UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 24, 2009

Mr. Jon A. Franke, Vice President
Crystal River Nuclear Plant (NA1B)
ATTN: Supervisor, Licensing & Regulatory Programs
15760 W. Power Line Street
Crystal River, Florida 34428-6708

SUBJECT: CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT - ISSUANCE OF AMENDMENT REGARDING REVISION TO FINAL SAFETY ANALYSIS REPORT SECTIONS 5.4.3 AND 5.4.5.3 (TAC NO MD8919)

Dear Mr. Franke:

The Nuclear Regulatory Commission (NRC or the Commission) has issued the enclosed Amendment No. 235 to Facility Operating License No. DPR-72 for Crystal River, Unit 3 (CR-3) in response to your application dated June 3, 2008, as supplemented by letter dated November 17, 2008, and letters dated April 8 and May 22, 2009. The April 8 and May 22, 2009 submittals superseded in its entirety the licensee's submittals dated June 3 and November 17, 2008. The proposed amendment would revise the methodology and code of record, in the Final Safety Analysis Report (FSAR), Sections 5.4.3, "Structural Design Criteria" and 5.4.5.3, "Missile Analysis," used to qualify the east wall of the Auxiliary Building (AB) for abnormal loads and load combinations, described in the FSAR, from American Concrete Institute (ACI) 318-63 to ACI 349-97. The critical abnormal loads and load combinations that governed the qualification of the AB east wall involve tornado wind, pressure drop, and tornado missile loading.

A copy of the safety evaluation is enclosed. The notice of issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

Farideh E. Saba

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Amendment No. 235 to Facility Operating License No. DPR-72
2. Safety Evaluation

cc w/enclosures: Distribution via ListServ

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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FLORIDA POWER CORPORATION

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CITY OF BUSHNELL

CITY OF GAINESVILLE

CITY OF KISSIMMEE

CITY OF LEESBURG

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SEMINOLE ELECTRIC COOPERATIVE, INC.

DOCKET NO. 50-302

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 235
License No. DPR-72

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Florida Power Corporation, et al. (the licensees), dated June 3, 2008, as supplemented by letter dated November 17, 2008, and letters dated April 8 and May 22, 2009, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Final Safety Analysis Report as indicated in the safety evaluation attached to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-72 is hereby amended to read as follows:

Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 235 , are hereby incorporated in the license. Florida Power Corporation shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA by EBrown for/

Thomas H. Boyce, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Operating License

Date of Issuance: July 24, 2009

ATTACHMENT TO LICENSE AMENDMENT NO. 235

FACILITY OPERATING LICENSE NO. DPR-72

DOCKET NO. 50-302

Replace the following page of Facility Operating License No. DPR-72 with the attached revised page. The revised page is identified by amendment number and contains a vertical line indicating the area of change.

Remove	Insert
4	4

of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

2.C.(1) Maximum Power Level

Florida Power Corporation is authorized to operate the facility at a steady state reactor core power level not in excess of 2609 Megawatts (100 percent of rated core power level).

2.C.(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 235 , are hereby incorporated in the license. Florida Power Corporation shall operate the facility in accordance with the Technical Specifications.

The Surveillance Requirements contained in the Appendix A Technical Specifications and listed below are not required to be performed immediately upon implementation of Amendment 149. The Surveillance Requirements shall be successfully demonstrated prior to the time and condition specified below for each.

a) SR 3.3.8.2.b shall be successfully demonstrated prior to entering MODE 4 on the first plant start-up following Refuel Outage 9.

b) SR 3.3.11.2, Function 2, shall be successfully demonstrated no later than 31 days following the implementation date of the ITS.

c) SR 3.3.17.1, Functions 1, 2, 6, 10, 14, & 17 shall be successfully demonstrated no later than 31 days following the implementation date of the ITS.

d) SR 3.3.17.2, Function 10 shall be successfully demonstrated prior to entering MODE 3 on the first plant start-up following Refuel Outage 9.

e) SR 3.6.1.2 shall be successfully demonstrated prior to entering MODE 2 on the first plant start-up following Refuel Outage 9.

f) SR 3.7.12.2 shall be successfully demonstrated prior to entering MODE 2 on the first plant start-up following Refuel Outage 9.

g) SR 3.8.1.10 shall be successfully demonstrated prior to entering MODE 2 on the first plant start-up following Refuel Outage 9.

h) SR 3.8.3.3 shall be successfully demonstrated prior to entering MODE 4 on the first plant start-up following Refuel Outage 9.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 235 TO FACILITY OPERATING LICENSE NO. DPR-72

FLORIDA POWER CORPORATION, ET AL.

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

DOCKET NO. 50-302

1.0 INTRODUCTION

By letter dated June 3, 2008 (Reference 8.1), as supplemented by letter dated November 17, 2008 (Reference 8.2), and letters dated April 8 (Reference 8.3) and May 22, 2009 (Reference 8.4), the Florida Power Corporation (the licensee) requested changes to the Final Safety Analysis Report (FSAR) for Crystal River Unit 3 (CR-3). The April 8 and May 22, 2009 submittals superseded in its entirety the licensee's submittals dated June 3 and November 17, 2008.

The amendment revises the CR-3 FSAR Sections 5.4.3, "Structural Design Criteria" and 5.4.5.3, "Missile Analysis," to include a statement regarding the design of the east wall of the CR-3 Auxiliary Building (AB). The amendment changes the methodology used to qualify the east wall of the AB. The current methodology uses the methods in American Concrete Institute Standard 318-63 (ACI 318-63), "Building Code Requirements for Reinforced Concrete," June 1963. The revised methodology is based on ACI 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures," as endorsed by the Nuclear Regulatory Commission (NRC or Commission) in Standard Review Plan (NUREG-0800), Revision 2 - March 2007, Section 3.8.4, "Other Seismic Category 1 Structures."

This safety evaluation addresses whether there is reasonable assurance that the existing AB east wall is adequately designed to withstand the effects of loads and load combinations for abnormal conditions from natural phenomena, including tornado wind and pressure drop loads, and tornado missiles as described in the FSAR, without loss of capability to perform its safety function and without causing loss of safety function of any safety-related structures, systems and components (SSCs).

The NRC staff's proposed no significant hazards consideration determination was published in the *Federal Register* on June 23, 2009 (74 FR 29732).

2.0 REGULATORY EVALUATION

General Design Criterion (GDC) 2 - Design bases for protection against natural phenomena, in Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, requires that SSCs important to safety shall be appropriately designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases of the SSCs shall reflect appropriate combination of the effects of normal and accident conditions with the effects of the natural phenomena.

GDC 4 – Environmental and dynamic effects design bases, in Appendix A to 10 CFR Part 50 requires that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids that may result from equipment failures and from events and conditions outside the nuclear power unit.

This license amendment request (LAR) specifically relates to meeting the intent of the design requirements in GDC 2 and GDC 4 with regard to design bases loads and load combinations for abnormal load conditions from natural phenomena, as described in the CR-3 FSAR, that include the governing loads/combinations involving tornado wind load, tornado pressure drop load and tornado missiles.

Paragraph (c)(2)(viii) of 10 CFR 50.59, "Changes, tests and experiments," requires that a licensee shall obtain a license amendment pursuant to 10 CFR 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment that would result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses. The licensee submitted this LAR, pursuant to 10 CFR 50.59(c)(2)(viii), to change the methodology and code of record for qualifying the east wall (only) of the AB for loads and load combinations described in the CR-3 FSAR for abnormal load conditions that include maximum hypothetical earthquake or safe-shutdown earthquake (MHE or SSE), tornado wind pressure, pressure drop (depressurization), and tornado missile loading based on ACI 349-97.

3.0 TECHNICAL EVALUATION

3.1 Proposed Change

Based on Attachments C and D of the Reference 8.3, the proposed change in the LAR will revise CR-3 FSAR Sections 5.4.3 and 5.4.5.3 to include appropriate statements regarding the design of the east wall of the CR-3 AB for abnormal loads and load combinations as described in the FSAR. Section 5.4 of CR-3 FSAR relates to "Other Class 1 Structures and Systems." The proposed revised FSAR sections are included Attachment E of Reference 8.3, as indicated below.

FSAR Section 5.4.3, "Structural Design Criteria," will be revised to read:

> This design has been based on ACI 318-63, "Working Stress Design," for normal operating conditions, and "Ultimate Strength Design" for tornado, earthquake, and missile impact conditions, except for the east wall of the Auxiliary Building, which has been based on ACI 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures."

FSAR Section 5.4.3.1 "Codes" will be revised to read:

> Same as Section 5.2.3.1 a, b, c, and e, and ACI 349-97.

The last paragraph of FSAR Section 5.4.3.2.2, "Abnormal Loads," will be revised to read:

> The structural design is in accordance with ACI 318-63, "Ultimate Strength Design," except for the east wall of the Auxiliary Building, which has been based on ACI 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures."

The second and third paragraphs of FSAR Section 5.4.5.3, "Missile Analysis," will be revised to read:

> The orientation of the pole to give the most critical load is end-on. For this condition, standard column formulas indicate that the pole will elastically buckle at a loading of 148 kips, which is considerably smaller than the crushing strength of either the pole or the concrete. The structural design was then checked by the ultimate strength provisions of ACI 318-63 for the capacity to withstand this pole load, except for the east wall of the Auxiliary Building, which has been based on ACI 349-97.
>
> The analysis for the automobile is based on the approach used in Reference 40, which has been verified +20% in tests conducted by Dr. T. J. Hirsh of the Texas Transportation Institute at Texas A&M University, and by tests indicated in the Reference. This approach was extrapolated for the case of a 2,000 lb automobile traveling at 150 mph. Although the variation of deceleration is sinusoidal, due to the scatter of the test results, the analysis was based on maximum deceleration to develop a maximum force applied to the structure. The structural design was then checked by the ultimate strength provisions of ACI 318-63 for capacity to withstand this automobile load, except for the east wall of the Auxiliary Building, which has been based on ACI 349-97.

3.2 NRC's Staff Evaluation

The licensee, in its letters dated April 8 and May 22, 2009, stated that the CR-3 AB is a Class 1 structure that contains and protects safety-related equipment. The licensee stated that the loads used in the design of the CR-3 Class 1 structures are as specified below:

- Loads During Normal Operation: Dead, Live, Wind, Equipment loads and Design Basis Earthquake (DBE); and

- Abnormal Loads: Tornado Loads, Main Steam turbine missiles, Tornado missiles, Maximum Hypothetical Earthquake (MHE).

The tornado load design requirements for CR-3, as stated in Section 5.2.1.2.6 of the FSAR, are:

a. Tangential wind velocity of 300 miles per hour (mph),

b. An external pressure drop of 3 pounds per square inch gauge (psig),

c. Missile equivalent to a utility pole 35 feet (ft) long, 14 inches in diameter, weighing 50 pounds per cubic foot, and traveling at 150 mph, and

d. Missile equivalent to a one ton automobile with a cross-section of 6.25 ft^2 traveling at 150 mph, which the licensee stated to be the limiting design basis missile.

The licensee stated that the structural design criteria for Class I structures summarized in FSAR Section 5.4.3 states that the design has been based on ACI 318-63, "Working Stress Design," for normal operating conditions and "Ultimate Strength Design" for tornado, earthquake, and missile impact conditions. The licensee stated that the design basis load combinations for the AB walls for the abnormal condition involving tornado wind loads and missiles are as indicated below:

$$C = (D + L + W_t + P_t)$$

$$C = (D + L + W_m)$$

Where, D = dead load, L = live load, W_t = tornado wind load, P_t = tornado pressure drop (or depressurization) load, and W_m = tornado missile load.

The licensee further stated that the governing loads and load combinations for the design of the AB east wall for the abnormal condition are those indicated in the previous paragraph. The dead and live loads, which act vertically, were conservatively neglected in the above load combinations since they are small compared to the lateral tornado loads and provide a beneficial effect under flexure. The licensee demonstrated, in its calculation in the Reference 8.4 submittal, that the tornado loads govern the design of the AB east wall over the earthquake (MHE or SSE) loads.

The licensee stated that upon review of the original design basis structural calculations for the east and south AB walls, it was discovered that calculations were not performed to reflect loading related to tornado driven missiles and tornado wind and depressurization load combinations, as described in the FSAR and, therefore, were not in conformance with its licensing basis. The original structural design basis of the AB, including the east wall, was based on ACI 318-63. The licensee stated that it completed an investigation and assessment of the operability of the east and south walls of the AB. The south wall was qualified using the

methods (ACI 318-63) described in the FSAR. Calculations performed to qualify the east wall using methods of ACI 318-63, as described in the FSAR, were not successful for loads and load combinations involving tornado wind pressure, pressure drop and tornado missiles. The licensee stated that calculations indicate the east wall is operable and does not pose a nuclear safety risk. However, the calculations to qualify the AB east wall are based on meeting the requirements of ACI 349-97, which is a change in the current code of record and a departure from the statements in the current FSAR Sections 5.4.3 and 5.4.5, that the design for abnormal load combinations has been based on ACI 318-63. Therefore, the current license amendment to revise the FSAR sections related to the structural design bases of the AB east wall was required pursuant to 10 CFR 50.59(c)(2)(viii).

As a result of the discovery of non-conformance of the AB east wall with its licensing design basis, the proposed amendment will revise the FSAR sections that describe the methodology and code of record used to qualify the AB east wall for abnormal loads and load combinations, as described in the FSAR, and bring it in conformance with its licensing design basis. The licensee's submittal in Reference 8.4 included, as Attachment B, the Calculation S07-0037, Revision 2, "Structural Qualification of Auxiliary Building East and South Walls for Tornado Wind and Missile Loading" that qualified the AB east wall, for the governing load combinations involving tornado wind, depressurization and missile loads, to the requirements of ACI 349-97. Based on the licensee's submittals, the existing reinforced concrete AB east wall has the following design configuration:

- Thickness = 2 ft
- Concrete compressive strength, f'_c = 3000 pounds per square inch (psi)
- Yield strength of reinforcement, f_y = 40 kilopounds per square inch (ksi)
- Clear cover to reinforcement = 2 inches on each face
- Reinforcement provided is #6 at 12 inches spacing on each face in both vertical and horizontal directions. This corresponds to an area of steel, As, provided equal to 0.44 square inch (in^2) per foot. This amounts to a steel ratio of 0.0015 (0.15 percent) based on gross section or 0.0017 (0.17 percent) based on effective section.
- The critical wall panel dimensions for design qualification was 24 ft x 24 ft with fixed boundary conditions (based on rigidity provided by 3 ft thick slabs and 36 inches x 50 inches deep columns forming the boundary of the wall panel).

The staff notes that the reinforcement ratio provided for the existing AB east wall is relatively low and, therefore, the cracking moment, M_{cr}, based on the uncracked concrete section with a modulus of rupture $f_r = 7.5 \sqrt{f'_c}$, is greater than the ultimate design moment capacity, M_u, provided by the reinforcement of the cracked section. In the calculations in Reference 8.4, the licensee reported M_{cr} = 39.44 kilopounds (kip)-ft/ft) and M_u = 30.74 kip-ft/ft.

The licensee stated that in FSAR Section 5.2.1.2.6, "Tornado Load," it was concluded that a minimum of two feet of concrete provides sufficient resistance to the local impact effects (penetration, perforation, scabbing and punching shear) of the postulated tornado missile spectrum and no additional calculations for local effects are required for the AB east wall. Therefore, this license amendment specifically addresses the global structural response of the AB east wall to the requirements of ACI 349-97 for the two governing design abnormal load

combinations. As discussed previously, these include: one involving tornado wind pressure plus depressurization loads; and the second involving tornado missile impact load.

Section 7.12.5 of ACI 349-97, related to minimum reinforcement requires that:

> "On a tension face of a structural slab, wall, or shell, where a calculated reinforcement requirement exists, the ratio of reinforcement area provided at the tension face to gross area of concrete shall not be less than 0.0018 unless the area of reinforcement provided at the tension face is at least one-third greater than that required by analysis." The reinforcement ratio provided in the CR-3 AB east wall is 0.0015, which is less than 0.0018.

Therefore, in order to satisfy Section 7.12.5 of ACI 349-97 for a lower ratio of reinforcement, the licensee based its calculations in Reference 8.4, for the AB east wall, using a reduced area of reinforcement which is three-quarters of the actual reinforcement area in the east wall. The reduced design ultimate moment capacity of the AB east wall is reported in Reference 8.4 to be M_{ur} = 20.82 kip-ft/ft. The staff finds that this is a logical and acceptable approach to verify the requirement in Section 7.12.5 of ACI 349-97, that the area of reinforcement provided is at least one third greater than that required by analysis, is satisfied.

For the tornado wind plus depressurization load combination, the licensee determined in Reference 8.4, the maximum uniform pressure on the wall due to leeward wind plus pressure drop to be 0.61 kip per square foot and the resulting maximum applied moment on the wall (based on elastic analysis) to be 18.17 kip-ft/ft, which is less than the reduced moment capacity of 20.82 kip-ft/ft. Therefore, the staff finds that the licensee appropriately concluded that the AB east wall is adequate for the tornado wind plus depressurization load combination.

To qualify the AB east wall for tornado missile impact loads, the licensee used the "Special Provisions for Impulsive and Impactive Loads" in Appendix C of ACI 349-97. Appendix C of ACI 349-97 is based on limit or plastic methods of analysis/design that allows structural response into the inelastic region of material behavior based on an idealized elasto-plastic displacement-resistance-ductility relationship shown in Figure C.3.1 of ACI 349-97. The licensee estimated the maximum impact force on the wall due to the automobile missile, F_i, to be 270 kip applied as a rectangular pulse of 0.081-second duration. This envelopes the impact force due to the utility pole missile of 148 kip. Therefore, the licensee based its calculations in Reference 8.4 on the governing 1-ton automobile missile at a velocity of 150 mph. The magnitude of the missile impact force used and the methodology based on which the force was determined are taken from CR-3's current licensing basis described in FSAR Section 5.4.5.3, and existing Calculation Book 4.01.1.

Since the AB east wall configuration has its cracking moment greater than the ultimate moment capacity provided by the reinforcement, on request by the NRC staff, the licensee estimated the value of maximum resistance, R_m, in the material force-displacement relationship of Figure C.3.1 of ACI 349-97, by two methods. The first value, R_{m1}, was estimated as the dynamic ultimate collapse load for the wall based on the yield line theory using the reduced reinforcement and a circular fan yield line pattern for a concentrated load. The second value, R_m 2, was estimated as the concentrated load that would cause the maximum moment in the

wall to be equal to the cracking moment, M_{cr}. The licensee estimated the values of R_{m1} and R_{m2} as 314 kip and 294 kip, respectively. The value of R_m used for the response analysis of the wall under missile impact loading was the smaller of the values of R_{m1} and R_{m2}, which was 294 kip. The staff finds that this approach of determining the value of R_m conservatively accounts for any uncertainties in the material behavior of the constructed configuration of the AB east wall with a low reinforcement ratio, and therefore acceptable.

In the Reference 8.4 submittal, the licensee determined the structural response of the AB east wall using an approximate method of dynamic analysis based on idealizing the wall panel as a single-degree-of-freedom system elasto-plastic system, of appropriate stiffness in the elastic range, subject to a 270 k rectangular pulse load of 0.081-second duration. The response solution for such systems, determined in the form of ductility demand ($\mu_r = X_r/X_y$), is a function of ratios t_d/T and R_m/F_i, where td = duration of impact load; T = natural period of the structure; R_m = maximum resistance in the elasto-plastic displacement-resistance relationship (Reference: Figure C.3.1 of ACI 349-97); F_i = maximum impact force; X_r = maximum response displacement; X_y = yield displacement. The dynamic response solution for the above described system subject to a rectangular pulse loading is provided in graphical form in Figure 2.23 of the text book, "Introduction to Structural Dynamics," by John Biggs (Reference 8.5). Using the calculated values of ratios t_d/T and R_m/F_i, the licensee determined the response ductility demand (μ_r) for the AB east wall from Figure 2.23 of Reference 8.5 and compared it to the permissible ductility ratio from Section C.3.3 of ACI 349-97. Also, the maximum response displacement (X_r) and maximum response rotation (θ_r) are derived from the response ductility demand (μ_r) and evaluated against criteria in Sections C.3.1 and C.3.4 of ACI 349-97. The acceptance criteria in C.3.3 and C.3.4 are applicable only when flexure controls the design.

In the Reference 8.4 submittal, for the tornado missile evaluation of the AB east wall, the licensee demonstrated that the applicable provisions and acceptance criteria of Section C.3 - Deformation of ACI 349-97 were satisfied as discussed in the following paragraphs. The licensee appropriately determined the deformation-related provisions in Sections C.3.8, C.3.6, C.3.3, C.3.4 and C.3.1 were applicable to the AB east wall.

Section C.3.8 of ACI 349-97 defines the permissible ductility ratio for beam-columns, walls and slabs carrying axial compression loads and subject to impulsive or impactive loads producing flexure. Section C.3.8(b) requires that: "When the compression load does not exceed 0.1f'cAg (where A_g is the gross section area) or one-third of that which would produce balanced conditions, whichever is smaller, the permissible ductility ratio shall be as given in C.3.3 or C.3.4." The licensee stated that since the east wall experiences both axial loads due to the floor loading above and flexure due to impactive loads, Section C.3.8 applies. Section C.3.8(b) limits compressive load to $0.1f'_cA_g$ or one-third of that which would produce balanced design, whichever is smaller. For the AB east wall, this limiting value was calculated to be 86.4 kip/ft. Based on the licensee's calculations that take into account the floor framing and tributary areas, the factored compression load on the wall is 24.6 kip/ft. Since the applied loading is less than the limiting load, the staff finds that the licensee appropriately concluded that application of the permissible ductility ratio as prescribed by Section C.3.3 and C.3.4 of ACI 349-97 is appropriate.

Section C.3.6 of ACI 349-97 requires that, for flexure to control the design, thus allowing the permissible ductility ratios or rotational capacities given in Sections C.3.3 and C.3.4 of ACI 349-97 to be used, the load capacity of a structural element in shear shall be at least

20 percent greater than the load capacity in flexure. In its calculation in Reference 8.4, the licensee demonstrated that the load capacity of the AB east wall in shear was 50 percent greater than the load capacity in flexure. Therefore, the staff finds that the licensee appropriately concluded that flexure controls the design of the AB east wall and, thus, the permissible ductility ratios and rotational capacities of C.3.3 and C.3.4 can be applied to the wall.

Section C.3.3 of ACI 349-97 requires that: for beams, walls, and slabs where flexure controls design, the permissible ductility ratio shall either be taken as $0.05/(\rho - \rho')$ not to exceed 10 (where ρ and ρ' are tension and compression steel ratios), or shall be determined from the rotational capacity as defined in Section C.3.4. The licensee determined the permissible ductility ratio to be 10, using the former criteria of Section C.3.3. Using the approximate dynamic analysis methodology described previously, the licensee determined the maximum ductility demand response of the wall under the governing missile impact load to be 6, which is less than 10. Therefore, the licensee appropriately concluded that the AB east wall satisfies the ductility response criteria in Section C.3.3 of ACI 349-97. Also, the licensee calculated the yield displacement (X_y) of the wall as 0.06 inches and, based on the ductility demand response of 6, the licensee calculated the maximum response displacement (X_r) of the wall as 0.38 inches, which the staff noted is small for a 2 ft thick wall spanning 24 ft.

Section C.3.4 of ACI 349-97 states that: when flexure controls design, the rotational capacity $r\theta$ in radians of any yield hinge shall be limited to 0.0065(d/c) but shall not exceed 0.07 radians, where d is the effective depth of section and c is the depth of neutral axis at ultimate strength. The licensee calculated the limiting value of r_θ for the AB east wall as 0.07 radians. Based on the calculated maximum response displacement of 0.38 in., the licensee calculated the maximum rotational response (θ_r) of the wall under the missile impact load as 0.01 radians, which is less than the rotation capacity of 0.07 radians. Therefore, the staff finds that the licensee appropriately concluded that the AB east wall satisfies the rotational deformation limit specified in Section C.3.4 of ACI 349-97.

Section C.3.1 of ACI 349-97 requires that, in addition to the deformation limits imposed under C.3.3 and C.3.4, the maximum deformation shall not result in the loss of intended function of the structural element nor impair the safety related function of other systems and components. Further, Regulatory Position 10.1 in Regulatory Guide (RG) 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)," Revision 2 (Reference 6), states that the deformation and degradation of the structure resulting from such an analysis (i.e. limit analysis with local exceeding beyond yield) must not cause loss of function of any safety-related SSCs. As discussed previously, the licensee calculated the response displacement and response rotation of the wall under the governing tornado missile impact load as 0.38 inches and 0.01 radians, respectively, which the staff notes are small for a 2 ft thick wall spanning 24 ft. Therefore, the staff finds that the licensee appropriately concluded that the maximum deformation will not result in loss of function of the AB east wall nor any other safety-related SSCs. Thus, the AB east wall satisfies the deformation criteria in Section C.3.1 of ACI 349-97 and Regulatory Position 10.1 in RG 1.142.

The staff noted that the licensee also demonstrated in the Reference 8.4 submittal that the columns that form the boundary of the wall panels are adequate to withstand the tornado missile impact loads. The licensee concluded that the ultimate strength of the AB east wall exceeds the

applied tornado wind and pressure drop loads and that no overall failure for the walls will occur due to tornado missile impact, which the staff finds acceptable.

The staff notes that ACI 349-97 has special provisions for evaluation of structures for impulsive and impactive loads that are not available in ACI 318-63. The NRC has endorsed ACI 349-97, subject to certain regulatory positions, in RG 1.142. Regulatory Guide 1.142 is also referenced in Section 3.8.4 and Section 3.5.3, "Barrier Design Procedures," of NUREG-0800. Therefore, the staff finds the use of ACI 349-97, as endorsed in RG 1.142, for qualification of the CR-3 AB east wall for abnormal loads and load combinations as described in the FSAR, acceptable. Based on the methodology and summary of results of the licensee's evaluation of the AB east wall for the governing load combinations involving tornado wind pressure and depressurization and the governing tornado missile (1-ton automobile) previously discussed in this safety evaluation, the staff finds that the licensee has demonstrated that the east wall of the CR-3 AB meets the requirements of ACI 349-97, as endorsed, and supplemented by regulatory positions, in Revision 2 of RG 1.142, for the design basis abnormal loads and load combinations as described in the FSAR.

Since the reinforcement ratio provided in the existing AB east wall is relatively low (0.15 percent of gross section), the staff performed a confirmatory dynamic time-history finite element analysis of the AB east wall panel for the governing tornado missile impact load of F = 270 kip applied at the center of the wall over a 0.081-second duration (Reference 8.7). The analysis was performed using LS-DYNA computer code, for the purpose of validation of results from the licensee's approximate method of dynamic analysis, and was based on the actual reinforcement ratio (0.15 percent of gross section) provided for the wall. The model used solid elements to model the concrete and bar elements to model the reinforcement. The LS-DYNA Winfrith model with strain rate effects was used to simulate the material behavior of concrete and the bilinear plastic model with kinematic hardening and strain rate effects was used to simulate the material behavior of the reinforcement. The results of the analysis indicated that the maximum displacement under the impact loading (F = 270 kip) was 0.07 in and the maximum rotation was 2 x 0.0005 = 0.001 radians. Also, the results indicated no yielding of the steel reinforcement with the maximum rebar tensile stress in the order of 22 ksi. The results indicated that there was radial moderate cracking to about 1.5 ft and minor cracking to about 2.5 ft from the center of the wall. The results of the dynamic time-history finite element analysis confirm that the results obtained from the licensee's approximate method of dynamic analysis are conservative.

Based on results of the licensee's evaluation of the AB east wall in the Reference 8.4 submittal and the staff's confirmatory analysis, the staff finds that there is reasonable assurance that the existing CR-3 AB east wall is adequately designed to withstand the effects of abnormal loads and load combinations, including the governing tornado wind and pressure drop and tornado missile loads, as described in the FSAR, without loss of capability to perform its safety function and without causing loss of safety function of any safety-related SSCs. Thus, the existing AB east wall meets the intent of GDC 2 and GDC 4. Therefore, the staff finds the proposed license amendment request to change the code of record to ACI 349-97, as endorsed in RG 1.142, to qualify the east wall of the CR-3 AB for abnormal loads and load combinations as described in the FSAR, acceptable.

Since the licensee's submittals for this license amendment does not reconcile the original design of the wall for normal operating conditions (based on ACI 318-63 -Working Stress Design) to the new code (ACI 349), the staff notes that the licensing design basis of the AB east wall for normal loads and load combinations, as described in the FSAR, remains in accordance with the original design based on ACI 318-63 - Working Stress Design.

4.0 FINAL NO SIGNIFACANT HAZARD CONSIDERATION DTERMINATION

The Commission's regulations in 10 CFR 50.92(c), "Issuance of amendment," states that the Commission may make a final determination that a licensee's amendment involves no significant hazard consideration if operation of the facility is in accordance with the amendment would not:

1) Involve a significant increase in the probability of consequences of an accident previously evaluated; or

2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

3) Involve a significant reduction in a margin of safety.

The NRC staff has reviewed the licensee's analysis in its letter dated April 8, 2009, against the above standards. The licensee's analysis is presented below:

1. Does not involve a significant increase in the probability or consequences of an accident previously evaluated.

   The proposed LAR will revise the methodology used to qualify the east wall of the CR-3 AB for all expected and postulated loads including tornado wind and missile loading. The Yield Line Theory methodology is an industry standard that is used for the design and analysis of concrete slabs and is applied to CR-3 in accordance with American Concrete Institute (ACI) 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures." A change in the methodology of an analysis used to verify qualification of an existing structure will not have any impact on the probability of accidents previously evaluated.

   The analysis performed demonstrates that the CR-3 Auxiliary Building east wall will remain structurally intact following the worst case loadings assumed in the calculation. Therefore, this proposed change does not involve a significant increase in the probability or consequences previously evaluated.

2. Does not create the possibility of a new or different kind of accident from any accident previously evaluated.

   The function of the CR-3 Auxiliary Building wall is to house and protect the equipment that is important to safety from damage during normal

operation, transients, and design basis accidents. The use of ACI 349-97 for qualifying the east wall of the CR-3 Auxiliary Building has no impact on the capability of the structure. A calculation that uses the Yield Line Theory methodology demonstrated that the structure meets required design criteria. This ensures that the wall is capable of performing its design basis function without alteration or compensatory actions of any kind. No changes to any plant system, structure, or component (SSC) are proposed. No changes to any plant operating practices, procedures, computer firmware/software will occur.

Therefore, the proposed change will not create the possibility of new or different type of accident from any previously evaluated.

3. Does not involve a significant reduction in a margin on safety.

The design basis of the plant requires structures to be capable of withstanding normal and accident loads including those from a design basis tornado. The requirements of ACI 349-97, as applied in an approved plant calculation, demonstrated that the east wall of the CR-3 Auxiliary Building is capable of performing its design function. There is a slight reduction in conservatism between the method used for the remaining Class 1 structures, ACI 318-63 and ACI 349-97, but the calculation performed validates the requirement that the east wall of the Auxiliary Building will protect the important to safety systems, structures, and components located in proximity to the wall from damage.

Therefore, the proposed change does not involve a significant reduction in the margin of safety.

The NRC staff has reviewed the licensee's analysis and, based on this review, has concluded that the three standards of 10 CFR 50.92(c) are satisfied. Therefore, the NRC staff has made a final determination that the proposed amendment involves no significant hazards consideration.

5.0 STATE CONSULTATION

Based upon a letter dated May 2, 2003, from Michael N. Stephens of the Florida Department of Health, Bureau of Radiation Control, to Brenda L. Mozafari, NRC Senior Project Manager, the State of Florida does not desire notification of issuance of license amendments.

6.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has made a final finding that the amendment involves no significant hazards consideration. Accordingly, the amendment meets the eligibility criteria for categorical exclusion

set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

7.0 CONCLUSION

The NRC has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

8. REFERENCES

8.1 Letter dated June 3, 2008 from Dale E. Young (Progress Energy, Crystal River Nuclear Plant) to the NRC, "Crystal River Unit 3 – License Amendment Request #303, Revision 0, Revision to Final Safety Analysis Report Sections 5.4.3, "Structural Design Criteria," and 5.4.5.3, "Missile Analysis"" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML081700089).

8.2 Letter dated November 17, 2008 from Dale E. Young (Progress Energy, Crystal River Nuclear Plant) to the NRC, "Crystal River Unit 3 – License Amendment Request #303, Revision 0: Revision to Final Safety Analysis Report Sections 5.4.3, "Structural Design Criteria," and 5.4.5.3, "Missile Analysis," (TAC No. MD8919) – Response to Request for Additional Information" (ADAMS Accession No. ML083370315).

8.3 Letter dated April 8, 2009 from Dale E. Young (Progress Energy, Crystal River Nuclear Plant) to the NRC, "Crystal River Unit 3 – License Amendment Request #303, Revision 1, Revision to Final Safety Analysis Report Sections 5.4.3, "Structural Design Criteria," and 5.4.5.3, "Missile Analysis" – Response to Request for Additional Information" (ADAMS Accession No. ML091030168: cover letter and Attachment A; ADAMS Accession No. ML091030167: Attachments B thru E).

8.4 Letter dated May 22, 2009 from Jon A. Franke (Progress Energy, Crystal River Nuclear Plant) to the NRC, "Crystal River Unit 3 – License Amendment Request #303, Revision 1, Supplement 1: Revision to Final Safety Analysis Report Sections 5.4.3, "Structural Design Criteria,: and 5.4.5.3, "Missile Analysis," – Response to Request for Additional Information" (ADAMS Accession No. ML091480087).

8.5 Biggs, J.M., *Introduction to Structural Dynamics*, McGraw Hill Book Company, 1964.

8.6 NRC Guidance Document, Regulatory Guide 1.142, Revision 2, "Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)," November 2001.

Principal Contributor: George Thomas

Date: July 24, 2009

July 24, 2009

Mr. Jon A. Franke, Vice President
Crystal River Nuclear Plant (NA1B)
ATTN: Supervisor, Licensing & Regulatory Programs
15760 W. Power Line Street
Crystal River, Florida 34428-6708

SUBJECT: CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT - ISSUANCE OF AMENDMENT REGARDING REVISION TO FINAL SAFETY ANALYSIS REPORT SECTIONS 5.4.3 AND 5.4.5.3 (TAC NO MD8919)

Dear Mr. Franke:

The Nuclear Regulatory Commission (NRC or the Commission) has issued the enclosed Amendment No. 235 to Facility Operating License No. DPR-72 for Crystal River, Unit 3 (CR-3) in response to your application dated June 3, 2008, as supplemented by letter dated November 17, 2008, and letters dated April 8 and May 22, 2009. The April 8 and May 22, 2009 submittals superseded in its entirety the licensee's submittals dated June 3 and November 17, 2008. The proposed amendment would revise the methodology and code of record, in the Final Safety Analysis Report (FSAR), Sections 5.4.3, "Structural Design Criteria" and 5.4.5.3, "Missile Analysis," used to qualify the east wall of the Auxiliary Building (AB) for abnormal loads and load combinations, described in the FSAR, from American Concrete Institute (ACI) 318-63 to ACI 349-97. The critical abnormal loads and load combinations that governed the qualification of the AB east wall involve tornado wind, pressure drop, and tornado missile loading.

A copy of the safety evaluation is enclosed. The notice of issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,
/RA/
Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Amendment No. 235 to Facility Operating License No. DPR-72
2. Safety Evaluation

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Accession Number: ML091830946 NRR-058

OFFICE	LPL2-2/PM	LPL2-2/LA	EMCB/BC*	OGC NLO w/ comment	LPL-2/BC
NAME	FSaba	CSola	MKhanna	A. Jones	TBoyce
DATE	07/22/09	07/13/09	05/27/09	07/22/09	07/24/09

* by memo

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