Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

June 7, 2010
U7-C-STP-NRC-100129

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Request for Additional Information

Reference: Letter, Scott Head to Document Control Desk, "Response to Request for Additional Information," dated April 29, 2010. U7-C-STP-NRC-100093 (ML101250162)

The attachment provides a revised response to the NRC staff question included in Request for Additional Information (RAI) letter number 302 related to Combined License Application (COLA) Part 2, Tier 2, Section 3.7. The reference above provides the previous response to the following RAI question:

- RAI 03.07.01-19

Where there are COLA markups, they will be made at the first routine COLA update following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions regarding this response, please contact Scott Head at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32687519

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

Executed on 6-7-2010

MAMcBurnett

Mark McBurnett
Vice President, Oversight & Regulatory Affairs
South Texas Project Units 3 & 4

jep

Attachment: RAI 03.07.01-19, Revision 2

cc: w/o attachment except*
(paper copy)

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RAI 03.07.01-19, Revision 2

QUESTION:

(Follow-up Question to RAI 03.07.01-6)

In response to RAI 03.07.01-6, the applicant referred to COLA Part 2, Tier 2, Section 3A.17 for description of the supporting media, dimensions of the structural foundation, and total structural height for the Reactor Building (RB) and Control Building (CB). However, the referenced section does not include the requested information for the Diesel Generator Fuel Oil Storage Vaults (DGFOSV) which is listed as Seismic Category I structure in Revision 3 of the FSAR Section 2.5S.4.10.2. As such, the applicant was requested to provide information on supporting media for DGFOSV. Since the shear wave velocity parameter of the subgrade material (soil or backfill) supporting this structure may be less than 1000 fps, the applicant is also requested to provide quantitative results of the reconciliatory site specific seismic analysis (with appropriate consideration of dynamic soil or backfill properties) addressing the potential impact on FIRS, SSI, settlement calculations, and structural design concerning DGFOSV.

2. In the response to item 3 of RAI 03-07-01-6 it was stated that "The resulting strain-compatible properties for the three profiles are presented in COLA Part 2, Tier 2 Table 3H.6-1." A review of Table 3H.6-1 indicates that the S-wave and P-wave damping ratio used in the SSI analysis for an individual layer is the same. The applicant is requested to provide the basis for maintaining the S-wave and P-wave damping the same for an individual layer.

3. In response to RAI 03.07.01-6, Item 3, the applicant states that, "The seismic site response analysis was conducted, as described in Section 2.5S.2.5, using P-SHAKE to develop Ground Motion Response Spectrum (GMRS). ...." No reference to P-SHAKE program was found in Section 2.5S.2.5 of Revision 3, and no proposed FSAR markup is provided for future incorporation. As such, the applicant is requested to clarify whether P-SHAKE program has been used to develop GMRS and strain-compatible soil properties, as described in Section 2.5S.2.5, and if so, how P-SHAKE program performs site-response analysis (e.g. deterministic or probabilistic method, etc.). The applicant is further requested to clarify whether P-SHAKE program was also used to perform deconvolution of the SSE design motion specified at the freefield ground surface to calculate the foundation motion for the Seismic Category I structures.

REVISED RESPONSE:

Revision 1 of the response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100093, dated April 29, 2010. Due to the discovery of discrepancies in extraction of the reported results in revision 1 of this response, the response is revised. The revised portions of the response are marked with a revision bar. Table 3H.6-11 and Figures 3H.6-147, 148, 149, 150, 164, 165, 169, 186, 191, 194, and 196 are revised. Also, the values for embedment depth to the bottom of the mudmat and the maximum height from the bottom of the mudmat are revised.

(Paragraph 1)

The Diesel Generator Fuel Oil Storage Vaults (DGFOSV) are reinforced concrete structures, located below grade with an access room above grade. The DGFOSV house fuel oil tanks and transfer pumps. The DGFOSV are buried in the structural back-fill. The embedment depth to the bottom of the 2 ft thick mudmat is approximately 45 ft, the maximum height from the bottom of the mudmat is approximately 61 ft, and the basemat dimensions are approximately 81.5 ft by 48 ft. Properties of the backfill are described in COLA Part 2, Tier 2 Section 3H.6.5.2.4. Conservatively, a 3-dimensional SAP2000 response spectrum analysis was used to obtain the safe-shutdown earthquake (SSE) design forces due to structure inertia. The seismic induced dynamic soil pressures on DGFOSV walls were computed using the method of ASCE 4-98, Subsection 3.5.3.2.

Two DGFOSV are located about 50 feet away from the south face of the Reactor Building (RB), which is a heavy multistory structure. The third DGFOSV is located approximately 38 feet away from the north face of the Reactor Service Water (RSW) Pump House. Considering the soil profile at the STP Units 3 & 4 site, the induced acceleration at the foundation level of the DGFOSV during a SSE event may be amplified due to their close proximity to the RB (for the two) or the RSW Pump House (for the third). To establish the input motion for the soil-structure interaction (SSI) analysis of the DGFOSV, considering the impact of the nearby heavy RB (for the two) and RSW Pump House (for the third) structures, an analysis as described below was performed.

Five interaction nodes at the ground surface and five at the depth corresponding to the bottom elevation of the DGFOSV foundations are added to the three dimensional SSI SASSI2000 model of the RB for obtaining free field responses for the two DGFOSV close to the RB. These five nodes correspond to the four corners and the center of the DGFOSV. This RB SSI model is analyzed for the STP site-specific SSE. For each of these two DGFOSV, first an average of the spectra at five nodes at the surface and foundation each is calculated and then envelope of the two average spectra is calculated. A similar SSI analysis is performed for the third DGFOSV close to the RSW Pump House. Finally, the envelope of the envelope average spectra for the three DGFOSV and the 0.3g Regulatory Guide 1.60 response spectrum is used as the input response spectrum for the SSI analysis of the DGFOSV. The DGFOSV and the equipment and components inside the vault are designed using the results of the SSI analysis.

The comparison of response spectra (the minimum required 0.1g Regulatory Guide 1.60 spectra, the FIRS, and the deconvolved SHAKE outcrop spectra) at the foundation level of the DGFOSV is presented in Figures 3H.6-11d through 3H.6-11L, included in Enclosure 1. As can be seen from these figures, the deconvolved SHAKE outcrop spectra envelop the minimum required spectra and FIRS for the three sets of soil properties.

The applicable codes, standards, and specifications from COLA Part 2, Tier 2 Section 3H.6.4 are used for analysis and design of the DGFOSV.

The DGFOSV are designed to the applicable loads and load combinations specified in COLA Part 2, Tier 2 Section 3H.6.4.

The settlement information on the DGFOSV is included in COLA Part 2, Tier 2, Section 2.5S.4.10.

The forces and moments at critical locations in the DGFOSV along with the provided longitudinal and transverse reinforcement are included in Table 3H.6-11 in conjunction with Figures 3H.6-140 through 3H.6-208, provided in Enclosure 2.

The calculated factors of safety against sliding, overturning, and flotation for the DGFOSV are included in Table 3H.6-12, provided in Enclosure 2.

The tornado missile impact evaluation results for the DGFOSV are included in Table 3H.6-13, provided in Enclosure 2.

2. The P-wave damping ratios are assigned the same values as those calculated for the S-wave damping ratios. This is based on the recommendations of the upcoming ASCE 4-09 standards (see Reference below). The recommendation is based on the recent observation of earthquake data and the realization that the waves generated due to SSI effects are mainly surface and shear waves. It should be noted that the S-wave damping ratios for the best estimate profile are very low (around 1.5% and not exceeding 2%). Moreover, using the maximum strains, as shown in FSAR Figure 2.5S.2-47, and applying the effective strain ratio of 0.65, as described in FSAR Subsection 2.5S.2.5.4, the uniform strains for 1E-4 hazard level do not exceed 0.02%.

   Reference Used for this RAI Response:

   American Society of Civil Engineers (ASCE), Seismic Analysis of Safety-Related Nuclear Structures, ASCE 4-09, to be published in 2010.

3. The P-SHAKE program was used to develop the GMRS in Section 2.5S.2.5. A mark-up of COLA Part 2, Tier 2, Section 2.5S.2.5, that describes the P-SHAKE program and its use in site response analysis, is included as part of the response to RAI 02.05.02-23 submitted with STPNOC Letter U7-C-STP-NRC-090146, dated September 21, 2009.

The SHAKE program was used to perform deconvolution of the SSE design motion specified at the free field ground surface to calculate the SHAKE outcrop motion at the foundation elevation of the Seismic Category I structures.

The COLA mark-up for Section 2.5S.2.5 provided in response to RAI 02.05.02-23 is reproduced in the following for ready reference:

"The description of the RVT approach in the STP COLA will be modified and expanded to include a more detailed discussion.
The first and second paragraphs of FSAR Section 2.5S.2.5.4, COLA Revision 3 will be revised as follows:

The site response analysis performed for the STP 3 & 4 site is conducted using the program P-SHAKE (refer to Appendix 3C), which uses a procedure based on Random Vibration Theory (RVT) (References 2.5S.2-52 and 2.5S.2-53) with the following assumptions:

- Vertically-propagating shear waves are the dominant contributor to site response
- An equivalent-linear formulation of soil nonlinearity is appropriate for the characterization of site response

These are the same assumptions that are implemented in the SHAKE program (Reference 2.5S.2-54). ~~and that constitute standard practice for site response calculations. In this respect, RVT and SHAKE solve the same problem, but RVT works with ground-motion power spectral densities or response spectra (and its relation to peak values), while SHAKE works with individual time histories and their Fourier spectra.~~ With respect to RVT implementation, the major steps used in P-SHAKE are as follows:

1. The input motion is provided in terms of acceleration response spectrum (ARS) and its associated spectral damping, instead of spectrum-compatible acceleration time histories. The input ARS is converted to acceleration power spectral density (PSD) using the RVT based procedure with the peak factor function.

2. From the frequency domain solution of the soil profile (following SHAKE approach), the transfer function for shear strain in each layer is obtained and convolved with the power spectral density (PSD) of input motion to get the PSD and the maximum strain in each layer. The effective strain is obtained from the maximum strain and is used to obtain the new soil properties (soil shear modulus and damping) for the next iteration.

3. The iterations are repeated until convergence is reached in all layers to the convergence limit set by the user.

4. Once the final frequency domain solution is obtained, the acceleration response spectrum at each layer interface can be computed from the solution using an inverse process of obtaining PSD from the acceleration response spectrum.

References:

2.5S.2-52 "Structural Response to Stationary Excitation," Journal of the Engineering Mechanics Division ASCE, v. 106, No. EM6, December, pp. 1195-1213, Der Kiureghian, A., 1980.

2.5S.2-53 "Site-Specific Validation of Random Vibration Theory-Based Seismic Site Response Analysis," Journal of Geotechnical and Geoenvironmental Engineering, Vo. 132, No. 7, July, pp. 911-922, Rathje, E. and Ozbey, C.M., 2006.

2.5S.2-54 "SHAKE91: A computer program for conducting equivalent linear seismic response analyses of horizontally layered soil deposits," Idriss, I. M., and Sun, J. I., Dept. of Civil and Environmental Engineering, Center for Geotechnical Modeling, Univ. of California, 1992."

The STP Units 3 and 4 COLA will be revised as follows as a result of this response.

1. Revise Sections 3H.6.1 and 3H.6.3 as follows:

3H.6.1 Objective and Scope

The objective of this appendix is to describe the structural analysis and design of the STP 3 & 4 site-specific seismic Category I structures that are identified below ~~and shown in Figures 1.2-34 through 1.2-36.~~

(1) Ultimate Heat Sink (UHS) for each unit consists of a water retaining basin with enclosed cooling towers situated above the basin and a Reactor Service Water (RSW) pump house that is integral with the UHS basin.

(2) RSW piping tunnel for each unit.

(3) Diesel Generator Fuel Oil Storage Vault for each unit.

The details of analysis and design for Items (1) and (2) are provided in Sections 3H.6.3 through 3H.6-6. The details for Item (3) are provided in Section 3H.6.7.

3H.6.3 Structural Descriptions

The site-specific Seismic Category I structures at STP 3 & 4 consist of one set of the following for each unit: UHS basin, enclosed UHS cooling towers located on top of the basin, RSW pump house contiguous with and adjacent to the UHS basin, and buried RSW piping tunnels and access shafts to the tunnels (see Figures 1.2-34 through 1.2-36). Each UHS basin and RSW pump house has a 10-ft (3.05-m) thick foundation mat and are connected at

a common wall; and the RSW piping tunnels extend from the pump house to the Control Buildings. Each of these structures is described in more detail in the following subsections.

2. Add the following new subsection in Section 3H.6, and revise the subsection number for the References:

3H.6.7 Diesel Generator Fuel Oil Storage Vaults (DGFOSV)

The Diesel Generator Fuel Oil Storage Vaults (DGFOSV) are reinforced concrete structures, located below grade with an access room above grade. The DGFOSV house fuel oil tanks and transfer pumps. The DGFOSV are buried in the structural back-fill. The embedment depth to the bottom of the 2 ft thick mudmat is approximately 45 ft, the maximum height from the bottom of the mudmat is approximately 61 ft, and the basemat dimensions are approximately 81.5 ft by 48 ft. Properties of the backfill are described in Section 3H.6.5.2.4. A 3-dimensional SAP2000 response spectrum analysis was used to obtain the SSE design forces due to structure inertia. The seismic induced dynamic soil pressures on DGFOSV walls and roof were computed using the method of ASCE 4-98, Subsection 3.5.3.2.

Two DGFOSV are located about 50 feet away from the south face of the Reactor Building (RB), which is a heavy multistory structure. The third DGFOSV is located approximately 38 feet away from the north face of the Reactor Service Water (RSW) Pump House. Considering the soil profile at the STP Units 3 & 4 site, the induced acceleration at the foundation level of the DGFOSV during a SSE event may be amplified due to their close proximity to the RB (for the two) or the RSW Pump House (for the third). To establish the input motion for the soil-structure interaction (SSI) analysis of the DGFOSV, considering the impact of the nearby heavy RB (for the two) and RSW Pump House (for the third) structures, an analysis as described below was performed.

Five interaction nodes at the ground surface and five at the depth corresponding to the bottom elevation of the DGFOSV foundations are added to the three dimensional SSI SASSI2000 model of the RB for obtaining free field responses for the two DGFOSV close to the RB. These five nodes correspond to the four corners and the center of the DGFOSV. This RB SSI model is analyzed for the STP site-specific SSE. For each of these two DGFOSV, first an average of the spectra at five nodes at the surface and foundation each is calculated and then envelope of the two average spectra is calculated. A similar SSI analysis is performed for the third DGFOSV close to the RSW Pump House. Finally, the envelope of the envelope average spectra for the three DGFOSV and the 0.3g Regulatory Guide 1.60 response spectrum is used as the input response spectrum for the SSI analysis of the DGFOSV. The DGFOSV and the equipment and components inside the vault are designed using the results of the SSI analysis.

The comparison of response spectra (the minimum required 0.1g Regulatory Guide 1.60 spectra, the FIRS, and the deconvolved SHAKE outcrop spectra) at the foundation level of the DGFOSV is presented in Figures 3H.6-11d through 3H.6-11L. As can be seen from these figures, the deconvolved SHAKE outcrop spectra envelop the minimum required spectra and FIRS for the three sets of soil properties.

The applicable codes, standards, and specifications from Section 3H.6.4 are used for analysis and design of the DGFOSV.

The DGFOSV are designed to the applicable loads and load combinations specified in Section 3H.6.4.

The settlement information on the DGFOSV is included in Section 2.5S.4.10.

The forces and moments at critical locations in the DGFOSV along with the provided longitudinal and transverse reinforcement are included in Table 3H.6-11 in conjunction with Figures 3H.6-140 through 3H.6-208.

The calculated factors of safety against sliding, overturning, and flotation for the DGFOSV are included in Table 3H.6-12.

The tornado missile impact evaluation results for the DGFOSV are included in Table 3H.6-13.

~~3H.6.6.6~~ 3H.6.8 References

3. Add enclosed Figures 3H.6-11d through 3H.6-11L, and 3H.6-140 through 3H.6-208. Also, add Tables 3H.6-11 through 3H.6-13.

Enclosure 1 to Response to RAI 03.07.01-19

New COLA Figures 3H.6-11d through 3H.6-11L

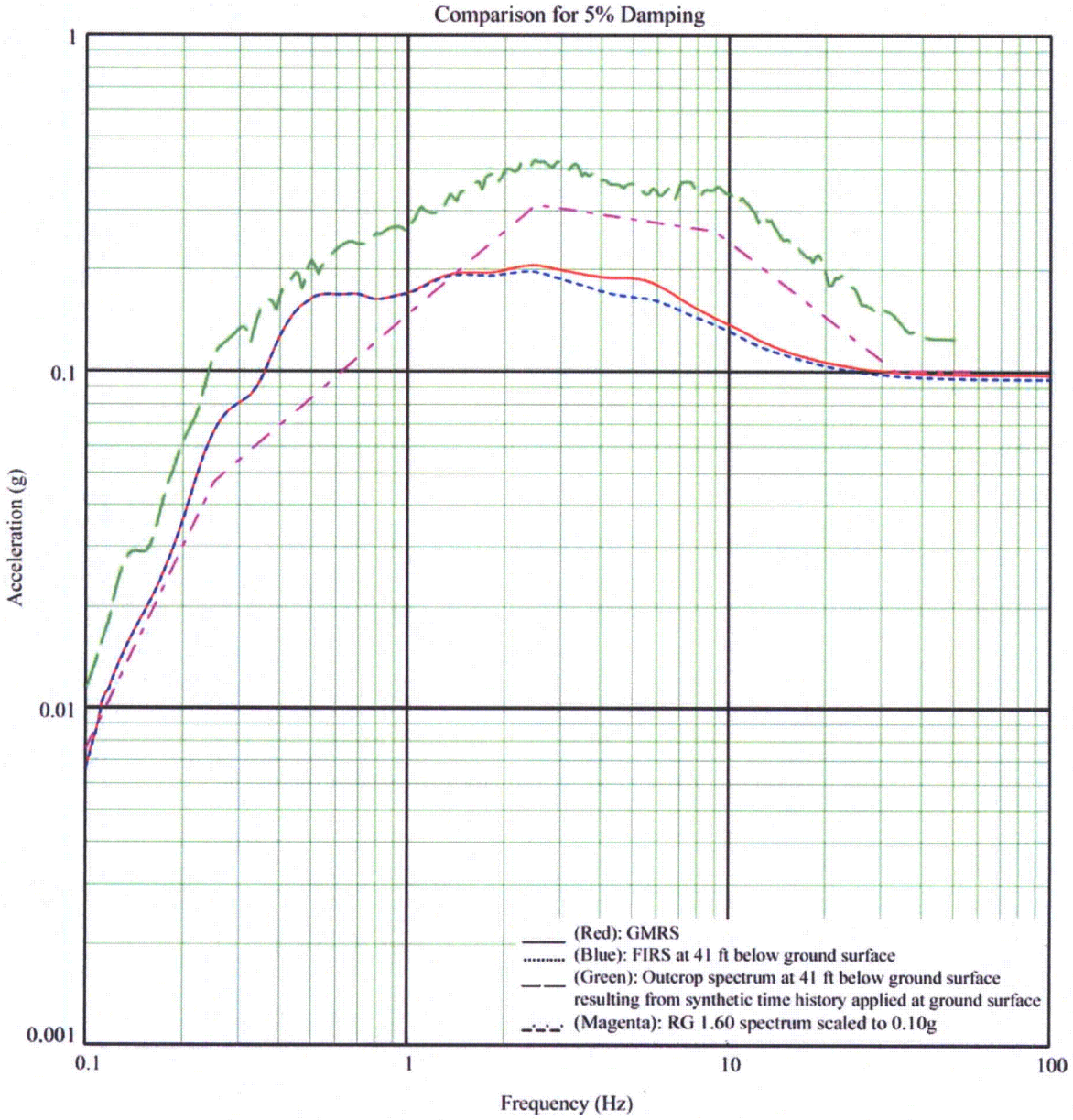

Figure 3H.6-11d: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Mean Soil Properties, E-W Direction

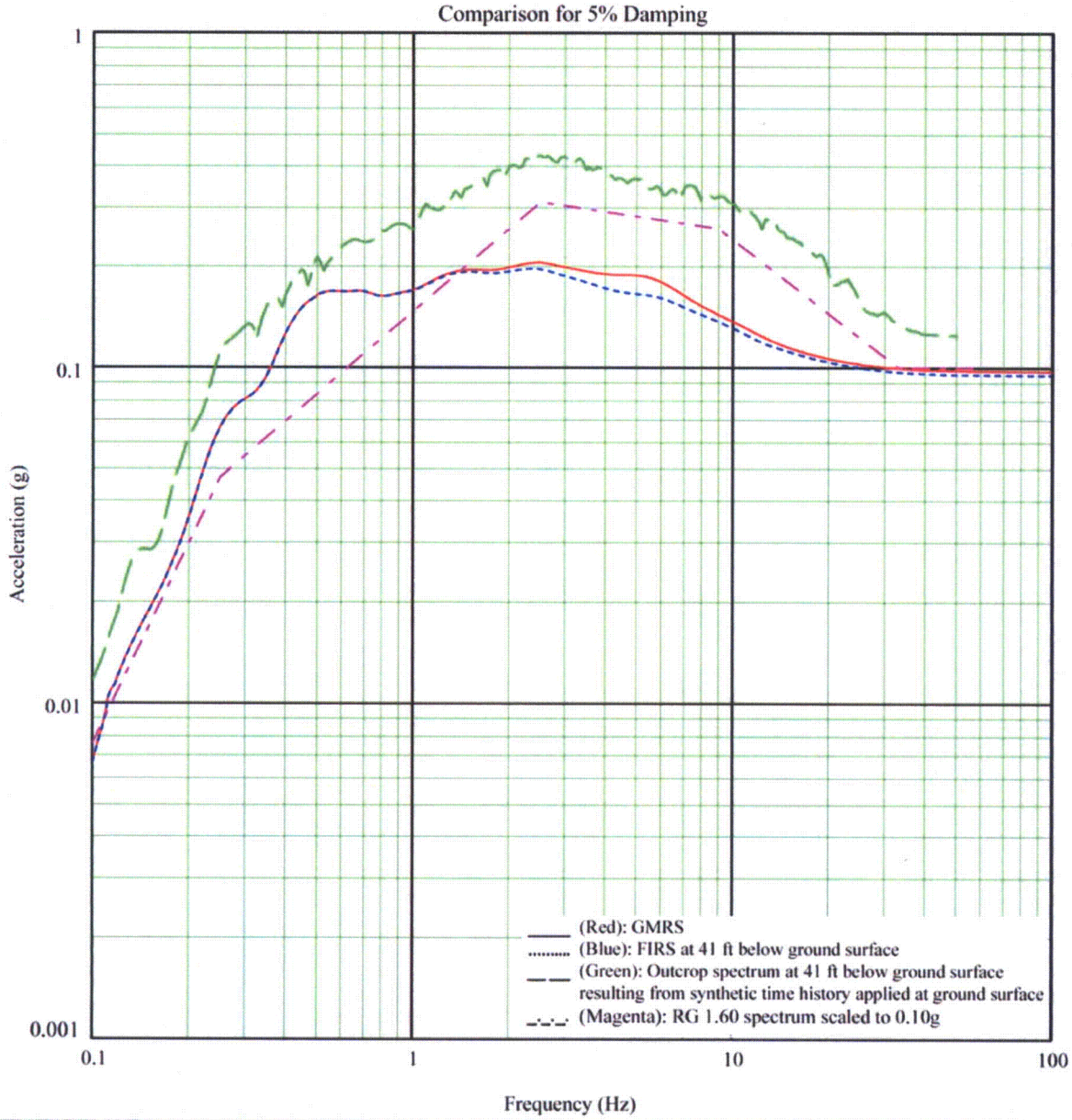

Figure 3H.6-11e: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Upper Bound Soil Properties, E-W Direction

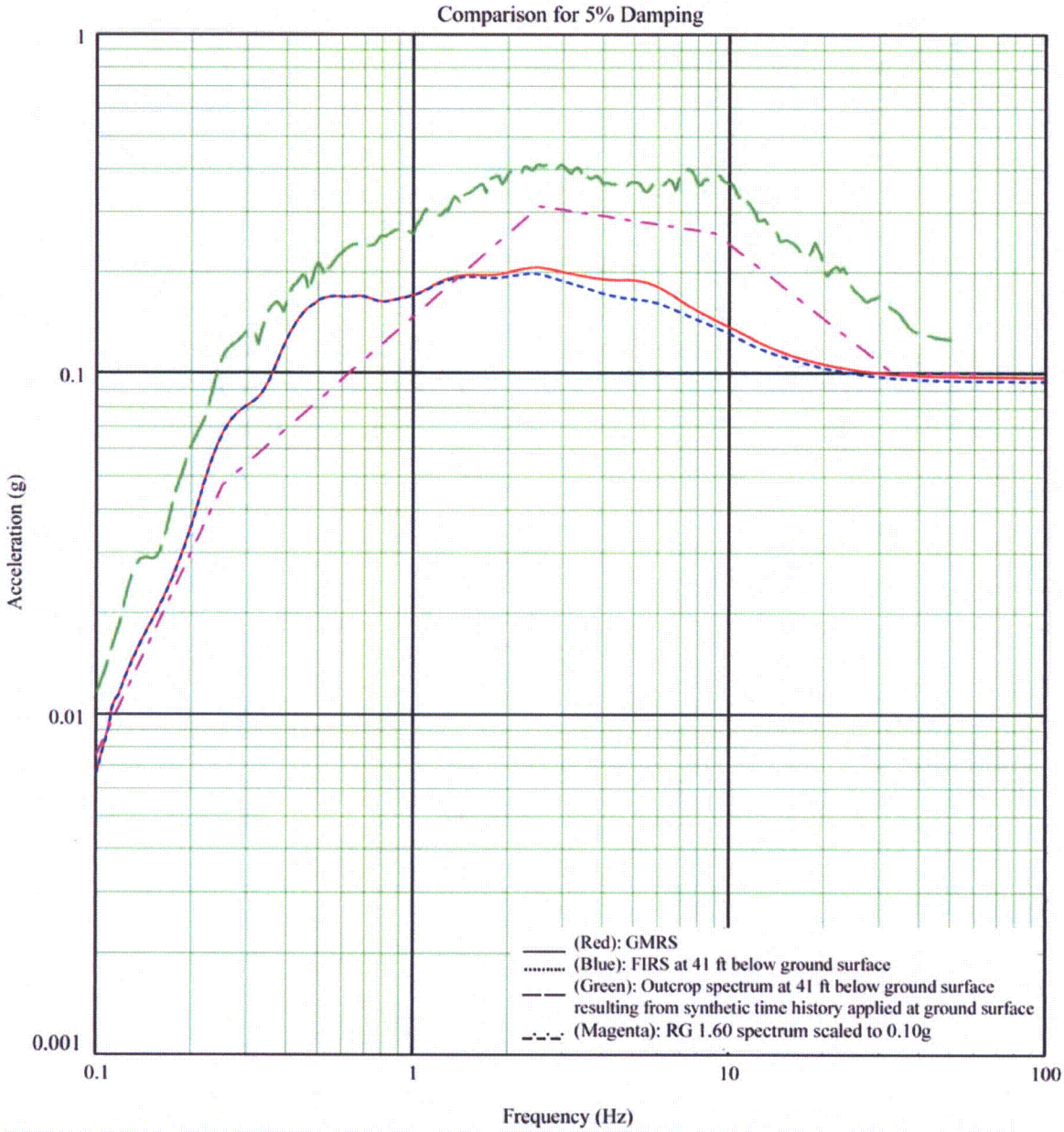

Figure 3H.6-11f: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Lower Bound Soil Properties, E-W Direction

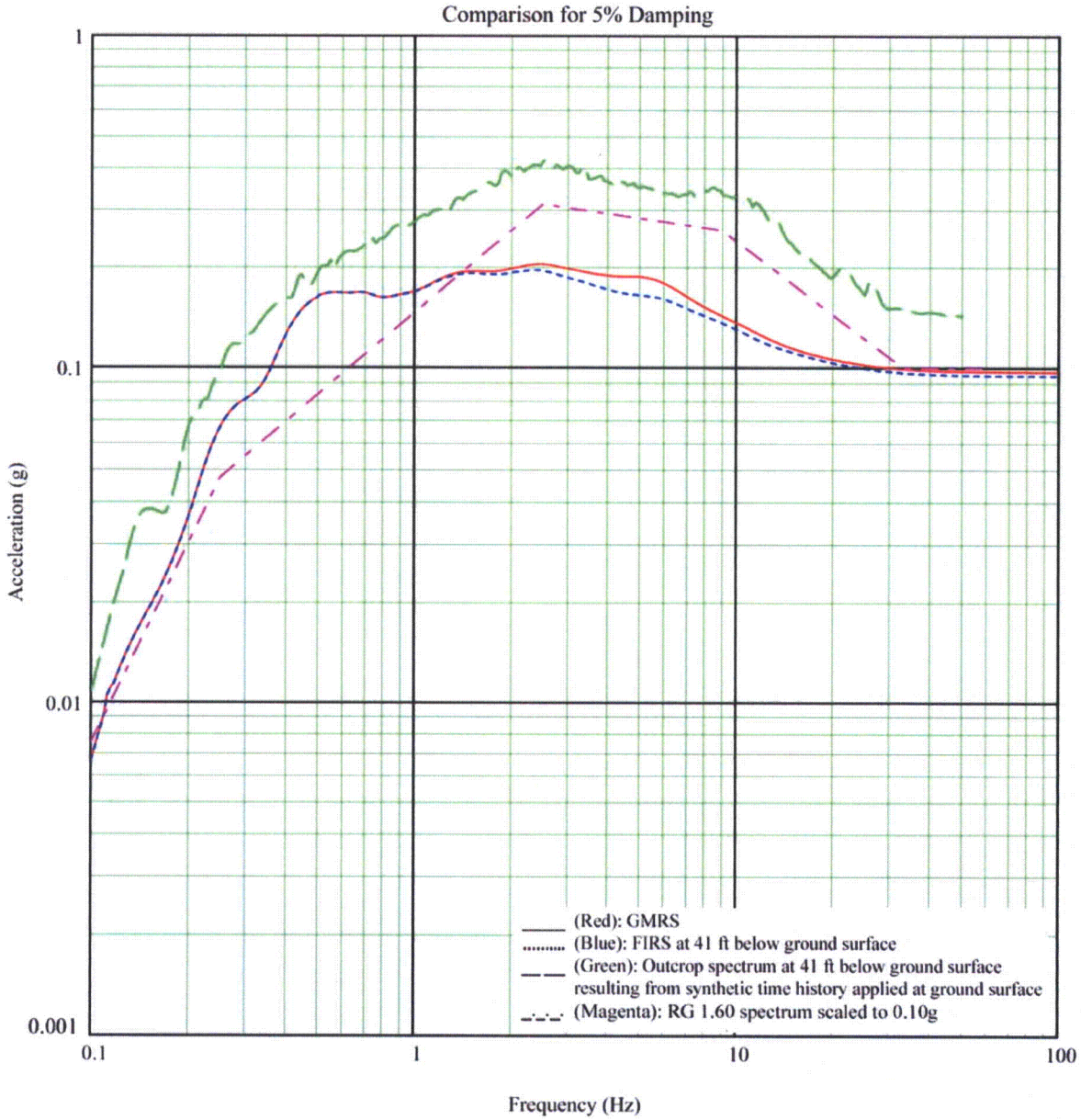

Figure 3H.6-11g: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Mean Soil Properties, N-S Direction

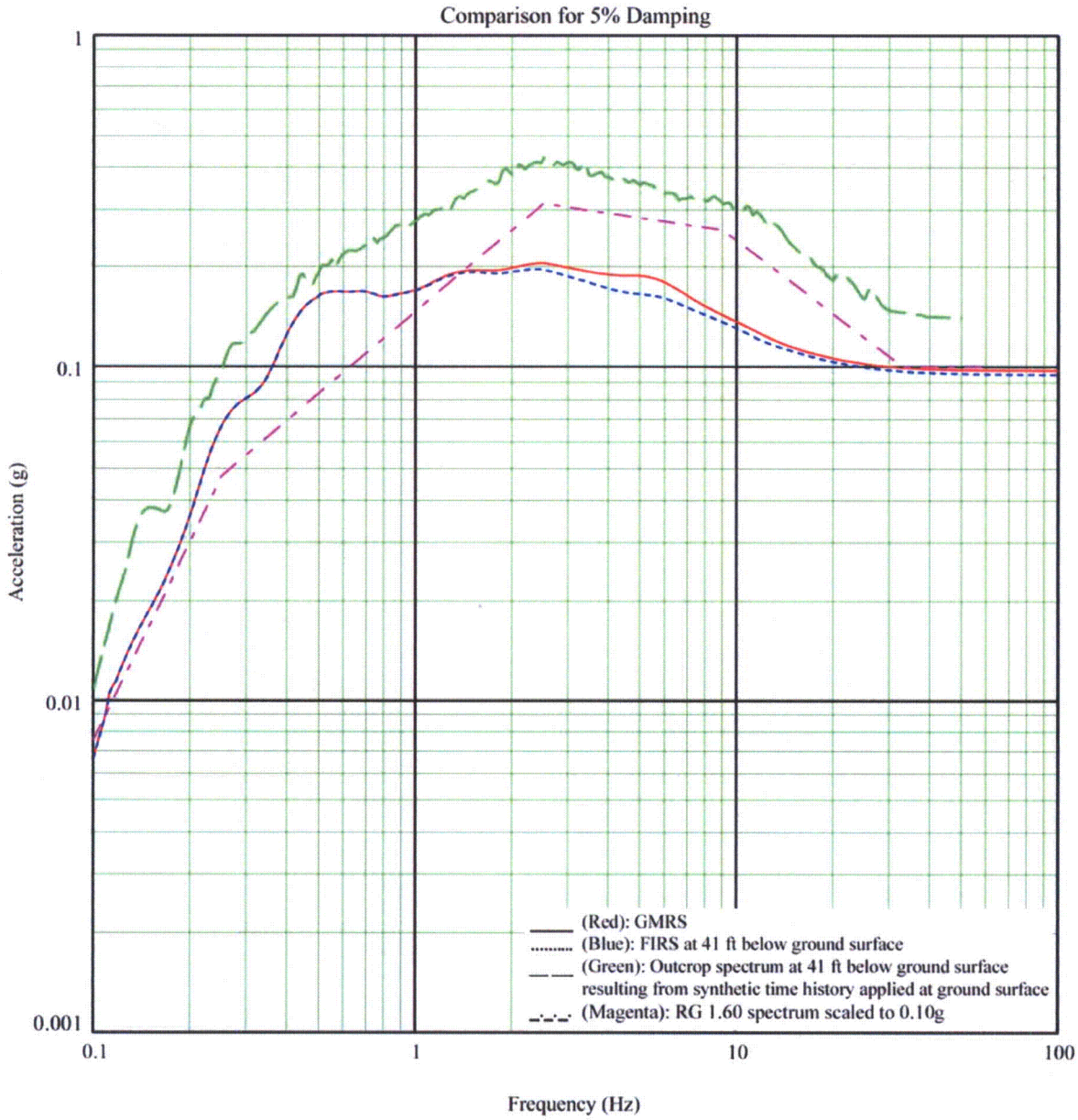

Figure 3H.6-11h: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Upper Bound Soil Properties, N-S Direction

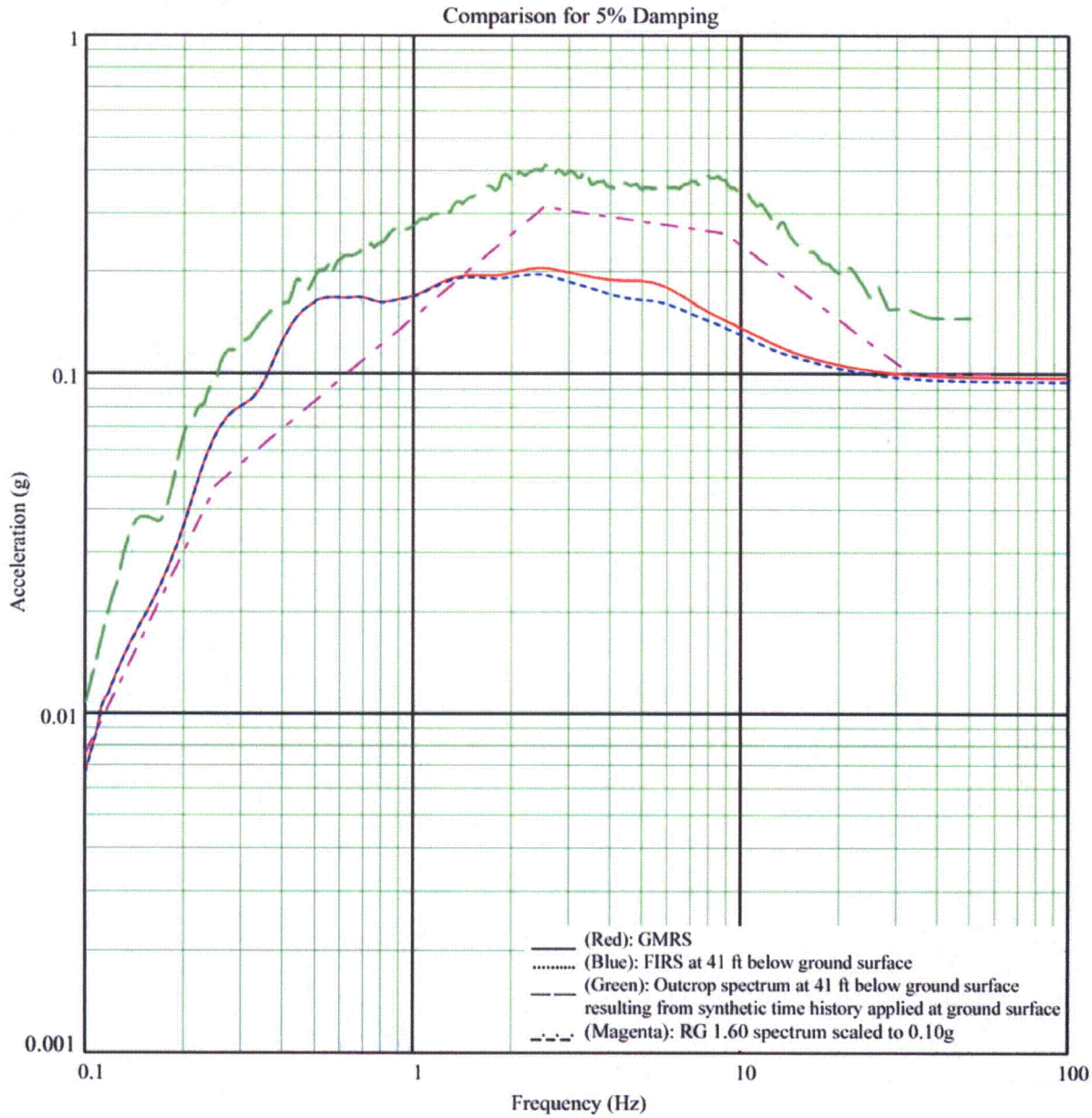

Figure 3H.6-11i: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Lower Bound Soil Properties, N-S Direction

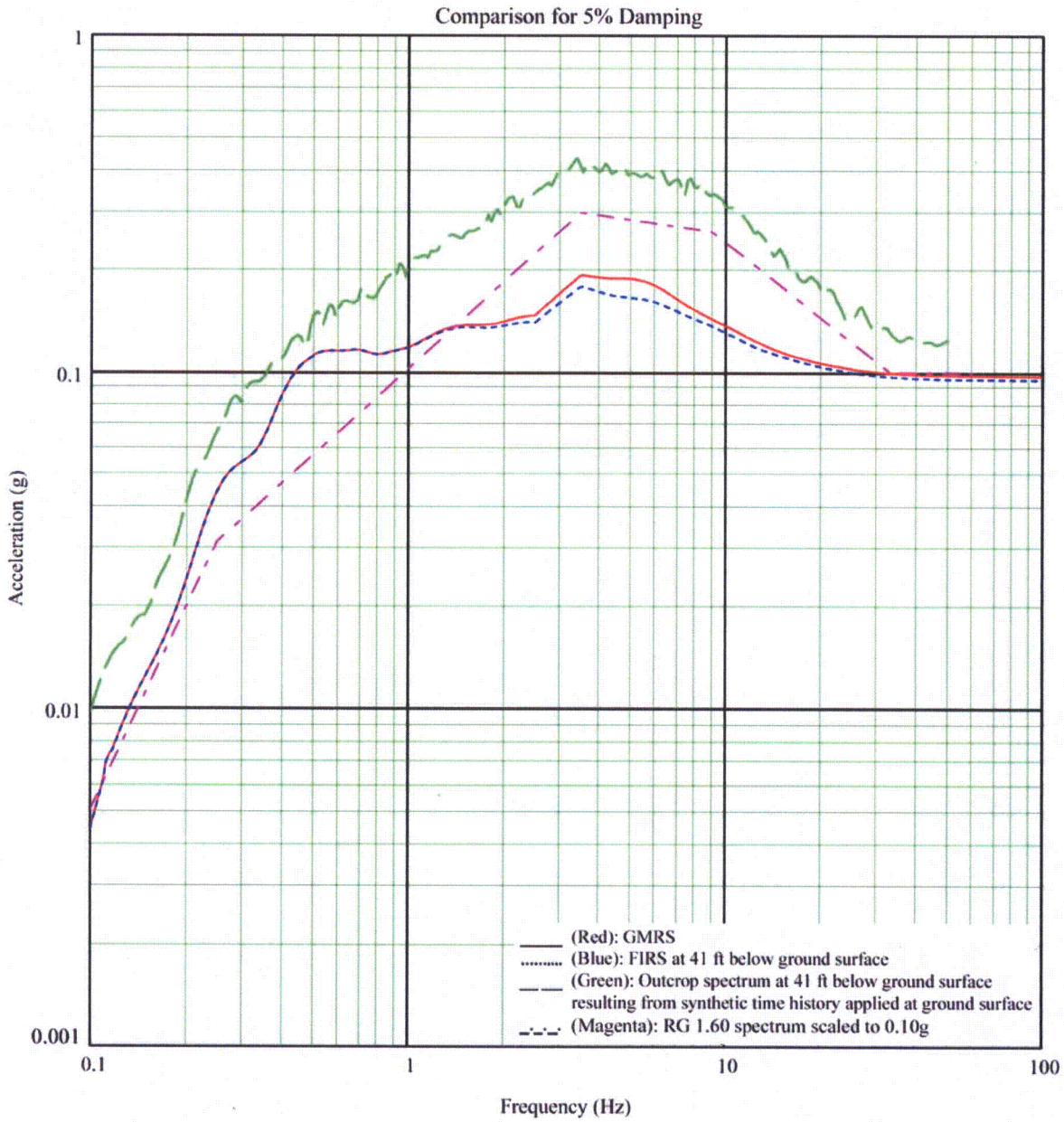

Figure 3H.6-11j: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Mean Soil Properties, Vertical Direction

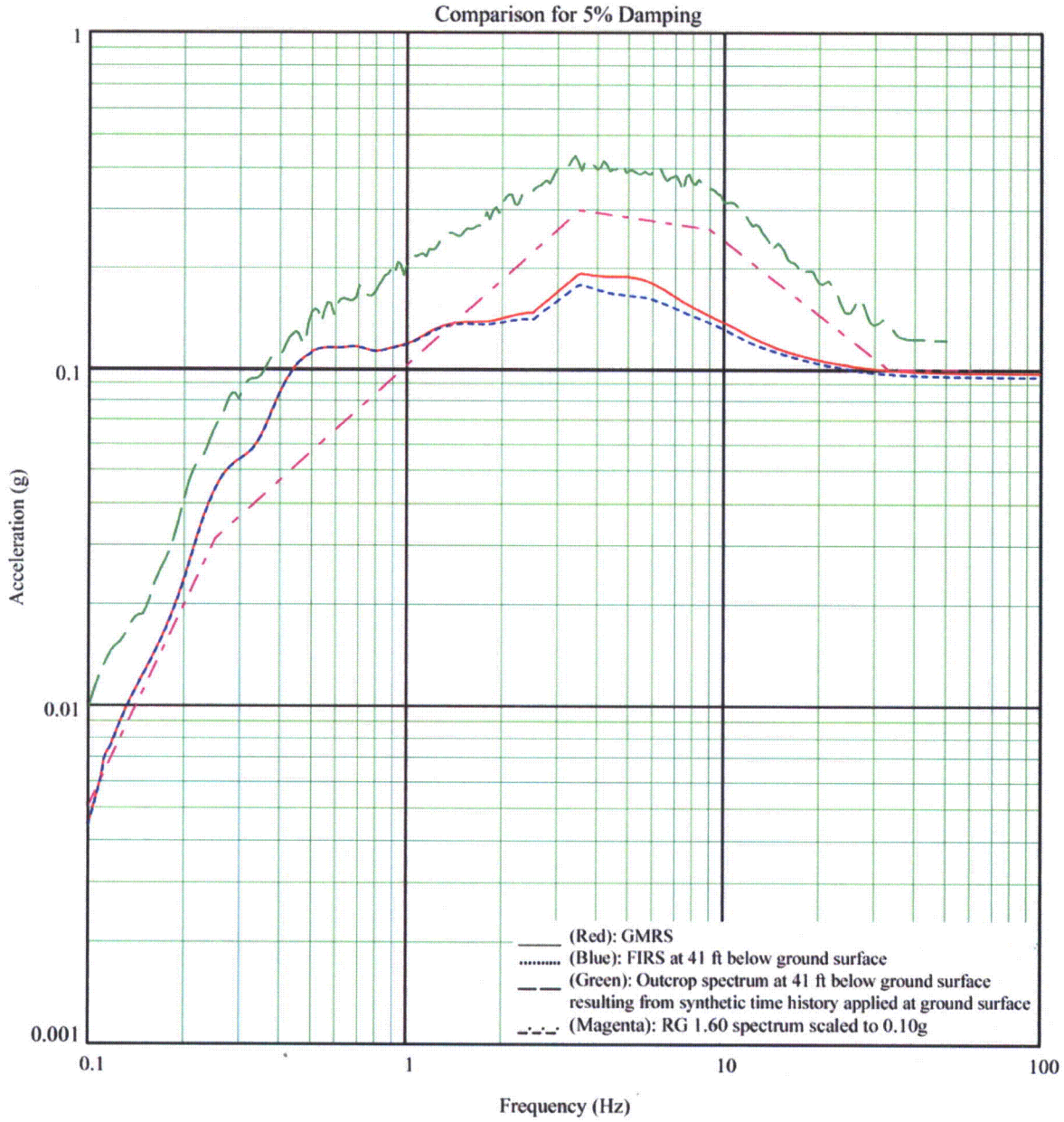

Figure 3H.6-11k: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Upper Bound Soil Properties, Vertical Direction

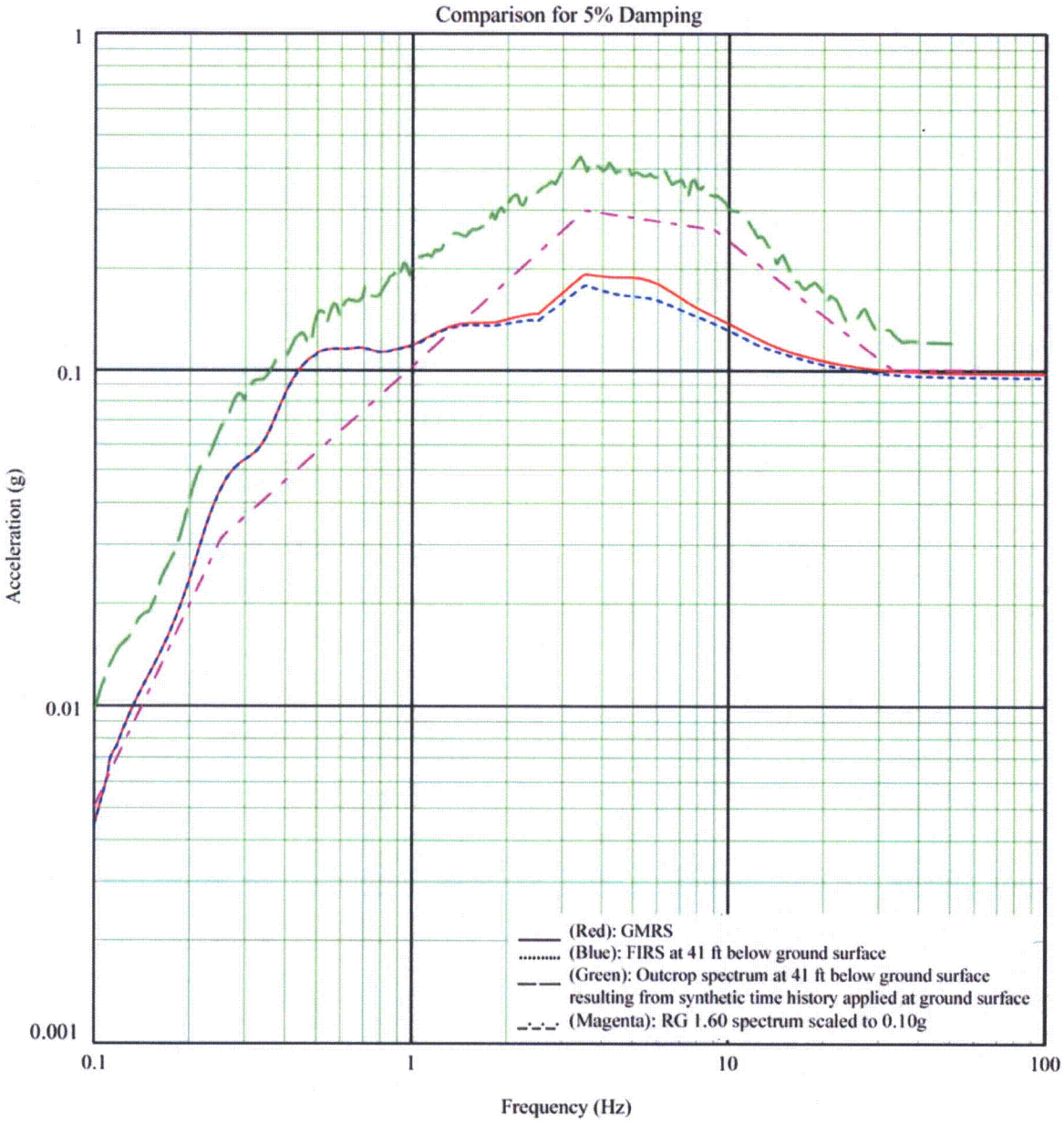

Figure 3H.6-11L: Comparison of Spectra at Foundation of Emergency Diesel Generator Fuel Storage Vault – Lower Bound Soil Properties, Vertical Direction

Enclosure 2 to Response to RAI 03.07.01-19

New COLA Tables 3H.6-11 through 3H.6-13 and Figures 3H.6-140 through 3H.6-208

Table 3H.6-11: Results of DGFOS Vault Concrete Design

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/ft^2)	Remarks
Slab 1	6	Near Side	Horizontal	3H-6-1-2	1-HL	Max Tension w/ corresponding moment	372	D + F + L + H' + E'	54	-502	D + F + L + H' + E'	21	3.17	-	-	-	
						Max Compression w/ corresponding moment	367	D + F + L + H' + E'	-49	-164							
						Max Moment with axial tension	25	D + F + L + H' + E'	3	-555							
						Max Moment with axial compression	367	D + F + L + H' + E'	-7	-168							
					2-HL	Max Tension w/ corresponding moment	35	D + F + L + H' + E'	43	-275	D + F + L + H' + E'	21	7.6	-	-	-	
						Max Compression w/ corresponding moment	36	D + F + L + H' + E'	-44	-1064							
						Max Moment with axial tension	36	D + F + L + H' + E'	6	-1264							
						Max Moment with axial compression	36	D + F + L + H' + E'	-7	-1264							
					3-HL	Max Tension w/ corresponding moment	377	D + F + L + H' + E'	59	-201	D + F + L + H' + E'	21	7.6	-	-	-	
						Max Compression w/ corresponding moment	378	D + F + L + H' + E'	-67	-894							
						Max Moment with axial tension	377	D + F + L + H' + E'	3	-968							
						Max Moment with axial compression	378	D + F + L + H' + E'	-42	-1127							
					4-HL	Max Tension w/ corresponding moment	22	D + F + L + H' + E'	54	-149	D + F + L + H' + E'	21	7.6	-	-	-	
						Max Compression w/ corresponding moment	22	D + F + L + H' + E'	-63	-208							
						Max Moment with axial tension	21	D + F + L + H' + E'	9	-1183							
						Max Moment with axial compression	21	D + F + L + H' + E'	-7	-1183							
					5-HL	Max Tension w/ corresponding moment	364	D + F + L + H' + E'	64	-211	D + F + L + H' + E'	21	7.6	-	-	-	
						Max Compression w/ corresponding moment	364	D + F + L + H' + E'	-70	-214							
						Max Moment with axial tension	363	D + F + L + H' + E'	1	-1252							
						Max Moment with axial compression	363	D + F + L + H' + E'	-44	-1252							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in²/ft²)	Remarks
Slab 1	6	Near Side	Vertical	3H.6-143	1-H-L	Max Tension w/ corresponding moment	183	D + F + L + H' + E'	108	-477	D + F + L + H' + E'	13	4.68	-	-	-	
						Max Compression w/ corresponding moment	327	D + F + L + H' + E'	-131	-294							
						Max Moment with corresponding axial tension	72	D + F + L + H' + E'	2	-765							
						Max Moment with corresponding axial compression	327	D + F + L + H' + E'	-13	-764							
					2-H-L	Max Tension w/ corresponding moment	4	D + F + L + H' + E'	17	-231	D + F + L + H' + E'	17	4.68	-	-	-	
						Max Compression w/ corresponding moment	2	D + F + L + H' + E'	-44	-46							
						Max Moment with axial tension	18	D + F + L + H' + E'	3	-705							
						Max Moment with axial compression	18	D + F + L + H' + E'	0	-501							
					3-H-L	Max Tension w/ corresponding moment	21	D + F + L + H' + E'	43	-685	D + F + L + H' + E'	28	7.8	-	-	-	
						Max Compression w/ corresponding moment	36	D + F + L + H' + E'	-196	-421							
						Max Moment with axial tension	36	D + F + L + H' + E'	24	-1317							
						Max Moment with axial compression	36	D + F + L + H' + E'	-6	-1317							
					4-H-L	Max Tension w/ corresponding moment	345	D + F + L + H' + E'	51	-755	D + F + L + H' + E'	30	7.8	-	-	-	
						Max Compression w/ corresponding moment	374	D + F + L + H' + E'	-190	-330							
						Max Moment with axial tension	363	D + F + L + H' + E'	26	-1258							
						Max Moment with axial compression	363	D + F + L + H' + E'	-6	-1258							
					5-H-L	Max Tension w/ corresponding moment	382	D + F + L + H' + E'	23	-540	D + F + L + H' + E'	18	3.12	-	-	-	
						Max Compression w/ corresponding moment	387	D + F + L + H' + E'	-35	-44							
						Max Moment with axial tension	381	D + F + L + H' + E'	4	-434							
						Max Moment with axial compression	381	D + F + L + H' + E'	-2	-432							
		Far side	Horizontal	3H.6-144	1-H-L	Max Tension w/ corresponding moment	346	D + F + L + H' + E'	73	902	D + F + L + H' + E'	21	3.12	-	-	-	
						Max Compression w/ corresponding moment	364	D + F + L + H' + E'	-70	85							
						Max Moment with axial tension	344	D + F + L + H' + E'	46	718							
						Max Moment with axial compression	374	D + F + L + H' + E'	-1	709							
			Vertical	3H.6-145	1-H-L	Max Tension w/ corresponding moment	344	D + F + L + H' + E'	137	1110	D + F + L + H' + E'	30	7.8	-	-	-	
						Max Compression w/ corresponding moment	36	D + F + L + H' + E'	-196	416							
						Max Moment with corresponding axial tension	232	D + F + L + H' + E'	3	1381							
						Max Moment with corresponding axial compression	202	D + F + L + H' + E'	-128	1810							
					2-H-L	Max Tension w/ corresponding moment	16	D + F + L + H' + E'	44	382	D + F + L + H' + E'	17	3.12	-	-	-	
						Max Compression w/ corresponding moment	19	D + F + L + H' + E'	-45	69							
						Max Moment with axial tension	17	D + F + L + H' + E'	4	600							
						Max Moment with axial compression	17	D + F + L + H' + E'	0	634							
					3-H-L	Max Tension w/ corresponding moment	384	D + F + L + H' + E'	44	368	D + F + L + H' + E'	18	3.12	-	-	-	
						Max Compression w/ corresponding moment	337	D + F + L + H' + E'	-42	83							
						Max Moment with axial tension	382	D + F + L + H' + E'	6	748							
						Max Moment with axial compression	382	D + F + L + H' + E'	-11	748							
			Horizontal Face	3H.6-146	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	120	0.20 (#4 @12)	
				3H.6-146	2-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	120	0.20 (#4 @12)	

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (4) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (5) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in²/ft²)	Remarks
Roof 2	2	Near Side	Horizontal	3H-6-147	1-HL	Max Tension w/ corresponding moment	539	D + F + L + H' + E'	95	-15	D + F + L + H + W1	67	3.12	-	-	-	(9)
						Max Compression w/ corresponding moment	539	D + F + L + H' + E'	-144	-31							
						Max Moment with axial tension	555	D + F + L + H + W1	22	-105							
						Max Moment with axial compression	407	1.4D + 1.4F + 1.7L + 1.7H + 1.7W	-33	-107							
					2-HL	Max Tension w/ corresponding moment	566	D + F + L + H + W1	143	-33	D + F + L + H + W1	54	4.68	-	-	-	(9)
						Max Compression w/ corresponding moment	566	D + F + L + H' + E'	-180	-21							
						Max Moment with axial tension	566	D + F + L + H + W1	92	-49							
						Max Moment with axial compression	566	D + F + L + H' + E'	-21	-61							
					3-HL	Max Tension w/ corresponding moment	553	D + F + L + H + W1	189	-40	D + F + L + H + W1	67	4.68	-	-	-	(9)
						Max Compression w/ corresponding moment	553	D + F + L + H' + E'	-189	-20							
						Max Moment with axial tension	554	D + F + L + H + W1	50	-123							
						Max Moment with axial compression	553	D + F + L + H' + E'	-115	-62							
			Vertical	3H-6-148	1-HL	Max Tension w/ corresponding moment	554	D + F + L + H' + E'	113	-11	D + F + L + H' + E'	80	4.68	-	-	-	
						Max Compression w/ corresponding moment	534	D + F + L + H' + E'	-220	-71							
						Max Moment with corresponding axial tension	534	D + F + L + H' + E'	8	-49							
						Max Moment with corresponding axial compression	584	D + F + L + H' + E'	-143	-134							
		Far side	Horizontal	3H-6-143	1-HL	Max Tension w/ corresponding moment	556	D + F + L + H + W1	34	11	D + F + L + H + W1	56	1.88	-	-	-	(9)
						Max Compression w/ corresponding moment	472	D + F + L + H' + E'	-62	2							
						Max Moment with axial tension	557	D + F + L + H' + E'	2	66							
						Max Moment with axial compression	558	D + F + L + H + W1	-12	62							
					2-HL	Max Tension w/ corresponding moment	569	D + F + L + H + W1	80	15	D + F + L + H + W1	54	3.12	-	-	-	(9)
						Max Compression w/ corresponding moment	569	D + F + L + H' + E'	-160	33							
						Max Moment with axial tension	565	D + F + L + H' + E'	-7	59							
						Max Moment with axial compression	565	D + F + L + H + W1	-22	58							
					3-HL	Max Tension w/ corresponding moment	553	D + F + L + H + W1	138	19	D + F + L + H + W1	67	3.12	-	-	-	(9)
						Max Compression w/ corresponding moment	553	D + F + L + H' + E'	-189	32							
						Max Moment with axial tension	555	D + F + L + H' + E'	5	55							
						Max Moment with axial compression	534	D + F + L + H + W1	-32	113							
			Vertical	3H-6-150	4-HL	Max Tension w/ corresponding moment	554	D + F + L + H' + E'	113	35	D + F + L + H' + E'	80	3.12	-	-	-	
						Max Compression w/ corresponding moment	555	D + F + L + H' + E'	-155	2							
						Max Moment with corresponding axial tension	565	D + F + L + H + W1	21	44							
						Max Moment with corresponding axial compression	490	1.4D + 1.4F + 1.7L + 1.7H + 1.7W	-51	77							
Slab 3	2	Near Side	Horizontal	3H-6-151	1-HL	Max Tension w/ corresponding moment	651	D + F + L + H' + E'	62	-21	D + F + L + H + W1	31	1.56	-	-	-	
						Max Compression w/ corresponding moment	651	D + F + L + H' + E'	-119	-16							
						Max Moment with axial tension	642	D + F + L + H + W1	1	-40							
						Max Moment with axial compression	644	D + F + L + H + W1	-10	-55							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/ft^2)	Remarks
Slab 3	2	Near Side	Vertical	3H.6-152	1-VL	Max Tension w/ corresponding moment	574	D + F + L + H' + E'	64	-34	D + F + L + H + Wt	21	1.58	-	-	-	
						Max Compression w/ corresponding moment	574	D + F + L + H' + E'	-122	-13							
						Max Moment with corresponding axial tension	651	D + F + L + H + Wt	3	-47							
						Max Moment with corresponding axial compression	574	D + F + L + H' + E'	-17	-43							
		Far side	Horizontal	3H.6-153	1-HL	Max Tension w/ corresponding moment	651	D + F + L + H + Wt	59	10	D + F + L + H + Wt	31	1.58	-	-	-	
						Max Compression w/ corresponding moment	651	D + F + L + H' + E'	-119	5							
						Max Moment with axial tension	652	D + F + L + H + Wt	34	36							
						Max Moment with axial compression	573	D + F + L + H + Wt	-10	74							
			Vertical	3H.6-154	1-VL	Max Tension w/ corresponding moment	574	D + F + L + H + Wt	61	14	D + F + L + H + Wt	21	1.58	-	-	-	
						Max Compression w/ corresponding moment	574	D + F + L + H + Wt	-206	51							
						Max Moment with corresponding axial tension	653	D + F + L + H + Wt	11	29							
						Max Moment with corresponding axial compression	574	D + F + L + H + Wt	-136	-90							
Roof 5	2	Near Side	Horizontal	3H.6-155	1-HL	Max Tension w/ corresponding moment	630	D + F + L + H + Wt	107	-17	D + F + L + H + Wt	61	1.58	-	-	-	
						Max Compression w/ corresponding moment	695	D + F + L + H + Wt	-91	-7							
						Max Moment with axial tension	770	D + F + L + H' + E'	1	-32							
						Max Moment with axial compression	764	D + F + L + H' + E'	-8	-41							
			Vertical	3H.6-156	1-VL	Max Tension w/ corresponding moment	767	D + F + L + H + Wt	138	-15	D + F + L + H + Wt	29	2.08	-	-	-	
						Max Compression w/ corresponding moment	718	D + F + L + H + Wt	-128	0							
						Max Moment with corresponding axial tension	731	D + F + L + H' + E'	1	-20							
						Max Moment with corresponding axial compression	731	D + F + L + H' + E'	-4	-20							
		Far side	Horizontal	3H.6-157	1-HL	Max Tension w/ corresponding moment	704	D + F + L + H + Wt	77	4	D + F + L + H + Wt	61	1.58	-	-	-	
						Max Compression w/ corresponding moment	765	D + F + L + H + Wt	-271	22							
						Max Moment with axial tension	699	D + F + L + H + Wt	3	37							
						Max Moment with axial compression	694	D + F + L + H + Wt	-138	48							
			Vertical	3H.6-158	1-VL	Max Tension w/ corresponding moment	761	D + F + L + H + Wt	33	7	D + F + L + H + Wt	29	2.08	-	-	-	
						Max Compression w/ corresponding moment	737	D + F + L + H + Wt	-334	14							
						Max Moment with corresponding axial tension	732	D + F + L + H' + E'	1	18							
						Max Moment with corresponding axial compression	535	D + F + L + H + Wt	-190	20							
Roof 6	2	Near Side	Horizontal	3H.6-159	1-HL	Max Tension w/ corresponding moment	684	D + F + L + H + Wt	111	-8	D + F + L + H + Wt	63	1.58	-	-	-	
						Max Compression w/ corresponding moment	689	D + F + L + H + Wt	-335	-63							
						Max Moment with axial tension	669	D + F + L + H' + E'	27	-62							
						Max Moment with axial compression	689	D + F + L + H + Wt	-190	-64							
			Vertical	3H.6-160	1-VL	Max Tension w/ corresponding moment	689	D + F + L + H + Wt	39	-6	D + F + L + H + Wt	125	2.08	-	-	-	
						Max Compression w/ corresponding moment	689	D + F + L + H + Wt	-209	-12							
						Max Moment with corresponding axial tension	659	D + F + L + H' + E'	0	-11							
						Max Moment with corresponding axial compression	689	D + F + L + H + Wt	-209	-12							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (4) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (5) Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/ft^2)	Remarks
Roof 6	2	Far side	Horizontal	3H-6-161	1-HL	Max Tension w/ corresponding moment	673	D + F + L + H +W1	65	3	D + F + L + H +W1	68	1.56	-	-	-	
						Max Compression w/ corresponding moment	656	D + F + L + H +W1	-452	29							
						Max Moment with axial tension	658	D + F + L + H +W1	14	53							
						Max Moment with axial compression	658	D + F + L + H' + E'	-89	45							
			Vertical	3H-6-162	5-VL	Max Tension w/ corresponding moment	669	D + F + L + H' + E'	22	3	D + F + L + H +W1	125	2.08	-	-	-	
						Max Compression w/ corresponding moment	664	D + F + L + H +W1	-429	24							
						Max Moment with corresponding axial tension	653	D + F + L + H +W1	12	12							
						Max Moment with corresponding axial compression	672	D + F + L + H +W1	-262	34							
Wall 7	4	Near side	Horizontal	3H-6-163	1-HL	Max Tension w/ corresponding moment	843	D + F + L + H' + E'	144	-81	D + F + L + H' + E'	47	3.12	-	-	-	
						Max Compression w/ corresponding moment	843	D + F + L + H' + E'	-200	-42							
						Max Moment with axial tension	811	D + F + L + H' + E'	2	-238							
						Max Moment with axial compression	809	D + F + L + H' + E'	-139	-330							
					2-HL	Max Tension w/ corresponding moment	803	D + F + L + H' + E'	63	-132	D + F + L + H' + E'	47	7.6	-	-	-	
						Max Compression w/ corresponding moment	799	D + F + L + H' + E'	-178	-763							
						Max Moment with axial tension	803	D + F + L + H' + E'	3	-263							
						Max Moment with axial compression	800	D + F + L + H' + E'	-169	-766							
					3-HL	Max Tension w/ corresponding moment	891	D + F + L + H +W1	421	-100	D + F + L + H +W1	43	6.24	-	-	-	
						Max Compression w/ corresponding moment	1042	D + F + L + H +W1	-412	-63							
						Max Moment with axial tension	1042	D + F + L + H' + E'	150	-315							
						Max Moment with axial compression	1057	D + F + L + H' + E'	-145	-319							
					4-HL	Max Tension w/ corresponding moment	1046	D + F + L + H +W1	65	-35	D + F + L + H' + E'	47	7.6	-	-	-	
						Max Compression w/ corresponding moment	1053	D + F + L + H' + E'	-179	-817							
						Max Moment with axial tension	1016	D + F + L + H' + E'	13	-98							
						Max Moment with axial compression	1055	D + F + L + H' + E'	-173	-853							
			Vertical	3H-6-164	1-VL	Max Tension w/ corresponding moment	1042	D + F + L + H +W1	292	-63	D + F + L + H' + E'	105	6.24	-	-	-	
						Max Compression w/ corresponding moment	1042	D + F + L + H +W1	-340	-68							
						Max Moment with corresponding axial tension	869	D + F + L + H' + E'	9	-366							
						Max Moment with corresponding axial compression	891	D + F + L + H' + E'	-134	-337							
					2-VL	Max Tension w/ corresponding moment	796	D + F + L + H' + E'	288	-94	D + F + L + H' + E'	105	10.82	-	-	-	
						Max Compression w/ corresponding moment	798	D + F + L + H' + E'	-232	-48							
						Max Moment with corresponding axial tension	852	D + F + L + H' + E'	13	-1203							
						Max Moment with corresponding axial compression	852	D + F + L + H' + E'	-39	-1204							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number [1]	Reinforcement Zone Number [2]	Maximum Forces [3]	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial [4] (kips / ft)	Flexure [5] (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane [6] Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft) eq	Transverse Shear Design Loads: Load Combination	Transverse Shear [H] Reinforcement Design Loads (kips / ft)	Transverse Shear [7] Reinforcement Provided (in^2/ft^2)	Remarks
Wall 7	4	Fa s de	Horizonta	3H6-165	1-H-L	Max Tension w/ corresponding moment	1042	D + F + L + H +W	463	94	D + F + L + H' + E'	67	4.68	-	-	-	
						Max Compression w/ corresponding moment	691	D + F + L + H' + E'	-404	70							
						Max Moment with axial tension	1047	D + F + L + H' + E'	14	227							
						Max Moment with axial compression	614	D + F + L + H' + E'	-89	279							
			Vertica	3H6-166	1-V-L	Max Tension w/ corresponding moment	691	D + F + L + H +W	339	94	D + F + L + H' + E'	105	6.24	-	-	-	
						Max Compression w/ corresponding moment	784	D + F + L + H' + E'	-258	67							
						Max Moment with corresponding axial tension	656	D + F + L + H' + E'	11	693							
						Max Moment with corresponding axial compression	656	D + F + L + H' + E'	-31	693							
			Horizonta Face	3H6-167	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	82	0.31 (#5 @12)	
				3H6-167	2-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	149	0.62 (#5 @6)	
			Vertica Face	3H6-167	1-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	98	0.31 (#5 @12)	
				3H6-167	2-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	98	0.31 (#5 @12)	
				3H6-167	3-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	124	0.62 (#5 @6)	
Wall 8	4	Near Side	Horizonta	3H6-168	1-H-L	Max Tension w/ corresponding moment	1159	D + F + L + H' + E'	143	-46	D + F + L + H' + E'	66	5.12	-	-	-	
						Max Compression w/ corresponding moment	1136	D + F + L + H' + E'	-301	-27							
						Max Moment with axial tension	1185	D + F + L + H' + E'	2	-212							
						Max Moment with axial compression	1163	D + F + L + H' + E'	-145	-336							
					2-H-L	Max Tension w/ corresponding moment	1276	D + F + L + H +W	50	-44	D + F + L + H' + E'	66	7.6	-	-	-	
						Max Compression w/ corresponding moment	1305	D + F + L + H' + E'	-175	-833							
						Max Moment with axial tension	1282	D + F + L + H' + E'	0	-129							
						Max Moment with axial compression	1311	D + F + L + H' + E'	-173	-668							
					3-H-L	Max Tension w/ corresponding moment	1108	D + F + L + H' + E'	231	-310	D + F + L + H +W	40	6.24	-	-	-	
						Max Compression w/ corresponding moment	1280	D + F + L + H +W	-404	-71							
						Max Moment with axial tension	1280	D + F + L + H' + E'	189	-362							
						Max Moment with axial compression	1301	D + F + L + H' + E'	-156	-387							
					4-H-L	Max Tension w/ corresponding moment	1126	D + F + L + H' + E'	63	-100	D + F + L + H' + E'	66	7.6	-	-	-	
						Max Compression w/ corresponding moment	1192	D + F + L + H' + E'	-178	-785							
						Max Moment with axial tension	1186	D + F + L + H' + E'	5	-230							
						Max Moment with axial compression	1192	D + F + L + H' + E'	-178	-786							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (7) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in²/ft²)	Remarks
Wall 8	4	Near Side	Vertical	3H.6-169	1-H-L	Max Tension w/ corresponding moment	1160	D + F + L + H' + E'	181	-85	D + F + L + H' + E'	107	4.68	-	-	-	
						Max Compression w/ corresponding moment	1280	D + F + L + H +W1	-326	-61							
						Max Moment with corresponding axial tension	1108	D + F + L + H' + E'	17	-406							
						Max Moment with corresponding axial compression	1106	D + F + L + H' + E'	-107	-442							
					2-H-L	Max Tension w/ corresponding moment	1189	D + F + L + H' + E'	289	-100	D + F + L + H' + E'	107	10.92	-	-	-	
						Max Compression w/ corresponding moment	1189	D + F + L + H' + E'	-232	-29							
						Max Moment with corresponding axial tension	1133	D + F + L + H' + E'	13	-1209							
						Max Moment with corresponding axial compression	1133	D + F + L + H' + E'	-38	-1208							
		Far side	Horizontal	3H.6-170	1-H-L	Max Tension w/ corresponding moment	1280	D + F + L + H +W1	368	142	D + F + L + H' + E'	96	3.12	-	-	-	
						Max Compression w/ corresponding moment	1108	D + F + L + H' + E'	-362	105							
						Max Moment with axial tension	1275	D + F + L + H' + E'	13	282							
						Max Moment with axial compression	1280	D + F + L + H' + E'	-209	384							
					2-H-L	Max Tension w/ corresponding moment	1181	D + F + L + H' + E'	14	96	D + F + L + H' + E'	96	4.68	-	-	-	
						Max Compression w/ corresponding moment	1183	D + F + L + H' + E'	-140	331							
						Max Moment with axial tension	1181	D + F + L + H' + E'	11	97							
						Max Moment with axial compression	1175	D + F + L + H' + E'	-48	399							
			Vertical	3H.6-171	1-V-L	Max Tension w/ corresponding moment	1280	D + F + L + H +W1	233	86	D + F + L + H' + E'	107	6.24	-	-	-	
						Max Compression w/ corresponding moment	1189	D + F + L + H' + E'	-299	73							
						Max Moment with corresponding axial tension	1145	D + F + L + H' + E'	11	694							
						Max Moment with corresponding axial compression	1145	D + F + L + H' + E'	-30	694							
		Horizontal Faces		3H.6-172	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H' +E'	92	0.31 (#5 @12)	
				3H.6-172	2-H-T	-	-	-	-	-	-	-	-	D + F + L + H' +E'	148	0.62 (#5 @6)	
		Vertical Faces		3H.6-172	1-V-T	-	-	-	-	-	-	-	-	D + F + L + H' +E'	123	0.62 (#5 @6)	
				3H.6-172	3-V-T	-	-	-	-	-	-	-	-	D + F + L + H' +E'	98	0.31 (#5 @12)	
				3H.6-172	3-V-T	-	-	-	-	-	-	-	-	D + F + L + H' +E'	98	0.31 (#5 @12)	
Wall 9	2	Near Side	Horizontal	3H.6-173	1-H-L	Max Tension w/ corresponding moment	1019	D + F + L + H +W1	131	-2	D + F + L + H +W1	125	3.12	-	-	-	
						Max Compression w/ corresponding moment	865	D + F + L + H +W1	-165	-4							
						Max Moment with axial tension	1018	D + F + L + H' + E'	30	-84							
						Max Moment with axial compression	1035	D + F + L + H' + E'	-36	-111							
					2-H-L	Max Tension w/ corresponding moment	1030	D + F + L + H +W1	271	-12	D + F + L + H +W1	125	4.68	-	-	-	
						Max Compression w/ corresponding moment	1030	D + F + L + H +W1	-241	-13							
						Max Moment with axial tension	1030	D + F + L + H' + E'	90	-112							
						Max Moment with axial compression	1030	D + F + L + H' + E'	-19	-112							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number[1]	Reinforcement Zone Number[2]	Maximum Forces[3]	Elevation	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial[4] (kips / ft)	Flexure[5] (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane[6] Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear[6] Reinforcement Design Loads (kips / ft)	Transverse Shear[7] Reinforcement Provided (in²/ft²)	Remarks
Wall 9	2	Near Side	Vertical	3H.6-174	1-H-L	Max Tension w/ corresponding moment	1019	D + F + L + H +W1	103	-16	D + F + L + H +W1	114	3.12	-	-	-	
						Max Compression w/ corresponding moment	1019	D + F + L + H +W1	-205	-20							
						Max Moment with corresponding axial tension	1031	D + F + L + H' + E'	35	-114							
						Max Moment with corresponding axial compression	1031	D + F + L + H' + E'	-88	-114							
					6-H-L	Max Tension w/ corresponding moment	1030	D + F + L + H +W1	806	-32	D + F + L + H +W1	100	6.34	-	-	-	
						Max Compression w/ corresponding moment	1030	D + F + L + H +W1	-825	-82							
						Max Moment with corresponding axial tension	1030	D + F + L + H' + E'	131	-197							
						Max Moment with corresponding axial compression	1030	D + F + L + H' + E'	-171	-197							
					3-H-L	Max Tension w/ corresponding moment	1035	D + F + L + H +W1	161	-9	D + F + L + H +W1	109	4.68	-	-	-	
						Max Compression w/ corresponding moment	1035	D + F + L + H +W1	-219	-14							
						Max Moment with corresponding axial tension	1035	D + F + L + H' + E'	68	-42							
						Max Moment with corresponding axial compression	1035	D + F + L + H' + E'	-30	-42							
		Far Side	Horizontal	3H.6-175	5-H-L	Max Tension w/ corresponding moment	1019	D + F + L + H +W1	148	6	D + F + L + H +W1	125	3.12	-	-	-	
						Max Compression w/ corresponding moment	896	D + F + L + H +W1	-316	6							
						Max Moment with axial tension	875	D + F + L + H +W1	2	62							
						Max Moment with axial compression	883	D + F + L + H +W1	-15	64							
					8-H-L	Max Tension w/ corresponding moment	1030	D + F + L + H +W1	160	17	D + F + L + H +W1	125	4.68	-	-	-	
						Max Compression w/ corresponding moment	1030	D + F + L + H' + E'	-218	36							
						Max Moment with axial tension	1030	D + F + L + H' + E'	0	23							
						Max Moment with axial compression	1030	D + F + L + H' + E'	-169	56							
			Vertical	3H.6-176	10-H-L	Max Tension w/ corresponding moment	952	D + F + L + H +W1	134	9	D + F + L + H +W1	114	3.12	-	-	-	
						Max Compression w/ corresponding moment	1011	D + F + L + H +W1	-167	3							
						Max Moment with corresponding axial tension	956	D + F + L + H +W1	1	57							
						Max Moment with corresponding axial compression	999	D + F + L + H +W1	-5	71							
					2-H-L	Max Tension w/ corresponding moment	1000	D + F + L + H +W1	51	11	D + F + L + H +W1	100	6.34	-	-	-	
						Max Compression w/ corresponding moment	1030	D + F + L + H' + E'	-403	21							
						Max Moment with corresponding axial tension	1018	D + F + L + H +W1	11	28							
						Max Moment with corresponding axial compression	1018	D + F + L + H' + E'	-248	43							
Wall 10	2	Near Side	Horizontal	3H.6-177	9-H-L	Max Tension w/ corresponding moment	1246	D + F + L + H' + E'	93	-28	D + F + L + H +W1	100	3.12	-	-	-	
						Max Compression w/ corresponding moment	1204	D + F + L + H +W1	-163	-3							
						Max Moment with axial tension	1258	D + F + L + H' + E'	29	-41							
						Max Moment with axial compression	1197	D + F + L + H' + E'	-36	-107							
					2-H-L	Max Tension w/ corresponding moment	1257	D + F + L + H' + E'	122	-43	D + F + L + H +W1	95	4.68	-	-	-	
						Max Compression w/ corresponding moment	1257	D + F + L + H +W1	-233	-15							
						Max Moment with axial tension	1257	D + F + L + H' + E'	85	-107							
						Max Moment with axial compression	1257	D + F + L + H' + E'	-13	-107							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in²/ft²)	Remarks
Wall 10	2	Near Side	Vertical	3H.6-178	1-V-L	Max Tension w/ corresponding moment	1246	D + F + L + H +W1	166	-6	D + F + L + H +W1	64	3.12	-	-	-	
						Max Compression w/ corresponding moment	1246	D + F + L + H +W1	-187	-22							
						Max Moment with corresponding axial tension	1245	D + F + L + H' + E'	21	-123							
						Max Moment with corresponding axial compression	1245	D + F + L + H' + E'	-64	-123							
					2-V-L	Max Tension w/ corresponding moment	1197	D + F + L + H +W1	152	-9	D + F + L + H +W1	80	4.68	-	-	-	
						Max Compression w/ corresponding moment	1197	D + F + L + H +W1	-176	-7							
						Max Moment with corresponding axial tension	1197	D + F + L + H' + E'	65	-49							
						Max Moment with corresponding axial compression	1197	D + F + L + H' + E'	-32	-48							
					3-V-L	Max Tension w/ corresponding moment	1257	D + F + L + H +W1	458	-21	D + F + L + H +W1	71	6.24	-	-	-	
						Max Compression w/ corresponding moment	1257	D + F + L + H +W1	-462	-58							
						Max Moment with corresponding axial tension	1257	D + F + L + H' + E'	111	-204							
						Max Moment with corresponding axial compression	1257	D + F + L + H' + E'	-139	-204							
		Far Side	Horizontal	3H.6-179	1-H-L	Max Tension w/ corresponding moment	1246	D + F + L + H +W1	117	10	D + F + L + H +W1	100	3.12	-	-	-	
						Max Compression w/ corresponding moment	1265	D + F + L + H +W1	-303	17							
						Max Moment with axial tension	1189	D + F + L + H' + E'	1	51							
						Max Moment with axial compression	1232	D + F + L + H +W1	-36	65							
					2-H-L	Max Tension w/ corresponding moment	1257	D + F + L + H +W1	214	16	D + F + L + H +W1	95	4.68	-	-	-	
						Max Compression w/ corresponding moment	1257	D + F + L + H' + E'	-336	-43							
						Max Moment with axial tension	1245	D + F + L + H' + E'	9	33							
						Max Moment with axial compression	1257	D + F + L + H' + E'	-155	-52							
			Vertical	3H.6-180	1-V-L	Max Tension w/ corresponding moment	1281	D + F + L + H +W1	140	7	D + F + L + H +W1	64	3.12	-	-	-	
						Max Compression w/ corresponding moment	1189	D + F + L + H +W1	-149	1							
						Max Moment with corresponding axial tension	1234	D + F + L + H' + E'	0	29							
						Max Moment with corresponding axial compression	1245	D + F + L + H +W1	-25	69							
					2-V-L	Max Tension w/ corresponding moment	1260	D + F + L + H' + E'	61	9	D + F + L + H +W1	71	6.24	-	-	-	
						Max Compression w/ corresponding moment	1257	D + F + L + H' + E'	-340	16							
						Max Moment with corresponding axial tension	1260	D + F + L + H' + E'	61	9							
						Max Moment with corresponding axial compression	1256	D + F + L + H' + E'	-239	42							
Wall 11	2	Near Side	Horizontal	3H.6-181	1-H-L	Max Tension w/ corresponding moment	951	D + F + L + H +W1	116	-54	D + F + L + H +W1	46	3.12	-	-	-	
						Max Compression w/ corresponding moment	924	D + F + L + H +W1	-131	-4							
						Max Moment with axial tension	951	D + F + L + H +W1	79	-43							
						Max Moment with axial compression	944	D + F + L + H' + E'	-16	-40							
			Vertical	3H.6-182	1-V-L	Max Tension w/ corresponding moment	944	D + F + L + H +W1	137	-9	D + F + L + H' + E'	20	1.56	-	-	-	
						Max Compression w/ corresponding moment	944	D + F + L + H +W1	-123	-6							
						Max Moment with corresponding axial tension	935	D + F + L + H +W1	5	-40							
						Max Moment with corresponding axial compression	807	D + F + L + H +W1	-41	-33							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (1)	Maximum Forces (2)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (3) Reinforcement Provided (in²/ft²)	Remarks
Wall 11	2	Face B	Horizontal	3H6-183	1-HL	Max Tension w/ corresponding moment	844	D + F + L + H +Wt	58	7	D + F + L + H +Wt	46	3.12	-	-	-	
						Max Compression w/ corresponding moment	827	D + F + L + H +Wt	-428	30							
						Max Moment with axial tension	853	D + F + L + H +Wt	7	64							
						Max Moment with axial compression	827	D + F + L + H +Wt	-4	83							
			Vertical	3H6-184	1-VL	Max Tension w/ corresponding moment	844	D + F + L + H +Wt	89	10	D + F + L + H' + E'	20	1.56	-	-	-	
						Max Compression w/ corresponding moment	844	D + F + L + H +Wt	-134	7							
						Max Moment with corresponding axial tension	835	D + F + L + H +Wt	2	23							
						Max Moment with corresponding axial compression	907	D + F + L + H +Wt	-80	104							
Wall 12	4	Near Side	Horizontal	3H6-185	1-HL	Max Tension w/ corresponding moment	1348	D + F + L + H' + E'	87	-151	D + F + L + H' + E'	127	3.12	-	-	-	
						Max Compression w/ corresponding moment	1346	D + F + L + H' + E'	-187	-340							
						Max Moment with axial tension	1348	D + F + L + H' + E'	17	-207							
						Max Moment with axial compression	1346	D + F + L + H' + E'	-174	-382							
					2-HL	Max Tension w/ corresponding moment	1341	D + F + L + H' + E'	85	-79	D + F + L + H' + E'	127	7.8	-	-	-	
						Max Compression w/ corresponding moment	1337	D + F + L + H' + E'	-189	-789							
						Max Moment with axial tension	1341	D + F + L + H' + E'	3	-211							
						Max Moment with axial compression	1337	D + F + L + H' + E'	-187	-761							
					3-HL	Max Tension w/ corresponding moment	1437	D + F + L + H' + E'	99	-119	D + F + L + H' + E'	127	6.24	-	-	-	
						Max Compression w/ corresponding moment	1433	D + F + L + H' + E'	-186	-487							
						Max Moment with axial tension	1445	D + F + L + H' + E'	1	-219							
						Max Moment with axial compression	1442	D + F + L + H' + E'	-175	-746							
			Vertical	3H6-186	1-VL	Max Tension w/ corresponding moment	1336	D + F + L + H' + E'	120	-64	D + F + L + H' + E'	107	3.12	-	-	-	
						Max Compression w/ corresponding moment	1330	D + F + L + H' + E'	-220	-56							
						Max Moment with corresponding axial tension	1373	D + F + L + H' + E'	2	-222							
						Max Moment with corresponding axial compression	1373	D + F + L + H' + E'	-24	-222							
					2-VL	Max Tension w/ corresponding moment	1438	D + F + L + H' + E'	286	-73	D + F + L + H' + E'	107	6.24	-	-	-	
						Max Compression w/ corresponding moment	1334	D + F + L + H' + E'	-305	-69							
						Max Moment with corresponding axial tension	1406	D + F + L + H' + E'	56	-162							
						Max Moment with corresponding axial compression	1406	D + F + L + H' + E'	-30	-162							
					3-VL	Max Tension w/ corresponding moment	1388	D + F + L + H' + E'	95	-610	D + F + L + H' + E'	107	7.8	-	-	-	
						Max Compression w/ corresponding moment	1389	D + F + L + H' + E'	-103	-88							
						Max Moment with corresponding axial tension	1374	D + F + L + H' + E'	27	-683							
						Max Moment with corresponding axial compression	1358	D + F + L + H' + E'	-5	-846							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane Shear (6) (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/in^2)	Remarks
Wall 12	4	Far side	Horizontal	3H.6-157	1-H-L	Max Tension w/ corresponding moment	1446	D + F + L + H' + E'	90	7	D + F + L + H' + E'	127	3.12	-	-	-	
						Max Compression w/ corresponding moment	1429	D + F + L + H' + E'	-181	47							
						Max Moment with axial tension	1357	D + F + L + H' + E'	2	118							
						Max Moment with axial compression	1393	D + F + L + H' + E'	-157	310							
			Vertical	3H.6-158	1-V-L	Max Tension w/ corresponding moment	1438	D + F + L + H' + E'	184	8	D + F + L + H' + E'	107	6.24	-	-	-	
						Max Compression w/ corresponding moment	1334	D + F + L + H' + E'	-289	17							
						Max Moment with corresponding axial tension	1334	D + F + L + H' + E'	16	325							
						Max Moment with corresponding axial compression	1392	D + F + L + H' + E'	0	321							
			Horizontal Plane	3H.6-159	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	84	0.31 (#5 @12)	
			Vertical Plane	3H.6-159	1-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	102	0.31 (#5 @12)	
				3H.6-159	2-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	109	0.31 (#5 @12)	
Wall 13	4	Near Side	Horizontal	3H.6-160	1-H-L	Max Tension w/ corresponding moment	1880	D + F + L + H' + E'	16	-13	D + F + L + H' + E'	119	3.12	-	-	-	
						Max Compression w/ corresponding moment	1844	D + F + L + H' + E'	-163	-191							
						Max Moment with axial tension	1867	D + F + L + H' + E'	0	-39							
						Max Moment with axial compression	1874	D + F + L + H' + E'	-36	-216							
					2-H-L	Max Tension w/ corresponding moment	1871	D + F + L + H' + E'	68	-12	D + F + L + H' + E'	119	7.8	-	-	-	
						Max Compression w/ corresponding moment	1941	D + F + L + H' + E'	-187	-802							
						Max Moment with axial tension	1871	D + F + L + H' + E'	36	-405							
						Max Moment with axial compression	1855	D + F + L + H' + E'	-178	-833							
					3-H-L	Max Tension w/ corresponding moment	1884	D + F + L + H' + E'	49	-240	D + F + L + H' + E'	119	7.8	-	-	-	
						Max Compression w/ corresponding moment	1954	D + F + L + H' + E'	-188	-516							
						Max Moment with axial tension	1884	D + F + L + H' + E'	34	-455							
						Max Moment with axial compression	1968	D + F + L + H' + E'	-173	-870							
			Vertical	3H.6-161	1-V-L	Max Tension w/ corresponding moment	1870	D + F + L + H' + E'	208	-42	D + F + L + H' + E'	114	4.68	-	-	-	
						Max Compression w/ corresponding moment	1857	D + F + L + H' + E'	-263	-55							
						Max Moment with corresponding axial tension	1860	D + F + L + H' + E'	37	-369							
						Max Moment with corresponding axial compression	1880	D + F + L + H' + E'	-60	-369							
					2-V-L	Max Tension w/ corresponding moment	1868	D + F + L + H' + E'	106	-150	D + F + L + H' + E'	88	7.8	-	-	-	
						Max Compression w/ corresponding moment	1958	D + F + L + H' + E'	-138	-64							
						Max Moment with corresponding axial tension	1865	D + F + L + H' + E'	27	-686							
						Max Moment with corresponding axial compression	1896	D + F + L + H' + E'	-1	-452							
		Far side	Horizontal	3H.6-162	1-H-L	Max Tension w/ corresponding moment	1471	D + F + L + H' + E'	64	12	D + F + L + H' + E'	119	4.68	-	-	-	
						Max Compression w/ corresponding moment	1632	D + F + L + H' + E'	-181	126							
						Max Moment with axial tension	1482	D + F + L + H' + E'	4	259							
						Max Moment with axial compression	1994	D + F + L + H' + E'	-150	377							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (H) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/ft^2)	Remarks
Wall 13	4	Far side	Vertical	3H.6-193	1-V-L	Max Tension w/ corresponding moment	1657	D + F + L + H +Wt	161	3	D + F + L + H' + E'	1.14	4.68	-	-	-	
						Max Compression w/ corresponding moment	1657	D + F + L + H' + E'	-290	13							
						Max Moment with corresponding axial tension	1622	D + F + L + H' + E'	1	310							
						Max Moment with corresponding axial compression	1622	D + F + L + H' + E'	-8	-309							
		-	Horizontal Plane	3H.6-194	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	92	0.31 (#5 @12)	
			Vertical Plane	3H.6-194	1-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	123	0.62 (#5 @6)	
				3H.6-194	2-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	107	0.31 (#5 @12)	
				3H.6-194	3-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	80	0.31 (#5 @12)	
				3H.6-194	4-V-T	-	-	-	-	-	-	-	-	D + F + L + H' + E'	118	0.62 (#5 @6)	
Wall 14	2	Near side	Horizontal	3H.6-195	1-H-L	Max Tension w/ corresponding moment	1632	D + F + L + H +Wt	96	-7	D + F + L + H +Wt	67	3.12	-	-	-	
						Max Compression w/ corresponding moment	1632	D + F + L + H' + E'	-311	-46							
						Max Moment with axial tension	1653	D + F + L + H' + E'	7	-77							
						Max Moment with axial compression	1632	D + F + L + H' + E'	-136	-40							
			Vertical	3H.6-196	1-V-L	Max Tension w/ corresponding moment	1496	D + F + L + H +Wt	241	-6	D + F + L + H +Wt	82	3.12	-	-	-	
						Max Compression w/ corresponding moment	1496	D + F + L + H +Wt	-231	-5							
						Max Moment with corresponding axial tension	1628	D + F + L + H +Wt	14	-105							
						Max Moment with corresponding axial compression	1578	D + F + L + H +Wt	-1	-42							
					2-V-L	Max Tension w/ corresponding moment	1496	D + F + L + H +Wt	433	-107	D + F + L + H +Wt	82	6.24	-	-	-	
						Max Compression w/ corresponding moment	1496	D + F + L + H' + E'	-283	-3							
						Max Moment with corresponding axial tension	1496	D + F + L + H +Wt	215	-124							
						Max Moment with corresponding axial compression	1496	D + F + L + H +Wt	-3	-79							
					3-V-L	Max Tension w/ corresponding moment	1632	D + F + L + H +Wt	500	-139	D + F + L + H +Wt	47	6.24	-	-	-	
						Max Compression w/ corresponding moment	1632	D + F + L + H' + E'	-341	-8							
						Max Moment with corresponding axial tension	1632	D + F + L + H +Wt	312	-170							
						Max Moment with corresponding axial compression	1632	D + F + L + H' + E'	40	-82							
		Far side	Horizontal	3H.6-197	1-H-L	Max Tension w/ corresponding moment	1640	D + F + L + H' + E'	114	16	D + F + L + H +Wt	67	3.12	-	-	-	
						Max Compression w/ corresponding moment	1639	D + F + L + H +Wt	-314	28							
						Max Moment with axial tension	1632	D + F + L + H' + E'	61	68							
						Max Moment with axial compression	1567	D + F + L + H +Wt	-103	71							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in²/ ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (6) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in²/ft²)	Remarks
Wall 14	2	Rear side	Vertical	3H.6-198	1-H-L	Max Tension w/ corresponding moment	1435	D + F + L + H' + E'	166	12	D + F + L + H +W1	82	3.12	-	-	-	
						Max Compression w/ corresponding moment	1533	D + F + L + H +W1	-340	15							
						Max Moment with corresponding axial tension	1534	D + F + L + H +W1	15	72							
						Max Moment with corresponding axial compression	1540	D + F + L + H +W1	-78	120							
					2-V-L	Max Tension w/ corresponding moment	1496	D + F + L + H' + E'	199	10	D + F + L + H +W1	82	4.68	-	-	-	
						Max Compression w/ corresponding moment	1496	D + F + L + H +W1	-442	101							
						Max Moment with corresponding axial tension	1496	D + F + L + H' + E'	8	70							
						Max Moment with corresponding axial compression	1496	D + F + L + H +W1	-242	123							
					3-H-L	Max Tension w/ corresponding moment	1652	D + F + L + H' + E'	223	16	D + F + L + H +W1	47	6.24	-	-	-	
						Max Compression w/ corresponding moment	1652	D + F + L + H +W1	-504	104							
						Max Moment with corresponding axial tension	1652	D + F + L + H' + E'	12	80							
						Max Moment with corresponding axial compression	1652	D + F + L + H +W1	-318	134							
	-		Horizontal Plane	3H.6-199	1-H-T	-	-	-	-	-	-	-	-	D + F + L + H +W1	25	0.20 (#4 @12)	
Wall 15	2	Near Side	Horizontal	3H.6-200	1-H-L	Max Tension w/ corresponding moment	1784	D + F + L + H +W1	538	-17	D + F + L + H +W1	58	3.12	-	-	-	
						Max Compression w/ corresponding moment	1836	D + F + L + H +W1	-178	-8							
						Max Moment with axial tension	1843	D + F + L + H' + E'	3	-85							
						Max Moment with axial compression	1829	D + F + L + H' + E'	-35	-107							
			Vertical	3H.6-201	1-V-L	Max Tension w/ corresponding moment	1690	D + F + L + H +W1	123	-24	D + F + L + H +W1	81	3.12	-	-	-	
						Max Compression w/ corresponding moment	1846	D + F + L + H' + E'	-106	-11							
						Max Moment with corresponding axial tension	1690	D + F + L + H' + E'	3	-39							
						Max Moment with corresponding axial compression	1786	D + F + L + H' + E'	-11	-42							
					2-V-L	Max Tension w/ corresponding moment	1689	D + F + L + H +W1	163	-36	D + F + L + H +W1	81	4.68	-	-	-	
						Max Compression w/ corresponding moment	1689	D + F + L + H' + E'	-110	-3							
						Max Moment with corresponding axial tension	1689	D + F + L + H' + E'	75	-44							
						Max Moment with corresponding axial compression	1689	D + F + L + H' + E'	-24	-44							
					3-H-L	Max Tension w/ corresponding moment	1845	D + F + L + H +W1	154	-35	D + F + L + H +W1	50	4.68	-	-	-	
						Max Compression w/ corresponding moment	1845	D + F + L + H' + E'	-112	-10							
						Max Moment with corresponding axial tension	1843	D + F + L + H' + E'	62	-42							
						Max Moment with corresponding axial compression	1845	D + F + L + H' + E'	-28	-42							
		Far side	Horizontal	3H.6-202	1-H-L	Max Tension w/ corresponding moment	1711	D + F + L + H +W1	32	7	D + F + L + H +W1	88	1.88	-	-	-	
						Max Compression w/ corresponding moment	1697	D + F + L + H +W1	-359	13							
						Max Moment with axial tension	1740	D + F + L + H' + E'	2	-46							
						Max Moment with axial compression	1738	D + F + L + H +W1	-103	66							
			Vertical	3H.6-203	1-V-L	Max Tension w/ corresponding moment	1689	D + F + L + H' + E'	103	6	D + F + L + H +W1	81	3.12	-	-	-	
						Max Compression w/ corresponding moment	1689	D + F + L + H +W1	-230	42							
						Max Moment with corresponding axial tension	1686	D + F + L + H +W1	11	-74							
						Max Moment with corresponding axial compression	1697	D + F + L + H +W1	-2	71							

Table 3H.6-11: Results of DGFOS Vault Concrete Design (Continued)

Location	Thickness (ft)	Face	Direction	Reinforcement Layout Drawing Number (1)	Reinforcement Zone Number (2)	Maximum Forces (3)	Element	Longitudinal Reinforcement Design Loads: Axial and Flexure Loads: Load Combination	Axial (4) (kips / ft)	Flexure (5) (ft-kips / ft)	In-Plane Shear Loads: Load Combination	In-plane (6) Shear (kips / ft)	Longitudinal Reinforcement Provided (in^2/ ft)	Transverse Shear Design Loads: Load Combination	Transverse Shear (8) Reinforcement Design Loads (kips / ft)	Transverse Shear (7) Reinforcement Provided (in^2/ft^2)	Remarks
Wall 16	2	Near Side	Horizontal	3H.6-204	1-H-L	Max Tension w/ corresponding moment	1447	D + F + L + H' + E'	31	-3	D + F + L + H +W1	69	1.36	-	-	-	
						Max Compression w/ corresponding moment	1447	D + F + L + H +W1	-104	-25							
						Max Moment with axial tension	1432	D + F + L + H +W1	4	-30							
						Max Moment with axial compression	1478	D + F + L + H +W1	-35	-29							
			Vertical	3H.6-205	1-V-L	Max Tension w/ corresponding moment	1450	D + F + L + H +W1	101	-15	D + F + L + H' + E'	15	1.56	-	-	-	
						Max Compression w/ corresponding moment	1447	D + F + L + H +W1	-151	-76							
						Max Moment with corresponding axial tension	1458	D + F + L + H +W1	5	-54							
						Max Moment with corresponding axial compression	1447	D + F + L + H +W1	-70	-86							
		Far Side	Horizontal	3H.6-206	1-H-L	Max Tension w/ corresponding moment	1447	D + F + L + H' + E'	31	4	D + F + L + H +W1	69	1.56	-	-	-	
						Max Compression w/ corresponding moment	1421	D + F + L + H +W1	-362	37							
						Max Moment with axial tension	1483	D + F + L + H +W1	6	31							
						Max Moment with axial compression	1476	D + F + L + H +W1	-35	82							
			Vertical	3H.6-207	1-V-L	Max Tension w/ corresponding moment	1451	D + F + L + H +W1	108	17	D + F + L + H' + E'	15	1.36	-	-	-	
						Max Compression w/ corresponding moment	1431	D + F + L + H +W1	-143	6							
						Max Moment with corresponding axial tension	1434	D + F + L + H +W1	40	52							
						Max Moment with corresponding axial compression	1481	D + F + L + H +W1	-40	88							
		-	Horizontal Faces	3H.6-208	1-H-T	-	-	-	-	-	-	-	-	-	-	0.62 (#5 @6)	Transverse shear reinforcement provided due to torsion in-plane shear evaluation
				1H.6-209	2H-T	-	-	-	-	-	-	-	-	-	-	0.62 (#5 @4)	

Notes:

(1) The reinforcement layout drawings show the various zones used to define the minimum reinforcement that will be provided based on finite element analysis results. Actual provided reinforcement based on final rebar layout and including development length may exceed the reported provided reinforcement and the zones with higher reinforcement may be extended beyond their reported boundaries. The dimensions in the reinforcement drawings are based on the dimensions of the 2D SAP2000 shell elements, which are modeled at the centerline of the walls and slabs. Therefore, the reinforcement drawing dimensions do not match actual building dimensions.

(2) Each reinforcement layout drawing is divided into reinforcement zones. The reinforcement zone naming convention is as follows: "H" = horizontal, "V" = vertical, "L" = longitudinal reinforcement, "T" = transverse reinforcement. For slabs, vertical corresponds to Y-axis and horizontal corresponds to X-axis as shown on Figure 3H.6-140.

(3) The maximum tension and compression axial forces are provided with the corresponding moment from the same load combination. The maximum moment that has a corresponding tension in the same load combination and the maximum moment that has a corresponding compression in the same load combination are also provided. For zones where either axial tension or axial compression does not occur for any load combination, dashes are input into the corresponding cell.

(4) Negative axial load is compression and positive axial load is tension. Negative moment applies tension to the top face of the shell element and positive moment applies tension to the bottom face of the shell element. For walls or slabs where the same reinforcement is provided on both faces, the moment is shown as absolute value. The axial and flexural loads reported in the table are the average of the 2 node pairs that form the 4 edges of the critical rectangular shell element. If the 2 node pairs on the shell element edges parallel to the reinforcement direction do not satisfy P&M interaction criteria, then only the 2 node pairs on the shell element edges perpendicular to the reinforcement direction are used for design (effective width considered).

(5) The reported in-plane shear is the maximum average in-plane shear along a plane that crosses the longitudinal reinforcement zone.

(6) The reported transverse shear is the maximum average transverse shear along a plane in that transverse reinforcement zone.

(7) In areas where horizontal and vertical transverse shear zones overlap, the total transverse shear reinforcement to be supplied in the overlapping area is the sum of the transverse reinforcement required from the horizontal and vertical zones.

(8) For certain areas of the structure, the standard element post-processing methods were too conservative. For such cases, detailed manual design was performed and the design forces determined by the detailed manual design are provided in the table.

(9) The reported forces are from the FEM analysis. The provided longitudinal reinforcement includes additional reinforcement required due to manual one-way design calculations.

Table 3H.6-12: Factors of Safety Against Sliding, Overturning, and Flotation for Diesel Generator Fuel Oil Storage Vaults

Load Combination	Calculated Safety Factor			Notes
	Overturning	Sliding	Flotation	
D + F'	---	---	1.28	2,3
D + H + W	73.3	63.1	---	
D + H + Wt	32.5	27.3	---	
D + H + E'	1.1	1.1	---	3,4

Notes:

1) Loads D, H, W, Wt, and E` are defined in Subsection 3H.6.4.3.4.1. F` is the buoyant force corresponding to the design basis flood.

2) Reported safety factors are conservatively based on considering empty weight of the fuel oil tank.

3) Coefficients of friction for sliding resistance are 0.58 for static conditions and 0.39 for dynamic conditions for the Diesel Generator Fuel Oil Storage Vault.

4) The calculated safety factors consider less than half of the full passive pressure. The calculated saftey factors increase if full passive pressure (Kp = 3.0) is considered.

Table 3H.6-13: Tornado Missile Impact Evaluation for Diesel Generator Fuel Oil Storage Vault

Local Check	**DGFOS Vault**	Minimum required thickness to prevent pentration, perforation, and scabbing = 13.6"
		Minimum provided thickness = 18"
Overall Check of Impacted Element	**Roof**	Flexure controls. Maximum impact load including Dynamic Load Factor (DLF) = 432 kips Ductility demand = 0.5 < Ductility limit = 10
	Protection Hood	Flexure controls. Maximum impact load including Dynamic Load Factor (DLF) = 432 kips Ductility demand = 5 < Ductility limit = 10
	Walls	Flexure controls. Maximum impact load including Dynamic Load Factor (DLF) = 938 kips Ductility demand = 0.7 < Ductility limit = 10
	Entry Way Wall	Shear controls. Maximum impact load including Dynamic Load Factor (DLF) = 617 kips Minimum capacity = 929 kips Shear ties are required locally to withstand a missile strike near the top and bottom panel supports. See Table 3H.6-11 and Figure 3H.6-208 for reinforcement size and location.
Global Check		Equivalent static impact forces are applied to the FEM analysis of the DGFOS Vault. The analysis results presented in Table 3H.6-11 provide a summary of the results for all load combinations including those affected by the tornado missile impact.

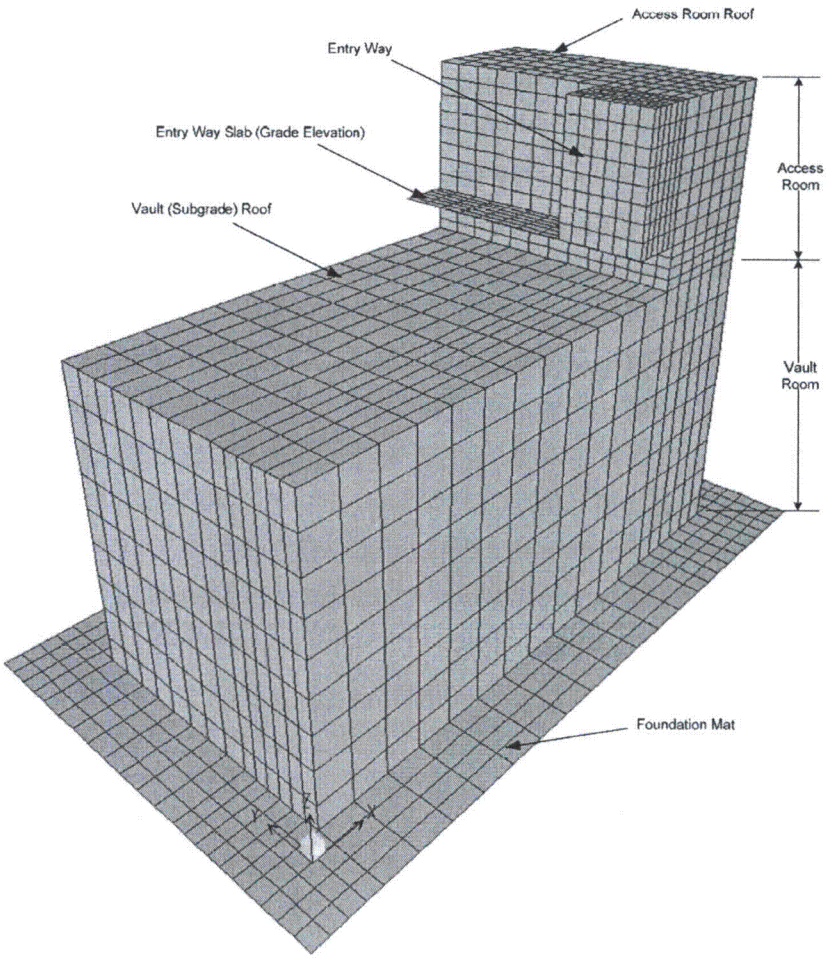

FIGURE 3H.6-140: DGFOSV SAP2000 Model

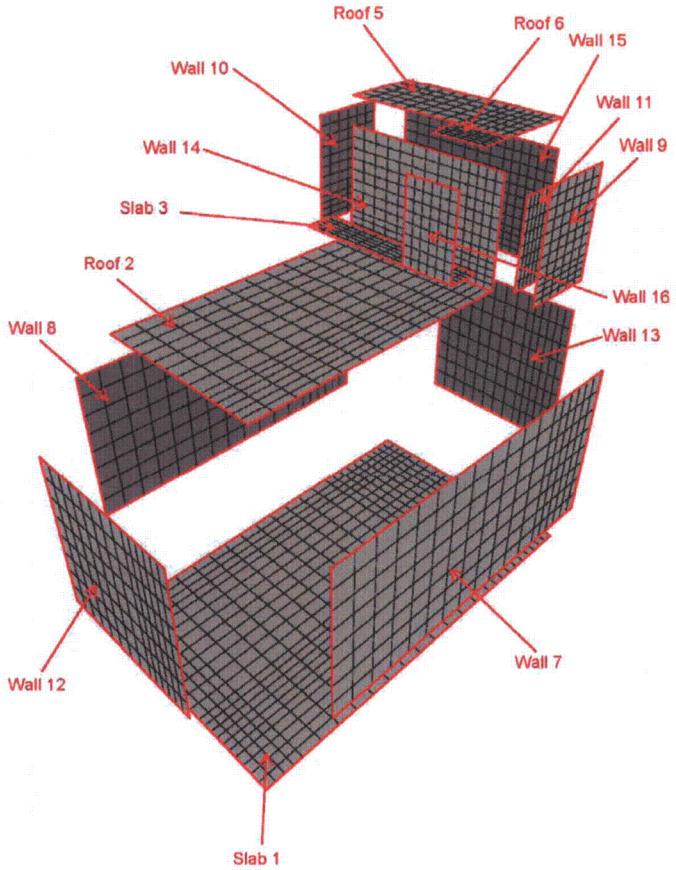

FIGURE 3H.6-141: DGFOSV Wall and Slab Labeling Convention

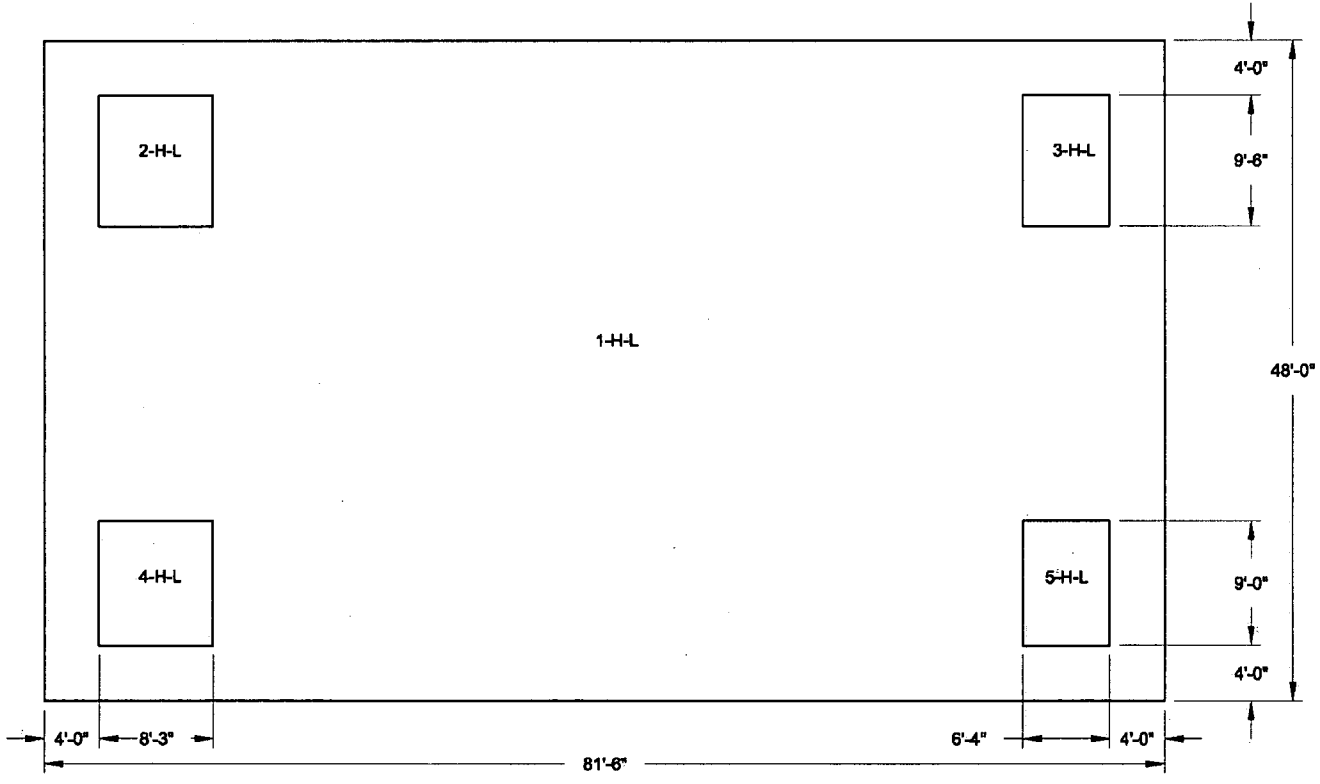

FIGURE 3H.6-142: SLAB 1 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

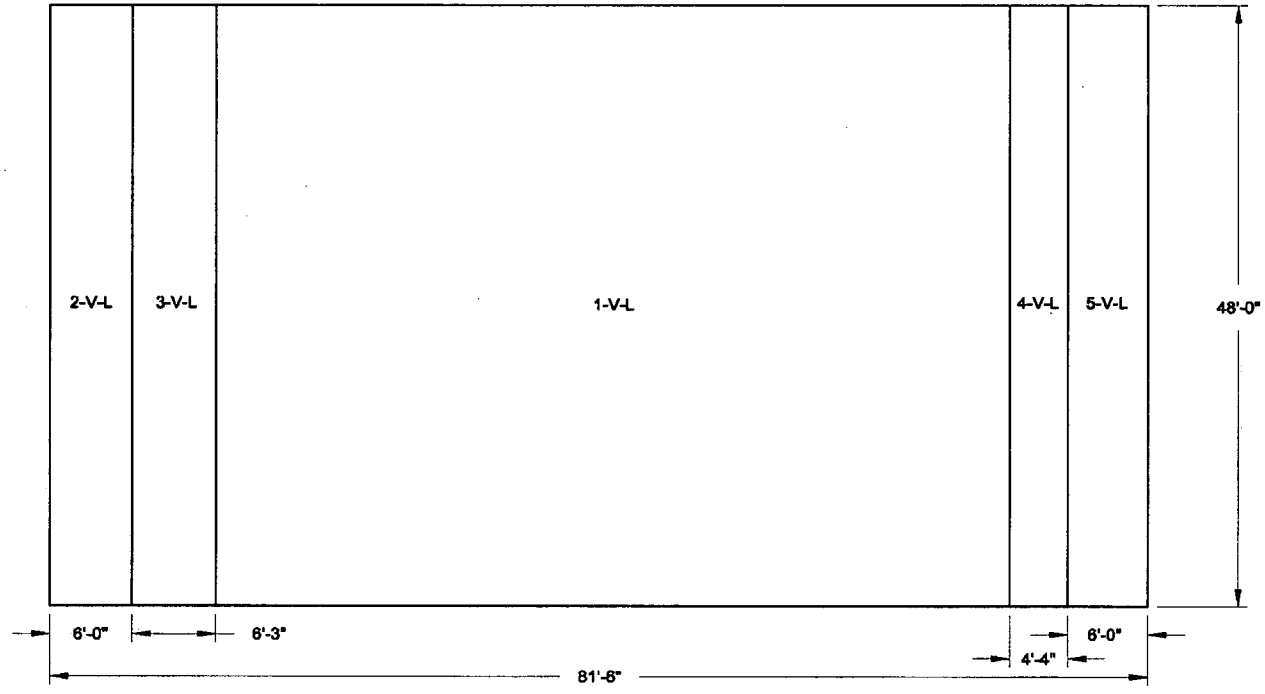

FIGURE 3H.6-143: SLAB 1 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

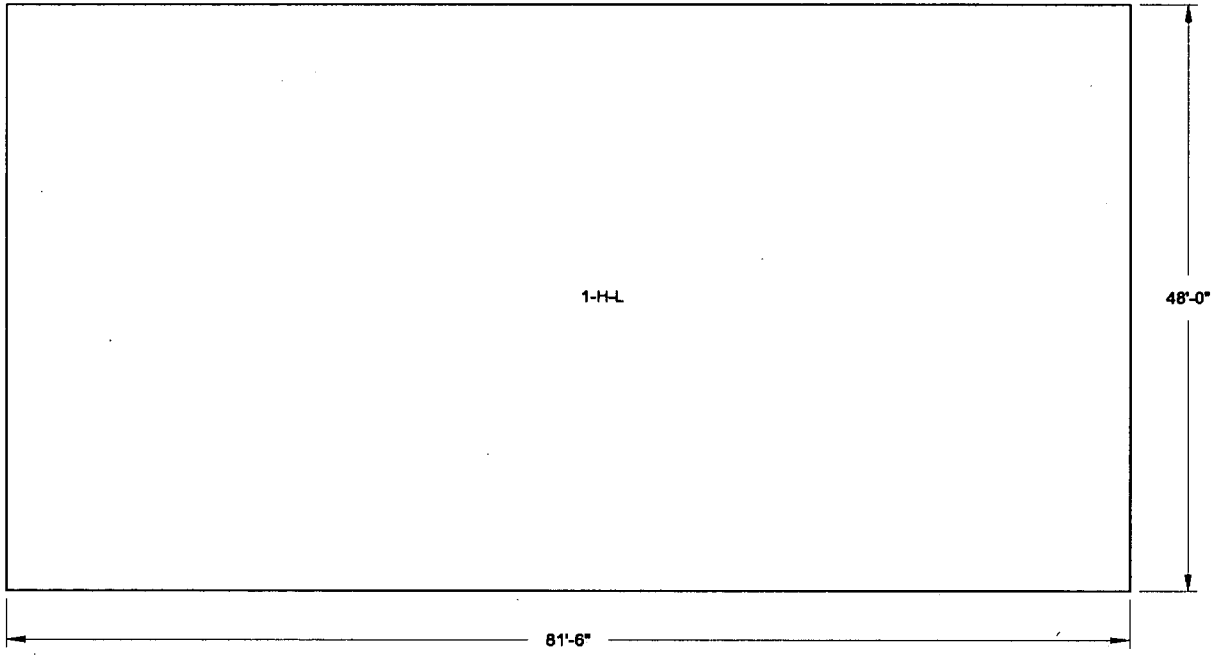

FIGURE 3H.6-144: SLAB 1 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

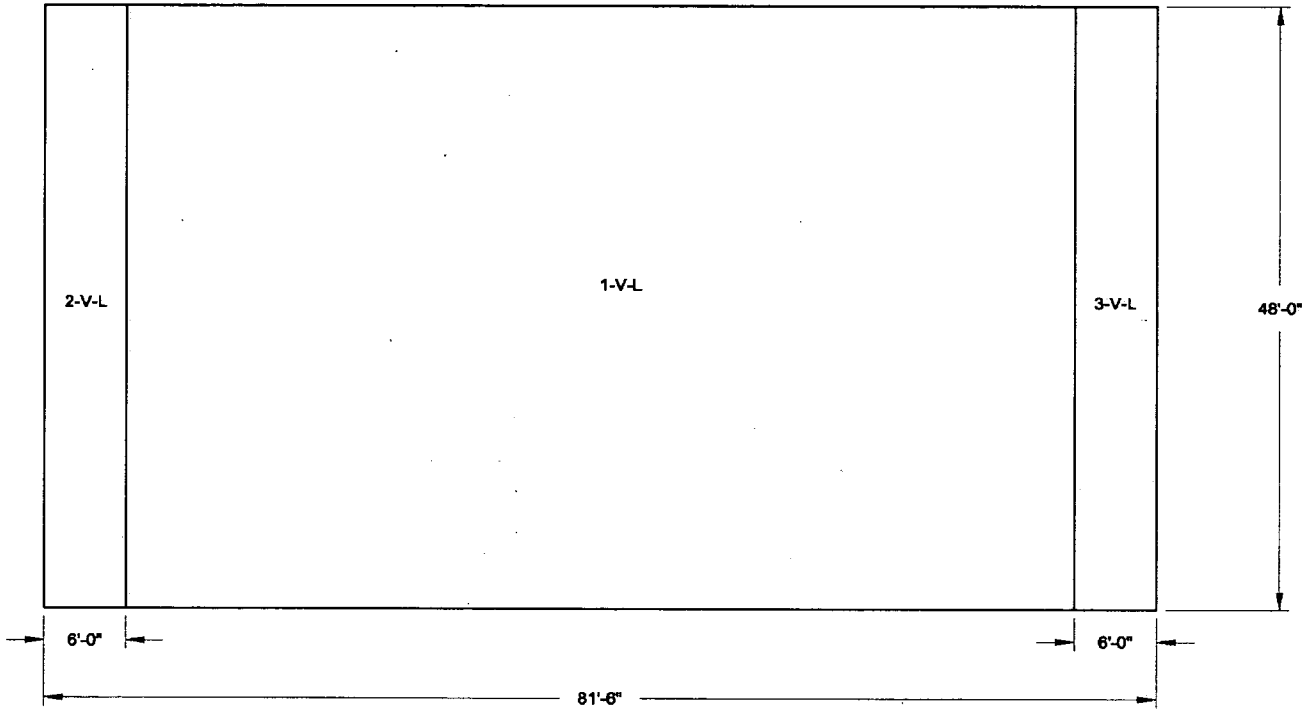

FIGURE 3H.6-145: SLAB 1 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

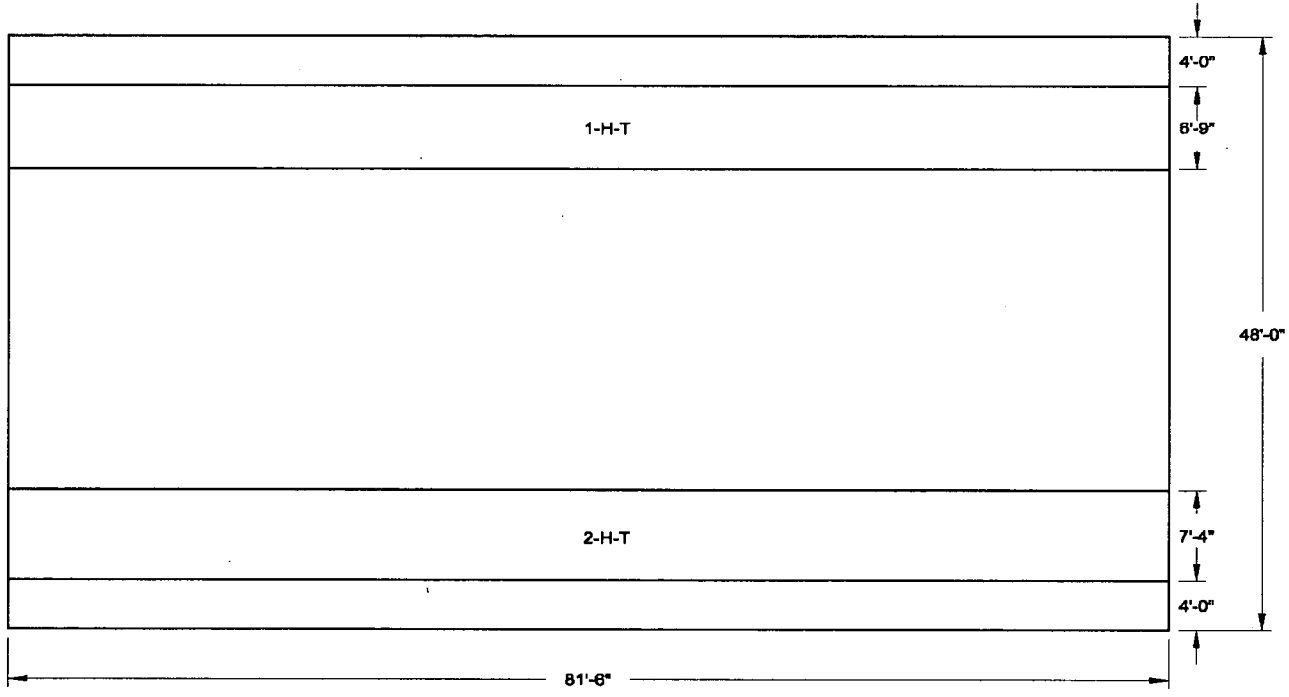

FIGURE 3H.6-146: SLAB 1 LOOKING DOWN TRANSVERSE REINFORCEMENT ZONES

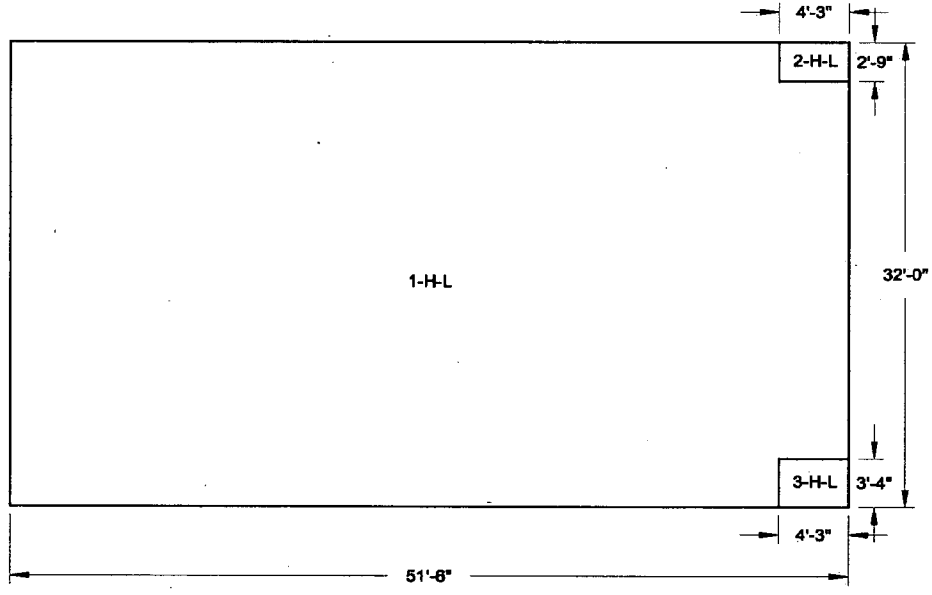

FIGURE 3H.6-147: ROOF 2 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

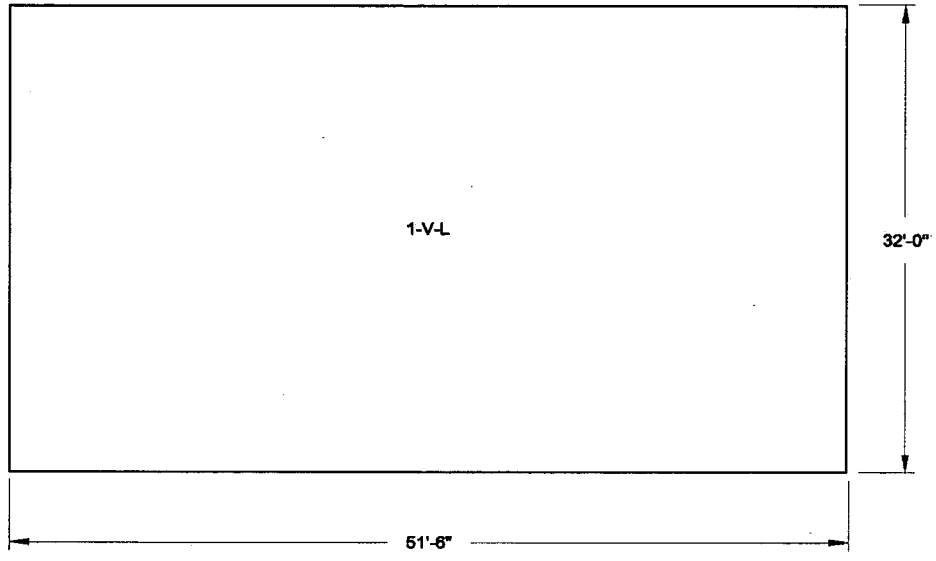

FIGURE 3H.6-148: ROOF 2 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

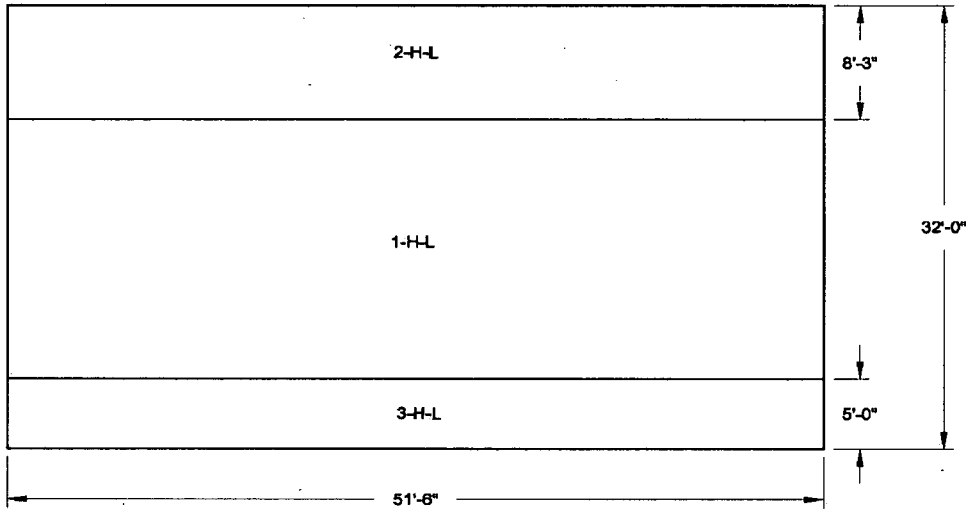

FIGURE 3H.6-149: ROOF 2 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

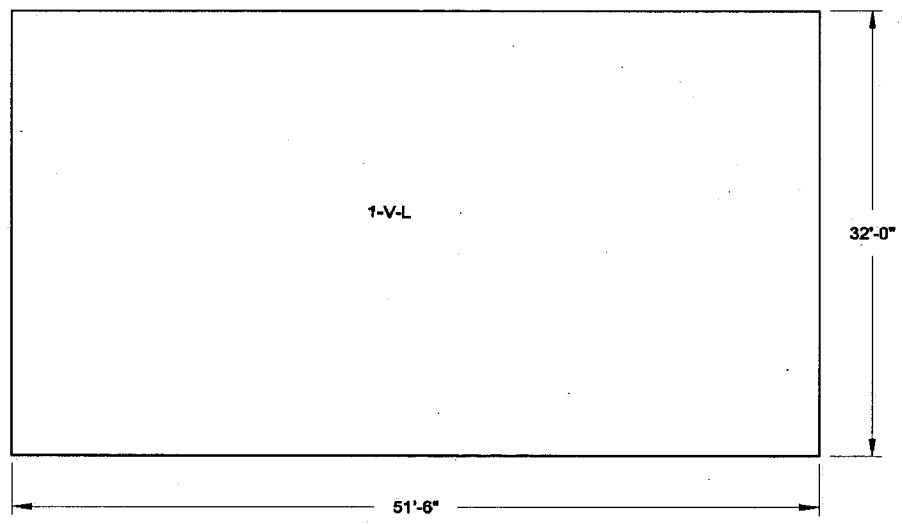

FIGURE 3H.6-150: ROOF 2 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

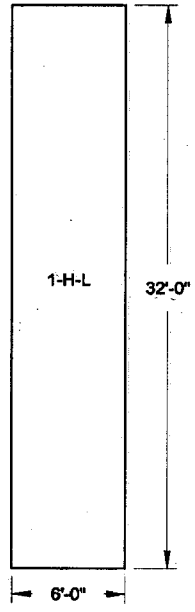

FIGURE 3H.6-151: SLAB 3 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

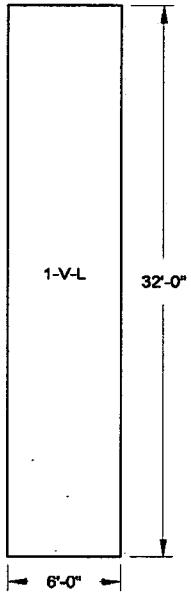

FIGURE 3H.6-152: SLAB 3 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

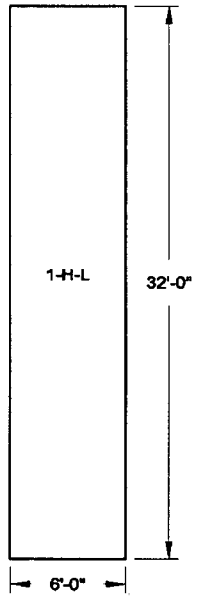

FIGURE 3H.6-153: SLAB 3 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

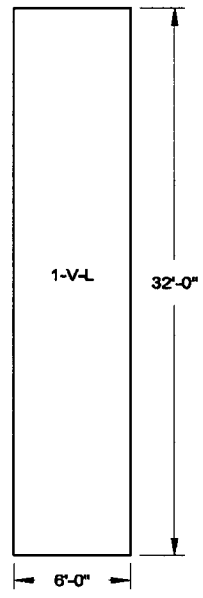

FIGURE 3H.6-154: SLAB 3 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

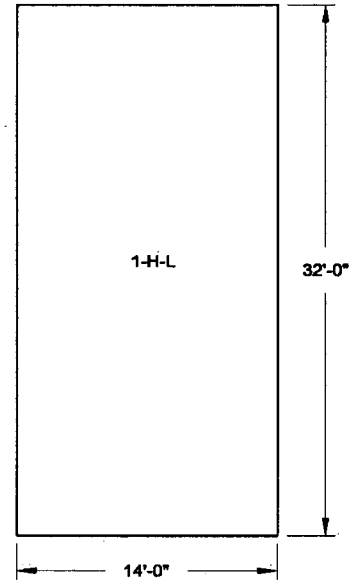

FIGURE 3H.6-155: ROOF 5 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

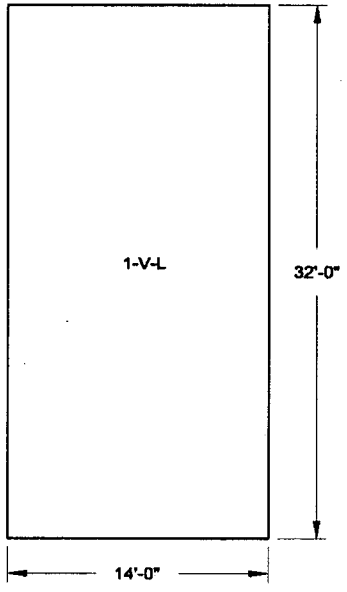

FIGURE 3H.6-156: ROOF 5 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

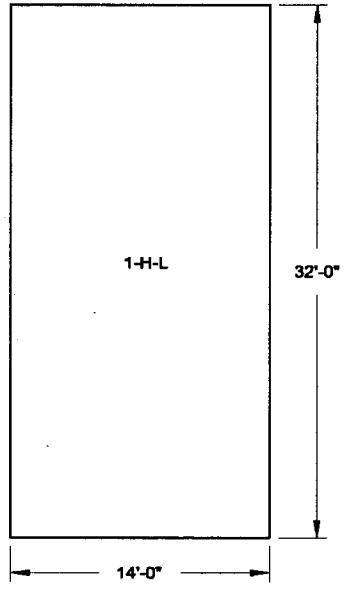

FIGURE 3H.6-157: ROOF 5 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

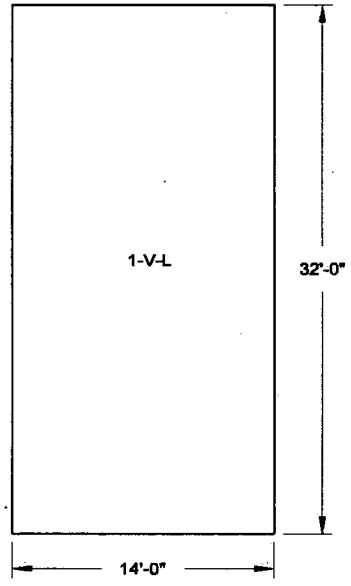

FIGURE 3H.6-158: ROOF 5 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

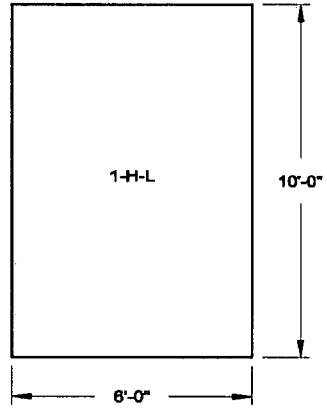

FIGURE 3H.6-159: ROOF 6 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

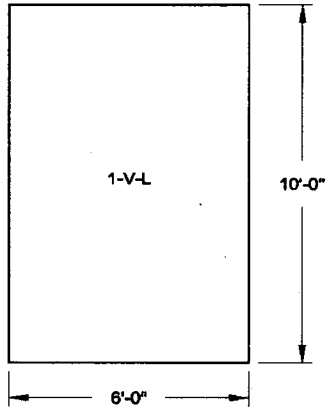

FIGURE 3H.6-160: ROOF 6 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

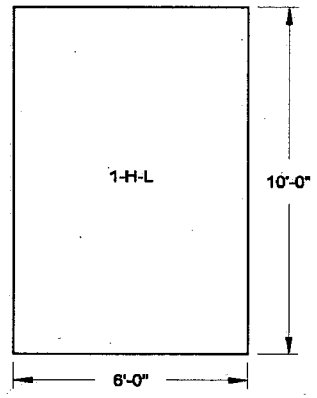

FIGURE 3H.6-161: ROOF 8 LOOKING DOWN
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

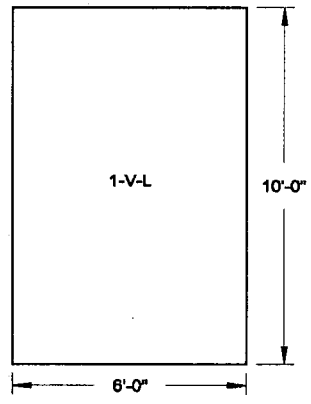

FIGURE 3H.6-162: ROOF 6 LOOKING DOWN
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

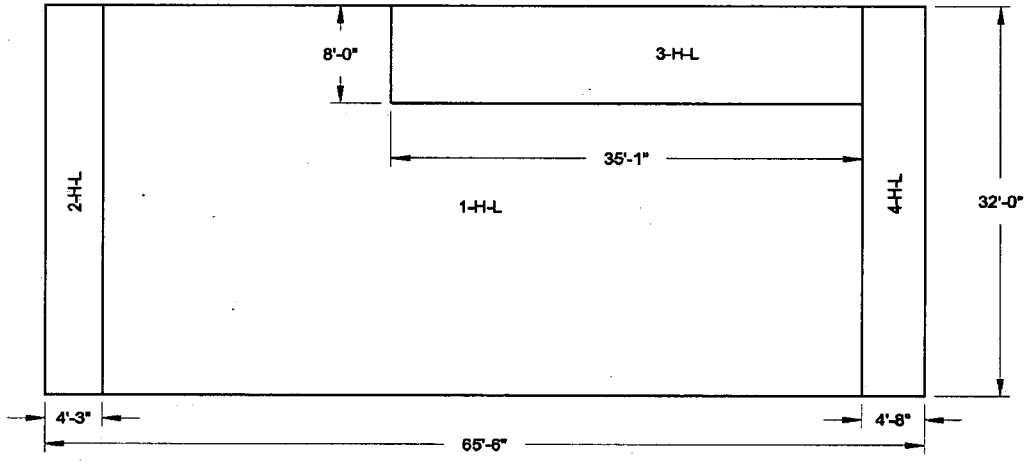

FIGURE 3H.6-183: WALL 7 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

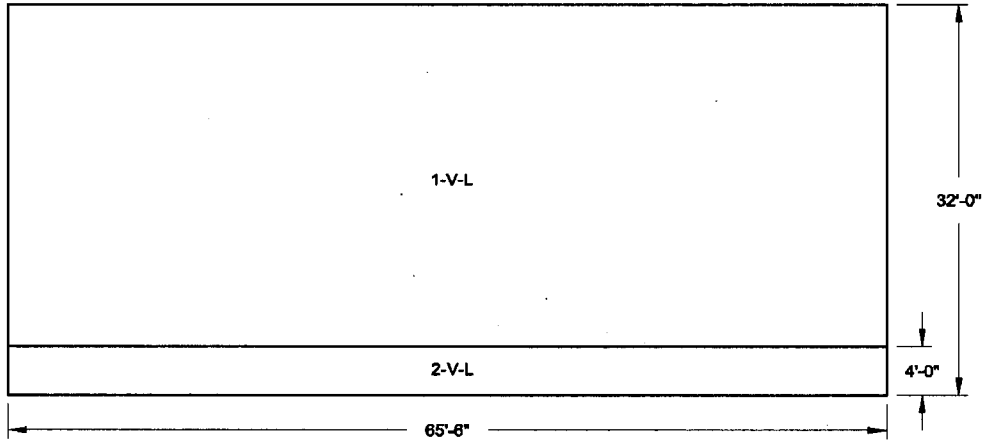

FIGURE 3H.6-164: WALL 7 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

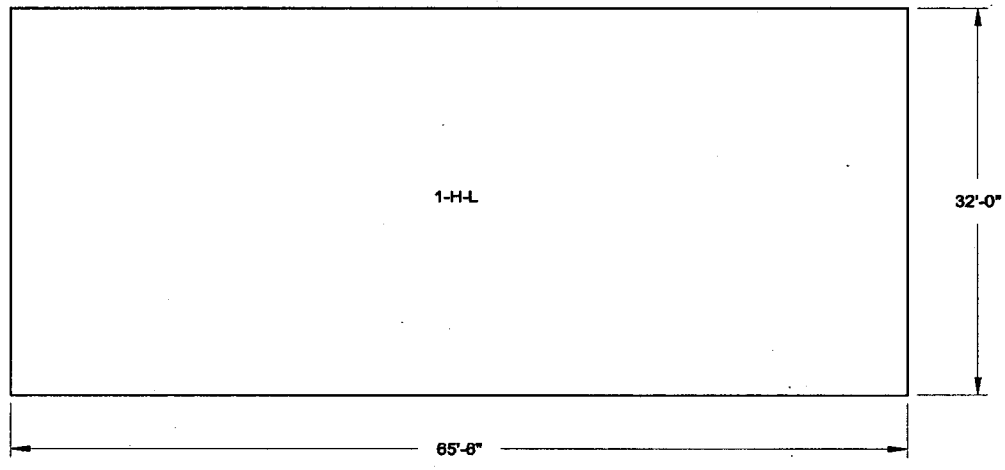

FIGURE 3H.6-165: WALL 7 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

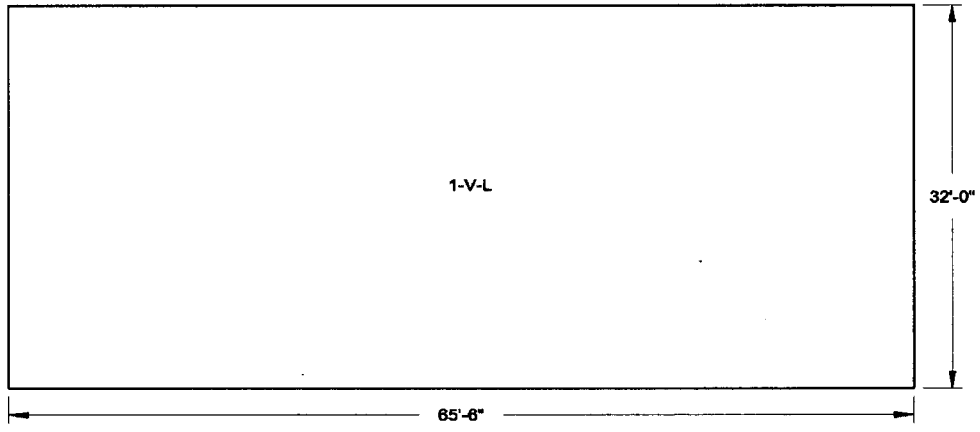

FIGURE 3H.6-166: WALL 7 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

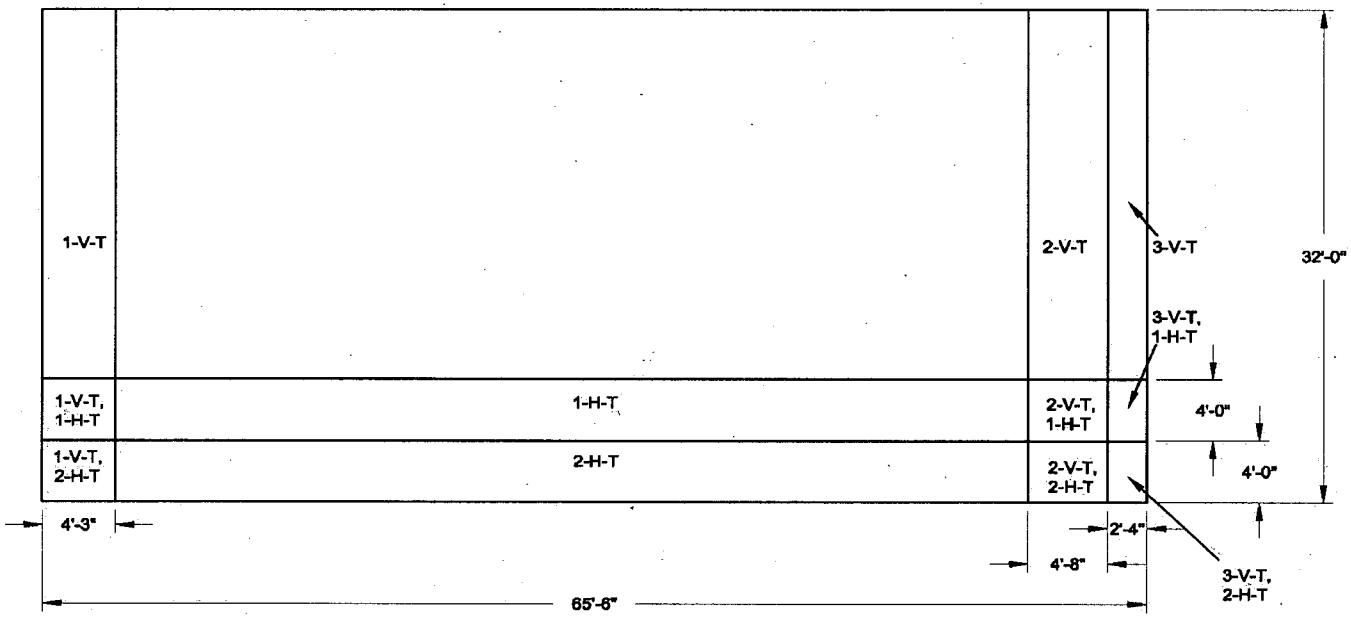

FIGURE 3H.6-187: WALL 7 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES

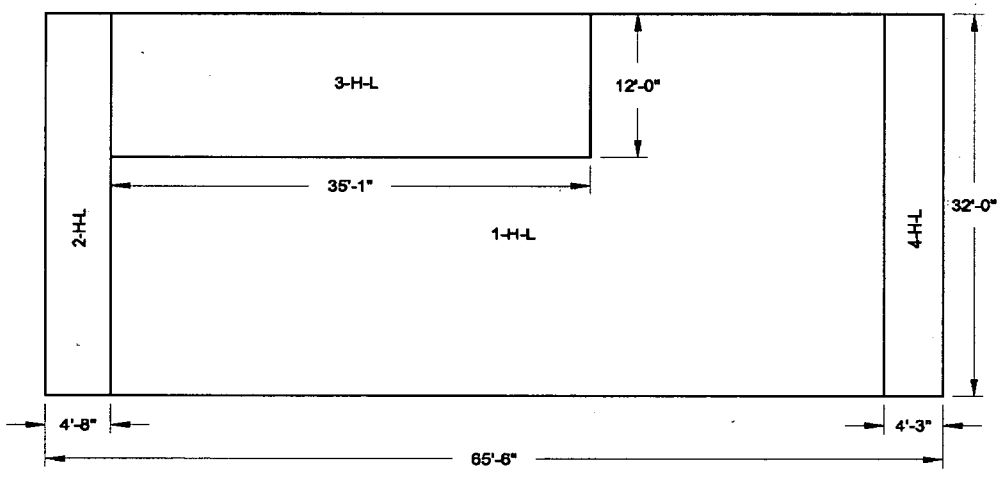

FIGURE 3H.6-168: WALL 8 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

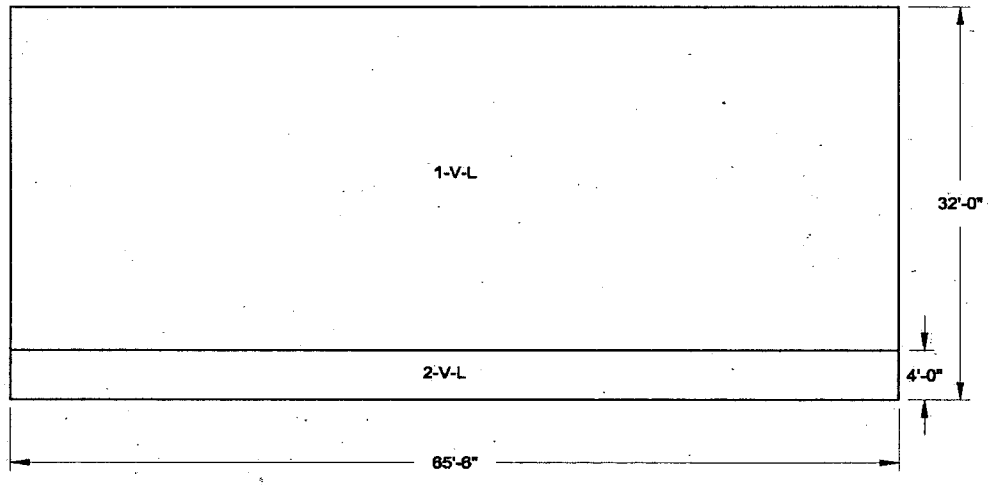

FIGURE 3H.6-169: WALL 8 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

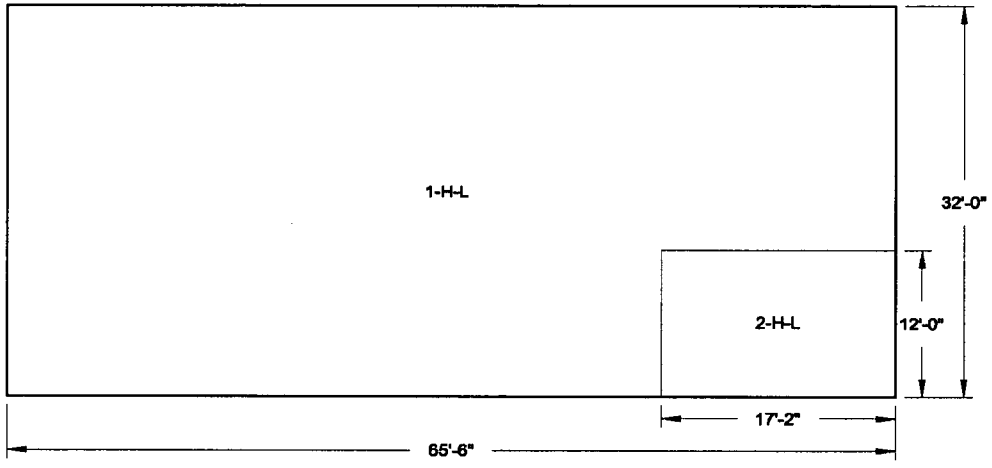

FIGURE 3H.6-170: WALL 8 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

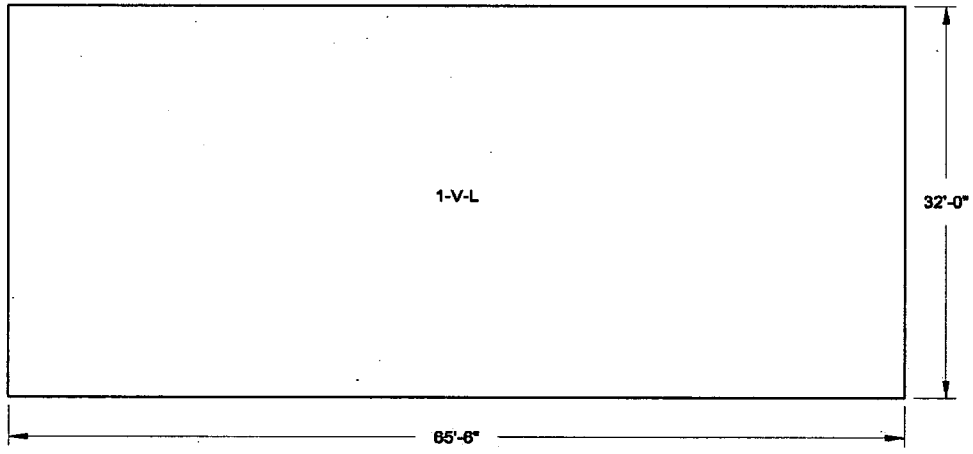

FIGURE 3H.6-171: WALL 8 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

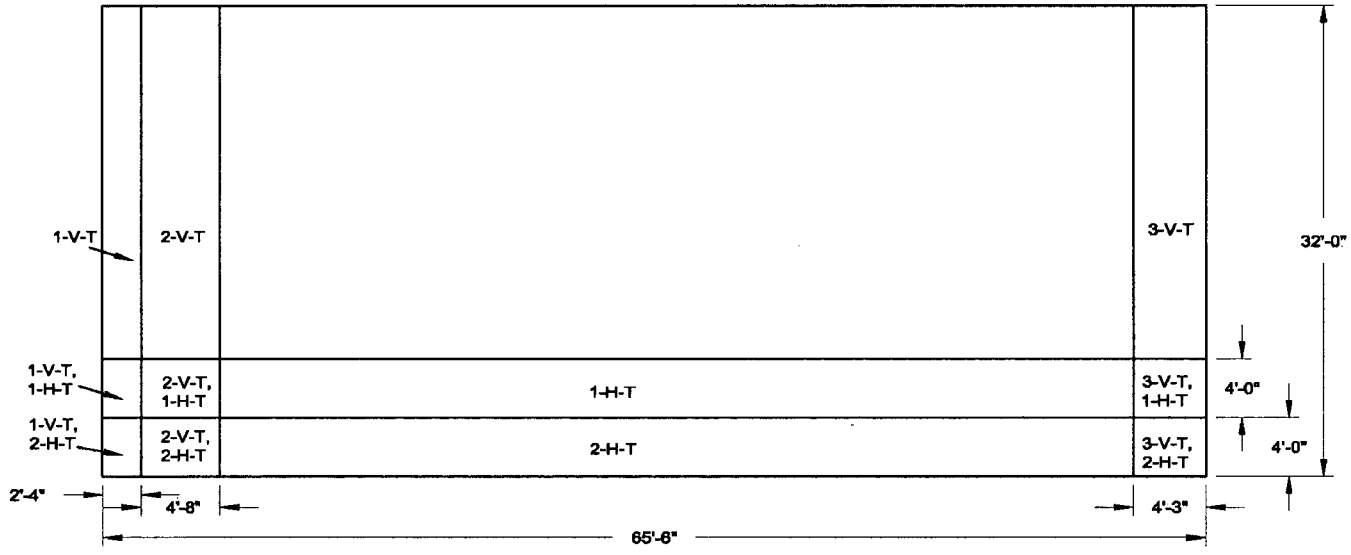

FIGURE 3H.6-172: WALL 8 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES

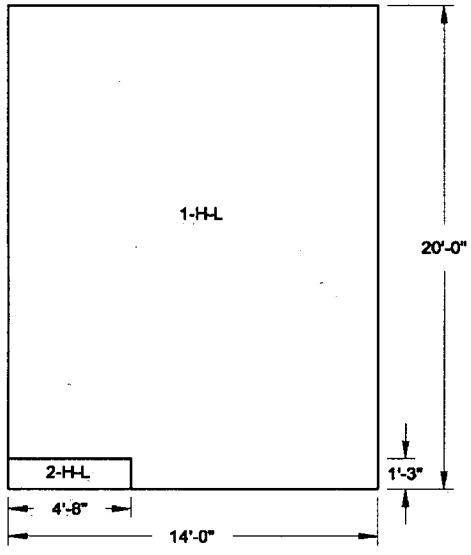

FIGURE 3H.6-173: WALL 9 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

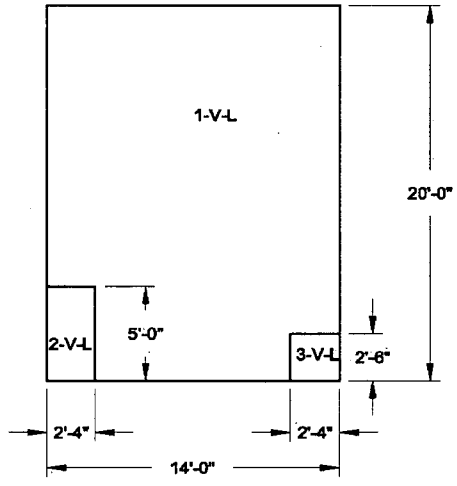

FIGURE 3H.6-174: WALL 9 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

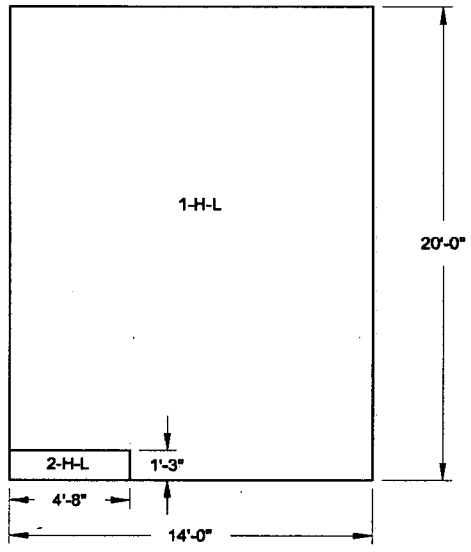

FIGURE 3H.6-175: WALL 9 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

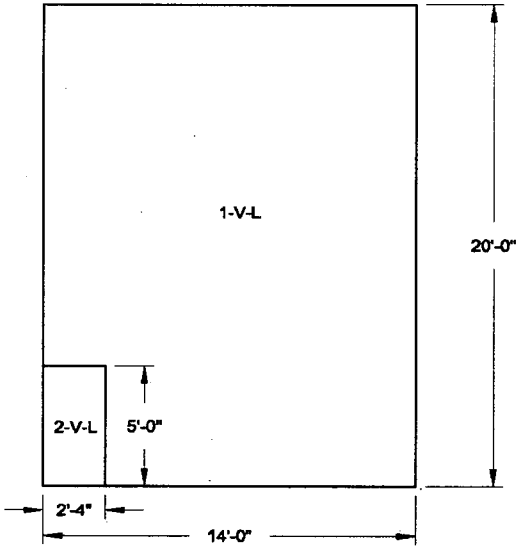

FIGURE 3H.6-176: WALL 9 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

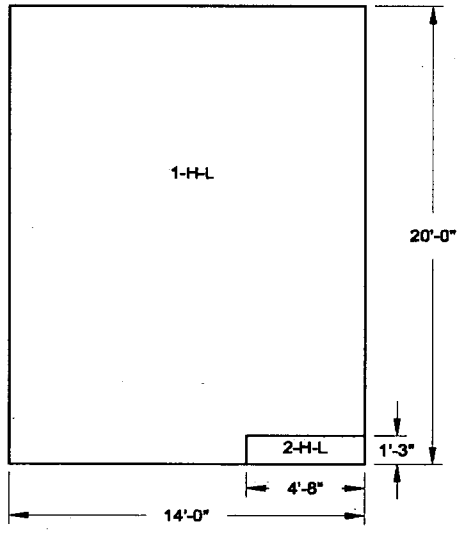

FIGURE 3H.6-177: WALL 10 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

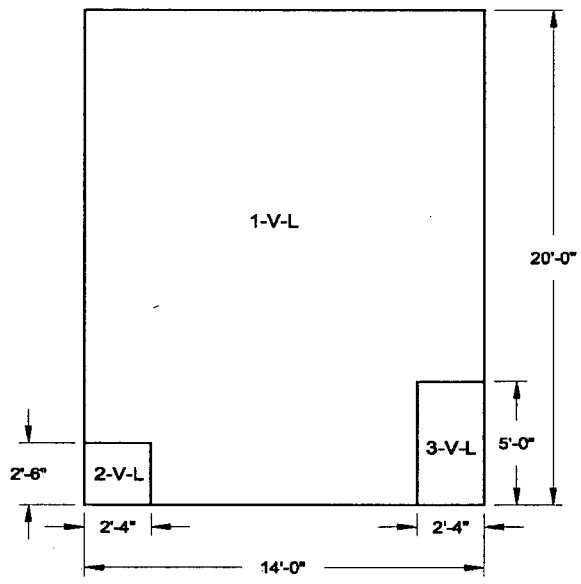

FIGURE 3H.6-178: WALL 10 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

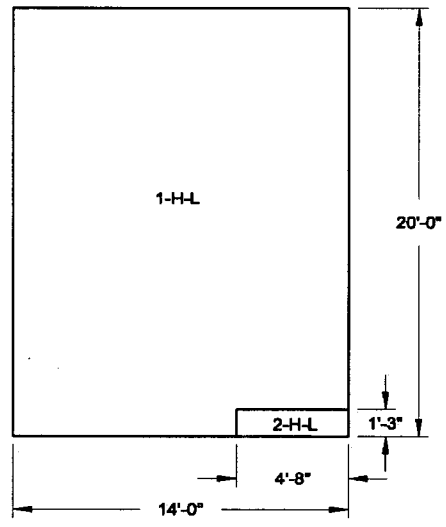

FIGURE 3H.6-179: WALL 10 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

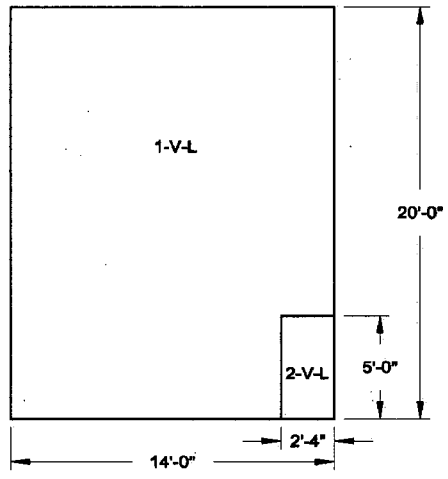

FIGURE 3H.6-180: WALL 10 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

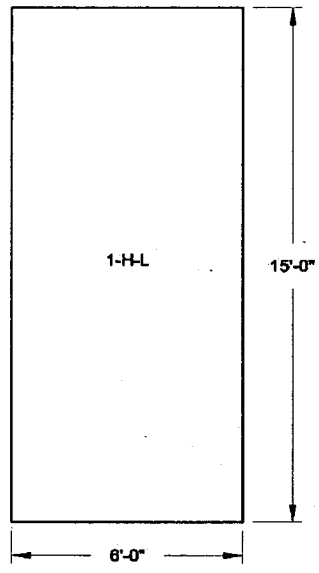

FIGURE 3H.6-181: WALL 11 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

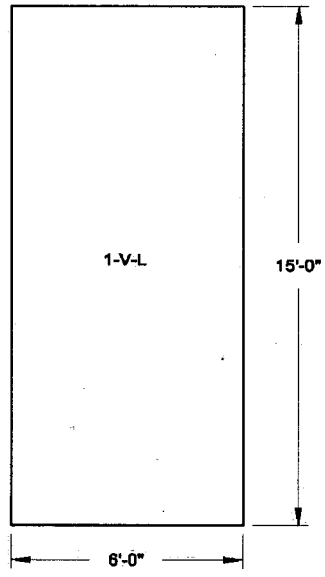

FIGURE 3H.6-182: WALL 11 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

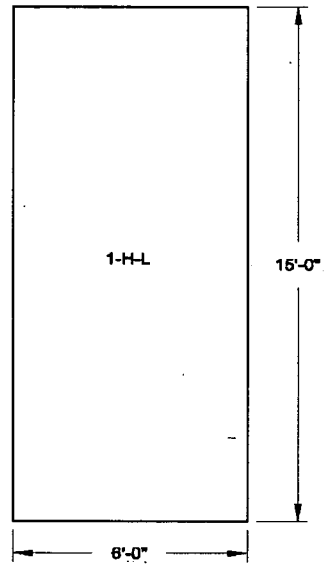

FIGURE 3H.6-183: WALL 11 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

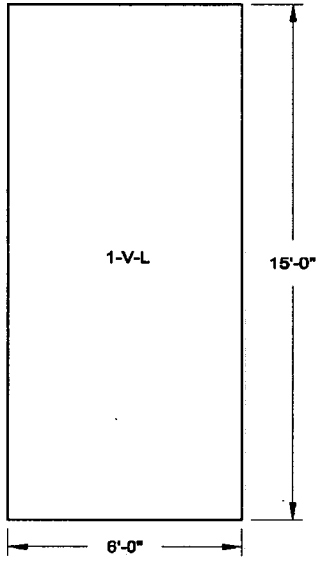

FIGURE 3H.6-184: WALL 11 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

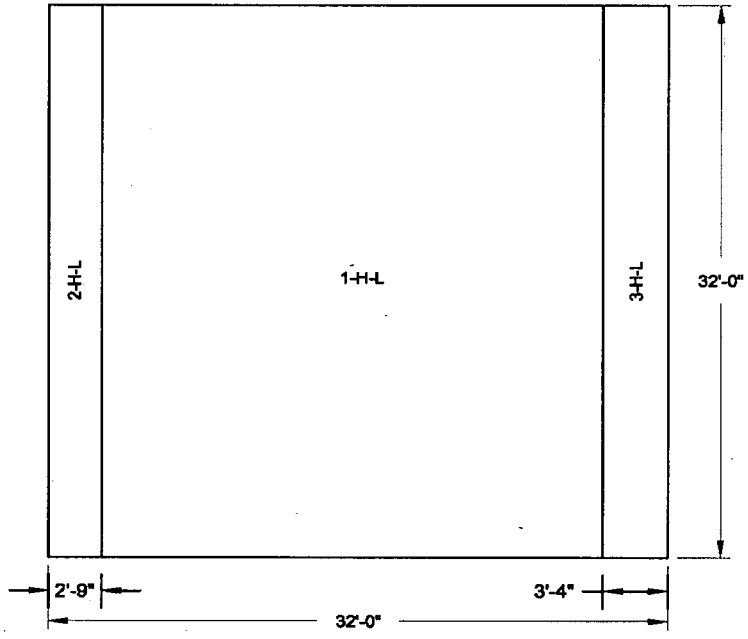

FIGURE 3H.6-185: WALL 12 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

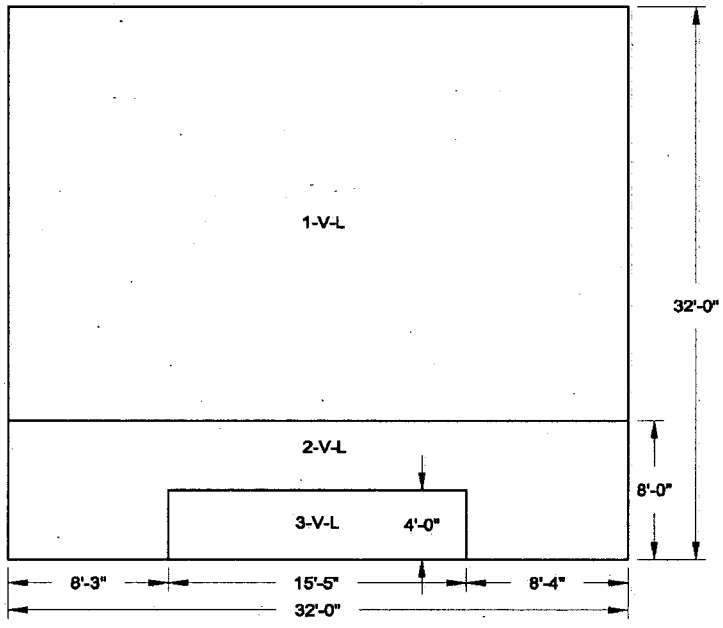

FIGURE 3H.8-186: WALL 12 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

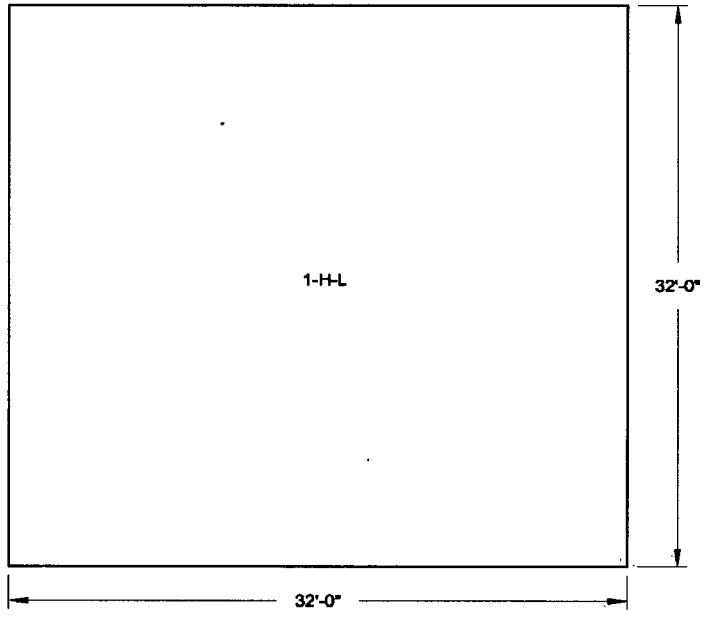

FIGURE 3H.6-187: WALL 12 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

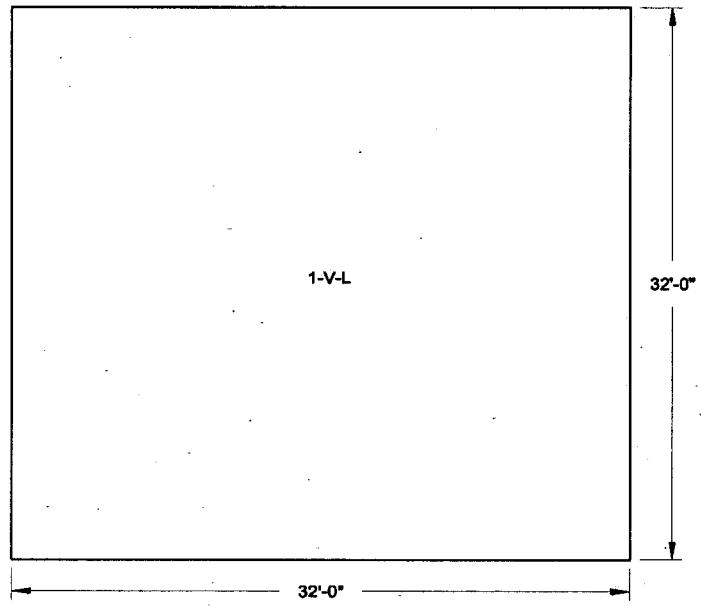

FIGURE 3H.6-188: WALL 12 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

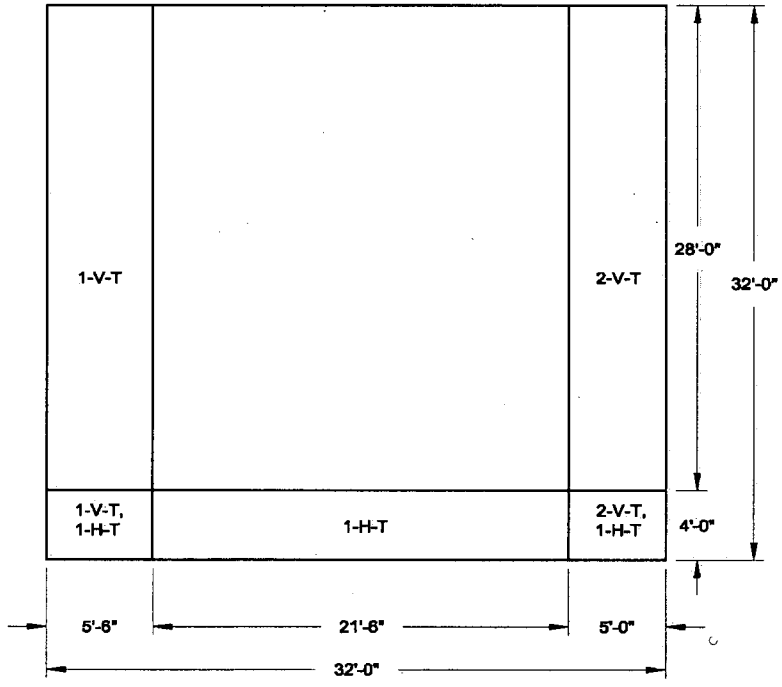

FIGURE 3H.6-189: WALL 12 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES

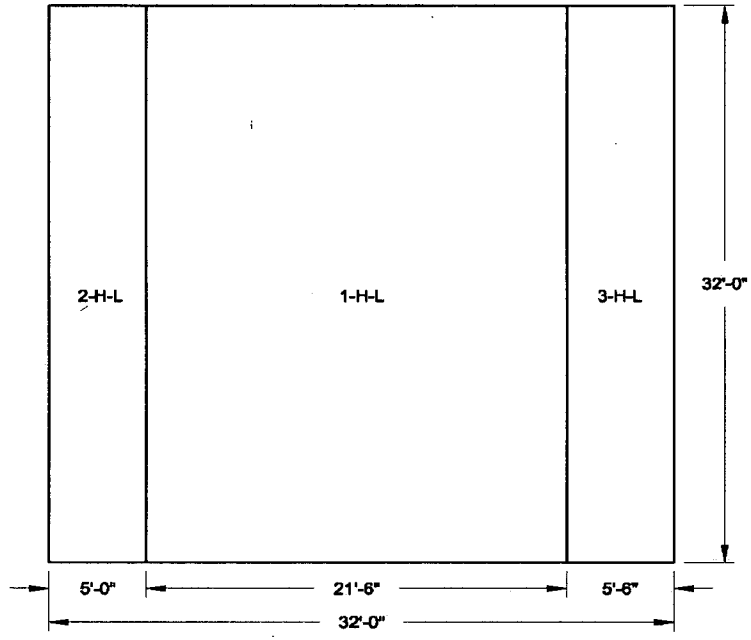

FIGURE 3H.6-190: WALL 13 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

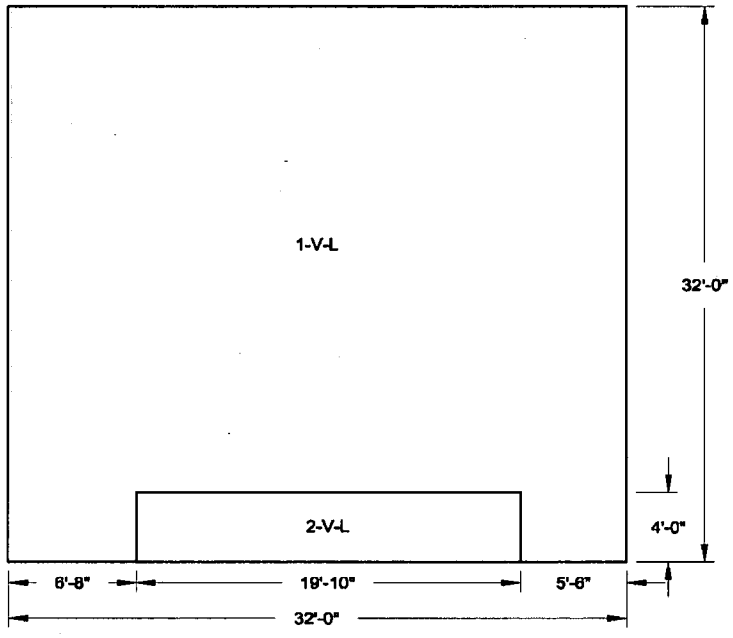

FIGURE 3H.6-191: WALL 13 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

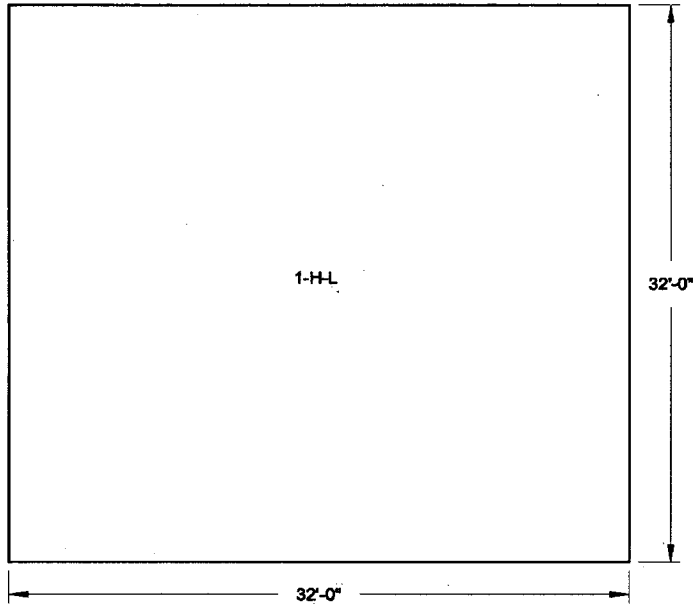

FIGURE 3H.6-192 WALL 13 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

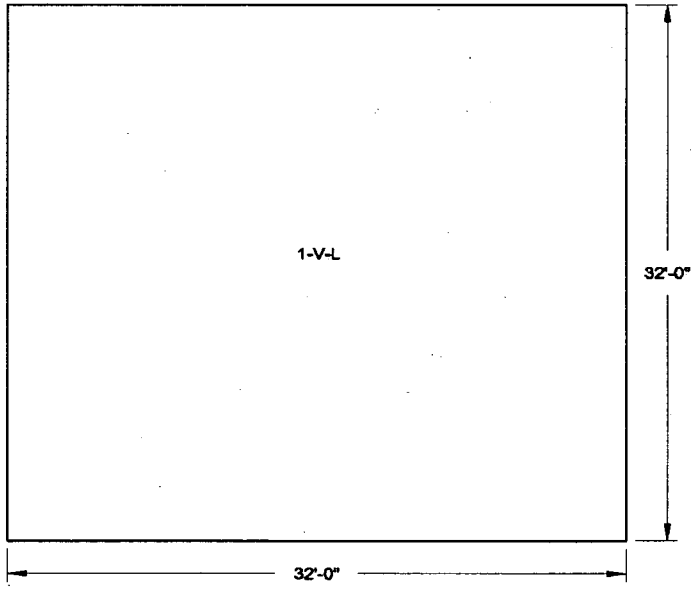

FIGURE 3H.6-193: WALL 13 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

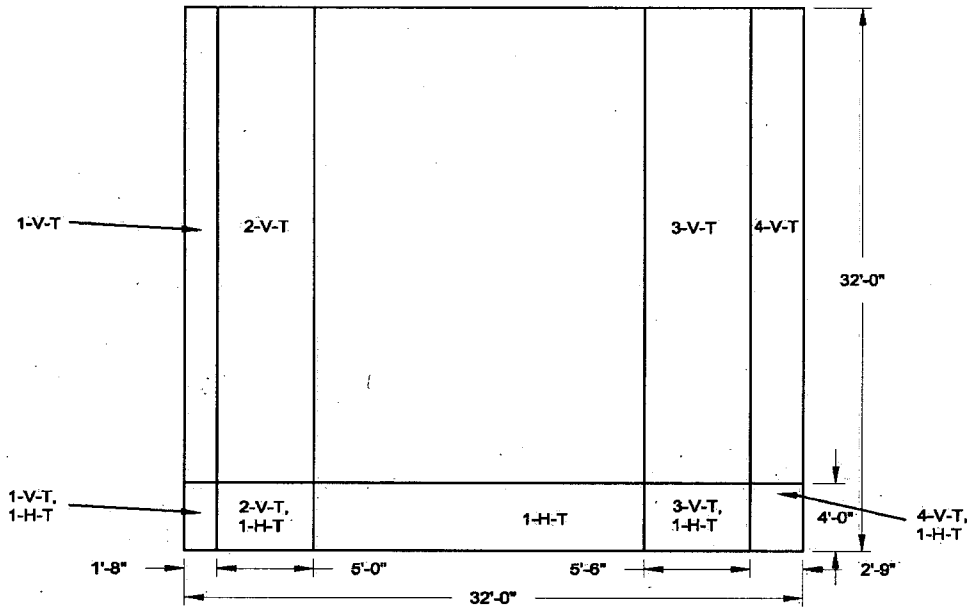

FIGURE 3H.6-194: WALL 13 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES

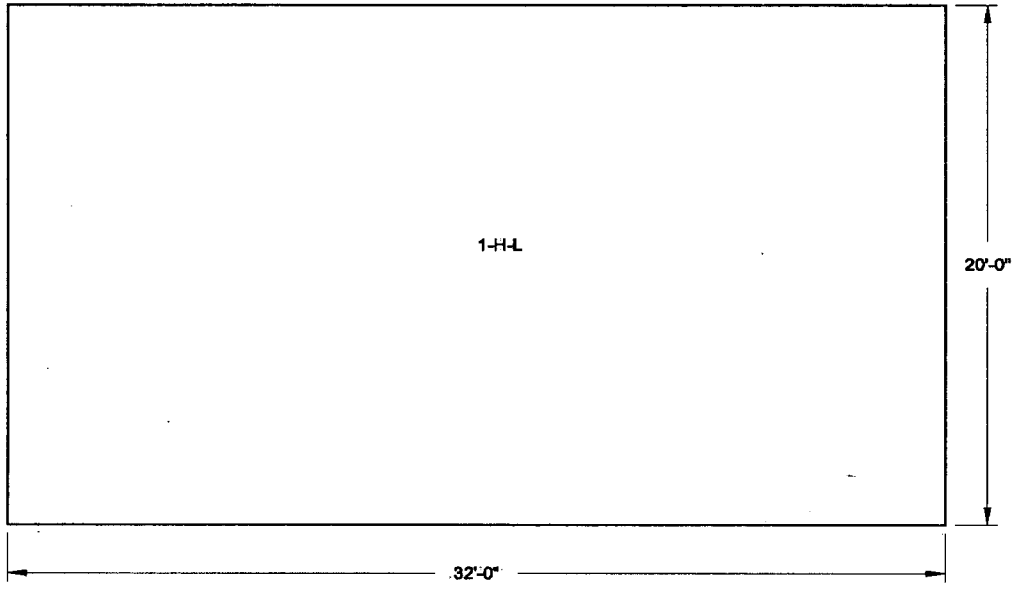

FIGURE 3H.6-195: WALL 14 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

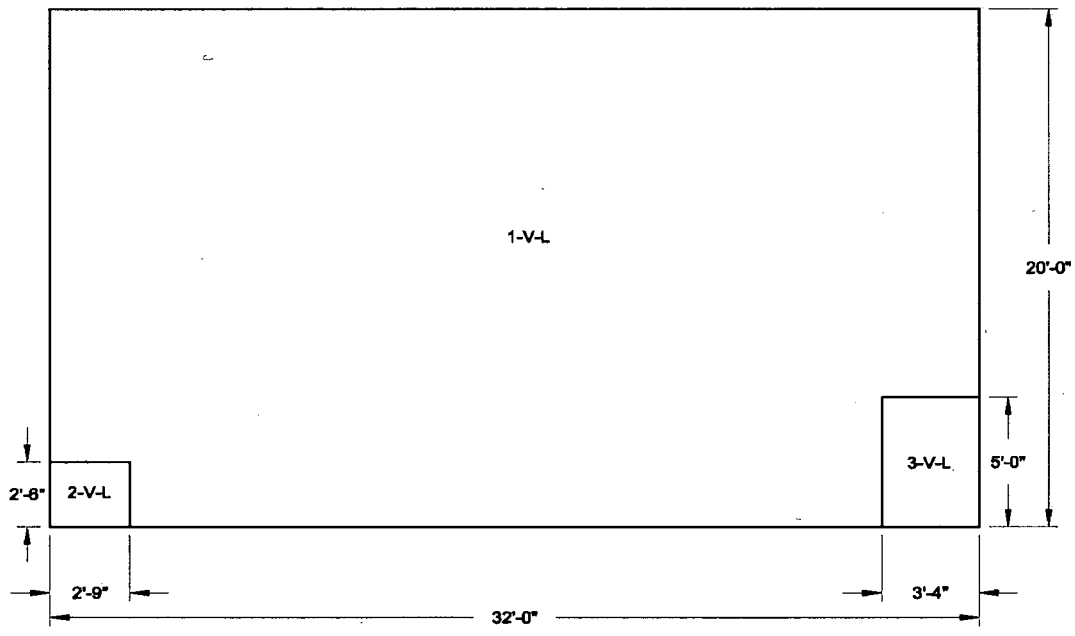

FIGURE 3H.6-196: WALL 14 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

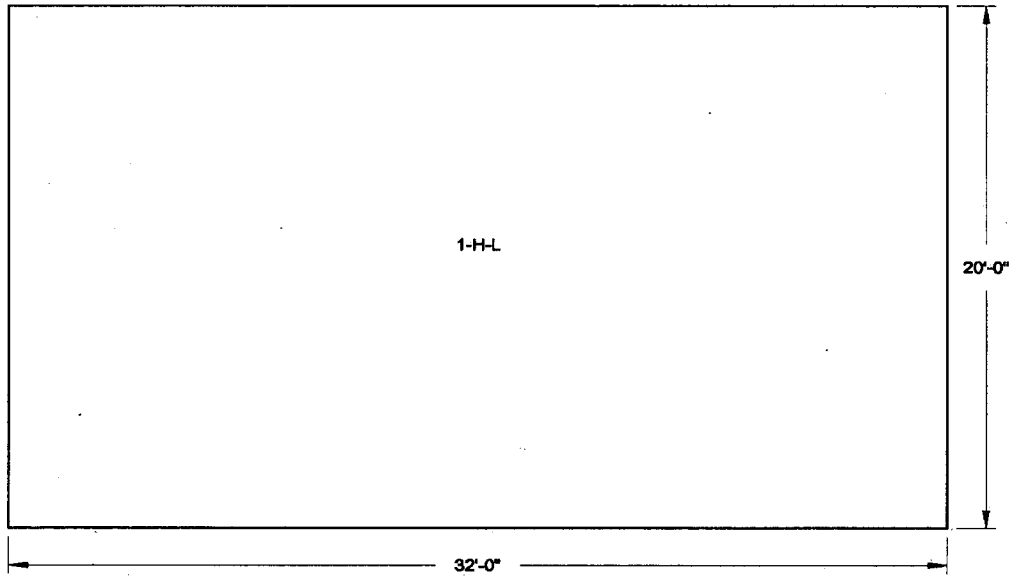

FIGURE 3H.6-197: WALL 14 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

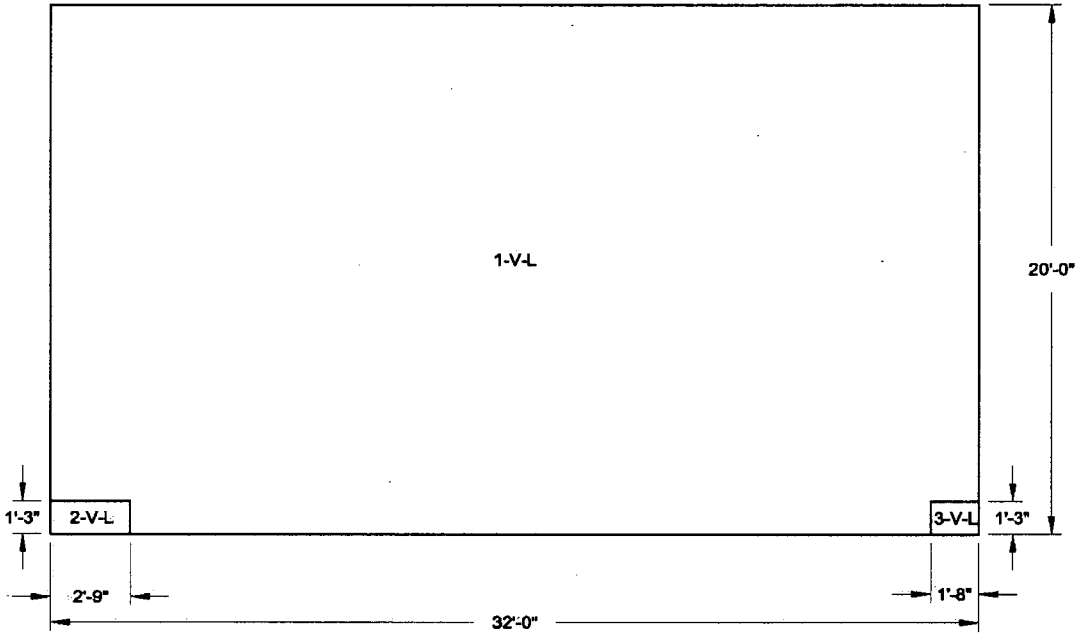

FIGURE 3H.6-198: WALL 14 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

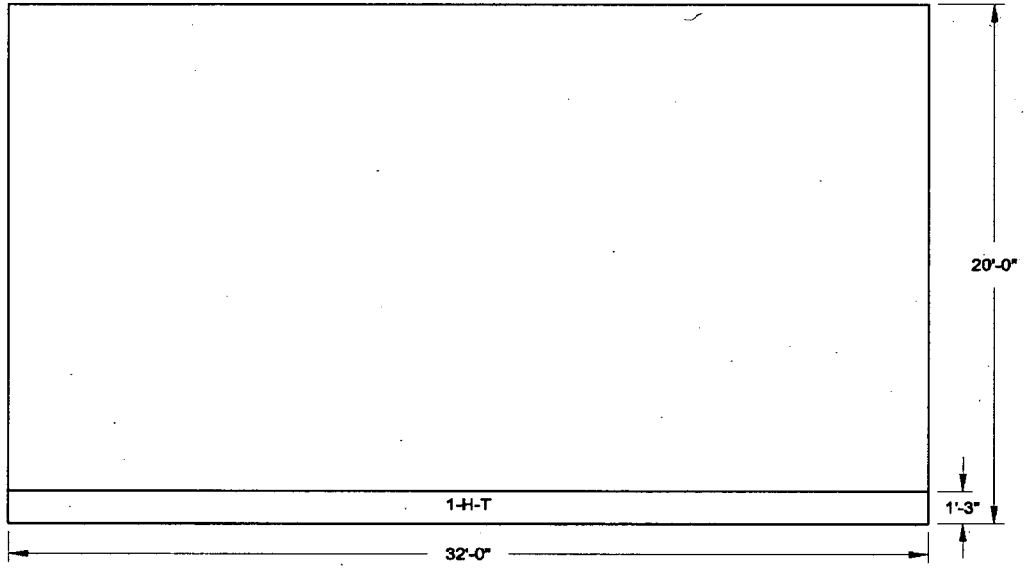

FIGURE 3H.6-199: WALL 14 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES

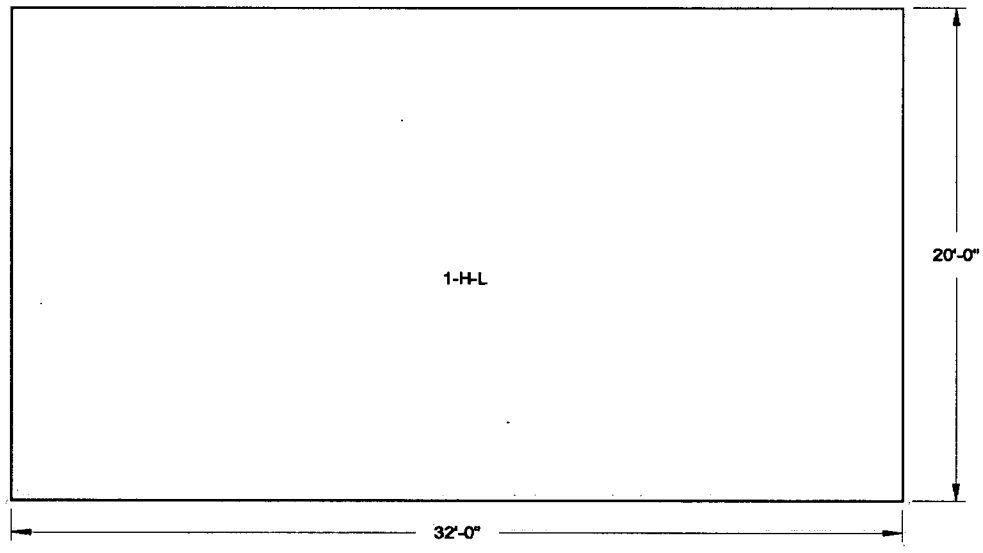

FIGURE 3H.6-200: WALL 15 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

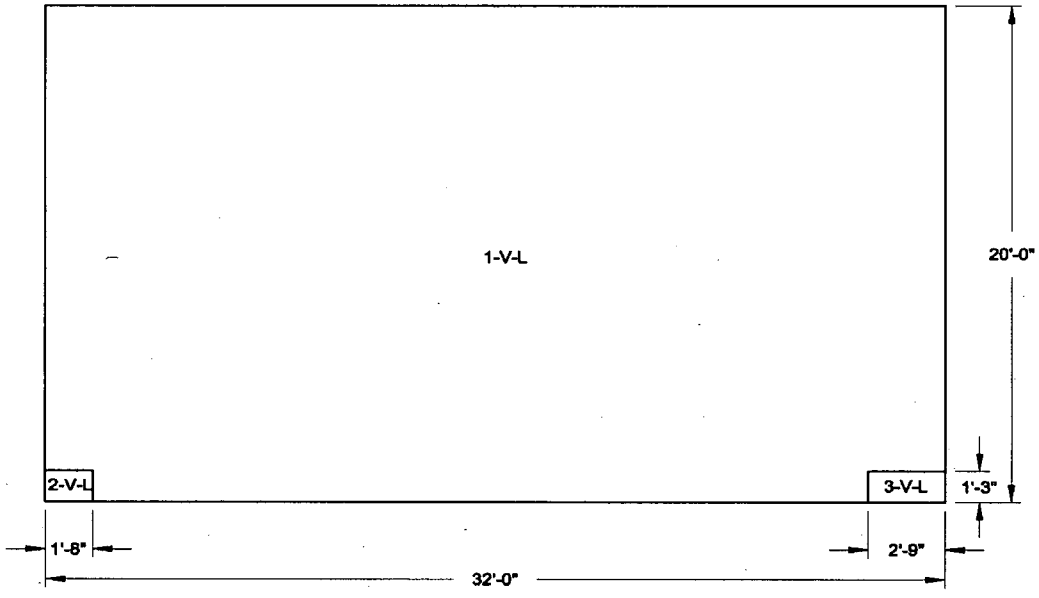

FIGURE 3H.6-201: WALL 15 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

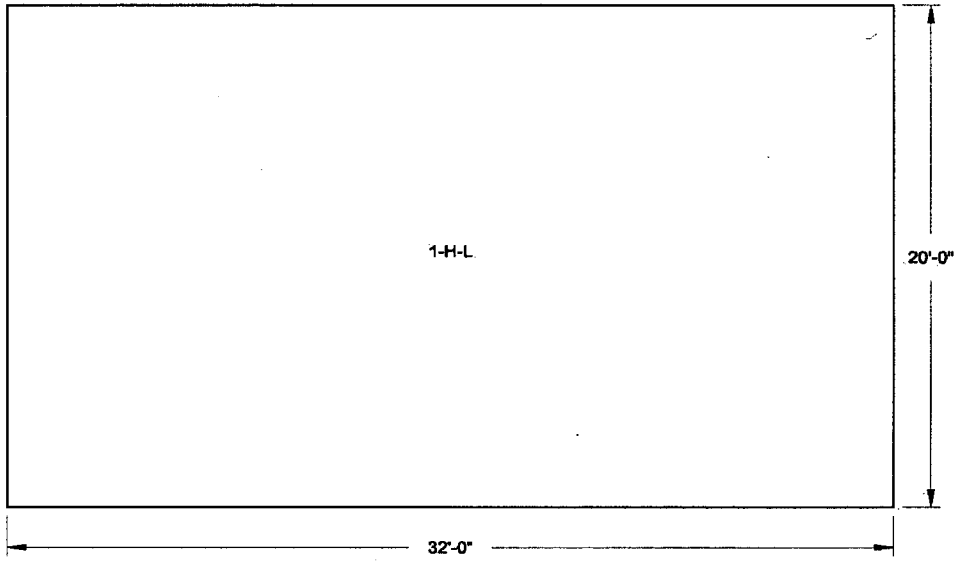

FIGURE 3H.6-202: WALL 15 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

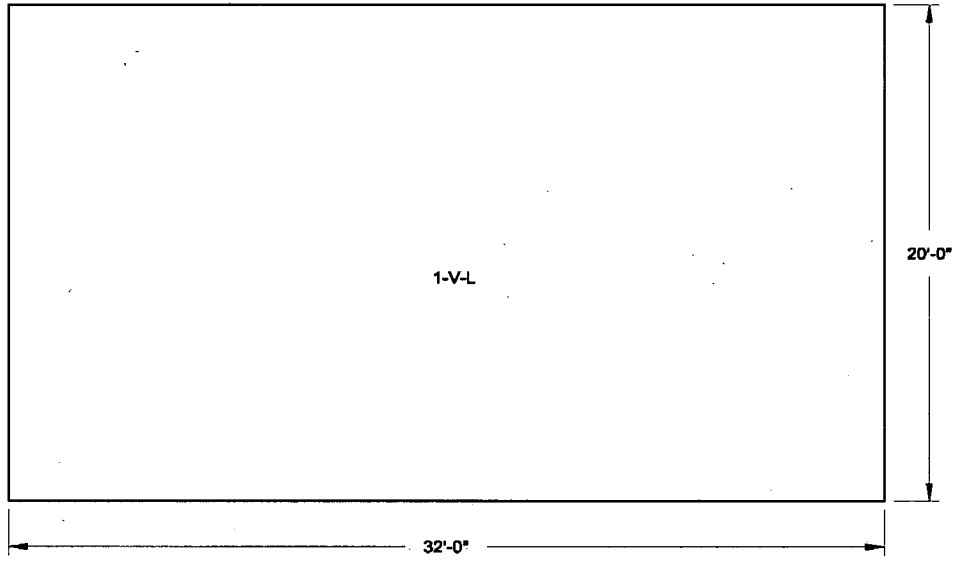

FIGURE 3H.6-203: WALL 15 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

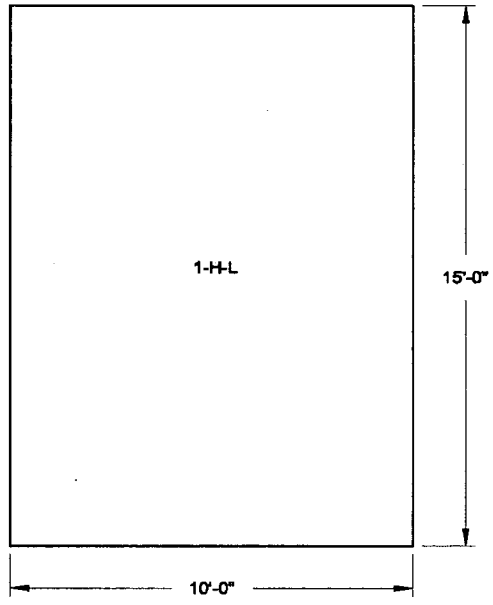

FIGURE 3H.6-204: WALL 16 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
NEAR SIDE FACE

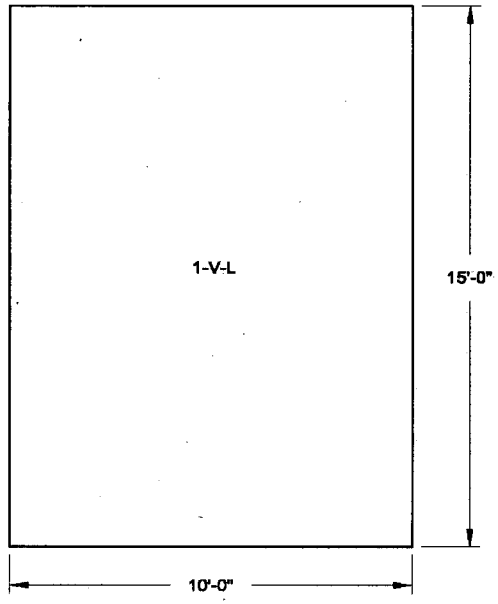

FIGURE 3H.6-205: WALL 16 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
NEAR SIDE FACE

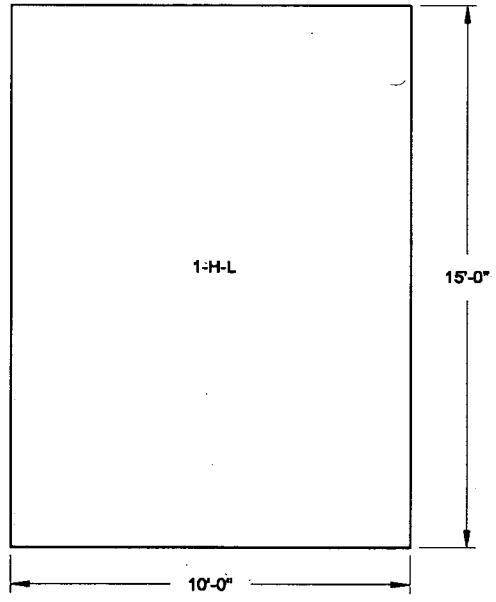

FIGURE 3H.6-206: WALL 16 LOOKING FROM OUTSIDE
HORIZONTAL REINFORCEMENT ZONES
FAR SIDE FACE

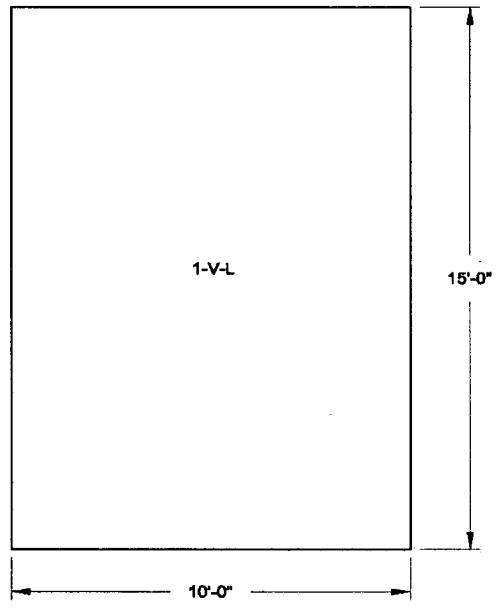

FIGURE 3H.6-207: WALL 16 LOOKING FROM OUTSIDE
VERTICAL REINFORCEMENT ZONES
FAR SIDE FACE

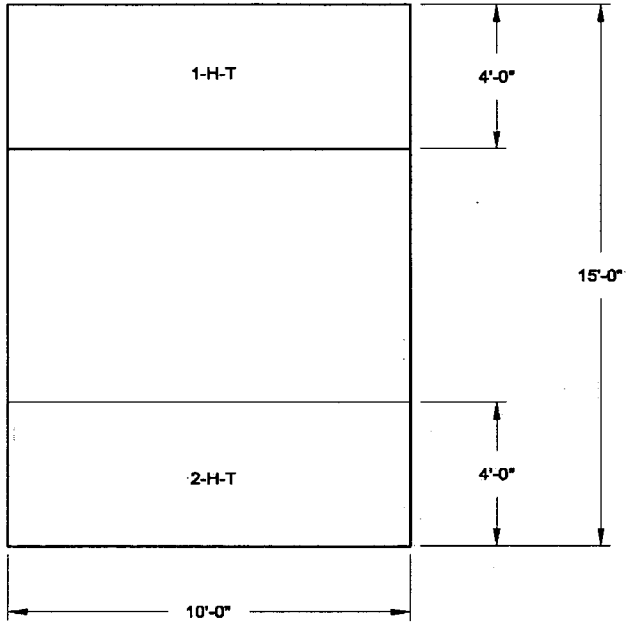

FIGURE 3H.6-208: WALL 18 LOOKING FROM OUTSIDE
TRANSVERSE REINFORCEMENT ZONES