NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

General Offices • Selden Street, Berlin, Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06141-0270
(203) 665-5000

December 31, 1985

Docket Nos. 50-213
50-245
A05084

Director of Nuclear Reactor Regulation
Attn: Mr. Christopher I. Grimes
Integrated Safety Assessment Project Directorate
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Haddam Neck Plant
Millstone Nuclear Power Station, Unit No. 1
Masonry Wall Design, IE Bulletin 80-11
Request for Additional Information

In a July 22, 1985 letter(1) the Staff provided a request for additional information for both the Haddam Neck Plant and Millstone Unit No. 1. In addition a site visit/audit was requested to review calculations and discuss the responses to the enclosed requests for additional information. As summarized in the Staff meeting summary of November 14, 1985(2) the Staff and licensees met on October 28 - 30, 1985 to discuss and review plant modifications made in response to IE Bulletin 80-11.

We have enclosed the responses to the requests for additional information enclosed in the July 22, 1985 letter(1) and have also incorporated the Staff comments provided during the October 28 - 30, 1985 site meeting. As identified in the November 14, 1985 meeting summary(2) the licensee committed to clarify the effect of identified cracking on selected masonry walls by performing a plant walkdown of Millstone Unit No. 1 to identify any wall cracking. This walkdown was performed at Millstone Unit No. 1 and no cracking was identified as discussed in the enclosed Millstone Unit No. 1 response. Connecticut Yankee Atomic Power Company is still investigating this issue for the Haddam Neck Plant and will provide a response to the NRC by February 14, 1986.

(1)J. A. Zwolinski letter to J. F. Opeka, dated July 22, 1985.

(2)F. M. Akstulewicz meeting summary, dated November 14, 1985.

A001
1/40

Add: IE File — Ltr Encl 1 1
IE/DEPER/EGCB 1 1
IE/DEPER/EGCB/S 1 1
NRR PWR-A AOTS 1 1
NRR PWR-B AOTS 1 1

The attached responses provide our complete response to IE Bulletin 80-11. We trust you will find this information satisfactorily.

Very truly yours,

CONNECTICUT YANKEE ATOMIC POWER COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

J. F. Opeka
Senior Vice President

Docket No. 50-245

Millstone Nuclear Power Station, Unit No. 1

Response to Request for Additional Information
IE Bulletin 80-11, Masonry Wall Design

December, 1985

Introduction

In developing a response to IE Bulletin 80-11 at Millstone Unit 1, Northeast Nuclear Energy Company (NNECO) was faced with two factors. First was the lack of seismic floor response spectra at Unit 1, at that time being reviewed under the Systematic Evaluation Program. Second, the plant operations schedule necessitated addressing the bulletin prior to receiving final acceptance criteria from NRC.

As a result, NNECO took a conservative approach to the evaluation of the Unit 1 masonry walls, opting to implement modifications rather than use detailed analysis for qualification. Masonry walls and blockouts were checked against span tables which were developed using very conservative procedures. Some blockouts were qualified using a very conservative arching action approach, and reinforced walls were qualified using a conservative static approach. These procedures have been described in our previous submittals.

A large percentage of the masonry walls and blockouts were modified. The modifications consisted of structural strengthening of both walls and boundary connections. In addition to seismic loads, pressure loads from pipe break and tornado were considered. The implementation procedure resulted in safety-related masonry walls having substantial, but unquantified, margins of safety. In order to answer the present request for additional information, it has been necessary to perform a complete review of the Bulletin 80-11 calculations. Table I provides a summary of the pertinent data for each of the safety-related masonry walls at Millstone Unit 1.

Subsequent to assembling the data in Table I, an evaluation was performed to assess the margin of safety of each wall relative to the SGEB criteria. The evaluation used simplified, hand calculation techniques conforming to ACI 531-79 and the SGEB criteria.

The evaluation procedure was as follows:

- All walls and blockouts were considered to span either horizontally or vertically. Calculations were based on simple spans between supports. Cantilever and wing walls (one vertical edge free) were converted to equivalent simple spans.

- The wall fundamental frequency was computed based on the governing span. The seismic acceleration applied was the SEP floor response spectrum value at 7% damping, corresponding to the computed frequency.

- The bending and shear stress computed was the greater of either seismic plus pipe break pressure, or tornado pressure. Stresses were calculated on a static basis assuming simple span bending. Seismic stresses were increased 30%.

- Blockouts were assumed to transfer shear at unreinforced, mortared boundaries, provided stresses were low. The maximum computed shear stress at an unreinforced, mortared boundary was less than 3 psi.

- Multi-wythe walls were treated as composite sections, provided collar joint shear was low (the effect of this assumption is discussed further below). The maximum computed collar joint shear was less than 4 psi.

- Penetrations in blockouts were neglected, provided stresses were low. The maximum computed bending stress in a blockout was less than 20 psi.

The results of the evaluation are shown in Table II. The seismic accelerations are from the SEP floor response spectra for 7% damping. Calculations performed during the original Bulletin 80-11 evaluation showed that deadweight, in-plane stress, and drift effects were negligible. The allowable bending and shear stresses given in Table II are based on ACI 531-79 and the SGEB criteria. For reinforced walls, the allowable bending stress shown is the allowable moment for the reinforced section divided by the section modulus of the equivalent unreinforced section.

An additional analysis was performed to test the effect of the composite action assumption for multi-whythe walls. The largest block size used at Millstone Unit 1 was 12 inches thick. Table II-A presents results wherein all walls whose thickness exceeds 12 inches were assumed to be made up of 12-inch thick whythes. Where the thickness was not an integral multiple of 12 inches, a smaller whythe thickness was used. The frequency and stresses for a single whythe were computed assuming pressure loads were equally distributed among the whythes. The results in Table II-A show that the walls meet SGEB allowables even without the assumption of composite action.

It should be noted that the results given in the following tables are for comparison purposes only. The original Bulletin 80-11 calculations remain the calculations of record for Millstone Unit 1.

Questio⁻ 1

In Response 10 of Reference 1, Northeast Nuclear Energy Company (NNECO) indicated that the seismic evaluation of masonry walls used the floor accelerations of the original design multiplied by a factor of 5 (Response 6) and that this criterion would be compared with the SEP floor response spectra. Provide a summary of this comparison and the conclusions drawn from it and clarify whether the SEP spectra were actually used.

Response

In the original Bulletin 80-11 evaluation NNECO used the following for seismic loads:

- For unreinforced walls, an allowable span was used which (a) made the wall frequency be greater than 20 Hertz and (b) made the wall stress be less than the allowable using the floor acceleration of the original design multiplied by 1.3.

- For reinforced walls, there was no frequency restriction but walls had to be within the allowable moments using the floor acceleration of the original design multiplied by a factor of 5.

As described in the introduction, the present review used the SEP floor response spectra. As shown in Table II, all walls except T-18 meet the SGEB allowable stresses when SEP response spectra are applied in conjunction with other extreme environmental loads as defined in the Millstone Unit 1 FSAR. Wall T-18 meets the SGEB allowable for seismic. For tornado pressure, a detailed analysis showed that while stresses exceeded allowable at some locations, overall stability of the wall was assured by the addition of structural steel.

Question 2

Identify the 24 walls that have been qualified by arching action. The NRC position on this issue states that the use of the 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 (3). (The NRC position is enclosed as Attachment 3.)

Response

A total of 39 safety-related blockouts were qualified using arching action. As originally reported, 24 blockouts were qualified based on a generic arching action analysis. Four of these were later found to be non-saefty related. Nineteen other blockouts were qualified using special case arching analysis. Arching action was used in cases where blockouts appeared to have substantial capacity, and modification would be difficult because of accessibility or interference problems.

All of the blockouts qualified by arching action are constructed of solid blocks and are multi-whythe with tight boundaries. In the present review (without use of arching action), walls are assumed composite if collar joint shear is low, and unreinforced mortared boundaries are assumed to transfer shear if boundary shear stresses are low. The results for the 39 blockouts previously qualified by arching action are presented in Table III. As can be seen, a substantial margin of safety exists in comparison with SGEB allowables without the use of arching action. The maximum bending stress is less than 3 psi, and maximum collar joint shear is less than 4 psi. Both values are quite low. Table III-A presents results when whythes are assumed noncomposite (see discussion of Tables II and II-A in the introduction). Stresses are still within the SGEB allowables. Thus, these blockouts have adequate capacity to resist seismic and pressure loads without relying on arching action.

Question 3

Identify the number of walls that required modifications in order to be qualified under the NNECO reevaluation criteria, and specify how many of these can be qualified under the SGEB criteria (3) design method after modification.

Response

One hundred forty walls and blockouts were modified under the original 80-11 evaluation. The results of the latest review (described in the introduction) for the modified walls are presented in Table IV. Each of the modified walls meets the SGEB criteria.

Question 4

Exhibit C-2 in Attachment 2 of Reference 2 lists the allowable shear stress for reinforced walls in flexure as 1.1 $\sqrt{f'm}$; this agrees with ACI 531-79. However, the revised Exhibit C-2 in Attachment 6 of Reference 1 lists the allowable value for out-of-plane shear as 1.5 $\sqrt{f'm}$. Explain why this value was chosen for reinforced walls.

Response

The allowable shear stress for reinforced masonry in bending given in ACI 531-79 is based on beam bending of masonry spanning openings such as doors or windows. In this case bending is in the plane of the wall and reinforcement is provided horizontally to carry tensile stresses (as in concrete beams).

In the original 80-11 evaluation, it was felt that out of plane response of a wall was more analagous to a slab than a beam, and the allowable shear should be based on a peripheral shear model. The value of 1.5 $\sqrt{f'm}$ was derived using formulas for peripheral shear in plain concrete slabs. However, as described below in the response Question 5, the walls have adequate margin of safety with respect to shear to also meet the ACI 531-79 allowable of 1.1 $\sqrt{f'm}$.

Question 5

Exhibit C-2 in attachment 2 of Reference 1 indicated that an increase factor of 1.5 for allowable masonry shear stress was used for reinforced walls. If a basic allowable of 1.5 $\sqrt{f'm}$ was used (as suggested by Exhibit C-2 [1]) and an increase factor 1.5 was applied to it, that would be equivalent to applying an increase factor of about 2 to the basic allowable found in ACI 531-79, which is 1.1 $\sqrt{f'm}$. The SGEB criteria [3], however,allow an increase factor of only 1.3 for masonry shear. Indicate whether the maximum shear stress in the reinforced walls still meets the SGEB criteria, which is based on ACI 531-79. If any walls would not qualify, provide the percentages by which the SGEB allowable are exceeded.

Response

Table V presents the results of latest review for reinforced masonry walls. The allowable shear stress given is 1.1 $\sqrt{f'm}$, as given in ACI 531-79, increased by a factor of 1.3 in accordance with the SGEB criteria. A comparison of computed shear stress to allowable shear stress shows that the reinforced walls still meet the SGEB criteria.

Question 6

Indicate whether any walls at the Millstone Unit 1 were built without mortar. If so, the walls must be modified so that loose blocks do not impact safety-related equipment. Provide some sample sketches or drawings of this type of modification if applicable to this plant.

Response

None of the safety-related masonry walls at Millstone Unit 1 were built without mortar.

TABLE 1

SUMMARY OF DATA FOR SAFETY-RELATED WALLS

Column (1): Wall identifier

(2): Wall type:
- S = span wall
- C = cantilever wall
- W = wing wall
- BO = blockout
- V = vertical

(3): Whether wall was modified

(4): Whether wall was qualified by arching action

(5): Whether wall is reinforced

(6): Nominal wall thickness (inches)

(7): Weight of attachments (psf)

(8): Pipe break pressure load (psf)

(9): Tornado pressure load (psf)

(10): Governing wall span (feet)

TABLE I

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-30	S	YES	NO	NO	8	0.0	0.0	0.0	10.0
T-36	S	YES	NO	NO	8	0.0	0.0	0.0	6.0
T-37	S	YES	NO	NO	8	0.0	0.0	0.0	8.0
T-44	S	YES	NO	NO	8	0.0	0.0	0.0	10.0
T-39B	S	YES	NO	NO	6	11.7	0.0	0.0	7.5
T-39B	S	YES	NO	NO	6	0.0	0.0	0.0	9.2
T-8	S	YES	NO	NO	8	1.4	0.0	0.0	8.8
T-2D	S	NO	NO	NO	8	3.3	0.0	0.0	7.3
T-2E	S	YES	NO	NO	6	1.5	0.0	0.0	7.3
T-26A	S	YES	NO	NO	4	0.0	0.0	0.0	3.1
T-26B	S	YES	NO	NO	4	0.0	0.0	0.0	6.4
T-28	S	YES	NO	NO	8	0.0	0.0	0.0	4.0
T-33A	S	YES	NO	NO	8	0.0	0.0	0.0	9.6
T-33B	S	YES	NO	NO	8	0.0	0.0	0.0	7.3
T-33C.D	S	YES	NO	NO	8	0.0	0.0	0.0	8.9
T-34	S	YES	NO	NO	8	0.0	0.0	0.0	6.6
T-35	S	YES	NO	NO	8	0.0	0.0	0.0	6.1
T-38	W	YES	NO	NO	8	0.0	0.0	0.0	9.5
T-45	S	YES	NO	NO	8	0.0	0.0	0.0	9.5
T-3	S	YES	NO	NO	4	3.5	0.0	0.0	6.8
T-4A	S	NO	NO	NO	12	0.0	0.0	0.0	6.8
T-4B	S	YES	NO	NO	12	8.8	0.0	0.0	4.8
T-4C	S,W	NO	NO	NO	12	0.0	0.0	0.0	7.9
T-4D	S	YES	NO	NO	12	12.0	0.0	0.0	4.0
T-7	S	YES	NO	NO	8	0.0	0.0	0.0	9.6
T-24A	S,C	YES	NO	NO	4	0.0	0.0	0.0	6.7
T-24B	S	YES	NO	NO	4	0.0	0.0	0.0	7.0
T-24C	S	YES	NO	NO	4	5.3	0.0	0.0	6.6
T-25A	S	YES	NO	NO	6	0.0	0.0	0.0	3.5
T-25B	S	YES	NO	NO	6	0.0	0.0	0.0	8.0
T-25C	S	YES	NO	NO	6	0.0	0.0	0.0	3.5
T-31A	S	YES	NO	NO	8	1.5	0.0	0.0	9.4
T-31B	S	YES	NO	NO	8	0.0	0.0	0.0	10.0
T-31C.D	S	YES	NO	NO	8	0.0	0.0	0.0	9.5
T-6	S	YES	NO	NO	8	1.7	0.0	0.0	6.6
T-16	S	YES	NO	NO	12	0.0	0.0	0.0	6.3
T-40	S	YES	NO	NO	6	2.0	0.0	0.0	8.6
T-42	S	YES	NO	NO	4	0.0	0.0	0.0	7.0
T-23A	BO,V	NO	YES	NO	18	0.0	0.0	0.0	6.5
T-23B	BO	NO	YES	NO	18	2.0	0.0	0.0	8.0
T-23C	BO	NO	YES	NO	18	8.4	0.0	0.0	5.0
T-23D	BO	NO	YES	NO	18	0.0	0.0	0.0	8.0
T-23E	BO	YES	NO	NO	18	0.0	0.0	0.0	7.7
T-23F	BO	NO	YES	NO	18	0.0	0.0	0.0	9.0
T-23G	S	YES	NO	NO	6	1.6	0.0	0.0	6.8
T-23H	C	NO	NO	NO	6	0.0	0.0	0.0	7.3
T-23J	S	YES	NO	NO	6	5.0	0.0	0.0	8.1
T-51A	S,W	YES	NO	NO	4	0.0	0.0	0.0	5.6
T-51B	S	YES	NO	NO	4	1.8	0.0	0.0	5.6
T-51C	S	YES	NO	NO	4	0.0	0.0	0.0	5.3
T-18	S	YES	NO	NO	8	7.0	0.0	144.0	7.6
T-22A	S	NO	NO	NO	12	0.0	0.0	0.0	5.7
T-22B	W	NO	NO	NO	12	0.0	0.0	0.0	4.0
T-22C	W	NO	NO	NO	12	0.0	0.0	0.0	4.0
T-22D	W	NO	NO	NO	12	0.0	0.0	0.0	6.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-22E	W	NO	NO	NO	6	0.0	0.0	0.0	3.0
T-22F	S	NO	NO	NO	6	0.0	0.0	0.0	2.5
T-22G	S	NO	NO	NO	6	0.0	0.0	0.0	1.6
T-29A	S	YES	NO	NO	8	0.0	0.0	0.0	9.0
T-29B	S	YES	NO	NO	8	0.0	0.0	0.0	10.3
T-50	S	YES	NO	NO	4	3.0	0.0	0.0	6.9
T-53A	S	YES	NO	NO	4	0.0	0.0	0.0	5.5
T-53B	S	YES	NO	NO	4	0.5	0.0	0.0	6.5
T-53C	S	YES	NO	NO	4	0.0	0.0	0.0	7.0
T-53D	S	YES	NO	NO	4	0.0	0.0	0.0	2.9
T-5A	BO	YES	NO	NO	36	0.0	0.0	0.0	5.0
T-5B	BO	YES	NO	NO	36	0.0	0.0	0.0	6.4
T-5C	BO	YES	NO	NO	36	0.0	0.0	0.0	6.5
T-5D	BO	YES	NO	NO	36	0.0	0.0	0.0	6.4
T-5E	BO	YES	NO	NO	36	0.0	0.0	0.0	6.4
T-5F	BO	YES	NO	NO	36	0.0	0.0	0.0	6.4
T-5G	BO	YES	NO	NO	36	0.0	0.0	0.0	6.4
T-5H	BO	YES	NO	NO	36	0.0	0.0	0.0	5.0
T-9	BO	YES	NO	NO	36	4.3	0.0	0.0	8.0
T-10	W	YES	NO	NO	36	0.0	0.0	0.0	10.7
T-11	BO	YES	NO	NO	36	5.0	0.0	0.0	5.0
T-12	BO,V	YES	NO	NO	36	2.0	72.0	0.0	4.0
T-13	BO,V	YES	NO	NO	36	0.0	72.0	0.0	4.0
T-94A,B	S	YES	NO	NO	16	0.0	0.0	0.0	5.0
T-20	S	YES	NO	NO	36	40.0	72.0	0.0	3.5
T-95A,B	S	YES	NO	NO	8	0.0	0.0	0.0	4.5
T-22H	W	NO	NO	NO	6	0.0	0.0	0.0	5.3
T-52	S	YES	NO	NO	8	3.0	0.0	0.0	7.5
T-89	S	YES	NO	NO	8	7.0	72.0	0.0	5.2
T-1	SV	YES	NO	YES	12	8.0	72.0	360.0	13.2
T-27	SV	YES	NO	YES	12	4.5	0.0	360.0	16.8
T-21A	SV	YES	NO	YES	12	6.0	72.0	0.0	16.7
T-21B	SV	YES	NO	YES	12	0.0	72.0	250.0	16.7
T-21C	SV	YES	NO	YES	12	6.0	72.0	360.0	16.7
T-32A,B	SV	YES	NO	YES	12	3.0	0.0	360.0	9.7
T-32C,D	SV	YES	NO	YES	12	2.2	0.0	360.0	16.7
T-47	SV	YES	NO	YES	12	1.1	0.0	360.0	16.7
TB-1	BO	YES	NO	NO	36	0.0	72.0	0.0	2.8
TB-2	BO	NO	YES	NO	36	0.0	72.0	0.0	5.8
TB-4	BO	NO	YES	NO	36	0.0	0.0	0.0	4.7
TB-5	BO	YES	NO	NO	56	0.0	72.0	0.0	3.5
TB-6	BO	YES	NO	NO	56	5.0	72.0	0.0	3.3
TB-13	BO	YES	NO	NO	36	0.0	0.0	0.0	3.3
TB-14	BO	YES	NO	NO	36	0.0	72.0	0.0	4.8
TB-15	BO	YES	NO	NO	36	5.0	72.0	0.0	5.0
TB-19	BO	NO	YES	NO	36	0.0	72.0	0.0	5.0
TB-20	BO	YES	NO	NO	36	5.0	72.0	0.0	4.5
TB-25	BO	YES	NO	NO	36	5.0	72.0	0.0	3.0
TB-26	BO	YES	NO	NO	36	5.0	72.0	0.0	4.5
TB-28	BO	YES	NO	NO	56	0.0	72.0	0.0	3.5
TB-29	BO	YES	NO	NO	36	5.0	72.0	0.0	2.8
TB-36	BO	YES	NO	NO	36	0.0	72.0	0.0	4.5
TB-41	BO	YES	NO	NO	36	5.0	72.0	0.0	2.7
TB-43	BO	YES	NO	NO	36	5.0	72.0	0.0	7.1
TB-44	BO	YES	NO	NO	36	0.0	72.0	0.0	7.1
TB-45	BO	YES	NO	NO	36	5.0	72.0	0.0	2.8
TB-16	BO	YES	NO	NO	36	5.0	72.0	0.0	5.0
TB-22	BO	YES	NO	NO	36	5.0	72.0	0.0	4.5

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TB-24	BO	YES	NO	NO	36	5.0	72.0	0.0	2.8
TB-35	BO	YES	NO	NO	36	5.0	72.0	0.0	4.5
TB-46	BO	YES	NO	NO	36	5.0	72.0	0.0	5.3
TB-3	BO	NO	YES	NO	36	0.0	72.0	0.0	3.0
TB-7	BO	NO	YES	NO	56	0.0	72.0	0.0	2.9
TB-30	BO	NO	YES	NO	36	0.0	72.0	0.0	3.0
TB-31	BO	NO	YES	NO	36	0.0	72.0	0.0	2.5
TB-32	BO	NO	YES	NO	36	0.0	72.0	0.0	6.0
TB-37	BO	NO	YES	NO	36	0.0	72.0	0.0	2.0
TB-40	BO	NO	YES	NO	36	0.0	72.0	0.0	2.0
RB-1	BO	YES	NO	NO	60	8.6	0.0	0.0	7.0
RB-3	BO	YES	NO	NO	60	11.6	0.0	0.0	7.0
RB-4	BO	NO	YES	NO	60	2.0	0.0	0.0	7.0
RB-5	BO	NO	YES	NO	60	5.0	0.0	0.0	7.0
R-2	S,C	YES	NO	NO	48	0.0	0.0	0.0	5.0
R-3A	W	NO	NO	NO	14	0.0	0.0	0.0	10.0
R-3B	S,W	NO	NO	NO	10	0.0	0.0	0.0	6.3
R-3C	C	NO	NO	NO	10	0.0	0.0	0.0	7.5
R-4	S	YES	NO	NO	12	0.0	0.0	0.0	5.5
R-5	S	NO	NO	NO	48	0.0	0.0	0.0	4.0
R-6	S	YES	NO	NO	24	0.0	0.0	0.0	6.0
RB-2	BO	NO	YES	NO	60	19.6	0.0	0.0	7.0
R-9	S	YES	NO	NO	24	7.0	0.0	0.0	6.5
R-10A	S	YES	NO	NO	24	7.0	0.0	0.0	7.5
R-10B	C	NO	NO	NO	24	0.0	0.0	0.0	4.3
R-13A	S	YES	NO	NO	6	5.0	0.0	0.0	7.3
R-13B,C	S	YES	NO	NO	6	5.0	0.0	0.0	6.8
R-13D	S	YES	NO	NO	6	5.0	0.0	0.0	8.0
R-13E	S	YES	NO	NO	6	0.0	0.0	0.0	10.0
R-14	S	YES	NO	NO	20	9.1	0.0	0.0	6.0
R-15A	S	YES	NO	NO	16	7.0	0.0	0.0	6.7
R-15B	S	YES	NO	NO	16	7.0	0.0	0.0	7.8
R-20	S	NO	NO	NO	20	7.0	0.0	0.0	7.2
R-20B	S	YES	NO	NO	20	7.0	0.0	0.0	8.0
R-8A	S	YES	NO	NO	6	0.0	0.0	0.0	5.1
R-8B	S	YES	NO	NO	60	2.1	0.0	0.0	5.0
R-11	BO	YES	NO	NO	48	1.9	0.0	0.0	4.7
R-16A	S	NO	NO	NO	20	0.0	0.0	0.0	5.1
R-16B	C	NO	NO	NO	20	0.0	0.0	0.0	3.7
R-16C	S	YES	NO	NO	48	0.0	0.0	0.0	8.5
RB-6	BO	YES	NO	NO	24	0.0	0.0	0.0	5.0
RB-7	BO	NO	YES	NO	30	0.0	0.0	0.0	6.8
RB-8	BO	NO	YES	NO	30	0.0	0.0	0.0	5.0
RB-9	BO	NO	YES	NO	36	0.0	0.0	0.0	6.9
RB-10	BO	YES	NO	NO	30	0.0	0.0	0.0	7.0
RB-11	BO	NO	YES	NO	30	0.0	0.0	0.0	3.0
RB-12	BO	NO	YES	NO	30	0.0	0.0	0.0	4.9
RB-14	BO	NO	YES	NO	24	2.0	0.0	0.0	7.0
RB-15	BO	NO	YES	NO	24	0.0	0.0	0.0	4.9
RB-21	BO	YES	NO	NO	30	0.0	0.0	0.0	4.0
RB-23	BO	YES	NO	NO	36	0.0	0.0	0.0	3.8
RB-30	BO	NO	YES	NO	36	0.0	0.0	0.0	14.0
R-1A	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-1B,C	S	NO	NO	YES	8	2.0	0.0	0.0	10.8
R-1D	S	YES	NO	YES	8	1.0	0.0	0.0	9.7
R-1E	S	NO	NO	YES	8	2.3	0.0	0.0	9.0
R-7A	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-7B	S	YES	NO	YES	8	0.5	0.0	0.0	10.8

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R-7C	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-12A	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-12B	S	NO	NO	YES	8	2.0	0.0	0.0	10.8
R-12C	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-18A	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
R-18B	S	YES	NO	YES	8	2.0	0.0	0.0	11.0
R-18C	S	YES	NO	YES	8	2.0	0.0	0.0	10.4
RB-13	BO	NO	YES	NO	24	0.0	0.0	0.0	5.7
RB-16	BO,V	NO	YES	NO	24	0.0	0.0	0.0	2.6
RB-19	BO	NO	YES	NO	36	0.0	0.0	0.0	4.0
RB-20	BO	NO	YES	NO	36	0.0	0.0	0.0	4.0
RB-27	BO	NO	YES	NO	42	0.0	0.0	0.0	1.5
RB-22	BO	NO	YES	NO	30	0.0	0.0	0.0	6.5
RB-24	BO,V	NO	YES	NO	24	0.0	0.0	0.0	2.0
RB-25	BO,V	NO	YES	NO	24	0.0	0.0	0.0	2.0
RB-33	BO	NO	YES	NO	24	0.0	0.0	0.0	1.5
RB-26	BO	NO	YES	NO	48	0.0	0.0	0.0	1.9
RB-31	BO,V	NO	YES	NO	36	0.0	0.0	0.0	2.6
R-17A	BO,V	NO	YES	NO	24	0.0	0.0	0.0	2.0
R-17B	BO,V	NO	YES	NO	24	0.0	0.0	0.0	2.0

TABLE II

COMPARISON WITH SGEB CRITERIA

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

TABLE II

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-30	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-36	57	0.31	7.2	0.0	63.6	1.3	0.0	35.9	0.0
T-37	32	0.43	17.8	0.0	63.6	2.4	0.0	35.9	0.0
T-44	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-39B	23	0.63	44.6	0.0	63.6	4.8	0.0	35.9	0.0
T-39B	18	0.68	49.3	0.0	63.6	4.3	0.0	35.9	0.0
T-8	22	0.35	42.2	0.0	63.6	2.1	0.0	47.0	0.0
T-2D	37	0.33	12.5	0.0	63.6	1.8	0.0	35.9	0.0
T-2E	28	0.35	17.2	0.0	63.6	1.9	0.0	35.9	0.0
T-26A	108	0.46	5.7	0.0	63.6	1.0	0.0	35.9	0.0
T-26B	25	0.62	32.4	0.0	63.6	2.7	0.0	35.9	0.0
T-28	128	0.31	3.2	0.0	63.6	0.9	0.0	35.9	0.0
T-33A	22	0.45	26.9	0.0	63.6	3.0	0.0	35.9	0.0
T-33B	38	0.42	14.5	0.0	63.6	2.1	0.0	35.9	0.0
T-33C,D	26	0.45	23.2	0.0	63.6	2.8	0.0	35.9	0.0
T-34	47	0.33	9.3	0.0	63.6	1.5	0.0	35.9	0.0
T-35	54	0.31	7.6	0.0	63.6	1.3	0.0	35.9	0.0
T-38	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-45	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-3	20	0.35	25.3	0.0	63.6	2.0	0.0	35.9	0.0
T-4A	57	0.30	14.0	0.0	63.6	1.4	0.0	47.0	0.0
T-4B	112	0.30	7.3	0.0	63.6	1.0	0.0	47.0	0.0
T-4C	42	0.33	20.8	0.0	63.6	1.8	0.0	47.0	0.0
T-4D	157	0.30	5.3	0.0	63.6	0.9	0.0	47.0	0.0
T-7	22	0.35	20.9	0.0	63.6	2.3	0.0	35.9	0.0
T-24A	23	0.63	36.6	0.0	63.6	2.9	0.0	35.9	0.0
T-24B	21	0.65	41.2	0.0	63.6	3.1	0.0	35.9	0.0
T-24C	21	0.65	48.0	0.0	63.6	3.9	0.0	35.9	0.0
T-25A	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	0.0
T-25B	24	0.52	28.7	0.0	63.6	2.9	0.0	35.9	0.0
T-25C	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	0.0
T-31A	23	0.45	27.0	0.0	63.6	3.1	0.0	35.9	0.0
T-31B	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-31C,D	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-6	45	0.33	9.9	0.0	63.6	1.6	0.0	35.9	0.0
T-16	79	0.30	5.1	0.0	63.6	1.3	0.0	35.9	0.0
T-40	20	0.65	44.8	0.0	63.6	4.2	0.0	35.9	0.0
T-42	21	0.45	28.2	0.0	63.6	2.2	0.0	35.9	0.0
T-23A	93	0.35	10.1	0.0	27.6	1.6	0.0	47.0	2.3
T-23B	61	0.35	15.4	0.0	63.6	1.9	0.0	47.0	2.9
T-23C	154	0.35	6.2	0.0	63.6	1.2	0.0	47.0	1.9
T-23D	61	0.35	15.3	0.0	63.6	1.9	0.0	47.0	2.9
T-23E	67	0.35	14.1	0.0	63.6	1.8	0.0	47.0	2.7
T-23F	48	0.36	19.9	0.0	63.6	2.2	0.0	47.0	3.3
T-23G	33	0.38	15.9	0.0	63.6	1.9	0.0	35.9	0.0
T-23H	28	0.39	18.1	0.0	63.6	2.0	0.0	35.9	0.0
T-23J	21	0.42	28.3	0.0	63.6	2.8	0.0	35.9	0.0
T-51A	33	0.56	22.7	0.0	63.6	2.2	0.0	35.9	0.0
T-51B	31	0.57	25.9	0.0	63.6	2.5	0.0	35.9	0.0
T-51C	37	0.55	19.6	0.0	63.6	2.0	0.0	35.9	0.0
T-18	32	0.35	15.8	80.0	63.6	2.2	17.1	35.9	0.0
T-22A	81	0.30	9.9	0.0	63.6	1.2	0.0	47.0	0.0
T-22B	163	0.30	4.9	0.0	63.6	0.8	0.0	47.0	0.0
T-22C	163	0.30	4.9	0.0	63.6	0.8	0.0	47.0	0.0
T-22D	72	0.30	11.1	0.0	63.6	1.2	0.0	47.0	0.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-22E	145	0.30	5.5	0.0	63.6	0.6	0.0	47.0	0.0
T-22F	209	0.30	3.8	0.0	63.6	0.5	0.0	47.0	0.0
T-22G	543	0.30	1.5	0.0	63.6	0.3	0.0	47.0	0.0
T-29A	25	0.45	23.6	0.0	63.6	2.8	0.0	35.9	0.0
T-29B	19	0.35	24.0	0.0	63.6	2.5	0.0	35.9	0.0
T-50	20	0.35	25.2	0.0	63.6	2.0	0.0	35.9	0.0
T-53A	34	0.38	14.9	0.0	63.6	1.4	0.0	35.9	0.0
T-53B	24	0.39	22.0	0.0	63.6	1.8	0.0	35.9	0.0
T-53C	21	0.47	29.8	0.0	63.6	2.3	0.0	35.9	0.0
T-53D	120	0.35	3.9	0.0	63.6	0.7	0.0	35.9	0.0
T-5A	313	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.5
T-5B	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5C	185	0.30	4.3	0.0	63.6	1.3	0.0	47.0	2.0
T-5D	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5E	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5F	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5G	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5H	313	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.5
T-9	122	0.30	6.6	0.0	63.6	1.7	0.0	47.0	2.5
T-10	68	0.30	11.7	0.0	63.6	2.2	0.0	47.0	3.3
T-11	311	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.6
T-12	488	0.30	2.3	0.0	27.6	1.2	0.0	47.0	1.7
T-13	489	0.30	2.3	0.0	27.6	1.2	0.0	47.0	1.7
T-94A,B	139	0.30	5.8	0.0	63.6	1.0	0.0	47.0	1.5
T-20	612	0.30	1.9	0.0	63.6	1.1	0.0	47.0	1.6
T-95A,B	86	0.30	9.3	0.0	63.6	0.9	0.0	47.0	0.0
T-22H	47	0.33	18.6	0.0	63.6	1.2	0.0	47.0	0.0
T-52	35	0.43	17.0	0.0	63.6	2.4	0.0	35.9	0.0
T-89	69	0.85	46.5	0.0	63.6	9.5	0.0	35.9	0.0
T-1	14	0.60	177.1	406.5	672.3	10.8	24.7	52.5	0.0
T-27	9	1.13	282.5	657.6	672.3	13.5	31.4	52.5	0.0
T-21A	9	0.80	331.2	0.0	672.3	15.9	0.0	52.5	0.0
T-21B	9	0.80	319.9	452.3	672.3	15.4	21.7	52.5	0.0
T-21C	9	0.80	331.2	651.3	672.3	15.9	31.3	52.5	0.0
T-32A,B	26	1.13	92.8	219.2	672.3	7.7	18.1	52.5	0.0
T-32C,D	9	1.13	274.7	653.6	672.3	13.2	31.3	52.5	0.0
T-47	9	1.13	270.8	651.3	672.3	13.0	31.3	52.5	0.0
TB-1	1035	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-2	230	0.30	4.9	0.0	63.6	1.7	0.0	47.0	2.5
TB-4	359	0.30	2.2	0.0	63.6	1.0	0.0	47.0	1.4
TB-5	994	0.30	1.0	0.0	63.6	0.9	0.0	47.0	1.4
TB-6	1148	0.30	0.9	0.0	63.6	0.8	0.0	47.0	1.3
TB-13	741	0.30	1.1	0.0	63.6	0.7	0.0	47.0	1.0
TB-14	347	0.31	3.3	0.0	63.6	1.4	0.0	47.0	2.1
TB-15	311	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-19	313	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-20	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-25	865	0.31	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-26	384	0.30	2.9	0.0	63.6	1.3	0.0	47.0	2.0
TB-28	994	0.30	1.0	0.0	63.6	0.9	0.0	47.0	1.4
TB-29	1029	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-36	386	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-41	1092	0.30	1.0	0.0	63.6	0.8	0.0	47.0	1.2
TB-43	154	0.31	7.5	0.0	63.6	2.1	0.0	47.0	3.2
TB-44	155	0.31	7.4	0.0	63.6	2.1	0.0	47.0	3.1
TB-45	1029	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-16	311	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-22	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TB-24	1029	0.31	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-35	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-46	282	0.31	4.1	0.0	63.6	1.6	0.0	47.0	2.3
TB-3	869	0.30	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-7	1428	0.30	0.7	0.0	63.6	0.8	0.0	47.0	1.1
TB-30	869	0.30	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-31	1293	0.30	0.9	0.0	63.6	0.7	0.0	47.0	1.1
TB-32	217	0.30	5.2	0.0	63.6	1.7	0.0	47.0	2.6
TB-37	1956	0.31	0.6	0.0	63.6	0.6	0.0	47.0	0.9
TB-40	1956	0.30	0.6	0.0	63.6	0.6	0.0	47.0	0.9
RB-1	265	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
RB-3	264	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
RB-4	266	0.37	3.7	0.0	63.6	1.8	0.0	47.0	2.7
RB-5	265	0.37	3.7	0.0	63.6	1.8	0.0	47.0	2.7
R-2	417	0.37	2.4	0.0	63.6	1.3	0.0	47.0	1.9
R-3A	36	0.39	14.4	0.0	63.6	2.7	0.0	35.9	1.3
R-3B	64	0.37	7.6	0.0	63.6	1.6	0.0	35.9	0.0
R-3C	45	0.37	10.8	0.0	63.6	1.9	0.0	35.9	0.0
R-4	86	0.37	11.5	0.0	63.6	1.4	0.0	47.0	0.0
R-5	652	0.37	1.5	0.0	63.6	1.0	0.0	47.0	1.5
R-6	145	0.37	6.8	0.0	63.6	1.5	0.0	47.0	2.3
RB-2	263	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
R-9	122	0.47	10.4	0.0	63.6	2.1	0.0	47.0	3.2
R-10A	92	0.47	13.8	0.0	63.6	2.5	0.0	47.0	3.7
R-10B	282	0.47	4.4	0.0	63.6	1.4	0.0	47.0	2.1
R-13A	27	0.52	28.2	0.0	63.6	3.1	0.0	35.9	0.0
R-13B,C	31	0.52	24.5	0.0	63.6	2.9	0.0	35.9	0.0
R-13D	22	0.55	36.3	0.0	63.6	3.6	0.0	35.9	0.0
R-13E	15	0.57	49.2	0.0	63.6	3.9	0.0	35.9	0.0
R-14	119	0.52	11.9	0.0	63.6	2.2	0.0	47.0	3.3
R-15A	77	0.52	18.4	0.0	63.6	2.4	0.0	47.0	3.7
R-15B	56	0.52	25.3	0.0	63.6	2.9	0.0	47.0	4.3
R-20	82	0.52	17.1	0.0	63.6	2.6	0.0	47.0	3.9
R-20B	67	0.52	21.0	0.0	63.6	2.9	0.0	47.0	4.4
R-8A	51	0.47	24.8	0.0	63.6	1.6	0.0	47.0	0.0
R-8B	521	0.47	2.4	0.0	63.6	1.6	0.0	47.0	2.4
R-11	468	0.47	2.7	0.0	63.6	1.5	0.0	47.0	2.3
R-16A	168	0.52	8.2	0.0	63.6	1.8	0.0	47.0	2.7
R-16B	321	0.52	4.3	0.0	63.6	1.3	0.0	47.0	2.0
R-16C	144	0.52	9.6	0.0	63.6	3.0	0.0	47.0	4.5
RB-6	209	0.37	4.7	0.0	63.6	1.3	0.0	47.0	1.9
RB-7	143	0.37	6.9	0.0	63.6	1.7	0.0	47.0	2.6
RB-8	261	0.37	3.8	0.0	63.6	1.3	0.0	47.0	1.9
RB-9	163	0.37	6.0	0.0	63.6	1.7	0.0	47.0	2.6
RB-10	133	0.37	7.4	0.0	63.6	1.8	0.0	47.0	2.7
RB-11	725	0.37	1.4	0.0	63.6	0.8	0.0	47.0	1.1
RB-12	269	0.37	3.7	0.0	63.6	1.2	0.0	47.0	1.9
RB-14	106	0.37	9.3	0.0	63.6	1.8	0.0	47.0	2.7
RB-15	215	0.37	4.6	0.0	63.6	1.2	0.0	47.0	1.9
RB-21	408	0.26	1.7	0.0	63.6	0.7	0.0	47.0	1.1
RB-23	556	0.37	1.8	0.0	63.6	0.9	0.0	47.0	1.4
RB-30	40	0.26	17.4	0.0	63.6	2.5	0.0	47.0	3.7
R-1A	11	0.44	63.0	0.0	358.0	3.2	0.0	52.5	0.0
R-1B,C	10	0.45	68.5	0.0	358.0	3.4	0.0	52.5	0.0
R-1D	13	0.42	50.9	0.0	358.0	2.8	0.0	52.5	0.0
R-1E	15	0.40	42.9	0.0	358.0	2.5	0.0	52.5	0.0
R-7A	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
R-7B	11	0.52	77.5	0.0	358.0	3.8	0.0	52.5	0.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
[illegible]-7C	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
[illegible]-12A	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
[illegible]-12B	10	0.56	86.7	0.0	358.0	4.3	0.0	52.5	0.0
[illegible]-12C	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
[illegible]-18A	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0
[illegible]-18B	10	0.69	110.0	0.0	358.0	5.3	0.0	52.5	0.0
[illegible]-18C	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0
[illegible]-13	162	0.37	6.1	0.0	63.6	1.4	0.0	47.0	2.1
[illegible]-16	772	0.37	1.3	0.0	27.6	0.7	0.0	47.0	1.0
[illegible]-19	489	0.26	1.4	0.0	63.6	0.7	0.0	47.0	1.1
[illegible]-20	489	0.26	1.4	0.0	63.6	0.7	0.0	47.0	1.1
[illegible]-27	4057	0.47	0.3	0.0	63.6	0.5	0.0	47.0	0.7
[illegible]-22	154	0.37	6.4	0.0	63.6	1.6	0.0	47.0	2.5
[illegible]-24	1304	0.47	1.0	0.0	27.6	0.6	0.0	47.0	1.0
[illegible]-25	1304	0.47	1.0	0.0	27.6	0.6	0.0	47.0	1.0
[illegible]-33	2318	0.47	0.5	0.0	63.6	0.5	0.0	47.0	0.7
[illegible]-26	2830	0.47	0.4	0.0	63.6	0.6	0.0	47.0	0.9
[illegible]-31	1157	0.26	0.6	0.0	27.6	0.5	0.0	47.0	0.7
[illegible]-17A	1304	0.52	1.1	0.0	27.6	0.7	0.0	47.0	1.1
[illegible]-17B	1304	0.52	1.1	0.0	27.6	0.7	0.0	47.0	1.1

TABLE II-A

COMPARISON WITH SGEB CRITERIA
(NON-COMPOSITE)

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-30	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	NA
T-36	57	0.31	7.2	0.0	63.6	1.3	0.0	35.9	NA
T-37	32	0.43	17.8	0.0	63.6	2.4	0.0	35.9	NA
T-44	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	NA
T-39B	23	0.63	44.6	0.0	63.6	4.8	0.0	35.9	NA
T-39B	18	0.68	49.3	0.0	63.6	4.3	0.0	35.9	NA
T-8	22	0.35	42.2	0.0	63.6	2.1	0.0	47.0	NA
T-2D	37	0.33	12.5	0.0	63.6	1.8	0.0	35.9	NA
T-2E	28	0.35	17.2	0.0	63.6	1.9	0.0	35.9	NA
T-26A	108	0.46	5.7	0.0	63.6	1.0	0.0	35.9	NA
T-26B	25	0.62	32.4	0.0	63.6	2.7	0.0	35.9	NA
T-28	128	0.31	3.2	0.0	63.6	0.9	0.0	35.9	NA
T-33A	22	0.45	26.9	0.0	63.6	3.0	0.0	35.9	NA
T-33B	38	0.42	14.5	0.0	63.6	2.1	0.0	35.9	NA
T-33C,D	26	0.45	23.2	0.0	63.6	2.8	0.0	35.9	NA
T-34	47	0.33	9.3	0.0	63.6	1.5	0.0	35.9	NA
T-35	54	0.31	7.6	0.0	63.6	1.3	0.0	35.9	NA
T-38	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	NA
T-45	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	NA
T-3	20	0.35	25.3	0.0	63.6	2.0	0.0	35.9	NA
T-4A	57	0.30	14.0	0.0	63.6	1.4	0.0	47.0	NA
T-4B	112	0.30	7.3	0.0	63.6	1.0	0.0	47.0	NA
T-4C	42	0.33	20.8	0.0	63.6	1.8	0.0	47.0	NA
T-4D	157	0.30	5.3	0.0	63.6	0.9	0.0	47.0	NA
T-7	22	0.35	20.9	0.0	63.6	2.3	0.0	35.9	NA
T-24A	23	0.63	36.6	0.0	63.6	2.9	0.0	35.9	NA
T-24B	21	0.65	41.2	0.0	63.6	3.1	0.0	35.9	NA
T-24C	21	0.65	48.0	0.0	63.6	3.9	0.0	35.9	NA
T-25A	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	NA
T-25B	24	0.52	28.7	0.0	63.6	2.9	0.0	35.9	NA
T-25C	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	NA
T-31A	23	0.45	27.0	0.0	63.6	3.1	0.0	35.9	NA
T-31B	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	NA
T-31C,D	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	NA
T-6	45	0.33	9.9	0.0	63.6	1.6	0.0	35.9	NA
T-16	79	0.30	5.1	0.0	63.6	1.3	0.0	35.9	NA
T-40	20	0.65	44.8	0.0	63.6	4.2	0.0	35.9	NA
T-42	21	0.45	28.2	0.0	63.6	2.2	0.0	35.9	NA
T-23A	46	0.35	20.2	0.0	27.6	1.6	0.0	47.0	NA
T-23B	30	0.35	31.1	0.0	63.6	1.9	0.0	47.0	NA
T-23C	76	0.35	12.8	0.0	63.6	1.3	0.0	47.0	NA
T-23D	31	0.35	30.6	0.0	63.6	1.9	0.0	47.0	NA
T-23E	33	0.35	28.1	0.0	63.6	1.8	0.0	47.0	NA
T-23F	24	0.36	39.8	0.0	63.6	2.2	0.0	47.0	NA
T-23G	33	0.38	15.9	0.0	63.6	1.9	0.0	35.9	NA
T-23H	28	0.39	18.1	0.0	63.6	2.0	0.0	35.9	NA
T-23J	21	0.42	28.3	0.0	63.6	2.8	0.0	35.9	NA
T-51A	33	0.56	22.7	0.0	63.6	2.2	0.0	35.9	NA
T-51B	31	0.57	25.9	0.0	63.6	2.5	0.0	35.9	NA
T-51C	37	0.55	19.6	0.0	63.6	2.0	0.0	35.9	NA
T-18	32	0.35	15.8	80.0	63.6	2.2	17.1	35.9	NA
T-22A	81	0.30	9.9	0.0	63.6	1.2	0.0	47.0	NA
T-22B	163	0.30	4.9	0.0	63.6	0.8	0.0	47.0	NA
T-22C	163	0.30	4.9	0.0	63.6	0.8	0.0	47.0	NA
T-22D	72	0.30	11.1	0.0	63.6	1.2	0.0	47.0	NA

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-22E	145	0.30	5.5	0.0	63.6	0.6	0.0	47.0	NA
T-22F	209	0.30	3.8	0.0	63.6	0.5	0.0	47.0	NA
T-22G	543	0.30	1.5	0.0	63.6	0.3	0.0	47.0	NA
T-29A	25	0.45	23.6	0.0	63.6	2.8	0.0	35.9	NA
T-29B	19	0.35	24.0	0.0	63.6	2.5	0.0	35.9	NA
T-50	20	0.35	25.2	0.0	63.6	2.0	0.0	35.9	NA
T-53A	34	0.38	14.9	0.0	63.6	1.4	0.0	35.9	NA
T-53B	24	0.39	22.0	0.0	63.6	1.8	0.0	35.9	NA
T-53C	21	0.47	29.8	0.0	63.6	2.3	0.0	35.9	NA
T-53D	120	0.35	3.9	0.0	63.6	0.7	0.0	35.9	NA
T-5A	104	0.30	7.7	0.0	63.6	1.0	0.0	47.0	NA
T-5B	63	0.30	12.7	0.0	63.6	1.3	0.0	47.0	NA
T-5C	62	0.30	13.0	0.0	63.6	1.3	0.0	47.0	NA
T-5D	63	0.30	12.7	0.0	63.6	1.3	0.0	47.0	NA
T-5E	63	0.30	12.7	0.0	63.6	1.3	0.0	47.0	NA
T-5F	63	0.30	12.7	0.0	63.6	1.3	0.0	47.0	NA
T-5G	63	0.30	12.7	0.0	63.6	1.3	0.0	47.0	NA
T-5H	104	0.30	7.7	0.0	63.6	1.0	0.0	47.0	NA
T-9	40	0.30	20.2	0.0	63.6	1.7	0.0	47.0	NA
T-10	23	0.30	35.2	0.0	63.6	2.2	0.0	47.0	NA
T-11	103	0.30	7.9	0.0	63.6	1.1	0.0	47.0	NA
T-12	162	0.30	7.0	0.0	27.6	1.2	0.0	47.0	NA
T-13	163	0.30	6.9	0.0	27.6	1.2	0.0	47.0	NA
T-94A,B	70	0.30	11.5	0.0	63.6	1.0	0.0	47.0	NA
T-20	189	0.30	6.3	0.0	63.6	1.2	0.0	47.0	NA
T-95A,B	86	0.30	9.3	0.0	63.6	0.9	0.0	47.0	NA
T-22H	47	0.33	18.6	0.0	63.6	1.2	0.0	47.0	NA
T-52	35	0.43	17.0	0.0	63.6	2.4	0.0	35.9	NA
T-89	69	0.85	46.5	0.0	63.6	9.5	0.0	35.9	NA
T-1	18	0.60	177.1	406.5	672.3	10.8	24.7	52.5	NA
T-27	11	1.13	282.5	657.6	672.3	13.5	31.4	52.5	NA
T-21A	11	0.80	331.2	0.0	672.3	15.9	0.0	52.5	NA
T-21B	11	0.80	319.9	452.3	672.3	15.4	21.7	52.5	NA
T-21C	11	0.80	331.2	651.3	672.3	15.9	31.3	52.5	NA
T-32A,B	34	1.13	92.8	219.2	672.3	7.7	18.1	52.5	NA
T-32C,D	11	1.13	274.7	653.6	672.3	13.2	31.3	52.5	NA
T-47	11	1.13	270.8	651.3	672.3	13.0	31.3	52.5	NA
TB-1	345	0.30	3.3	0.0	63.6	0.8	0.0	47.0	NA
TB-2	77	0.30	14.7	0.0	63.6	1.7	0.0	47.0	NA
TB-4	120	0.30	6.7	0.0	63.6	1.0	0.0	47.0	NA
TB-5	199	0.30	5.1	0.0	63.6	0.9	0.0	47.0	NA
TB-6	226	0.30	4.5	0.0	63.6	0.9	0.0	47.0	NA
TB-13	247	0.30	3.2	0.0	63.6	0.7	0.0	47.0	NA
TB-14	116	0.31	10.0	0.0	63.6	1.4	0.0	47.0	NA
TB-15	103	0.31	11.3	0.0	63.6	1.5	0.0	47.0	NA
TB-19	104	0.31	11.1	0.0	63.6	1.5	0.0	47.0	NA
TB-20	127	0.31	9.2	0.0	63.6	1.4	0.0	47.0	NA
TB-25	285	0.31	4.1	0.0	63.6	0.9	0.0	47.0	NA
TB-26	127	0.30	9.0	0.0	63.6	1.3	0.0	47.0	NA
TB-28	199	0.30	5.1	0.0	63.6	0.9	0.0	47.0	NA
TB-29	339	0.30	3.3	0.0	63.6	0.8	0.0	47.0	NA
TB-36	129	0.31	9.0	0.0	63.6	1.3	0.0	47.0	NA
TB-41	360	0.30	3.2	0.0	63.6	0.8	0.0	47.0	NA
TB-43	51	0.31	22.8	0.0	63.6	2.1	0.0	47.0	NA
TB-44	52	0.31	22.3	0.0	63.6	2.1	0.0	47.0	NA
TB-45	339	0.30	3.3	0.0	63.6	0.8	0.0	47.0	NA
TB-16	103	0.31	11.3	0.0	63.6	1.5	0.0	47.0	NA
TB-22	127	0.31	9.2	0.0	63.6	1.4	0.0	47.0	NA

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TB-24	339	0.31	3.4	0.0	63.6	0.8	0.0	47.0	NA
TB-35	127	0.31	9.2	0.0	63.6	1.4	0.0	47.0	NA
TB-46	93	0.31	12.5	0.0	63.6	1.6	0.0	47.0	NA
TB-3	290	0.30	3.9	0.0	63.6	0.9	0.0	47.0	NA
TB-7	286	0.30	3.5	0.0	63.6	0.8	0.0	47.0	NA
TB-30	290	0.30	3.9	0.0	63.6	0.9	0.0	47.0	NA
TB-31	431	0.30	2.6	0.0	63.6	0.7	0.0	47.0	NA
TB-32	72	0.30	15.6	0.0	63.6	1.7	0.0	47.0	NA
TB-37	652	0.31	1.8	0.0	63.6	0.6	0.0	47.0	NA
TB-40	652	0.30	1.7	0.0	63.6	0.6	0.0	47.0	NA
RB-1	52	0.37	19.6	0.0	63.6	1.9	0.0	47.0	NA
RB-3	51	0.37	20.0	0.0	63.6	1.9	0.0	47.0	NA
RB-4	53	0.37	18.8	0.0	63.6	1.8	0.0	47.0	NA
RB-5	52	0.37	19.2	0.0	63.6	1.8	0.0	47.0	NA
R-2	104	0.37	9.5	0.0	63.6	1.3	0.0	47.0	NA
R-3A	18	0.39	28.9	0.0	63.6	2.7	0.0	35.9	NA
R-3B	64	0.37	7.6	0.0	63.6	1.6	0.0	35.9	NA
R-3C	45	0.37	10.8	0.0	63.6	1.9	0.0	35.9	NA
R-4	86	0.37	11.5	0.0	63.6	1.4	0.0	47.0	NA
R-5	163	0.37	6.1	0.0	63.6	1.0	0.0	47.0	NA
R-6	72	0.37	13.6	0.0	63.6	1.5	0.0	47.0	NA
RB-2	50	0.37	21.0	0.0	63.6	2.0	0.0	47.0	NA
R-9	60	0.47	21.3	0.0	63.6	2.2	0.0	47.0	NA
R-10A	45	0.47	28.3	0.0	63.6	2.5	0.0	47.0	NA
R-10B	141	0.47	8.9	0.0	63.6	1.4	0.0	47.0	NA
R-13A	27	0.52	28.2	0.0	63.6	3.1	0.0	35.9	NA
R-13B,C	31	0.52	24.5	0.0	63.6	2.9	0.0	35.9	NA
R-13D	22	0.55	36.3	0.0	63.6	3.6	0.0	35.9	NA
R-13E	15	0.57	49.2	0.0	63.6	3.9	0.0	35.9	NA
R-14	58	0.52	24.6	0.0	63.6	2.3	0.0	47.0	NA
R-15A	38	0.52	38.0	0.0	63.6	2.5	0.0	47.0	NA
R-15B	27	0.52	52.4	0.0	63.6	3.0	0.0	47.0	NA
R-20	41	0.52	35.1	0.0	63.6	2.7	0.0	47.0	NA
R-20B	33	0.52	43.2	0.0	63.6	3.0	0.0	47.0	NA
R-8A	51	0.47	24.8	0.0	63.6	1.6	0.0	47.0	NA
R-8B	104	0.47	12.2	0.0	63.6	1.6	0.0	47.0	NA
R-11	116	0.47	10.9	0.0	63.6	1.5	0.0	47.0	NA
R-16A	84	0.52	16.5	0.0	63.6	1.8	0.0	47.0	NA
R-16B	160	0.52	8.7	0.0	63.6	1.3	0.0	47.0	NA
R-16C	36	0.52	38.5	0.0	63.6	3.0	0.0	47.0	NA
RB-6	104	0.37	9.5	0.0	63.6	1.3	0.0	47.0	NA
RB-7	48	0.37	20.7	0.0	63.6	1.7	0.0	47.0	NA
RB-8	87	0.37	11.4	0.0	63.6	1.3	0.0	47.0	NA
RB-9	54	0.37	18.1	0.0	63.6	1.7	0.0	47.0	NA
RB-10	44	0.37	22.3	0.0	63.6	1.8	0.0	47.0	NA
RB-11	242	0.37	4.1	0.0	63.6	0.8	0.0	47.0	NA
RB-12	90	0.37	11.0	0.0	63.6	1.2	0.0	47.0	NA
RB-14	53	0.37	18.8	0.0	63.6	1.8	0.0	47.0	NA
RB-15	108	0.37	9.2	0.0	63.6	1.2	0.0	47.0	NA
RB-21	136	0.26	5.1	0.0	63.6	0.7	0.0	47.0	NA
RB-23	185	0.37	5.3	0.0	63.6	0.9	0.0	47.0	NA
RB-30	13	0.26	52.2	0.0	63.6	2.5	0.0	47.0	NA
R-1A	19	0.44	63.0	0.0	358.0	3.2	0.0	52.5	NA
R-1B,C	18	0.45	68.5	0.0	358.0	3.4	0.0	52.5	NA
R-1D	23	0.42	50.9	0.0	358.0	2.8	0.0	52.5	NA
R-1E	26	0.40	42.9	0.0	358.0	2.5	0.0	52.5	NA
R-7A	19	0.52	74.4	0.0	358.0	3.8	0.0	52.5	NA
R-7B	18	0.52	77.5	0.0	358.0	3.8	0.0	52.5	NA

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R-7C	19	0.52	74.4	0.0	358.0	3.8	0.0	52.5	NA
R-12A	19	0.56	80.1	0.0	358.0	4.1	0.0	52.5	NA
R-12B	18	0.56	86.7	0.0	358.0	4.3	0.0	52.5	NA
R-12C	19	0.56	80.1	0.0	358.0	4.1	0.0	52.5	NA
R-18A	19	0.69	98.7	0.0	358.0	5.1	0.0	52.5	NA
R-18B	17	0.69	110.0	0.0	358.0	5.3	0.0	52.5	NA
R-18C	19	0.69	98.7	0.0	358.0	5.1	0.0	52.5	NA
RB-13	81	0.37	12.2	0.0	63.6	1.4	0.0	47.0	NA
RB-16	386	0.37	2.6	0.0	27.6	0.7	0.0	47.0	NA
RB-19	163	0.26	4.3	0.0	63.6	0.7	0.0	47.0	NA
RB-20	163	0.26	4.3	0.0	63.6	0.7	0.0	47.0	NA
RB-27	1014	0.47	1.2	0.0	63.6	0.5	0.0	47.0	NA
RB-22	51	0.37	19.2	0.0	63.6	1.6	0.0	47.0	NA
RB-24	652	0.47	1.9	0.0	27.6	0.6	0.0	47.0	NA
RB-25	652	0.47	1.9	0.0	27.6	0.6	0.0	47.0	NA
RB-33	1159	0.47	1.1	0.0	63.6	0.5	0.0	47.0	NA
RB-26	708	0.47	1.8	0.0	63.6	0.6	0.0	47.0	NA
RB-31	386	0.26	1.8	0.0	27.6	0.5	0.0	47.0	NA
R-17A	652	0.52	2.1	0.0	27.6	0.7	0.0	47.0	NA
R-17B	652	0.52	2.1	0.0	27.6	0.7	0.0	47.0	NA

TABLE III

BLOCKOUTS QUALIFIED BY ARCHING ACTION
COMPARISON WITH SGEB CRITERIA

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-23A	93	0.35	10.1	0.0	27.6	1.6	0.0	47.0	2.3
T-23B	61	0.35	15.4	0.0	63.6	1.9	0.0	47.0	2.9
T-23C	154	0.35	6.2	0.0	63.6	1.2	0.0	47.0	1.9
T-23D	61	0.35	15.3	0.0	63.6	1.9	0.0	47.0	2.9
T-23F	48	0.36	19.9	0.0	63.6	2.2	0.0	47.0	3.3
TB-2	230	0.30	4.9	0.0	63.6	1.7	0.0	47.0	2.5
TB-4	359	0.30	2.2	0.0	63.6	1.0	0.0	47.0	1.4
TB-19	313	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-3	869	0.30	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-7	1428	0.30	0.7	0.0	63.6	0.8	0.0	47.0	1.1
TB-30	869	0.30	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-31	1293	0.30	0.9	0.0	63.6	0.7	0.0	47.0	1.1
TB-32	217	0.30	5.2	0.0	63.6	1.7	0.0	47.0	2.6
TB-37	1956	0.31	0.6	0.0	63.6	0.6	0.0	47.0	0.9
TB-40	1956	0.30	0.6	0.0	63.6	0.6	0.0	47.0	0.9
RB-4	266	0.37	3.7	0.0	63.6	1.8	0.0	47.0	2.7
RB-5	265	0.37	3.7	0.0	63.6	1.8	0.0	47.0	2.7
RB-2	263	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
RB-7	143	0.37	6.9	0.0	63.6	1.7	0.0	47.0	2.6
RB-8	261	0.37	3.8	0.0	63.6	1.3	0.0	47.0	1.9
RB-9	163	0.37	6.0	0.0	63.6	1.7	0.0	47.0	2.6
RB-11	725	0.37	1.4	0.0	63.6	0.8	0.0	47.0	1.1
RB-12	269	0.37	3.7	0.0	63.6	1.2	0.0	47.0	1.9
RB-14	106	0.37	9.3	0.0	63.6	1.8	0.0	47.0	2.7
RB-15	215	0.37	4.6	0.0	63.6	1.2	0.0	47.0	1.9
RB-30	40	0.26	17.4	0.0	63.6	2.5	0.0	47.0	3.7
RB-13	162	0.37	6.1	0.0	63.6	1.4	0.0	47.0	2.1
RB-16	772	0.37	1.3	0.0	27.6	0.7	0.0	47.0	1.0
RB-19	489	0.26	1.4	0.0	63.6	0.7	0.0	47.0	1.1
RB-20	489	0.26	1.4	0.0	63.6	0.7	0.0	47.0	1.1
RB-27	4057	0.47	0.3	0.0	63.6	0.5	0.0	47.0	0.7
RB-22	154	0.37	6.4	0.0	63.6	1.6	0.0	47.0	2.5
RB-24	1304	0.47	1.0	0.0	27.6	0.6	0.0	47.0	1.0
RB-25	1304	0.47	1.0	0.0	27.6	0.6	0.0	47.0	1.0
RB-33	2318	0.47	0.5	0.0	63.6	0.5	0.0	47.0	0.7
RB-26	2630	0.47	0.4	0.0	63.6	0.6	0.0	47.0	0.9
RB-31	1157	0.26	0.6	0.0	27.6	0.5	0.0	47.0	0.7
R-17A	1304	0.52	1.1	0.0	27.6	0.7	0.0	47.0	1.1
R-17B	1304	0.52	1.1	0.0	27.6	0.7	0.0	47.0	1.1

TABLE III-A

BLOCKOUTS QUALIFIED BY ARCHING ACTION
COMPARISON WITH SGEB CRITERIA
(NON-COMPOSITE)

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8	(9)	(10)
T-23A	46	0.35	20.2	0.0	27.6	1.6	0.0	47.0	NA
T-23B	30	0.35	31.1	0.0	63.6	1.9	0.0	47.0	NA
T-23C	76	0.35	12.8	0.0	63.6	1.3	0.0	47.0	NA
T-23D	31	0.35	30.6	0.0	63.6	1.9	0.0	47.0	NA
T-23F	24	0.36	39.8	0.0	63.6	2.2	0.0	47.0	NA
TB-2	77	0.30	14.7	0.0	63.6	1.7	0.0	47.0	NA
TB-4	120	0.30	6.7	0.0	63.6	1.0	0.0	47.0	NA
TB-19	104	0.31	11.1	0.0	63.6	1.5	0.0	47.0	NA
TB-3	290	0.30	3.9	0.0	63.6	0.9	0.0	47.0	NA
TB-7	286	0.30	3.5	0.0	63.6	0.8	0.0	47.0	NA
TB-30	290	0.30	3.9	0.0	63.6	0.9	0.0	47.0	NA
TB-31	431	0.30	2.6	0.0	63.6	0.7	0.0	47.0	NA
TB-32	72	0.30	15.6	0.0	63.6	1.7	0.0	47.0	NA
TB-37	652	0.31	1.8	0.0	63.6	0.6	0.0	47.0	NA
TB-40	652	0.30	1.7	0.0	63.6	0.6	0.0	47.0	NA
RB-4	53	0.37	18.8	0.0	63.6	1.8	0.0	47.0	NA
RB-5	52	0.37	19.2	0.0	63.6	1.8	0.0	47.0	NA
RB-2	50	0.37	21.0	0.0	63.6	2.0	0.0	47.0	NA
RB-7	48	0.37	20.7	0.0	63.6	1.7	0.0	47.0	NA
RB-8	87	0.37	11.4	0.0	63.6	1.3	0.0	47.0	NA
RB-9	54	0.37	18.1	0.0	63.6	1.7	0.0	47.0	NA
RB-11	242	0.37	4.1	0.0	63.6	0.8	0.0	47.0	NA
RB-12	90	0.37	11.0	0.0	63.6	1.2	0.0	47.0	NA
RB-14	53	0.37	18.8	0.0	63.6	1.8	0.0	47.0	NA
RB-15	108	0.37	9.2	0.0	63.6	1.2	0.0	47.0	NA
RB-30	13	0.26	52.2	0.0	63.6	2.5	0.0	47.0	NA
RB-13	81	0.37	12.2	0.0	63.6	1.4	0.0	47.0	NA
RB-16	386	0.37	2.6	0.0	27.6	0.7	0.0	47.0	NA
RB-19	163	0.26	4.3	0.0	63.6	0.7	0.0	47.0	NA
RB-20	163	0.26	4.3	0.0	63.6	0.7	0.0	47.0	NA
RB-27	1014	0.47	1.2	0.0	63.6	0.5	0.0	47.0	NA
RB-22	51	0.37	19.2	0.0	63.6	1.6	0.0	47.0	NA
RB-24	652	0.47	1.9	0.0	27.6	0.6	0.0	47.0	NA
RB-25	652	0.47	1.9	0.0	27.6	0.6	0.0	47.0	NA
RB-33	1159	0.47	1.1	0.0	63.6	0.5	0.0	47.0	NA
RB-26	708	0.47	1.8	0.0	63.6	0.6	0.0	47.0	NA
RB-31	386	0.26	1.8	0.0	27.6	0.5	0.0	47.0	NA
R-17A	652	0.52	2.1	0.0	27.6	0.7	0.0	47.0	NA
R-17B	652	0.52	2.1	0.0	27.6	0.7	0.0	47.0	NA

TABLE IV

MODIFIED MASONRY WALLS
COMPARISON WITH SGEB CRITERIA

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

TABLE IV

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-30	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-36	57	0.31	7.2	0.0	63.6	1.3	0.0	35.9	0.0
T-37	32	0.43	17.8	0.0	63.6	2.4	0.0	35.9	0.0
T-44	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-39B	23	0.63	44.6	0.0	63.6	4.8	0.0	35.9	0.0
T-39B	18	0.68	49.3	0.0	63.6	4.3	0.0	35.9	0.0
T-8	22	0.35	42.2	0.0	63.6	2.1	0.0	47.0	0.0
T-2E	28	0.35	17.2	0.0	63.6	1.9	0.0	35.9	0.0
T-26A	108	0.46	5.7	0.0	63.6	1.0	0.0	35.9	0.0
T-26B	25	0.62	32.4	0.0	63.6	2.7	0.0	35.9	0.0
T-28	128	0.31	3.2	0.0	63.6	0.9	0.0	35.9	0.0
T-33A	22	0.45	26.9	0.0	63.6	3.0	0.0	35.9	0.0
T-33B	38	0.42	14.5	0.0	63.6	2.1	0.0	35.9	0.0
T-33C,D	26	0.45	23.2	0.0	63.6	2.8	0.0	35.9	0.0
T-34	47	0.33	9.3	0.0	63.6	1.5	0.0	35.9	0.0
T-35	54	0.31	7.6	0.0	63.6	1.3	0.0	35.9	0.0
T-38	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-45	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-3	20	0.35	25.3	0.0	63.6	2.0	0.0	35.9	0.0
T-4B	112	0.30	7.3	0.0	63.6	1.0	0.0	47.0	0.0
T-4D	157	0.30	5.3	0.0	63.6	0.9	0.0	47.0	0.0
T-7	22	0.35	20.9	0.0	63.6	2.3	0.0	35.9	0.0
T-24A	23	0.63	36.6	0.0	63.6	2.9	0.0	35.9	0.0
T-24B	21	0.65	41.2	0.0	63.6	3.1	0.0	35.9	0.0
T-24C	21	0.65	48.0	0.0	63.6	3.9	0.0	35.9	0.0
T-25A	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	0.0
T-25B	24	0.52	28.7	0.0	63.6	2.9	0.0	35.9	0.0
T-25C	125	0.46	4.9	0.0	63.6	1.1	0.0	35.9	0.0
T-31A	23	0.45	27.0	0.0	63.6	3.1	0.0	35.9	0.0
T-31B	20	0.45	29.1	0.0	63.6	3.1	0.0	35.9	0.0
T-31C,D	23	0.45	26.3	0.0	63.6	3.0	0.0	35.9	0.0
T-6	45	0.33	9.9	0.0	63.6	1.6	0.0	35.9	0.0
T-16	79	0.30	5.1	0.0	63.6	1.3	0.0	35.9	0.0
T-40	20	0.65	44.8	0.0	63.6	4.2	0.0	35.9	0.0
T-42	21	0.45	28.2	0.0	63.6	2.2	0.0	35.9	0.0
T-23E	67	0.35	14.1	0.0	63.6	1.8	0.0	47.0	2.7
T-23G	33	0.38	15.9	0.0	63.6	1.9	0.0	35.9	0.0
T-23J	21	0.42	28.3	0.0	63.6	2.8	0.0	35.9	0.0
T-51A	33	0.56	22.7	0.0	63.6	2.2	0.0	35.9	0.0
T-51B	31	0.57	25.9	0.0	63.6	2.5	0.0	35.9	0.0
T-51C	37	0.55	19.6	0.0	63.6	2.0	0.0	35.9	0.0
T-18	32	0.35	15.8	80.0	63.6	2.2	17.1	35.9	0.0
T-29A	25	0.45	23.6	0.0	63.6	2.8	0.0	35.9	0.0
T-29B	19	0.35	24.0	0.0	63.6	2.5	0.0	35.9	0.0
T-50	20	0.35	25.2	0.0	63.6	2.0	0.0	35.9	0.0
T-53A	34	0.38	14.9	0.0	63.6	1.4	0.0	35.9	0.0
T-53B	24	0.39	22.0	0.0	63.6	1.8	0.0	35.9	0.0
T-53C	21	0.47	29.8	0.0	63.6	2.3	0.0	35.9	0.0
T-53D	120	0.35	3.9	0.0	63.6	0.7	0.0	35.9	0.0
T-5A	313	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.5
T-5B	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5C	185	0.30	4.3	0.0	63.6	1.3	0.0	47.0	2.0
T-5D	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5E	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5F	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-5G	190	0.30	4.2	0.0	63.6	1.3	0.0	47.0	2.0
T-5H	313	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.5
T-9	122	0.30	6.6	0.0	63.6	1.7	0.0	47.0	2.5
T-10	68	0.30	11.7	0.0	63.6	2.2	0.0	47.0	3.3
T-11	311	0.30	2.6	0.0	63.6	1.0	0.0	47.0	1.6
T-12	488	0.30	2.3	0.0	27.6	1.2	0.0	47.0	1.7
T-13	489	0.30	2.3	0.0	27.6	1.2	0.0	47.0	1.7
T-94A,B	139	0.30	5.8	0.0	63.6	1.0	0.0	47.0	1.5
T-20	612	0.30	1.9	0.0	63.6	1.1	0.0	47.0	1.6
T-95A,B	86	0.30	9.3	0.0	63.6	0.9	0.0	47.0	0.0
T-52	35	0.43	17.0	0.0	63.6	2.4	0.0	35.9	0.0
T-89	69	0.85	46.5	0.0	63.6	9.5	0.0	35.9	0.0
T-1	14	0.60	177.1	406.5	672.3	10.8	24.7	52.5	0.0
T-27	9	1.13	282.5	657.6	672.3	13.5	31.4	52.5	0.0
T-21A	9	0.80	331.2	0.0	672.3	15.9	0.0	52.5	0.0
T-21B	9	0.80	319.9	452.3	672.3	15.4	21.7	52.5	0.0
T-21C	9	0.80	331.2	651.3	672.3	15.9	31.3	52.5	0.0
T-32A,B	26	1.13	92.8	219.2	672.3	7.7	18.1	52.5	0.0
T-32C,D	9	1.13	274.7	653.6	672.3	13.2	31.3	52.5	0.0
T-47	9	1.13	270.8	651.3	672.3	13.0	31.3	52.5	0.0
TB-1	1035	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-5	994	0.30	1.0	0.0	63.6	0.9	0.0	47.0	1.4
TB-6	1148	0.30	0.9	0.0	63.6	0.8	0.0	47.0	1.3
TB-13	741	0.30	1.1	0.0	63.6	0.7	0.0	47.0	1.0
TB-14	347	0.31	3.3	0.0	63.6	1.4	0.0	47.0	2.1
TB-15	311	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-20	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-25	865	0.31	1.3	0.0	63.6	0.9	0.0	47.0	1.3
TB-26	384	0.30	2.9	0.0	63.6	1.3	0.0	47.0	2.0
TB-28	994	0.30	1.0	0.0	63.6	0.9	0.0	47.0	1.4
TB-29	1029	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-36	386	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-41	1092	0.30	1.0	0.0	63.6	0.8	0.0	47.0	1.2
TB-43	154	0.31	7.5	0.0	63.6	2.1	0.0	47.0	3.2
TB-44	155	0.31	7.4	0.0	63.6	2.1	0.0	47.0	3.1
TB-45	1029	0.30	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-16	311	0.31	3.7	0.0	63.6	1.5	0.0	47.0	2.2
TB-22	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-24	1029	0.31	1.1	0.0	63.6	0.8	0.0	47.0	1.2
TB-35	384	0.31	3.0	0.0	63.6	1.3	0.0	47.0	2.0
TB-46	282	0.31	4.1	0.0	63.6	1.6	0.0	47.0	2.3
RB-1	265	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
RB-3	264	0.37	3.8	0.0	63.6	1.8	0.0	47.0	2.7
R-2	417	0.37	2.4	0.0	63.6	1.3	0.0	47.0	1.9
R-4	86	0.37	11.5	0.0	63.6	1.4	0.0	47.0	0.0
R-6	145	0.37	6.8	0.0	63.6	1.5	0.0	47.0	2.3
R-9	122	0.47	10.4	0.0	63.6	2.1	0.0	47.0	3.2
R-10A	92	0.47	13.8	0.0	63.6	2.5	0.0	47.0	3.7
R-13A	27	0.52	28.2	0.0	63.6	3.1	0.0	35.9	0.0
R-13B,C	31	0.52	24.5	0.0	63.6	2.9	0.0	35.9	0.0
R-13D	22	0.55	36.3	0.0	63.6	3.6	0.0	35.9	0.0
R-13E	15	0.57	49.2	0.0	63.6	3.9	0.0	35.9	0.0
R-14	119	0.52	11.9	0.0	63.6	2.2	0.0	47.0	3.3
R-15A	77	0.52	18.4	0.0	63.6	2.4	0.0	47.0	3.7
R-15B	56	0.52	25.3	0.0	63.6	2.9	0.0	47.0	4.3
R-20B	67	0.52	21.0	0.0	63.6	2.9	0.0	47.0	4.4
R-8A	51	0.47	24.8	0.0	63.6	1.6	0.0	47.0	0.0
R-8B	521	0.47	2.4	0.0	63.6	1.6	0.0	47.0	2.4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R-11	468	0.47	2.7	0.0	63.6	1.5	0.0	47.0	2.3
R-16C	144	0.52	9.6	0.0	63.6	3.0	0.0	47.0	4.5
RB-6	209	0.37	4.7	0.0	63.6	1.3	0.0	47.0	1.9
RB-10	133	0.37	7.4	0.0	63.6	1.8	0.0	47.0	2.7
RB-21	408	0.26	1.7	0.0	63.6	0.7	0.0	47.0	1.1
RB-23	556	0.37	1.8	0.0	63.6	0.9	0.0	47.0	1.4
R-1A	11	0.44	63.0	0.0	358.0	3.2	0.0	52.5	0.0
R-1D	13	0.42	50.9	0.0	358.0	2.8	0.0	52.5	0.0
R-7A	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
R-7B	11	0.52	77.5	0.0	358.0	3.8	0.0	52.5	0.0
R-7C	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
R-12A	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
R-12C	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
R-18A	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0
R-18B	10	0.69	110.0	0.0	358.0	5.3	0.0	52.5	0.0
R-18C	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0

TABLE V

REINFORCED MASONRY WALLS
COMPARISON WITH SGEB CRITERIA

Column (1): Wall identifier
(2): Frequency (Hertz)
(3): Response spectrum acceleration (g's)
(4): Bending stress from SSE + PBOC (psi)
(5): Bending stress from Tornado (psi)
(6): SGEB allowable tensile stress (psi)
(7): Shear stress from SSE + PBOC (psi)
(8): Shear stress from Tornado (psi)
(9): SGEB allowable shear stress (psi)
(10): Maximum collar joint shear stress (psi)

TABLE V

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T-1	14	0.60	177.1	406.5	672.3	10.8	24.7	52.5	0.0
T-27	9	1.13	282.5	657.6	672.3	13.5	31.4	52.5	0.0
T-21A	9	0.80	331.2	0.0	672.3	15.9	0.0	52.5	0.0
T-21B	9	0.80	319.9	452.3	672.3	15.4	21.7	52.5	0.0
T-21C	9	0.80	331.2	651.3	672.3	15.9	31.3	52.5	0.0
T-32A,B	26	1.13	92.8	219.2	672.3	7.7	18.1	52.5	0.0
T-32C,D	9	1.13	274.7	653.6	672.3	13.2	31.3	52.5	0.0
T-47	9	1.13	270.8	651.3	672.3	13.0	31.3	52.5	0.0
R-1A	11	0.44	63.0	0.0	358.0	3.2	0.0	52.5	0.0
R-1B,C	10	0.45	68.5	0.0	358.0	3.4	0.0	52.5	0.0
R-1D	13	0.42	50.9	0.0	358.0	2.8	0.0	52.5	0.0
R-1E	15	0.40	42.9	0.0	358.0	2.5	0.0	52.5	0.0
R-7A	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
R-7B	11	0.52	77.5	0.0	358.0	3.8	0.0	52.5	0.0
R-7C	11	0.52	74.4	0.0	358.0	3.8	0.0	52.5	0.0
R-12A	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
R-12B	10	0.56	86.7	0.0	358.0	4.3	0.0	52.5	0.0
R-12C	11	0.56	80.1	0.0	358.0	4.1	0.0	52.5	0.0
R-18A	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0
R-18B	10	0.69	110.0	0.0	358.0	5.3	0.0	52.5	0.0
R-18C	11	0.69	98.7	0.0	358.0	5.1	0.0	52.5	0.0

QUESTION 7

Identify whether any QA/QC records are available to ensure conformance of masonry construction to design drawings and specifications.

Response

The safety-related masonry walls at the Millstone Unit 1 Power Plant have been systematically analyzed for their functional capability. These evaluations were performed by Earthquake Engineering Services (EES), Boston, Massachusetts, for NUSCO, in response to and to the requirements of NRC I&E Bulletin 80-11. The report of the reevaluation was submitted to NRC staff per Reference 4. The original engineering, design, and construction of these walls were by Ebasco Services, Incorporated.

The inspection of construction and workmanship of block walls was controlled by use of the original design drawing and the adherence to the construction specification, Reference 1. The specification guarantees the control of the construction qualities by the contractors/subcontractors. The work covered by this specification includes furnishing all labor, material, tools, equipment, scaffolding and other appliances required to perform the masonry work. The materials procured for masonry walls by this specification were to the requirements of ASTM specifications. The construction quality of these masonry walls was maintained at least equal to the local building code and this specification during the construction phase. During this period prints of the engineering drawings were made available to facilitate the contractors to follow the sequence. The inspection of the work was reserved by the engineers to monitor and check that the workmanship and sequence of construction were to the drawing requirements. Therefore, it can be concluded that the masonry walls at Millstone Unit 1 (MP1) were engineered, designed, built, and inspected by a systematic manner.

Sections 4.5 and 4.6 of the latest ACI 531-79 building code requirements for concrete masonry structures provides the specification of material acceptance for masonry work and the inspection requirements during the construction phase. Though the referenced specification for the masonry work is much earlier than this ACI building code requirement, the requirements imposed by the specification meet or exceed the intent of the ACI building code.

Moreover, as part of the reevaluation report, the MP1 facilities were surveyed by the team of engineers to obtain the field data. The survey of the facility includes visual inspection of the masonry walls as to its soundness, such as cracks in the blocks/joints, chippings, or any such physical damages. The drawings and other documents used in gathering necessary data found that the masonry wall thicknesses, locations, and material were

consistent with the physical as-built conditions. This infers that an inspection program existed during the course of construction and thus Reference 1 was effectively enforced. During the modification stage, reinforcing bars were encountered when attempting to bolt through masonry blocks. These observations provide further confirmation that walls were reinforced per the original design drawings.

In order to enhance the confidence level, samples of blocks collected randomly have been tested for compression and water absorption according to the requirements of ASTM C-140, Reference 3. The specimen's compressive strength from the tests in psi on gross area indicated that the blocks have an inherent higher strength, Table 7-1, as compared to the values used in the reevaluation report, Reference 4.

The relative strength values suggests that the values in Table 7-1 used in the final report using criteria, Reference 2, are conservative.

Based upon the preceding information, it can be concluded that conformance of masonry construction to design drawings and specifications was maintained.

References

1. Ebasco Services, Incorporated, Specification for Masonry for Millstone Nuclear Power Station Unit 1, document No. MPC-MI-A3, Revision 1, dated October 5, 1967.

2. Design criteria No. DC-1, Revision 3, by Earthquake Engineering Services (EES), Boston, Massachusetts, for Millstone Nuclear Power Station Unit 3, attachment to Reference 4.

3. Concrete block wall test report, project No. 50,858, by Briggs, Norwell, Massachusetts, dated August 13, 1985.

4. W. G. Counsil letter to B. H. Grier, NRC, subject: Millstone Power Station Unit 1, I&E Bulletin 80-11, Masonry Wall Design, Northeast Utilities, November 4, 1980, A01021.

CS-D6-22

TABLE 7-1
MASONRY BLOCKS STRENGTH PROPERTIES

Description	Test Samples	Tested Comp. Stress On Gross Area In Psi	ASTM Block Type Used in Masonry Walls Reevaluation Report f'm Values in Psi	Remarks
Blocks				
a. ASTM C-140 (Hollow Unit)	Random From Turb. Bldg.	1,625.	-	Ref. 3
b. ASTM C-90		-	1,350.	
C-129	Ref. 1	-	630.	Ref. 2
C-145		-	1,080.	

Blocks				
a. ASTM C-140 (100/solid unit)	Random From Aux. Bldg.	4,010.	-	Ref. 3
b. ASTM C-90		-	1,350.	
C-129	Ref. 1	-	630.	Ref. 2
C-145		-	1,080.	

AUDIT QUESTION

Provide a survey of masonry walls at Millstone Unit No. 1 to identify any signs of cracking.

RESPONSE

In response to the above request, a walkdown of the walls included in the IE 80-11 bulletin was performed. This walkdown encompassed almost all walls in the program with the exception of a small number of walls which were inaccessible due to high radiation levels. The walkdown revealed no indications of cracking or other signs of distress.

Subsequent to the above survey, 33 walls were randomly chosen and their original walkdown drawings obtained. These drawings were reviewed to determine if the original evaluation indicated any signs of cracking or distress. The examination showed 20 walls which were noted as having some form of cracking prior to modifications. It is noted that the majority of cracking was along the boundaries with only a few locations where step cracks were shown. These 20 walls were resurveyed to verify the indications on the walkdown drawings were addressed. In all cases modifications were employed which eliminated any adverse effects these cracks would have on the walls structural integrity. These modifications included installation of plates or angles along the boundary or grouting of step cracks.

Based upon this survey the applicant feels that all structural discontinuities were addressed in the original evaluation and have not reappeared. Therefore, the assumptions made in response to the IE 80-11 bulletin about the physical condition of the walls remains valid.

Docket No. 50-213

Haddam Neck Plant

Response to Request for Additional Information
IE Bulletin 80-11, Masonry Wall Design

December, 1985

INTRODUCTION TO REQUEST FOR ADDITIONAL INFORMATION
MASONRY WALL DESIGN, IE BULLETIN 80-11
HADDAM NECK PLANT
DOCKET NO. 50-213

In order to respond to the questions, a review of the calculations was performed. This review indicated that the walls could be grouped into five categories which are:

a. Walls CYPAB 107 and 108, CYDG 1002 and 1003, and CYTB 2005 were actually column strips at the edge of reinforced concrete walls. These column strips were tied to the wall by anchor bolts which were drilled through the column strips into the walls. The anchor bolts bear on the columns by base plates. Thus, these column strips become an appendage to the reinforced concrete wall and the allowable stresses in blocks are nonsignificant.

b. Walls CYPAB 201, 202, 203, and 204 were modified and qualified as structural walls in the SEP program. These four walls were modified to act as reinforced shear walls, and after modifications behave as reinforced concrete sections. The accelerations used on these walls were directly from the SEP program. Therefore, these walls fall outside the scope of the IE Bulletin and will not be considered further.

c. Walls CYPAB 102, 103, and 104; CYSB 1002; CYSB 1003; and CYTB 1008 were qualified by assuming that they could fail but a metal barrier was erected so that the blocks could not fall and impact equipment. Hence, allowable stresses are not a factor in this case.

d. Walls CYPAB 101C, 101D, 101E, and CYDG 1004 were qualified as having lower stresses than allowables in accordance with NUSCO criteria. The only modifications to these walls were to add angles and plates on the boundaries for stability considerations. These four walls may be impacted by criteria changes. However, these walls were analyzed using very conservative analytical techniques.

e. The rest of the walls were modified structurally as their stresses were higher than allowable stresses in the NUSCO criteria. The modifications, in general, reduced wall stress substantially below allowables and that is expected to be a favorable factor when comparing them with allowables in the NRC criteria which are not significantly lower than those in the NUSCO criteria.

QUESTION 1

In Response 17 of Reference 1, Connecticut Yankee Atomic Power Company (CYAPCO) indicated that the seismic evaluation of masonry walls used estimated floor spectra based on the Interim Seismic Design Ground Spectrum and that this criterion was later compared to the SEP floor response spectra. Provide the conclusions that were drawn from this comparison and clarify whether the SEP spectra were actually used.

Response

Table 1 lists all the block walls at the CY plant at the time of the NRC IE Bulletin 80-11 project. The table also summarizes the available data in response to Question 1 of the recent NRC inquiry. The column of design responses gives the accelerations in (g) used to evaluate the walls. These accelerations are 1.3 times the spectral accelerations for the fundamental frequency of the wall. The 1.3 factor is (per criteria) to allow for contribution of higher modes. The spectral accelerations are from the floor response spectra used in the Bulletin effort.

The SEP response accelerations are unfactored spectral accelerations from the SEP floor response spectra for the fundamental frequency of the walls. The SEP floor response spectra were developed for the Category I structures of the CY plant and were available after the IE Bulletin 80-11 effort had been concluded. As noted in the table, the SEP program did not require spectra developed in all the buildings which had walls in the IE Bulletin 80-11 scope.

Walls CYPAB 107 and 108, CYDG 1002 and 1003, and CYTB 2005 were actually column strips at the edge of reinforced concrete walls. These column strips were tied to the wall by anchor bolts which were drilled through the column strips into the walls. The anchor bolts bear on the columns by base plates. Thus, these column strips become an appendage to the reinforced concrete wall and the allowable stresses in blocks are nonsignificant.

Walls CYPAB 201, 202, 203, and 204 were modified and qualified as structural walls in the SEP program, and as stated earlier need not be discussed further.

Walls CYPAB 102, 103, and 104; CYCT 1001; CYSB 1002, and 1003; and CYTB 1008 were qualified by assuming that they could fail but a metal barrier was erected so that the blocks could not fall and impact equipment. Hence, allowable stresses are not a factor in this case.

Wall CYPAB 101C was originally qualified on the basis of arching action. A reevaluation of this wall indicates that the wall in its present configuration is not safety related; i.e., failure would not jeopardize any safety-related equipment. In the original evaluation many walls were classified safety related on a very conservative basis.

The rest of the walls were qualified on the basis of modifications designed to reduce allowable stresses to comply with criteria developed for this project. During the design of the modifications, the calculation files show that the designer did one of the following:

a. Calculated those stresses being considered as controlling and compared them to allowables.

b. Calculated demand forces (moments, shears, and axial forces) which were considered to be controlling and compared them to allowables.

c. Calculated displacements and compared them with allowables.

The stress ratio (R_1) column in Table 1 gives the maximum ratio of calculated stress to SGEB allowable stresses for those walls for which stresses were calculated as described in (a) above. This ratio is not calculated for those walls where the stresses were not calculated specifically. However, those stresses can be calculated now and the ratios R_1 ascertained.

The stress ratio (R_2) column in Table 1 estimates the ratio of calculated stresses to SGEB allowable stress if the walls were qualified to the SEP floor response spectra (where applicable). The calculated stresses for the modified walls are based on a set of very conservative assumptions. Some of the more significant of these are:

a. The spectra accelerations used for the design of modifications is from an envelop of floor response spectra at the top and bottom of the walls rather than an average of the two which would have been more appropriate.

b. The fundamental frequency of the modified walls and the stress calculations were uniformly based on one-way action of the walls. Plate (two-way) action of the walls would be more appropriate and lead to lower calculated stresses.

c. Codirectional forces on the wall were combined on an absolute sum basis rather than on the basis of SRSS. The later combination would be

more appropriate and lead to lower calculated stresses.

d. Factoring the spectral accelerations from the fundamental mode of the wall by 1.3 to reflect contribution of higher modes is very conservative.

e. The SEP floor response spectra are envelopes for the whole floor. Using a floor spectra at the location of the block wall would be more appropriate and lead to lower spectral accelerations.

f. In response to Question 7, some insitu test data is presented for masonry units at the site. As can be seen from Table 7-2, the allowable stresses are higher for the in-place properties than those used in the original calculations. Therefore, it would be more appropriate to base the R_1 and R_2 ratios on the insitu properties.

g. Recent investigations indicate that the criteria initially used to classify walls as safety related was very conservative. Therefore, some walls whose ratio R_2 is greater than unity may not be required for safe shutdown of the unit. Further investigations could be made to determine the actual safety category of walls as needed.

A review of the table indicates a portion of the walls with a stress ratio R_2 greater than unity. As stated previously, CY PAB 101C has been determined to be nonsafety related, and therefore the stress ratio R_2 greater than one is of no significance.

In order to address the stress ratios exceeding unity, a systematic evaluation of the conservatisms mentioned above has been performed. This evaluation was initiated for CY PAB 101E, which exhibited the highest stress ratio R_2 (3.19). The original analysis was investigated in detail and four areas of obvious conservatism were chosen for evaluation. Some of these areas included a more rigorous calculation of the walls frequency so that a more appropriate spectral acceleration is chosen, and also including the effects of higher modes thereby eliminating the need to amplify the fundamental mode by 1.3. The spectra at the top and bottom of the wall which is much more appropriate was utilized. Finally, the maximum moment in the wall was calculated on a much more rigorous bases utilizing two-way action. This reevaluation resulted in the reported stress ratio R being reduced from 3.19 to an

acceptable value of 0.76. The more rigorous frequency portion contributed 72.4 percent, multi-mode consideration 13.6 percent, utilizing average spectra 9.1 percent, and revised moment calculation contributed 4.9 percent to the total reduction. This evaluation has demonstrated the conservatisms inherent in the original evaluation, and that by eliminating these reduces the ratio R_2 to an acceptable level. Therefore, it can be concluded that the SEP spectra and SGEB criteria have no adverse impact on the original evaluation.

QUESTION 2

With respect to Attachment 2 in Reference 1, explain how the wall attachment weights were determined. Indicate why these forces are divided by the area of the entire wall.

Response

The earlier submittal to NRC referred to in Question 2 of subject NRC request was misleading. It gave as an example for anchor bolt pullout evaluation a case where the bolts were qualified by inspection due to low pullout loads. Calculations shown on the same sheet where equipment weight was divided by total area of wall were for the purposes of retrofit design rather than for evaluating pullout integrity of appendage attachments. Attachment 1 to this response gives two examples where the attachments were not qualified by inspection and show a full evaluation of punching shear in wall as well as bolt stresses vs. allowables per criteria.

QUESTION 3

With respect to Attachment 5, Section 5.1 (Appendix A) in Reference 1, CYAPCO indicates that allowable stresses can be increased by 33 percent for OBE seismic loadings. However, the SGEB criteria, Section 3(a), expressly forbids the increase of allowable stress when wind or seismic loads (OBE) are involved. CYAPCO should identify the walls that require an increase in allowable stress for OBE load combinations in order to be qualified. Also, provide the actual percentage increase in allowable stress that is needed to qualify these walls.

Response

Although it was stated in Section 5.1 that OBE allowable stresses could be increased by 33 percent, this was not considered in the reevaluation. In response to the IE 80-11 Bulletin, only stresses for the SSE condition were considered. This was because SSE yielded larger ratios of actual stress to allowable stress than the OBE even without consideration of 33 percent increase.

QUESTION 4

In Response 11 of Reference 1, CYAPCO indicated that all allowable stresses were increased by a factor of 1.67 for load cases involving SSE. The SGEB criteria permit increase factors of only 1.3 for masonry shear and tension normal to the bed joint and 1.5 for tension parallel to the bed joint. CYAPCO should identify those walls which would not qualify if the SGEB factors were used and provide the percentages by which the SGEB factored allowables are exceeded.

Response

Table 1 presents the results of a comparison of the calculated stresses to the SGEB allowables. The stress ratios R_1 and R_2 indicate which walls do not meet the SGEB criteria as stated. In response to Question 1, a number of conservatisms that are inherent to these types of calculations are presented. As stated in Question 1, quantification of these conservatisms for the largest ratio R_2 indicate that overstressed conditions do not result from utilization of SGEB criteria.

QUESTION 5

Identify the total number of walls that required modifications in order to be qualified under the SGEB criteria (2). Also, indicate how many of these are unmortared walls.

Response

All the walls investigated under the IE Bulletin required some form of modification. The introduction to these responses describes some of the modification types. It is felt that if all the conservatisms were eliminated from the original evaluations that the amount of overstressed conditions would be negligible and additional modifications would not be justified. This has been quantified in response to Question 1. There were three walls which were unmortared in this evaluation, which were CYCT 1001, CY PAB 102, and CY PAB 103. These walls were qualified by addition of barriers which prevented collapse of these walls onto safety-related equipment.

QUESTION 6

In Response 8 of Reference 1, CYAPCO stated that one wall at the Haddam Neck plant was analyzed using the "arching action" technique. Identify this wall. The NRC position on this issue states that the use of the arching action theory to qualify unreinforced masonry walls is not acceptable. These walls should be repaired so they can be qualified based on the SGEB criteria (2). (The NRC position is provided as Attachment 3.)

Response

Attachment 2 gives revised calculations for wall CYPAB 101C which shows that eliminating some of the exaggerated conservatisms in the original analysis reduces wall stresses to within allowable. These calculations are based on original floor spectra and criteria used for IE Bulletin 80-11 work. The differences in the revised calculations from those used for the original report are:

a. The original analysis calculated the wall frequencies and stresses on the basis of a 24-inch vertical wall strip in beam action with the mass of all the wall appendages lumped in the middle of that strip. This is clearly conservative as the wall aspect ratio is 2:1 and thus will have considerable two-way action.

   In the revised calculations, the fundamental frequency is calculated on the basis of a simply supported plate with the mass of appendages distributed over the whole plate. This frequency is varied over a range of ±15 percent to find the maximum response acceleration per criteria.

b. The original criteria calculated the moment on the wall due to the vertical accelerations on the appendages and lumped all those moments and added them on an absolute sum basis to the out-of-plane wall moment at the center of the 24-inch strip.

   The revised calculations calculate the out-of-plane moment at the center of the plate due to horizontal motions on the basis of ACI code for two-way slabs. This is conservative and plate theory will give lower moments. We then added the moment from the bulletin board (which is the only appendage close to the middle of the wall) due to vertical motions to

the out-of-plane moments due to horizontal motions on an SRSS basis.

c. The remainder of the stress evaluations are the same as the old calculations. The final maximum stress we calculate is 21.2 psi compared with an allowable of 17.8 psi, or 20.5 psi based upon in-place properties, according to the SGEB criteria.

d. As can be seen from Table 1, the ratio R_2 greatly exceeds unity. A recent investigation of this wall has indicated that failure of this wall would not affect safe shutdown of the plant, and therefore the wall is not safety related. Thus, the stress ratio R_2 reported is acceptable.

QUESTION 7

Identify whether any QA/QC records are available to ensure conformance of masonry construction to design drawings and specifications.

Response

The safety-related masonry walls at the Connecticut Yankee Atomic Power Plant have been systematically analyzed for their functional capability. These evaluations were performed by URS/Blume and Associates for NUSCO, in response to and to the requirements of NRC I&E Bulletin 80-11. The original engineering, design, and construction of these walls were by Stone & Webster Engineering, Boston, Massachusetts.

The inspection of construction and workmanship of block walls was controlled by use of the original design drawing and the adherence to the construction specification, Reference 1. The specification guarantees the control of the construction qualities by the contractors/subcontractors. The work covered by this specification includes furnishing all labor, material, tools, equipment, scaffolding and other appliances required to perform the masonry work. The materials procured for masonry walls by this specification were to the requirements of ASTM specifications. The construction quality of these masonry walls was maintained at least equal to the local building code and this specification during the construction phase During this period prints of the engineering drawings were made available to facilitate the contractors to follow the sequence. The inspection of the work was reserved by the engineers to monitor and check that the workmanship and sequence of construction were to the drawing requirements. Therefore, it can be concluded that the masonry walls at Connecticut Yankee (CY) were engineered, designed, built, and inspected by a systematic manner.

Sections 4.5 and 4.6 of the latest ACI 531-79 building code requirements for concrete masonry structures provides the specification of material acceptance for masonry work and the inspection requirements during the construction phase. Though the referenced specification for the masonry work is much earlier than this ACI building code requirement, the requirements imposed by the specification meet or exceed the intent of the ACI building code.

Moreover, as part of the reevaluation report, the CY facilities were surveyed by the team of engineers to obtain the field data. The drawings and other documents used in gathering necessary data found that the masonry wall thicknesses, locations, and material were consistent with the physical as-built conditions. This

infers that an inspection program existed during the course of construction and thus Reference 1 was enforced to the fullest extent.

In order to enhance the confidence level, samples of blocks collected randomly have been tested for compression and water absorption according to the requirements of ASTM C-140, Reference 4. The specimen's compressive strength from the tests in psi on gross area indicated that the blocks have an inherent higher strength, Table 7-1, as compared to the values used in the reevaluation report, Reference 2, or the ACI 531-79, Section 4.3, minimum values.

The attached table 7-2, which describes the relative strength values, suggests that the values used in the final report are conservative and well below the maximum values suggested by the code.

Based upon the preceding information, it can be concluded that conformance of masonry construction to design drawings and specifications was maintained.

References

1. Stone & Webster's specification for masonry work for Unit 1, Connecticut Yankee Atomic Power Plant, Connecticut Yankee Atomic Power Company, Haddam, Connecticut, dated July 14, 1965.

2. Final report on safety-related masonry walls at the Connecticut Yankee Atomic Power Plant prepared by URS/Blume and Associates for Northeast Utilities Service Company dated August 1981.

3. Summary of Design Conditions, Nuclear Power Plant Unit 1, Connecticut Yankee Atomic Power Company, Haddam, Connecticut, dated April 1964 and revised through May 1966.

4. Concrete block wall test results by Briggs, Norwell, Massachusetts, dated December 8, 1984.

CS-D6-9

TABLE 7-1

MASONRY BLOCKS PROPERTIES
COMPRRESSIVE STRESSES ON GROSS AREA

Description	Test Samples	Test Results Mean Values	Values Used In Final Report	Remarks
Blocks				
(1)	Random	1,513 psi 1,260 (lowest)	-	Ref. 4
(2)(a) ASTM C-129 (b) ASTM C-90 Gr. A	Assumed	- -	350 psi 1,000 psi	Ref. 2

TABLE 7-2
MASONRY STRUCTURES BUILDING CODE
ALLOWABLE STRESSES, PSI

Description			Code (Minimum)	Values Per Report	Values From Test	Factor of Safety Code/Test
Compressive strength of concrete masonry		f'm	800.	700.	1,000.	1.14/1.43
Flexural (compressive)	F_m	0.33 f'm	264.	231.	330.	1.14/1.43
Bearing						
On full area	F_a	0.25 f'm	200.	175.	250.	1.14/1.43
On one-third area or less	F_a	0.375 f'm	300.	262.5	375.	1.14/1.43
Shear						
No shear reinforcement						
Flexural members	m	1.1 f'm	31.1	29.1	34.8	1.07/1.20
Shearwalls						
$M/VD_v > 1$	m	0.9 f'm	25.5	23.8	28.5	1.07/1.20
$M/Vd_v < 1$	m	2.0 f'm	56.6	52.9	63.2	1.07/1.20
Tension						
No tension reinforcement			(m_o = 1,000)	(m_o = 750.)	(m_o = 1000)	
Tension normal to bed joints						
Hollow units	F	0.5 m_o	15.8	13.7	15.8	1.15/1.15
Tension parallel to bed joints in running bond						
Hollow units	F	1.0 m_o	31.6	27.4	31.6	1.15/1.15
Modulus of elasticity	E_m	1,000 f'm	800,000	420,000	1,000,000	1.9/2.38
Modulus of rigidity	E_g	400 f'm	320,000	168,000	400,000	1.9/2.38

Audit Question

During the site walkdown, several cracks were noted in walls CYTB 1009 and CYTB 1010, provide the staff a response on the cause of the cracks and what action is required to address this issue.

Response

The licensee is still investigating these two areas and will have a complete response for staff review by January 31, 1986.

CS-D7-20

TABLE 1

RESPONSE TO QUESTION 1 OF NRC INQUIRY

Wall ID Number	Direction of Response	Wall Orientation	Calculated Fundamental Frequency (Hz)	a_d Design Response (g)	a_{sep} SEP response accelerations for 7% damping (g)
CYPAB102 &	N-S	Out-of-plane	NC	0.55	1.93
CYPAB103	E-W	In-plane	NC	0.55	1.66
CYPAB104	N-S	Out-of-plane	NC	0.55	1.93
	E-W	In-plane	NC	0.55	1.66
CYPAB107	N-S	Column	NC	0.55	1.93
CYPAB108	E-W		NC	0.55	1.66
CYCT1001	N-S	In-plane	NC	0.55	NA
	E-W	Out-of-plane	NC	0.55	NA
CYSB1002	N-S	Out-of-plane	14.8	0.97	NA
	E-W	In-plane	40.5	0.61	NA
CYDG1001	N-S	Out-of-plane	>10	0.45	NA
	E-W	In-plane	>11.5	0.63	NA
CYDG1002	N-S	Column	>10	0.45	NA
CYDG1003	E-W		>11.5	0.63	NA
CYSF1001	N-S	Out-of-plane	>33	0.34	NA
	E-W	In-plane	>33	0.45	NA
CYSF1002	N-S	In-plane	>33	0.34	NA
	E-W	Out-of-plane	>33	0.45	NA

Stress Ratio R_1	Stress Ratio R_2
Barriers added to contain wall if failed	
Barriers added to contain wall if failed	
Column strip bolted to concrete wall	
Barriers added to contain wall if failed	
Barriers added to contain wall if failed	
1.03	*
Column strip bolted to concrete wall	
1.24	*
0.26	*

Table 1 (continued)

Wall ID Number	Direction of Response	Wall Orientation	Calculated Fundamental Frequency (Hz)	a_d Design Response (g)	a_{sep} SEP response accelerations for 7% damping (g)
CYPAB101A	N-S	Out-of-plane	27	0.26	.54
	E-W	In-plane	>33	0.26	.42
CYPAB101B	N 60° E	Out-of-plane	>33	0.26	.43
	N 30° W	In-plane	NC	0.59	1.93
CYPAB101C	N-S	Out-of-plane	17.8	0.36	0.95
	E-W	In-plane	>33	0.26	0.42
CYPAB101D	N-S	In-plane	22.5	0.39	0.67
	E-W	Out-of-plane	16.5	0.39	0.81
CYPAB101E	N-S	Out-of-plane	16.5	0.39	1.12
	E-W	In-plane	22.5	0.39	0.56
CYPAB101F	N-S	In-plane	>33	0.26	0.46
	E-W	Out-of-plane	23	0.33	0.55
CYDG1004	N-S	Out-of-plane	20.5	0.34	NA
	E-W	In-plane	>33	0.21	NA
CYSB2002	N-S	Out-of-plane	12.3	0.39	NA
	E-W	In-plane	>24	0.50	NA
CYSB2003	N-S	In-plane	24	0.39	NA
	E-W	Out-of-plane	11.8	0.50	NA
CYPAB105	N-S	Out-of-plane	23.8	0.39	0.58
	E-W	In-plane	23.8	0.39	0.51

Stress Ratio R_1	Stress Ratio R_2
0.37	0.77
0.33	1.08
0.93	3.18
0.86	2.33
0.86	3.19
0.34	0.74
0.82	*
**	*
**	*
0.66	1.27

Table 1 (continued)

Wall ID Number	Direction of Response	Wall Orientation	Calculated Fundamental Frequency (Hz)	a_d Design Response (g)	a_{sep} SEP response accelerations for 7% damping (g)
CYTB1009	N-S	Out-of-plane	13.4	0.98	0.61
	E-W	In-plane	>23	0.34	0.50
CYTB2004	N-S	Out-of-plane	27.7	0.98	0.25
	E-W	In-plane	>23	0.34	0.78
CYTB1010	N-S	In-plane	23	0.34	0.50
	E-W	Out-of-plane	11.6	0.65	1.33
CYTB2005	N-S	Column	16	0.98	0.28
	E-W		16	0.61	0.82
CYPAB106	N-S	Out-of-plane	17	0.39	1.12
	E-W	In-plane	17	0.39	0.81
CYTB1007	N-S	Group of	>13	0.98	0.42
	E-W	Several Walls	NC	1.30	0.61
CYSF2001	N-S	In-plane	>33	0.34	NA
	E-W	Out-of-plane	>33	0.45	NA
CYSB1003	N-S	Out-of-plane	NC	0.10	NA
	E-W	In-plane	NC	--	NA
CYTB1008	N-S	In-plane	NC	--	0.56
	E-W	Out-of-plane	NC	1.30	0.78

Stress Ratio R_1	Stress Ratio R_2
0.68	1.30
**	
0.38	1.01
Column strip bolted to concrete wall	
0.68	2.18
1.22	0.74
0.73	*
Barriers added to contain wall if failed	
Barriers added to contain wall if failed	

Table 1 - Notes

a. N-S means north-to-south; E-W means east-to-west. North is defined as "grid north".

b. Column means that the wall identification number represents a rectangular pilaster b

c. NC means "not Calculated;" the peak of the response curve was used.

d. The design response is equal to $1.3S_a$ (S_a is the response spectral acceleration).

e. Stress Ratio R_1 is the maximum ratio of calculated stresses to allowable stress per

f. Stress Ratio R_2 is equal to stress ratio R_1 factored by ratio of spectral accelerati those estimated in IE Bulletin 80-11 project.

$$R_2 = R_1 \frac{1.3\ a_{sep}}{a_d}$$

g. (*) identify walls in buildings which were not in the SEP scope-of-work.

h. (**) identify walls which were qualified to criteria other than stresses (e.g. allow displacements).

lock column, not a wall.

NRC criteria R_1 = Max.

on calculated in SEP project to

able moments, allowable

Comparison of SSE Stresses in CY Block Walls
With Allowable Stresses per NUSCO Criteria and NRC Criteria

Stress	Allowable Stress NUSCO Criteria	Allowable Stress* NRC Criteria	Calculated Stresses in Wall***																	
			CYSF 1001	CYSF 1002	CYPAB 101A	CYPAB 101B	CYPAB 101D	CYPAB 101E	CYPAB 101F	CYDG 1004	CYSB 2002	CYSB 2003	CYPAB 105	CYTB 1009	CYTB 2004	CYTB 1010	CYPAB 106	CYTB 1007	CYSF 2001	CYDG 1001
Tension Parallel to Bed Joint	45.7	41.1 (20.6)	-	10.8	-	-	-	-	-	33.6	-	-	4.5	28.1	-	-	28	34.8	-	23.06
Tension Normal to Bed Joint	22.9	17.8 (8.97)	4.65	3.98	6.6	5.8	15.3	15.3	6.0	-	-	-	11.8	-	-	6.8	10.4	21.7	12.9	18.38
In-Plane Shear	39.8	30.9 (15.5)	38.4	5.83	-	-	21.7	21.7	-	-	-	-	15.7	-	-	-	21	-	7.24	4.48
Out-of-Plane Shear	48.6	30.9 (15.5)	-	-	-	-	-	-	-	-	-	-	15.7	-	-	-	12	-	-	-

* ( ) Allowable Stresses for Uninspected Walls

** Calculated Stresses Readily Available from Calculations

CALCULATION PACKAGE COVER SHEET

Project: CONNECTICUT YANKEE BLOCK WALLS

Client: NUSCO

Calc. No: CYPAB101A

Subject: ANALYSIS OF WALL

This calculation package has been prepared, checked and approved in accordance with procedures in the URS/Blume Quality Assurance Manual.

Rev	Prepared By	Date	Checked By	Date	Approved By	Date
0	[signature]	11-26-80	[signature]	11-28-80	TC PAN	12-16-80

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 1

JOB NO. 8090-3 JOB CB BLOCK WALL EVALUATION BY JSM DATE 11-11-80

CLIENT NUSCO SUBJECT CYPAGI01A CHK'D JOE DATE 11-26-80

ANALYSIS SUMMARY

OUT OF PLANE LOADING

	(STRIP 2)	ALLOWABLE
FREQUENCY	10.4 HZ ±15 %	
HORIZ. ACCELERATION	.40 g	
ARCHING STRESS	107 psi	
MAXIMUM COMPRESSIVE STRESS	200.5 psi	386 psi
MAXIMUM SHEAR STRESS	12.7 psi	39.7 psi
MAXIMUM DEFLECTION OF WALL	.284"	0.5"
MAXIMUM g CAPACITY OF WALL	1.27 g	

WALL LOADS ON CONCRETE FLOOR BEAMS (INCLUDES ARCHING, DL, VERT. SEIS.)

MAXIMUM MOMENT 46.6 K-FT

MAXIMUM SHEAR 12.1 KIPS

MAXIMUM DEFLECTION FROM ARCHING LOADS = .0046"

ULTIMATE MOMENT CAPACITY 711 K-FT

SHEAR CAPACITY 89 KIPS

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 2

JOB NO. 5040-3 JOB CY BLOCK WALL EVALUATION BY JSM DATE 11-13-80

CLIENT NUSCO SUBJECT CYPAB101A CHK'D IOE DATE 11-26-80

IN PLANE LOADING

FREQUENCY 21 HZ ± 15%

HORIZONTAL ACCELERATION .28g

MAXIMUM SHEAR STRESS = 12.5 psi ALLOWABLE 39.7 psi

MAXIMUM COMPRESSIVE STRESS = 49.5 psi ALLOWABLE 386 psi

SLIDING COEFFICIENT = .518 ALLOWABLE .533

ATTACHMENT PULL OUT

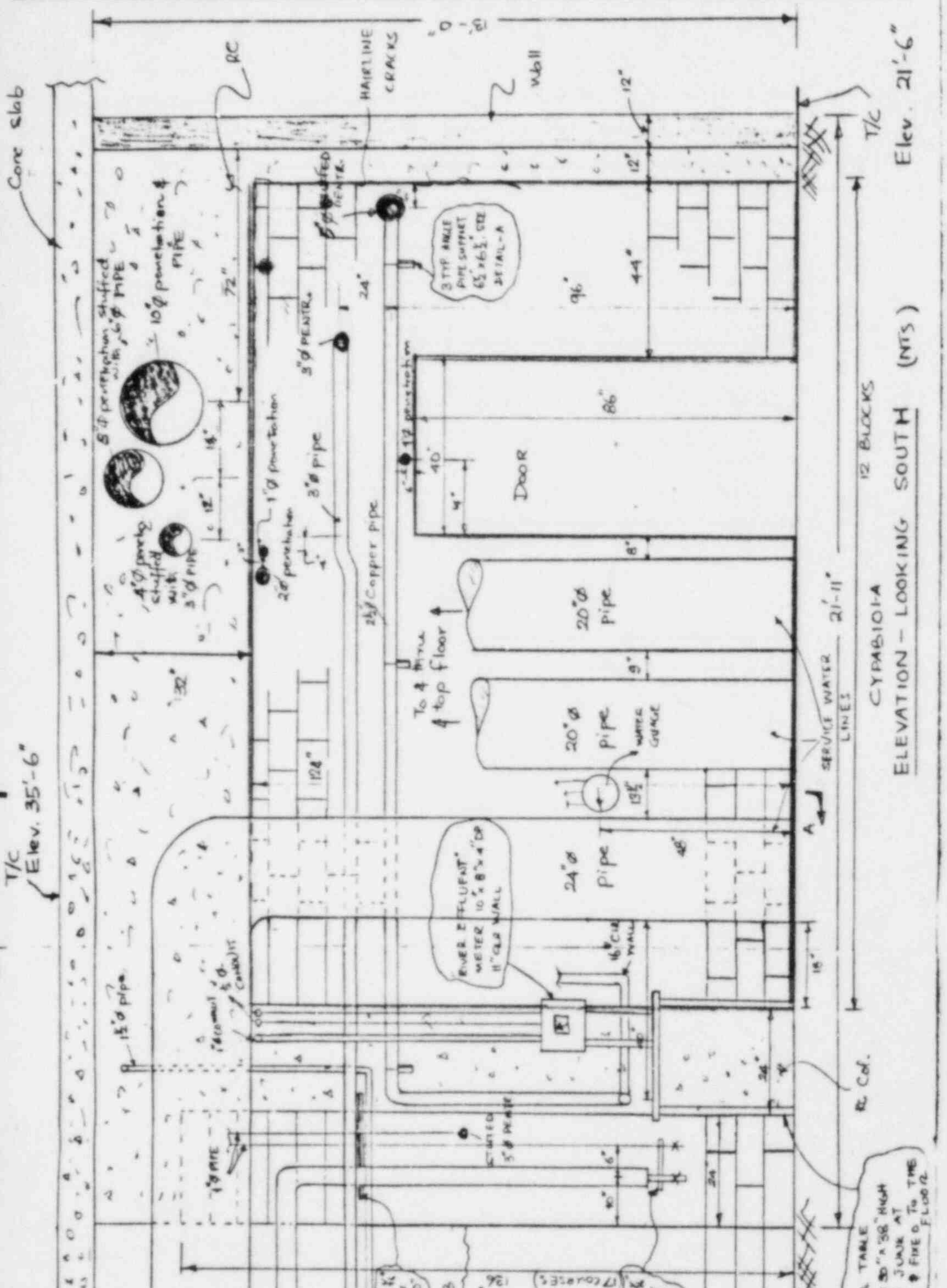
ALL BOLTED ATTACHMENTS ARE ADEQUATE

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET 7

JOB NO. 8040-01	JOB CY- BLOCK W LS	BY IDE	DATE 7-19-?
CLIENT NUSCO	SUBJECT CYPAB 101 (A)	CHK'D ?	DATE 8/5/80

SHEET NO.

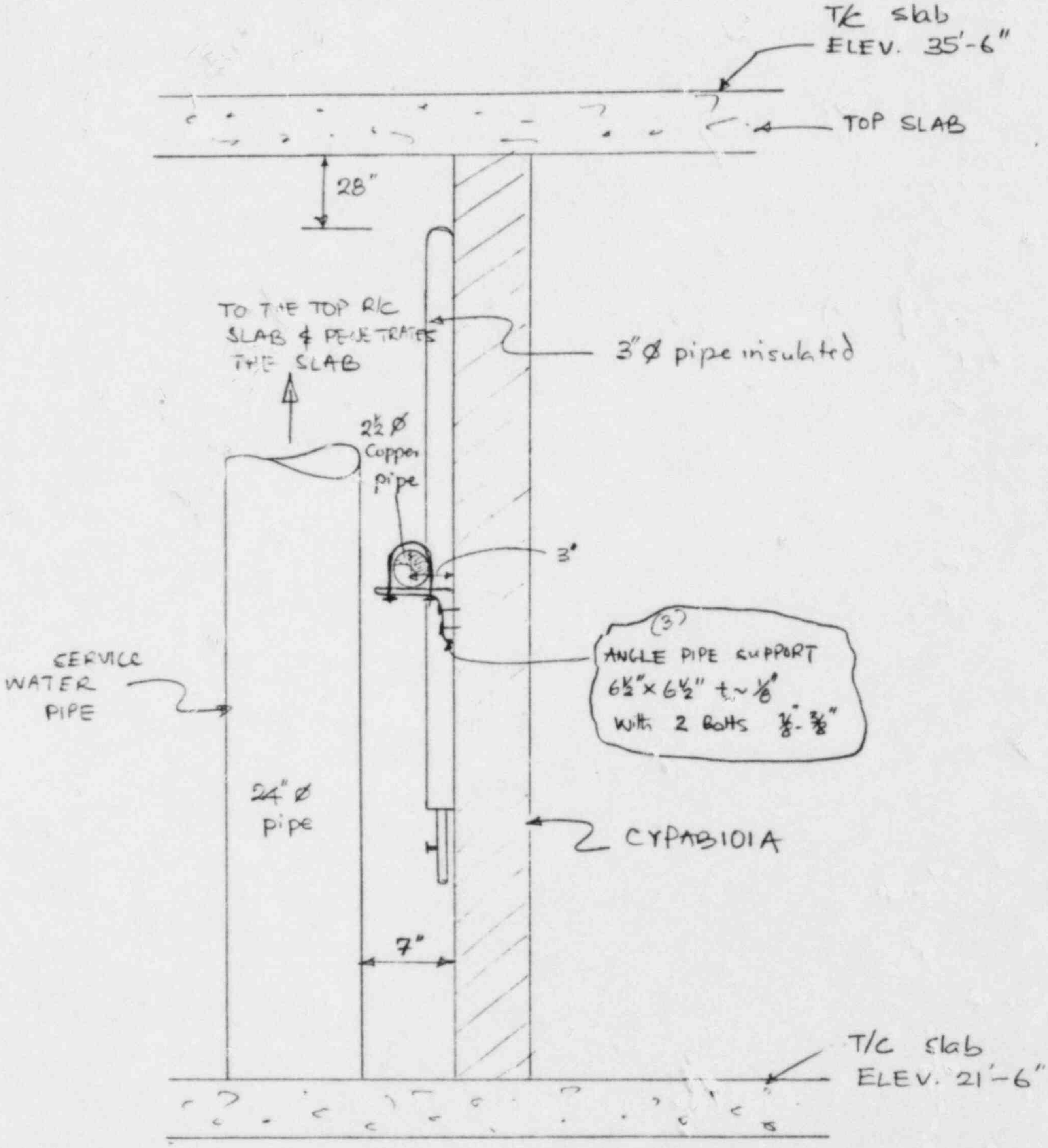


URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 8

JOB NO. 8040-01 JOB CY- BLOCK WALLS BY IOE DATE 7-25-80

CLIENT NUSCO SUBJECT CY-PAB101 (A) CHK'D JSM DATE 8/5/80



CYPAB101-A
SECTION A-A
(NTS)

ATTACHMENT WEIGHTS

1. 2½" ϕ COPPER PIPE
USE THE WEIGHT OF A 2½" SCH 5 PIPE

PIPE WT = 2.475 lbs/ft
WATER WT = 2.499
TOTAL ≈ 5.0 lbs/ft

APPROXIMATE SPAN LENGTH = 10'-0"

WEIGHT/SUPPORT = 5.0 X 10 = 50 lbs/support

2. MISC. ATTACHMENTS LIGHT FIXTURES, GAUGES, ETC.

EST. 50 lbs CONCENTRATED LOAD AT MIDSPAN

3 CONDUITS
EST. WT. FOR CONDUIT = 2 lb/ft

EST. TOTAL LENGTH OF CONDUIT = 5 CONDUITS X 5 SPAN = 25'

TOTAL WT OF CONDUIT = 25 X 2 = 50 lbs

4 DOOR + DOOR FRAME

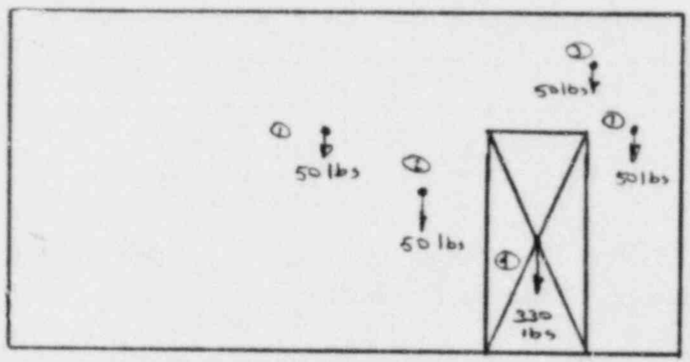
DOOR = 100 lbs EST.

ATTACHMENT WEIGHTS CONT.

DOOR FRAME
ASSUME A 6X13 [SECTION

$$WT = \frac{2 \times 86 + 40}{12} \times 13 = 230 \text{ lbs}$$

TOTAL = 100 + 230 = 330 lbs

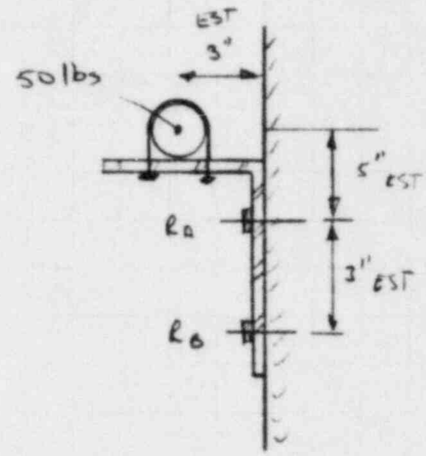


DISTRIBUTION OF ATTACHMENT WEIGHTS

CHECK BOLT CAPACITY

1. 2½" COPPER PIPE

ESTIMATED WEIGHT PER SUPPORT = 50 lbs



DETERMINE REACTION AT R_A

TOTAL VERTICAL FORCE

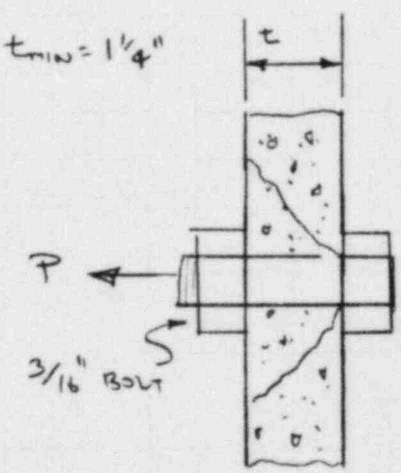
$F_V = 50 + .13 \times 50 = 56$ lbs

TOTAL HORIZONTAL FORCE

$F_H = 1.3 \times .39 \times 50 = 22$ lbs

Σm_B

$R_A = \dfrac{56 \times 3 + 22 \times 8}{3} = \underline{115 \text{ lbs}}$



DETERMINE CAPACITY OF A 3/16" BOLT IN A HOLLOW MASONRY BLOCK.

EFFECTIVE SHEAR AREA $= \pi\left(\frac{3}{16} + 1\frac{1}{4}\right) \times 1\frac{1}{4}$
$= 5.65 \text{ in}^2$

ALLOWABLE STRESS $= 2\sqrt{f_m'} = 2\sqrt{700} = 53$ psi

$P_{ALL} = V \times A = 53 \times 5.65 = \underline{\underline{300 \text{ lbs}}} > \underline{\underline{115 \text{ lbs}}}$ OK

CALCULATION PACKAGE COVER SHEET

Project: CONNECTICUT YANKEE BLOCK WALLS

Client: NUSCO

Calc. No: CYPAB101C

Subject: ANALYSIS OF WALL

This calculation package has been prepared, checked and approved in accordance with procedures in the URS/Blume Quality Assurance Manual.

Rev	Prepared By	Date	Checked By	Date	Approved By	Date
0	J. Mom[illegible]	12-15-80	[illegible]	12-15-80	T.C. PAN	12-16-80

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 1

JOB NO. 8090-3 JOB CY BLOCK WALL EVALUATION BY JSM DATE 11-4-80

CLIENT NUSCO SUBJECT CYPAB101C CHK'D IOE DATE 11-5-80

SUMMARY OF RESULTS

OUT OF PLANE ANALYSIS

PERIOD = .08 SEC - .11 SEC

g_{max} = .37g SSE HORIZONTAL .113g VERTICAL

SHEAR STRESS = 13.6 psi v_{ALL} 39.7 psi OK

MAXIMUM MOMENT = 18877 IN-lbs

ELASTIC STRESS = 59 psi ARCHING ACTION REQUIRED

MAXIMUM ARCHING STRESS = 103.6 PSI

MAXIMUM COMPRESSIVE STRESS = 103.6 + 61.4 = 165 psi σ_{ALL} = 386 psi OK

MAXIMUM ARCHING DEFLECTION = .33"

MAXIMUM "g" CAPACITY = .86 g @ .5" DEFLECTION

MAXIMUM PULLOUT STRESS = 7.9 psi ALLOW = 53 psi

IN PLANE ANALYSIS

PERIOD .28 SEC - .38 SEC

g_{max} = .45g SSE HORIZONTAL .113g VERTICAL

MAXIMUM COMPRESSIVE STRESS = 47.4 psi σ_{ALL} = 386 psi OK

MAXIMUM SHEAR STRESS = 26.5 psi τ_{ALL} = 39.7 psi OK

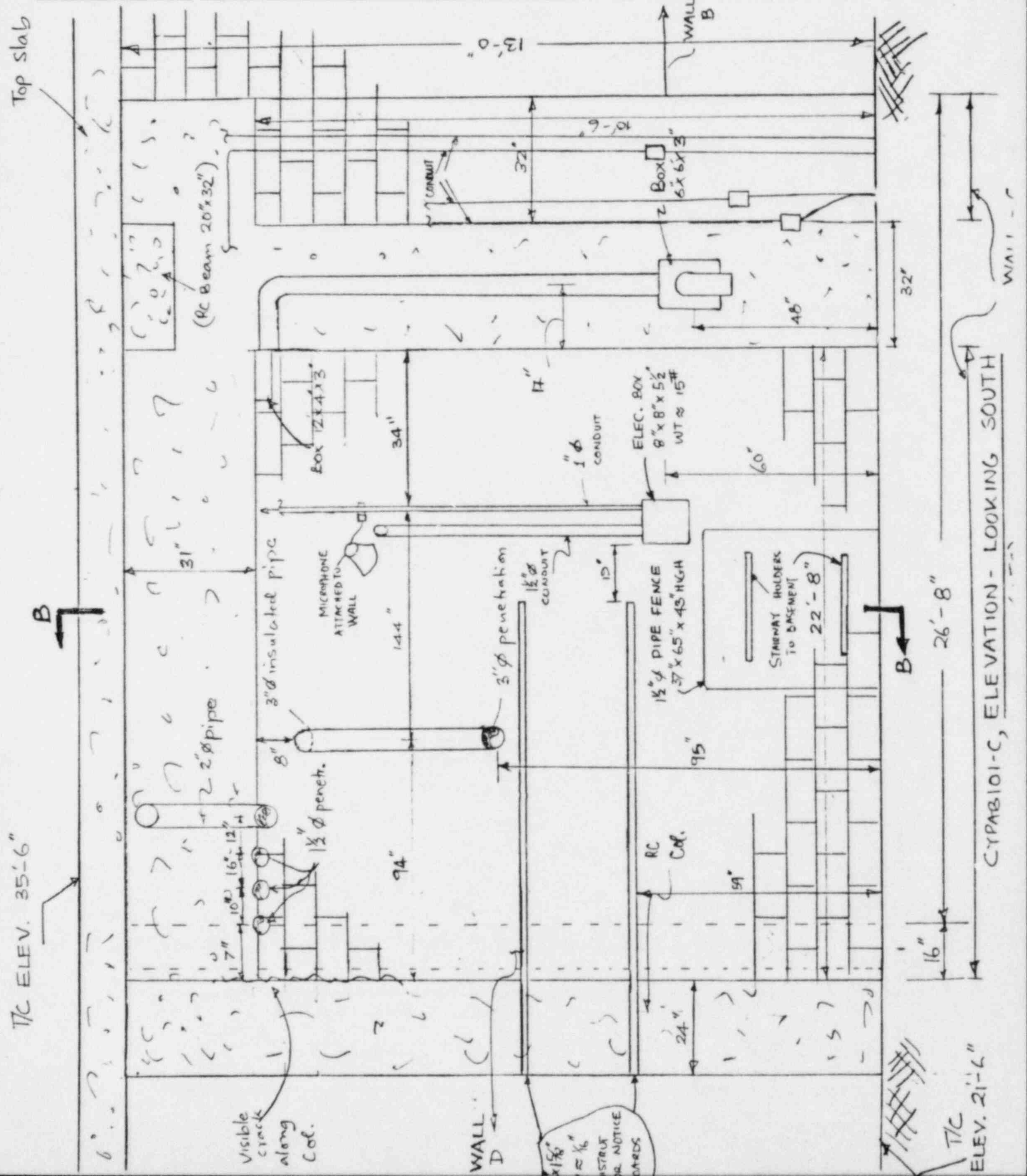
WALL SLIDES, MODIFICATIONS REQUIRED

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 6

JOB NO. 8040-01 JOB CY- BLOCK WALLS BY IOE DATE 7-21-80

CLIENT NUSCO SUBJECT CYPAB101 (C) CHK'D JSM DATE 8/5/85

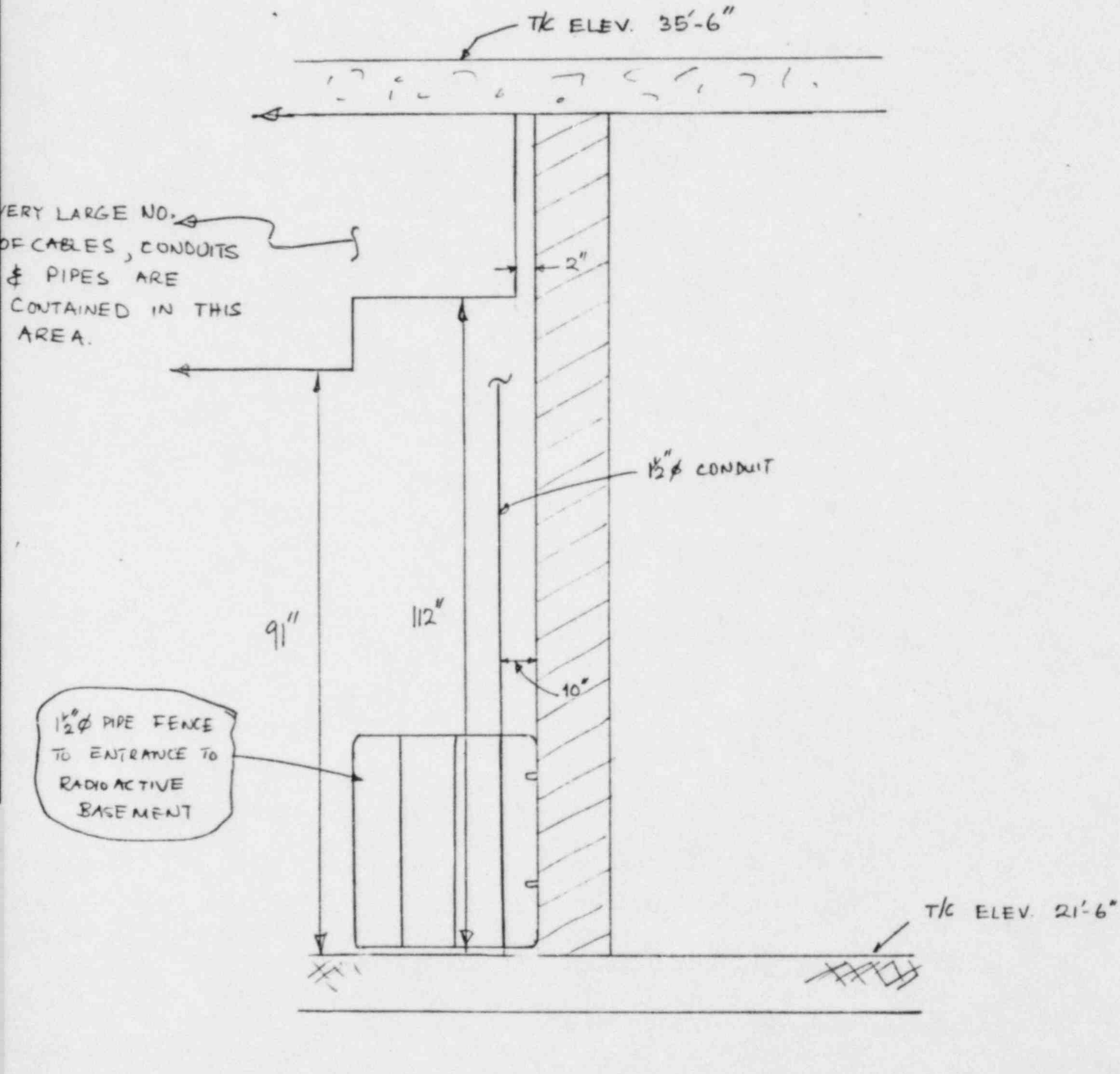


URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 7

JOB NO. 8040-01 JOB CY-BLOCK WALLS BY IOE DATE 7-25-80

CLIENT NUSCO SUBJECT CY-PAB101 (C) CHK'D JSM DATE 8/15/80



CYPAB101-C

SECTION B-B (NTS)

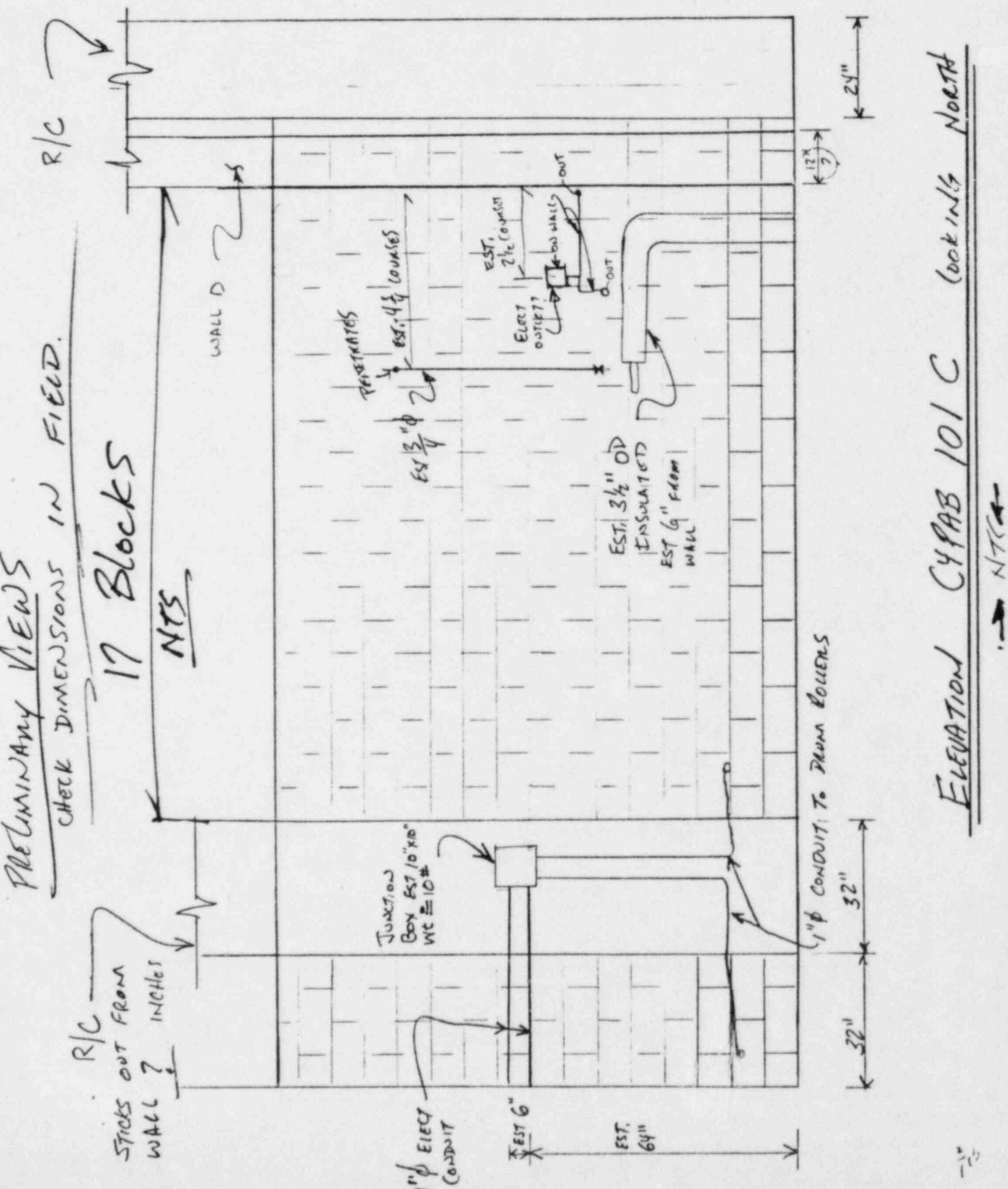
URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 8

JOB NO. 8040.01 JOB CY BLOCK WALLS BY STR DATE 7-31-80

CLIENT NUSCO SUBJECT CYPAB 101 C CHK'D [illegible] DATE 8/5/80

VIEW FROM INSIDE DRUM ROOM



URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

JOB NO. 8040-3 JOB CY BLOCK WALL EVALUATION BY JSM DATE 10-22-80

CLIENT NUSCO SUBJECT ANCHOR BOLT CAPACITY CHK'D IOE DATE 10-23-80

FOR HOLLOW MASONRY BLOCKS $t_{min} = 1.25''$

PULLOUT FORCE $P = v_m \times A$

$= 53 \times \pi (d + 1.25) \times 1.25 = 208d + 260$

BOLT DIAMETER	PULL OUT FORCE
3/16"	300 lbs
1/4"	312 lbs
3/8"	338 lbs
1/2"	364 lbs
5/8"	390 lbs
3/4"	416 lbs

BY INSPECTION, ALL ATTACHMENT BOLTS ARE SECURE.

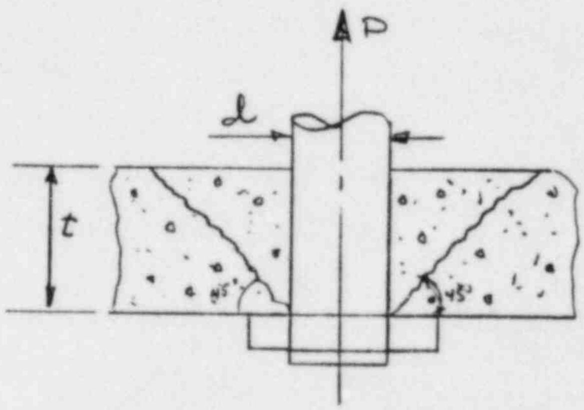
MAXIMUM PULLOUT STRESS $= \frac{53 \times 44.6}{300} = 7.9$ PSI (ASSUMING A 3/16" BOLT)

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

JOB NO. 8040-3 JOB CY BLOCK WALL EVALUATION BY JSM DATE 10-22-80
CLIENT MYSCO SUBJECT ATTACHMENT BOLT CAPACITY CHK'D IDE DATE 10-23-80

MOST OF THE BOLTS USED TO ATTACH COMPONENTS TO BLOCK WALLS ARE OF UNKNOWN SIZE AND TYPE

A CONSERVATIVE VALUE FOR A BOLTS PULL OUT CAPACITY IN A HOLLOW MASONARY BLOCK SHALL BE CALCULATED.



FAILURE DUE TO PUNCH OUT

EFFECTIVE SHEAR AREA

$A = \pi (d + t) \times t$

ALLOWABLE STRESS $= 2\sqrt{f_m'}$

FOR ASTM C90 BLOCK $f_m' = 700$ psi

ALLOWABLE STRESS $= 2\sqrt{700} = 53$ psi

2 GATE

$$F_1 = \frac{(50 \times 1.13)15}{48} = 17.7 \text{ lbs}$$

$$F_2 = \frac{50 \times 1.3 \times .37}{2} = 12 \text{ lbs}$$

29.7 lbs

3 ATTACHMENTS

$$F = 45 \times 1.3 \times .37 = 21.6 \text{ lbs}$$

4 Copper Pipe

$$F = 30 \times 1.3 \times .37 = 14.4 \text{ lbs}$$

CHECK PULL OUT FORCE OF BOLTS HOLDING ATTACHMENTS TO WALL

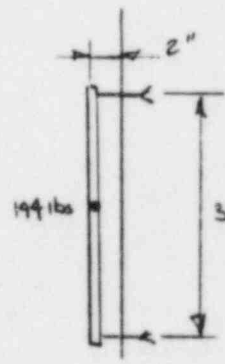
ACCELERATION VALUES

VERTICAL .113g

OUT OF PLANE = .37g

IN PLANE .45g

1 BULLETIN BOARD



MAXIMUM PULLOUT FORCE OCCURS AT UPPER BOLT

FORCE DUE TO VERTICAL LOADS

$$F_1 = \frac{(144 \times 1.113)\,2}{32} = 10 \text{ lbs}$$

FORCE DUE TO OUT OF PLANE LOADS

$$F_2 = \frac{144 \times 1.3 \times .37}{2} \quad 34.6 \text{ lbs}$$

FORCES DUE TO IN PLANE LOADS ASSUME HORIZONTAL BOLT SPACING OF 5'

$$F_3 = \frac{(144 \times 1.3 \times .95) \times 2}{5 \times 12} \times \frac{1}{2} = 1.4 \text{ lb}$$

$$F_{max} = 10 + 34.6 = 44.6 \ \frac{\text{lbs}}{\text{BOLT}}$$

ATTACHMENT 2

URS/BLUME

130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. i

JOB NO. 6586-01 JOB Cy Block walls BY SIR DATE 9/17/85

CLIENT NUSCO SUBJECT CYPAB 101-C Two way action CHK'D DATE

Summary of Assumptions

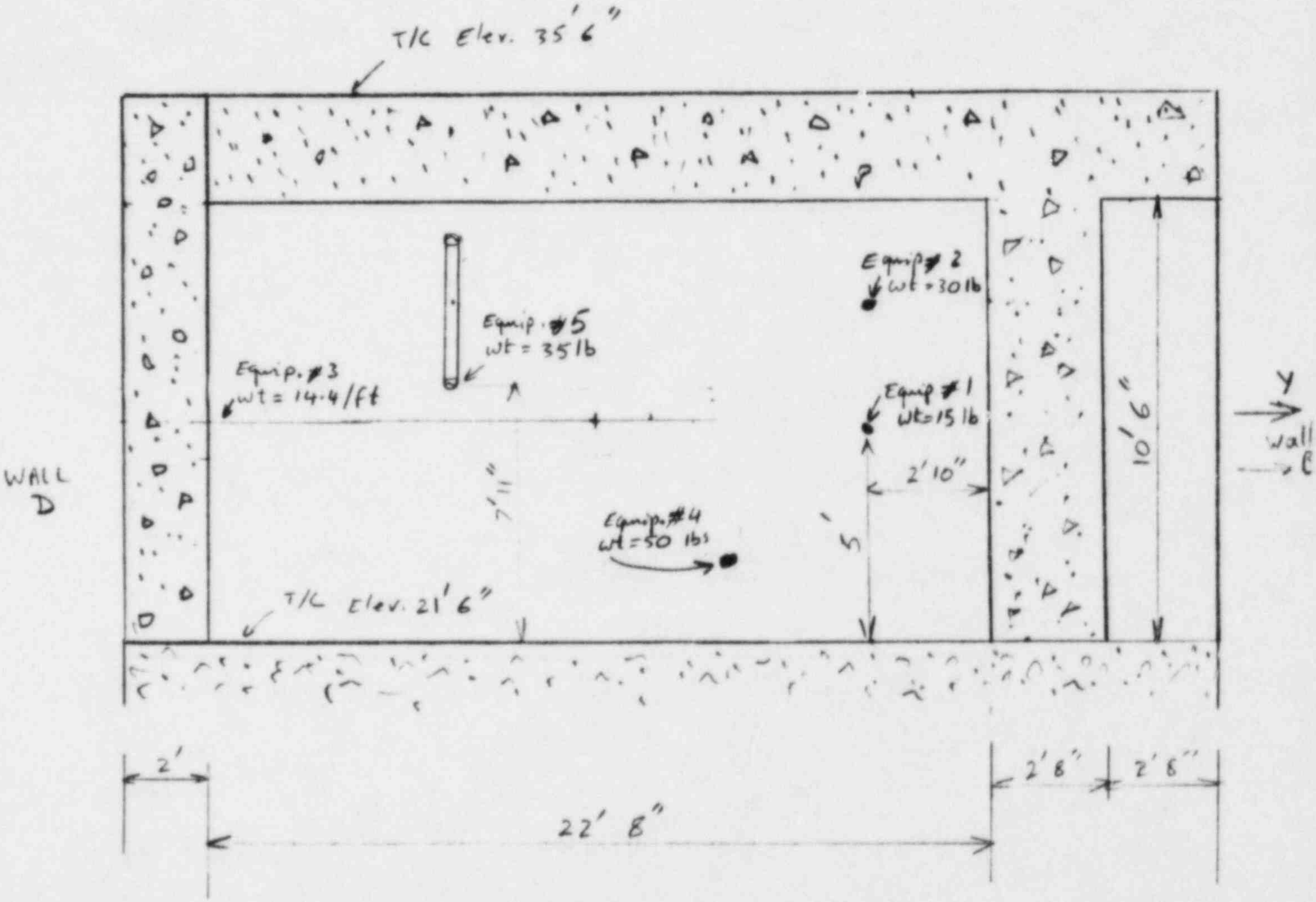
- using plate theory to calculate the frequencies of the wall
- Using 2-way action to calculate stresses in the wall
- The codirectional stress responses due to perpendicular inputs are combined by SRSS method (i.e. codirectional moments due to Horizontal and Vertical input are combined by SRSS method)

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 1

JOB NO. 85660-1 JOB Cy Block wall BY SB DATE 9/16/85

CLIENT NUSCO SUBJECT CYPAB 101-C Two-way action CHK'D DATE



ELEATION VIEW OF CYPAB101-C WALL

Notes:

Equip #1 is Electric Box; wt = 30 lb
Equip. #2 is Load speaker & Conduit; wt = 15 lb
} total 1+2 = 45 lb, eccentricity e = 8"

Equip #3 is Bulletin Board; wt = 14.4 lb/ft ; e = 8"
Equip #4 is Gate ; wt = 50 lbs ; e = 21"
Equip #5 is 3/4" insulated pipe ; wt = 35 lbs ; e = 0

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 2

JOB NO. 5586-01 JOB Cy Block wall BY SB DATE 9/16/85

CLIENT NUSCO SUBJECT wall CYPAB 101-C Two way action CHK'D DATE

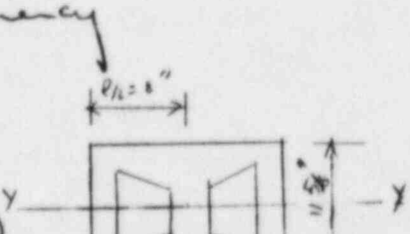
Equipment mass on wall CYPAB 101-C

Electric box & conduit ①+②	45 lb
Bulletin board for 10 ft length	144 lb
Gate	50 lb
3/4" pipe	30 lb
Total	269 lbs

Out-of-Plane Fundamental Frequency

For SS plate out of plane frequency

$$f = \frac{\pi}{2}\left(\frac{1}{a^2}+\frac{1}{b^2}\right)\sqrt{\frac{E h_e^3}{12\, m(1-\nu^2)}}$$



$I_{yy} = 619$ for Half a block i.e. 8" length (see Att. p.3)

$h_e = \sqrt[3]{\frac{12\, I_{yy}}{\ell/2}} = \sqrt[3]{\frac{12 \times 619}{8}} \simeq 9.76"$ effective thickness

$m_w = \frac{74}{8 \times 16 \times 386.4} = .0015 \ \frac{lb - sec^2}{in^3}$ unit mass of wall

$m_e = \frac{269}{126 \times 772}\ \frac{1}{386.4} = .00002 \ \frac{lb - sec^2}{in^3}$

$m = 1.52 \times 10^{-3} \ \frac{lb - sec^2}{(in)^3}$ unit mass of wall and smired mass of Equipment.

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 3

JOB NO. 8586-01 JOB Cy Block wall BY SB DATE 9/16/85

CLIENT Nusco SUBJECT wall CYPAB 101-C Two-way action CHK'D DATE

$$f = \frac{\pi}{2}\left(\frac{1}{(126)^2} + \frac{1}{(272)^2}\right)\sqrt{\frac{420{,}000 \times 9.76^3}{12 \times .00152(1 - .15^2)}}$$

$$f = \frac{\pi}{2}\left(7.64 \times 10^{-5}\right) 1.480 \times 10^5 \simeq 17.8 \quad HZ \quad \pm 15\%$$

$f_r = 15.1 - 20.5$ HZ frequency range

frequency based on vertical 24" strip (cal CYPAB 101-C)

$f = 10.9$ HZ $\pm 15\%$

$f_r = 9.3 - 12.5$ HZ

Stress Calculations

The maximum bending moment at the mid-span of the wall is given by ACI 318-56 (pages 944-945)

$$M_w = C w S^2$$

where for aspect ratio $= \frac{\text{short span}}{\text{long span}} = 0.47 < 0.5$

$C = 0.083$

$S = 10'6'' = 126$ inches short span

and w = effective weight per unit area

Now; using preliminary spectra for PAB bldg elev. 35'6" with 7% damping (see URS/Blume report, Final Report on Safety-Related Masonry walls at the CY, May 1981, page D-9) for frequency of 15.1 HZ (page 3)

$S_a = 0.28\,g = 0.28 \times 386.4 = 108.2$ in/sec^2

$w = 108.2 \times .00152 = .1645$ lb/in^2

$M_w = .083 \times .1645 \times (126)^2 = 216.8$ lb-in / unit width

The above maximum moment occurs at the center of the plate. This moment is about an axis along the center line of plate in the long span direction (i.e. y-direction see page 1)

There is a codirectional moment due to the eccentricity of attachments subjected to vertical input. Taking a vertical strip at the center of the wall (where moment due to horizontal input is maximum). The equipment at this strip is the bulletin board

$wt_{bull.} = \frac{14.4}{12} = 1.2$ lb/in eccentricity $= 8''$

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

JOB NO. 856601 JOB CY Block Wall BY SB DATE 9/17/85
CLIENT NUXO SUBJECT CY PAB 101-C Two-way action CHK'D DATE

taking vertical acceleration as $\frac{2}{3}$ of ZPA of SSE ground spectra:

$$\text{vertical acceleration} = \frac{2}{3} \times .17(g) = .113\,g$$

vertical force P = Dead load + vertical seismic

$$P = m(1.0g) + m(.113g)$$

$$P = m \times 1.113\,g = wt \times 1.113 \qquad \text{ie } wt = m \times g$$

for bulletin board

$$P = 1.2 \times 1.113 = 1.336 \quad \text{lb /unit width}$$

Assuming the bulletin board to be at mid-span of the wall

$$M_v = P \times \text{eccentricity} = 1.336 \times 8$$

$$M_v = 10.69 \quad \text{lb-in /unit width}$$

Increase the moment due to horizontal by 1.3 factor in accordance to the criteria for seismic load on the wall

$$M_\omega = 1.3\,M_\omega = 1.3 \times 216.8 = 281.8 \quad \text{lb-in /unit width}$$

Combining the codirection moment due to horizontal and vertical input by SRSS method

$$M = \sqrt{(M_\omega)^2 + (M_v)^2} = \sqrt{(281.8)^2 + (10.69)^2}$$

$$M = 282.0 \quad \text{lb-in /unit width}$$

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 6

JOB NO. 8566-01 JOB CY Block wall BY SB DATE 9/17/85

CLIENT NUSCO SUBJECT CYPAB101-C Two-way action CHK'D DATE

Maximum stress is

$$\sigma_{max} = \frac{M}{S}$$

where $S = \frac{I}{c} = \frac{\frac{1}{8} \times 619}{\frac{1}{2} \times 11.625} = 13.31$ for unit width

$$\sigma_{max} = \frac{282}{13.31} = 21.2 \text{ psi}$$

$\sigma_{max} = 21.2$ psi ; $\sigma_{ALL} = 1.67 \times 13.7^{*} = 22.9$ psi

$\sigma_{max} < \sigma_{ALL}$ ok. ✓

* $FT_V = 0.5\sqrt{m_o} = 0.5\sqrt{750} = 13.7$ psi Tension Vertical Slip
ACI allowables

URS/BLUME
130 Jessie Street (at New Montgomery)
San Francisco, California 94105

APPENDIX A

SHEET NO. 1 –

JOB NO. 8040-03 JOB CY-BLOCK WALLS BY IOE DATE 9-16-80

CLIENT NUSCO SUBJECT BLOCK SECTION PROPERTIES. CHK'D JSM DATE 9/23/80

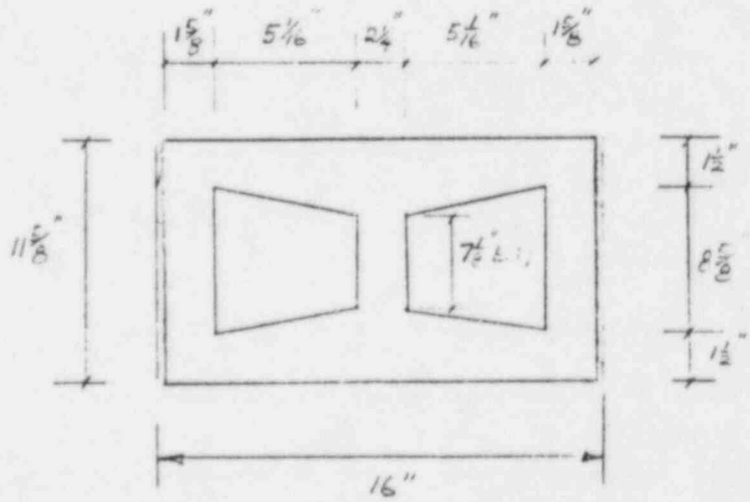
BLOCK 16"x 8"x 12" SECTION PROPERTIES.

REFERENCE:

BASALT ROCK CO. INC. PRODUCTS CATALOGUE.

MATERIAL DENSITY = 150 LBS/FT^3

* ALL CALCULATIONS INCLUDE A 3/8" MORTAR JOINT



VOLUME OF SOLID BLOCK = $16 \times 11\frac{5}{8} \times 8 = 1488\ IN^3$

WEIGHT OF SOLID BLOCK = $160 \times \frac{1488}{1728} =$ 129 LBS.

VOLUME OF HOLLOW BLOCK = $1488 - 2\left[\left(\frac{8.625 + 7.125}{2}\right) \times 5.0625 \times 8\right] = 850\ IN^3$

WEIGHT OF HOLLOW BLOCK = $150 \times \frac{850}{1728} =$ 74 LBS.

130 Jessie Street (at New Montgomery)
San Francisco, California 94105

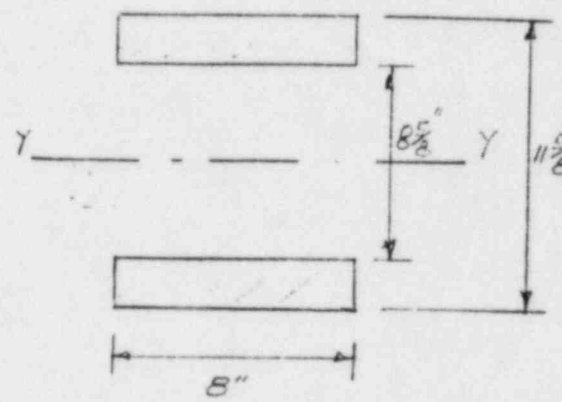
JOB NO. 8040-03 JOB CY-BLOCK WALLS SHEET NO. ____
BY ICE DATE 9-16-80
CLIENT NUSCO SUBJECT BLOCK SECTION PROPERTIES
CHK'D JSM DATE 9/23/80

HORIZONTAL STRIP: (SOLID BLOCK)

$$I_{YY} = \frac{8 \times 11.625^3}{12} = \underline{1047 \text{ in}^4}$$

$$S_{YY} = \frac{8 \times 11.625^2}{6} = \underline{180.2 \text{ IN}^3}$$

$$A_V = 8 \times 11.625 = \underline{93 \text{ IN}^2}$$



HOLLOW BLOCK:

$$I_{YY} = 1047 - \frac{8 \times 8.625^3}{12} = \underline{619 \text{ IN}^4}$$

$$S_{YY} = \frac{I}{c} = \frac{619}{11.625/2} = \underline{106.5 \text{ IN}^3}$$

$$A_V = 3 \times 8 = \underline{24 \text{ IN}^2}$$