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GAMMILL,W.P. Assistant Director for Standard & Advanced Reactors

SUBJECT: Submits evaluation results in response to NRC 790723 & 790808 ltrs re offsite power & onsite distribution sys. Evaluations currently under review to determine need for addl Tech Specs.

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FPL

FLORIDA POWER & LIGHT COMPANY

November 9, 1979
L-79-324

Office of Nuclear Reactor Regulation
Attn: Mr. William Gammill
Acting Assistant Director
for Operating Reactors Projects
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Gammill:

Re: St. Lucie Unit 1
Docket No. 50-335
Station Electric
Distribution Systems

As a result of NRC letters dated July 23 and August 8, 1979, we have performed evaluations (attached) related to offsite power and the onsite distribution system at St. Lucie Unit 1. Our operating department is now reviewing the evaluations to determine the need for additional Technical Specifications. If such Specifications are needed, we will provide a schedule for their submittal by December 15, 1979.

Based on the results of the evaluations and proposed plant modifications, we have deferred scheduling a distribution system test pending NRC review of this submittal.

Please call if you have additional questions on this subject.

Very truly yours,

Robert E Uhrig

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/MAS/mld

cc: R. W. Reid, Operating Reactors Branch #4
Harold Reis, Esquire

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In response to NRC letter to FPL dated July 23, 1979, Request for Additional Information, St. Lucie, Degraded Grid Voltage

The following response addresses the adequacy of the undervoltage setpoints and time delays regarding the operation of 480V safety equipment as required in the above referenced Request for Additional Information. Also, as requested, this response details the coincident logic for undervoltage protection, describes how IEEE 279-1971 requirements are satisfied, and resolves the discrepancy noted between our letters of September 22, 1976 and July 25, 1977.

Our September 22, 1976 letter stated that it is improbable that the voltage on the 480 volt bus would remain between the undervoltage setpoint and the nominal equipment ratings. This is due to the fact that only transients would cause the voltage to pass through this region. Therefore, equipment would not be required to operate at such a voltage.

Since 1977 when the original concern was raised, FPL in the normal course of review of plant operational data and experience has changed the tap setting of the 4.16kV/480V safety related transformers. Considering actual loads, this then brings the MCC bus average voltage corresponding to the 88.3% 4.16kV undervoltage relay setting to approximately 85%. Considering cable to equipment voltage drops and actual operating conditions, equipment can be demonstrated to continue to operate without damage at 85% of 480V. Except for motor operated valves the maximum cable voltage drops do not cause device terminal voltage to drop below 400 volts while the equipment is running. The low voltage operating point of equipment given by our September 22, 1976 is the nominal lowest point at which the manufacturer rates operation of the equipment. The equipment, however, was specified with conservatism which allows continued operation at even lower voltages.

A discussion of the various 480 volt equipment is given below:

Pump and Fan Motors - These motors are specified as 460 volt, 1.15 service factor, Class B motors capable of starting and accelerating their connected load at 75% of nameplate terminal voltage. Furthermore, continuous operation at ±10% of the nameplate voltage of 460 volts is also required.

Since the motors are designed with sufficient torque to accelerate their load at 75% voltage, operation at 75% from a torque requirement is possible. Continuous operation at this lower voltage (345V) however, would require a corresponding increase in current of approximately 1.33 times the nominal 460 volt current. This increased current would cause the motors to run hotter than the Class B 1.15 service factor temperature rise of 90°C, which for extended periods of time would shorten the life of the motor. However, operation at 115% of rated current is within the temperature rating of the motors. Considering this satisfactory, full output continuous operation could be expected at 400 volts which is 83.3% of 480 volts.

This voltage is considered to be conservative since the full output horsepower of the motor is not generally required to power the driven load. The general philosophy used in sizing these motors is to select the next largest standard size motor above the highest point on the loads operating curve.

Valve motors - Motor operated valves employ special torque motors for their operation. Manufacturer's data and plant tests reveal that these motors can start at 368 volts and generally operate near or in the saturated region. That is, with a decrease in voltage the current also decreases. Therefore, at low voltages there is less temperature rise and thermal overheating is not a problem. Therefore, continued operation below 400 volts is possible without equipment damage. Each MOV operating voltage was calculated and none fell below 368 volts.

Motor Control Center Contactors - The motor control center contactors are powered from 480/120 volt transformers. These transformers are oversized, with 50 VA being used for size 1 and 2 starters and 500 VA for size 3 and 4. Tests were performed on several contactors and the highest pickup voltage required on any size starter was 95.2 volts. The highest drop out voltage was 74.8 volts. Considering the above transformer ratio and typical transformer impedance, operation at 400 volts is acceptable.

Battery Chargers - The battery charger manufacturer indicates that similar type chargers have been tested at 400 volts AC input and still obtained the full range of regulation. Readings taken at the plant indicate that the connected load on the chargers is less than half its rating, therefore, operation down to 400 volts is acceptable.

Boric Acid Heat Tracing - This system was specified to operate at a minimum 80% of 120 volts. Considering transformer drops this system would be capable of operation down to at least 394 volts input to the heat tracing transformer.

As demonstrated by the above analysis, in the unlikely event that equipment would be required to continue to operate at the undervoltage setpoint for a long period of time, it could do so without damage.

As stated in our previous responses, St. Lucie Plant incorporates a Westinghouse type CV-2 undervoltage relay on each of the safety related 4.16 kV busses. Upon actuation of the relay the offsite power source is disconnected, the bus is stripped and the diesel starting sequence is initiated. These relays are induction disc type which inversely relate time and voltage. That is, the lower the bus voltage the faster the relay responds. Therefore, this relay provides protection against sustained low voltage conditions as well as complete loss of power since the relay response is very fast on complete loss of power and much slower on low voltage conditions. Since its time response to low voltage is slower it will not be actuated by motor starting or other transient conditions which might cause spurious relay actuation if such a feature were not used.

The CV-2 relays are connected to the 4.16 kV busses through 4200/120 volt potential transformers. The relays are of the 55 to 140 volt range and are set at the 105 volt tap. This corresponds to 88.3% of 4.16 kV. Time dial 1 was selected for the time characteristic. The relay is designed such that the induction disc begins to move at the tap voltage. For example, if the bus voltage remained at 79.5% of 4.16kV for approximately 6 seconds, the relay would actuate. If the voltage were at 70% of 4.16kV the relay would actuate in approximately 3 seconds. This then allows motor starting without spurious actuation of the bus undervoltage relay.

To avoid spurious loss of all offsite power and to provide the required redundancy, each safety related 4.16 kV bus has individual undervoltage relay and logic circuits for diesel starting. There is one undervoltage relay on each 4.16 kV safety related bus. Actuation of that relay will start the diesel on that bus.

In addition, there is no intertie between A and B undervoltage bus stripping logic. Should a relay malfunction occur, it would effect one bus. The other bus would remain connected to the offsite power source.

In view of the above and the fact that the relays are on separate busses, their cabling and associated logic are separated and they activate separate diesels, the redundancy, single failure and separation requirements of IEEE 279-1971 are met.

The FPL letters dated September 22, 1976 and July 25, 1977 and the latest wiring diagrams, have been reviewed. The latest circuit design concurs with the statement made in the July 25, 1977 letter. For each train, approximately 0.2 seconds after the diesel generator breaker is closed, the 4.16 kV bus undervoltage relay is bypassed. The circuit design also provides for automatic reinstatement of the 4.16 kV bus undervoltage relay (and hence load shedding capabilities) when the diesel generator breaker is tripped.

In response to NRC letter to FPL dated August 8, 1979
Re: Adequacy of Station Electric Distribution Systems Voltages

The following response addresses the NRC concern that the offsite power system (grid) and on-site electrical distribution system is of sufficient capacity and capability to automatically start and operate all required safety loads. Specifically, the NRC required confirmation that potential overloading due to transfers of either safety or non-safety loads and potential starting transient problems do not result in unacceptably degraded voltage to safety loads or spurious shedding of safety loads from the offsite electrical grid.

During 1978 and 1979, the steady voltage experienced on the transmission system at St. Lucie varied between 230 kV and 244 kV. On May 16, 1977, the loss of FPL Turkey Point Unit 3 necessitated a large import of power into southeast Florida. The subsequent loss of a major transmission line resulted in a blackout south of Ranch Substation. During the interval between loss of Turkey Point Unit 3 and the transmission fault, the St. Lucie transmission bus voltage varied between 240 kV and 219 kV for approximately 10 minutes before collapse of the grid south of Midway Substation. On October 3, 1979, St. Lucie 1 tripped off the line and the switchyard voltage subsequently dipped to 216 kV, recovering to approximately 222 kV within seconds. The voltage recovered to 230 kV within approximately 90 minutes. However, from experience, voltages less than 230 kV at St. Lucie are considered to be short term and transient in nature with recovery or collapse of the system expected to occur in a short period of time.

Florida Power & Light has no contingency plans to lower transmission voltages to reduce load. A program is in progress which will lower only distribution voltage for load reduction.

Because either a unit trip or safety injection signal initiates automatic transfer of the onsite distribution system from the auxiliary transformer to the start-up transformer, the voltage analyses were performed assuming connection to the start-up transformer. Two cases were analyzed, one with normal running loads being supplied by the start-up transformer (unit trip) and the other with safety loads being simultaneously started without tripping the normal running loads (accident condition). All automatic actions were assumed to occur as designed and no credit was taken for manual load shedding. The following assumptions were made for the calculations.

1) The normal loads used were measured values with the plant at full load.
2) The power factor of the running loads were assumed as .85
3) The measured normal running loads were assumed to include the following safety related loads; the intake cooling water pumps and component cooling water pumps on the 4 kV system; containment fan coolers, RAB exhaust fan and charging pumps on the 480V load center; and all safety related loads (such as battery chargers etc.) on the 480V motor control centers except for motor operated valves.

4) The starting power factor of the 4 kV motors was assumed as .22. The starting current used was from nameplate data.
5) The starting power factor of the 480V motor operated valves was assumed as .60. The starting current used was taken from the original plant start up test data.
6) All currents were assumed to remain constant for the calculation.

Considering the above assumptions the voltage at all safety related equipment would be sufficient for their continued operation should the plant trip and all loads transfer to the startup transformer. Should there be a concurrent safeguard signal with the transfer, there would be sufficient voltage to start the required safety related motors. The voltage at the safety related motor control centers would not drop below 400 volts.

Although 400V is below the minimum pick-up point guaranteed by the contactor manufacturer, tests were performed whose results indicate this to be conservative. The motor control center contactors are powered from 480/120 volt transformers. These transformers are oversized; 150 VA is used for size 1 and 2 starters and 500 VA for size 3 and 4. Results of these tests on several contactors revealed the highest pickup voltage required on any size starter was 95.2 volts. The highest drop out voltage was 74.8 volts. Considering the above transformer ratio and typical transformer impedance, operation at 400 volts is acceptable.

In order to further assure that degraded grid voltage would not prevent safety equipment from starting, a design modification is planned to add undervoltage relays to the 480V busses. Actuation of these undervoltage relays concurrent with a safeguards signal will transfer the safety loads to the diesel-generator.