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SHIELDS L. DALTROFF
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March 21, 1984

Docket Nos. 50-277
50-278

Mr. John F. Stolz, Chief
Operating Reactors Branch No. 4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: I.E. Bulletin No. 80-11
Masonry Wall Design

REFERENCE: Letter to E. G. Bauer, Jr., PECo., from J. F. Stolz, dated February 7, 1984 (Masonry Wall Design, I.E. Bulletin 80-11)

Dear Mr. Stolz:

Your above referenced letter of February 7, 1984, requested additional information concerning our previous submittals on I.E. Bulletin No. 80-11, "Masonry Wall Design", for Peach Bottom Atomic Power Station. The enclosed attachment "Response to Additional NRC Questions Regarding I.E. Bulletin No. 80-11, Masonry Wall Design for Peach Bottom Atomic Power Station", provides a response to each item in your letter.

Should you have any questions or require additional information, please do not hesitate to contact us.

Very truly yours,

Attachment

cc: A. R. Blough, Site Inspector
Dr. T. E. Murley, Office of Inspection and Enforcement (NRC)
NRC Document Control Desk

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ATTACHMENT

RESPONSE TO ADDITIONAL NRC QUESTIONS

regarding

I.E. BULLETIN NO. 80-11

MASONRY WALL DESIGN

for

PEACH BOTTOM ATOMIC POWER STATION

UNITS 2 AND 3

DOCKET NUMBERS 50-277 AND 50-278

Submitted to

THE UNITED STATES NUCLEAR REGULATORY COMMISSION

March 1984

RESPONSE TO ADDITIONAL NRC QUESTIONS REGARDING I.E. BULLETIN NO. 80-11 MASONRY WALL DESIGN FOR PEACH BOTTOM ATOMIC POWER STATION UNITS 2 AND 3

Question No. 1:

With regard to Response No. 2 of Reference 1, it is noted that the SGEB criteria (developed by the Structural and Geotechnical Engineering Branch of the NRC), specify that no increase factor is allowed for load combinations including Operating Basis Earthquake (OBE) loads. In view of this, the Licensee is requested to provide the following information:

a. If no increase factor is used, indicate whether the walls can still be qualified for load combinations including OBE loads. It is recommended that some worst cases could be reviewed to obtain this information.

b. If the walls cannot be qualified, the Licensee is advised to explain all conservative measures used in the analysis to justify the proposed increase factor and also to identify all affected walls and the actual increase factor used in each wall.

Response:

As stated in Tables 1 and 2 of Appendix I, Part 1, Criteria for the Re-evaluation of Concrete Masonry Walls, of the "Report on the Re-evaluation of Concrete Masonry Walls in Response to NRC I.E. Bulletin 80-11 for Peach Bottom Atomic Power Station Units 2 and 3", as transmitted by our May 4, 1981 letter (B. H. Grier, NRC, from S. L. Daltroff, PECo.), an increase of 30 percent in allowable stresses is allowed when OBE loads are combined with operating temperature loads. Our analyses for the worst cases indicate, however, that the walls can be qualified for this load combination without relying on the increase factor of 1.3.

Question No. 2.:

Indicate whether any wall is subjected to tornado load and other impulsive loads (i.e., jet impingement). If so, provide a typical calculation for each case (with necessary explanation to make the calculation understandable).

Response:

Some masonry walls at Peach Bottom are subjected to tornado and/or other impulsive loads (i.e., jet impingement). A sample (typical) calculation is attached showing the procedure adopted for the re-evaluation of these walls for tornado and jet impingement loads.

Sample Calculation

STATEMENT:

Determine the structural adequacy of a masonry wall subjected to tornado, high energy line break pressurization, and jet impingement loads. The wall is simply supported at the bottom and the sides and is free at the top. In Figure 1, 'Mathematical Model', the cutout portion at the lower left corner is actually a lintel beam passing through and connecting with the wall.

ANALYTICAL TECHNIQUE:

A plate finite element static analysis was performed using the STRUDL computer code. To recognize the impulsive nature of the jet impingement loads, a 1.25 dynamic load factor was used. Since the peak pressure in a compartment due to high energy line break does not occur at the instant when the impulse of jet impingement takes place, the 1.25 dynamic load factor was not used for the load combination including the pressurization loads.

For the sample calculation, a multiple wythe wall was selected. However, the analytical technique is also applicable to single wythe walls since no composite action is considered for the multiple wythe walls.

GIVEN:

Wall Designation: #406.9 (Reference - Table-3, Sheet 3 of 3, List of Safety Related Walls Analyzed with Wall Configurations of "Report on the Re-evaluation of Concrete Masonry Walls in Response to NRC I.E. Bulletin 80-11", submitted to the NRC by letter (B. H. Grier, NRC, from S. L. Daltroff, PECo., May 4, 1981).

Wall height: 6'-0"
Wall length: 6'-7"
Wall thickness: 36" (nominal)
Wall construction: 2 outer 8" wythes are reinforced. The interior consists of one 8" and three 4" unreinforced wythes. All grouted.
Reinforcing steel: (Grade 40)

Vertical: #7 @ 24" (for each outer wythe)
Horizontal: 2 #5 @ 40" (for each outer wythe in bond beams)

Ultimate compressive strength of masonry,	f_m'	=	1175	psi
Ultimate compressive strength of grout,	f_c'	=	3800	psi
Modulus of elasticity of steel,	E_s	=	29×10^6	psi
Modulus of elasticity of masonry,	E_m	=	1.175×10^6	psi
Modulus of elasticity of grout,	E_c	=	3.55×10^6	psi
Poisson ratio,	V_c	=	0.17	

ANALYSIS:

Loadings:

W' = Tornado loads due to compartment depressurization = 0.09 psi applied uniformly on the entire wall

P = Jet impingement loads = 2,454 lbs. acting on an area of 741.3 in.^{2}. It is uniformly applied with a factor of 1.25 on elements 23, 24 and 25 of the finite element model in Figure 1

P' = Pressurization load due to high energy line break = 5.06 psi applied uniformly on the entire wall

D = Dead load (conservatively neglected for out-of-plane analysis since the wall is non-bearing)

Other loads such as earthquake and temperature loads are not included in this sample calculation since they do not combine with the above loads in accordance with the criteria adopted for the subject report.

Load Combinations:

1. 1.05D + 1.0 W'
2. 1.05D + 1.25P
3. 1.05D + 1.0P' + 1.0P

Mathematical Model

The mathematical model for the finite element computer analysis is shown in Figure 1.

Moment Capacities of the Wall

The following equations were used to determine the flexural capacities of the wall in the horizontal and vertical directions:

$M_{cap} = 1/2\ f_m \times b \times c\ (d - \frac{c}{3})$ based on compression in masonry

$M_{cap} = A_s \times f_s\ (d - \frac{c}{3})$ based on tension in steel

where:

$f_m = (0.33f'_m) \times 2.5$ increase factor allowed for the load combinations considered

$= 970$ psi

$b = 12$ in.

d = effective depth for the 8 in. wythe

$= \frac{7.625}{2} = 3.81$ in.

A_s = area of steel/ft
= 0.3 in.^{2}

c = depth to neutral axis of the 8" wythe

= 1.586 in. for vertical moment capacity
= 1.36 in. for horizontal moment capacity

$f_s = 0.9 \times f_y = 36$ ksi

Using these equations the capacities for each 8 in. wythe are obtained as:

Vertical moment capacity of each wythe = 2.53 k-ft/ft
Horizontal moment capacity of each wythe = 1.87 k-ft/ft

Total Vertical moment capacity of the wall = 2 x 2.53
= 5.06 k-ft/ft
Total Horizontal moment capacity of the wall = 2 x 1.87
= 3.74 k-ft/ft

Resulting Moments from STRUDL Run:

Load Combination 1:

Vertical moment = 0.026 k-ft/ft (Element 11)
Horizontal moment = 0.031 k-ft/ft (Element 24)

Load Combination 2:

Vertical moment = 0.479 k-ft/ft (Element 11)
Horizontal moment = 0.684 k-ft/ft (Element 24)

Load Combination 3:

Vertical moment = 1.83 k-ft/ft (Element 11)
Horizontal moment = 2.28 k-ft/ft (Element 24)

The above resulting element moments are the average values of the moments at four nodes of the element. By comparing these resulting moments with the capacities, it is seen that they are all below the capacities of the block wall.

Support Reactions form STRUDL Run:

The maximum reaction (R) for the entire wall is obtained from load combination 3, (1.05D+1.0P'+1.0P), for the right side of the wall (i.e., 6 ft. side) as:

R = 8.9 kips

3/4" diameter Phillips concrete fasteners are provided for this side to match wall reinforcing for connections.

Shear capacity of each fastener = 3.79k

No. of fasteners = $(1 + \frac{6 \times 12}{40}) \times 2 = 5.6$; assume 5 for conservatism; therefore,

Total capacity = 5 x 3.79 = 18.95 kips, which is greater than the maximum reaction for the entire wall (8.9 kips).

The other sides are connected with lintel beams or other block walls by dowels which have larger capacity.

Conclusion

Since the resulting moments and reactions are within the allowable capacities of the wall, it is concluded that the wall will be structurally adequate under the loading conditions considered.

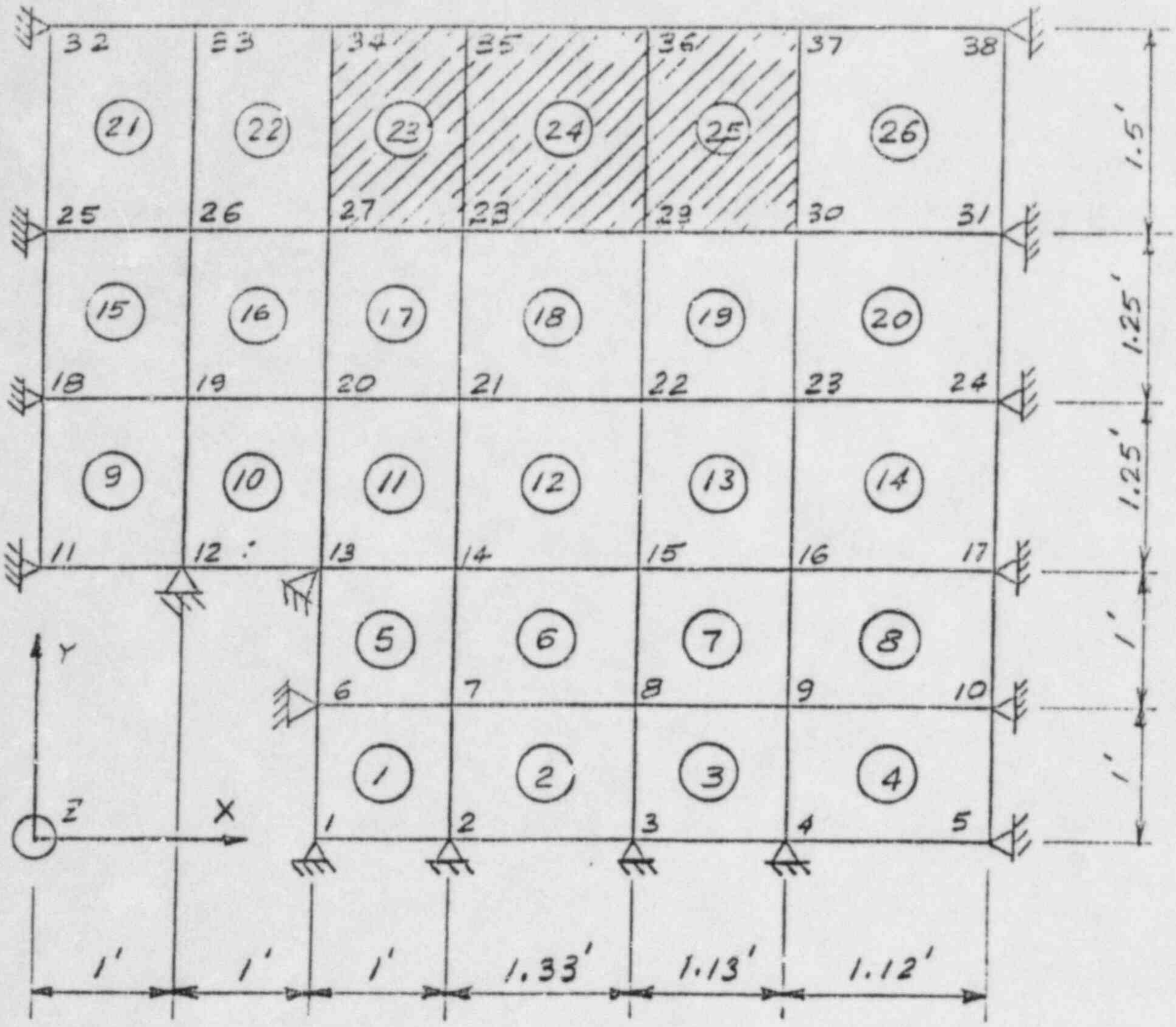
Question No. 3:

With reference to the reinforcement in masonry walls, the ACI-531-79 Code (Reference 2) specifies that the minimum area of reinforcement in a wall in each direction, vertical or horizontal, shall be 0.0007 (0.07%) times the gross cross-sectional area of the wall and that the minimum total area of steel, combined vertical and horizontal, shall not be less than 0.002 (0.2%) times the gross cross-sectional area. In view of this, clarify whether the reinforced walls at this plant meet the above requirements. It should be noted that the horizontal reinforcement is installed to satisfy the minimum reinforcement requirement for a reinforced wall.

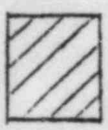
If the joint reinforcement is used to resist tension, it should follow the working stress design method which limits its allowable to 30 ksi. The Licensee is requested to clarify if this requirement has been satisfied. If this requirement is not satisfied, identify all affected walls along with the calculated stress value for each wall.

Response:

The minimum reinforcement for all of the block walls at Peach Bottom Atomic Power Station exceed the requirements as outlined in the question. The joint reinforcement for the block walls is not used to resist tension.



WALL #406.9



Elements loaded with jet impingement.
Load intensity = $1.25 \times \frac{2454}{741.3} = 4.14$ psi

Mathematical Model

Figure 1