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NUCLEAR REGULATORY COMMISSION
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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT 1

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STATION BLACKOUT

1.0 INTRODUCTION

Station blackout is defined as the complete loss of offsite and onsite AC power to the essential and non-essential electrical buses in a nuclear power plant. A blackout at St. Lucie Unit No. 1 would cause complete loss of all AC-powered systems used to remove decay heat from the reactor core and to provide makeup water to the core. A blackout would require Unit No. 1 to operate only on its DC battery supply and on a turbine-driven auxiliary feed water pump, with the primary system being cooled by natural circulation. An extended blackout could cause depletion and failure of the DC battery supply used to provide the light and power needed to control non-AC safety systems.

2.0 DISCUSSION AND EVALUATION

The Atomic Safety and Licensing Appeal Board (Board) examined the blackout issue at the St. Lucie Station in connection with St. Lucie Unit No. 2. The Board decided (in ALAB-603 of July 30, 1980) to require Florida Power and Light (FP&L) to (1) submit an analysis demonstrating the ability of Unit No. 2 to operate through a blackout, and (2) detail its training programs and procedures for station operation during a blackout transient and for the restoration of AC power. In December 1981 (in NUREG-0843 Supplement No. 1) the staff accepted the FP&L submittal as meeting the requirements of ALAB-603, subject to some additional work on station blackout procedures and subject to staff review of the CESEC III Computer Code used to predict Unit No. 2 behavior.

On October 10, 1980 the staff advised FP&L that "the Unit No. 2 requirements of ALAB-603 are appropriate for St. Lucie Unit No. 1." FP&L was asked, pursuant to 10 CFR 50.54(f), to submit an analysis demonstrating the ability of Unit No. 1 to be safely controlled through a total loss of AC power. FP&L was also asked to describe in detail its training programs and procedures for station operation during blackout and for restoration of power. On December 18, 1981, FP&L responded by submitting its station blackout analysis for Unit No. 2, dated October 1981, together with a description of the differences between Unit No. 1 and Unit No. 2 as they affect the analysis. On November 23, 1981, Unit No. 1 was authorized to stretch power from 2560 to 2700 Megawatts thermal (Mwt). Therefore, on January 22, 1982, FP&L revised its submittal. FP&L said its January evaluation showed that, after blackout, Unit No. 1 could maintain natural circulation and core cooling for at least 3 hours.

On March 25, 1982, the staff asked FP&L to submit an analysis of blackout for Unit No. 1 which demonstrated the ability to maintain core cooling for 4 hours, as FP&L had submitted for Unit No. 2, or to provide additional detail supporting the restoration of AC power to Unit No. 1 in less than 4 hours. FP&L was also informed that the existing analysis of Unit No. 2 could not be applied to Unit No. 1 for 4 hours because the plants had different setpoints for operation of their safety injection tanks (SIT's). (The analysis of Unit No. 2 showed that injection occurred at 583 psia at 3 hours 29 minutes, but the same injection timing would not occur for Unit No. 1 because the SIT setpoint at Unit No. 1 is down at 200 psia.) FP&L was also asked to submit details of the analysis at the stretch power of 2700 Mwt so as to allow an adequate staff review.

On May 14, 1982, FP&L provided a response in support of 3 hours of core cooling. The FP&L technical analysis of Unit No. 1 behavior during blackout was based on FP&L's prior analysis of Unit No. 2 behavior during blackout, with adjustments made to compensate for differences between Unit No. 1 and Unit No. 2. The essence of the comparison and adjustment process is that FP&L:

(1) Compared the overall primary system leak rates of Unit No. 1 and Unit No. 2 by comparison of safety valve leak rates and by comparison of Technical Specification limits on leak rates, and concluded that the reactor coolant system inventory of Unit No. 1 is maintained at least as well as at Unit No. 2 under such leak rate limits;

(2) Lengthened the time span the operators kept open atmospheric steam dump valves on the secondary side in order to maintain hot leg subcooling, this being necessary due to valve differences and power level differences between Unit No. 1 and Unit No. 2;

(3) Indicated that natural (single phase) circulation would exist for at least 3 hours without benefit of safety injection tanks if Unit No. 1 were run at the Unit No. 2 power rating;

(4) Indicated that the CESEC III blackout analysis of Unit No. 2 showed that the pressurizer level was about 20% above emptying at 3 hours, so that the water remaining in the Unit No. 1 pressurizer at 3 hours would compensate for the 6% higher power level in Unit No. 1 and assure no hot leg voiding and no loss of natural single phase circulation in Unit No. 1 for at least 3 hours after the start of a blackout;

(5) Indicated peak pressure during blackout as being the same as for loss of only offsite AC power, with this peak pressure at stretch power being 2534 psia and thus well below 110% of design pressure;

(6) Indicated fuel failure based on minimum DNBR during blackout as being the same as for loss of only offsite AC power, with no fuel failure found for this event at stretch power; and

(7) Indicated no depletion of shutdown margin after 3 hours.

We find FP&L's technical discussion in support of 3 hours is reasonable and acceptable. With regard to Items (5) and (6), the FP&L reanalysis is under review by the NRC staff.

The May 14, 1982 response by FP&L also provided additional detail supporting the restoration of AC power to Unit No. 1 in less than 4 hours; however, that detail has been provided to the NRC previously and is still being evaluated as part of the overall assessment of offsite power systems for Unresolved Safety Issue A-44, Station Blackout (USI A-44). FP&L also provided arguments based on the Commission's "Proposed Policy Statement On Safety Goals for Nuclear Power Plants;" however, to place significant weight to these arguments would be premature before implementation of the policy.

With regard to whether a 3 hour capability is reasonable, we note that the Board (ALAB-603 of July 30, 1980) considered only one failure mode as a direct effect of blackout-induced loss of AC-power. The effect was a loss of makeup to the primary system so that a continued slow leak past the seals of the reactor coolant pumps would eventually cause the primary water level to fall below the primary coolant outlet pipes with eventual loss of core cooling. This failure mode may be a significant one but there may be comparable risks from other failure modes not considered in ALAB-603. The technical resolution of USI A-44 can be used to establish acceptability requirements for AC power supply reliability and decay heat removal capability during blackout. We note that, until implementation of the findings from resolving USI A-44, operating PWRs are required to meet the January 1980 requirement of NUREG-0645 to protect against blackout to the extent of ensuring that an auxiliary feedwater system and supporting DC battery power supply will operate for 2 hours without AC. We conclude that requiring Unit No. 1 to have a capability beyond 3 hours for one specific failure mode during the time prior to implementation of USI A-44 would be premature and could be counterproductive to a more balanced evaluation and resolution of potential failure modes. We therefore conclude that further resolution of this issue for Unit No. 1 should await resolution of USI A-44.

With regard to the scenario examined in ALAB-603, long term blackout at Unit No. 1 could eventually result in hot leg voiding and core uncovery due to inadequate primary system makeup. Core uncovery would not, however, occur until after the pressurizer emptied. Analyses, supported by LOFT and Semi-scale experiments, have demonstrated that natural circulation cooling of the primary system would not terminate with emptying of the pressurizer, but would continue under two phase flow. This would lengthen the time to core uncovery.

3.0 CONCLUSION

All blackout operations, whether or not beyond 3 hours, require continued availability of DC power to provide lights and some control capability. Additionally, the absence of DC may hinder recovery of AC power. Therefore, FP&L should describe its DC battery power capability and address any reduced capability at Unit No. 1 compared to Unit No. 2.

Training programs and procedures will facilitate safe operation through a blackout. FP&L was asked on October 10, 1980 to describe in detail its training programs and procedures for operation at Unit No. 1 during blackout and for restoration of power at Unit No. 1. Therefore, the staff recommends retention and completion of the previous requirements for review of training programs and procedures.

In summary, the staff finds that, in a blackout:

(1) Primary system safety valve leak rates and tech spec leak rate limits at Unit No. 1 would not cause loss of natural single phase circulation for at least 3 hours;

(2) Natural circulation would continue for a longer term with two phase flow and this would make safe shutdown more likely after recovery of AC power;

(3) The failure mode considered in ALAB-603 may be significant, but other failure modes may be of comparable risk. Therefore requiring Unit No. 1 to have a capability beyond 3 hours for one specific failure mode would be premature prior to technical resolution of USI A-44 in 1983.

These conclusions are subject to satisfactory followup to the following items:

(1) Unit No. 1 maintaining adequate DC battery capability; demonstration of a D.C. capability equivalent to Unit No. 2 is sufficient in this regard.

(2) NRC review of blackout procedures and training for station operation during and after blackout; and

(3) Approval by NRC of revised Loss of All Non-Emergency AC Power Event calculations.

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