PMTurkeyCOLPEm Resource

From: CHILDRESS, ELWOOD [ELWOOD.CHILDRESS@fpl.com]
Sent: Friday, May 09, 2014 3:21 PM
To: Williamson, Alicia; Lieto, Amanda; Maher, William; Comar, Manny; Hoeg, Tim; Terry, Tomeka; McCree, Victor
Subject: FPL Letter L-2014-130 Dated 05-9-2014: NRC RAI Letter No. 064 (eRAI 6544) Voluntary Submittal
Attachments: image001.jpg; L-2014-130 AunDated 05-09-2014 Barrier Design Proprietary Response_.pdf

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
Voluntary 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 Procedure

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. In Reference 3 FPL submitted a supplement to the response to address calculation audit questions. FPL is providing clarifications to that supplement in this voluntary submittal. A proprietary clarification to Table 7, note 2, is presented in Enclosure 3. Non-Proprietary FSAR clarifications are presented in Enclosure 4. Enclosure 2 has been updated to provide the same pagination as the supplemental response in Enclosure 3.

FPL provides, as Enclosure 4 to this letter, new associated COLA revisions as part of its voluntary submittal to NRC's RAI 03.05.03-34. The enclosure identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

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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)

L-2014-130
10 CFR 52.3
10 CFR 2.390

May 9, 2014

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

Re: Florida Power & Light Company
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FPL provides, as Enclosure 4 to this letter, new associated COLA revisions as part of its voluntary submittal to NRC's RAI 03.05.03-34. The enclosure identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

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 1, 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-14-3948 and should be addressed to Robert B. Sisk, Manager, Korea/UAE, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, 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 561-691-7490.

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

Executed on May 9, 2014.

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/ETC

Enclosure 1: Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-14-3948 (6 Pages)

Enclosure 2: Voluntary submittal to NRC RAI No. 03.05.03-34 (eRAI 6544), Contains Westinghouse Non-Proprietary Class 3 Information (20 Pages)

Enclosure 3: Voluntary submittal to NRC RAI No. 03.05.03-34 (eRAI 6544), Contains Westinghouse Proprietary Class 2 Information (21 Pages)

Enclosure 4: Associated COLA Revisions (3 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-14-3948

(6 Total Pages)

Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-14-3948, accompanying Affidavit, Proprietary Information Notice, and Copyright Notice pursuant to 10 CFR 2.390(a)(4)

Enclosure 3 of this letter, "Supplement to RAI-6544", TPG-GW-GLR-002, Revision 1, contains Westinghouse Proprietary Class 2 information.

As Enclosure 3 of this letter contains proprietary information to Westinghouse Electric Company LLC, it is supported by an affidavit signed by Westinghouse, the owner of the information. The Westinghouse affidavit sets forth the basis 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).

Accordingly, it is respectfully requested that the information which is proprietary be withheld from public disclosure in accordance 10 CFR 2.390.

Correspondence with respect to the proprietary aspects of this application for withholding or the accompanying affidavit should reference CAW-14-3948 and should be addressed to Robert B. Sisk, Manager, Korea/UAE, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared **Robert B. Sisk**, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Robert B. Sisk
Program Manager Korea/UAE

Sworn to and subscribed
before me this 7th day
of May 2014.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Linda J. Bugle, Notary Public
City of Pittsburgh, Allegheny County
My Commission Expires June 18, 2017
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

Notary Public

(1) I am Program Manager Korea/UAE, 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" 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.

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.

(iii) 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.

(iv) 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.

(v) The proprietary information sought to be withheld from within the "**Transmittal of Westinghouse Calculation Audit Action Items Subsequent to Initial Response to NRC RAI-6544 "Supplement to RAI-6544", TPG-GW-GLR-002 Revision 1 (Proprietary)** (APC_TPG_000058), for submittal to the Commission, being transmitted by Florida Power and Light Company letter 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 **Transmittal of Westinghouse Calculation Audit Action Items Subsequent to Initial Response to NRC RAI-6544 "Supplement to RAI-6544", TPG-GW-GLR-002 Revision 1 (Proprietary)**, and may be used only for that purpose.

The information requested to be withheld reveals details of the AP1000 design; timing and content of procurement; sequence and method of construction; and timing and content of inspection and testing. This information was developed and continues to be developed by Westinghouse. The information is part of that which enables Westinghouse to manufacture and deliver products to utilities based on proprietary designs.

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 commercial power reactors without commensurate expenses.

The information requested to be withheld 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.

Enclosure 2

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

Revision 1

Contains Westinghouse Non-Proprietary Class 3 Information

(20 Total Pages)

Note: The footer pagination matches the Enclosure 3 version.

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):

$\phi\ V_n \geq V_u$ (11-1)

$V_n = V_c + V_s$ (11-2)

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

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

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

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

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

(b) $V_c = \left(\frac{\alpha_s d}{b_0} + 2\right)\sqrt{f_c'}\, b_0 d$ (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.

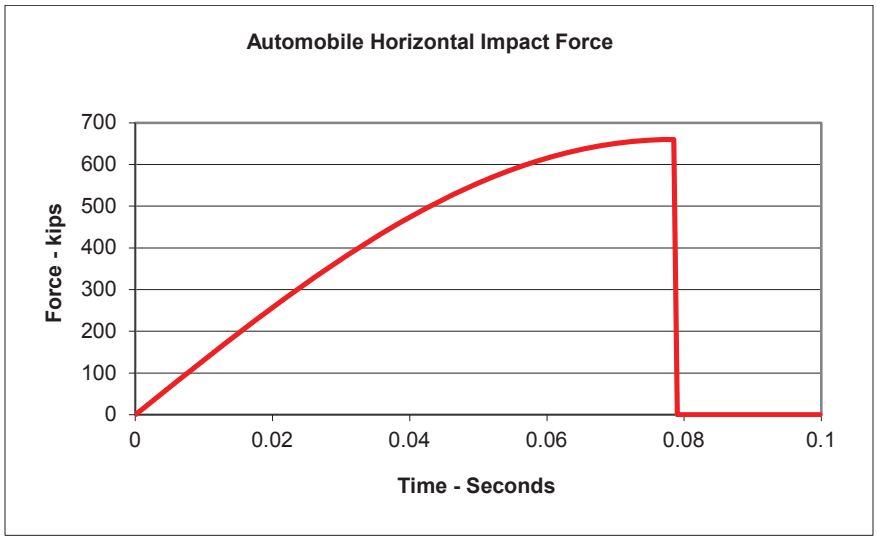

Figure 2 – Automobile Horizontal Hurricane Impact Force

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

Similar to interior impact, 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 directly above the impact. In the case of one-way shear, the allowable is $V_c = \phi 2\sqrt{f'_c}\,d$ over the entire span. [

].[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

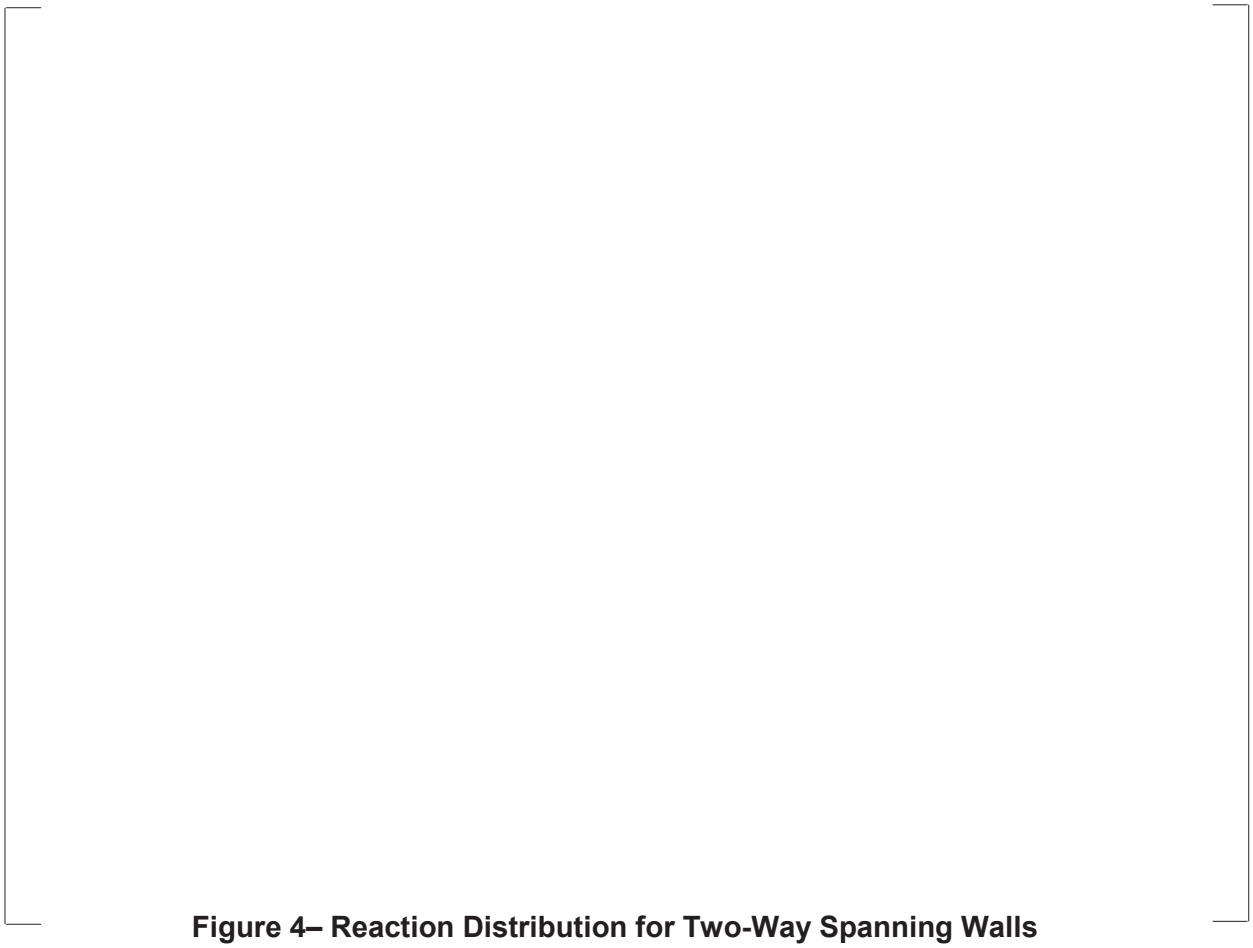

Figure 4– Reaction Distribution for Two-Way Spanning Walls

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

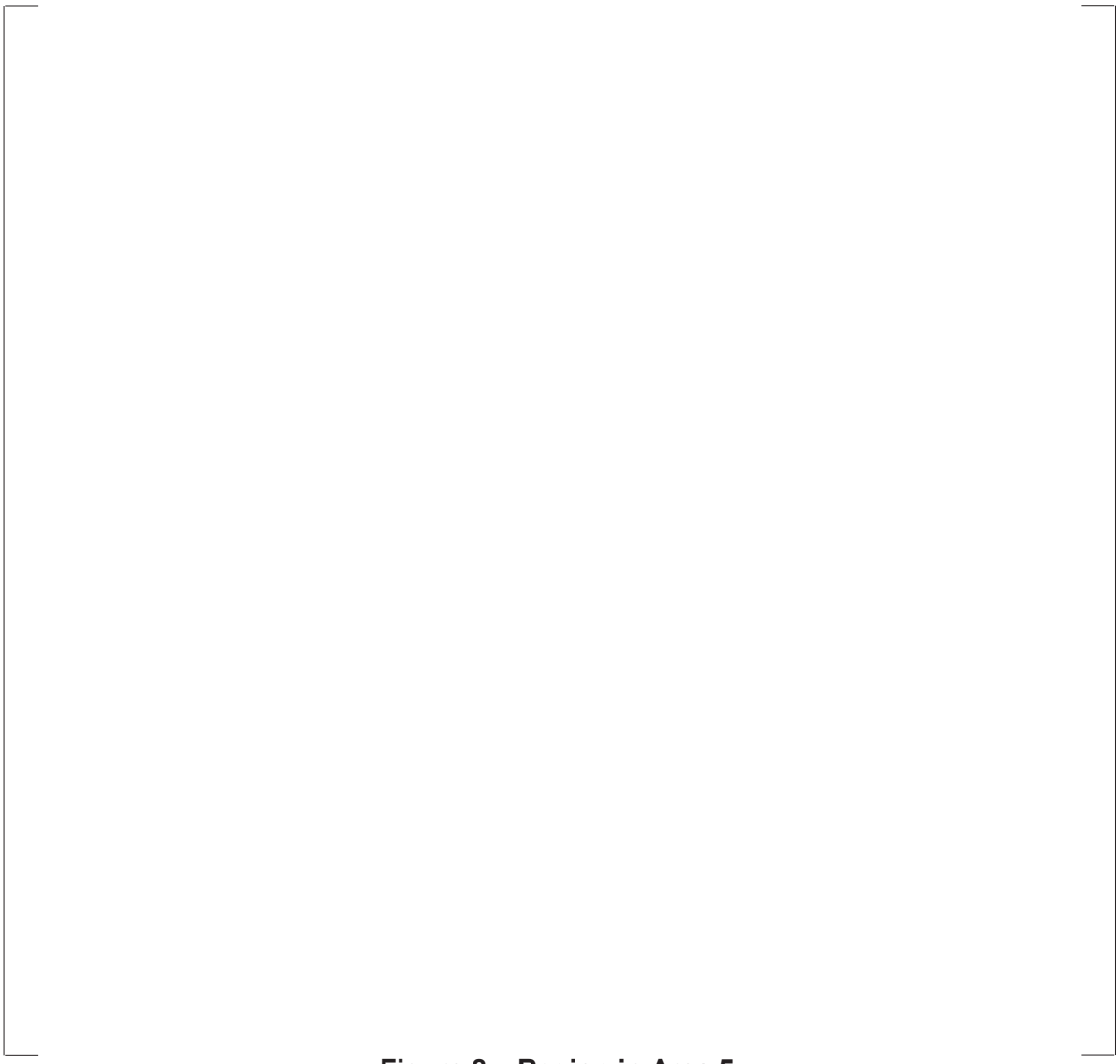

Figure 8 – Region in Area 5

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
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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:

Refer to Enclosure 4.

ASSOCIATED ENCLOSURES:

None

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 1

Contains Westinghouse Proprietary Class 2 Information

(21 Total Pages)

Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-14-3948, accompanying Affidavit, Proprietary Information Notice, and Copyright Notice pursuant to 10 CFR 2.390(a)(4)

Enclosure 3 of this letter, "Supplement to RAI-6544", TPG-GW-GLR-002, Revision 1, contains Westinghouse Proprietary Class 2 information.

As Enclosure 3 of this letter contains proprietary information to Westinghouse Electric Company LLC, it is supported by an affidavit signed by Westinghouse, the owner of the information. The Westinghouse affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and address with specificity the considerations listed in 10 CFR 2.390(b)(4).

Accordingly, it is respectfully requested that the information which is proprietary be withheld from public disclosure in accordance 10 CFR 2.390.

Correspondence with respect to the proprietary aspects of this application for withholding or the accompanying affidavit should reference CAW-14-3948 and should be addressed to Robert B. Sisk, Manager, Korea/UAE, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

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

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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

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

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

(b) $V_c = \left(\frac{\alpha_s d}{b_0} + 2\right)\sqrt{f_c'}\, b_0 d$ (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

Wall ID	11-35	11-36	11-37
1W	80.37	76.47	65.20
2W	67.65	60.59	55.32
3W	70.08	63.55	57.21
4W	70.15	63.63	57.27
5W	80.37	76.47	65.20

[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 [ductility factors higher than 1.0, and have therefore experienced yielding under the maximum load R_m].[a,c] V_u is calculated as:

$$[V_u = R_m / (2L \text{ or } 2W)]^{a,c}$$

For walls 2W and 4W, where [ductility factors are below 1.0, the resistance experienced is stiffness multiplied by deflection].[a,c] Wind load is added as shown in the calculation of V_u as shown in the equation below:

$$[V_u = (V_{wind} + V_{missile}) / (2L \text{ or } 2W)]^{a,c}$$

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

Table 3 – Beam Action Reactions

a,c

Wall ID	Dynamic Load Factor (DLF)	Beam Shear V_u klf	Allowables[2] ϕV_c klf
1W [1]	0.97	9.64	31.08
2W	1.35	18.26	27.66
3W	1.20	16.63	28.61
4W	1.56	20.32	28.63
5W	1.25	13.93	32.60

1. Dynamic increase factor of 1.1 not considered in the allowable since DLF is below 1.2 per Regulatory Guide 1.142.
2. One-Way Beam Action Allowable Shear Stress, $\phi V_c = 0.85(2)\sqrt{(1.1)4000}\, d$

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

Wall ID	Dynamic Load Factor (DLF)	Punching Shear V_u klf	ACI Allowable ϕV_c [1] klf
1W	0.97	21.92	62.16
2W	1.35	31.58	55.32
3W	1.20	27.90	57.21
4W	1.56	36.13	57.27
5W	1.25	28.11	65.20

1. Allowables (Table 2, Formula 11-37) have been adjusted removing the DIF of 1.1 where DLF is below 1.2 (Wall 1W).

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

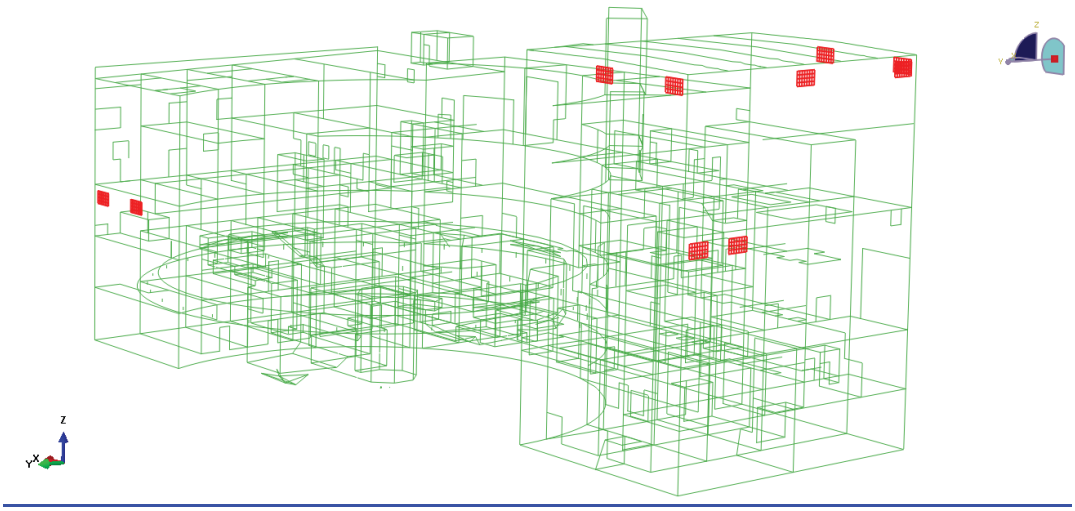

Figure 1 - Schematic of Impact Locations on Auxiliary Building Exterior Walls

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.

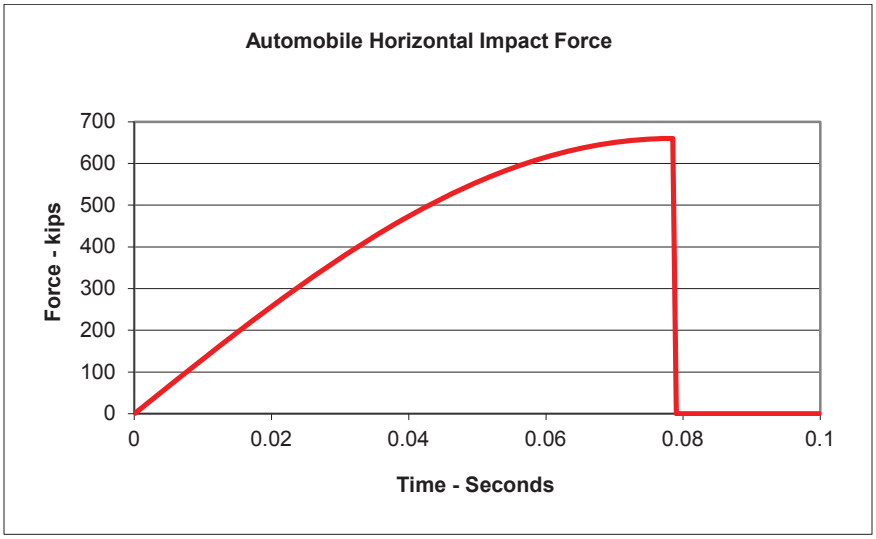

Figure 2 – Automobile Horizontal Hurricane Impact Force

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 $\geq$ 1.2). [The (DLF) was calculated from the ratio of the peak displacement calculated with the time history dynamic analysis versus the displacement calculated with the static analysis].[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

Wall ID	Wall Segment	Elevation	Corner Case	Edge Case
1W	Wall 1 Between Walls N&I	135'3" to 180'	1.128	1.274
2W	Wall N Between Walls 1&4	135'3" to 180'	1.141	1.4
3W	Wall I Between Walls 1&4	153' to 180'	1.139	1.135
4W (1)	Wall Q Between Walls 9.1&11	100' to 117'6"	1.056	1.061
5W (2)	Wall 1 Between Walls N&K2	100' to 135'3"	1.036	1.021

1. Elevation of Wall Q is different than given for 4W in Table 1. This lower elevation is added to study edge and corner effects. The higher elevation of Wall Q considered is not included here since similar configurations of impact are considered for other walls.
2. The portion of Wall 1 (Wall ID 5W) analyzed here is from N to K2 and not from L2 to I. This smaller portion was chosen since it is stiffer, and may have larger corner and edge effects than others. The portion from L2 to I is similar to other walls evaluated and therefore not considered here.

Edge and Corner Impacts - One-Way Action

Similar to interior impact, 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 directly above the impact. In the case of one-way shear, the allowable is $V_c = \phi 2\sqrt{f'_c}\,d$ over the entire span. [Since the entire span length is much more than two times the length of 6.6' + d, two-way action will govern].[a,c]

Edge and Corner Impacts - Two-Way Action

The peak out-of-plane shear member forces evaluated by [time history dynamic analysis][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 [to reflect the removal of the DIF of 1.1 since the DLF is below 1.2].[a,c] As shown in Table 6, [Impact Case 2 (edge case SF5) of Wall Q has the maximum peak out-of-plane shear at the edge of the impact area of the automobile missile equal to 51.42 kips/ft].[a,c] For Impact Case 1 [(corner case SF5), the peak value is equal to 44.65 kips/ft for SF5].[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

Wall ID	Wall Segment	Elevation	Corner Case		Edge Case		Allowable(1) (kips/ft)
			SF4 (kips/ft)	SF5 (kips/ft)	SF4 (kips/ft)	SF5 (kips/ft)	
1W	Wall 1 Between Walls N&I	135'3" to 180'	38.97	36.58	46.7	25.99	62.16
2W	Wall N Between Walls 1&4	135'3" to 180'	40.68	39.27	25.03	44.47	52.74
3W	Wall I Between Walls 1&4	153' to 180'	39.62	39.1	24.83	42.8	54.55
4W(2)	Wall Q Between Walls 9.1&11	100' to 117'6"	35.39	44.65	23.72	51.42	54.69
5W(3)	Wall 1 Between Walls N&K2	100' to 135'3"	36.18	26.34	41.66	35.32	62.16

1. Allowables (Table 1) have been adjusted removing the DIF of 1.1 since for the edge and corner cases the DLFs are below 1.2.
2. Elevation of Wall Q is different than given for 4W in Table 1. This lower elevation is added to study edge and corner effects. The heigher elevation of Wall Q considered is not included here since similar configurations of impact are considered for other walls.
3. The portion of Wall 1 (Wall ID 5W) analyzed here is from N to K2 and not from L2 to I. This smaller portion was chosen since it is stiffer, and may have larger corner and edge effects than others. The portion from L2 to I is similar to other walls evaluated and therefore not considered here.

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 [with the narrowest margin from impact scenarios 1W thru 5W-Corner and 5W-Edge. The resulting impact case is the impact directly over the opening in the diaphragm at elevation 135' 3"].[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 [no greater than the compression corresponding to the 70% of balance point. Using 70% of balance point axial load][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 [is allowed to fan out to the support at a slope of 1:1 as shown in Figure 3].[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

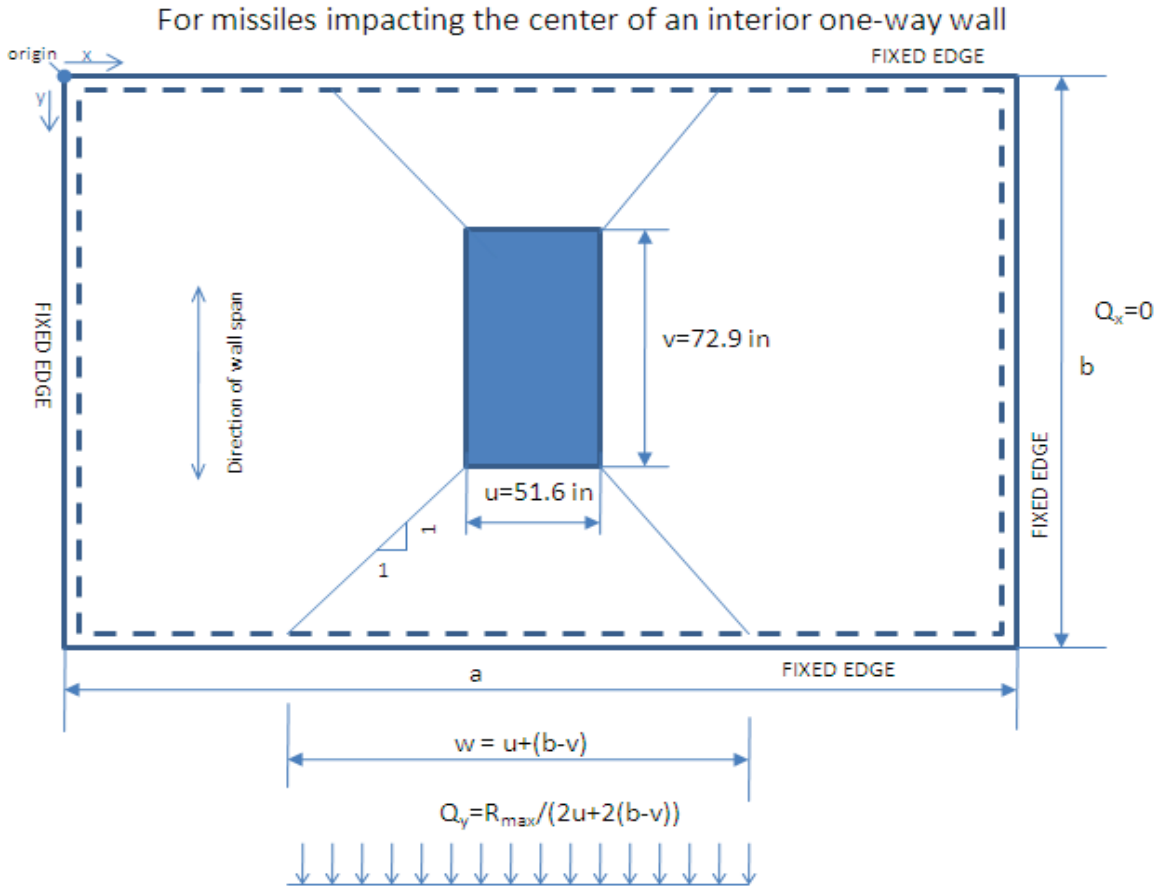

Figure 3 – Reaction Distribution for One-Way Spanning Walls

a,c

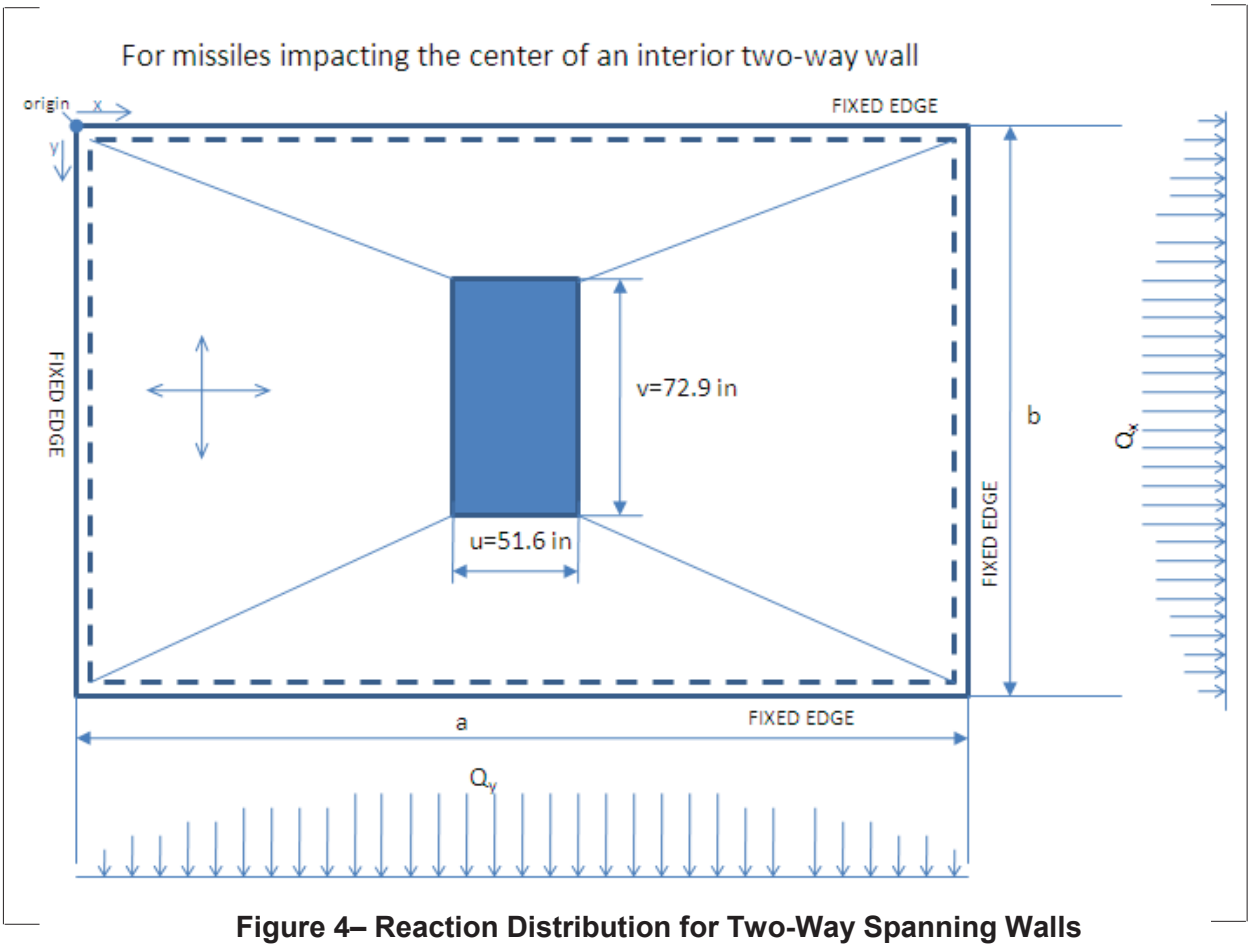

Figure 4– Reaction Distribution for Two-Way Spanning Walls

Similar to the centered impact scenarios, the reactions from these impact loads are [averaged over the support as shown in Figure 5].[a,c]

[The parabolic distributions of the reactions in Figures 5 and 6 were obtained directly from the Navier's plate equations in Timoshenko (Reference 5). But it is overly conservative to design the support for the peak of the parabolic distribution. Therefore an average support reaction is obtained for all the impact scenarios. For the two-way spanning walls with center impact scenarios, the Navier's equations give a parabolic distribution over the entire edge perimeter. To convert to a uniform distribution that is meaningful, the uniform distribution of an edge subjected to impulse from Reference 4 was used. For the edge and corner cases, Navier's plate equations show that only about one-third of edge perimeter is actually supporting the impact since it is so close to one edge. To get the average, the area under the parabola was set equal to the area for a uniform rectangular loading with the peak intensity equal to two-third of the parabola. This 2/3 factor was obtained from setting the area under a perfect parabola to a rectangle with variable height but the same base. The height of that rectangle would 2/3 of the peak of the parabola. But since Navier's plate equation yields a parabola with a long decay (i.e. a long near zero tail), the area under the Navier's parabola was set to a rectangle with the base as a variable but the height set to 2/3 of the peak of the Navier's parabola. The base computed in this manner is the w_e or l_e shown in Fig. 5 and 6 respectively].[a,c]

a,c

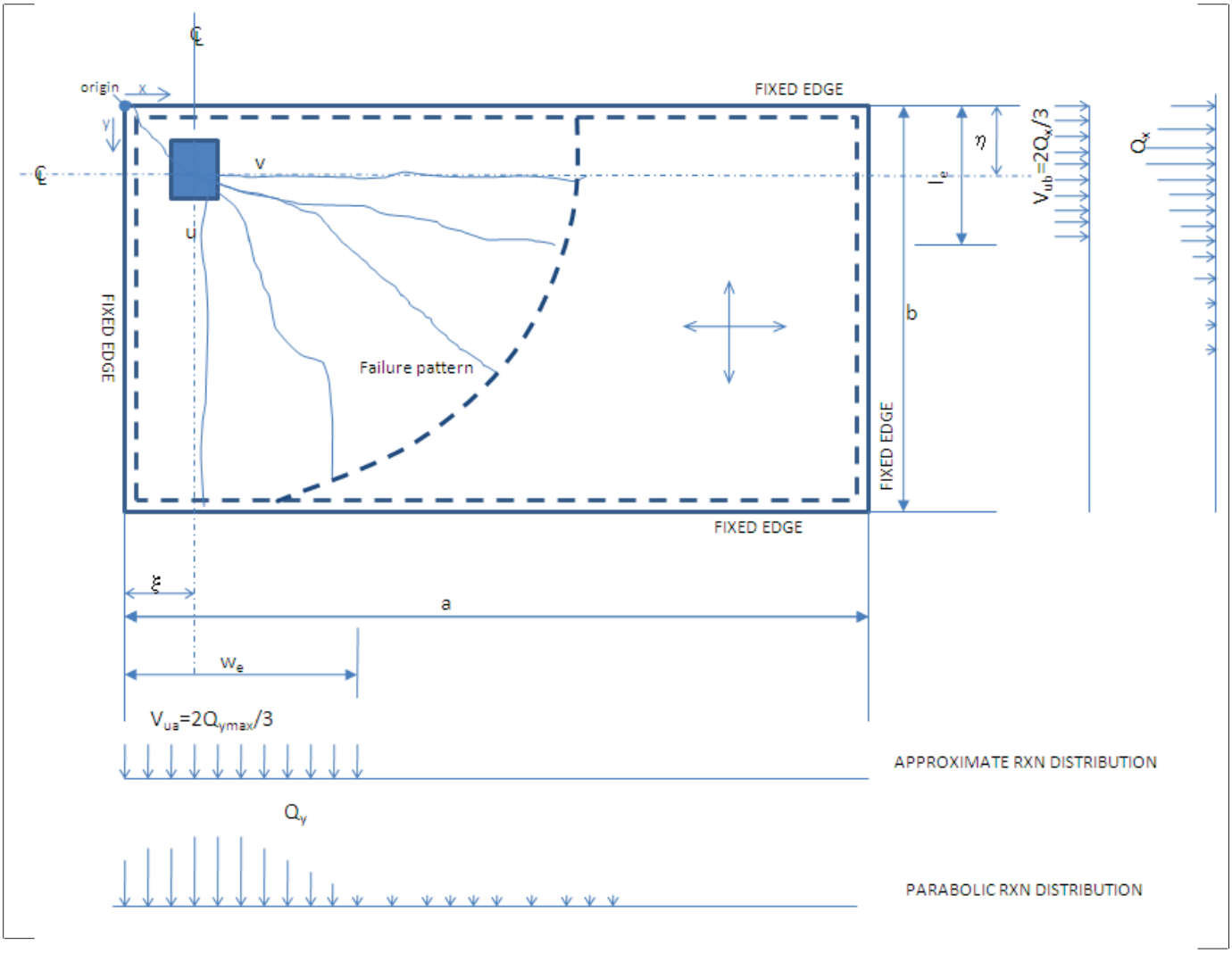

Figure 5 – Reaction Distribution for Corner Impact

a,c

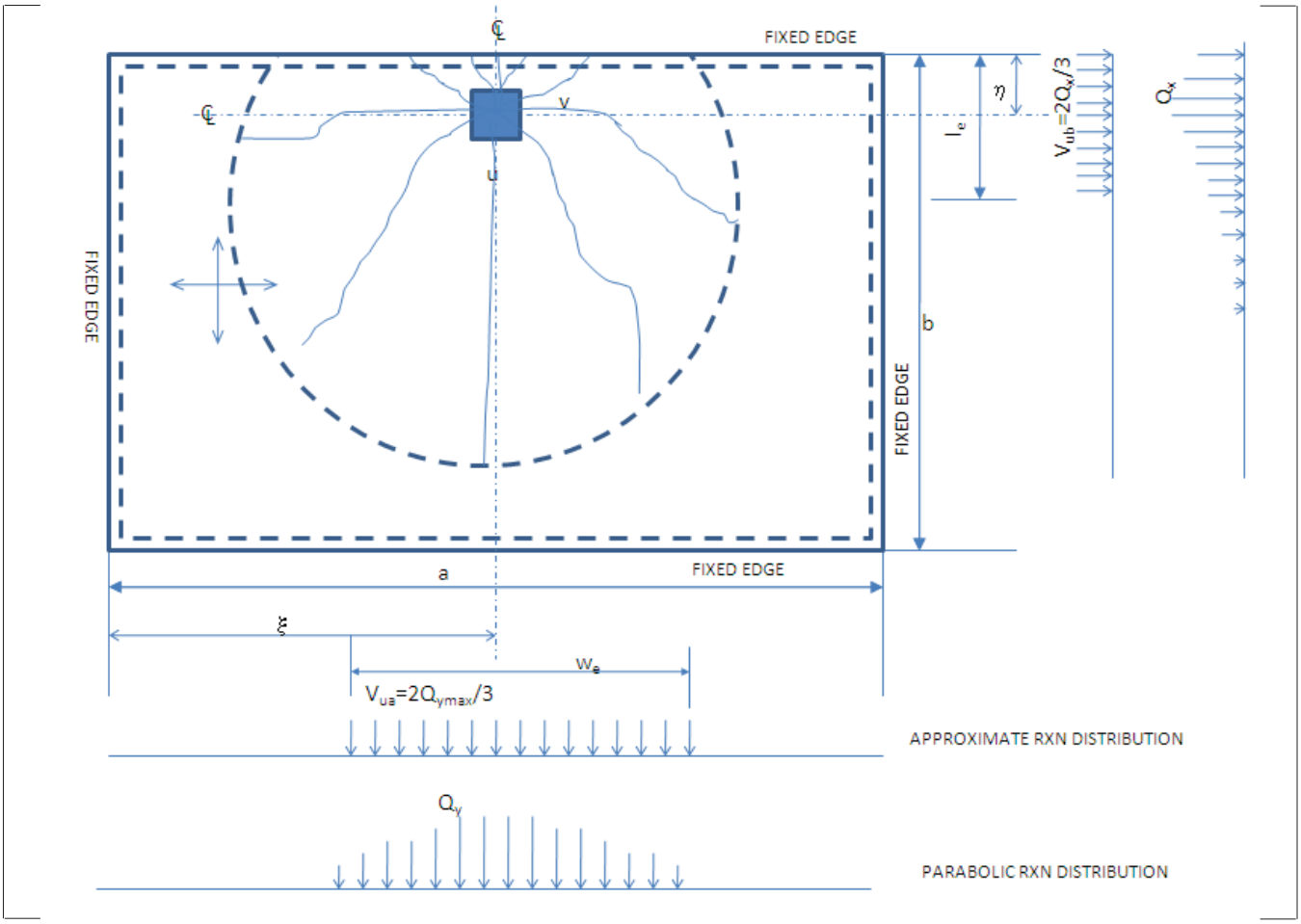

Figure 6 – Reaction Distribution for Edge Impact

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 [Elevation 153 ft, Areas 5 and 6; Elevation 117 ft 6 in, Areas 1 and 2; Elevation 135 ft 3 inches Areas 5 and 6 with the fuel handling access hatch opening considered; the walls along grid line 11; and the wall along grid line L-3].[a,c] See Figure 7 for definition of areas in the Aux building.

a,c

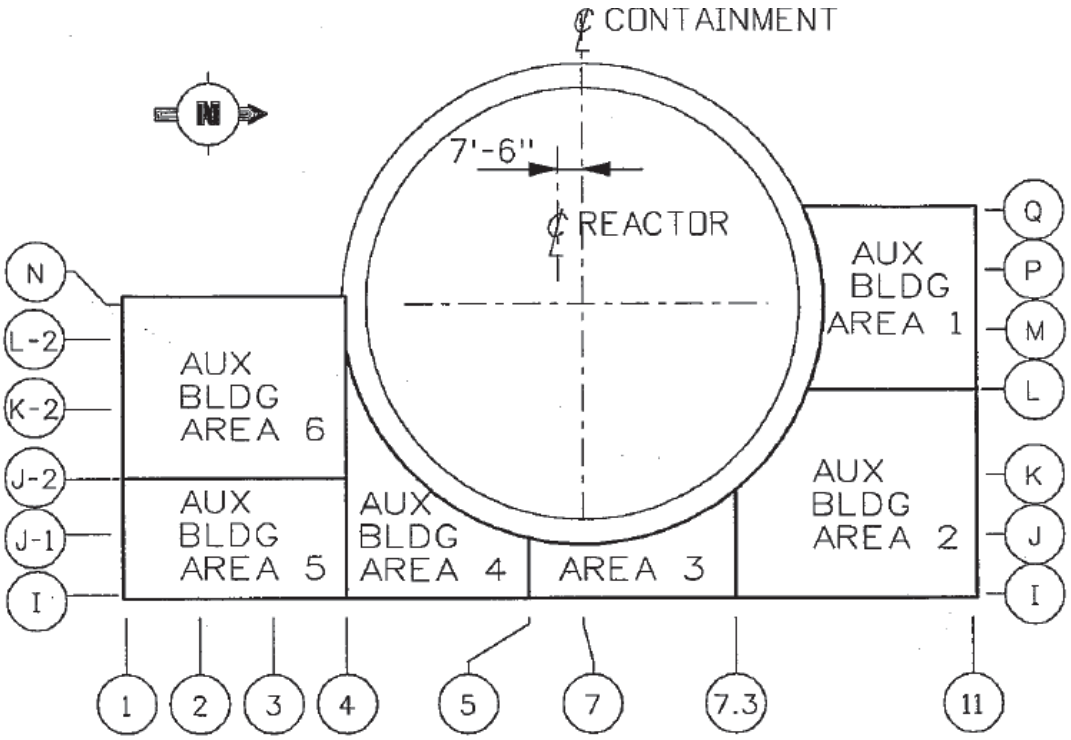

Figure 7 – Nuclear Island Key Plan

The walls with the impact at the center of the wall are either considered to be one-way spanning or two-way spanning. [Impact scenarios 1W, 3W and 5W were considered as one-way spanning with the supports being the diaphragms. Impact scenarios 2W and 4W were considered two-way spanning with the supports being the walls and diaphragms. The critical diaphragm is the slab at elevation 153' for the one-way spanning wall impact scenarios, because it received a high shear reaction and the slab depth is only 18.5 ft. This diaphragm support corresponds to impact 3W. To conservatively envelope impact scenarios 1W, 3W and 5W, the diaphragm capacity for 3W was checked against the highest shear from scenario 5W].[a,c]

[The margin of interest is the margin provided against the shear limit because of large margins in compression capacities (See Table 7). The exception to this is Area 5 at the edge of the opening (see Figure 8). The compression in this region is obtained assuming the impact is centered at this edge and that the compression over the edge of the opening is transferred back to this edge as a reaction. The compression intensity at this edge is 152.4 k/ft. This is still less than the 156.41 k/ft capacity but greater than the $0.7P_b$ limit initially set. The true margin, however, is obtained by considering the moment capacities concurrent with compression. The diaphragms are designed for a moment capacity of 49 k-ft/ft assuming that P_u is equal to zero kips. However, the value of P_u is now equal to 152.4 k/ft compression, and the concurrent moment capacity is 79 k-ft/ft. This means the moment capacity margin is (1- [49 /79 k]), or 38%. The smallest margin (shear) provided in the current design to the load expected from the one way spanning impact analysis is 77.5%. This means the impact only uses 22.5% of current design capacity].[a,c]

For the two-way spanning walls the critical diaphragms checked were those at [elevation 117' 6" in areas 1 & 2 for the center impact. At elevation 135' 3" areas in 5 & 6, the edge impact condition was checked because openings were considered in the check of that diaphragm. The margin provided in the current modified design to the load expected from the impact is 30.8% if the impact was directly across the opening].[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. [From Table 7 the maximum shear is 385.7 kips and compared to the capacity of 474.1 kips yields a margin provided in the diaphragm with the opening of 18.6%].[a,c]

The critical walls checked were the walls along [Wall 11][a,c] for the center impact scenario, and [Wall L-3][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

Critical Diaphragm or Wall Checked	Compression Check			Shear Check		
	Load	Capacity	Margin	Load	Capacity	Margin
Diaphragm at Elev. 153', Areas 5 & 6 no openings (5)	18.2 k/ft	109 k/ft	83.3%	245.5K	1089.2K	77.5%
Diaphragm at Elev. 117' 6", Areas 1 & 2 (6)	16.8 k/ft		84.6%	322K		70.4%
Wall 11 (7)	NA (4)	NA (4)	NA (4)	440.3K	12173.8K	96.4%
Diaphragm at Elev. 135' 3" Areas 5 & 6 Openings considered	152.4k/ft	156.4k/ft (11)	38% (3)	324.2K (8)	474.1K (2)	31.6%
				451K (9)	1553.4K	70.9%
				385.7K (1),(10)	474.1K (2)	18.6%
Wall L-3	31.2k/ft	83.22 k/ft	62.5%	31.2.1k/ft	65.38 k/ft	52.3%

1. This load is for a direct automobile missile impact at the diaphragm in Area 5 right centered at the opening.
2. Capacity is based on detailing modifications to correct constructability issues incorporated as part of design finalization into the Standard Design for ***AP1000*** at 5W edge at Elevation 135' 3". This does not impact the licensing basis.
3. This is the moment margin as discussed in the text to Item 6 response.
4. NA means not available. These conditions were not explicitly analyzed because they are deemed enveloped by the compression check for the diaphragm at elevation 153 ft.
5. One way spanning walls with center impact (1W, 3W & 5W).
6. Two way spanning walls with center impact (2W &4W).
7. Two way spanning walls with center impact (4W).
8. Two way spanning walls with edge or corner impact (5W), Area 5.
9. Area 6.
10. Area 5 with Direct Impact at Diaphragm.
11. This is the compression at balance point not $0.7P_{b.}$

a,c

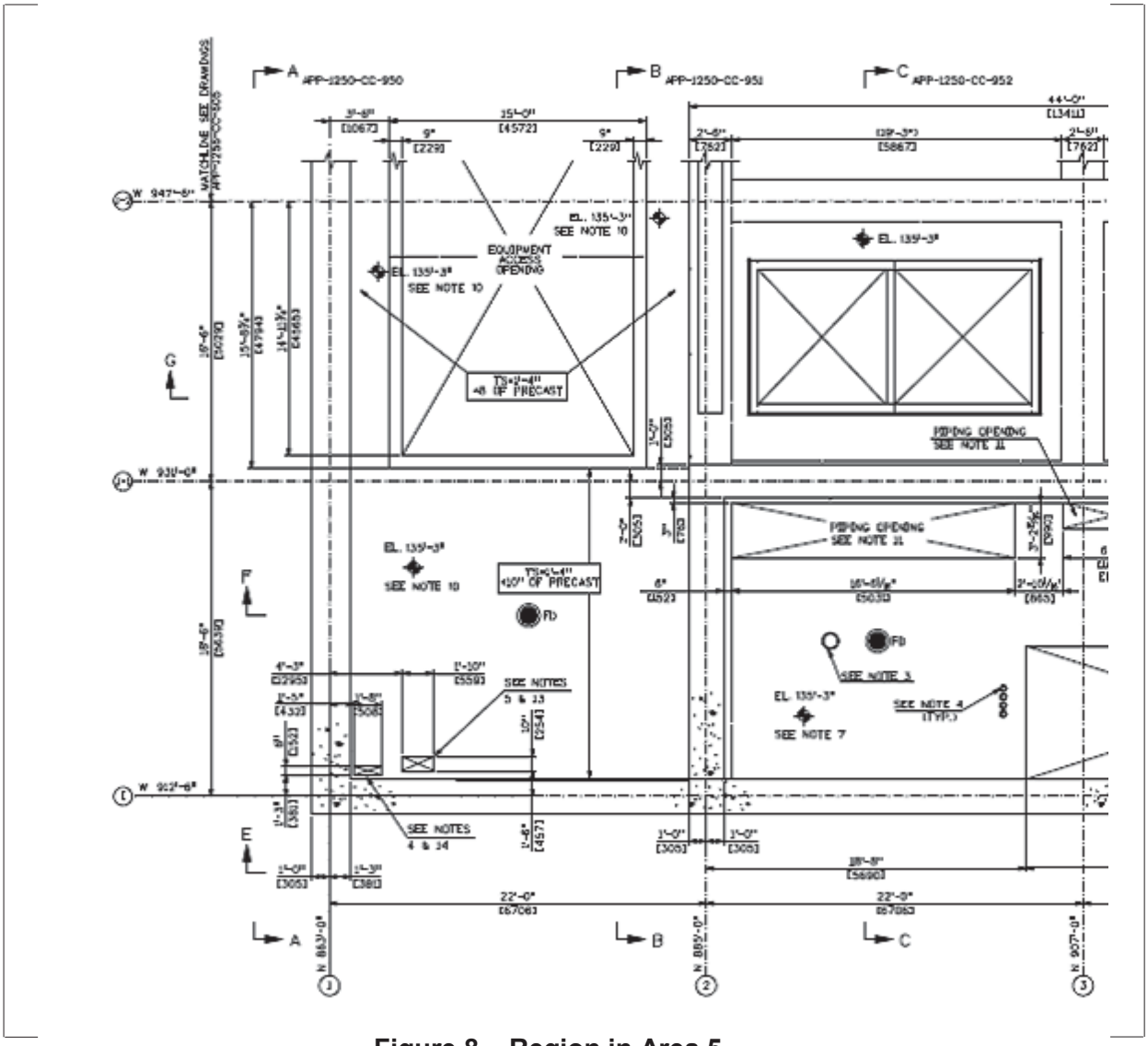

Figure 8 – Region in Area 5

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. [Westinghouse Report Calculation TPG-1000-CCC-001, Rev. 1, "Turkey Point Units 6 & 7 Nuclear Island – Hurricane Missile Impact."][a,c]
2. [Westinghouse Summary Report TPG-1000-S3R-001, Rev. 1, "Turkey Point Units 6 & 7 Nuclear Island – Hurricane Missile Impact."][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:

Refer to Enclosure 4.

ASSOCIATED ENCLOSURES:

None

Enclosure 4

ASSOCIATED COLA REVISIONS

(3 Total Pages)

FSAR Subsection 3.5.2, fourth bullet will be replaced with the text given below in a future COLA revision.

- **For the 4000-pound automobile missile, the Turkey Point site-specific, hurricane-generated missile horizontal velocity is 180 mph. Therefore, for the hurricane-generated automobile horizontal missile, an evaluation was performed to determine whether the nuclear island exterior walls are adequate to withstand the effect of the automobile impact. Reference 201 provides the evaluation of the tornado-generated automobile missile and Reference 202 provides the evaluation of the hurricane-generated automobile impact on the nuclear island. The horizontal hurricane-generated automobile missile velocity at Turkey Point is greater than the horizontal tornado-generated automobile missiles used in Reference 201 (180 mph vs. 105 mph). Reference 201 considered the auxiliary building walls 30' and higher above the grade elevation. For the Turkey Point site, evaluations above the grade 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 Reference 201. The Turkey Point punching shear calculation is based on ACI 349-01, Section 11.12.1.2 requirements. The evaluation determined that the maximum shear stress on the walls is 51.42 k/ft (Reference 202) which is below the allowable stress of 54.69 k/ft (Reference 202) and the maximum ductility factor of 1.10 is well below the allowable limit of 10. Thus it was concluded that the nuclear island is adequately protected against the hurricane generated automobile missile impact.**

  In summary, the following is concluded for the hurricane missile evaluations for the site:

  - **All of the external missile velocities for the hurricane are enveloped by the tornado missiles except for those generated by horizontal hurricane wind. The comparison of the RG 1.221, Revision 0 hurricane missile velocities to those for the tornado missiles given in AP1000 DCD Tier 1, Table 5.0-1 show that the automobile hurricane missile, the Schedule 40 pipe (6.625 inch diameter) hurricane missile, and the one inch solid sphere hurricane missile have a greater velocity than that shown in DCD Table 5.0-1.**

  - **The postulated hurricane missiles for horizontal impact above grade on the nuclear island were evaluated for the increased hurricane wind speed in those cases where the hurricane wind speed exceeds the tornado wind speed. It was determined that the AP1000 nuclear island structural integrity is maintained for the higher hurricane external missiles.**

- **Automobile impact was found to be the bounding scenario and was evaluated in dynamic analyses of impact on representative external walls of the auxiliary building. The representative exterior walls were selected to evaluate impacts at mid span, edges and corners. Both flexure and shear were evaluated and shown to be within the ACI 349-01 acceptance criteria. Reactions on the supporting interior walls and floors were also evaluated. The results of the analyses of the walls, and for impact directly over these supporting elements, were found to be acceptable.**

FSAR Subsection 3.5.5, References, will be added to the FSAR in a future COLA revision.

3.5.5 References:

1. **201. APP-GW-GLR-133, "Summary of Automobile Tornado Missile 30' above Grade," Revision 1**

2. **202. TPG-GW-GLR-001, "Supplement to RAI-6544" (Non-Proprietary), Revision 0**

Revise FSAR Subsection 3.5.2, second bullet, second sentence to:

…missile velocity, the concrete perforation ~~**or**~~ **and** scabbing is calculated…

Revise FSAR Subsection 3.5.2, third bullet, second sentence to:

…concrete perforation ~~**or**~~ **and** scabbing is calculated…