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April 23, 1984

ARTHUR E. LUNDVALL, JR.
VICE PRESIDENT
SUPPLY

Director of Nuclear Reactor Regulation
Attention: Mr. J. R. Miller, Chief
Operating Reactors Branch #3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Calvert Cliffs Nuclear Power Plant
Units Nos. 1 & 2; Dockets Nos. 50-317 and 50-318
I&E Bulletin 80-11, Masonry Wall Design

Gentlemen:

Your letter dated March 11, 1984 requested additional information concerning our re-evaluation of the seismic qualification of masonry walls at Calvert Cliffs.

A detailed response to your questions is enclosed. If you should have any questions concerning this information, please do not hesitate to contact us.

Sincerely,

AEL/BSM/vf

Enclosure: Response to NRC (SGB) 2/24/84 Request for Additional Information
Re: Masonry Wall Design

cc: J. A. Biddison, Jr., Esq.
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Mr. D. H. Jaffe, NRC
Mr. T. Foley, NRC
Mr. J. C. Ventura, Bechtel

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A028
1/1

bcc: Messrs. A. E. Lundvall, Jr.
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RESPONSE TO NRC (SGEB)
February 24, 1984
REQUEST FOR ADDITIONAL INFORMATION
Masonry Wall Design, IE Bulletin 80-11
Calvert Cliffs Nuclear Power Plant Units 1 & 2
Docket No. 50-317/318

Question 1: With reference to Response 3 of Reference 1, the Licensee identified eight walls as being unqualified by the SGEB increase factors (2). These walls were qualified based on the inelastic method; however, Table 3.3 of the same response indicated that these walls were qualified by the Licensee's elastic design criteria. Please clarify this contradiction. Also, with respect to the increase factor higher than the SGEB allowable. (1.67 as opposed to 1.3 per the SGEB for tension normal to the bed joint), please identify all affected walls along with the percentage of exceedance for each wall. Also, explain all conservative measures (if any) used in the analysis to justify a higher increase factor.

Response: The above question states that there is a contradiction in our Response 3 of Reference 1. The following explanation is provided to further clarify the qualification methods for the walls listed in Table 3.3 of the above reference:

- o As stated in the Table 3.3 title, these were "walls qualified by the Calvert Cliffs Elastic Criteria which would not qualify elastically by the SEB criteria". This means that the maximum allowable tensile stress perpendicular to the bed joint was less than $1.67 \times \text{ALLOWABLE}$ rather than $1.3 \times \text{ALLOWABLE}$.
- o Further discussion provided in Response 3 stated that even though the walls were qualified by the Calvert Cliffs Elastic Criteria, they also satisfied the requirements of our inelastic criteria. However, for purposes of our response to the Bulletin, the walls were qualified by the elastic criteria.

The following table identifies all walls with increase factors higher than the SGEB allowable tension and the associated percentage of exceedance. It should be noted that these percentages reflect stress comparisons for the most severe loading combination. Also included in the table is the actual increase factor required to qualify the wall. As stated in Response 3 of Reference 1, all walls satisfied the Calvert Cliffs Elastic Criteria with the tension perpendicular to the bed joint less than 1.67 times the ALLOWABLE for the most severe loading combination. Also please note as shown in the following table that wall A23 was originally qualified to the SGEB allowables.

<u>Elevation</u>	<u>Wall</u>	<u>% of Exceedance of SGEB Allowable</u>	<u>Required Stress Increase Factor</u>
-10'-0"	J	17.7%	1.53
5'-0"	O	13.8	1.48
45'-0"	A21	20.0	1.56
45'-0"	A23	0.0	1.05
45'-0"	A30	26.2	1.64
69'-0"	C*	----	----
69'-0"	A1	11.5	1.45
69'-0"	A17	13.1	1.47

*See Response to Question 2

Also requested in the above question was an explanation of all conservative measures used in the analysis which justifies the use of a higher increase factor. The following is a brief summary of some conservative assumptions utilized in the re-evaluation effort. It should be noted that these conservatisms are in addition to those outlined in Attachment E of Reference 3 and Response 3 of Reference 1.

1. For walls which consisted of multi-wythe construction, the collar joint strength was assumed zero. Of the walls listed above; J, O, A21, A23, A30 and A1 are of multi-wythe construction. In each case, the most critical wall geometry and loading condition observed on the individual wythes was used in wall qualification.
2. Conservative assumptions for wall attachment weights were used.
3. Conservative assumptions on wall boundary conditions were considered (i.e., completely pinned connections vs. partially fixed).
4. When wall natural frequencies occurred less than the peak of the response spectra, the peak acceleration was used in the seismic analysis.

Question 2: With regard to the nonlinear analysis technique (energy balance technique and arching action theory), please note the following and provide the information requested:

- a. Arching Action: The NRC position on this issue states that the use of arching action theory to qualify unreinforced masonry walls is not acceptable; these walls should be repaired so that they can be qualified based on the SGEB criteria (2). (The NRC position is attached.) In view of this, indicate your intended actions and schedule to bring the affected walls in compliance with the staff position.

- b. Energy Balance Techniques: The NRC is currently preparing a position statement regarding this technique, which will be forwarded to the Licensee in the near future.
- c. In a meeting of the NRC on January 20, 1983, the Licensee identified 24 walls qualified by the arching action theory and 22 walls qualified by the energy balance technique. However, according to Attachment F of Reference 3, there were 43 walls qualified by the arching action theory and 20 walls qualified by the energy balance technique. Please identify all walls qualified by each technique.

Response:

Subsequent to our March 30, 1981 submittal (Reference 3), continued evaluation and review of the Calvert Cliffs CMU wall program was conducted. Due to this continued effort, several changes and clarifications have been identified to the above submittal which will be discussed in this response.

It should be noted that the "SGEB Criteria for Safety-Related Masonry Wall Evaluation" (July 1981) was received after our final re-evaluation submittal (March 30, 1981). Attachments D and E of Reference 3 clearly define the criteria used in wall qualification at Calvert Cliffs. Allowable stresses with the associated increase factors as provided in Section 5.2.1 were the basis of the reevaluation effort. As a general practice and as an added safety measure, when, through elastic analysis allowable tension was observed perpendicular to the bed joint, an inelastic review of the wall was automatically performed. The result of this inelastic review was presented along with the elastic results in Attachment F and Attachment G of Reference 3. It should be noted that in both of those attachments, when the tensile stress in the masonry was observed to be greater than zero but less than the allowable (with the appropriate increase factor), the wall was assumed qualified elastically. In addition, for many inelastic cases presented in the table, an arching and an energy balance evaluation was performed and the results for the individual walls included.

Therefore, it can be seen that a summation of the entries in each of the qualification headings presented in Attachment F of Reference 3 will not be an accurate determination of number of walls qualified by elastic or inelastic methods. Attachment F is provided only to tabulate analytical results while Attachment G provides the summary of result of the total re-evaluation program.

In order to further clarify the Calvert Cliffs response to I.E. Bulletin 80-11, Attachment G has been revised and attached to this response for your reference. When walls were qualified elastically and masonry tension greater than zero was observed in the analysis, the Attachment Remarks Column has been revised to reflect the magnitude of this stress. Also, the method of inelastic wall qualification is defined in the appropriate column.

It should be noted that as stated previously in this response several changes to the CMU wall program have been made since the March 30, 1981 submittal. These changes are described below and reflected in the attached revision to Attachment G.

1. Wall A20 at Elevation 45'-0": This blockout was originally qualified by inelastic analysis (arching) and has since been physically removed.
2. Wall C at Elevation 69'-0": This single wythe partition wall was previously qualified by inelastic analysis. A detailed finite element analysis of the wall was performed and it was requalified to the Calvert Cliffs elastic criteria.

It is therefore concluded from the revised Attachment G, that twenty two walls were qualified by the energy balance inelastic criteria, one wall was qualified by the arching theory, and the remaining walls satisfy all Calvert Cliffs elastic criteria. It is our intention to make modifications to the wall qualified by arching (ZZ at Elevation 69'-0") by October 1, 1984. These modifications will be provided to ensure wall ZZ will satisfy the SGEB elastic requirements.

References:

1. A. E. Lundvall (Baltimore Gas and Electric); letter to R. A. Clark (NRC) - Subject: IE Bulletin 80-11 - December 13, 1982
2. SGEB Criteria for Safety-Related Masonry Wall Evaluation; Developed by the Structural and Geotechnical Engineering Branch (SGEB) of the NRC - July 1981
3. A. E. Lundvall (Baltimore Gas and Electric); letter to B. H. Grier (NRC) - Subject: IE Bulletin 80-11 - March 30, 1981

REVISION TO ATTACHMENT G
OF REFERENCE 3

LISTING OF ALL MASONRY WALLS

G.1

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY-RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING, EL. (-) 10'-0" (FIG. C-5)</u>						
A		X		-	-	Shield walls with no attached or proximal safety-related equipment
B		X		-	-	
C		X		-	-	
D		X		-	-	
E		X		-	-	
F	X			X		Tensile Stress < 1.67 allowable
G	X			X		
H	X			X		
I	X			X		
J	X			X		
K	X			X		Loose-block shield wall observed to have proximal safety-related systems. Removed 06/17/80
L	-	-	-	-	-	
M		X		-	-	
N		X		-	-	Shield walls with no attached or proximal safety-related equipment
P		X		-	-	
<u>AUXILIARY BUILDING, EL. 5'-0" (FIG. C-4)</u>						
A	X			X		
B	X			X		
C	X			X		

LISTING OF ALL MASONRY WALLS

G.2

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 5'-0" (FIG. C-4)</u>						
D	X			X		
E	X			X		
F	X			X		
G	X			X		
H	X			X		
I	X			X		
J	X			X		
K	X			X		
L		X				
M	X			X		
N	-	-	-	-	-	Loose-block shield wall observed to have proximal safety-related systems. Removed 06/17/80
O	X			X		Tensile Stress <1.67 allowable
<u>AUXILIARY BUILDING, EL. 27'-0" (FIG. C-3)</u>						
A	X				Energy Balance	
B	X			X		
C	X			X		
D	X			X		
E	X			X		
F	X			X		

LISTING OF ALL MASONRY WALLS

G.3

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 27'-0" (FIG. C-3)</u>						
G	X			X		
H		X		-	-	
J		X		-	-	
K	X			X		
L	X			X		
M	X			X		
N	X			X		
O	X			X		
P	X			X		
Q	X			X		
R	X				Energy Balance	
S	X			X		
T	X			X		
U		X		-	-	
V		X		-	-	
W		X		-	-	
X		X		-	-	
Y	X			X		
Z	X			X		
AA	X			X		

LISTING OF ALL MASONRY WALLS

G.4

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 27'-0" (FIG. C-3)</u>						
BB	X			X		
CC		X		-	-	
DD		X		-	-	
EE		X		-	-	
FF		X		-	-	
GG	X			X		
HH	X			X		
JJ	X			X		
KK			X	X		
LL			X	X		
MM			X	X		
NN			X	X		
OO	X			X		
PP	X			X		
QQ	X			X		
RR	X			X		
SS		X		-	-	Shield wall with no attached or proximal safety-related equipment
TT			X	X		
UU			X	X		
VV			X	X		

LISTING OF ALL MASONRY WALLS

G.5

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY-RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 27'-0" (FIG. C-3)</u>						
WW			X	X		
XX			X	X		
YY		X		-	-	Shield walls with no attached or proximal safety-related equipment
ZZ		X		-	-	
A1	X			X		
A2		X		-	-	Not safety-related per new inspection info.
A3	X			X		Tensile Stress < 1.3 allowable
A4	X			X		
A5	X			X		
A6	X			X		
A7		X		-	-	
A8		X		-	-	
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
A		X		-	-	
B		X		-	-	
C	X			X		
D	X			X		
E	X			X		
F	X				Energy Balance	

LISTING OF ALL MASONRY WALLS

G.6

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
G	X			X		
H	X			X		
J		X		-	-	
K	-	-	-	-	-	Partition wall in office area; no longer exists
L		X		-	-	
M			X	X		
N			X	X		
O	X			X		
P	X			X		
Q	X			X		
R		X		-	-	
S	X			X		Tensile stress < 1.3 allowable
T	X				Energy Balance	
U	X			X		
V			X		Energy Balance	
W	X				Energy Balance	
X	X			X		
Y	X			X		
Z	X			X		

LISTING OF ALL MASONRY WALLS

G.7

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
AA	X			X		
BB	X			X		
CC	X				Energy Balance	
DD			X		Energy Balance	
EE	X				Energy Balance	
FF	X				Energy Balance	
GG	XX			X		
HH	X			X		Tensile stress < 1.3 allowable
JJ	X			X		
KK	X			X		
LL	-	-	-	-	-	Masonry walls have been replaced by removable steel missile barriers
MM	-	-	-	-	-	
NN		X				"Lok-in block" wall
OO		X				"Lok-in block" wall
PP	-		-	-	-	Masonry wall has been re- placed by removable steel missile barrier
QQ	X				Energy Balance	

LISTING OF ALL MASONRY WALLS

G.8

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
RR	X				Energy Balance	
SS	X				Energy Balance	
TT	X				Energy Balance	
UU	X				Energy Balance	
VV	X				Energy Balance	
WW	X			X		
XX		X		-	-	
YY	X			X		
ZZ		X		-	-	
A1	X			X		
A2	X			X		
A3	X			X		
A4		X		-	-	Not safety-related per BG&E review of S.R. status of HVAC ductwork
A5	X			X		
A6		X		-	-	
A7	-	-	-	-	-	Included in Wall P, same elevation
A8	X			X		

LISTING OF ALL MASONRY WALLS

G.9

CAULVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
A9	X			X		
A10		X		-	-	Note safety-related per BG&E review of S.R. status of HVAC ductwork
A11	X			X		
A12		X		-	-	Determined to be not safety-related per revised mechanical data
A13	X			X		
A14	X			X		
A15	X			X		
A16	X			X		
A17		X		-	-	Shield wall with no attached or proximal safety-related equipment
A18	X			X		Tensile stress <1.3 allowable
A19	X			X		Tensile stress <1.3 allowable
A20	X					Wall removed
A21	X			X		Tensile stress <1.67 allowable
A22	X			X		Tensile stress <1.3 allowable
A23	X			X		Tensile stress <1.67 allowable
A24	X				Energy Balance	
A25		X		-	-	
A26		X		-	-	

LISTING OF ALL MASONRY WALLS

G.10

CAULVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY-RELATED	NON-SAFETY-RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 45'-0" (FIG. C-2)</u>						
A27		X		-	-	
A28	X			X		Tensile stress <1.3 allowable
A29	X			X		
A30	X			X		Tensile stress <1.67 allowable
A31	X			X		Tensile stress <1.3 allowable
A32	X			X		Tensile stress <1.3 allowable
A33	X			X		
A34	X			X		Tensile stress <1.3 allowable
A35	-	-	-	-	-	Loose-block shield wall observed to have proximal safety-related systems. Removed 07/30/80. New wall.
A36	X			X		
<u>AUXILIARY BUILDING EL. 69'-0" (FIG. C-1)</u>						
A	X			X		
B	X				Energy Balance	
C	X			X		Requalified elastically by detailed F.E. Analysis
D	X				Energy Balance	
E	X			X		
F	X			X		
G	X			X		

LISTING OF ALL MASONRY WALLS

G.11

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY-RELATED	NON-SAFETY-RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 69'-0" (FIG. C-1)</u>						
H	X			X		
I	X			X		
J		X		-	-	
K		X		-	-	
L	X			X		
M	X			X		
N		X		-	-	
O		X		-	-	
P		X		-	-	Not safety-related per revised mechanical data
Q		X		-	-	
R	X			X		
S		X		-	-	
T	X			X		
U	X			X		
V	X			X		
W	X			X		
X	X				Energy Balance	
Y		X		-	-	
Z	X				Energy Balance	

LISTING OF ALL MASONRY WALLS

G.12

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 69'-0" (FIG. C-1)</u>						
AA			X	X		
BB			X	X		
CC		X		-	-	
DD		X		-	-	
EE		X		-	-	
FF			X	X		
GG			X	X		
HH		X		-	-	
II	X			X		
JJ		X		-	-	
KK		X		-	-	
LL		X		-	-	
MM		X		-	-	
NN		X		-	-	
OO	X			X		
PP	X			X		
QQ			X	X		
RR		X		-	-	
SS		X		-	-	
TT		X		-	-	
UU	X			X		

LISTING OF ALL MASONRY WALLS

G.13

CAULVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 69'-0" (FIG. C-1)</u>						
VV	X				Energy Balance	
WW		X		-	-	
XX		X		-	-	
YY			X	X		Partially inaccessible wall not identified in 60-day report
ZZ	X				Arching	
A1	X			X		Tensile stress <1.67 allowable
A2	X			X		Tensile stress <1.3 allowable
A3		X		-	-	
A4	X			X		
A5	X			X		
A6	X			X		
A7		X		-	-	
A8		X		-	-	
A9	X			X		Tensile stress <1.3 allowable
A10	X			X		
A11	X			X		Tensile stress <1.3 allowable
A12	X			X		Tensile stress <1.3 allowable
A13		X		-	-	
A14	X			X		

LISTING OF ALL MASONRY WALLS

G.14

CALVERT CLIFFS NUCLEAR POWER PLANT

Revised 03/23/84

WALL	SAFETY- RELATED	NON-SAFETY RELATED	INACCESSIBLE OR PARTIALLY INACCESSIBLE	QUALIFIED BY ELASTIC ANALYSIS	QUALIFIED BY INELASTIC ANALYSIS	REMARKS
<u>AUXILIARY BUILDING EL. 69'-0" (FIG. C-1)</u>						
A15		X		-	-	
A16		X		-	-	
A17	X			X		Tensile stress <1.67 allowable
A18	X			X		
A19	X			X		Tensile stress <1.3 allowable
A20				-	-	
<u>YARD AREA</u>						
A	-	-	-	-	-	Temporary loose-block shield walls which have been removed
B	-	-	-	-	-	