two scenarios must be addressed to demonstrate the adequacy of the design. The first scenario would be to postulate an accident with a degraded grid voltage condition where the 4160V safeguards bus voltage is degraded but is still of a sufficient magnitude to allow the safeguards motors to start and accelerate, and the second scenario would be to postulate an accident with a degraded grid voltage condition where the 4160V safeguards bus voltage is degraded to a level where the safeguards motors cannot start and accelerate.

For the first scenario, the degraded grid voltage will be at a level such that upon the initiation of a SIAS signal, the voltage on the safeguards buses during the initiation of the safeguards motor starting transient will not drop below 72% of the nominal 4160V bus voltage. (72% of nominal 4160V bus voltage corresponds to 75% of rated motor voltage.) Since the bus voltage does not drop below 72% of the nominal value, the motors will start and accelerate. As the 4160V bus voltage was degraded coincident with the transient, the CV-2 Degraded Grid Voltage relays have started their timing cycle, and will trip after the motors are running. Figure 1 depicts the operation of the CV-2 degraded grid undervoltage relays for the motor starting transient which will occur after initiation of the SIAS signal. The voltage transient shown in Figure 1 includes the effects of the motor cable voltage drops. For the LOCA transient shown in Figure 1, the CV-2 Degraded Grid Voltage Relays will trip at 15 seconds after the initiation of the transient. When the CV-2 Degraded Grid Relays trip, they will trip the offsite source supply breakers to 4160V safeguards buses 1F (2F) and 1G (2G). After the offsite source supply breakers are tripped, the loss of voltage relays on buses 1F (2F) and 1G (2G) will initiate a load shed on the safeguards buses, and the safeguards loads will be automatically sequenced onto the Diesel Generators. For this scenario during the initiation of the LOCA transient, the Degraded Grid Voltage Relays have no effect on the response times assumed in the accident analyses, as they do not trip until after the safeguards motors are running. The sequence of events and associated times for this scenario are shown in Table 1 (attached).

From a review of Table 1 Time Base 1, it can be seen that the Safeguards equipment was provided with a starting SIAS signal when the LOCA transient occurred, and the safeguards motors were accelerated and running six seconds after the transient was initiated. The motors continued to run for an additional nine seconds at which point the Degraded Grid Voltage Relays on 4160V Buses 1F and 1G (2F and 2G) trip. Table 1 Time Base 2 indicates the sequence of events and the associated times for the events which occur after the Degraded Grid Voltage Relays trip. The bracketed numbers in the Time Base 2 column are the maximum time delays assumed in the FSAR Accident Analyses. A comparison of the Time Base 2 non-bracketed and bracketed times demonstrates for this scenario that the maximum time delays considered in the accident analyses are not exceeded.. The Time Base 2 non-bracketed times remain unchanged for any Degraded Grid Voltage condition which would result in a voltage level equal to or higher than 72% of the nominal 4160V bus voltage during the initiation of the safeguards motor starting transient.

TABLE 1

DEGRADED GRID VOLTAGE, LOCA, SAFEGUARDS MOTORS ACCELERATE AND RUN

Time Base 1* (Seconds	Time Base 2** (Seconds)	Description of Event
0	--	Degraded Voltage Condition on 4160V Buses 1F and 1G (2F and 2G), SIAS signal, D.G. start signal from SIAS, Engineered Safeguards Equipment Start Signal from SIAS
6	--	Safeguards Motors are started and running
10	--	Diesel Generators at rated voltage and frequency
15	0	Degraded Grid Voltage Relays on 4160V Buses 1F and 1G (2F and 2G) trip and send trip signal to Offiste Source Feeder Breakers
15.1	0.1	Offsite Source Feeder Breakers to 4160V Buses 1F and 1G (2F and 2G) trip
15.5	0.5	Loss of Voltage Relays on 4160V Buses 1F and 1G (2F and 2G) trip, initiate load shed and send closing signal to Diesel Generator Breakers
15.6	0.6	Safeguards Motors are shed from Buses
17.6	2.6	Diesel Generator Breakers close and Step 1 loads on Engineered Safeguards Systems (ESS) Sequencer are provided with start signals
17.7	2.7 (25.95)	ESS Sequencer Step 1 loads (Charging/HHSI Pumps) are starting
22.6	7.6	ESS Sequencer Step 2 loads are provided with Start Signals
22.7	7.7 (48)	ESS Sequencer Step 2 loads (RHR/LHSI Pumps and Containment Spray Pumps) are starting
27.6	12.6	ESS Sequencer Step 3 loads are provided with Start Signals
27.7	12.7	ESS Sequencer Step 3 loads (Service Water Pumps) are starting
32.6	17.6	ESS Sequencer Step 4 loads are provided with Start Signals
32.7	17.7 (27.4)	ESS Sequencer Step 4 loads (Component Cooling Pumps and Containment Coolers) are starting

*Length of time from accident occurence coincident with degraded grid condition (Diesel Generator and Safeguards Motors are started and running)

**Length of time from trip of Degraded Grid Voltage relays

Table 1 (Cont'd)

Degraded Grid Voltage, LOCA, Safeguards Motors Accelerate and Run

Time Base 1 (Seconds)	Time Base 2 (Seconds)	Description of Event
37.6	22.6	ESS Sequencer Step 5 loads are provided with Start Signals
37.7	22.7 (60)	ESS Sequencer Step 5 loads (Reactor Cavity H_2 Dilution Fans and Auxiliary Feedwater Pumps) are starting
42.6	27.6	ESS Sequencer Step 6 loads are provided with Start Signals
42.7	27.7	ESS Sequencer Step 6 loads (Battery Chargers) are energized.

For the second scenario, the Degraded Grid Voltage will be at a level such that upon the initiation of a SIAS signal, the voltage on the safeguards buses during the initiation of the safeguards motor starting transient will drop below 72% of the nominal 4160V bus voltage. As the 4160V bus voltage drops below 72% of the nominal value, the motors may not start and accelerate and therefore, the voltage may not recover on the 4160V safeguards buses. Figure 2 depicts the relay curves for the CV-2 Degraded Grid and Loss of Voltage Relays. From Figure 2, it can be seen for this scenario that the Loss of Voltage Relays will trip in 3.6 seconds. Due to the inverse time characteristics of the CV-2 relay, for voltages lower than 72% of the nominal bus value, the Loss of Voltage Relay will trip faster than 3.6 seconds. However, in Table 2 which shows the sequence of events and associated times for this scenario, 3.6 seconds will be used for the trip time delay of the Loss of Voltage Relays which will produce conservative results.

The bracketed times in Table 2 are the maximum time delays assumed in the FSAR Accident Analyses. A comparison of the non-bracketed and bracketed times associated with the events described in Table 2 demonstrate that the maximum time delays assumed in the FSAR Accident Analyses are not exceeded.

TABLE 2

DEGRADED GRID VOLTAGE, LOCA, SAFEGUARDS MOTORS FAIL TO ACCELERATE

Time (Seconds)	Description of Event
0	Degraded Voltage Condition on 4160V Buses 1F and 1G (2F and 2G), SIAS SIGNAL, D.G. Start Signal from SIAS, Engineered Safeguards Equipment Start Signal from SIAS
3.6	Loss of Voltage Relays on Buses 1F and 1G (2F and 2G) trip, initiate load shed, and send trip signal to Offsite Source Feeder Breakers
3.7	Offsite Source Feeder Breakers to 4160V Buses 1F and 1G (2F and 2G) trip and send permissive closing signal to Diesel Generator Breakers
10	Diesel Generators at rated voltage and frequency
10.1	Diesel Generator Breakers close and Step 1 loads on ESS Sequencer are provided with Start Signals
10.2 (25.95)	ESS Sequencer Step 1 loads (Charging/HHSI Pumps) are starting
15.1	ESS Sequencer Step 2 loads are provided with Start Signals
15.2 (48)	ESS Sequencer Step 2 loads (RHR/LHSI Pumps and Containment Spray Pumps) are starting
20.1	ESS Sequencer Step 3 loads are provided with Start Signals
20.2	ESS Sequencer Step 3 loads (Service Water Pumps) are starting
25.1	ESS Sequencer Step 4 loads are provided with Start Signals
25.2 (27.4)	ESS Sequencer Step 4 loads (Component Cooling Pumps and Containment Coolers) are starting
30.1	ESS Sequencer Step 5 loads are provided with Start Signals
30.2 (60)	ESS Sequencer Step 5 loads (Reactor Cavity H_2 Dilution Fan and Auxiliary Feedwater Pumps) are starting

Table 2 (Cont'd)

Degraded Grid Voltage, LOCA, Safeguards Motors Fail to Accelerate

Time (Seconds)	Description of Event
35.1	ESS Sequencer Step 6 loads are provided with Start Signals
35.2	ESS Sequencer Step 6 loads (Battery Chargers) are energized

For the sequence of events tables presented above, the tolerances on the voltage trip point and the time delay for the CV-2 Loss of Voltage and Degraded Grid Voltage Relays were not included. The relay voltage trip band will be plus or minus 1% of the calibrated trip point, and the relay time delay trip tolerance will be plus or minus 5%. Due to the magnitude of the differences between the engineered safety features response times tabulated above and the maximum time delays assumed in the FSAR Accident Analyses, inclusion of the relay tolerances will not alter the conclusions stated above, i.e., the maximum tin delays assumed in the FSAR Accident Analysis will not be exceeded.

FIGURE 1 – OPERATION OF CV-2 DEGRADED GRID UV RELAY WITH LOCA TRANSIENT SIMULTANEOUSLY OCCURRING WITH DEGRADED GRID CONDITION

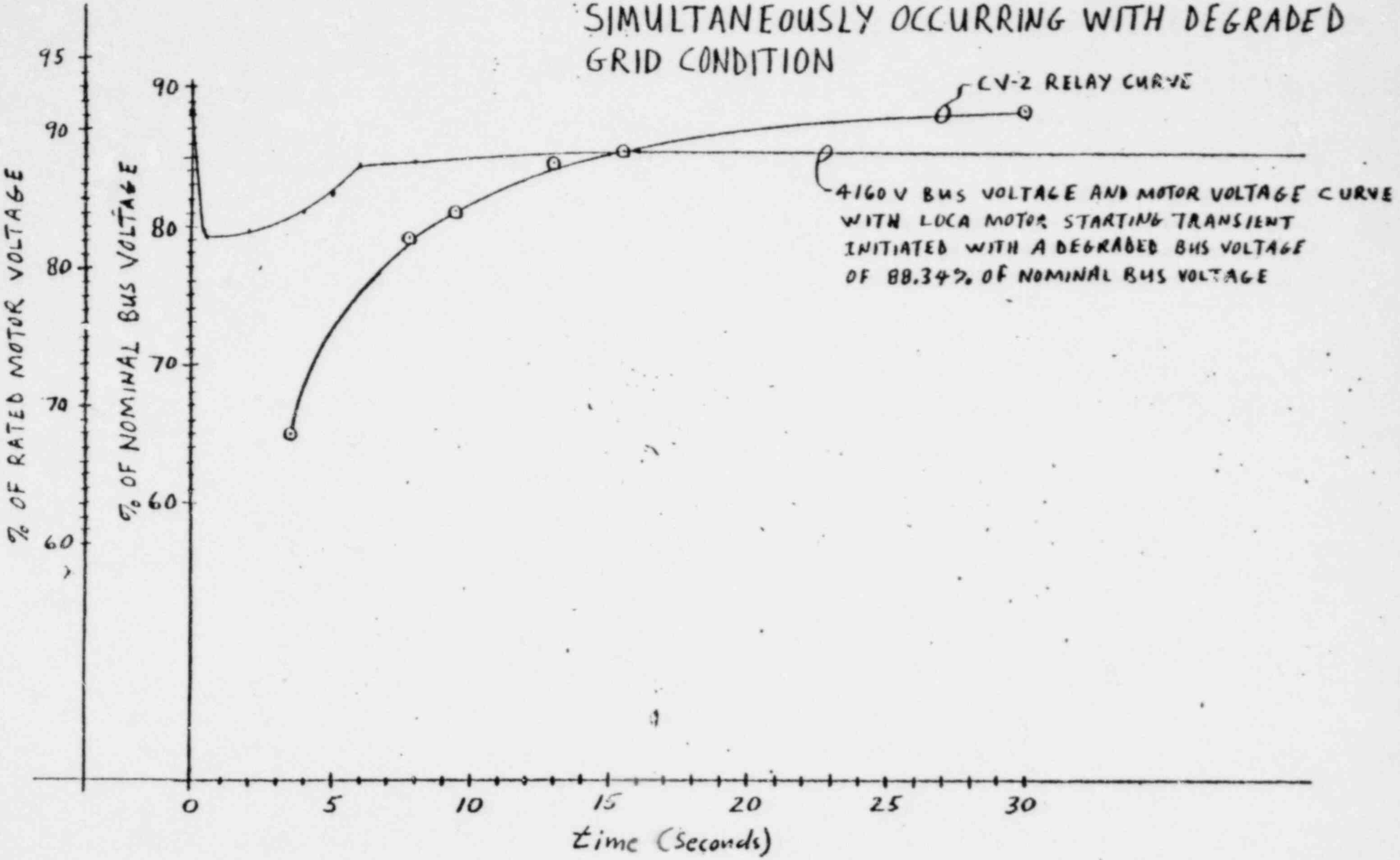
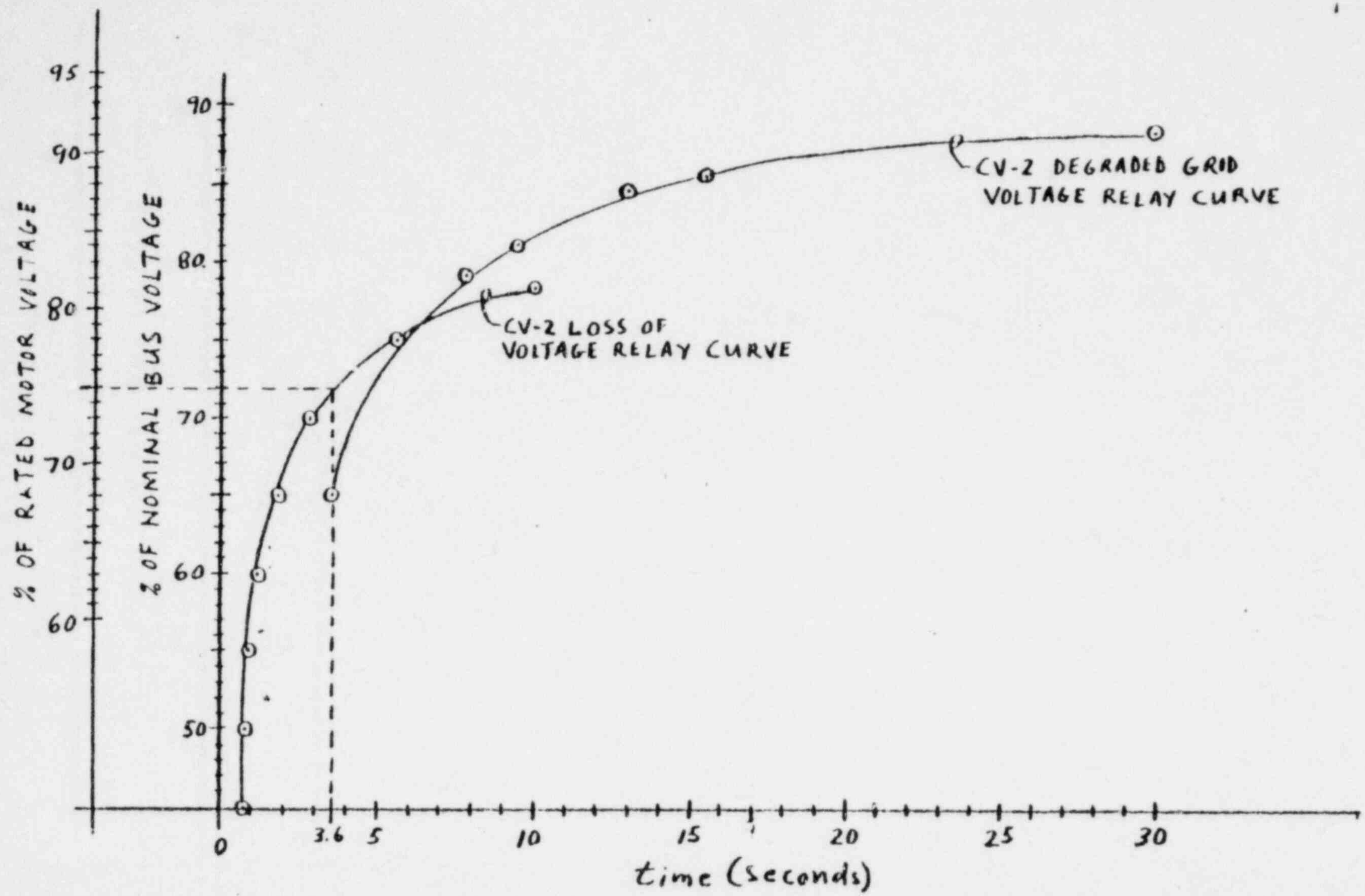


FIGURE 2 – CV-2 LOSS OF VOLTAGE AND DEGRADED GRID VOLTAGE RELAY CURVES



POSITION 2:

In regard to NRC Position 2, Interaction of Onsite Power Sources with the Load Shed Feature, the NRC has indicated that the present design which retains the load shedding feature on the emergency buses when these buses are supplied power from the diesel generators, is inconsistent with the NRC requirements and requested APC to either automatically prevent load shedding of the emergency buses once the onsite sources are supplying power to all safety related equipment and automatically reinstate this load shed feature if the onsite source supply breakers are tripped, or provide adequate basis for retaining the load shed feature when loads are energized by the onsite power system. The NRC also indicated that an alternate acceptable design would be to bypass the load shed feature only during load sequencing. The following provides the basis for retaining the load shed feature when loads are energized by the onsite power system.

The load shedding feature of all 4 kv emergency buses 1F, 1H, 1G, 1J (2F, 2H, 2G, 2J) is initiated by a bus undervoltage condition (sensed by the loss of voltage relays) and will automatically load strip the bus regardless of the source (offsite or onsite) supplying power to that bus.

The load shedding feature provides the necessary function for transferring a bus from the offsite power system to an onsite diesel generator.

The load shedding feature of the train A buses is required to be maintained in an operable status even after the train A diesel generators are connected to those buses, in order to permit proper operation of the train A diesel generators under any postulated sequence of events, which may require realigning the train A diesel generators. This is due to the swing feature of the train A diesel generators.

On train B the present design provides for Diesel Generator 2C to be backed up by Diesel Generators 1B and 2B in the event of failure of Diesel Generator 2C. The load shedding feature of buses 1J and 2J on bus undervoltage is necessary in conjunction with this backup feature to avoid the possibility of tying Diesel Generator 1B or 2B to a loaded bus.

The above discussion demonstrates the necessity of retaining our present design on 6 out of 8 of the diesel generator buses. In order to avoid undue complexity and to maintain uniformity of design it is desirable to retain the same feature on the other two train B buses.

The load shedding feature also performs a protective function against an undervoltage condition which will damage the equipment, if its operation continues. For this reason the load shedding feature is maintained in an operable status regardless of which source is supplying power to the bus (offsite or onsite). If an undervoltage condition occurs while an emergency bus is supplied power from a diesel generator, it indicates that a problem has developed in the operation of that diesel (voltage regulator failure, excitation system failure, etc.) and the equipment will be affected if operation continues. The load shedding feature will prevent damage to safety components, while the safe shutdown of the plant will not be impaired since components of the redundant train will perform the necessary safety function. An inadvertent operation of the load shedding feature of an emergency bus supplied power from a diesel generator constitutes a single failure, and the plant can accept this single failure without safety implications.

From the NRC review, it appears that the basic concern relates to the possibility of having the load shedding feature activated during the load sequencing process. In this respect, it should be noted that the onsite sources are designed with the capability of starting and accelerating to rated speed, in the required sequence, all the needed engineered safety feature and emergency shutdown loads, and the undervoltage relay settings are selected such that at no time during the load sequence should the voltage decrease to a level which will actuate the load shedding feature. The diesel generator loading sequence as shown in Table 3 indicates that the maximum voltage drop (24%) occurs when applying the first step of safeguard motors. In this case the voltage on the 4 kv bus drops to 76% and recovers in 1.4 seconds. Due to the inverse time characteristic of the undervoltage relays (CV-2), 7 seconds are required for the voltage to remain at 76% of the bus nominal in order for these relays to trip. This assures that sufficient margin exists between the bus voltage profile during the loading process of the diesel to prevent the load shedding feature from being activated. An inadvertent operation of the load shedding feature during the load sequencing process constitutes a single failure, with no safety implications. In addition, the load sequencing process is being periodically tested, at least once per 18 months during shutdown, as required by the Technical Specification-Surveillance Requirements 4.8.1.1.2.c.

TABLE 3

LOAD SEQUENCE FOR DIESEL GENERATORS 1-2A, 1B AND 2B

Step No.	Load	SKVA	Volt. Dip %	Volt. Recov. Specs.	% Freq. Dip	Secs. Freq. Recov.	Peak KW
1	1250	7700	24	1.4	3.0	0.42	2250
2	750	5146	22	1.1	1.75	0.28	1350
3	1200	7485	23	1.35	3.0	0.60	2250
4	650	4052	15	0.90	1.5	0.39	1170
5	450	2807	10	0.75	1.0	0.30	810
6	145	904	4	0.4	0.4	0.14	264
7	250	1560	7	0.5	0.6	0.21	450

POSITION 3:

In regard to NRC Position 3, Onsite Power Testing, the NRC requested that the Technical Specification include a test to demonstrate that on interruption of the onsite sources the load shed feature has been automatically reinstated and that subsequent loading upon reconnection of onsite power sources is through the load sequencer.

The logics of all three subject functions (load shedding, LOSP loads sequencing and ESS loads sequencing) do not recognize which source of power, offsite or onsite, supplied power to the corresponding emergency bus prior to its de-energization. As a result, any one of the above functions is performed by the same circuitry regardless of whether its initiation was generated by the interruption of the onsite source, or by the loss of offsite power.

The proposed modifications to the Technical Specification contained in Alabama Power Company letter to the NRC dated October 10, 1979, provide independent tests for the verification of the three above functions, under Surveillance Requirements 4.8.1.1.2, as follows:

c.6.a - for verification of the load shedding

c.6.b - for verification of LOSP loads sequencing

c.3.a - for verification of ESS loads sequencing

The additional tests requested by the NRC under Position 3 will duplicate the tests already provided by APCo in the proposed modifications to the Technical Specification, since no additional components or circuitry will be verified. From this point of view, the NRC request under Position 3 would require additional plant outage time and is thus not technically justified.

POSITION 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:

In response to IE Information Notice 79-04, Alabama Power Company submitted additional information to the NRC concerning the adequacy of station electrical distribution system voltages by letters dated December 11, 1979 and May 1, 1980. The December 11, 1979 letter contained voltage profiles which demonstrated that the voltage tap settings of the distribution system transformers have been optimized for the full load and minimum load conditions that are expected throughout the anticipated range of voltage variations of the offsite power source. A computer analysis was performed to obtain the optimum tap settings for the distribution system transformers, and the optimum tap settings for each transformer are shown on the single line diagram which is contained in the December 11, 1979 letter. Farley-Unit 1 is currently operating with the transformer taps set as indicated on the referenced single line, and Farley-Unit 2 will utilize the same tap settings.

The adequacy of the tap setting design which was performed by computer analysis was verified by performing a test at Farley-Unit 1 as described in the referenced December 11, 1979 letter. The test case was modeled on the voltage drop computer program and correlation of the measured voltage test values with the computer analysis voltage results indicated that the computer calculated bus voltage was within 0.3% of the measured bus voltage. Although the referenced test was performed on Farley-Unit 1, due to the similarity in design, the results are also applicable to Farley-Unit 2. Alabama Power Company's position is that the above referenced testing was adequate to demonstrate accuracy of the analysis.

However, after several telephone discussions with the NRC Staff and their consultant where it was stated that further testing was required, Alabama Power Company proposes the following test on Unit 2.

It is our understanding that the purpose of the additional testing is to verify the calculational data used in the computer calculation which was utilized for the worst case analysis presented in our December 11, 1979 letter to the NRC. From discussions with your consultant, an acceptable test would consist of measuring the electrical parameters under steady state load conditions on the 4160V, 600V, and 208V buses which were determined by analysis to exhibit the largest voltage drops during the worst case analysis. Due to the similarity between the design of Units 1 and 2, the testing proposed by Alabama Power Company will be performed on Unit 2 only. The test configuration would then be modeled on the computer program used for the worst case analysis, and the program would be executed. The computer results would then be compared with the measured test parameters to demonstrate the adequacy of the calculational constants.