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RECIP.NAME RECIPIENT AFFILIATION
VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Forwards suppl to util 840928 response to NRC 840813 request for addl info re proposed amend to spent fuel storage facility expansion.Changes involve Item 1.3 on "Region 2 Racks,Summary of Design Stresses & Min Margins of Safety."

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FLORIDA POWER & LIGHT COMPANY

October 18, 1984
L-84-284

Office of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactor Branch #1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Varga:

Re: Turkey Points Units 3 & 4
Docket Nos. 50-250 & 50-251
Proposed Amendment to
Spent Fuel Storage Facility Expansion
Additional Information

By letter dated August 13, 1984, the NRC requested additional information regarding the structural design of the spent fuel pit and new storage racks. Responses to these questions were submitted to the NRC via our Letter No. L-84-263, dated September 28, 1984. In a subsequent telephone conversation with Mr. Clyde Herrick of Franklin Research Center, on October 12, 1984, Florida Power & Light Company was requested to submit supplemental information for Questions 4b and 10. The attachment to this letter provides this supplemental information.

If you have any questions, please contact us.

Very truly yours,

J.W. Williams, Jr.
Group Vice President
Nuclear Energy

JWW/GJK/mp

Attachment

cc: J.P. O'Reilly, Region II
Harold F. Reis, Esquire

A001 1/1

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT UNITS 3 & 4
PROPOSED AMENDMENT TO SPENT FUEL
STORAGE FACILITY EXPANSION
SUPPLEMENT TO REQUEST FOR ADDITIONAL
INFORMATION - STRUCTURAL BRANCH

In a telephone conversation with Florida Power & Light Company and Westinghouse on October 12, 1984, Mr. Clyde Herrick of Franklin Research Center requested that supplemental information be added to the responses to Questions 4b and 10, which were submitted to the NRC by our Letter L-84-263, dated September 28, 1984. These questions and our response are attached (Question 4b pages 5 & 6 of 26, Question 10 pages 10 thru 21 of 26). The supplemental information added to each question is underlined for clarity. Please note that the only changes/additions involve item 1.3 on the "Region 2 Racks, Summary of Design Stresses and Minimum Margins of Safety" found on Page 6 of 26, Question 4b, and note 7 to Table A found on Page 14 of 26, Question 10. However, these two responses are being resubmitted in their entirety. The change to Question 4b changes the design stress and the allowable stress shown from a stress range to a maximum stress for consistency with the other values shown on the table.

4. b. Also provide the margins of safety for the maximum stresses under various seismic loading conditions.

RESPONSE:

REGION I RACKS

SUMMARY OF DESIGN STRESSES AND MINIMUM MARGINS OF SAFETY

Normal & Upset Conditions

			Design Stress (psi)	Allowable Stress (psi)	Margin of Safety
1.0	Support Pad Assembly				
	1.1	Support Pad			
		Shear	2009	23150*	10.52
		Axial and Bending	5701	23150*	3.06
		Bearing	4230	23150*	4.47
	1.2	Support Pad Screw			
		Shear	3675	9260	1.52
	1.3	Support Plate			
		Shear	2152	9260	3.30
		Weld Shear	15672	23150*	.48
2.0	Cell Assembly				
	2.1	Cell to Bottom Grid Weld			
		Weld Shear	15840	23150*	.46
	2.2	Cell to Top Grid Weld			
		Weld Shear	15840	23150*	.46
	2.3	Cell			
		Axial and Bending	.514	1.0**	.94
	2.4	Cell to Wrapper Weld			
		Weld Shear	4517	9260	1.05
3.0	Grid Assembly				
	3.1	Top Grid Box Member			
		Shear	2055	9260	3.51
		Axial and Bending	1659	13890	7.37
	3.2	Top Grid Members			
		Weld Shear	13544	21000	.55
	3.3	Top Grid Outer Member			
		Axial and Bending	1707	13890	7.14
		Shear	146	9260	62.51
	3.4	Bottom Grid Structure			
		Shear	3349	9260	1.77
		Axial and Bending	12057	13890	.15
	3.5	Bottom Grid Members Welds			
		Weld Shear	15702	21000	.34
	3.6	Bottom Grid Base Plate Weld			
		Weld Shear	15941	21000	.32

* Thermal Plus OBE Stress is Limiting

** Allowable Per Appendix XVII - 2215 Eq. (24)

4. b. Continued:

REGION 1 RACKS

SUMMARY OF DESIGN STRESSES AND MINIMUM MARGINS OF SAFETY

Normal & Upset Conditions

		Design Stress (psi)	Allowable Stress (psi)	Margin of Safety
1.0	Grid Assembly - Cont'd			
3.7	Bottom Grid Outer Member			
	Axial and Bending	12050	13890	.15
	Shear	768	9260	11.06
3.8	Base Plate Stiffener to Base Plate Weld			
	Weld Shear	13500	21000	.56

REGION 2 RACKS

SUMMARY OF DESIGN STRESSES AND MINIMUM MARGINS OF SAFETY

Normal & Upset Conditions

		Design Stress (psi)	Allowable Stress (psi)	Margin of Safety
1.0	Support Pad Assembly			
1.1	Support Pad			
	Shear	3504	23150*	5.61
	Axial and Bending	10288	23150*	1.25
	Bearing	7631	23150*	2.03
1.2	Support Pad Screw			
	Shear	6974	9260	.33
1.3	Support Plate			
	Shear	4403	9260	1.10
	Weld Shear	16556	21000*	.27
2.0	Cell Assembly			
2.1	Cell			
	Axial and Bending	.899	1.0†	.11
2.2	Cell to Base Plate Weld			
	Weld Shear	15482	21000	.36
2.3	Cell to Cell Weld			
	Weld Shear	18389	23150*	.26
2.4	Cell Seam Weld			
	Weld Shear	1751†	2194††	.25
2.5	Cell to Wrapper Weld			
	Weld Shear	10299	18520**	.80

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* Thermal Plus OBE Stress is Limiting.
** SSE Stress is Limiting
† Allowable per Appendix XVII-2215 Eq (24)
†† Design Load and Allowable Load in Lbs is Shown

10. Please provide a summary of the stress analysis of the spent fuel pool structure (walls, foundation mat, and liner plates); also the bearing stress of the soil and bed rock supporting the pool.

<u>RESPONSE:</u> The stress analysis was performed in accordance with the criteria included in the Turkey Point Updated FSAR, Appendix 5A, Section II (Design Bases). In summary, this criteria includes the following for Category I structures outside the containment;

$$Y = 1/\phi\,(1.25D + 1.25E)$$

$$Y = 1/\phi\,(1.25D + 1.0R)$$

$$Y = 1/\phi\,(1.25D + 1.25H + 1.25E)$$

$$Y = 1/\phi\,(1.0D + 1.0E')$$

where Y = required yield strength of the structures.

D = dead load of structure and equipment plus any other permanent loads contributing stress, such as soil or hydrostatic loads. In addition, a portion of "live load" is added when such load is expected to be present when the unit is operating. An allowance is also made for future permanent loads.

R = force or pressure on structure due to rupture of any one pipe.

H = force on structure due to restrained thermal expansion of pipes under operating conditions.

E = design earthquake load

E' = maximum earthquake load

W = wind load (to replace E in the above load equations whenever it produces higher stresses).

Per the FSAR, design is in accordance with ACI 318-63. These criteria were used to evaluate the structure for effects from the replacement fuel racks. (Note that the Spent Fuel Storage Facility Modification Safety Analysis Report incorrectly states that SRP Section 3.8.4 and the NRC OT Position Paper were also employed in this evaluation.)

The analysis consisted of obtaining the state of stress in the pool using the analytical model described in the response to Question 9. Dead weight, hydrostatic pressure, and spent fuel rack loadings on the pool were considered separately and in combination with seismic, thermal, and wind loads to satisfy the following load combinations:

1. 1.25 (D + P + L) with and without T
2. 1.25 (D + P + L) with and without W
3. 1.25 (D + P + L + E) with and without T
4. 1.0 (D + P + L + E′) with and without T

where,

D = weight of the structure
P = hydrostatic pressure of pool water
L = weight of loaded fuel racks in pool
E = design earthquake load, 0.05 g horizontally
2/3 (0.05 g) vertically
E' = maximum earthquake load, 0.15 horizontally
2/3 (0.15 g) vertically
T = thermal loads
W = wind loads

By using enveloping considerations, these load combinations were reduced to the following controlling load combinations:

1.25 (D + P + L) with and without T
1.25 (D + P + L) + E' with and without T

Seismic input loads for the analysis of the pool structure were obtained using the results of the seismic analysis discussed in FSAR Appendix 14E, Section 3.2. Seismic loads for the new racks were taken into account in the pool structural evaluation. Because analysis has shown that these racks do not uplift during the seismic event, no added amplification factor for impact was considered.

Analysis showed that the seismic loading created a more severe effect than the combined effect of tornado wind and depressurization.

The thermal effect was obtained by imposing a uniform thermal gradient across the solid elements. In accordance with FSAR Section 5.2.3, the temperature of the inside face of the pool was taken as 180°F while that of the exposed outside face of the walls was taken as 30°F. The temperature of the bottom face of the slab was taken as 50°F. This represents the effect after thermal equilibrium is reached. Based on the methodology suggested in Reference 1, Appendix A, this represents a worst case design condition.

Representative critical elements of the finite element model in the base mat and all walls were identified based both on high stress results and locations which result in severe loading. These elements are shown in Figures 3 through 7 and were further evaluated in the manner described below:

1. Resulting stresses in elements caused by mechanical loads (all identified loads in the load case except thermal loads) were evaluated by computing the capacities of the individual sections and comparing the capacities to the actual normal forces and moments.

2. For the combination of mechanical and thermal loads, the sections were analyzed in accordance with the methodology discussed in Reference 2, Section 2.5.6.3.3 and Appendix A.

A summary of the controlling stresses is provided in Table A for the locations identified in Figures 3 through 7. These stresses represent maximum stresses for load transfer. Controlling stresses occur in reinforcing steel, except for one instance where concrete shear governs.

The average bearing stress under the mat is 5 ksf, with a localized maximum of 9 ksf. This is below the design allowable pressure of 10 ksf for the compacted limerock fill. The average bearing stress on the bedrock, approximately 20 feet below the mat foundation, is also 5 ksf, with a conservatively computed localized maximum of 7.4 ksf. This is below the design allowable pressure of 7.5 ksf. This value accounts for the weight of the limestone backfill under the mat.

The liner plate was not considered to provide structural resistance in the analysis of the spent fuel pool. However, a separate analysis was conducted to determine the effects of thermal, hydrostatic and hydrodynamic loads on the functionality of the liner system. This analysis reviewed the buckling potential of the liner plate, as well as stresses in welds and embeds associated with it. The analysis shows that there will be no loss of function.

The reported analysis, as indicated above, was conducted on the assumption of a maximum water temperature of 180°F, based on the updated FSAR criteria. Recent evaluations using more conservative criteria indicate that the maximum water temperature may reach 183°F. By comparing the results of the analysis performed for 180°F water temperature with that performed for 212°F water temperature (see response to NRC Question No. 8 submitted to Florida Power and Light via NRC letter of September 6, 1984), an upper bound interpolation indicates that the maximum stresses reported would not be increased by more than 0.5 ksi if the water temperature were assumed to be 183°F. This increase results in stress levels which remain within the specified allowables.

References:
1. Commentary to ACI 349R-80
2. ACI Committee 349 Report Criteria for Reinforced Concrete Nuclear Power Containment Structure, ACI Journal 1972.

TABLE A

LOAD COMBINATION

	MECHANICAL LOADS								MECHANICAL & THERMAL	
	1.25 (D + P + L)				1.25 (D + P + L) + E				1.25 (D + P + L) + E + T	
			(1)				(1)	(2)	(3)	
Location	N (K/ft)	M K-ft/ft	Mm K-ft/ft	Mm/M	N (K/ft)	M K-ft/ft	Mm K-ft/ft	Mm/M	Rebar Stress	ØFY / Rebar Stress
Base Mat	18.1	7.8	23	2.95	13.2	16.7	27	1.6	fs = 12.8 ksi (5)	2.81
East Wall (Canal)	9.6	-22 (fv = 82 psi)	-52	2.36 1.80(4)	25.0	-29.3 (fv = 142 psi)	-43	1.47 1.04 (4)	fv = 142 psi (6)	1.04 (4)
East Wall (Pool)	33.2	122	568	4.66	64.6	163	490	3.0	fs = 35.1 ksi f's = -9.6 ksi	1.03
North Wall	19.8	-96.6	-123	1.27	13.1	-140	-151	1.08	fs = 27.1 ksi f's = -2.65 ksi	1.33
South Wall	18.9	-38.5	-192	4.99	23.0	-76.1	-182	2.39	fs = 35.3 ksi(7) f's = 1.4 ksi	1.02
Middle Wall	28.5	22.1	209	9.46	2.6	32.5	218	6.7	fs = 9.6 ksi f's = 9.0 ksi	3.75

N = Applied normal force on section
M = Applied moment on section
M_m = Maximum elastic moment
(negative sign indicates compressive stress)

fs = Stress in tension steel
f's = Stress in compression steel
fv = Concrete shear stress

NOTES:

(1) Maximum elastic moment for a section with normal force N imposed on it.

(2) Based on a cracked analysis per the methodology discussed in Reference 2, reinforcing steel stress is obtained directly.

(3) Due to the self relieving nature of thermal loads on reinforced concrete, the ratio of maximum moment capacity to actual moment cannot be uniquely determined. As an alternative, the ratio of ϕF_y to computed reinforcing steel stress is provided. Since structural integrity is maintained beyond the allowable stress for thermal loading, the actual safety factor is greater than the ratio reported.

(4) Where shear stresses control, the ratio provided is that of allowable shear stress (conservatively taken as 148 psi) divided by f_v.

(5) This stress represents the maximum stress found in the top layer of reinforcing steel in the thinner center section of the base mat. The top steel in this area is important for transfer of the tensile loads imposed by the lateral water pressure from the pool. The bottom steel in the center portion of the base mat of the pool is used primarily for crack control. Since the base mat rests directly on competent fill material, stresses in this bottom (secondary) steel resulting from thermal loads have no adverse effect on the ability of the pool to transfer load. Therefore, the stress in the bottom steel is not included in Table A.

(6) As shown in Figure 6, this section occurs in the 3 foot wide by 18 inch thick section of the east wall between the two canal walls. Because of the short span of this section, and the large ratio of section thickness to span length, the section does not resist loads in the fashion of a shallow beam; shear stresses control the section capacity. Since shear stirrups are provided, the allowable shear stress in the concrete exceeds 148 psi. The reinforcing steel on the outside face of this section is used only for crack control and is not needed to resist mechanical loads. Therefore, the flexural stresses in this reinforcing steel are not included in Table A.

(7) This represents an average stress (total force on the total section) over the top 10 feet of the outside face horizontal reinforcing steel. The result indicates that the section in general remains below the minimum specified yield stress. However, a maximum stress of 38 ksi has been calculated for the reinforcing steel in the top element of the wall. Realizing the self-relieving nature of the thermal stresses and further acknowledging that the section in general remains elastic, pool function and structural integrity are maintained. Additionally, in accordance with the Turkey Point Updated FSAR, Appendix 5A, Section II, limited yielding is allowable provided the deflection is checked to ensure that the affected Class I systems and equipment are not stressed beyond their allowables. No Class I systems or equipment are attached to this section of wall. REV. 10-17-84

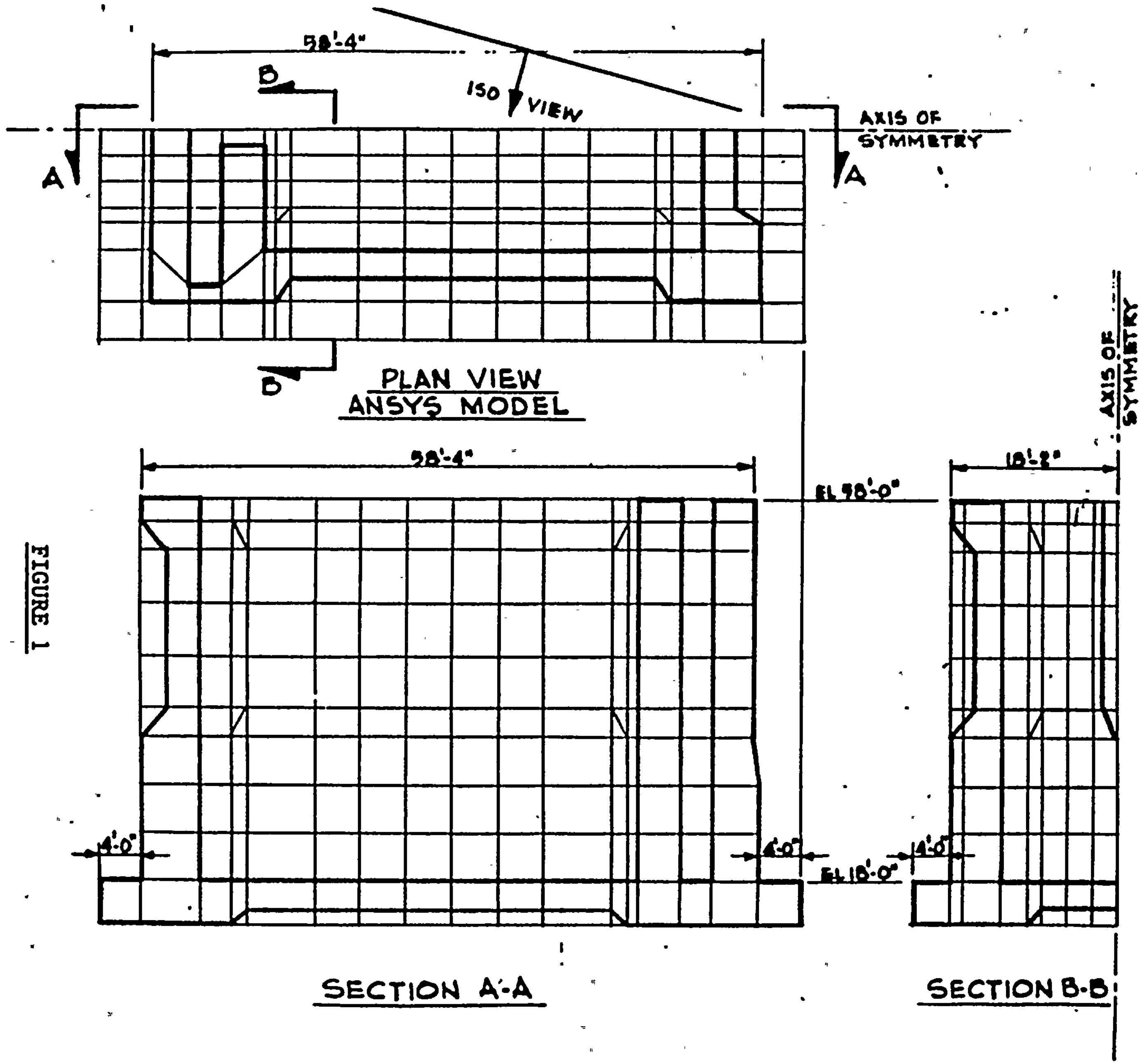

58'-4"
B
ISO VIEW
AXIS OF SYMMETRY
A
A
B
PLAN VIEW
ANSYS MODEL
58'-4"
EL 58'-0"
18'-2"
AXIS OF SYMMETRY
4'-0"
4'-0"
EL 18'-0"
4'-0"
SECTION A-A
SECTION B-B

FIGURE 1

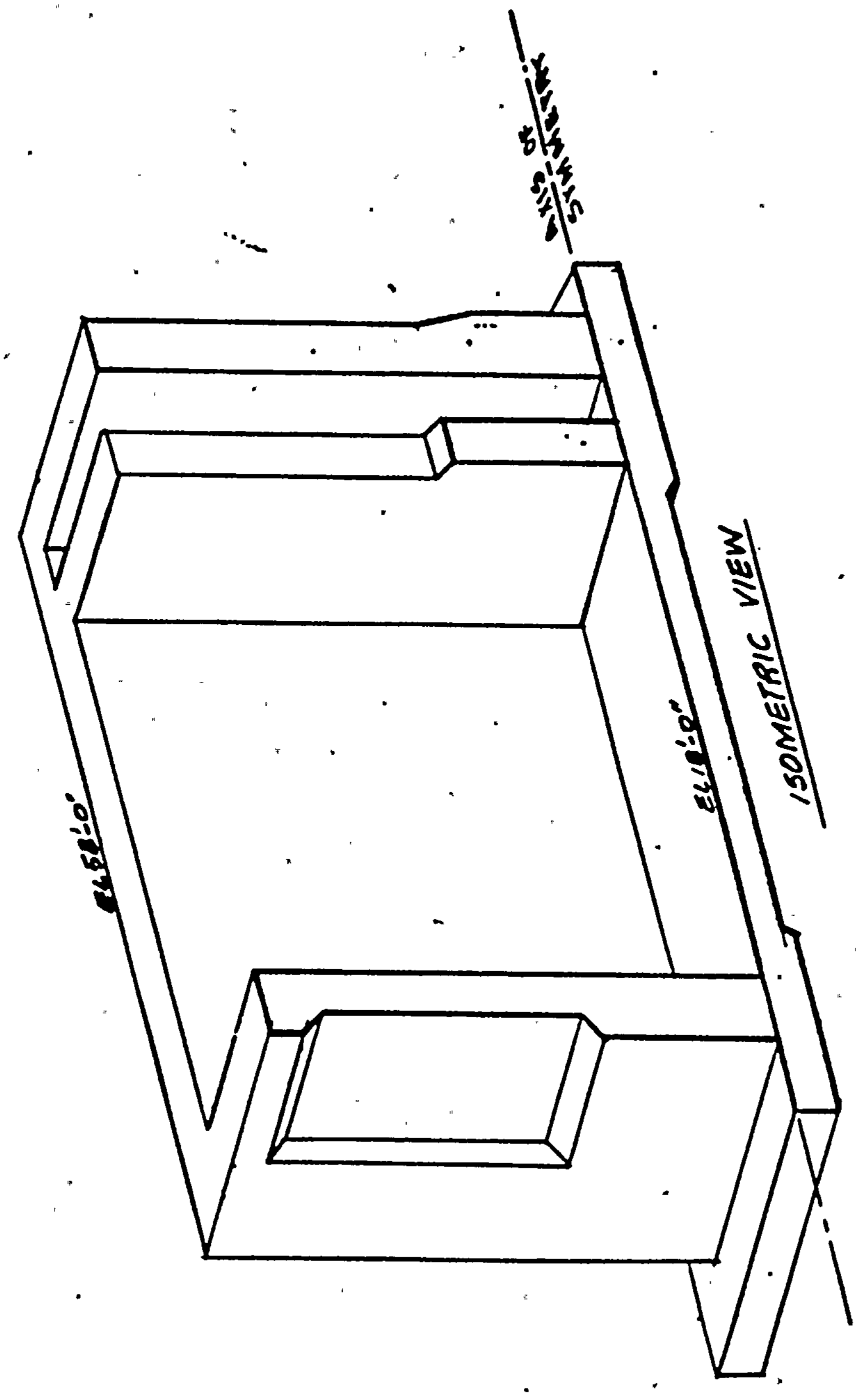
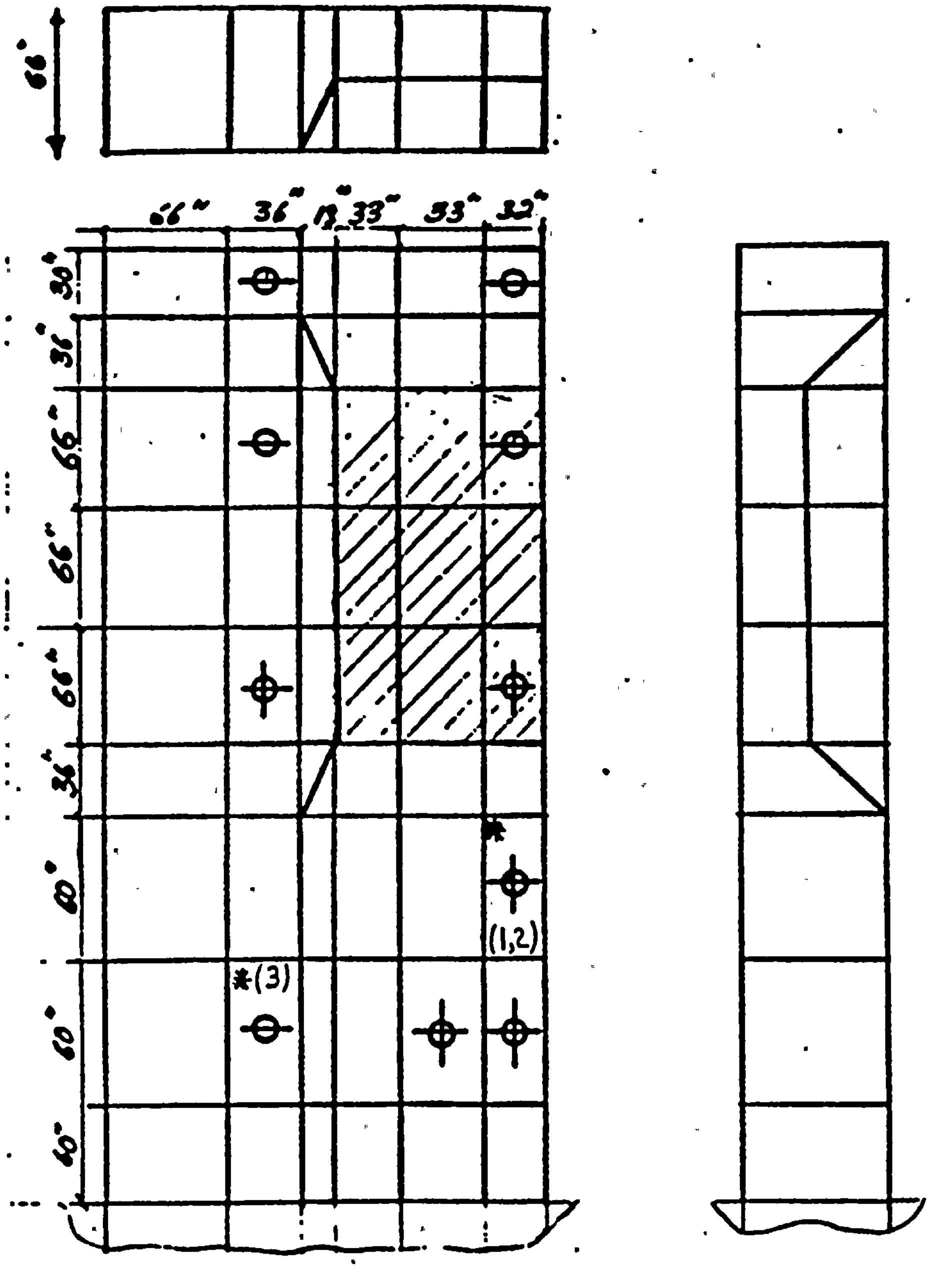


FIGURE 2



NORTH WALL
(Looking South)

SIDE VIEW
(Looking West)

LEGEND

Stresses evaluated in horizontal direction

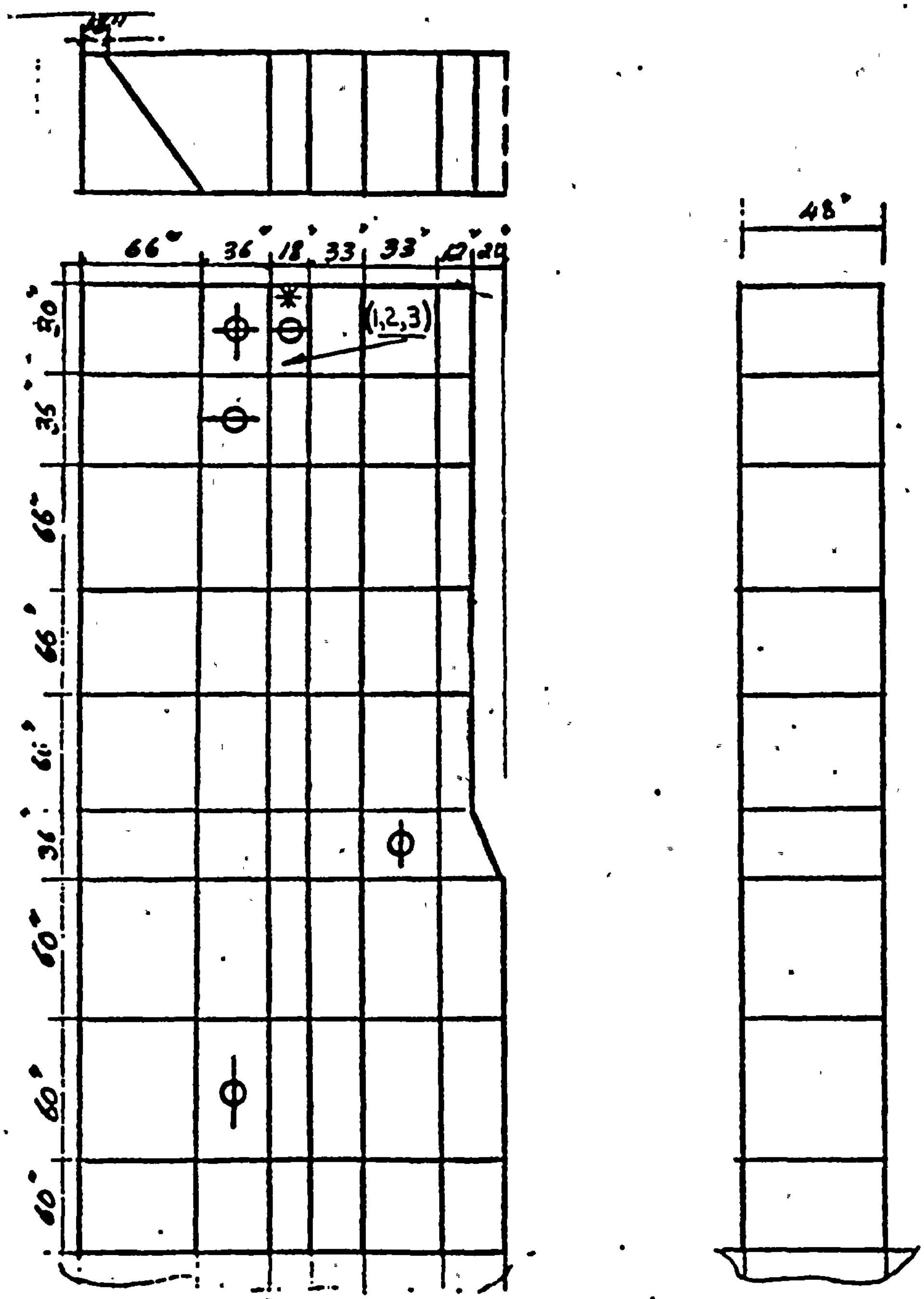
Stresses evaluated in vertical direction

Location of governing stress reported in Table A

( ) Number in parentheses indicates governing load combination number in table A.

FIGURE 3

QUESTION 10 (Continued)

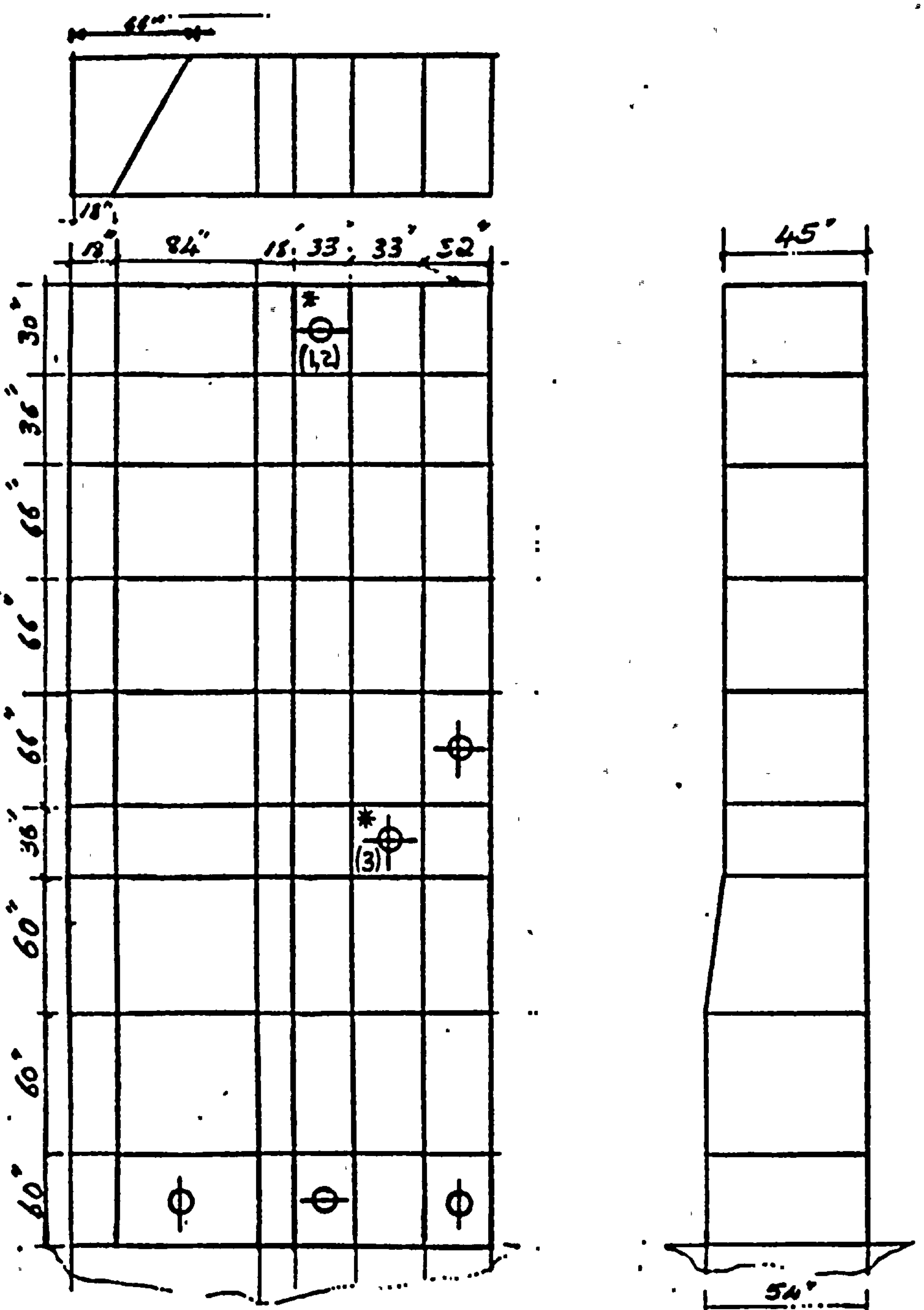


MIDDLE WALL
(Looking south)

(For legend, see Figure 3)

FIGURE 4

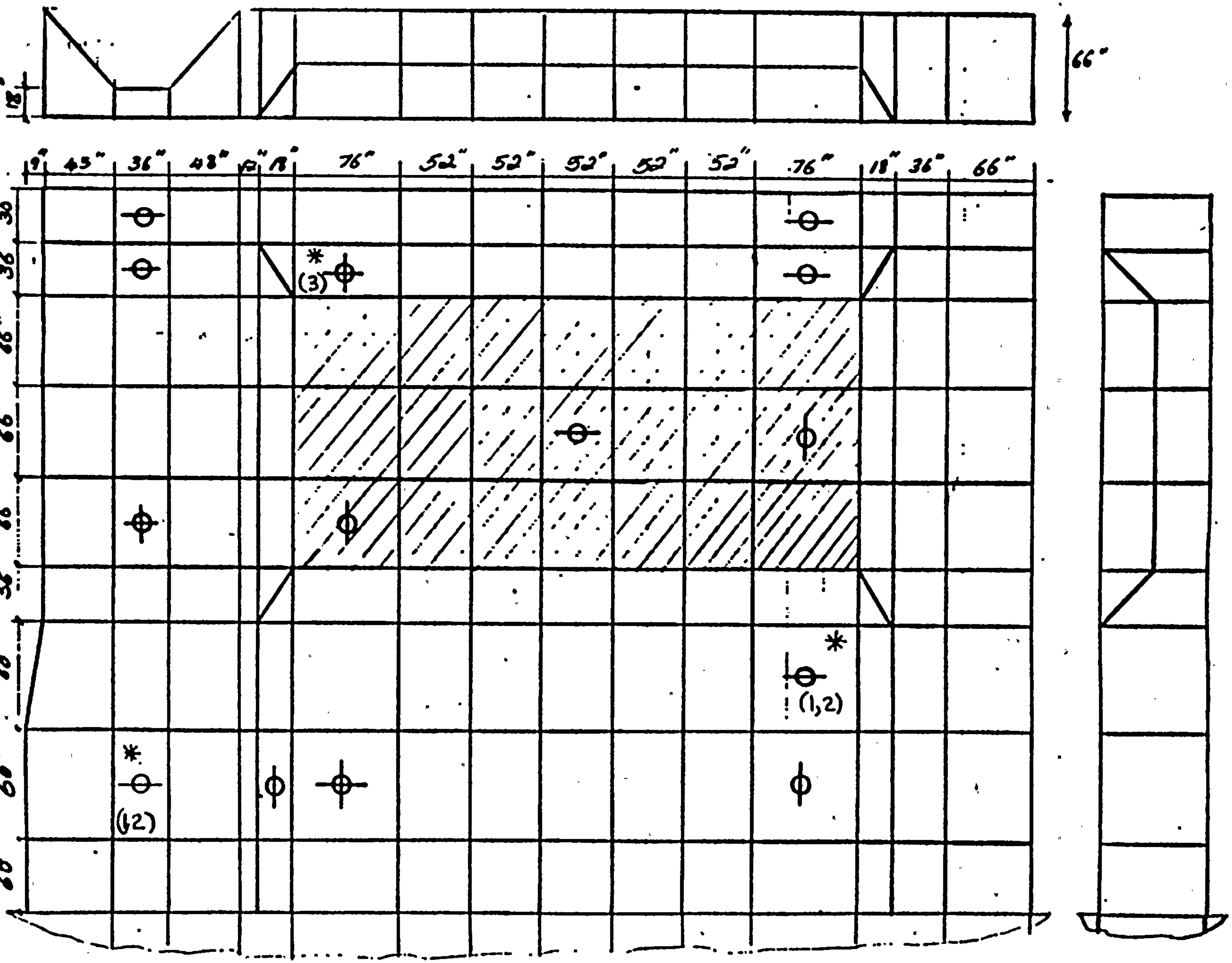
QUESTION 10 (Continued)



SOUTH WALL
(Looking South)

(For legend, see Figure 3)

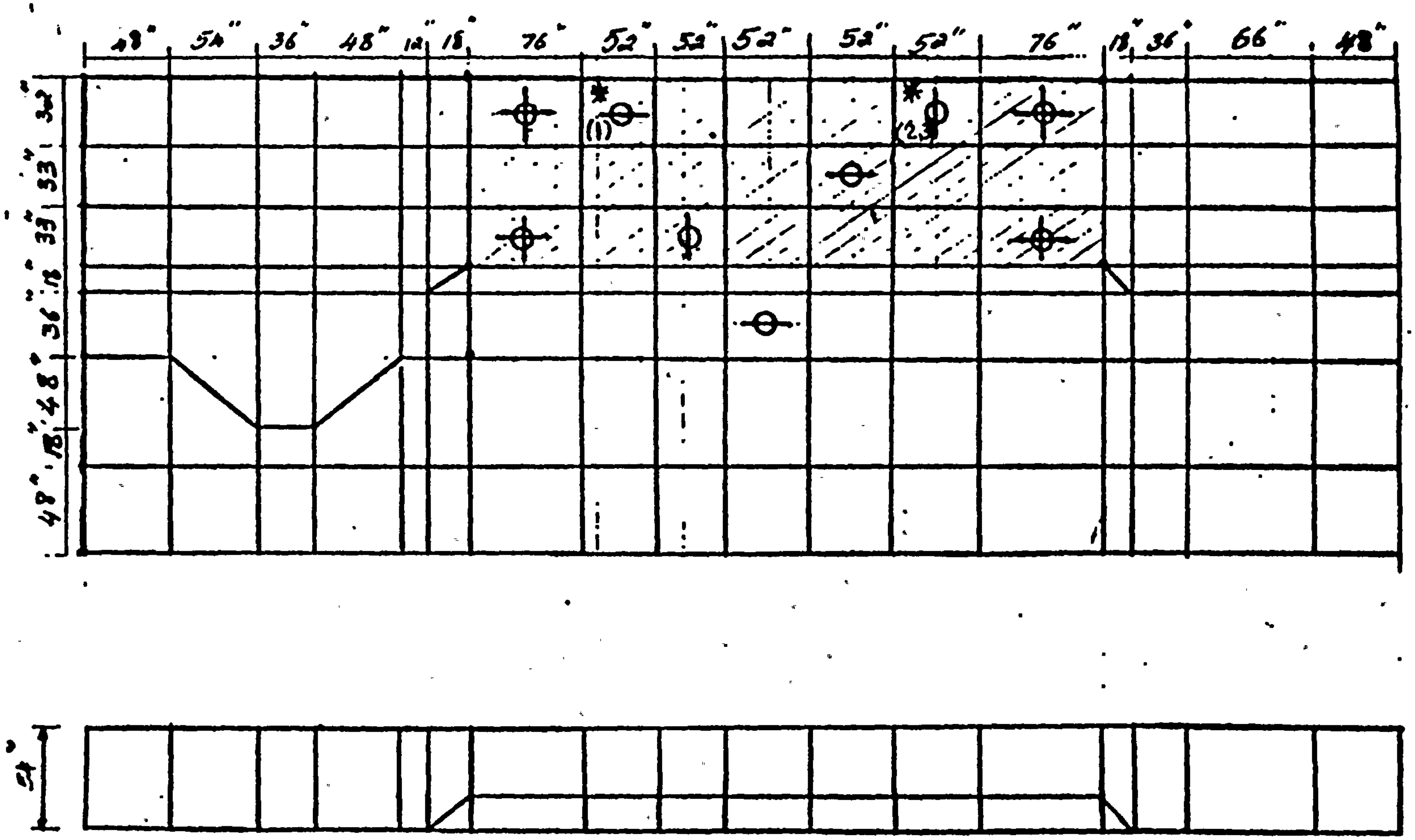
FIGURE 5



EAST WALL (Looking West)

(For legend, see Figure 3)

FIGURE 6



BASE MAT

(For legend, see Figure 3)

FIGURE 7