August 1, 2000

Mr. John Paul Cowan
Vice President, Nuclear Operations
Florida Power Corporation
ATTN: Manager, Nuclear Licensing (NA1B)
Crystal River Energy Complex
15760 W. Power Line Street
Crystal River, Florida 34428-6708

SUBJECT: SAFETY EVALUATION REPORT FOR UNRESOLVED SAFETY ISSUE (USI) A-46 PROGRAM IMPLEMENTATION AT CRYSTAL RIVER UNIT 3 (TAC NO. M69440)

Dear Mr. Cowan:

Enclosed is the Nuclear Regulatory Commission (NRC) staff's safety evaluation (SE) of the Florida Power Corporation (FPC) Unresolved Safety Issue (USI) A-46 implementation program at Crystal River Unit 3 (CR-3). The USI A-46 program at CR-3 was established in response to Generic Letter 87-02 through a 10 CFR 50.54(f) [Title 10, *Code of Federal Regulations*, Part 50, Section 54(f)] letter. The staff concludes that the FPC USI A-46 implementation program has, in general, met the purpose and intent of the criteria in the CR-3 Plant-Specific Procedure (PSP), Revision 1, and the staff's SE on the PSP. The staff has determined that the corrective actions and completed physical modifications for resolution of outliers will result in safety enhancements which, in certain aspects, are beyond the original licensing basis, and provide sufficient basis to close the USI A-46 review at CR-3. The staff also concludes that the FPC implementation program to resolve USI A-46 at CR-3 has adequately addressed the purpose of the 10 CFR 50.54(f) request. Activities related to USI A-46 implementation may be subject to future NRC inspection.

This completes the staff review under TAC No. M69440. If you have any questions concerning this issue, please contact me at (301) 415-1495.

Sincerely,
/RA/
L. Wiens, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosure: Safety Evaluation

cc w/enclosure: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO UNRESOLVED SAFETY ISSUE A-46 PROGRAM IMPLEMENTATION

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NO: 50-302

1.0 BACKGROUND

In December 1980, the U.S. Nuclear Regulatory Commission (NRC) designated "Seismic Qualification of Equipment in Operating Plants" as an unresolved safety issue (USI A-46). The safety issue of concern was that equipment in nuclear plants for which construction permit applications had been docketed before about 1972 had not been reviewed according to the 1980-81 licensing criteria for seismic qualification of equipment [i.e., Regulatory Guide 1.100; Institute of Electrical and Electronics Engineers (IEEE) Standard 344-1975, and Section 3.10 of the Standard Review Plan (NUREG-0800, July 1981)]. In Generic Letter (GL) 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," which was issued on February 19, 1987, to implement the resolution to USI A-46, the staff concluded that the seismic adequacy of certain equipment in operating nuclear power plants should be demonstrated.

In GL 87-02, Supplement 1, dated May 22, 1992 (Ref. 1), the staff asked Florida Power Corporation (FPC, the licensee) to commit to use either Generic Implementation Procedure, Revision 2 (GIP-2, Ref. 2) or other specific criteria and procedures for resolving USI A-46 at Crystal River Unit 3 (CR-3). By letter dated September 4, 1992 (Ref. 3), in response to the staff's request, rather than providing either a commitment to comply with the entire GIP-2 or a specific set of criteria and procedures, FPC informed the NRC staff that it was planning to develop a plant-specific procedure, based on the GIP, for verifying the seismic adequacy of the safe shutdown equipment installed at CR-3. By letter dated November 18, 1992 (Ref. 4), the staff informed the licensee that FPC's response of September 4, 1992, was unacceptable because its procedure did not commit to addressing certain essential elements (e.g., anchorage) to satisfy the resolution of USI A-46.

In a submittal dated April 16, 1993 (Ref. 5), the licensee provided information related to the development of in-structure response spectra (IRS) to be used for resolving USI A-46. After reviewing that submittal, the staff sent the licensee a request for additional information (RAI) (Ref. 6). The licensee responded to the RAI in submittals dated September 7, and October 6, 1993 (Ref. 7). By letter dated December 16, 1993 (Ref. 8), the staff approved the licensee's method used to develop the IRS and accepted the resulting IRS for the resolution of the licensee's USI A-46 program with the provision that the licensee verify the equipment and anchorages in accordance with GIP-2 (Ref. 2) and Supplement 1 to GL 87-02 (Ref. 1).

Enclosure

By an August 27, 1993, letter (Ref. 9), the licensee submitted the "Plant-Specific Procedure for Seismic Verification of Nuclear Plant Equipment for Crystal River 3" (CR-3 PSP) and the "Technical Basis for the CR-3 PSP" to resolve GL 87-02. In a letter dated April 12, 1994 (Ref. 10), the staff described the general criteria that an implementation program should contain to satisfy the intent of GL 87-02 for facilities such as CR-3 located in low seismic regions, and identified specific areas in which FPC's then current program appeared deficient when evaluated against these criteria. The primary areas of concern were the lack of an adequate relay evaluation, an unacceptable anchorage evaluation approach, lack of supporting information for cable and conduit raceways, and inadequate justifications for proposed deviations from the GIP caveats for the 20 classes of equipment.

In response to Ref. 10, FPC sent the staff a letter on August 15, 1994 (Ref. 11) addressing some of the issues raised by the staff, and committed to submit a revision to the CR-3 PSP. By letter dated September 16, 1994 (Ref. 12), the licensee submitted Revision 1 to the CR-3 PSP. By letter dated May 2, 1996 (Ref. 13), the staff issued the safety evaluation (SE) on FPC's CR-3 PSP, identifying the open issues that included many of the earlier concerns delineated in Ref. 10.

In the meantime, FPC conducted a seismic "walkdown" for the USI A-46 program at CR-3 and submitted a summary report on January 2, 1996 (Ref. 14). The staff reviewed the summary report and sent an RAI to FPC on January 28, 1997 (Ref. 15). FPC responded to the RAI in letters dated March 27 and August 1, 1997 (Refs. 16 and 17). After reviewing the FPC responses, the staff noted that some areas in the RAI were not satisfactorily addressed, especially the resolution of the open issues identified in the SE (Ref. 13) of FPC's PSP. The staff performed the audit of the licensee's implementation program November 3-7, 1997. The purpose of the audit was to verify, on a sampling basis, that the licensee's implementation of the USI A-46 program was completed and documented in accordance with the licensee's commitments in the PSP for CR-3, Revision 1, docketed on September 16, 1994 (Ref. 12), supplemented by the NRC staff's SE on CR-3 Criteria and Procedures dated May 2, 1996 (Ref. 13). The audit review also facilitated the staff's review of the FPC summary report, submitted on January 2, 1996 (Ref. 14), and follow-up on RAIs previously provided to FPC. By letter dated December 16, 1997 (Ref. 18), the licensee provided supplemental information to support FPC's responses to the NRC's RAI dated January 28, 1997 (Ref. 15). In addition, Ref. 18 provided clarification to FPC's RAI responses (Refs. 16 and 17), which were discussed during the NRC audit of November 3-7, 1997. By letter dated January 30, 1998 (Ref. 19), FPC submitted Revision 8 to Abnormal Procedure (AP) 961, "Earthquake," as a supplemental response for the resolution of USI A-46 at CR-3. In a letter dated April 10, 1998 (Ref. 20), the staff issued the audit report of the USI A-46 program implementation at CR-3 and the staff's evaluation of USI A-46 issues related to the restart of CR-3 from Refueling Outage 10.

The staff requested additional information in a letter dated February 2, 1998, regarding operator actions specified in the licensee's summary report. By letter dated March 30, 1998 (Ref. 21), the licensee responded to the staff's RAI.

In responding to the staff's audit report which identified numerous concerns and requested additional information regarding USI A-46 issues that remained unresolved, the licensee submitted additional information dated December 31, 1998 (Ref. 22). By letters dated September 21, 1999 (Ref. 23), and December 15, 1999 (Ref. 24), FPC notified the NRC that it

has completed its actions relating to the commitments made by it in Refs. 18, 21, and 22, involving the outstanding issues.

In Reference 24, the licensee noted that each outstanding item was being tracked by the Corrective Action Program (CAP) and that the reviews performed to meet the commitments have identified additional issues that will be addressed by FPC's CAP. By letter dated June 7, 2000 (Ref. 25), the licensee provided an up-to-date status of the open items and stated that those items are being tracked and completed by CAP.

This report provides the staff's evaluation of FPC's USI A-46 implementation program at CR-3, based on the staff's review of FPC's summary report (Ref. 14), the staff's audit report (Ref. 20), and other documentation provided by FPC in response to the staff's RAIs.

2.0 DISCUSSION AND EVALUATION

2.1 Seismic Demand Determination (Ground Spectra and In-structure Response Spectra)

By letter dated December 16, 1993 (Ref. 8), the staff approved the ground response spectra utilized, and the method used, by FPC to develop the IRS as they were in accordance with the licensing commitment, and were acceptable for the resolution of USI A-46 for CR-3. As described in Ref. 8, the (licensing basis) design response spectra (DRS) were developed for the peak horizontal ground acceleration of 0.1g corresponding to the safe shutdown earthquake (SSE) applicable to the CR-3 site. The spectral shape was determined by utilizing the Housner spectral shape above 2.5 Hz. For frequencies below 2.5 Hz, the spectral values were determined by a method more conservative than Housner's spectral shape, thus obtaining larger spectral ordinates (compared to Housner's spectra) for frequencies lower than 2.5 Hz. The licensee used the response spectrum method to develop the IRS from the DRS, and demonstrated that it was conservative (Ref. 8). In response to a staff question earlier, the licensee had agreed to verify the seismic adequacy of equipment and anchorages by considering the vertical component of IRS as being two-thirds of the horizontal components of IRS (Ref. 7).

The existing design-basis IRS is for equipment damping values of 0.5% and 2% of the critical damping, whereas GIP-2 permits the use of higher damping values of 3% and 5% of the critical damping. Therefore, the licensee proposed to use the higher damping values by extrapolating the existing IRS corresponding to the lower (0.5% and 2%) damping values by using analytical procedures. The staff reviewed and approved these procedures. While so approving the use of higher damping values, the staff stated (Ref. 8) that its approval of higher damping values was based on the assumption that the licensee's subsequent verification of equipment and anchorages would be in accordance with GIP-2 (Ref. 2) and Supplement 1 to GL 87-02 (Ref. 1). In January 1996, FPC submitted its "Seismic Evaluation Report for Unresolved Safety Issue A-46" (Ref. 14) in which it summarized the results of the implementation of its plant-specific procedure for verification of the seismic adequacy of mechanical and electrical equipment at CR-3. This seismic evaluation report provides (1) design spectral acceleration spectra, and (2) plots of GIP-2 bounding and reference spectra versus CR-3 plant IRS. The staff has determined that the seismic demands used in the implementation of the USI A-46 program at CR-3 are acceptable for the resolution of the USI A-46 program because it meets the staff-approved provisions of CR-3 PSP.

2.2 Seismic Evaluation Personnel

In Section 2 of the CR-3 PSP (Ref. 12), the licensee defined the responsibilities and qualifications of the individuals who would implement the PSP. The seismic evaluation personnel include individuals to identify safe shutdown equipment, perform the plant walkdown and verify the seismic adequacy of equipment. This involves a number of plant and engineering disciplines including seismic, structural, mechanical, electrical, systems, and plant operations.

In the seismic evaluation report (Ref. 14), the licensee stated that all CR-3 USI A-46 work was performed by FPC personnel, assisted by outside engineering consultants. The Project team was organized and managed as a combined effort of the FPC licensing department and the structural engineering department.

Plant walkdowns were performed by Seismic Capability Engineers (SCE) who met the training, educational, and experience qualifications of Section 2 of the PSP. Preparation of the safe shutdown equipment list (SSEL) was performed by FPC personnel. Resumes for SCEs are provided in Appendix A of Reference 14. The third-party audit of the CR-3 A-46 work was performed by Mr. Charbel Abou-Jaoude of VECTRA Technologies. Mr. Abou-Jaoude's resume is provided in Appendix A, and his report is in Appendix D of Reference 14.

The following consultants were contracted by FPC to assist in performing the seismic screening walkdown.

Paul Smith, The Readiness Operation, Inc.
Harry Johnson, Programmatic Solutions, Inc.
Donald Ruth, Programmatic Solutions, Inc.

The staff finds that FPC's seismic evaluation personnel qualifications meet the provisions of CR-3 PSP, and are, therefore, acceptable.

2.3 Safe Shutdown Path

The licensee identified and discussed the seismic design limitations of the plant equipment in that it met the intent of the GIP-2 requirements without specific commitment to use GIP-2 for the implementation of the USI A-46 resolution at CR-3. FPC's A-46 program scope includes the systems and corresponding equipment to ensure that hot standby can be achieved and maintained for 72 hours following an SSE event. To meet this provision, in its submittals of August 15, 1994 (Ref. 11), and March 30, 1998 (Ref. 21), the licensee addressed the following plant safety functions: reactor reactivity control, pressure control, inventory control, and decay heat removal. The licensee identified a primary and an alternate safe shutdown path with their support systems and instrumentation for each of these safety functions to ensure that the plant is capable of being brought to, and maintained in, a hot standby condition for 72 hours following an SSE.

The reactor decay heat removal function is accomplished by relieving steam from the reactor by establishing natural circulation conditions and steaming the steam generators (SGs) via the main steam safety valves until such time that the decay heat decreases to the point where the atmospheric dump valves can be used. Makeup water to the SGs would be supplied by the

emergency feedwater system (EFS) which takes suction from the emergency feedwater tank (EFT-1). Other water sources are the condensate storage tank and the condenser hotwell which would be aligned to the EFS by the existing operating procedure.

The operators have another alternative available, by implementing the primary “bleed-feed“ mode of cooling which uses the borated water storage tank and high pressure injection system. When this water source is exhausted, core cooling can be maintained by using the low pressure injection system in combination with the high pressure injection system. Water suction is taken from the reactor building sump and recirculated through the decay heat removal heat exchangers, to the high pressure injection system, to the reactor. The licensee confirmed that the equipment items necessary for this mode of operation are seismically adequate.

The plant operations department reviewed the equipment with respect to the plant operating procedures and operator training and concluded that the plant operating procedures and operator training were adequate to establish and maintain the plant in a hot standby condition following an SSE.

The staff concludes that the approach to achieve and maintain a hot standby for 72 hours following a seismic event is acceptable for resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.4 Seismic Screening verification and Walkdown of Mechanical and Electrical Equipment

The licensee stated in Reference 14 that the seismic screening and walkdown included verification of 727 equipment items in the 20 classes of equipment and the "other" equipment class.

The review of the seismic adequacy of mechanical and electrical equipment in the CR-3 SSEL was performed in accordance with Section 4 of the PSP (Ref. 12). Seismic Evaluation Worksheets (SEWS forms) in conformance with the PSP were used to record the screening and walkdown results. All data were recorded in a common database with the SSEL.

The results of the screening and walkdown are presented in the Screening Verification Data Sheet (SVDS) forms included in Appendix C of Reference 14.

2.4.1 Equipment Seismic Capacity Compared to Seismic Demand

In Attachment 2 to its August 27, 1993, submittal (Ref. 9), FPC provided a detailed discussion of the CR-3 seismic demand versus seismic capacity of equipment at CR-3. In its CR-3 PSP, FPC elected to use Method B.1 of GIP-2 (Table 4.1, Ref. 2) for the seismic capacity vs. seismic demand evaluation of equipment in the SSEL, and compared the seismic demand (represented by the CR-3 IRS) with the Seismic Qualification Utility Group (SQUG) reference spectrum (RS) (which is the earthquake-experience-based equipment seismic capacity spectrum defined in GIP-2). Figure A1 in Appendix A, Seismic Demand of Reference 9 shows that the CR-3 IRS are less than the SQUG reference spectrum, except around 11 Hz to 19 Hz at Auxiliary Building (AB) elevation 162 feet (67-feet above the plant grade level). Appendix A to Ref. 9 stated that there were only three items of CR-3 SSEL equipment at elevations where the IRS exceeded the SQUG RS.

Subsequently, in its January 2, 1996, seismic evaluation report (Ref. 14), FPC identified six items of equipment (including the three listed in Ref. 9, Appendix A) whose IRS (i.e., seismic demand) exceeded the SQUG RS (seismic capacity), and classified them as outliers. The resolution of these outliers was initially discussed in Table 5.4 "Equipment Outlier Description and Resolution Summary" of FPC's seismic evaluation report (Ref. 14). In this Table, FPC indicated that the resolution of these outliers would be carried out by reviewing the amplitudes of IRS and determining if there were any available test reports. The staff reviewed the seismic evaluation report and issued an RAI on January 28, 1997 (Ref. 15). After reviewing FPC's responses of March 27, 1997, and August 1, 1997 (Refs.16 and 17), the staff conducted a site audit in November 1997. In its December 16, 1997 submittal (Ref. 18), containing supplemental information, FPC indicated that five out of the six outliers have been resolved by engineering evaluation. The sixth outlier remains to be resolved as stated in FPC's submittal dated June 7, 2000 (Ref. 25). The resolution of this outlier and a few others identified by FPC subsequently is being tracked in the CR-3 CAP.

Based on its reviews, the staff concludes that FPC's approach for the comparison of equipment seismic capacity to seismic demand is acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.4.2 Assessment of Equipment "Caveats"

In Reference 14, the licensee stated that, except for the tanks and heat exchangers identified in Table 5-3, the PSP equipment caveats are met for electrical or mechanical equipment. For tanks and heat exchangers, the intent, but not the letter, of the PSP equipment caveats is met. However, in Section 3.6 of the NRC Audit Report (Ref. 20) the staff stated that meeting all GIP-2 caveats is a prerequisite for use of the earthquake experience-based approach as pointed out in the Supplemental Safety Evaluation Report No. 2 on GIP-2 (Ref. 1). It also states that the NRC staff does not accept prescreening of caveats based on the argument of low seismicity. The NRC Audit Report stated that one of the weaknesses in the PSP is that it does not require the engineers to adhere to the entire GIP-2 caveat list. It further stated that the issue of missing caveats can be resolved when FPC confirms that all GIP-2 caveats were systematically verified and satisfied for all safe shutdown equipment. By letter dated December 31, 1998 (Ref. 22), FPC committed to perform additional evaluations to systematically address GIP-2 caveats that had previously been prescreened (not included in the PSP). Depending on the nature of the caveats, one resolution strategy involved obtaining signed letters from SCEs documenting that the caveats were considered during the walkdowns. These letters were placed in the SEWS files. In addition, FPC also performed a walkdown of a sample of these caveats to ensure there were no concerns. FPC also contracted Duke Engineering and Services (DE&S) to perform an independent assessment of some equipment caveats by conducting plant walkdowns and evaluations, and reviewing existing drawings and photographs where equipment was inaccessible.

By letter dated December 15, 1999 (Ref. 24), FPC reported that some caveats are adequately resolved based on the supporting justification and validation provided by the SCEs and the sample walkdowns of the SSEL equipment that were performed. In addition, the DE&S walkdowns identified five new outliers associated with differences between the caveats in GIP-2 and those in the PSP.

The licensee stated, in Reference 23, that it has adequately addressed all GIP-2 caveats for CR-3 SSEL equipment, and the resolution of the new outliers is included in the CR-3 CAP (Ref. 25). The staff finds FPC's efforts in addressing the equipment caveats acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved provisions of the CR-3 PSP.

2.4.3 Equipment Anchorage

The licensee's position for anchorage evaluation as described in its PSP, Revisions 0 and 1 (Refs. 9 and 12) was that the preferred method to determine the adequacy of the anchorage was through the inspection and judgment of the SCEs who were to perform a walkdown of the plant for the A-46 program. The NRC staff stated in its SE on CR-3's PSP (Ref. 13), that this position was unacceptable, since the determination of the adequacy of the anchorage required a certain degree of quantitative analyses and hardware verification in addition to engineering judgment. Analyses and hardware verification using the procedures in Appendix C of GIP-2 are essential parts of the evaluation. Therefore, the staff, in its safety evaluation (Ref. 13) of the PSP, informed FPC that the staff would verify, during its site audit, FPC's implementation of Section 4.4 of GIP-2 and its documentation of the results of anchorage evaluation and how any outliers were handled in its seismic evaluation report.

In its seismic evaluation report (Ref. 14) and in several responses (Refs. 16, 17, and 18) to the staff's RAI of January 28, 1997 (Ref. 15), FPC documented the results of its anchorage evaluation including an independent assessment by its consultant, Stevenson & Associates. The staff conducted its site audit after reviewing FPC's responses. In its audit report (Ref. 20), the staff stated that FPC's responses to many of the RAI items were incomplete. In its December 31, 1998, response (Ref. 21) to the staff's audit report, FPC committed to perform approximately 100 component anchorage calculations by December 15, 1999, to satisfy its earlier commitment to perform GIP-2 anchorage calculations for approximately 50% of the electrical equipment. Accordingly, FPC reported in Ref. 24 that it had completed the calculations of the anchorage for electrical equipment on the SSEL, and that these calculations demonstrated the anchorage of these equipment items are adequate, except for anchorage of 480-V buses (MTSW-3A and MTSW-3C). FPC stated in its letter dated December 15, 1999 (Ref. 24), that the completion of the modification of the 480-v buses is being tracked under the CR-3 CAP.

The actions taken by FPC to verify the adequacy of the equipment anchorages at CR-3 are adequate and acceptable for the resolution of the USI-A46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.4.4 Seismic Spatial Interaction Evaluation

FPC evaluated seismic spatial interactions of safe shutdown equipment with nearby equipment and structures that might affect the performance of the safe shutdown function. Three areas of interactions investigated by FPC are: (1) proximity effects, (2) overhead or adjacent equipment failure, and (3) flexibility of attached lines or cables. The guidelines for judging interaction effects, when verifying the seismic adequacy of equipment, are presented in Appendix D of Ref. 12.

In response to a staff question regarding the potential for seismic interaction of Category II and Category I structures (Ref. 15), FPC reported that no interactions of concern for USI A-46 were noted by the seismic review team (Ref. 17).

Therefore, the staff finds FPC's approach for addressing potential seismic interaction acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.5 Tanks and Heat Exchangers

As stated in the staff's May 2, 1996, evaluation (Ref. 13), of FPC's PSP, Revision 1, the staff stated that the review of tanks and heat exchangers for seismic adequacy contains an evaluation of the stability of tank wall, anchorage, support saddle and legs, and the adequacy of piping flexibility to accommodate motion of the tank. The guidelines used by the licensee in its evaluation of tanks and heat exchangers are based on Electric Power Research Institute (EPRI) Report NP-5228, Revision 1 (Ref. 26) which was endorsed in GIP-2. The staff, therefore, finds the proposed guidelines acceptable.

In its April 10, 1998, audit report (Ref. 20), the staff confirmed that FPC had followed, in general, the GIP-2 guidelines for evaluation of tanks and heat exchangers. However, the NRC Audit team identified cracks at the base of the EFT-1 support pad that were not previously identified by FPC. FPC evaluated the cracks and determined that they were confined to the grout only and that they did not affect the integrity of the structural concrete foundation. In addition, FPC submitted the detailed calculations of its seismic evaluation of EFT-1 (Ref. 18, Attachment B) for staff review. The staff reviewed these calculations and found that the methodology and acceptance criteria used are acceptable. FPC utilized, wherever applicable, the GIP-2 criteria to determine the seismic capacity of the EFT-1 tank. To determine the seismic demand, FPC performed detailed soil-structure interaction analyses of the EFT-1 tank using appropriate input (i.e., SSE of 0.1g in Regulatory Guide 1.60 spectra applicable for the CR-3 site) for the seismic loading, and considering the variability in soil properties in its analysis. The anchorage base shear and base moment capacities for the tank were obtained consistent with the GIP-2 guidelines. These analyses were independently checked by FPC's consultant who reviewed and agreed with the procedure used for the modeling of the fluid sloshing effects in the tank. The results of EFT-1 tank calculations indicated that the minimum value of the capacity/demand ratio (safety factor) was 1.76 in the three cases of analyses performed by FPC considering different assumptions to determine the seismic capacities. The staff considers this value of safety factor acceptable. Subsequently, FPC also submitted a summary of its calculations for the Condensate Storage Tank (CDT-1) in its December 15, 1999, letter (Ref. 24). The minimum value of the capacity/demand ratio of this tank is 1.09 which is acceptable per GIP-2 guidelines.

The staff finds FPC's evaluation of tanks and heat exchangers for verification of their seismic adequacy acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.6 Cable and Conduit Raceway Supports

In its August 27, 1993, submittal (Ref. 9), the licensee stated that the raceways need not be evaluated in accordance with the GIP-2, because of, among other things, the good performance of non-seismically designed raceways, the prior re-evaluation of the raceways, and the location of CR-3 in a low seismic region. While disagreeing with the licensee's position, the staff indicated that a reduced scope based on original design, prior re-evaluation, and analytical evaluations with appropriate documentation may be acceptable. After several rounds of discussions, the staff finally rejected the licensee's arguments as they were too qualitative for the staff to evaluate and to reach a positive conclusion. Lacking specific technical data, the staff maintained that an additional evaluation should be performed to ensure that there were no gross plant-specific design and installation problems.

After reviewing FPC's January 2, 1996, seismic evaluation report (Ref. 14), the staff requested the licensee to: (1) identify the cable and conduit raceways examined by the SCEs during its plant-specific walkdown, and (2) summarize the results of the assessment and the bases for the conclusions reached by the SCEs in verifying their seismic adequacy (Ref. 15). In its August 1, 1997, response (Ref. 17), FPC stated that the cable tray and conduit raceways were not systematically examined in the A-46 walkdowns. However, systematic walkdowns were performed in response to a Third Party Reviewer's finding, and as part of the Maintenance Rule (MR) inspections by the same SCEs who performed the A-46 walkdown, and were familiar with the A-46 issues related to cable trays and conduits. The MR inspections revealed 154 anomalies out of which 127 were associated with conduits (e.g., missing clamp), and 27 with cable trays, (e.g., tray hold-down missing). The required fixes were carried out through the MR inspections.

During the staff's site audit on November 3-7, 1997, FPC indicated that it was performing what GIP-2 called Limited Analytical Review (LAR) for selected cable trays, and provided sample calculations requested by the staff. After reviewing these calculations, the staff raised certain concerns about the lack of independent review and verification of the calculations (Ref. 19, Enclosure 2). In its December 31, 1998, response (Ref. 22), FPC agreed to prepare a new calculation package, in accordance with current design and licensing basis requirements, to demonstrate the adequacy of the typical supports for cable trays. In its December 15, 1999, letter, FPC notified NRC of the completion of its commitments to resolve the USI A-46 issue, and committed to perform new calculations (using the existing calculations) to document the seismic adequacy of all raceway supports. In Ref. 25, FPC stated raceways support items are being tracked under the CR-3 CAP.

Based on its reviews, as stated above, the staff finds that FPC's approach in verifying the seismic adequacy of cable and conduit raceway support systems is acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.7 Essential Relays

Section 3.8 of the NRC Audit Report (Ref. 20) stated the NRC staff had accepted in its SE on FPC's PSP (Ref. 13), a reduced scope review of relays which includes replacement or otherwise justification for the "Bad Actor" relays and spot checks of mounting of other relays. The staff also stated that FPC determined that none of the "Bad Actor" relays would be required

to perform any safety function. However, the NRC Audit Report stated that the SE allowed a reduced scope review with the understanding that FPC would develop a “top-level” procedure to deal with potential relay chatter.

By letter dated December 15, 1999 (Ref. 24), the licensee committed to revise the PSP to address the staff’s comments on relay review. The summary of the revised PSP related to relay review is described in Section 8 of Ref. 23. The licensee has provided a revised Abnormal Procedure AP-961, “Earthquake,” to be the “top-level” procedure to deal with potential relay chatter. The staff’s evaluation of AP-961 appears in Section 2.8 of this SE. In Ref. 24, the licensee stated in Section 2, “Self Assessment,” that it had validated the “Bad Actor Relay” list. This validation identified additions and deletions from the list previously prepared. Based on the validation results, FPC has concluded that there are no “bad actor relays” which would have an adverse impact on the ability of CR-3 to shutdown after an SSE. The licensee stated that AP-961 will be revised to reflect the results of the validation. This action will be tracked under the CR-3 CAP.

Based on its review, the staff finds that FPC’s approach in addressing the relay chatter issues appeared adequate to resolve the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.8 Human Factors Aspects

The staff's review focused on verifying that the licensee’s operations department had conducted a detailed review of the SSEL, and had considered aspects of human performance in determining what operator actions could be used to achieve and maintain safe shutdown (e.g., resetting relays, manual operation of plant equipment). As a basis for its safety finding, the staff considered it acceptable for the licensee to use one or more of the following methods for conducting the detailed review:

1. A "desk-top" review of applicable normal and emergency operating procedures.
2. Use of a simulator to model the expected transient.
3. Performing a limited control room and local in-plant walk-down of actions required by plant procedures.

The licensee provided information which outlined the use of the "desk-top" method by the operations department to verify that existing Normal and Abnormal procedures and Emergency Operating Procedures (EOPs), including Abnormal Procedure AP-961, “Earthquake,” were adequate to mitigate the postulated transient and that operators could place and maintain the plant in a safe shutdown condition. The licensee determined that the systems and equipment selected for seismic review in the USI A-46 program are those for which Normal and Abnormal procedures and EOPs are available to bring the plant from a normal operating mode to a hot standby condition. The shutdown paths selected were reviewed by the CR-3 operations staff and determined that the procedures would provide adequate guidance to the operators in response to a seismic event. The licensee provided assurance that ample time existed for operators to take the required actions to safely shut down the plant. This was accomplished during validation of the pertinent plant operating procedures related to the A-46 program review.

The staff verified that the licensee had considered its operator training programs and verified that its training was sufficient to ensure that those actions specified in the procedures could be

accomplished by the operating crews. The operations department verified that all actions necessary to safely shutdown the plant, were included in existing Normal and Abnormal procedures and EOPs.

The staff requested verification that the licensee had adequately evaluated potential challenges to operators, such as lost or diminished lighting, harsh environmental conditions, potential for damaged equipment interfering with the operators tasks, and the potential for placing an operator in unfamiliar or inhospitable surroundings. The licensee committed to perform a confirmatory self-assessment of the USI A-46 activities, which will include the need to consider a more detailed emergency lighting analysis and a detailed review of local operator actions to identify those that might be affected by potentially adverse environmental conditions resulting from the seismic event. The licensee completed this review and forwarded a response to the NRC dated December 15, 1999 (Ref. 24). In the December 15, 1999, letter, the licensee described the review conducted by the seismic review team which included a broad review and walk-down of the overhead structures, distribution systems [raceways, piping, and heating, ventilation, and air conditioning], and other components in the CR-3 control, turbine, intermediate, and auxiliary buildings. The review confirmed that the environmental conditions resulting from the SSE would not impact the ability of personnel to perform the actions required to respond to the event. With respect to emergency lighting, the licensee verified that the existing emergency operating procedure (EOP) program requires verification of all operator actions and identification of actions which would require the use of portable emergency lighting. In those instances where emergency lighting was deemed necessary, portable flashlights and lanterns were staged in dedicated EOP storage boxes located throughout the plant.

Additionally, the licensee explicitly evaluated the potential for local failure of architectural features and the potential for adverse spacial interactions in the vicinity of safe shutdown equipment, where operator action may be required, as part of their plant-specific seismic evaluation process. As a result of the review, several potential control room interaction sources were identified as associated with the Control Room ceiling, non-nuclear instrumentation (NNI) cabinets and integrated control system (ICS) cabinets, event recorder cabinets, engineering safeguards actuation relay cabinets, and Nuclear Instrumentation and Protection Cabinet D2. The licensee stated that all issues have been corrected with the exception of the NNI and ICS cabinets which have been scheduled for modification.

The licensee also performed a review to identify operator actions credited for an earthquake. The review determined that all short-term actions required to assure the plant is safely shutdown are performed from the control room. As noted above, interaction effects which might inhibit the operators ability to perform these control room activities were analyzed and corrected. The licensee also reviewed the long-term operator actions required to maintain the reactor in a safe shutdown condition (e.g., reactivity control, reactor coolant pressure control, reactor coolant inventory control, and decay heat removal). In each case, the licensee determined that adequate time and ingress/egress pathways would be available to accomplish the procedural actions which might require local plant equipment manipulation.

The licensee addressed issues concerning the identification of bad actor relays and the development of operator guidance to cope with relay chatter during a seismic event. The licensees review identified 74 relays which would actuate 71 different alarms. In response, AP-961, was revised to include a list of the 71 affected alarms and provide additional guidance to the operators to verify the status of the alarms through alternate means if required. The

licensee confirmed that none of the bad actor relays provide an essential function or have been identified as a seal-in type device. Spurious alarms indications would, therefore, only occur for a short duration and would not affect the operators ability to safely shutdown the plant.

The licensee has provided the staff with sufficient information to demonstrate that the licensee's operations department had conducted a detailed review of the SSEL, and the plant-specific seismic evaluation had considered aspects of human performance in determining what operator actions could be used to achieve and maintain safe shutdown and is, therefore, acceptable for the resolution of the USI A-46 program at CR-3 because it meets the staff-approved CR-3 PSP provisions.

2.9 Outlier Identification and Resolutions

In FPC's seismic evaluation report (Ref. 14), the licensee stated that general types of outliers were found in equipment capacity, caveats, anchorage, and spacial interaction. A list of outliers and their resolutions provided in Table 5-4 of Ref. 14. The licensee also stated that no items were found to have design-basis deficiencies.

In Section 1 of Ref. 24, dated December 15, 1999, the licensee stated that the specific USI A-46 outliers at CR-3 identified in Enclosures 3 and 4 of FPC's letter to the NRC dated December 16, 1997 (Ref. 18), have been resolved. Outlier resolution efforts are documented on SEWS for each component. SEWS associated with the USI-46 project are contained in FPC Calculation S99-0093, Revision O, "Summary of USI A-46 Seismic Evaluations." The licensee also stated that two exceptions are MTSW-3A, 480-V Turbine Auxiliary Bus A, and MTSW-3C, 480V Reactor Auxiliary Bus A. Resolution of these two outliers has been deferred and is included in the CR-3 CAP and tracked by a precursor card (PC) PC-99-0190, Correction Action Steps for Resolution of USI A-46 Program Commitments The licensee provided an up-to-date status of all outlier resolutions in its letter dated June 7, 2000 (Ref. 25).

The staff's review of the licensee's actions regarding outliers indicates that identified outliers have been resolved by analysis, corrective actions, or tracked by the CR-3 CAP. The staff finds the licensee's actions reasonable for the resolution of the USI A-46 program at CR-3.

3.0 SUMMARY OF MAJOR FINDINGS

The staff's review of the licensee's USI A-46 implementation program, as provided for each area discussed above, revealed that FPC did not follow the entire SQUG GIP-2 criteria and procedures. Instead, FPC developed a plant-specific procedure, based on GIP-2, for verifying the seismic adequacy of the safe shutdown equipment installed at CR-3. By letter dated May 2, 1996 (Ref. 13), the NRC staff approved FPC's CR-3 PSP, Revision 1 (Ref. 12), with certain conditions. By letters dated December 16, 1997, March 30, 1998, and December 31, 1998 (Refs. 18, 21, and 22), FPC made commitments to address the unresolved issues in the CR-3 PSP and staff's concerns in the audit report (Ref. 20) regarding the licensee's walkdown and the seismic adequacy evaluation at CR-3. The staff finds FPC's USI A-46 implementation program acceptable for the resolution of the USI A-46 program at CR-3, even though some of the criteria and procedure have deviated from those of GIP-2.

4.0 CONCLUSION

FPC's USI A-46 program at CR-3 was established in response to Supplement 1 to GL 87-02 through a 10 CFR 50.54(f) [Title 10, *Code of Federal Regulations*, Part 50, Section 54(f) letter. FPC conducted the USI A-46 program implementation in accordance with its CR-3 plant-specific procedure, Revision 1 (Ref. 12) with additional requirements delineated in the staff's SE on CR-3 PSP (Ref. 13). Because FPC's initial walkdown was conducted in accordance with the unapproved CR-3 PSP, Revision 1 (Ref. 12), the staff performed an audit of FPC's initial walkdown results, issued an audit report (Ref. 20) and identified additional actions required by the licensee to resolve the staff concerns. By letters (Refs. 18, 21, 22, and 24), the licensee resolved the majority of outliers and provided an updated plan for final completion of the outstanding issues. By letter dated June 7, 2000 (Ref. 25), the licensee provided an up-to-date status of the open items and stated that these outstanding items are being tracked and completed by the CR-3 CAP. FPC's summary report and later submittals did not identify any instance where the operability of a particular system or component was questionable.

The staff concludes that FPC's USI A-46 implementation program has, in general, met the purpose and intent of the criteria in CR-3 PSP, Revision 1 (Ref. 12) and the staff's SE on CR-3 PSP (Ref. 13) for the resolution of USI A-46 at CR-3. The staff has determined that FPC's corrective actions and completed physical modifications for resolution of outliers will result in safety enhancements, in certain aspects, that are beyond the original licensing basis. As a result, FPC's actions provide sufficient basis to close the USI A-46 review at the facility. The staff also concludes that its findings regarding the licensee's implementation of USI A-46 do not warrant any further regulatory action under the provisions of 10 CFR 50.54(f). Licensee activities related to the USI A-46 implementation may be subject to NRC inspection.

5.0 REFERENCES

1. NRC "Supplement No. 1 to Generic Letter 87-02 Including Supplemental Safety Evaluation Report No. 2 on Seismic Qualification Utility Group's Generic Implementation Procedure, Revision 2, corrected February 14, 1992," dated May 22, 1992.

2. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Power Plant Equipment," Revision 2, corrected February 14, 1992, Seismic Qualification Utility Group.

3. Letter, P. M. Beard, Jr. (FPC) to NRC on FPC's response to GL 87-02, Supplement 1, dated September 4, 1992.

4. Letter, H. N. Berkow (NRC) to P. M. Beard, Jr. (FPC), on the evaluation of FPC's response to GL 87-02, Supplement 1, dated November 18, 1992.

5. Letter (with attachments), P. M. Beard, Jr. (FPC) to NRC on GL 87-02, Supplement 1, dated April 16, 1993.
6. Memorandum, G. Bagchi to H. Berkow, "Request for Additional Information (RAI) on Development of Floor Response Spectra," dated June 11, 1993 (faxed to FPC).

7. Letter, P. M. Beard, Jr. (FPC) to NRC Document Control Desk, "Response to RAI on Development of Floor Response Spectra," dated September 07, 1993 and October 06, 1993.

8. Letter, H. Silver (NRC) to P. M. Beard, Jr. (FPC), subject: "Evaluation of Methods for Developing Floor Response Spectra for the Resolution of Unresolved Safety Issue (USI) A-46 - Crystal River Unit 3 (CR-3)," dated December 16, 1993.

9. Letter, P. M. Beard, Jr. (FPC) to NRC Document Control Desk, "Generic Letter 87-02, Supplement 1 - Verification of Seismic Adequacy of Equipment in Older Operating Nuclear Plants," Attachment 2: Technical Basis for the Crystal River Unit 3 Plant Specific Procedure (Rev. 0) to resolve NRC Generic Letter 87-02, dated August 27, 1993.

10. Letter, L. Raghavan (NRC) to P. M. Beard, Jr. (FPC), "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46, Generic Letter 87-02," dated April 12, 1994.

11. Letter, P. M. Beard, Jr. (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46, Generic Letter 87-02," dated August 15, 1994.

12. Letter, P. M. Beard, Jr. (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46, Generic Letter 87-02," Attachment: FPC Plant Specific Procedure (PSP) for Seismic Verification of Nuclear Plant Equipment, Revision 1, dated September 16, 1994.

13. Letter, L. Raghavan (NRC) to P. M. Beard, Jr. (FPC), subject: "Crystal River Nuclear Generating Plant Unit 3 - Evaluation of Florida Power Corporation's Plant-Specific Criteria and Procedures for Implementing the Resolution of USI-A46 (Generic Letter 87-02) at Crystal River Unit 3," dated May 02, 1996.

14. Letter, P. M. Beard, Jr., (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46, Generic Letter 87-02," dated January 2, 1996.

15. Letter, L. Raghavan (NRC) to P. M. Beard, Jr. (FPC), subject: "Crystal River Nuclear Generating Plant Unit 3 - Request for Additional Information on the Resolution of Unresolved Safety Issue (USI) A-46 (Generic Letter 87-02), (TAC No. M69440)," dated January 28, 1997.

16. Letter, J. J. Holden (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," dated March 27, 1997.

17. Letter, J. J. Holden (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," dated August 1, 1997.

18. Letter, M. W. Rencheck (FPC) to NRC Document Control Desk, "Supplemental Response for the Resolution of Unresolved Safety Issue (USI) A-46 (GL 87-02), (TAC No. M69440)," dated December 16, 1997.

19. Letter, M. W. Rencheck (FPC) to NRC Document Control Desk, 3F0198-42, “Supplemental Response for the Resolution of Unresolved Safety Issue (USI) A-46,” dated January 30, 1998.

20. Letter, L. A. Wiens (NRC) to R. A. Anderson (FPC), “Audit Report of Unresolved Safety Issue A-46 Seismic Implementation and Subsequent Evaluations of Related Issues at Crystal River Unit 3 (TAC No. M69440) dated April 10, 1998.

21. Letter, M. W. Rencheck (FPC) to NRC Document Control Desk, 3F0398-16, “Response to Request for Additional Information Regarding Summary Report on the Verification of Seismic Adequacy of Mechanical and Electrical Equipment dated December 31, 1995 (TAC No. M69440),” dated March 30, 1998.

22. Letter, D. L. Roderick (FPC) to NRC Document Control Desk, ” Response to NRC Request for Additional Information Regarding Unresolved Safety Issue (USI) A-46 (TAC No. M69440)," dated December 31, 1998

23. Letter, J. J. Holden (FPC) to NRC Document Control Desk, 3F0399-20, “Crystal River Unit 3 - Change of Commitment for Unresolved Safety Issue (USI) A-46 (TAC No. M69440),” dated September 21, 1999.

24. Letter, D. L. Roderick (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46 (Generic Letter 87-02) - Notification of Commitment Completion and Status for Crystal River Unit 3 (TAC No. M69440),” dated December 15, 1999.

25. Letter, S. L. Bernhoft (FPC) to NRC Document Control Desk, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46 (Generic Letter 87-02) - Status Update of Remaining Activities for Crystal River Unit 3 (TAC No. M69440),” dated June 7, 2000.

26. EPRI Report NP-5228, Revision 1, "Seismic Verification of Nuclear Plant Equipment Anchorage,” Volume 4: "Guidelines for Tanks and Heat Exchangers,” Electric Power Research Institute, Palo Alto, CA, prepared by URS Corporation/John A. Blume & Associates, Engineers, dated June 1991.

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