Enclosure 3 Contains Westinghouse Proprietary Class 2 Information requested to be withheld from public disclosure under 10 CFR 2.390(a)(4)

FPL

L-2015-268
10 CFR 52.3
10 CFR 2.390

October 29, 2015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Supplemental Submittal to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures

References:

1. FPL Letter L-2012-352 to NRC dated September 19, 2012, Response to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures

2. NRC Letter to FPL dated July 11, 2012, Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures for the Turkey Point Nuclear Plant Units 6 & 7 Combined License Application

3. FPL Letter L-2013-304 to NRC dated October 28, 2013, Supplemental Response to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures

4. FPL Letter L-2014-130 to NRC dated May 9, 2014, Supplemental Submittal to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures

Florida Power & Light Company (FPL) provided its response in the Reference 1 letter to the Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) No. 03.05.03-34 (eRAI 6544) provided in Reference 2.

Additionally, FPL and the NRC Staff have been engaged in interactions with respect to the information submitted in Reference 1. As a result of these interactions, FPL supplemented its original response in References 3 and 4, dated October 28, 2013 and May 9, 2014, respectively. These supplements included non-proprietary and proprietary responses as Enclosures 2 and 3, respectively. In this letter, FPL provides further supplements to those previous responses with a new Appendix A to the previously submitted Enclosures 2 and 3.

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Enclosure 3 Contains Westinghouse Proprietary Class 2 Information requested to be withheld from public disclosure under 10 CFR 2.390(a)(4)

Enclosure 3, Supplement to RAI-6544, TPG-GW-GLR-002, Revision 2, contains Westinghouse Proprietary Class 2 information.

The Westinghouse proprietary information for which withholding is being requested is further identified in the affidavit signed by Westinghouse Electric Company, LLC (Enclosure 1). The Westinghouse affidavit sets forth the bases on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in 10 CFR 2.390(b)(4). Enclosure 2 is a redacted version of Enclosure 3 and is therefore non-proprietary.

Correspondence with respect to the proprietary aspects of this application for withholding or the accompanying affidavit should reference CAW-15-4284 and should be addressed to James A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 3 Suite 310, Cranberry Township, Pennsylvania 16066. Based on Enclosure 1 to this letter, FPL requests that Enclosure 3 be withheld from public disclosure under 10 CFR 2.390(a)(4).

If you have any questions, or need additional information, please contact me at 561-904-3794.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on October 29, 2015.

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/ETC

Enclosure 1: Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-15-4284 (7 Pages)

Enclosure 2: Supplement to RAI-6544, TPG-GW-GLR-001, Revision 2, contains Westinghouse Non-Proprietary Class 3 information (24 Pages)

Enclosure 3: Supplement to RAI-6544, TPG-GW-GLR-002, Revision 2, contains Westinghouse Proprietary Class 2 information (25 Pages)

CC: (W/O) Enclosure 3
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

Enclosure 1

Westinghouse Application for Withholding Proprietary Information from Public Disclosure Pursuant to 10 CFR 2.390(a)(4)

CAW-15-4284

(7 Total Pages)

CAW-15-4284
October 15, 2015

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF BUTLER:

I, Richard A. DeLong, am authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and I declare under penalty of perjury that the foregoing is true and correct.

Richard A. DeLong, Director
International Licensing & Regulatory Support

(1) I am Director, International Licensing & Regulatory Support, Westinghouse Electric Company LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse Application for Withholding Proprietary Information from Public Disclosure accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Westinghouse policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of

Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(iii) There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(v) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in TPG-GW-GLR-002, Revision 2, "Supplement to RAI-6544," (Proprietary), dated October 2015, for submittal to the Commission, being transmitted by Westinghouse letter, APC_TPG_000058, and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse is that associated with "Supplement to RAI-6544," TPG-GW-GLR-002 Revision 2 (Proprietary), and may be used only for that purpose.

(a) This information is part of that which will enable Westinghouse to:

(i) Respond to questions about the hurricane missile analysis performed for the proposed Turkey Point Units 6&7. The questions and their responses are contained in TPG-GW-GLR-002, Revision 2, "Supplement to RAI-6544" (Proprietary)

(b) Further this information has substantial commercial value as follows:

(i) Westinghouse plans to sell the use of similar information to its customers for the purpose of plant licensing, construction, and operation.

(ii) Westinghouse can sell support and defense of industry guidelines and acceptance criteria for plant-specific applications.

(iii) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar plant safety systems and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

CAW-15-4284
October 15, 2015

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the Affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.390 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Enclosure 2

"Supplement to RAI-6544", TPG-GW-GLR-001

Revision 2

Contains Westinghouse Non-Proprietary Class 3 Information

(24 Total Pages)

NRC RAI Letter No. PTN-RAI-LTR-064 Dated July 11, 2012

SRP Section: 03.05.03 – Barrier Design Procedures

Questions from Hydrologic Engineering Branch (RHEB)

NRC RAI Number: 03.05.03-34

This response is a follow-up to information previously submitted to the NRC in FPL letter L-2012-352, Response to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 – Barrier Design Procedures, dated September 19, 2012.

FPL RESPONSE:

The NRC staff review of the response to RAI 03.05.03-34 identified the need to review the details of the Westinghouse supporting calculations and summary report (References 1 and 2). The supporting calculations were inspected by the NRC at the Westinghouse Rockville office. Following that inspection, the NRC requested an audit of the calculations with Westinghouse and FPL present. The NRC audit of the calculations supporting the missile impact analysis took place on February 6, 2013. The NRC audit focused on the shear in the walls caused by the automobile impact. Following the audit, action items were identified that need to be addressed.

This supplemental response addresses each of the seven (7) action items resulting from the NRC audit. The seven (7) action items are:

1. Demonstrate how the critical location(s) for punching shear were located and assessed;
2. Demonstrate the use of ACI 318 in determining the critical sections;
3. Address the consideration of punching shear and shear at supports as discussed in ACI 349-01 Appendix C.5;
4. Address the use of flat plate or slab analysis methodology;
5. Provide a justification of the use of an increase in the factor that defines the shear perimeter (0.6 instead of 0.3);
6. Address propagation of the impact load to the rest of the structure;
7. Address significant differences with TR-133 (APP-GW-GLR-133).

FPL RESPONSE:

Action Item 1: Demonstrate how the critical location(s) for punching shear were located and assessed.

Response to Action Item 1

For the evaluation of punching shear, five critical walls of the Auxiliary Building are selected for evaluation. They are considered critical based on thickness, reinforcement, location, and span distance from the floor and wall supports associated with the critical wall slab being evaluated. The wall segments and location are identified in Table 1. All of these locations are associated with the Auxiliary Building. All of these locations are potentially vulnerable to a postulated automobile hurricane missile. The walls are of reinforced concrete design having a concrete compressive stress of 4,000 pounds per square inch (psi), and the reinforcement meeting ASTM 615, Grade 60 (yield stress of 60 kips per square inch [ksi]).

Auxiliary Building walls adjacent to seismic category II buildings (Turbine Building First Bay and Annex Building area 1-3) are protected. These seismic category II buildings (designed to seismic category I standards) are robust reinforced concrete structures which are resistant to missile penetration and are designed to remain standing under a hurricane. The Shield Building wall is thicker than the Auxiliary Building walls (3 feet versus 2 feet) and has more reinforcement. Therefore, the Shield Building (analyzed to survive a beyond-design basis event of a large airplane impact) is shown to be adequate by

demonstrating that the Auxiliary Building structural integrity is maintained for the automobile hurricane missile. An automobile missile generated within a half mile of the plant structures is considered to impact all elevations less than 30 feet above all grade levels, and therefore will not reach the elevation of the Passive Containment Cooling System (PCS) tank. This impact height and distance criteria are provided in Regulatory Guide 1.221 (October 2011).

Table 1 – Shear in Walls due to Automobile Missile Impact

Wall ID Number	Wall Segment (1)	Elevation
1W	Along wall 1 between walls N & I	135' 3" to 180' 0"
2W	Along wall N between walls 1 & 4	135' 3" to 180' 0"
3W	Along wall I between 1 & 4	153' 0" to 180' 0"
4W	Along wall Q between walls 9.1 & 11	117' 6" to 153' 0"
5W	Along wall 1 between I & L2	100' to 135' 3"

(1) Location of wall segment is shown in Westinghouse Design Control Document, Revision 19, Appendix 3H. See also Figure 7 of this report.

On each of the wall segments the location of the automobile missile impact varies. Beam action (one-way action) and punching shear (two-way action) are evaluated on each wall panel at three different locations: interior, edge and corner. The evaluation of these three locations is based on punching shear provisions from ACI 318-11 section 11.11.2 and ACI 349-01 section 11.12.2. ACI 349-01 section 11.12.1 states the shear strength of slabs in the vicinity of concentrated loads is governed by the more severe of two conditions, beam action or two-way action.

One-Way Beam Action Allowable Shear Stress

Beam action is considered in two directions extending in-plane across the entire width per ACI 349-01 section 11.12.1.1. Per ACI 349-01 code requirements (Sections 11.1 and 11.3):

$$\phi V_n \geq V_u \qquad (11\text{-}1)$$

$$V_n = V_c + V_s \qquad (11\text{-}2)$$

$$V_c = 2\sqrt{f'_c}\, b_w d \qquad (11\text{-}3) \quad \text{or}$$

$$V_c = \left(1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u d}{M_u}\right) b_w d \quad \text{and less than } 3.5\sqrt{f'_c}\, b_w d \qquad (11\text{-}5)$$

Where:
V_u = factored shear force at section
V_n = nominal shear strength
V_c = nominal shear strength provided by concrete
V_s = nominal shear strength provided by shear reinforcement – considered zero

$\phi = 0.85$ (9.3.2)

DIF= 1.10 for reinforcing steel with fy = 60 ksi (C.2.1)
DIF = Material dynamic increase factor

Allowable Shear $\phi V_c = 0.85(2)\sqrt{(1.1)4000}\, d$ klf

Two-Way Action Punching Shear Allowable

ACI 349-01 Section 11.12.1.2 states the critical sections shall be located so that its perimeter is a minimum but need not approach closer than d/2 to concentrated loads (where d is the effective depth of the section).

Shear allowable for two-way action specified in Section 11.12.2 is the smallest of the three equations below.

V_c shall be the smallest of:

(a) $V_c = (2 + \frac{4}{\beta_c})\sqrt{f_c'}\, b_0 d$ (11-35)

Where β_c is the ratio of long side to short side of the column, concentrated load or reaction area;

(b) $V_c = (\frac{\alpha_s d}{b_0} + 2)\sqrt{f_c'}\, b_0 d$ (11-36)

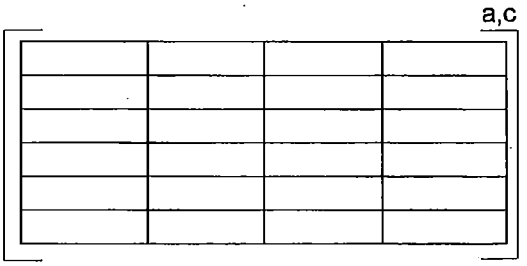
Where α_s is 40 for interior columns, 30 for edge columns, 20 for corner columns; and

(c) $V_c = 4\sqrt{f_c'}\, b_0 d$ (11-37)

A dynamic increase factor (DIF) of 1.1 and a strength reduction factor of ϕ equal to 0.85 are used. The term α_s, equal to 40 for interior columns, is used in equation 11-36. Values of α_s equal to 30 and 20 are not used since they apply to edge and corner columns. In these cases (edge and corner columns), the equations above are based on a column located on a portion of the slab with one or two sides of the slab unsupported, and consequently only has shear resistance along three or two sides of the concentrated load, respectively. In the case of the ***AP1000®***[1] Auxiliary Building walls, shear resistance is along all four sides of the automobile missile. The Auxiliary Building walls are continuous and lateral forces are transferred to the rest of the building via floors, interior and exterior walls, and roof. As shown in Table 2, equation 11-37 has the smallest shear allowable. The allowables include the 1.1 dynamic increase factor (DIF).

Table 2 – Punching Shear Allowable (klf)

a,c



[1] AP1000 is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

Allowable Shear $\phi V_c = 0.85(4)\sqrt{1.1(4000)}d$ klf

Shear Calculations for Interior Impact

Interior Impact - One-Way Action

Shear calculations for the missile striking the center of wall panels are summarized and addressed here considering one-way action. For the assessment of one-way action both the wind (V_{wind}) and automobile missile ($V_{missile}$) are considered. $V_{missile}$ is the shear force due to the maximum automobile missile impact load (660 kip), multiplied by the applicable dynamic load factor (see Table 3) associated with its impact forcing function (see Figure 2). V_{wind} is based on the sum of internal and external pressures due to wind. The values of V_{wind} and $V_{missile}$ are divided by the entire span in both directions for each wall per Section 11.12.1.1 in ACI 349-01. Walls 1W, 3W and 5W have [ ].[a,c] V_u is calculated as:

[ ][a,c]

For walls 2W and 4W, where [ ].[a,c] Wind load is added as shown in the calculation of V_u as shown in the equation below:

[ ][a,c]

Table 3 shows that the one-way beam shears are all below the ACI Code allowables.

Table 3 – Beam Action Reactions

a,c

Interior Impact - Two-Way Action

The punching shear is determined considering wind and automobile missile impact with the dynamic load factor. The shear area is defined by the perimeter of the critical section b_o, defined by the distance d/2 from the automobile missile impact zone having the dimension of 6.6' by 4.3', multiplied by the effective depth d.

In Table 4 are the punching shears at the critical perimeter b_o for the five walls. As seen they are all below the ACI allowables.

Table 4 – Punching Shear Reactions

a,c

Shear Calculations for Edge and Corner Impact

Edge and corner effects are studied with dynamic analysis using the finite element code ABAQUS and the ***AP1000*** NI05 model. The model is finely meshed in the areas associated with the automobile impact.

Five exterior Auxiliary Building walls were considered as the impacted walls. On each wall, Case 1 is referred to as the impact area close to the edge of the floor/roof and the wall to study the corner effect. Case 2 is referred to as the impact area close to the floor/roof along the middle edge of the wall to study the edge effect. The impact locations on each wall are shown in Figure 1.

a,c

Figure 1 - Schematic of Impact Locations on Auxiliary Building Exterior Walls

For each impact case, a time history dynamic analysis using the automobile missile impact forcing function is performed. The forcing function for the automobile missile is defined in Reference 3. The forcing function associated with the impact of the automobile missile onto the structure is defined as a quarter sine wave (see Figure 2). The basis of this formulation is that the automobile missile is considered as a deformable missile and the structure as a rigid target. This formulation is given below:

$F(t) = 0.625\ V_c\ W\ Sin\ (20t)$ $\quad 0 < t \leq 0.0785$ sec

$F(t) = 0$ $\quad t > 0.0785$ sec

Where

V_c = impact velocity during impact (fps)
V_c = 264 fps for horizontal impact based on the horizontal velocity of 180 mph
W = weight of automobile missile = 4000 lbs
$F(t)$ = 660 Sin (20t), kips for horizontal impact

The plot of this forcing function considering horizontal impact is shown in Figure 1. The frontal impact area is 6.6 feet x 4.3 feet as per Regulatory Guide 1.221, Revision 0, October 2011.

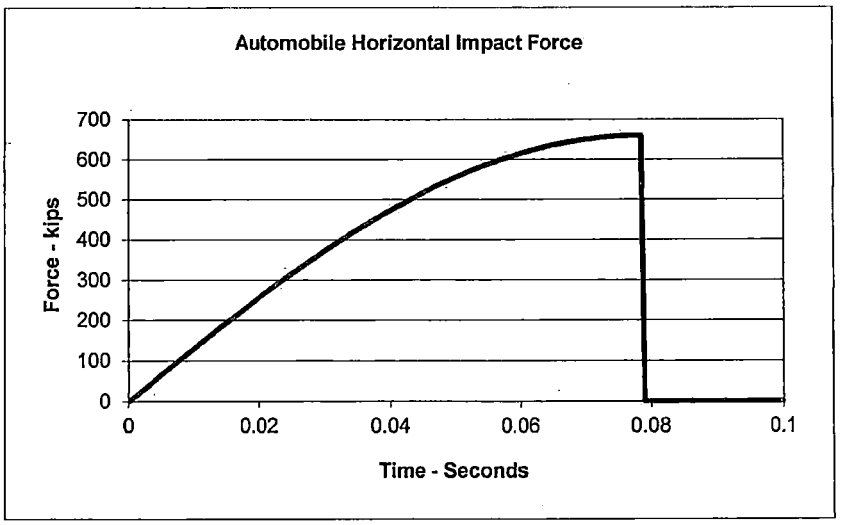


Figure 2 – Automobile Horizontal Hurricane Impact Force

A Dynamic Load Factor (DLF) was calculated to determine if the dynamic increase factor of 1.1 can be used in the calculation of the allowable stress (1.1 can be used if DLF ≥ 1.2). [

].[a,c] Table 5 summarizes DLFs of each wall impacted at the different locations as shown in Figure 1.

Table 5 – DLFs of Critical Exterior Walls a,c

Edge and Corner Impacts - One-Way Action

One-way shear does not govern in edge and corner impacts. For two-way action, the out-of-plane shear is within an allowable of $V_c = \phi 4\sqrt{f'_c}d$, over a length of 6.6'+ d + 4.3'. In the case of one-way shear, the allowable is $V_c = \phi 2\sqrt{f'_c}d$ over the entire span L. [

].[a,c]

Edge and Corner Impacts - Two-Way Action

The peak out-of-plane shear member forces evaluated by [ ]a,c for each impact case are given in Table 6. SF4 is out-of-plane shear along the vertical sides of the element and SF5 is out-of-plane shear along the horizontal sides of the element. The out-of-plane shear created by the hurricane automobile missile is evaluated using allowable stresses in accordance with ACI 349-01 that are shown in Table 4. However, it is noted that they are reduced [ ].a,c As shown in Table 6, [ ].a,c For Impact Case 1].a,c As seen from Table 6, all of the shear member forces are below the allowable.

Table 6 – Edge and Corner Impact Peak Out-of-Plane Shear Member Forces

a,c

Conclusion to Action Item 1

In conclusion, the automobile missile impact was evaluated for critical external walls of the Auxiliary Building that would potentially be subjected to hurricane automobile missiles. These critical walls are representative of the walls of the Auxiliary Building on the exterior boundary. Impacts were evaluated at mid span, edges and corners consistent with the ACI Code. Following ACI requirements, the punching shear is evaluated at three locations: (1) interior portion of an exterior wall that is away from the edge and corner; (2) at the edge location associated with a supporting wall or floor; and (3) at the corner defined by a wall and floor that support the wall segment. With consideration of one-way and two-way action, the shear stress was found to be within the ACI 349-01 shear allowables.

Action Item 2: Demonstrate the use of ACI 318 in determining the critical sections.

Response to Action Item 2

In Section 11.11 of ACI 318 provisions for slabs (applicable to walls being evaluated) are given. In this section of the code it is stated that the shear strength in the vicinity of concentrated loads (e.g., automobile missile impact) is governed by the more severe of two conditions:

1. Beam action (one-way action) where each critical section evaluated extends in a plane across the entire width.
2. For two-way action, each critical section investigated shall be located so that its perimeter b_o is a minimum but need not approach closer than d/2 to:
    a. Edges or corners of columns (considered wall boundaries), concentrated loads;
    b. Changes in slab thickness such as edges of capitals, drop panels, or shear caps (does not apply).

Also addressed are edge and corner cases having the concentrated load located on a portion of the slab with one or two sides of the slab unsupported, and consequently only has shear resistance along two or three sides of the concentrated load. These cases do not apply since the walls being evaluated are supported on four sides.

The ACI 318 requirements related to the critical sections are the same as those given in ACI 349-01.

Conclusion to Action Item 2

Two conditions are considered that define the most severe case: (1) beam action; and (2) two-way action. The critical locations to be evaluated on the impacted wall are in the interior, edge, and corner of the wall boundary. Following the requirements given in ACI 318 in determining and evaluating the critical sections for the shear resulting from the automobile missile impact will result in the same requirements given in ACI 349-01.

Action Item 3: Address the consideration of punching shear and shear at supports as discussed in ACI 349-01 Appendix C.5.

Response to Action Item 3

ACI 349-01 Appendix C provides special provisions for impactive and impulsive effects. Section C.5 addresses shear strength. Both one-way beam action and two-way punching shear are recognized. Provisions also apply for reaction shear at supported edges of walls. For the impactive or impulsive load a dynamic increase factors (DIF) of Section C.2 should be applied to the shear strength equations given in Sections 11.1 to 11.5, and for the punching shear strength of walls as defined in accordance with Section 11.12. Also, the shear strength equations should be reduced by the appropriate ϕ factor (0.85 per Section 9.3 for shear).

A dynamic increase factor of 1.1 (per Section C.2 for reinforcing steel having a yield stress of 60 ksi) is not considered in the allowable stress if the dynamic load factor is below 1.2 per Regulatory Guide 1.142.

Conclusion to Action Item 3

The provisions for impulsive and impactive effects for shear allowables given in Section C.5 are used in this evaluation. The use of the dynamic increase factor (DIF) is applied to the allowable shear equations as defined for one-way beam action and two-way punching shear unless the dynamic load factor is below 1.2.

Action Item 4: Address the use of flat plate or slab analysis methodology.

Response to Action Item 4

This methodology refers to the use of standard handbook flat plate formulas. These formulas were not used since finite element analyses are performed. The effects of impact on edge and corner panel locations are determined by finite element analysis with the ABAQUS program.

Conclusion to Action Item 4

In conclusion, the standard handbook flat plate formulas were not used in this evaluation since finite element analysis is used.

Action Item 5: Provide a justification of the use of an increase in the factor that defines the shear perimeter (0.6 instead of 0.3, where the perimeter is extended 0.6 times missile dimensions from the face of the missile). The factors of 0.3 and 0.6 are based on Reference 7. Instead of the span length the dimension of the impacting automobile area (6.6' x 4.3') was used to establish the shear perimeter. The 0.3 factor is the minimum and 0.6 is the maximum.

Response to Action Item 5

Item 5 applies to two-way action punching shear. ACI 349-01 requirements of extending the shear perimeter about the automobile missile impact zone (6.6' x 4.3') is used. Specifically, ACI 349-01 Section 11.12.1.2 states the critical sections shall be located so that its perimeter is a minimum but need not approach closer than d/2 to concentrated loads (where d is the effective depth of the section). The increase factor for the shear perimeter does not use 0.3 or 0.6, but is based on the ACI requirement of half of the effective section depth.

Conclusion to Action Item 5

Justification of the use of an increase in the factor that defines the shear perimeter does not need to be addressed since the punching shear perimeter is based on ACI 349-01, Section 11.12.1.2, and the 0.3 or 0.6 factors were not used in defining the punching shear perimeter from the automobile missile dimensions.

Action Item 6:

Address propagation of the impact load to the rest of the structure.

Response to Action Item 6

This response addresses the effects of the hurricane automobile missile impacts on the supporting walls and diaphragms. The approach taken to evaluate these supporting walls and diaphragms is to take the maximum response of the wall and pass the forces into the supports. The impact cases given in the response to Item 1 were checked along with an impact case for a direct strike over the support [

]^{a,c}

The supports were treated with the primary response of these walls and/or diaphragm being compression. But since the diaphragms are designed in the out-of-plane direction as purely flexural members, the compression loads into these supports is limited to [

]^{a,c} ensures that the strength of the wall or diaphragm is below the limit of the tension

controlled region of the load-moment (P-M) diagram where the moment capacity starts to decrease as the axial load increases. This is a reasonable simplification to preclude having to check the combination of compression with the out-of-plane bending capacities of the diaphragms.

Because the supports do bend in flexure to transmit the reactions further into the structure, the flexural response was also investigated. These supports were treated as slabs with in-plane bending with shear being the critical response.

Methodology

For one-way spanning walls the critical region of the support is taken as the length of the wall support obtained when the load [
].[a,c] This critical region is defined so as to compute the load intensity on the supporting diaphragm when the diaphragm is assumed as unyielding. Two-way spanning walls are shown in Figure 4.

a,c

Figure 3 – Reaction Distribution for One-Way Spanning Walls

a,c

Figure 4– Reaction Distribution for Two-Way Spanning Walls

Similar to the centered impact scenarios, the reactions from these impact loads are [ ].[a,c]

[

].[a,c]

a,c

Figure 5 – Reaction Distribution for Corner Impact

a,c

Figure 6 – Reaction Distribution for Edge Impact

The in-plane shear capacity of diaphragms and walls are given in Section 21.6.5 of the ACI 349-01 code, which gives the shear capacity of any segment of the diaphragm or wall (outside of the openings) as $\emptyset V_n = \phi A_{cv}\left(\alpha_c\sqrt{f_c'} + \rho_n f_y\right)$. With this equation the diaphragms and walls checked were the diaphragms at [

].[a,c] See Figure 7 for definition of areas in the Aux building.

a,c

Figure 7 – Nuclear Island Key Plan

The walls with the impact at the center of the wall are either considered to be one-way spanning or two-way spanning. [

].[a,c]

[

].[a,c]

For the two-way spanning walls the critical diaphragms checked were those at [

].[a,c]

The reaction near the corner and edges were observed to not be magnified significantly with DLFs closer to one. So if the impact was considered to be directly on the diaphragm the reaction to the support would be equal to or close to 660 kips. [

].[a,c]

The critical walls checked were the walls along [ ][a,c] for the center impact scenario, and [ ][a,c] for the corner scenario.

The different support conditions considered as well as the different locations of impact envelope all plausible scenarios of hurricane impact from an automobile missile and the margins provided against failure are adequate.

Table 7 – Margin Provided in Design

a,c

a,c

Figure 8 – Region in Area 5

Conclusion to Action Item 6

In conclusion, the automobile missile impact was evaluated for its effect on the supporting interior walls and floors, as well as for the automobile missile impact directly over the supporting elements. The supporting interior walls and floors are shown to be acceptable being within the ACI 349-01 acceptance criteria.

Action Item 7: Address all differences with TR-133 (Reference 6).

Response to Action Item 7

The horizontal hurricane automobile missile velocity at Turkey Point is greater than the horizontal automobile tornado missiles used in TR-133 (180 mph vs. 105 mph). TR-133 considered the auxiliary building walls 30' and higher above the ground elevation. For the Turkey Point site, evaluations above the ground elevation up to 180' of the auxiliary building were considered. The effective widths for the ductility calculations of the walls for Turkey Point site are consistent with TR-133. The Turkey Point punching

shear calculation is based on ACI 349-01, Section 11.12.1.2 requirements, and the 0.3 factor is not used in defining the punching shear perimeter from the automobile missile dimensions.

Conclusion to Action Item 7

The Turkey Point site is evaluated with larger automobile missile velocities for the horizontal direction. The exterior auxiliary building walls above the ground elevation were evaluated. The effective widths for the ductility calculations of the auxiliary building walls are consistent with TR 133. The Turkey Point site punching shear calculations follow ACI 349-01.

This response is PLANT SPECIFIC.

References

1. [ ]a,c
2. [ ]a,c
3. R. B. Linderman, J. V. Rotz, G. C. K. Yeh, "Design of Structures for Missile Impact," BC-TOP-9-A., Rev. 2, Bechtel Power Corporation, San Francisco, California, September 1974.
4. TM5-1300, Structures to Resist the Effects of Accidental Explosions, Department of the Army, Navy and Air Force, Washington DC, 19 November 1990.
5. Theory of Plates and Shells, Timoshenko, Stephen P., Woinowsky-Krieger, S., Second Edition, 1959, McGraw-Hill.
6. APP-GW-GLR-133, ***AP1000*** Standard Combined License Technical Report, "Summary of Automobile Tornado Missile 30' above Grade," Revision 1.
7. Reynolds, C.E., Reinforced Concrete Designer's Handbook, Concrete Publications Limited, London, 6th edition, 1964.
8. FPL Letter L-2012-352 to NRC dated September 19, 2012, Response to NRC Request for Additional Information Letter No. 64 (eRAI 6544) Related to SRP Section 03.05.03 - Barrier Design Procedures. [ML12265A065

ASSOCIATED COLA REVISIONS:

None

ASSOCIATED ENCLOSURES:

None

Appendix A: Response to NRC Questions

In September 2015, the NRC noted to Florida Power & Light (FPL) that additional information was needed in order to complete its safety review of the automobile hurricane missile impact on the walls and roof of the Turkey Point **AP1000** Auxiliary Building. The additional information was requested by the NRC in two rounds; an initial set of two written questions was followed by two questions received verbally during a telephone call on September 3, 2015. The questions and their responses are presented in this attachment

WRITTEN QUESTIONS

Question a.:

a. *In the applicant response to staff RAI, RAI 6544, Question 03.05.03-34 (1), where the staff requested the applicant to demonstrate how the critical location(s) for punching shear were located and addressed, the applicant stated, "On each of the wall segments the location of the automobile missile impact varies. Beam action (one-way action) and punching shear (two-way action) are evaluated on each wall panel at three locations: interior, edge, and corner." The applicant concluded that the automobile missile impacts were calculated at the midspan, the edges, and the corners of the Aux building walls, consistent with ACI 349-01. However, the staff reviewed the applicant response and noted that the tables (Table 3 – Beam Action Reactions and Table 4 – Punching Shear Reactions) presented only show the comparison of the results (One-Way vs Two-Way Action) of the automobile missile impact at the midspan of Aux building walls. The applicant is requested to provide the comparison of the results for the other two cases (edge and corner of the Aux building walls).*

Response:

As noted in the referenced report, five walls of the Auxiliary building were selected for evaluation of the hurricane missile based on thickness, reinforcement, location, and span distance from the supporting walls and floors. The walls are all of reinforced concrete with f_c' = 4,000 psi and reinforcement meeting ASTM 615, grade 60 (yield stress = 60 ksi).

On each of the selected wall segments, the hurricane missile (an automobile) impact is evaluated at three different locations: interior, edge, and corner. At each impact location, the wall is assessed for beam (one-way) action and punching shear (two- way action). The results for one way and two way action at the interior impact locations (i.e., the center of the wall panels) for each of the five walls are presented in Tables 3 and 4, respectively, of the referenced report.

Edge and corner impacts are evaluated in a finite element analysis to quantify the shear forces more accurately than the hand calculations performed for the interior impact locations. As noted in the referenced report, a time history dynamic analysis using the automobile missile impact forcing function was performed and the out-of-plane shear forces were compared to calculated allowable forces. The maximum out-of-plane shear forces are documented in Table 6 of the referenced report. One-way and two-way shear allowable forces calculated in accordance with Chapter 11 of ACI 349-01 are also presented in the table.

All shear results are within ACI allowable values.

Question b.:

b. *TR 133 provides combined license (COL) information related to the impact of automobile missile at any elevation of nuclear island safety-related structures. The report states that five typical walls and three typical roof slabs are selected for evaluation (Walls: 1W, 2W, 3W, 4W, 5W; and Roof Slabs: 1R, 2R, ~~2R~~3R). Per TR 133, the applicant is requested to demonstrate the adequacy of critical sections of the roof slabs subject to hurricane automobile missile impact.*

Response:

The AP1000 Design Control Document (DCD) presents tornado wind speed and missile spectra that are specified for the design of safety-related structures in Tier 1 Table 5.0-1. The design-basis vertical tornado wind speed is noted as 74 mph. USNRC Regulatory Guide 1.221 presents design basis hurricane wind speed and missile spectra, including the recommended design-basis vertical hurricane missile velocity of 26 m/s (equal to 58 mph). The design-basis vertical tornado wind speed in the DCD (74 mph) is greater than the recommended design-basis vertical hurricane missile velocity specified in Reg. Guide 1.221 (58 mph).

A comparison of the vertical kinetic energies from the tornado missiles shows that the AP1000 design tornado missiles bound the kinetic energies of the Turkey Point 6 and 7 hurricane missiles. The vertical kinetic energy of the AP1000 design tornado missile is more than 1.5 times that of the Turkey Point 6 and 7 vertical hurricane missile.

The AP1000 design is adequate for vertical Turkey Point hurricane loads.

VERBAL QUESTIONS

Two questions resulted after a phone call with the NRC on September 03, 2015, requesting further clarification on hurricane missiles.

Question 1:

Using Wall 5 as an example, illustrate the calculation of the allowable shear for one-way and two-way action. Illustrate how bo and bw are obtained and used.

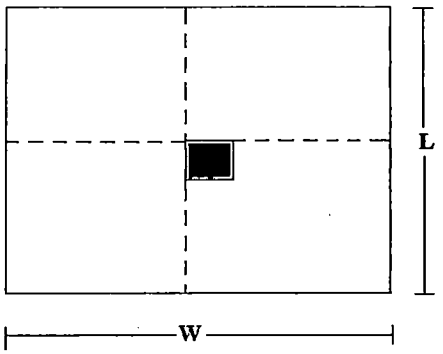
Response:

Wall 5 is used as an example to demonstrate how the shear allowable is calculated for one-way and two-way shear. Shear allowables are in compliance with ACI 349-01.

$\phi V_n \geq V_u$ (11-1)
$\phi = 0.85$ (9.3.2)
DIF= 1.10 for reinforcing steel with fy = 60ksi (C.2.1)

Mid-span Impact:

One-Way Shear



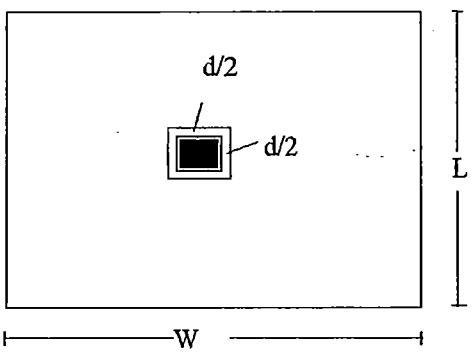
$V_c = 2\sqrt{f'_c}b_w d$ (11-3)

[ ]a,c

b_w is the minimum of the width (W) or length (L) of the slab. d is the distance from extreme compression fiber to centroid of longitudinal tension reinforcement.

[ ]a,c

Two-Way Shear



$V_c = 4\sqrt{f'_c}b_o d$ (11-37)

[ ]a,c

b_o is the perimeter of the critical section of the slab. d is the distance from extreme compression fiber to centroid of longitudinal tension reinforcement.

[ ]a,c

Edge and Corner Impact:

Two-way corner allowable is always the governing check due to the dimensions considered for b_o. Wall 5 is used as an example to demonstrate how shear allowables are calculated.

One-Way Shear

One-way shear allowable is the same as calculated in the previous section, for one way shear.

[ ]a,c

Two-Way Shear

Two-way shear allowable uses the same approach as the above section, and the only variable is b_o as it is different for edge and corner impacts.

[ ]a,c

[ ]a,c

Two-way corner allowable

[ ]a,c

Two-way edge allowable

[ ]a,c

[ ]a,c

Question 2:

Illustrate the calculation of the Dynamic Load Factor (DLF) of [ ]a,c for Wall 1 as shown in Tables 3 and 4.

Response:

[

]a,c

[ ]a,c

[ ]a,c

[ ]a,c

[ ]a,c

[ ]a,c

[ ]a,c

[ ]a,c