APPENDIX A
Results of Seismic Forces for All Cases

LIST OF TABLES

Table A-1 Moment Arm Length for RB/FB

(a) RCCV and Pedestal

	RB/FB			RCCV			Pedestal		
Elevation (m)	Node No.	Arm Length (m) X	Arm Length (m) Y	Node No.	Arm Length (m) X	Arm Length (m) Y	Node No.	Arm Length (m) X	Arm Length (m) Y
52.40	110	24.5	19.5						
34.00	109	24.8	24.7	209	20.2	20.0			
27.00	108	42.0	26.0	208	21.7	20.0			
22.50	107	43.7	24.5						
17.50	106	39.2	24.6	206	21.4	20.0			
13.57	105	38.5	24.8	205	20.1	20.0			
9.06	104	38.5	24.6	204	20.0	20.0			
4.65	103	41.3	25.1	203	20.0	20.0	303	8.0	8.0
-1.00	102	41.9	26.1	202	20.2	20.3	302	8.0	8.0
-6.40	101	42.6	25.9	201	20.3	20.0	301	8.0	8.0
-11.50	2	37.0	25.9						
-15.50	1	35.0	24.5						

(b) Vent Wall and RSW

Elevation (m)	Node No.	Arm Length (m)
17.5	701	8.35
14.5	702	8.35
11.5	703	8.35
8.5	704	8.35
7.4625	705	8.35
4.65	706	8.35
24.18	707	4.73
20.2	708	4.73
15.775	709	4.73
11.35	710	4.73
7.4625	711	4.73
4.65	712	4.73
2.4615	713	4.73
1.96	714	4.73
-0.8	715	4.73

Table A-1 Moment Arm Length for RB/FB (Continued)

(c) RPV

Structure	Elevation mm	Node No.	Radius mm	
Top of Fuel / Top Guide	7896.00	47	2100.00	See Note 1
Center of Fuel	5691.00	51	2100.00	See Note 1
Bottom of Fuel / Core Plate	4178.40	54	2100.00	See Note 1
Bottom of Standpipes	19527.80	31	2100.00	
Bottom of Chimney Head	17267.70	32	3092.10	
Chimney Restraint	16365.00	33	3098.50	
Top of Partitions	14510.00	34	3098.50	
Bottom of Core Plate	3759.30	44	3196.00	
Bottom of Shroud	2365.00	46	3196.00	
Top of RPV	27640.00	1	0.00	
Bottom of Dryer	22276.00	6	3647.00	
DPV / IC Nozzles	21824.70	7	3647.00	
Bottom of Separator /Feedwater Nozzles	19527.80	9	3647.00	
RWCU / SDC Nozzles	17267.70	10	3647.00	
IC Return Nozzles	12491.00	13	3647.00	
GDCS Nozzles	10472.00	14	3647.00	
RPV Support / Equalizing Nozzles	8453.00	15	3647.00	
Top of CRD Housing	765.70	27	2100.00	
Top of CRD Housing /Bottom of RPV	-131.50	28	0.00	
CRD Housing Flange /Restraint Beam	-2753.00	67	2100.00	
CRD Housing Flange /Restraint Beam	-2753.00	68	0.00	

Note 1. The vertical response of the Fuel Assemblies is not a function of the rotation of Fuel Nodes 47, 51, or 54. The vertical response of the Fuel Assemblies due to the arm radius of 2100 mm is a function of the rotation of the RPV bottom head represented by Node 28.

Table A-2 Moment Arm Length for CB

Elevation (m)	Node No.	Arm Length (m)	
		X	Y
13.80	6	15.26	12.26
9.06	5	15.21	12.06
4.65	4	15.30	12.26
-2.00	3	15.34	12.24
-7.40	2	15.21	12.03
-10.40	1	15.29	12.13

Table A-3 Maximum Response Forces and Moments RB/FB (BE)

(a) RB/FB

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
52.40	1110	110			701.5	662.7	
		109	57.7	59.8	1398.3	1610.5	397.9
34.00	1109	109			1841.8	2171.5	
		108	72.1	56.6	2259.7	2546.6	631.9
27.00	1108	108			2433.2	2958.5	
		107	169.7	127.6	3098.2	3493.0	1274.5
22.50	1107	107			3386.6	3745.0	
		106	189.2	142.6	4206.5	4380.4	2420.7
17.50	1106	106			4630.0	4580.2	
		105	202.4	166.4	5301.8	5137.2	1990.2
13.57	1105	105			5512.5	5279.5	
		104	215.7	176.6	6343.0	5950.8	2069.7
9.06	1104	104			6496.0	6069.0	
		103	233.0	189.4	7358.1	6751.4	2246.6
4.65	1103	103			4804.0	3920.8	
		102	254.9	174.5	5985.7	4584.7	2741.9
-1.00	1102	102			6251.4	4940.4	
		101	269.9	199.9	7458.2	5576.8	3048.4
-6.40	1101	101			4459.4	3592.4	
-11.50		2	116.5	88.4	4882.7	3644.7	1755.8

Table A-3 Maximum response Forces and Moments RB/FB (BE) (Continued)

(b) RCCV

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
34.00	1209	209			64.2	152.6	
		208	54.8	65.3	386.2	587.9	9.5
27.00	1208	208			565.1	895.3	
		206	66.0	73.9	1111.3	1591.8	744.3
17.50	1206	206			1206.3	1740.1	
		205	86.6	80.0	1503.5	2024.6	787.4
13.57	1205	205			1546.5	2096.4	
		204	96.6	86.8	1918.1	2436.3	866.0
9.06	1204	204			1999.4	2527.4	
		203	106.7	93.6	2432.1	2859.3	987.1
4.65	1203	203			2554.6	2960.6	
		202	55.3	54.7	2829.0	3149.7	744.3
-1.00	1202	202			2948.6	3229.7	
		201	74.3	68.9	3311.9	3492.6	772.4
-6.40	1201	201			3387.7	3539.7	
-11.50		2	29.1	23.6	3472.4	3570.4	294.6

(c) Pedestal

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
4.65	1303	303			163.8	130.9	
		377	11.3	10.8	176.9	161.0	36.7
2.4165	1377	377			218.2	197.2	
		302	16.8	15.9	246.3	232.6	44.6
-1.00	1302	302			228.3	210.8	
		376	21.8	19.9	257.9	241.2	38.6
-2.75	1376	376			258.0	241.2	
		301	21.9	20.0	326.4	305.4	38.6
-6.40	1301	301			307.9	301.7	
-11.50		2	11.0	8.4	348.3	326.0	17.7

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(d) Vent Wall and RSW

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
17.50	701	701			22.4	17.0	
		702	5.9	6.2	24.9	20.0	12.3
14.50	702	702			26.1	25.5	
		703	6.7	6.1	32.8	39.3	12.7
11.50	703	703			37.1	41.1	
		704	7.4	7.1	52.0	56.6	13.0
8.50	704	704			53.7	57.9	
		705	8.1	7.3	60.1	63.1	13.4
7.4625	705	705			62.2	53.7	
4.65		706,303	5.1	4.3	70.7	62.5	6.7

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
24.18	707	707			0.56	0.61	
		708	0.84	0.66	3.84	3.22	0.11
20.20	708	708			5.79	5.31	
		709	4.66	3.10	25.21	16.79	0.39
15.775	709	709			26.34	17.42	
		710	5.06	3.45	48.75	32.46	0.56
11.35	710	710			48.95	32.55	
		711	5.43	3.86	68.80	46.28	0.57
7.4625	711	711			57.93	52.00	
		712	13.21	11.05	82.47	73.41	7.10
4.65	712	712			34.76	26.92	
		713	4.93	4.63	40.46	36.01	7.81
2.4165	713	713			1.13	0.94	
1.96		714	0.43	0.36	0.93	0.79	0.05
1.96	714	714			0.86	0.70	
-0.80		715	0.28	0.21	0.18	0.14	0.03

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(e) RPV (1)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
27.64	801	801			0.00	0.00
		802	0.21	0.13	0.18	0.11
26.792	802	802			0.18	0.11
		803	0.60	0.38	0.68	0.43
25.944	803	803			0.68	0.43
		804	1.17	0.73	1.76	1.10
25.03	804	804			1.76	1.10
		805	1.51	0.98	2.83	1.80
24.3188	805	805			2.83	1.80
		806	2.14	1.36	7.20	4.58
22.276	806	806			7.20	4.58
		807	2.99	1.82	8.53	5.39
21.8247	807	807			8.53	5.39
		808	3.26	2.00	13.78	8.59
20.2	808	808			13.78	8.59
		809	1.04	0.66	14.48	8.90
19.5278	809	809			14.48	8.90
		810	1.74	0.98	18.40	10.78
17.2677	810	810			18.40	10.78
		811	2.16	1.40	20.45	11.89
16.365	811	811			20.45	11.89
		812	3.74	2.04	26.16	15.95
14.51	812	812			26.16	15.95
		813	3.42	2.16	33.03	20.27
12.491	813	813			33.03	20.27
		814	3.36	2.13	39.02	24.25
10.472	814	814			39.02	24.25
		815	4.09	2.66	43.30	28.03
8.453	815	815			30.13	22.11
		816	5.40	3.85	26.70	19.74
7.8071	816	816			26.70	19.74
		817	5.32	3.68	23.02	17.37
7.111	817	817			23.02	17.37
		818	5.26	3.26	19.40	15.45
6.401	818	818			19.40	15.45
5.691		819	5.12	2.98	16.36	12.84

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(f) RPV (2)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
5.691	819	819			16.36	12.84
		820	4.87	2.77	14.47	11.05
4.981	820	820			14.47	11.05
		821	4.73	2.62	12.58	9.33
4.2713	821	821			12.58	9.33
		822	4.61	2.52	11.63	8.25
3.7593	822	822			11.63	8.25
		823	4.53	2.39	10.89	7.34
3.215	823	823			10.89	7.34
		824	4.35	2.24	10.77	6.29
2.365	824	824			3.31	2.65
		825	2.27	1.81	2.01	1.60
1.785	825	825			2.01	1.60
		826	2.06	1.67	0.81	0.64
1.2	826	826			0.81	0.64
		827	1.83	1.46	0.21	0.23
0.7657	827	827			0.20	0.23
-0.1315		828	1.36	1.05	1.31	1.01

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(g) RPV (3)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
21.8247	828	829			0.0	0.0
		830	0.1	0.1	0.2	0.1
20.2	829	830			0.2	0.1
		831	0.3	0.2	0.6	0.4
19.5278	830	831			0.6	0.4
		832	0.4	0.2	1.3	0.6
17.2677	831	832			1.3	0.6
		833	0.5	0.2	1.7	0.8
16.365	832	833			1.7	0.8
		834	2.1	1.2	4.0	2.2
14.51	833	834			4.0	2.2
		835	1.6	0.6	6.8	3.4
12.491	834	835			6.8	3.4
		836	0.6	0.4	8.1	3.9
10.472	835	836			8.1	3.9
		837	1.3	0.8	5.6	2.5
8.453	836	837			5.6	2.5
		838	1.6	1.0	5.2	2.4
7.8071	837	838			5.2	2.4
		839	1.8	1.2	3.9	2.2
7.111	838	839			3.9	2.2
		840	2.2	1.1	3.4	2.2
6.401	839	840			3.4	2.2
		841	2.5	1.2	2.8	2.4
5.691	840	841			2.8	2.4
		842	2.8	1.2	3.7	2.6
4.981	841	842			3.7	2.6
		843	3.0	1.3	4.7	3.0
4.2713	842	843			4.7	3.0
		844	3.0	1.4	6.1	3.5
3.7593	843	844			6.1	3.5
		845	3.0	1.5	7.1	3.7
3.215	844	845			7.1	3.7
2.365		846	3.1	1.6	9.4	4.4

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(h) RPV (4)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
0.7657	859	827			0.0	0.0
		861	0.1	0.1	0.1	0.1
-0.788	861	861			0.1	0.1
		863	0.0	0.0	0.1	0.1
-1.443	863	863			0.1	0.1
		865	0.0	0.0	0.1	0.1
-2.098	865	865			0.1	0.1
		867	0.1	0.0	0.1	0.1
-2.753	867	867			0.1	0.1
		869	0.1	0.1	0.0	0.0
-3.4715	869	869			0.0	0.0
-4.2237		871	0.1	0.0	0.0	0.0
8.453	871	815			11.63	8.25
7.4625		711	4.53	2.39	10.89	7.34

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(i) RPV (5)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
7.896	845	847			0.0	0.0
		848	0.4	0.6	0.0	0.0
7.8071	846	848			0.0	0.0
		849	0.4	0.5	0.3	0.4
7.111	847	849			0.3	0.4
		850	0.2	0.3	0.5	0.7
6.401	848	850			0.5	0.7
		851	0.1	0.1	0.5	0.6
5.691	849	851			0.5	0.6
		852	0.3	0.3	0.3	0.4
4.981	850	852			0.3	0.4
		853	0.4	0.5	0.0	0.0
4.2713	851	853			0.0	0.0
		854	0.4	0.5	0.0	0.0
4.1784	852	854			0.0	0.0
		855	0.5	0.4	0.1	0.0
4.065	853	855			0.1	0.0
		856	0.4	0.3	0.4	0.3
3.215	854	856			0.4	0.3
		857	0.1	0.1	0.5	0.4
2.365	855	857			0.5	0.4
		858	0.3	0.2	0.4	0.3
1.785	856	858			0.4	0.3
		859	0.6	0.5	0.0	0.0
1.2	857	859			0.0	0.0
		860	0.9	0.7	0.4	0.3
0.7657	858	860			0.4	0.3
-0.1315		828	1.0	0.8	1.3	1.0

Table A-3 Maximum Response Forces and Moments RB/FB (BE) (Continued)

(j) RPV (6)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
-0.1315	860	828			0.1	0.1
		862	0.1	0.0	0.1	0.1
-0.788	862	862			0.1	0.1
		864	0.0	0.0	0.1	0.1
-1.443	864	864			0.1	0.1
		866	0.0	0.0	0.1	0.1
-2.098	866	866			0.1	0.1
		868	0.1	0.1	0.1	0.1
-2.753	868	868			0.1	0.1
		870	0.1	0.1	0.0	0.0
-3.4715	870	870			0.0	0.0
-4.2237		872	0.1	0.0	0.0	0.0

Table A-4 Maximum Response Forces and Moments RB/FB (LB)

(a) RB/FB

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
52.40	1110	110			654.9	601.3	
		109	53.4	56.7	1365.0	1533.5	366.3
34.00	1109	109			1856.6	2078.8	
		108	65.3	50.8	2230.1	2414.8	563.9
27.00	1108	108			2461.0	2808.9	
		107	149.1	114.4	3005.1	3306.4	1146.7
22.50	1107	107			3368.6	3556.5	
		106	167.5	132.7	4051.8	4150.0	2216.4
17.50	1106	106			4538.6	4366.1	
		105	173.5	156.2	5114.4	4884.1	1826.1
13.57	1105	105			5348.9	5044.6	
		104	178.6	165.0	6025.9	5658.6	1924.7
9.06	1104	104			6188.0	5805.6	
		103	189.7	173.2	6834.1	6426.9	2088.5
4.65	1103	103			4540.5	3785.5	
		102	226.8	167.3	5384.2	4341.0	2436.7
-1.00	1102	102			5663.4	4738.2	
		101	252.8	191.8	6676.4	5288.8	2638.8
-6.40	1101	101			4014.9	3488.3	
-11.50		2	116.8	85.2	4340.0	3451.7	1629.9

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(b) RCCV

Elev. (m)	Elem No.	Node No.	Shear		Moment		Torsion (MN-m)
			X-Dir. (MN)	Y-Dir. (MN)	X-Dir. (MN-m)	Y-Dir. (MN-m)	
34.00	1209	209			62.4	137.5	
		208	52.3	61.1	376.7	549.9	8.4
27.00	1208	208			573.8	826.6	
		206	58.5	70.2	1071.7	1486.0	669.3
17.50	1206	206			1166.9	1606.1	
		205	75.1	73.4	1427.1	1871.6	722.6
13.57	1205	205			1464.4	1929.6	
		204	81.0	81.2	1773.5	2247.4	805.2
9.06	1204	204			1852.8	2322.2	
		203	93.7	89.1	2191.8	2640.5	917.6
4.65	1203	203			2307.0	2714.4	
		202	54.2	51.7	2517.8	2890.7	653.7
-1.00	1202	202			2614.0	2952.8	
		201	72.9	64.3	2885.4	3215.2	669.3
-6.40	1201	201			2932.0	3241.7	
-11.50		2	29.2	23.8	2864.0	3234.8	274.6

(c) Pedestal

Elev. (m)	Elem No.	Node No.	Shear		Moment		Torsion (MN-m)
			X-Dir. (MN)	Y-Dir. (MN)	X-Dir. (MN-m)	Y-Dir. (MN-m)	
4.65	1303	303			153.2	141.9	
		377	10.9	9.4	160.6	157.4	32.3
2.4165	1377	377			197.8	193.4	
		302	16.4	13.8	213.1	227.7	39.2
-1.00	1302	302			197.0	195.1	
		376	22.1	18.6	222.3	224.3	33.4
-2.75	1376	376			222.4	224.3	
		301	22.2	18.7	284.3	286.9	33.4
-6.40	1301	301			265.8	280.1	
-11.50		2	11.1	8.5	304.8	311.8	16.5

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(d) Vent Wall and RSW

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
17.50	701	701			20.2	15.6	
		702	5.6	5.3	23.8	18.0	11.5
14.50	702	702			24.5	22.6	
		703	5.7	5.9	32.0	34.8	11.8
11.50	703	703			34.2	36.6	
		704	6.7	6.7	49.7	51.9	12.2
8.50	704	704			51.1	52.4	
		705	7.7	6.9	57.0	59.4	12.5
7.4625	705	705			59.7	56.4	
4.65		706,303	4.6	3.8	68.0	66.8	6.2

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
24.18	707	707			0.6	0.5	
		708	0.8	0.6	3.9	2.8	0.1
20.20	708	708			5.9	4.6	
		709	4.5	3.2	24.4	17.0	0.3
15.775	709	709			25.7	17.7	
		710	5.0	3.5	47.7	32.7	0.5
11.35	710	710			47.9	32.8	
		711	5.4	3.9	68.8	47.3	0.5
7.4625	711	711			57.3	51.6	
		712	11.9	9.9	78.5	83.2	6.6
4.65	712	712			33.2	26.7	
		713	4.7	4.0	36.6	35.9	6.9
2.4165	713	713			1.1	0.8	
		714	0.4	0.3	0.9	0.7	0.0
1.96	714	714			0.8	0.6	
-0.80		715	0.3	0.2	0.2	0.1	0.0

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(e) RPV (1)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
27.64	801	801			0.0	0.0
		802	0.2	0.1	0.2	0.1
26.792	802	802			0.2	0.1
		803	0.6	0.4	0.7	0.4
25.944	803	803			0.7	0.4
		804	1.1	0.7	1.7	1.1
25.03	804	804			1.7	1.1
		805	1.5	0.9	2.7	1.7
24.3188	805	805			2.7	1.7
		806	2.1	1.3	7.0	4.4
22.276	806	806			7.0	4.4
		807	2.9	1.8	8.2	5.2
21.8247	807	807			8.2	5.2
		808	3.1	2.0	13.3	8.3
20.2	808	808			13.3	8.3
		809	1.0	0.6	14.0	8.7
19.5278	809	809			14.0	8.7
		810	1.6	1.0	17.7	10.6
17.2677	810	810			17.7	10.6
		811	2.1	1.4	19.5	11.6
16.365	811	811			19.5	11.6
		812	3.6	2.0	25.0	15.5
14.51	812	812			25.0	15.5
		813	3.3	2.1	31.7	19.7
12.491	813	813			31.7	19.7
		814	3.3	2.1	37.5	23.6
10.472	814	814			37.5	23.6
		815	3.9	2.5	42.0	27.8
8.453	815	815			28.3	21.6
		816	5.2	3.8	25.4	19.4
7.8071	816	816			25.4	19.4
		817	5.1	3.7	21.8	17.0
7.111	817	817			21.8	17.0
		818	4.9	3.1	18.7	14.8
6.401	818	818			18.7	14.8
5.691		819	4.9	2.9	16.0	12.4

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(f) RPV (2)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
5.691	819	819			16.0	12.4
		820	5.3	2.7	13.6	10.7
4.981	820	820			13.6	10.7
		821	4.7	2.5	11.9	9.0
4.2713	821	821			11.9	9.0
		822	4.5	2.4	11.1	8.1
3.7593	822	822			11.1	8.1
		823	4.5	2.3	10.5	7.3
3.215	823	823			10.5	7.3
		824	4.4	2.2	10.4	6.3
2.365	824	824			3.1	2.6
		825	2.1	1.8	1.9	1.6
1.785	825	825			1.9	1.6
		826	1.9	1.6	0.8	0.6
1.2	826	826			0.8	0.6
		827	1.7	1.4	0.2	0.2
0.7657	827	827			0.2	0.2
-0.1315		828	1.3	1.0	1.2	0.9

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(g) RPV (3)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
21.8247	828	829			0.0	0.0
		830	0.1	0.1	0.2	0.1
20.2	829	830			0.2	0.1
		831	0.3	0.1	0.7	0.3
19.5278	830	831			0.7	0.3
		832	0.3	0.2	1.2	0.5
17.2677	831	832			1.2	0.5
		833	0.4	0.2	1.5	0.7
16.365	832	833			1.5	0.7
		834	2.2	1.2	4.1	2.1
14.51	833	834			4.1	2.1
		835	1.4	0.7	6.9	3.5
12.491	834	835			6.9	3.5
		836	0.6	0.4	7.5	3.7
10.472	835	836			7.5	3.7
		837	1.2	0.8	6.1	2.4
8.453	836	837			6.1	2.4
		838	1.5	0.9	4.4	2.3
7.8071	837	838			4.4	2.3
		839	1.7	1.2	4.3	2.1
7.111	838	839			4.3	2.1
		840	2.0	1.1	3.6	2.1
6.401	839	840			3.6	2.1
		841	2.4	1.1	2.8	2.3
5.691	840	841			2.8	2.3
		842	2.7	1.2	3.7	2.4
4.981	841	842			3.7	2.4
		843	3.5	1.3	4.6	2.9
4.2713	842	843			4.6	2.9
		844	3.5	1.4	5.8	3.3
3.7593	843	844			5.8	3.3
		845	3.1	1.3	6.8	3.7
3.215	844	845			6.8	3.7
2.365		846	3.2	1.4	9.0	4.3

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(h) RPV (4)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
0.7657	859	827			0.0	0.0
		861	0.1	0.1	0.1	0.1
-0.788	861	861			0.1	0.1
		863	0.0	0.0	0.1	0.1
-1.443	863	863			0.1	0.1
		865	0.0	0.0	0.1	0.1
-2.098	865	865			0.1	0.1
		867	0.1	0.0	0.1	0.1
-2.753	867	867			0.1	0.1
		869	0.1	0.1	0.0	0.0
-3.4715	869	869			0.0	0.0
-4.2237		871	0.1	0.0	0.0	0.0
8.453	871	815			10.5	7.3
7.4625		711	4.4	2.2	10.4	6.3

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(i) RPV (5)

Elev. (m)	Elem No.	Node No.	Shear		Moment	
			X-dir. (MN)	Y-dir. (MN)	X-dir. (MN·m)	Y-dir. (MN·m)
7.896	845	847			0.0	0.0
		848	0.4	0.5	0.0	0.0
7.8071	846	848			0.0	0.0
		849	0.4	0.5	0.3	0.4
7.111	847	849			0.3	0.4
		850	0.3	0.3	0.5	0.6
6.401	848	850			0.5	0.6
		851	0.1	0.1	0.5	0.6
5.691	849	851			0.5	0.6
		852	0.3	0.3	0.3	0.4
4.981	850	852			0.3	0.4
		853	0.4	0.5	0.0	0.0
4.2713	851	853			0.0	0.0
		854	0.4	0.5	0.0	0.0
4.1784	852	854			0.0	0.0
		855	0.5	0.3	0.1	0.0
4.065	853	855			0.1	0.0
		856	0.4	0.3	0.4	0.3
3.215	854	856			0.4	0.3
		857	0.1	0.1	0.5	0.4
2.365	855	857			0.5	0.4
		858	0.3	0.2	0.3	0.3
1.785	856	858			0.3	0.3
		859	0.6	0.4	0.0	0.0
1.2	857	859			0.0	0.0
		860	0.8	0.6	0.3	0.3
0.7657	858	860			0.3	0.3
-0.1315		828	0.9	0.7	1.2	0.9

Table A-4 Maximum Response Forces and Moments RB/FB (LB) (Continued)

(j) RPV (6)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
-0.1315	860	828			0.1	0.1
		862	0.1	0.0	0.1	0.1
-0.788	862	862			0.1	0.1
		864	0.0	0.0	0.1	0.1
-1.443	864	864			0.1	0.1
		866	0.0	0.0	0.1	0.1
-2.098	866	866			0.1	0.1
		868	0.1	0.0	0.1	0.1
-2.753	868	868			0.1	0.1
		870	0.1	0.1	0.0	0.0
-3.4715	870	870			0.0	0.0
-4.2237		872	0.0	0.0	0.0	0.0

Table A-5 Maximum Response Forces and Moments RB/FB (UB)

(a) RB/FB

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
52.40	1110	110			682.6	703.7	
		109	63.1	59.8	1612.6	1653.9	441.2
34.00	1109	109			2108.3	2167.1	
		108	73.4	59.7	2571.8	2557.2	665.0
27.00	1108	108			2869.6	2937.6	
		107	177.4	137.8	3530.0	3457.9	1287.9
22.50	1107	107			3853.5	3719.9	
		106	198.2	156.6	4719.7	4358.0	2433.8
17.50	1106	106			5109.0	4540.7	
		105	206.6	186.0	5853.9	5083.1	2061.2
13.57	1105	105			6078.0	5241.8	
		104	216.2	196.7	6977.0	5860.0	2176.5
9.06	1104	104			7129.7	5953.1	
		103	227.7	205.5	8039.8	6645.3	2368.5
4.65	1103	103			5255.2	3856.7	
		102	259.2	188.8	6511.3	4520.4	2882.3
-1.00	1102	102			6764.6	4865.6	
		101	279.1	208.8	8107.4	5654.3	3209.1
-6.40	1101	101			4766.1	3494.1	
-11.50		2	122.2	96.7	5286.3	3743.2	1861.8

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(b) RCCV

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
34.00	1209	209			67.0	163.5	
		208	61.6	67.5	433.4	591.0	10.0
27.00	1208	208			550.8	899.5	
		206	70.5	80.5	1114.7	1587.0	752.3
17.50	1206	206			1165.8	1743.0	
		205	93.8	81.8	1507.7	2024.7	815.3
13.57	1205	205			1533.1	2110.4	
		204	102.9	88.4	1956.1	2446.1	910.8
9.06	1204	204			1993.7	2550.5	
		203	110.0	97.0	2438.3	2879.2	1040.5
4.65	1203	203			2503.8	3005.1	
		202	57.4	54.5	2796.7	3189.3	773.9
-1.00	1202	202			2905.1	3345.5	
		201	78.0	69.8	3281.8	3717.9	813.7
-6.40	1201	201			3349.6	3766.1	
-11.50		2	29.3	23.6	3445.9	3857.5	312.5

(c) Pedestal

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
4.65	1303	303			160.6	148.7	
		377	12.0	10.3	174.1	167.9	38.2
2.4165	1377	377			214.5	206.2	
		302	17.6	15.2	245.2	262.5	46.4
-1.00	1302	302			223.1	237.0	
		376	23.1	20.1	252.8	266.8	40.6
-2.75	1376	376			252.9	266.8	
		301	23.3	20.2	321.5	334.3	40.6
-6.40	1301	301			304.2	332.5	
-11.50		2	11.0	8.4	340.5	362.4	18.8

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(d) Vent Wall and RSW

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
17.50	701	701			22.9	18.1	
		702	6.5	6.7	26.0	21.4	12.4
14.50	702	702			28.0	27.8	
		703	7.4	6.4	34.5	40.6	13.1
11.50	703	703			38.5	43.2	
		704	8.1	6.9	51.2	60.0	14.0
8.50	704	704			53.1	61.7	
		705	8.9	7.1	58.8	68.6	14.3
7.4625	705	705			65.4	58.0	
4.65		706,303	5.6	4.8	75.2	68.9	7.2

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
24.18	707	707			0.6	0.7	
		708	0.8	0.7	3.9	3.3	0.1
20.20	708	708			5.9	5.6	
		709	4.9	3.1	26.5	16.7	0.5
15.775	709	709			27.6	17.3	
		710	5.3	3.4	51.2	32.3	0.7
11.35	710	710			51.6	32.4	
		711	5.5	4.1	72.1	46.1	0.7
7.4625	711	711			61.4	53.3	
		712	14.4	12.5	86.6	81.3	7.6
4.65	712	712			34.9	30.3	
		713	5.3	4.5	40.2	38.2	8.2
2.4165	713	713			1.2	1.0	
		714	0.4	0.4	1.0	0.9	0.1
1.96	714	714			0.9	0.8	
-0.80		715	0.3	0.2	0.2	0.1	0.0

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(e) RPV (1)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
27.64	801	801			0.0	0.0
		802	0.2	0.1	0.2	0.1
26.792	802	802			0.2	0.1
		803	0.6	0.4	0.7	0.4
25.944	803	803			0.7	0.4
		804	1.2	0.7	1.8	1.1
25.03	804	804			1.8	1.1
		805	1.5	1.0	2.9	1.8
24.3188	805	805			2.9	1.8
		806	2.2	1.4	7.4	4.6
22.276	806	806			7.4	4.6
		807	3.0	1.8	8.7	5.5
21.8247	807	807			8.7	5.5
		808	3.3	2.0	14.1	8.7
20.2	808	808			14.1	8.7
		809	1.1	0.7	14.8	9.1
19.5278	809	809			14.8	9.1
		810	1.8	1.0	18.8	11.0
17.2677	810	810			18.8	11.0
		811	2.2	1.5	20.7	12.1
16.365	811	811			20.7	12.1
		812	3.9	2.2	27.2	15.8
14.51	812	812			27.2	15.8
		813	3.6	2.1	34.1	20.0
12.491	813	813			34.1	20.0
		814	3.5	2.3	40.4	24.2
10.472	814	814			40.4	24.2
		815	4.2	2.8	45.0	28.2
8.453	815	815			31.8	23.0
		816	5.6	4.0	28.1	20.6
7.8071	816	816			28.1	20.6
		817	5.6	3.7	24.1	18.1
7.111	817	817			24.1	18.1
		818	5.5	3.3	20.4	15.7
6.401	818	818			20.4	15.7
5.691		819	5.3	3.0	17.4	13.4

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(f) RPV (2)

Elev. (m)	Elem No.	Node No.	Shear		Moment	
			X-dir. (MN)	Y-dir. (MN)	X-dir. (MN·m)	Y-dir. (MN·m)
5.691	819	819			17.4	13.4
		820	5.1	2.8	15.4	11.5
4.981	820	820			15.4	11.5
		821	4.9	2.7	13.4	9.8
4.2713	821	821			13.4	9.8
		822	4.7	2.6	12.4	8.6
3.7593	822	822			12.4	8.6
		823	4.6	2.5	11.6	7.7
3.215	823	823			11.6	7.7
		824	4.5	2.4	11.3	6.6
2.365	824	824			3.4	2.8
		825	2.4	1.8	2.1	1.7
1.785	825	825			2.1	1.7
		826	2.1	1.7	0.8	0.7
1.2	826	826			0.8	0.7
		827	1.9	1.5	0.2	0.2
0.7657	827	827			0.2	0.2
-0.1315		828	1.4	1.1	1.4	1.0

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(g) RPV (3)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
21.8247	828	829			0.0	0.0
		830	0.1	0.1	0.2	0.1
20.2	829	830			0.2	0.1
		831	0.3	0.1	0.5	0.4
19.5278	830	831			0.5	0.4
		832	0.4	0.2	1.1	0.6
17.2677	831	832			1.1	0.6
		833	0.4	0.2	1.5	0.8
16.365	832	833			1.5	0.8
		834	2.2	1.2	4.1	2.3
14.51	833	834			4.1	2.3
		835	1.4	0.6	6.9	3.4
12.491	834	835			6.9	3.4
		836	0.6	0.5	7.5	3.2
10.472	835	836			7.5	3.2
		837	1.3	0.9	5.4	2.5
8.453	836	837			5.4	2.5
		838	1.7	1.0	4.8	2.5
7.8071	837	838			4.8	2.5
		839	1.9	1.2	3.9	2.2
7.111	838	839			3.9	2.2
		840	2.2	1.2	3.2	2.4
6.401	839	840			3.2	2.4
		841	2.5	1.2	2.9	2.6
5.691	840	841			2.9	2.6
		842	2.8	1.2	3.8	2.8
4.981	841	842			3.8	2.8
		843	2.9	1.3	4.9	3.1
4.2713	842	843			4.9	3.1
		844	3.0	1.4	6.2	3.6
3.7593	843	844			6.2	3.6
		845	3.0	1.7	7.3	3.8
3.215	844	845			7.3	3.8
2.365		846	3.1	1.7	10.2	4.6

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(h) RPV (4)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
0.7657	859	827			0.1	0.0
		861	0.1	0.1	0.1	0.1
-0.788	861	861			0.1	0.1
		863	0.0	0.0	0.1	0.1
-1.443	863	863			0.1	0.1
		865	0.0	0.0	0.1	0.1
-2.098	865	865			0.1	0.1
		867	0.1	0.1	0.1	0.1
-2.753	867	867			0.1	0.1
		869	0.1	0.1	0.0	0.0
-3.4715	869	869			0.0	0.0
-4.2237		871	0.1	0.0	0.0	0.0
8.453	871	815			11.6	7.7
7.4625		711	4.5	2.4	11.3	6.6

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(i) RPV (5)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
7.896	845	847			0.0	0.0
		848	0.4	0.6	0.0	0.1
7.8071	846	848			0.0	0.1
		849	0.4	0.6	0.3	0.4
7.111	847	849			0.3	0.4
		850	0.2	0.3	0.5	0.7
6.401	848	850			0.5	0.7
		851	0.1	0.1	0.5	0.7
5.691	849	851			0.5	0.7
		852	0.3	0.3	0.3	0.4
4.981	850	852			0.3	0.4
		853	0.4	0.5	0.0	0.0
4.2713	851	853			0.0	0.0
		854	0.4	0.5	0.0	0.0
4.1784	852	854			0.0	0.0
		855	0.5	0.4	0.1	0.0
4.065	853	855			0.1	0.0
		856	0.4	0.3	0.4	0.3
3.215	854	856			0.4	0.3
		857	0.1	0.1	0.5	0.4
2.365	855	857			0.5	0.4
		858	0.3	0.2	0.4	0.3
1.785	856	858			0.4	0.3
		859	0.6	0.5	0.0	0.0
1.2	857	859			0.0	0.0
		860	0.9	0.7	0.4	0.3
0.7657	858	860			0.4	0.3
-0.1315		828	1.0	0.8	1.3	1.0

Table A-5 Maximum Response Forces and Moments RB/FB (UB) (Continued)

(j) RPV (6)

Elev. (m)	Elem No.	Node No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN·m)	Moment Y-dir. (MN·m)
-0.1315	860	828			0.1	0.1
		862	0.1	0.1	0.1	0.1
-0.788	862	862			0.1	0.1
		864	0.0	0.0	0.1	0.1
-1.443	864	864			0.1	0.1
		866	0.0	0.0	0.1	0.1
-2.098	866	866			0.1	0.1
		868	0.1	0.1	0.1	0.1
-2.753	868	868			0.1	0.1
		870	0.1	0.1	0.0	0.0
-3.4715	870	870			0.0	0.0
-4.2237		872	0.1	0.0	0.0	0.0

Table A-6 Maximum Response Forces and Moments CB (BE)

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				49.3	32.0	
		6	12.1	11.7	87.1	69.4	8.2
9.06	5				118.2	87.9	
		5	22.0	22.4	209.3	174.8	17.9
4.65	4				124.8	59.1	
		4	30.1	27.9	314.9	241.1	15.4
-2.00	3				269.2	241.3	
-7.40	2	3	34.4	30.7	439.9	387.9	17.8

Table A-7 Maximum Response Forces and Moments CB (LB)

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				44.8	30.5	
		6	11.5	10.5	83.8	63.7	7.3
9.06	5				113.9	81.1	
		5	21.0	19.5	201.5	155.4	15.8
4.65	4				120.6	56.2	
		4	27.4	25.1	302.7	211.2	14.5
-2.00	3				259.4	213.0	
-7.40	2	3	30.7	30.6	422.4	344.1	17.4

Table A-8 Maximum Response Forces and Moments CB (UB)

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				52.1	33.5	
		6	12.4	13.4	86.5	73.5	9.0
9.06	5				117.1	90.7	
		5	23.9	25.2	207.9	195.2	19.9
4.65	4				123.2	61.4	
		4	33.0	31.5	313.3	270.2	17.1
-2.00	3				266.7	269.0	
-7.40	2	3	37.6	33.2	446.1	434.9	18.5

Table A-9 Maximum Absolute Acceleration RB/FB (BE)

RB/FB

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
52.40	110	RBFB	0.64	0.66	0.31
34.00	109	RBFB	0.45	0.38	0.25
27.00	108	RBFB	0.37	0.31	0.24
22.50	107	RBFB	0.34	0.28	0.22
17.50	106	RBFB	0.32	0.27	0.22
13.57	105	RBFB	0.28	0.24	0.21
9.06	104	RBFB	0.26	0.23	0.20
4.65	103	RBFB	0.24	0.20	0.19
-1.00	102	RBFB	0.19	0.20	0.18
-6.40	101	RBFB	0.22	0.19	0.17
-11.50	2	RBFB	0.19	0.15	0.17
-15.50	1	RBFB	0.19	0.15	0.17
52.40	9101	Oscillator	---	---	0.32
	9102	Oscillator	---	---	0.73
	9103	Oscillator	---	---	0.89
	9104	Oscillator	---	---	0.67
	9105	Oscillator	---	---	0.51
	9106	Oscillator	---	---	0.70
	9107	Oscillator	---	---	0.59
	9108	Oscillator	---	---	0.51
34.00	9091	Oscillator	---	---	0.36
	9092	Oscillator	---	---	0.28
27.00	9081	Oscillator	---	---	0.37
	9082	Oscillator	---	---	0.33
	9083	Oscillator	---	---	0.28
	9084	Oscillator	---	---	0.33
	9085	Oscillator	---	---	0.29
22.50	9071	Oscillator	---	---	0.62
	9072	Oscillator	---	---	0.68
	9073	Oscillator	---	---	0.72
	9074	Oscillator	---	---	0.41
	9075	Oscillator	---	---	0.31
17.50	9061	Oscillator	---	---	0.54
	9062	Oscillator	---	---	0.48
	9063	Oscillator	---	---	0.25
	9064	Oscillator	---	---	0.60
	9065	Oscillator	---	---	0.30
13.57	9051	Oscillator	---	---	0.25
	9052	Oscillator	---	---	0.32
9.06	9041	Oscillator	---	---	0.22
	9042	Oscillator	---	---	0.34
4.65	9031	Oscillator	---	---	0.46
	9032	Oscillator	---	---	0.27
	9033	Oscillator	---	---	0.38
	9034	Oscillator	---	---	0.48
	9035	Oscillator	---	---	0.34
-1.00	9021	Oscillator	---	---	0.36
	9022	Oscillator	---	---	0.50
	9023	Oscillator	---	---	0.31
	9024	Oscillator	---	---	0.29
	9025	Oscillator	---	---	0.32
	9026	Oscillator	---	---	0.48
	9027	Oscillator	---	---	0.24
-6.40	9011	Oscillator	---	---	0.32
	9012	Oscillator	---	---	0.33
	9013	Oscillator	---	---	0.38

Table A-9 Maximum Absolute Acceleration RB/FB (BE) (Continued)

(b) RCCV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
34.00	209	0.45	0.38	0.25
27.00	208	0.37	0.31	0.25
17.50	206	0.32	0.27	0.22
13.57	205	0.28	0.24	0.21
9.06	204	0.26	0.23	0.21
4.65	203	0.24	0.21	0.20
-1.00	202	0.19	0.20	0.19
-6.40	201	0.22	0.19	0.18

(c) Vent Wall and Pedestal

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
17.50	701	0.32	0.27	0.23
14.50	702	0.43	0.37	0.22
11.50	703	0.42	0.36	0.22
8.50	704	0.26	0.27	0.21
7.4625	705	0.24	0.23	0.21
4.65	706,303	0.24	0.21	0.20
-1.00	302	0.19	0.20	0.19
-6.40	301	0.22	0.19	0.18

(d) RSW

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
24.18	707	0.71	0.54	0.27
20.20	708	0.52	0.39	0.27
15.775	709	0.43	0.33	0.25
11.35	710	0.32	0.27	0.23
7.4625	711	0.24	0.23	0.21
4.65	712	0.24	0.21	0.20
2.4615	713	0.21	0.19	0.20
1.96	714	0.22	0.19	0.20
-0.80	715	0.25	0.20	0.20

Table A-9 Maximum Absolute Acceleration RB/FB (BE) (Continued)

(e) RPV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
27.64	801	1.35	0.97	0.37	21.8247	829	1.50	0.72	0.80					
26.792	802	1.28	0.93	0.37	20.2	830	0.76	0.46	0.80					
25.944	803	1.21	1.03	0.37	19.5278	831	0.70	0.50	0.80					
25.03	804	1.13	0.80	0.37	17.2677	832	0.55	0.43	0.78					
24.3188	805	1.08	0.77	0.37	16.365	833	0.53	0.41	0.78	7.896	847	0.53	0.32	0.43
22.276	806	0.89	0.65	0.36	14.51	834	0.53	0.38	0.74	7.8071	848	0.49	0.31	0.43
21.8247	807	0.85	0.62	0.36	12.491	835	0.50	0.33	0.71	7.111	849	0.34	0.34	0.42
20.2	808	0.72	0.50	0.35	10.472	836	0.45	0.30	0.68	6.401	850	0.31	0.44	0.41
19.5278	809	0.68	0.48	0.35	8.453	837	0.51	0.29	0.64	5.691	851	0.36	0.41	0.40
17.2677	810	0.60	0.38	0.33	7.8071	838	0.53	0.32	0.63	4.981	852	0.50	0.39	0.37
16.365	811	0.57	0.38	0.33	7.111	839	0.57	0.37	0.61	4.2713	853	0.70	0.56	0.35
14.51	812	0.55	0.38	0.31	6.401	840	0.61	0.42	0.58	4.1784	854	0.75	0.57	0.34
12.491	813	0.50	0.38	0.30	5.691	841	0.65	0.47	0.55	4.065	855	0.80	0.66	0.34
10.472	814	0.46	0.37	0.28	4.981	842	0.69	0.53	0.53	3.215	856	1.41	1.17	0.33
8.453	815	0.43	0.37	0.26	4.2713	843	0.73	0.55	0.50	2.365	857	1.84	1.49	0.32
7.8071	816	0.47	0.40	0.26	3.7593	844	0.75	0.57	0.48	1.785	858	1.98	1.58	0.31
7.111	817	0.52	0.42	0.26	3.215	845	0.75	0.59	0.45	1.2	859	2.00	1.58	0.31
6.401	818	0.56	0.45	0.27	2.365	846	0.79	0.61	0.41	0.7657	860	1.42	1.16	0.30
5.691	819	0.60	0.48	0.27	0.7657	827	0.91	0.69	0.30	-0.1315	828	0.95	0.73	0.30
4.981	820	0.65	0.51	0.27										
4.2713	821	0.69	0.53	0.27	-0.788	861	0.96	0.82	0.30	-0.788	862	0.94	0.73	0.30
3.7593	822	0.72	0.56	0.28	-1.443	863	0.82	0.72	0.30	-1.443	864	0.79	0.65	0.30
3.215	823	0.76	0.57	0.28	-2.098	865	0.57	0.43	0.30	-2.098	866	0.57	0.46	0.30
2.365	824	0.81	0.61	0.29	-2.753	867	0.59	0.60	0.30	-2.753	868	0.62	0.62	0.30
1.785	825	0.85	0.65	0.29	-3.4715	869	1.46	1.17	0.30	-3.4715	870	1.36	1.12	0.30
1.2	826	0.88	0.68	0.30	-4.2237	871	2.59	1.95	0.30	-4.2237	872	2.44	1.90	0.30

Table A-10 Maximum Absolute Acceleration RB/FB (LB)

(a) RB/FB

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
52.40	110	RBFB	0.60	0.63	0.28
34.00	109	RBFB	0.39	0.34	0.25
27.00	108	RBFB	0.33	0.29	0.23
22.50	107	RBFB	0.30	0.26	0.23
17.50	106	RBFB	0.31	0.23	0.20
13.57	105	RBFB	0.28	0.20	0.19
9.06	104	RBFB	0.24	0.22	0.18
4.65	103	RBFB	0.21	0.19	0.18
-1.00	102	RBFB	0.19	0.19	0.17
-6.40	101	RBFB	0.22	0.17	0.16
-11.50	2	RBFB	0.18	0.15	0.16
-15.50	1	RBFB	0.18	0.15	0.16
52.40	9101	Oscillator	---	---	0.33
	9102	Oscillator	---	---	0.65
	9103	Oscillator	---	---	1.04
	9104	Oscillator	---	---	0.57
	9105	Oscillator	---	---	0.47
	9106	Oscillator	---	---	0.66
	9107	Oscillator	---	---	0.49
	9108	Oscillator	---	---	0.40
34.00	9091	Oscillator	---	---	0.30
	9092	Oscillator	---	---	0.27
27.00	9081	Oscillator	---	---	0.35
	9082	Oscillator	---	---	0.30
	9083	Oscillator	---	---	0.28
	9084	Oscillator	---	---	0.30
	9085	Oscillator	---	---	0.28
22.50	9071	Oscillator	---	---	0.60
	9072	Oscillator	---	---	0.56
	9073	Oscillator	---	---	0.77
	9074	Oscillator	---	---	0.36
	9075	Oscillator	---	---	0.30
17.50	9061	Oscillator	---	---	0.60
	9062	Oscillator	---	---	0.40
	9063	Oscillator	---	---	0.25
	9064	Oscillator	---	---	0.63
	9065	Oscillator	---	---	0.25
13.57	9051	Oscillator	---	---	0.24
	9052	Oscillator	---	---	0.25
9.06	9041	Oscillator	---	---	0.23
	9042	Oscillator	---	---	0.26
4.65	9031	Oscillator	---	---	0.42
	9032	Oscillator	---	---	0.25
	9033	Oscillator	---	---	0.33
	9034	Oscillator	---	---	0.40
	9035	Oscillator	---	---	0.28
-1.00	9021	Oscillator	---	---	0.32
	9022	Oscillator	---	---	0.45
	9023	Oscillator	---	---	0.29
	9024	Oscillator	---	---	0.26
	9025	Oscillator	---	---	0.28
	9026	Oscillator	---	---	0.37
	9027	Oscillator	---	---	0.19
-6.40	9011	Oscillator	---	---	0.30
	9012	Oscillator	---	---	0.31
	9013	Oscillator	---	---	0.32

Table A-10 Maximum Absolute Acceleration RB/FB (LB) (Continued)

(b) RCCV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
34.00	209	0.39	0.34	0.26
27.00	208	0.33	0.29	0.27
17.50	206	0.31	0.24	0.21
13.57	205	0.28	0.20	0.20
9.06	204	0.24	0.22	0.19
4.65	203	0.21	0.19	0.18
-1.00	202	0.19	0.19	0.17
-6.40	201	0.22	0.18	0.16

(c) Vent Wall and Pedestal

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
17.50	701	0.31	0.24	0.22
14.50	702	0.44	0.30	0.20
11.50	703	0.36	0.29	0.20
8.50	704	0.24	0.25	0.19
7.4625	705	0.24	0.22	0.19
4.65	706,303	0.21	0.19	0.18
-1.00	302	0.19	0.19	0.17
-6.40	301	0.22	0.18	0.16

(d) RSW

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
24.18	707	0.71	0.51	0.24
20.20	708	0.53	0.37	0.23
15.775	709	0.41	0.34	0.22
11.35	710	0.33	0.27	0.21
7.4625	711	0.24	0.22	0.19
4.65	712	0.21	0.19	0.18
2.4615	713	0.22	0.18	0.18
1.96	714	0.23	0.18	0.18
-0.80	715	0.25	0.19	0.18

Table A-10 Maximum Absolute Acceleration RB/FB (LB) (Continued)

(e) RPV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
27.64	801	1.30	0.87	0.33	21.8247	829	1.13	0.68	0.70					
26.792	802	1.23	0.82	0.33	20.2	830	0.61	0.35	0.70					
25.944	803	1.16	0.77	0.33	19.5278	831	0.66	0.48	0.70					
25.03	804	1.09	0.71	0.33	17.2677	832	0.54	0.39	0.68					
24.3188	805	1.03	0.67	0.33	16.365	833	0.52	0.37	0.68	7.896	847	0.52	0.31	0.40
22.276	806	0.87	0.57	0.32	14.51	834	0.54	0.38	0.65	7.8071	848	0.48	0.28	0.40
21.8247	807	0.83	0.55	0.32	12.491	835	0.50	0.32	0.62	7.111	849	0.33	0.30	0.40
20.2	808	0.70	0.47	0.31	10.472	836	0.47	0.25	0.60	6.401	850	0.32	0.38	0.39
19.5278	809	0.65	0.44	0.31	8.453	837	0.50	0.28	0.57	5.691	851	0.31	0.37	0.37
17.2677	810	0.57	0.34	0.30	7.8071	838	0.52	0.31	0.56	4.981	852	0.45	0.37	0.36
16.365	811	0.55	0.33	0.29	7.111	839	0.56	0.35	0.54	4.2713	853	0.67	0.54	0.33
14.51	812	0.51	0.30	0.28	6.401	840	0.60	0.40	0.51	4.1784	854	0.71	0.57	0.33
12.491	813	0.47	0.32	0.27	5.691	841	0.63	0.46	0.49	4.065	855	0.76	0.64	0.33
10.472	814	0.44	0.34	0.25	4.981	842	0.67	0.50	0.47	3.215	856	1.32	1.11	0.32
8.453	815	0.41	0.37	0.24	4.2713	843	0.70	0.54	0.44	2.365	857	1.72	1.40	0.31
7.8071	816	0.44	0.39	0.24	3.7593	844	0.71	0.57	0.43	1.785	858	1.83	1.47	0.30
7.111	817	0.49	0.41	0.24	3.215	845	0.73	0.58	0.40	1.2	859	1.84	1.47	0.29
6.401	818	0.53	0.44	0.24	2.365	846	0.77	0.60	0.36	0.7657	860	1.31	1.10	0.29
5.691	819	0.57	0.47	0.25	0.7657	827	0.87	0.65	0.28	-0.1315	828	0.91	0.68	0.28
4.981	820	0.62	0.50	0.26										
4.2713	821	0.66	0.52	0.26	-0.788	861	0.86	0.77	0.28	-0.788	862	0.88	0.68	0.29
3.7593	822	0.70	0.54	0.26	-1.443	863	0.72	0.66	0.28	-1.443	864	0.71	0.65	0.29
3.215	823	0.73	0.57	0.27	-2.098	865	0.51	0.43	0.29	-2.098	866	0.53	0.45	0.29
2.365	824	0.77	0.59	0.28	-2.753	867	0.55	0.52	0.29	-2.753	868	0.57	0.54	0.29
1.785	825	0.81	0.62	0.28	-3.4715	869	1.35	1.05	0.29	-3.4715	870	1.26	0.99	0.29
1.2	826	0.84	0.64	0.28	-4.2237	871	2.40	1.75	0.29	-4.2237	872	2.20	1.72	0.29

Table A-11 Maximum Absolute Acceleration RB/FB (UB)

(a) RB/FB

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
52.40	110	RBFB	0.71	0.66	0.38
34.00	109	RBFB	0.49	0.40	0.31
27.00	108	RBFB	0.40	0.33	0.29
22.50	107	RBFB	0.35	0.31	0.25
17.50	106	RBFB	0.35	0.29	0.24
13.57	105	RBFB	0.30	0.25	0.23
9.06	104	RBFB	0.30	0.24	0.21
4.65	103	RBFB	0.27	0.21	0.20
-1.00	102	RBFB	0.20	0.21	0.20
-6.40	101	RBFB	0.23	0.19	0.20
-11.50	2	RBFB	0.21	0.16	0.18
-15.50	1	RBFB	0.20	0.16	0.18
52.40	9101	Oscillator	---	---	0.32
	9102	Oscillator	---	---	0.69
	9103	Oscillator	---	---	0.95
	9104	Oscillator	---	---	0.69
	9105	Oscillator	---	---	0.50
	9106	Oscillator	---	---	0.68
	9107	Oscillator	---	---	0.66
	9108	Oscillator	---	---	0.56
34.00	9091	Oscillator	---	---	0.41
	9092	Oscillator	---	---	0.39
27.00	9081	Oscillator	---	---	0.36
	9082	Oscillator	---	---	0.37
	9083	Oscillator	---	---	0.36
	9084	Oscillator	---	---	0.39
	9085	Oscillator	---	---	0.34
22.50	9071	Oscillator	---	---	0.60
	9072	Oscillator	---	---	0.72
	9073	Oscillator	---	---	0.57
	9074	Oscillator	---	---	0.42
	9075	Oscillator	---	---	0.35
17.50	9061	Oscillator	---	---	0.46
	9062	Oscillator	---	---	0.52
	9063	Oscillator	---	---	0.29
	9064	Oscillator	---	---	0.50
	9065	Oscillator	---	---	0.36
13.57	9051	Oscillator	---	---	0.28
	9052	Oscillator	---	---	0.35
9.06	9041	Oscillator	---	---	0.26
	9042	Oscillator	---	---	0.35
4.65	9031	Oscillator	---	---	0.47
	9032	Oscillator	---	---	0.31
	9033	Oscillator	---	---	0.43
	9034	Oscillator	---	---	0.51
	9035	Oscillator	---	---	0.33
-1.00	9021	Oscillator	---	---	0.43
	9022	Oscillator	---	---	0.50
	9023	Oscillator	---	---	0.38
	9024	Oscillator	---	---	0.29
	9025	Oscillator	---	---	0.37
	9026	Oscillator	---	---	0.55
	9027	Oscillator	---	---	0.26
-6.40	9011	Oscillator	---	---	0.39
	9012	Oscillator	---	---	0.34
	9013	Oscillator	---	---	0.41

Table A-11 Maximum Absolute Acceleration RB/FB (UB) (Continued)

(b) RCCV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
34.00	209	0.49	0.40	0.31
27.00	208	0.40	0.33	0.30
17.50	206	0.35	0.29	0.25
13.57	205	0.30	0.24	0.23
9.06	204	0.30	0.24	0.23
4.65	203	0.27	0.21	0.22
-1.00	202	0.20	0.21	0.21
-6.40	201	0.23	0.20	0.20

(c) Vent Wall and Pedestal

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
17.50	701	0.35	0.29	0.26
14.50	702	0.51	0.40	0.26
11.50	703	0.46	0.41	0.26
8.50	704	0.30	0.29	0.25
7.4625	705	0.28	0.25	0.24
4.65	706,303	0.27	0.21	0.23
-1.00	302	0.20	0.21	0.20
-6.40	301	0.23	0.20	0.19

(d) RSW

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
24.18	707	0.72	0.62	0.31
20.20	708	0.54	0.53	0.31
15.775	709	0.46	0.36	0.29
11.35	710	0.35	0.30	0.27
7.4625	711	0.28	0.25	0.24
4.65	712	0.27	0.21	0.23
2.4615	713	0.24	0.19	0.21
1.96	714	0.25	0.19	0.21
-0.80	715	0.27	0.22	0.22

Table A-11 Maximum Absolute Acceleration RB/FB (UB) (Continued)

(e) RPV

Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)	Elev. (m)	Node No.	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
27.64	801	1.38	0.86	0.39	21.8247	829	1.71	0.71	0.82					
26.792	802	1.31	0.81	0.39	20.2	830	0.89	0.45	0.82					
25.944	803	1.24	0.75	0.39	19.5278	831	0.69	0.49	0.82					
25.03	804	1.17	0.69	0.39	17.2677	832	0.57	0.46	0.80					
24.3188	805	1.10	0.65	0.39	16.365	833	0.56	0.45	0.79	7.896	847	0.54	0.33	0.44
22.276	806	0.92	0.56	0.38	14.51	834	0.55	0.42	0.73	7.8071	848	0.49	0.30	0.44
21.8247	807	0.87	0.54	0.38	12.491	835	0.51	0.39	0.70	7.111	849	0.36	0.35	0.44
20.2	808	0.74	0.48	0.37	10.472	836	0.47	0.32	0.68	6.401	850	0.31	0.43	0.43
19.5278	809	0.70	0.46	0.37	8.453	837	0.51	0.33	0.64	5.691	851	0.36	0.43	0.43
17.2677	810	0.61	0.41	0.35	7.8071	838	0.54	0.33	0.62	4.981	852	0.52	0.37	0.42
16.365	811	0.59	0.40	0.35	7.111	839	0.59	0.37	0.60	4.2713	853	0.73	0.58	0.40
14.51	812	0.56	0.41	0.33	6.401	840	0.63	0.43	0.57	4.1784	854	0.79	0.60	0.40
12.491	813	0.52	0.41	0.32	5.691	841	0.68	0.47	0.55	4.065	855	0.85	0.67	0.40
10.472	814	0.46	0.39	0.30	4.981	842	0.73	0.53	0.52	3.215	856	1.48	1.20	0.39
8.453	815	0.47	0.39	0.29	4.2713	843	0.76	0.57	0.49	2.365	857	1.94	1.53	0.38
7.8071	816	0.51	0.41	0.30	3.7593	844	0.79	0.60	0.47	1.785	858	2.05	1.62	0.37
7.111	817	0.56	0.44	0.31	3.215	845	0.80	0.62	0.44	1.2	859	2.06	1.62	0.37
6.401	818	0.61	0.47	0.31	2.365	846	0.86	0.65	0.40	0.7657	860	1.47	1.18	0.36
5.691	819	0.66	0.50	0.32	0.7657	827	0.97	0.73	0.35	-0.1315	828	1.02	0.76	0.36
4.981	820	0.70	0.53	0.33										
4.2713	821	0.75	0.56	0.33	-0.788	861	1.02	0.83	0.36	-0.788	862	1.00	0.75	0.36
3.7593	822	0.78	0.57	0.34	-1.443	863	0.87	0.74	0.36	-1.443	864	0.84	0.71	0.36
3.215	823	0.81	0.59	0.34	-2.098	865	0.59	0.48	0.36	-2.098	866	0.59	0.52	0.36
2.365	824	0.87	0.65	0.35	-2.753	867	0.60	0.65	0.36	-2.753	868	0.62	0.67	0.36
1.785	825	0.91	0.68	0.35	-3.4715	869	1.50	1.24	0.36	-3.4715	870	1.40	1.20	0.36
1.2	826	0.94	0.71	0.35	-4.2237	871	2.63	1.96	0.36	-4.2237	872	2.50	1.94	0.36

Table A-12 Maximum Absolute Acceleration CB (BE)

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
13.80	6	CB	0.46	0.45	0.29
11.43	156	CB	0.41	0.41	0.29
9.06	5	CB	0.37	0.38	0.28
6.855	145	CB	0.34	0.32	0.27
4.65	4	CB	0.30	0.29	0.25
1.325	134	CB	0.24	0.24	0.22
-2.00	3	CB	0.25	0.23	0.20
-4.70	123	CB	0.21	0.20	0.19
-7.40	2	CB	0.21	0.17	0.18
-10.40	1	CB	0.21	0.17	0.18
13.80	9001	Oscillator	---	---	0.86
	9002	Oscillator	---	---	0.48
	9003	Oscillator	---	---	0.46
9.06	9101	Oscillator	---	---	0.81
	9102	Oscillator	---	---	0.54
	9103	Oscillator	---	---	0.45
4.65	9201	Oscillator	---	---	0.44
	9202	Oscillator	---	---	0.43
-2.00	9301	Oscillator	---	---	0.49

Table A-13 Maximum Absolute Acceleration CB (LB)

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
13.80	6	CB	0.44	0.40	0.28
11.43	156	CB	0.39	0.36	0.27
9.06	5	CB	0.34	0.33	0.27
6.855	145	CB	0.30	0.31	0.26
4.65	4	CB	0.27	0.28	0.24
1.325	134	CB	0.23	0.24	0.22
-2.00	3	CB	0.24	0.22	0.19
-4.70	123	CB	0.20	0.19	0.18
-7.40	2	CB	0.20	0.17	0.17
-10.40	1	CB	0.20	0.17	0.17
13.80	9001	Oscillator	---	---	0.83
	9002	Oscillator	---	---	0.46
	9003	Oscillator	---	---	0.43
9.06	9101	Oscillator	---	---	0.79
	9102	Oscillator	---	---	0.52
	9103	Oscillator	---	---	0.43
4.65	9201	Oscillator	---	---	0.42
	9202	Oscillator	---	---	0.41
-2.00	9301	Oscillator	---	---	0.48

Table A-14 Maximum Absolute Acceleration CB (UB)

Elev. (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Z-dir. (g)
13.80	6	CB	0.47	0.51	0.30
11.43	156	CB	0.44	0.47	0.29
9.06	5	CB	0.41	0.43	0.29
6.855	145	CB	0.37	0.36	0.27
4.65	4	CB	0.33	0.31	0.26
1.325	134	CB	0.25	0.24	0.22
-2.00	3	CB	0.25	0.24	0.21
-4.70	123	CB	0.21	0.20	0.19
-7.40	2	CB	0.21	0.17	0.18
-10.40	1	CB	0.21	0.18	0.18
13.80	9001	Oscillator	---	---	0.87
	9002	Oscillator	---	---	0.49
	9003	Oscillator	---	---	0.48
9.06	9101	Oscillator	---	---	0.81
	9102	Oscillator	---	---	0.55
	9103	Oscillator	---	---	0.46
4.65	9201	Oscillator	---	---	0.45
	9202	Oscillator	---	---	0.44
-2.00	9301	Oscillator	---	---	0.50

Table A-15 Maximum Relative Displacement RB/FB

(a) BE

Locations	NODE		X-dir.	Y-dir.	Z-dir.
	I	J	(cm)	(cm)	(cm)
Fuel top to fuel center	847	850	0.21	0.27	0.00
Fuel center to fuel bottom	850	853	0.20	0.28	0.00
Core plate to vessel bottom	844	828	0.05	0.05	0.01
Top guide to vessel	838	816	0.06	0.02	0.01
Top guide to vessel bottom	838	828	0.12	0.10	0.01
Fuel center to vessel bottom	850	828	0.26	0.34	0.00
CRD housing to bottom head	868	828	0.11	0.08	0.00
CRD housing to bottom head	867	827	0.12	0.08	0.00
RCCV - RPV	206	807	0.16	0.10	0.02
RCCV - Lower Part in the VW	206	706	0.17	0.17	0.02
RPV - Lower Part in the VW	807	706	0.23	0.20	0.01

(b) LB

Locations	NODE		X-dir.	Y-dir.	Z-dir.
	I	J	(cm)	(cm)	(cm)
Fuel top to fuel center	847	850	0.22	0.24	0.00
Fuel center to fuel bottom	850	853	0.21	0.25	0.00
Core plate to vessel bottom	844	828	0.05	0.04	0.00
Top guide to vessel	838	816	0.06	0.03	0.01
Top guide to vessel bottom	838	828	0.11	0.10	0.01
Fuel center to vessel bottom	850	828	0.24	0.29	0.00
CRD housing to bottom head	868	828	0.09	0.07	0.00
CRD housing to bottom head	867	827	0.12	0.07	0.00
RCCV - RPV	206	807	0.15	0.10	0.02
RCCV - Lower Part in the VW	206	706	0.15	0.16	0.02
RPV - Lower Part in the VW	807	706	0.24	0.23	0.01

Table A-15 Maximum Relative Displacement RB/FB (Continued)

(c) UB

Locations	NODE		X-dir.	Y-dir.	Z-dir.
	I	J	(cm)	(cm)	(cm)
Fuel top to fuel center	847	850	0.20	0.28	0.00
Fuel center to fuel bottom	850	853	0.20	0.30	0.00
Core plate to vessel bottom	844	828	0.06	0.05	0.01
Top guide to vessel	838	816	0.06	0.03	0.01
Top guide to vessel bottom	838	828	0.12	0.10	0.01
Fuel center to vessel bottom	850	828	0.24	0.36	0.00
CRD housing to bottom head	868	828	0.13	0.10	0.00
CRD housing to bottom head	867	827	0.12	0.09	0.00
RCCV - RPV	206	807	0.16	0.10	0.02
RCCV - Lower Part in the VW	206	706	0.17	0.17	0.02
RPV - Lower Part in the VW	807	706	0.25	0.23	0.01

APPENDIX B
Foundations Stability Evaluation

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B.1 OVERTURNING STABILITY

The factors of safety against overturning for RB/FB and CB, using SSI seismic analysis results, are determined by the energy approach described in ESBWR DCD Tier 2 Subsection 3.7.2.14.

The factor of safety (FS) against overturning is defined as follows.

$$FS = \frac{E_0}{E_s} = \frac{m_0 gh + W_p - W_b}{E_s} \quad \text{.......} (1)$$

where,

E_0: Energy required to overturn the structure
E_s: Maximum kinetic energy
m_0gh: Potential energy needed to lift the structure to the overturning position
W_p: Potential energy caused by the effect of embedment
(neglected for conservatively)
W_b: Potential energy caused by the effect of buoyancy

The obtained FS is shown in Tables B-1 and B-2 for RB/FB and CB, respectively. Since the FS is not less than 1.1, which is the acceptance criteria given in SRP 3.8.5, it is concluded that the structures are stable against overturning.

B.2 SLIDING STABILITY

In accordance with SRP 3.8.5, the sliding evaluation is performed for two orthogonal horizontal directions separately. In each direction, time-consistent phasing between the FIRS overall horizontal shear and vertical force is considered to compute the sliding factor of safety (*FS(t)*) as a function of time when combined with deadweight and upward buoyancy force.

(a) RB/FB structure

The *FS* for RB/FB structure is evaluated by taking the minimum values of the *FS(t)* time history calculated per the following equation. The equation terms for the RB/FB are shown in Figure B-1.

$$FS(t) = \frac{F_{ub}(t) + F_{us} + F_r + F_{us}' + F_r'}{F_v(t) + F_o} \quad \text{.......} (2)$$

where,

$F_v(t)$: Overall force time histories of the embedded system as the summation of soil reaction forces at all interface nodes with soil at the base and side walls in the SASSI2000 model.

F_o: Lateral soil force on RB due to Turbine Building (TB) surcharge load.

$F_{ub}(t)$: Friction resistance force of the sliding plane at the bottom of shear keys. Sliding potential at the basemat/mud mat and mud mat/soil interfaces is precluded through intentional roughening of the mud mat top surface and making troughs in the soil underneath the mud mat.

$F_{ub}(t) = P \tan\phi = (0.9D - B - V_z(t)) \tan\phi$ .... (3)

where,
- D: Dead weight
- $V_z(t)$: Vertical seismic force time history
- B: Buoyancy
- ϕ: Angle of internal friction for bedrock is 52 degrees. However, the coefficient of friction, μ, between concrete and bedrock is 0.7 according to Reference 2-k and less than $\mu = tan52 = 1.28$. Therefore, $\mu = 0.7$ is used.

F_{us}: Skin friction resistance force provided by basemat side parallel to the direction of motion.

$F_{us} = \mu P_o$ [neglected for conservatism] .... (4)

where,
- μ: Skin friction coefficient of vertical sides of basemat parallel to the direction of motion.
- $P_o = k_o \gamma L(H_2^2 - H_1^2)/2$: At-rest soil force normal to the basemat vertical surface neglecting surcharge term and water pressure term.
- L: Skin friction length of both sides of basemat parallel to the direction of motion.
- H_1, H_2: Embedment depths at the top and bottom of basemat, respectively.

F_{us}': Skin friction resistance force provided by the outside vertical surface of shear key parallel to the direction of motion.

$F_{us}' = \mu P_o'$ [neglected for conservatism] .... (5)

where,
- μ: Skin friction coefficient of outside vertical surface of shear key parallel to the direction of motion.
- $P_o' = k_o \gamma L'(H_3^2 - H_2^2)/2$: At-rest soil force normal to the shear key vertical surface.
- L': Skin friction length of outside surfaces of shear key parallel to the direction of motion.
- H_2, H_3: Embedment depths at the top and bottom of shear key, respectively.

F_r: Lateral resistance pressure along the embedded exterior wall and basemat opposite to the direction of motion.

$F_r = \beta (k_p - k_a) \gamma L H_2^2 / 2$ [neglected for conservatism] .... (6)

where,
- $k_p = (1+\sin\phi)/(1-\sin\phi)$: Rankine's passive pressure coefficient

$k_a = (1\text{-}sin\phi)/(1+sin\phi)$: Rankine's active pressure coefficient
L: Horizontal length of building opposite to the direction of motion.
H_2: Embedment depth at the bottom of basemat.
β: Reduction factor of full passive/active pressure.

F_r': Lateral resistance pressure along shear key opposite to the direction of motion.
$F_r' = \beta (k_p\text{-}k_a)\ \gamma L'(H_3^2\text{-}H_2^2)/2$ [neglected for conservatism]......................(7)
where,
$k_p = (1+sin\phi)/(1\text{-}sin\phi)$: Rankine's passive pressure coefficient.
$k_a = (1\text{-}sin\phi)/(1+sin\phi)$: Rankine's active pressure coefficient.
L': Horizontal length of shear key opposite to the direction of motion.
H_2, H_3: Embedment depths at the top and bottom of shear key.
β: Reduction factor of full passive/active pressure, same as in equation (6).

For the sliding stability evaluation, it is demonstrated that base friction itself is adequate to resist the entire seismic load for the RB/FB to maintain sliding factor of safety significantly greater than the required factor of safety of 1.1 in SRP 3.8.5. Therefore, the resistance contributions from skin friction (F_{us} and F_{us}') and lateral resistance pressure (F_r and F_r') are not considered in the sliding stability evaluation for conservatism. The evaluation results are shown in Table B-3.

(b) CB structure

The *FS* for CB structure is evaluated by taking the minimum values of the *FS(t)* time history calculated per the following equation. The equation terms for the CB are shown in Figure B-2.

$$FS(t) = \frac{F_{ub}(t) + F_{us} + F_r}{F_v(t)} \quad \text{.......(8)}$$

where,
$F_v(t)$: Overall force time histories of the embedded system as the summation of soil reaction forces at all interface nodes with soil at the base and side walls in the SASSI2000 model.
$F_{ub}(t)$: Friction resistance force provided by basemat bottom.
$F_{ub}(t) = P\ tan\phi = (0.9D - B - V_z(t))\ tan\phi$ ....(9)
where, D: Dead weight
$V_z(t)$: Vertical seismic force time history
B: Buoyancy
ϕ: Angle of internal friction for bedrock is 52 degrees. However, the coefficient of friction, μ, between concrete and bedrock is 0.7 according to Reference 2-k and less than $\mu = tan52 = 1.28$. Therefore, $\mu = 0.7$ is used.

F_{us}: Skin friction resistance force provided by basemat side parallel to the direction of motion.

$F_{us} = \mu P_o$ [neglected for conservatism] ....(10)

where,

μ: Skin friction coefficient of vertical sides of basemat parallel to the direction of motion.

$P_o = k_o \gamma L(H_2^2 - H_1^2)/2$: At-rest soil force normal to the basemat vertical surface neglecting surcharge term and water pressure term.

L: Skin friction length of both sides of basemat parallel to the direction of motion.

H_1, H_2: Embedment depths at the top and bottom of basemat, respectively.

F_r: Lateral resistance pressure along the embedded exterior wall and basemat opposite to the direction of motion.

$F_r = \beta (k_p - k_a) \gamma L H_2^2 /2$ [neglected for conservatism]................................(11)

where,

$k_p = (1+\sin\phi)/(1-\sin\phi)$: Rankine's passive pressure coefficient.

$k_a = (1-\sin\phi)/(1+\sin\phi)$: Rankine's active pressure coefficient.

L: Horizontal length of building opposite to the direction of motion.

H_2: Embedment depth at the bottom of basemat.

β: Reduction factor of full passive/active pressure.

For the sliding stability evaluation, it is demonstrated that base friction itself is adequate to resist the entire seismic load for the CB to maintain sliding factor of safety significantly greater than the required factor of safety of 1.1 in SRP 3.8.5. Therefore, the resistance contributions from skin friction (F_{us}) and lateral resistance pressure (F_r) are not considered in the sliding stability evaluation for conservatism. The evaluation results are shown in Table B-4.

B.3 FLOATATION STABILITY

The factor of safety against floatation is defined as follows.

$FS = F_{DL}/F_B$

F_{DL} is the downward force due to dead load and F_B is the upward force due to buoyancy. Maximum flood level is 0.3m below the design plant grade level.

The factors of safety against floatation for the RB/FB and the CB are shown in Tables B-5 and B-6 respectively. Since the FS is not less than 1.1, which is the acceptance criteria given in SRP 3.8.5, it is concluded that the structure is stable against floatation.

B.4 SOIL BEARING PRESSURES

The maximum soil dynamic bearing pressure demand at the Fermi 3 site for the BE, UB, and LB subsurface profiles using the Fermi 3 FIRS are evaluated using the Modified Energy Balance (MEB) method (Reference 2-j).

The basemat uplift rotation, moment and the soil pressures are calculated in accordance with the MEB method using the SASSI2000 analysis results described in Sections 5 and 6. The overall vertical force time history for the basemat is calculated by summing up the reaction forces at all nodes. The overturning moment time histories for both directions are calculated from the nodal vertical time histories. Then the maximum soil bearing pressures in the time histories are calculated.

The calculated maximum soil bearing pressures for the critical bearing pressure cases are shown in Tables B-7 and B-8 for the RB/FB and CB, respectively. As described in Section 6, the site-specific seismic load is lower than the DCD standard plant seismic load. However, the maximum soil bearing pressures for the LB and UB subsurface profile cases for the RB/FB and for all the subsurface profile cases for the CB are larger than the DCD maximum dynamic bearing demands shown in DCD Table 2.0-1. The reason is considered as follows. The DCD SSI analysis model considers the full embedment up to the finished ground level grade, while the site-specific SSI analysis model for the Fermi 3 site considers the partial embedment condition without taking credit for the granular backfill above the top of the bedrock. Therefore, the structure overturning moments become larger than the DCD SSI analysis results. Then, the soil bearing pressure calculated for the Fermi 3 site provides the larger values. However, it is confirmed that site-specific maximum soil dynamic bearing pressure demands for the RB/FB and CB are still less than the allowable dynamic bearing capacity in Section 2.5.4.10 in the Fermi 3 FSAR.

Table B-1 Overturning Evaluation Results (RB/FB)

Soil Condition	LB		BE		UB	
	NS dir	EW dir	NS dir	EW dir	NS dir	EW dir
m_0gh (MN·m)	43,403	24,215	43,403	24,215	43,403	24,215
W_b (MN·m)	891	949	891	949	891	949
E_s (MN·m)	11.02	10.73	11.72	11.37	12.79	12.10
$FS=(m_0gh-W_b)/E_s$	3,858	2,168	3,627	2,046	3,324	1,923

where,
m_0 = total mass of structure and basemat
g = acceleration due to gravity
h = height of the center of structure mass at the overturning position
W_b = potential energy caused by the effect of buoyancy
E_s = maximum kinetic energy
FS = Factor of Safety

Table B-2 Overturning Evaluation Results (CB)

Soil Condition	LB		BE		UB	
	NS dir	EW dir	NS dir	EW dir	NS dir	EW dir
m_0gh (MN·m)	1,525	1,028	1,525	1,028	1,525	1,028
W_b (MN·m)	96	102	96	102	96	102
E_s (MN·m)	0.58	0.51	0.55	0.48	0.61	0.54
$FS=(m_0gh-W_b)/E_s$	2,464	1,816	2,598	1,929	2,343	1,715

where,
m_0 = total mass of structure and basemat
g = acceleration due to gravity
h = height of the center of structure mass at the overturning position
W_b = potential energy caused by the effect of buoyancy
E_s = maximum kinetic energy
FS = Factor of Safety

Table B-3 Sliding Evaluation Results (RB/FB)

Building width in EW	49.0 m					
Building width in NS	70.0 m					
Total Weight	2648 MN	(including shear key and soil inside shear key above the sliding plane)				
Buoyancy	538 MN					
Soil Condition	LB		BE		UB	
	NS dir	EW dir	NS dir	EW dir	NS dir	EW dir
Time (sec)	38.635	41.270	39.075	41.065	43.090	24.945
Vertical Seismic Load (MN)	44	-8	387	157	136	223
Minimum Vertical Load (MN)	1802	1853	1459	1689	1710	1623
F_V: Horizontal Seismic Force (MN)	196	232	27	207	173	183
F_o: Soil Force due to TB (MN)	127	0	127	0	127	0
F_{ub}: Bottom Friction Force (MN)	1261	1297	1021	1182	1197	1136
F_r: Lateral Resistance Pressure (MN)	0	0	0	0	0	0
F_r' : at Shear Key (MN)	0	0	0	0	0	0
F_{us}: Side Friction at Basemat (MN)	0	0	0	0	0	0
F_{us}' : at Shear Key (MN)	0	0	0	0	0	0
$FS = (F_{ub}+F_r+F_{us}+F_r'+F_{us}')/(F_V+F_o)$	3.90	5.60	6.63	5.71	3.99	6.21

Note: The FS does not consider resistance contributions form F_{us}, F_{us}', F_r and F_r' for conservatism.

Table B-4 Sliding Evaluation Results (CB)

Building width in EW	23.8 m					
Building width in NS	30.3 m					
Total Weight	197 MN					
Buoyancy	77 MN					
Soil Condition	LB		BE		UB	
	NS dir	EW dir	NS dir	EW dir	NS dir	EW dir
Time (sec)	37.325	41.065	37.325	41.065	37.325	27.290
Vertical Seismic Load (MN)	14.4	8.0	14.3	8.0	14.7	-3.1
Minimum Vertical Load (MN)	86.0	92.3	86.0	92.3	85.6	103.4
F_V: Horizontal Seismic Force (MN)	21.6	19.4	22.4	20.4	23.2	24.5
F_{ub}: Bottom Friction Force (MN)	60.2	64.6	60.2	64.6	59.9	72.4
F_r: Lateral Resistance Pressure (MN)	0.0	0.0	0.0	0.0	0.0	0.0
F_{us}: Side Friction at Basemat (MN)	0.0	0.0	0.0	0.0	0.0	0.0
$FS = (F_{ub}+F_r+F_{us})/F_V$	2.78	3.34	2.69	3.16	2.59	2.95

Note: The FS does not consider resistance contributions form F_{us} and F_r for conservatism.

Table B-5 Floatation Evaluation Results (RB/FB)

Dead Load (F_{DL})	2,321 MN
NS	70.0 m
EW	49.0 m
Area	3,430 m^2
Max. Flood Level	0.3 m below design plant grade
Water Height	19.85 m
Buoyancy (F_B)	668 MN
$FS=F_{DL}/F_B$	3.48

Note: Maximum Flood Level is conservatively set at the Standard Plant Design Flood Level.

Table B-6 Floatation Evaluation Results (CB)

Dead Load (F_{DL})	192 MN
NS	30.3 m
EW	23.8 m
Area	721 m^2
Max. Flood Level	0.3 m below design plant grade
Water Height	14.75 m
Buoyancy (F_B)	104 MN
$FS=F_{DL}/F_B$	1.85

Note: Maximum Flood Level is conservatively set at the Standard Plant Design Flood Level.

Table B-7 Soil Bearing Pressures (RB/FB)

Building width X		70.0 m (NS)					
Building width Y		49.0 m (EW)					
Total Building Weight		2360 MN					
Buoyancy		538 MN					
Soil Condition		LB		BE		UB	
Vertical Seismic Load Direction		downward		downward		downward	
SASSI*	Time (sec)	41.755		41.010		41.730	
	Vertical seismic load (MN)	173.0		328.8		133.1	
	Total vertical load N (MN)	2,533		2,689		2,493	
	NS-dir moment Mx(MN-m)	8,278		819		9,540	
	EW-dir moment My (MN-m)	6,073		6,591		8,244	
	Soil pressure distribution	No tension		No tension		No tension	
Simplified Method **		EB	MEB	EB	MEB	EB	MEB
NS dir. ↓ EW dir.	Maximum basemat uplift ratio α (%)	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum basemat rotation ϕ (10^{-4} rad)	0.249	0.249	0.056	0.056	0.116	0.116
	Maximum basemat moment Mx (MN-m)	8,278	8,278	819	819	9,540	9,540
	Maximum soil pressure 1 Px (MPa)	0.95	0.95	0.80	0.80	0.97	0.97
	Maximum soil pressure 2 Py (MPa)	---	0.22	---	0.24	---	0.29
	Maximum soil pressure Pxy=Px+Py (MPa)	---	1.16	---	1.04	---	1.26
EW dir. ↓ NS dir.	Maximum basemat uplift ratio α (%)	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum basemat rotation ϕ (10^{-4} rad)	0.253	0.253	0.153	0.153	0.100	0.100
	Maximum basemat moment My (MN-m)	6,073	6,073	6,591	6,591	8,244	8,244
	Maximum soil pressure 1 Py (MPa)	0.96	0.96	1.02	1.02	1.02	1.02
	Maximum soil pressure 2 Px (MPa)	---	0.21	---	0.02	---	0.24
	Maximum soil pressure Pyx=Py+Px (MPa)	---	1.16	---	1.04	---	1.26
	Envelope of Pxy and Pyx (MPa)	---	1.16	---	1.04	---	1.26

Note *: SASSI2000 analysis is a linear time history analysis with the 3D excitation.

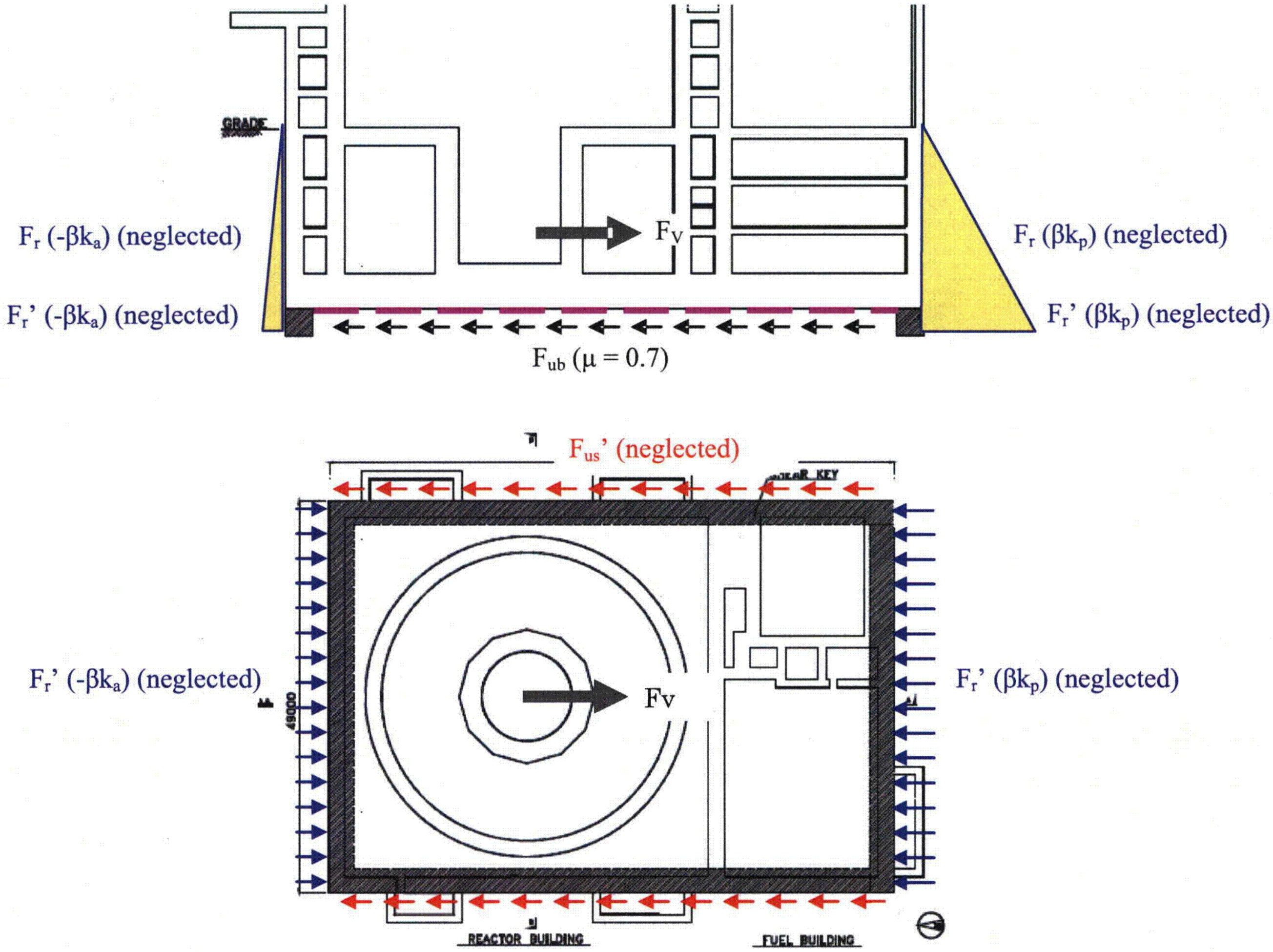
**: EB and MEB stand for energy balance and modified energy balance methods.

Table B-8 Soil Bearing Pressures (CB)

Building width X		30.3 m (NS)					
Building width Y		23.8 m (EW)					
Total Building Weight		197 MN					
Buoyancy		77 MN					
Soil Condition		LB		BE		UB	
Vertical Seismic Load Direction		downward		downward		downward	
SASSI*	Time (sec)	41.085		26.480		26.480	
	Vertical seismic load (MN)	15.9		27.4		28.7	
	Total vertical load N (MN)	213		224		226	
	NS-dir moment Mx(MN-m)	334		536		597	
	EW-dir moment My (MN-m)	302		169		179	
	Soil pressure distribution	No tension		No tension		No tension	
Simplified Method **		EB	MEB	EB	MEB	EB	MEB
NS dir. ↓ EW dir.	Maximum basemat uplift ratio α (%)	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum basemat rotation ϕ (10^{-4} rad)	0.039	0.039	0.040	0.040	0.116	0.116
	Maximum basemat moment Mx (MN-m)	334	334	536	536	597	597
	Maximum soil pressure 1 Px (MPa)	0.39	0.39	0.46	0.46	0.48	0.48
	Maximum soil pressure 2 Py (MPa)	---	0.11	---	0.06	---	0.06
	Maximum soil pressure Pxy=Px+Py (MPa)	---	0.49	---	0.52	---	0.54
EW dir. ↓ NS dir.	Maximum basemat uplift ratio α (%)	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum basemat rotation ϕ (10^{-4} rad)	0.047	0.047	0.033	0.033	0.022	0.022
	Maximum basemat moment My (MN-m)	302	302	169	169	179	179
	Maximum soil pressure 1 Py (MPa)	0.40	0.40	0.37	0.37	0.38	0.38
	Maximum soil pressure 2 Px (MPa)	---	0.09	---	0.15	---	0.16
	Maximum soil pressure Pyx=Py+Px (MPa)	---	0.49	---	0.52	---	0.54
	Envelope of Pxy and Pyx (MPa)	---	0.49	---	0.52	---	0.54

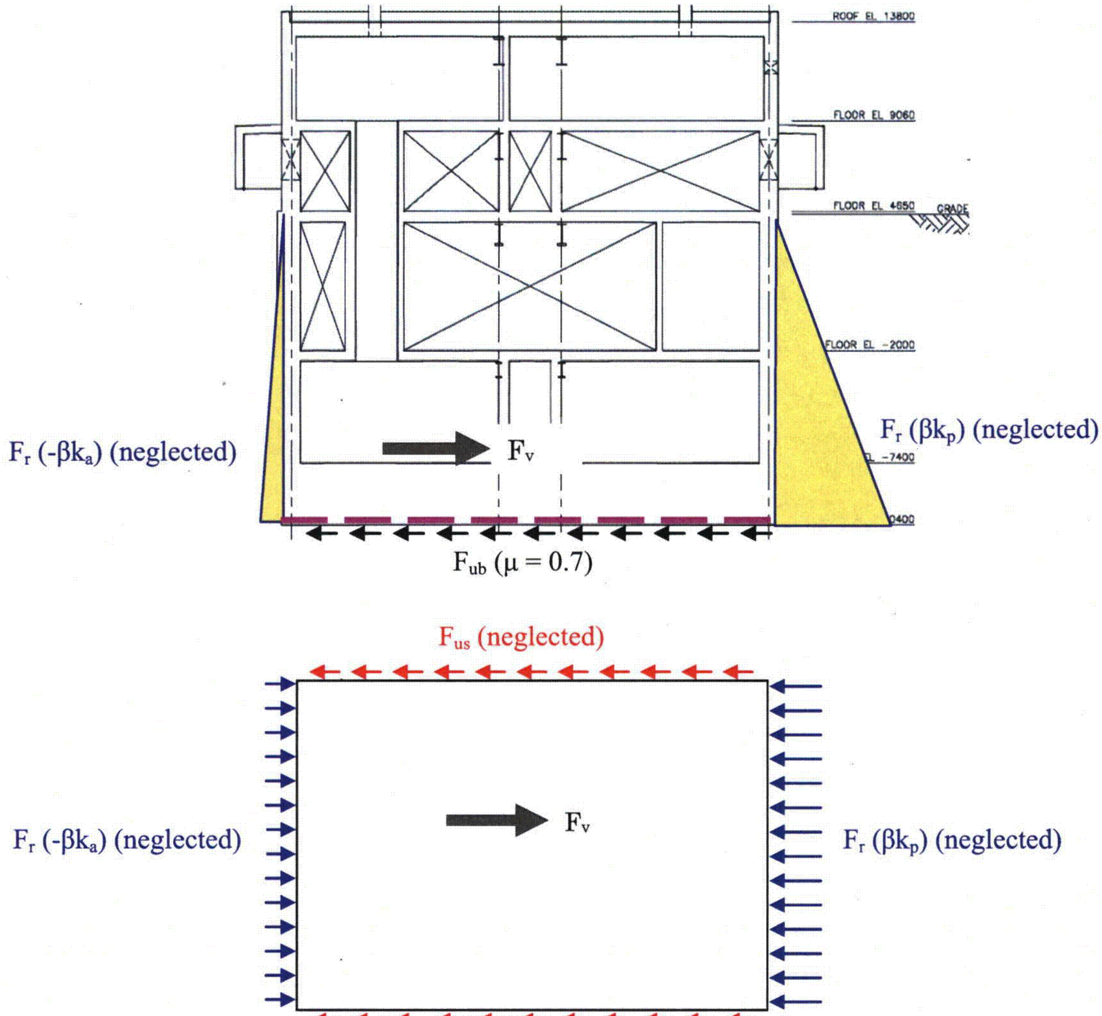
Note *: SASSI2000 analysis is a linear time history analysis with the 3D excitation.

**: EB and MEB stand for energy balance and modified energy balance methods.



Note: This is the plan view at the bottom of shear keys.

Figure B-1 Forces for RB/FB Sliding Evaluation



Note: This is the plan view at the basemat.

Figure B-2 Forces for CB Sliding Evaluation

Attachment 8
NRC3-12-0019
(52 pages)

SER-DTF-009, Rev. 0

Shimizu Engineering Report

Project	GE-Hitachi Nuclear Energy DTE Fermi 3 Project	Shimizu Document No.	SER-DTF-009
Title	Supplementary SSI Analysis Reports for the DTE Fermi 3 ESBWR	Rev.	0
		Issued Date	6/15/12
		Revised Date	

NOTE:

This document reports site-specific seismic Soil-Structure Interaction (SSI) analyses of the Control Building for the Detroit Edison Fermi 3 site conditions.

These analyses were performed to address the NRC RAIs 03.07.02-6, 03.07.02-7, 03.07.02-8, 03.08.05-2, 03.08.05-3, and 03.08.05-4.

TODI LC1-3-A25-TDI-0002, Revision 0
TODI LC1-3-A25-TDI-0003, Revision 1
TODI LC1-3-A25-TDI-0004, Revision 0
TODI LC1-3-A25-TDI-0005, Revision 0

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SHIMIZU CORPORATION

Prepared by	T. Hirotani	6/15/12
Reviewed by	N. Miura	6/15/12
Approved by	Y. Orito	6/15/12

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ESBWR	Economic Simplified Boiling Water Reactor
DCD	Design Control Document
FSAR	Final Safety Analysis Report
SRP	Standard Review Plan
RB/FB	Reactor Building/Fuel Building
CB	Control Building
CSDRS	Certified Seismic Design Response Spectra
FIRS	Foundation Input Response Spectra
SSE	Safe Shutdown Earthquake
OBE	Operating Basis Earthquake
BE	Best Estimate (subsurface condition)
LB	Lower Bound (subsurface condition)
UB	Upper Bound (subsurface condition)
SSI	Soil-Structure Interaction
SSSI	Structure-Soil-Structure Interaction
FRS	Floor Response Spectra
SRSS	Square Root of Sum of Squares
Sa	Spectral Acceleration
FWSC	Firewater Service Complex

1. INTRODUCTION AND PURPOSE

For the DTE Fermi 3 COLA Final Safety Analysis Report (FSAR), site-specific seismic soil-structure interaction (SSI) analyses using the SASSI2000 computer program were presented in References 2-a, 2-b, 2-c and 2-d for the ESBWR Reactor Building/Fuel Building (RB/FB) Complex, Control Building (CB), and Firewater Service Complex (FWSC) using the Fermi 3 site conditions.

In order to address the NRC RAIs 03.07.02-6, 03.07.02-7, 03.07.02-8, 03.08.05-2, 03.08.05-3 and 03.08.05-4, the supplementary SSI analyses were performed using the CB model with engineered granular backfill included and using the SASSI2000 direct method. This report provides the analysis results including the previously performed analyses to address the following issues:

1) Effect of structural damping values: Section 5.1

2) Confirmation of suitability of the SASSI2000 subtraction method:

a) Response spectra in adjacent nodes used to assess SSSI effects: Section 5.2

b) FRS and transfer function: Appendix A

c) Lateral soil pressures: Appendix A

3) Effect of backfill on transfer functions: Appendix B

4) Resultant lateral wall deflections Appendix C

2. REFERENCES

a. SER-DTF-003, DTE Fermi 3 ESBWR SSI Analysis using SASSI2000 Direct Method for Control Building, Rev. 1
b. SER-DTF-004, DTE Fermi 3 ESBWR SSI Analysis using SASSI2000 Direct Method for Reactor Building/Fuel Building, Rev. 1
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d. SER-DTF-008, Shimizu Response to NRC RAI 3.7.2-6, 3.7.2-8, and 3.8.5-4 item (c), Rev. 0
e. TODI LC1-3-A25-TDI-0002, Revision 0
f. TODI LC1-3-A25-TDI-0003, Revision 1
g. TODI LC1-3-A25-TDI-0004, Revision 0
h. TODI LC1-3-A25-TDI-0005, Revision 0
i. 26A6642, ESBWR Design Control Document
j. U73-5030(26A6648), Seismic Analysis of Control Building
k. NUREG/CR-6011 RD, RM

3. CONDITIONS

3.1 Site Conditions

The site-specific strain compatible dynamic subsurface properties based on the soil columns provided in References 2-f and 2-h are used, respectively for the elevation below the bedrock top (EL-6,870 mm) and the elevation within the engineered granular backfill (EL 4,500 mm through EL -6,870 mm). Only the best estimate (BE) subsurface properties were used for the SASSI2000 direct method analyses, and are provided in Table 3.1-1.

3.2 Input Motion

Three orthogonal ground motion time history components provided by Reference 2-f were used for the analyses. These ground motion time histories are the in-column motions at the foundation level, which are compatible with the outcrop FIRS. They are used directly in the Fermi 3 site-specific SSI analyses.

4. SOIL-STRUCTURE INTERACTION ANALYSIS

4.1 Analysis Method

The Fermi 3 site-specific SSI analysis follows the methodology presented in DCD Section 3A.5.2 but uses the direct method of the SASSI2000 computer program. The SASSI2000 program uses finite elements with complex moduli for modeling the structure and foundation properties and is based on the frequency domain complex response method. The lumped mass-beam model described in Reference 2-j and DCD Section 3A.5.1 is coupled with the finite element soil model using site-specific strain compatible dynamic subsurface properties in SASSI2000. The model details are described in Subsection 4.3 of this report. Structural responses in terms of accelerations, forces, and moments are computed directly. Floor response spectra are obtained from the calculated response acceleration time histories.

The SSI analyses for the three directional ground motion time history components are performed separately. The maximum co-directional responses for each of the three ground motion time history components are combined using the algebraic sum in the time domain considering both plus and minus directions.

In the seismic analysis, using the complex response method in the frequency domain, material damping can be included in the formulation of the complex stiffness matrix as indicated in the following equation:

$$\left[k_j^*\right] = \left[k_j\right]\left(1 + 2i\lambda_j\right) \qquad \text{(Equation 3.7-16 of DCD)}$$

where

$[k_j^*]$ = complex stiffness matrix of element j
$[k_j]$ = stiffness matrix of element j
λ_j = material damping ratio of element j
i = $\sqrt{-1}$

4.2 Soil-Structure Interaction Analysis Cases

The site-specific SSI analyses cases are summarized in Tables 4.2-1. The engineered granular backfill properties are considered in all the cases. The 7% structural damping ratio is applied to Cases CFB1a and CFB1c, and the 4% structural damping ratio is applied to Case CFB1b. The direct method of the SASSI2000 computer program is used for Cases CFB1a and CFB1b and the subtraction method is used for Case CFB1c.

4.3 Analysis Model

The analysis model is the three-dimensional lumped mass-beam model used in the DCD, which considers shear, bending, torsion and axial deformations. For the CB, the structural elements are modeled as one set of stick models considering vertical and horizontal eccentricity.

The exterior walls below grade and the foundation basemat are modeled using plate elements in the same manner as for the DCD SSI analysis model. However, the vertical spacing of the wall nodes is adjusted for a closer match with the site-specific subsurface layers.

The geometry of the excavated volume for the CB SASSI2000 analyses is shown in Figures 4.3-1 through 4.3-3. The excavated volume is modeled from the grade level (EL 4,500 mm) to the bottom of the mat foundation (EL -10,400 mm). The maximum mesh height in the excavated bedrock is 1.0 m. The shear wave velocity of the bedrock is 2,040 m/s for the BE soil profile; therefore, the highest frequency for the bedrock, f_n, is 2,040/1.0/5= 408 Hz. The maximum mesh height in the excavated engineering granular backfill is 1.5 m. The shear wave velocity of the engineering backfill is 240 m/s for the BE soil profile; therefore, the highest frequency for the engineered granular backfill, f_n, is 240/1.5/5= 31 Hz, which is less than the highest frequency of interest, 50 Hz. This is because the limitation of number of the elements in the program. Because the input motion is propagating vertically, the input energy entering near the base is evaluated correctly up to the high frequency range, while the input energy entering through the backfill above the bedrock may be calculated less accurately in the higher frequency. However, since the dominant frequency of the backfill above the bedrock is estimated to be about $f = Vs/(4h) = 240/4/11.3 = 5.3$ Hz, the higher frequency range of input motion energy will be reduced in nature. Therefore, the current mesh heights for the backfill are also considered to be adequate for this confirmatory analysis/sensitivity study.

Since the input energy is vertically propagating and enters near the base, the horizontal spacing is less important. The typical mesh size in the excavated bedrock is 1 m by 4 m with an aspect ratio 1(vertical):4(horizontal). The highest frequencies, f_n, are 408 Hz vertically and 2,040/4/5 = 102 Hz horizontally. Therefore, the DCD mesh sensitivity study (for the excavated volume) provided by GEH in MFN 06.252 Dated September 13.2006 (ML0627202441) can be applied to the Fermi site-specific conditions.

The CB stick model is connected to the basemat and side walls at floor EL -7,400 mm, -2,000 mm, and 4,500 mm by a set of rigid links. At the base of the model (EL -7,400 mm), a rigid link is used to connect the stick model to the center of the basemat.

The analysis model X- and Y-directions represent plant NS and EW directions of the Fermi 3 site, respectively. The Z-direction represents the vertical direction.

5. ANALYSIS RESULTS

5.1 Study of the Effect of Structural Damping Ratios

The 7% structural damping ratio was used for all the analyses presented in References 2-a, 2-b, 2-c and 2-d. To confirm the suitability of applying the 7% structural damping ratio to all the analyses, the study presented herein was performed. According to Reference 2-k, when the input motions are on the same level with the safe shutdown earthquake (SSE), the 7% structural damping ratio can be applied. However, if the input motions are smaller than 1/2 of the SSE or operating bases earthquake (OBE), the 4% structural damping has to be applied.

To study the suitability of applying the 7% structural damping ratio for buildings at the Fermi 3 in the SSI analyses using the SASSI2000 computer program, Cases CFB1a and CFB1b listed in Table 4.2-1 were performed. The 7% and 4% structural damping ratios were used for Cases CFB1a and CFB1b, respectively. The SASSI direct method was used for both analysis cases.

For comparison, the floor response spectra at 5% damping ratio are shown for the following locations on Figures 5.1-1 through 5.1-3:

Location	Node Number
CB Top	6
CB Basemat	2

The calculated co-directional floor response spectra (FRS) in the X-, Y-, and Z-directions are combined using the square root of sum of square (SRSS) method to obtain FRS at the building edges. The FRS were calculated considering the coupling effects between vertical and rocking, and between lateral and torsional motions. The moment arm lengths for the calculation of the CB are listed in Table 5.1-1.

The FRS at the locations listed above are shown in Figures 5.1-1 through 5.1-3, comparing between Cases CFB1a and CFB1b along with the DCD design spectra.

The Fermi 3 FRS on Figures 5.1-1 through 5.1-3 demonstrate that there are no so significant differences between the results using the 7% and 4% structural damping ratios. It is considered that the difference of the structural damping ratio does not significantly impact the FRS, because of the effect of the large radiation damping of SSI. The FRS for both cases are enveloped by the DCD design spectra.

The results of seismic forces for the CB stick members are shown in Tables 5.1-2 and 5.1-3, respectively for the 7% (CFB1a) and 4% (CFB1b) structural damping ratios. The results of maximum absolute accelerations are shown in Tables 5.1-4 and 5.1-5, respectively for the 7% (CFB1a) and 4% (CFB1b) structural damping ratios. These results are compared with the design envelopes specified in DCD Section 3A.9.

As shown on Tables 5.1-2 and 5.1-3, the largest ratios of site-specific seismic forces compared with the DCD seismic forces are 59% for the 7% structural damping ratio (CFB1a) and 60% for the 4% structural damping ratio (CFB1b). In terms of absolute accelerations, the largest ratios of site-specific acceleration compared with the DCD are 57% for the 7% structural damping ratio (CFB1a) and 86% for the 4% structural damping ratio (CFB1b). Both seismic forces and absolute accelerations are enveloped by the DCD design values.

From the results of this study, the SSI analysis results of other cases for the CB and RB/FB performed in Reference 2-a, 2-b, 2-c and 2-d are not impacted significantly by using either the 7% or 4% structural damping ratios.

5.2 Response Spectra in Adjacent Nodes used to assess SSSI effects

To confirm the suitability of using the SASSI2000 subtraction method for the analyses to obtain seismic responses of a soil point adjacent to a building, which are used to assess SSSI effects, an additional analysis case named Case CFB1c was performed and compared with Case CFB1a. The SASSI2000 direct and subtraction methods were used for Cases CFB1a and CFB1c, respectively.

Figure 5.2-1 shows the response spectra for the direct (CFB1a) and subtraction (CFB1c) methods at a point on top of the bedrock at the center of the FWSC. The response spectra for the direct (CFB1a) and subtraction (CFB1c) methods agree very well.

Figure 5.2-2 shows the transfer functions for the direct (CFB1a) and subtraction (CFB1c) methods for the same point plotted on Figure 5.2-1. The transfer functions are plotted with computed values and interpolated values.

The transfer functions for the direct (CFB1a) and subtraction (CFB1c) methods on Figure 5.2-2 agree well up to 30 Hz, with some minor variations just above 20 Hz. However, the response spectra on Figure 5.2-1 do not show significant differences between the direct (CFB1a) and subtraction (CFB1c) methods at the same frequency band.

Therefore, use of the SASSI2000 direct or subtraction analysis methods does not affect significantly the response spectra in adjacent nodes used to assess SSSI effects.

Table 3.1-1 Site-Specific Strain Compatible Dynamic Subsurface Properties – Best Estimate (BE) Soil Profile

Layer	Thickness (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation at Top of Layer (ft)
1	2.9	132.5	557	2.73	1028	589.0
2	2.9	132.5	588	4.19	1148	586.1
3	4.2	132.5	622	5.09	1291	583.2
4	3.2	132.5	663	5.49	1422	579.0
5	2.6	132.5	680	5.87	5000	575.8
6	4.3	132.5	702	6.08	5000	573.2
7	5	132.5	750	4.39	5000	568.9
8	4.9	132.5	772	4.54	5000	563.9
9	7	132.5	795	4.56	5000	559.0
1	10	150.0	6689	0.95	13202	552.0
2	2	150.0	6592	0.95	13202	542.0
3	8	150.0	6592	0.95	13202	540.0*
4	8	150.0	6745	0.95	13202	532.0
5	2	150.0	6745	0.95	13202	524.0*
6	10.2	150.0	6825	0.95	13202	522.0
7	11	150.0	6790	0.95	13202	511.8
8	11.9	150.0	6853	0.95	13202	500.8
9	11.7	150.0	6609	0.95	13202	488.9
10	15	150.0	4752	1.37	9835	477.2
11	20	150.0	3309	1.91	7889	462.2
12	19.9	150.0	3252	1.91	7889	442.2
13	19.9	150.0	3235	1.91	7889	422.3
14	21.3	150.0	3218	1.91	7889	402.4
15	21.1	150.0	4072	1.91	9537	381.1
16	21.1	150.0	4132	1.91	9537	360.0
17	9.9	150.0	5650	0.73	10477	338.9
18	19.7	150.0	9523	0.73	17679	329.0
19	21	150.0	9439	0.73	17679	309.3
20	20.5	150.0	9525	0.73	17679	288.3
21	22.1	150.0	9491	0.73	17679	267.8
22	45	160.0	8943	0.73	16282	245.7
23	44.6	160.0	9049	0.73	16282	200.7
24	Half Space	169.0	9494	0.10	17100	156.1

* : The layers at the building basemat are adjusted to match the ESBWR DCD (Reference 2-i), per Reference 2-g.

CB : 540.0ft → 540.4ft (EL-10.4m)

The randomization process of profile development allows for such adjustments.

Table 4.2-1 CB SSI Analysis Cases

Building	Case	SASSI2000 Analyis Method		Engineered Backfill		Bedrock Properties		Input Motions		Structural Damping	
		Subtraction	Direct	Neglect	Consider*1	TDI-0002*2	TDI-0003*3	TDI-0002*2	TDI-0003*3	7%	4%
CB	CFB1a		X		X		X		X	X	
	CFB1b		X		X		X		X		X
	CFB1c	X			X		X		X	X	

Note: *1: Engineered granular backfill properties are based on TODI LC1-3-A25-TDI-0005, Rev. 0.
*2: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0002, Rev. 0.
*3: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0003, Rev. 1.

Table 5.1-1 Moment Arm Length for CB

Elevation (m)	Node No.	Arm Length (m) X	Arm Length (m) Y
13.80	6	15.26	12.26
9.06	5	15.21	12.06
4.65	4	15.30	12.26
-2.00	3	15.34	12.24
-7.40	2	15.21	12.03
-10.40	1	15.29	12.13

Table 5.1-2 Ratio with DCD Enveloping Seismic Loads: CB Stick – 7% Damping (Case CFB1a)

(a) Enveloping Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				26	27	
		6	8.7	8.6	60	57	5.6
9.06	5				82	75	
		5	15.6	15.7	145	132	12.3
4.65	4				91	48	
		4	31.4	31.6	286	252	9.7
-2.00	3				171	191	
-7.40	2	3	54.9	58.7	465	481	11.1

(b) Ratio with DCD ((a)/DCD Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				16%	22%	
		6	26%	30%	24%	29%	8%
9.06	5				23%	27%	
		5	29%	29%	25%	30%	10%
4.65	4				13%	9%	
		4	42%	39%	25%	25%	5%
-2.00	3				14%	18%	
-7.40	2	3	44%	59%	30%	32%	4%

Note: Total torsional moments are obtained by the absolute sum of the accidental torsional moments and the values of the geometric torsional moments shown. The accidental torsional moment is the product of the horizontal force component and an eccentricity of 5% of the larger horizontal dimension at various elevations.

Table 5.1-3 Ratio with DCD Enveloping Seismic Loads: CB Stick – 4% Damping (Case CFB1b)

(a) Enveloping Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear		Moment		Torsion
			X-Dir. (MN)	Y-Dir. (MN)	X-Dir. (MN-m)	Y-Dir. (MN-m)	(MN-m)
13.80	6				33	30	
		6	9.5	9.9	67	65	6.2
9.06	5				90	80	
		5	17.3	17.7	162	148	13.7
4.65	4				99	55	
		4	32.3	32.6	299	264	11.1
-2.00	3				188	205	
-7.40	2	3	55.8	59.7	476	491	12.7

(b) Ratio with DCD ((a)/DCD Loads)

Elev. (m)	Node No.	Elem No.	Shear		Moment		Torsion
			X-Dir. (MN)	Y-Dir. (MN)	X-Dir. (MN-m)	Y-Dir. (MN-m)	(MN-m)
13.80	6				20%	24%	
		6	29%	34%	27%	33%	8%
9.06	5				25%	29%	
		5	32%	32%	28%	33%	11%
4.65	4				14%	10%	
		4	43%	41%	26%	27%	6%
-2.00	3				15%	20%	
-7.40	2	3	45%	60%	30%	32%	5%

Note: Total torsional moments are obtained by the absolute sum of the accidental torsional moments and the values of the geometric torsional moments shown. The accidental torsional moment is the product of the horizontal force component and an eccentricity of 5% of the larger horizontal dimension at various elevations.

Table 5.1-4 Ratio with DCD Enveloping Maximum Vertical Acceleration: 7% Damping (Case CFB1a)

(a) Enveloping Maximum Vertical Acceleration

Elevation (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Max. Vertical Acceleration (g)
13.80	6	CB	0.33	0.33	0.39
9.06	5	CB	0.26	0.26	0.37
4.65	4	CB	0.23	0.22	0.33
-2.00	3	CB	0.20	0.19	0.26
-7.40	2	CB	0.21	0.17	0.23
-10.40	1	CB	0.20	0.18	0.23
13.80	9001	Oscillator	---	---	1.09
	9002	Oscillator	---	---	0.65
	9003	Oscillator	---	---	0.82
9.06	9101	Oscillator	---	---	0.85
	9102	Oscillator	---	---	0.64
	9103	Oscillator	---	---	0.77
4.65	9201	Oscillator	---	---	0.54
	9202	Oscillator	---	---	0.79
-2.00	9301	Oscillator	---	---	0.73

Note: For structural design use only. Unit: g

(b) Ratio with DCD ((a)/DCD Acceleration)

Elevation (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Max. Vertical Acceleration (g)
13.80	6	CB	26%	30%	39%
9.06	5	CB	29%	29%	43%
4.65	4	CB	27%	27%	45%
-2.00	3	CB	25%	27%	46%
-7.40	2	CB	39%	32%	45%
-10.40	1	CB	37%	34%	45%
13.80	9001	Oscillator	---	---	50%
	9002	Oscillator	---	---	49%
	9003	Oscillator	---	---	57%
9.06	9101	Oscillator	---	---	43%
	9102	Oscillator	---	---	51%
	9103	Oscillator	---	---	54%
4.65	9201	Oscillator	---	---	41%
	9202	Oscillator	---	---	55%
-2.00	9301	Oscillator	---	---	53%

Table 5.1-5 Ratio with DCD Enveloping Maximum Vertical Acceleration: 4% Damping (Case CFB1b)

(a) Enveloping Maximum Vertical Acceleration

Elevation (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Max. Vertical Acceleration (g)
13.80	6	CB	0.36	0.38	0.46
9.06	5	CB	0.28	0.31	0.43
4.65	4	CB	0.24	0.24	0.38
-2.00	3	CB	0.21	0.21	0.24
-7.40	2	CB	0.20	0.18	0.23
-10.40	1	CB	0.20	0.18	0.22
13.80	9001	Oscillator	---	---	1.41
	9002	Oscillator	---	---	0.77
	9003	Oscillator	---	---	1.23
9.06	9101	Oscillator	---	---	1.06
	9102	Oscillator	---	---	0.78
	9103	Oscillator	---	---	1.01
4.65	9201	Oscillator	---	---	0.62
	9202	Oscillator	---	---	1.07
-2.00	9301	Oscillator	---	---	0.81

Note: For structural design use only. Unit: g

(b) Ratio with DCD ((a)/DCD Acceleration)

Elevation (m)	Node No.	Stick Model	X-dir. (g)	Y-dir. (g)	Max. Vertical Acceleration (g)
13.80	6	CB	29%	34%	46%
9.06	5	CB	32%	34%	50%
4.65	4	CB	28%	29%	51%
-2.00	3	CB	27%	30%	43%
-7.40	2	CB	37%	33%	45%
-10.40	1	CB	37%	34%	43%
13.80	9001	Oscillator	---	---	64%
	9002	Oscillator	---	---	58%
	9003	Oscillator	---	---	86%
9.06	9101	Oscillator	---	---	53%
	9102	Oscillator	---	---	62%
	9103	Oscillator	---	---	71%
4.65	9201	Oscillator	---	---	48%
	9202	Oscillator	---	---	75%
-2.00	9301	Oscillator	---	---	58%

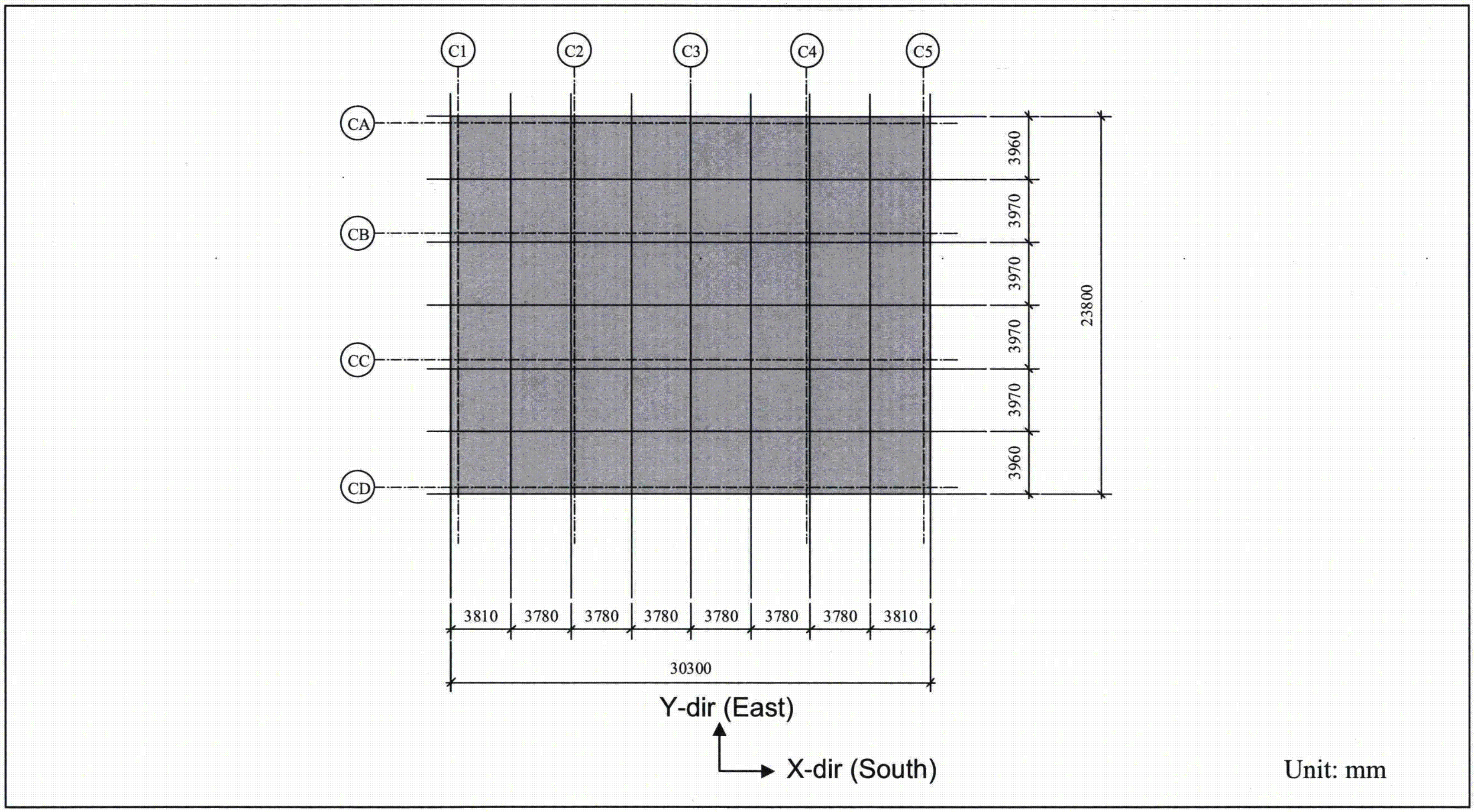
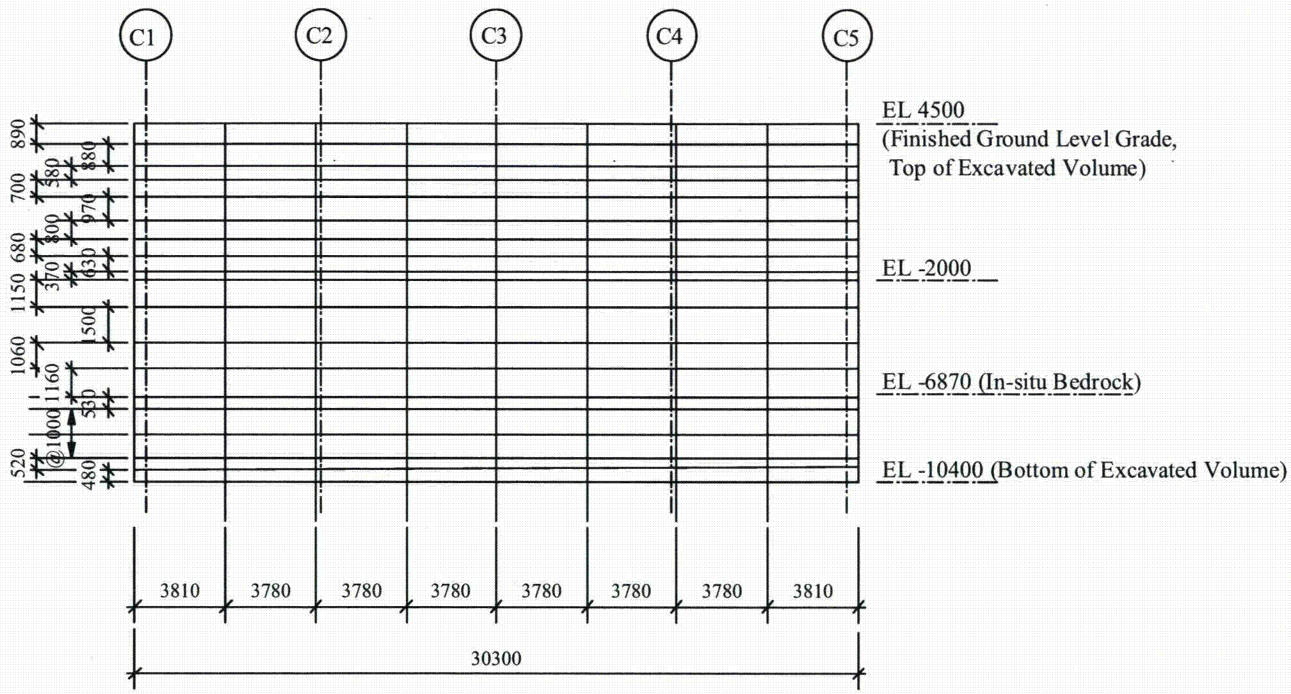


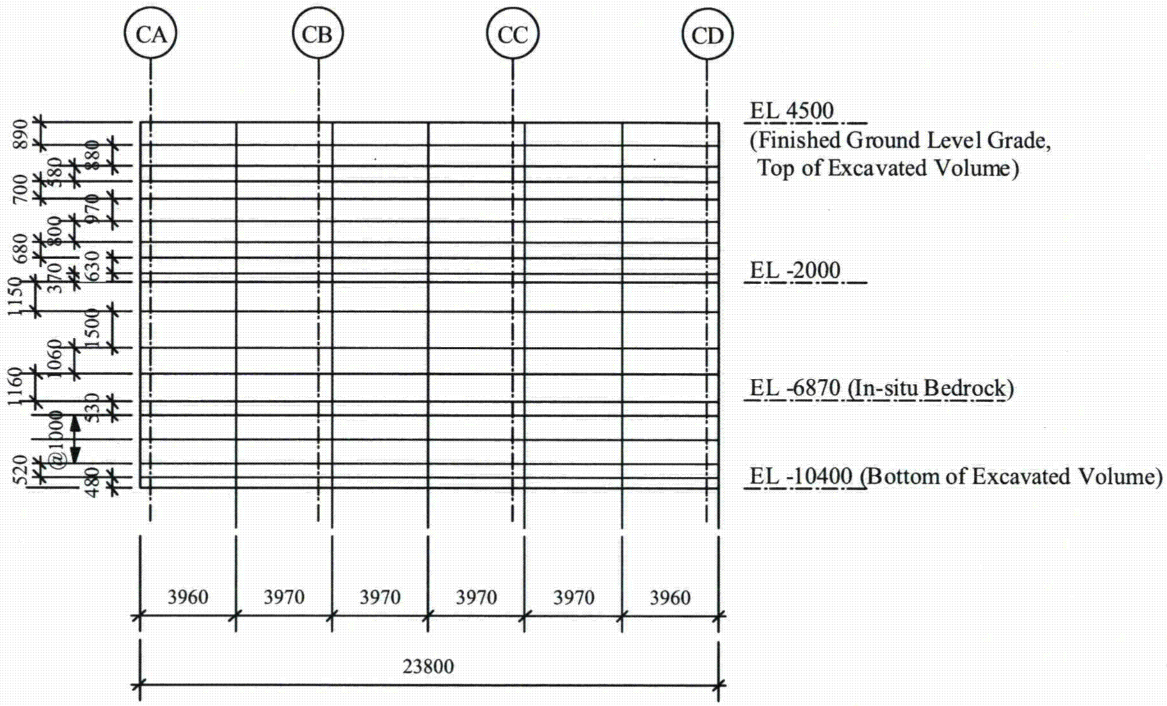
Figure 4.3-1 SASSI2000 Plate Elements for CB Basemat



(a) Walls on Column Rows CA and CD

Unit: mm

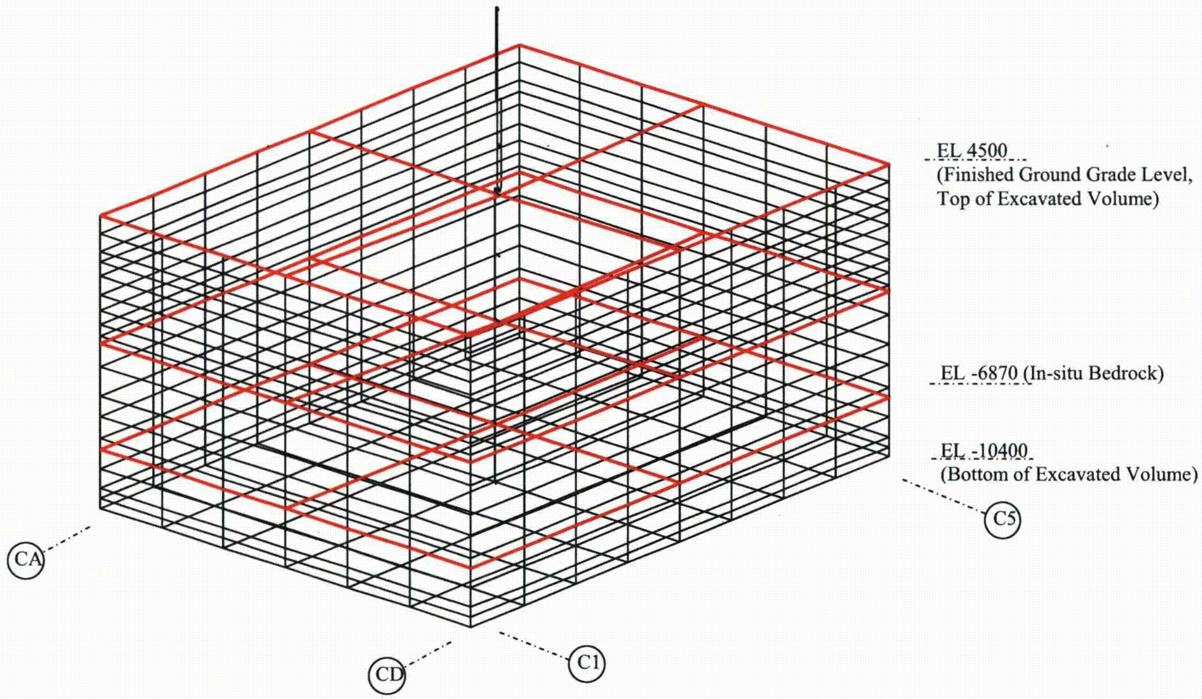
Figure 4.3-2 SASSI2000 Plate Elements for CB Exterior Walls



(b) Walls on Column Rows C1 and C5

Unit: mm

Figure 4.3-2 SASSI2000 Plate Elements for CB Exterior Walls (Continued)



Note: 1) Wall and basemat are modeled with shell element without mass.
2) Rigid beams indicated in red are installed at the floor levels.

Unit: mm

Figure 4.3-3 Overview of CB SASSI2000 SSI Model

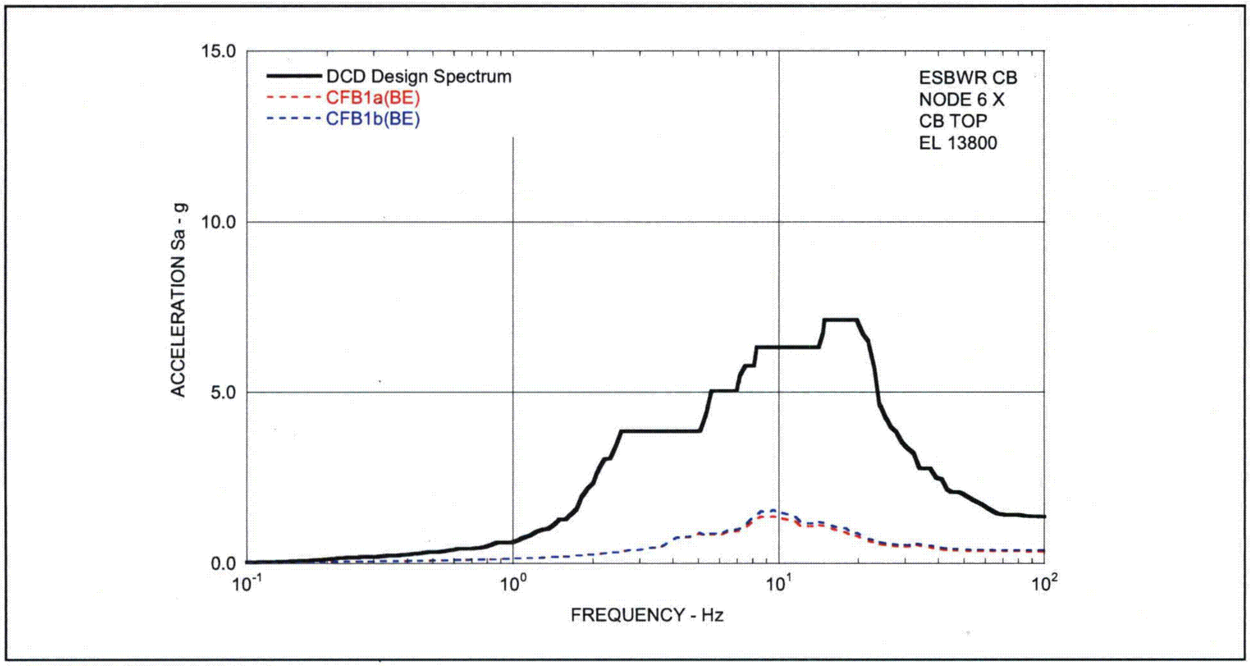


Figure 5.1-1a Comparison of Floor Response Spectra - CB Top in X-Direction

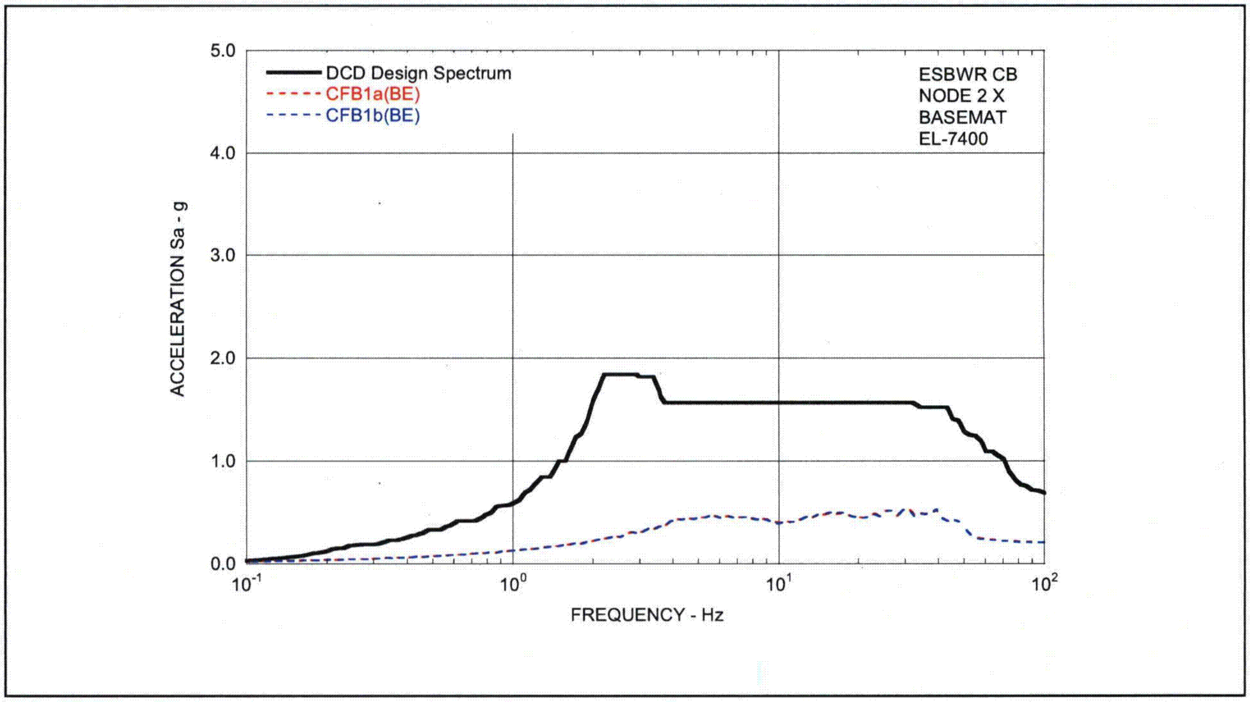


Figure 5.1-1b Comparison of Floor Response Spectra - CB Basemat in X-Direction

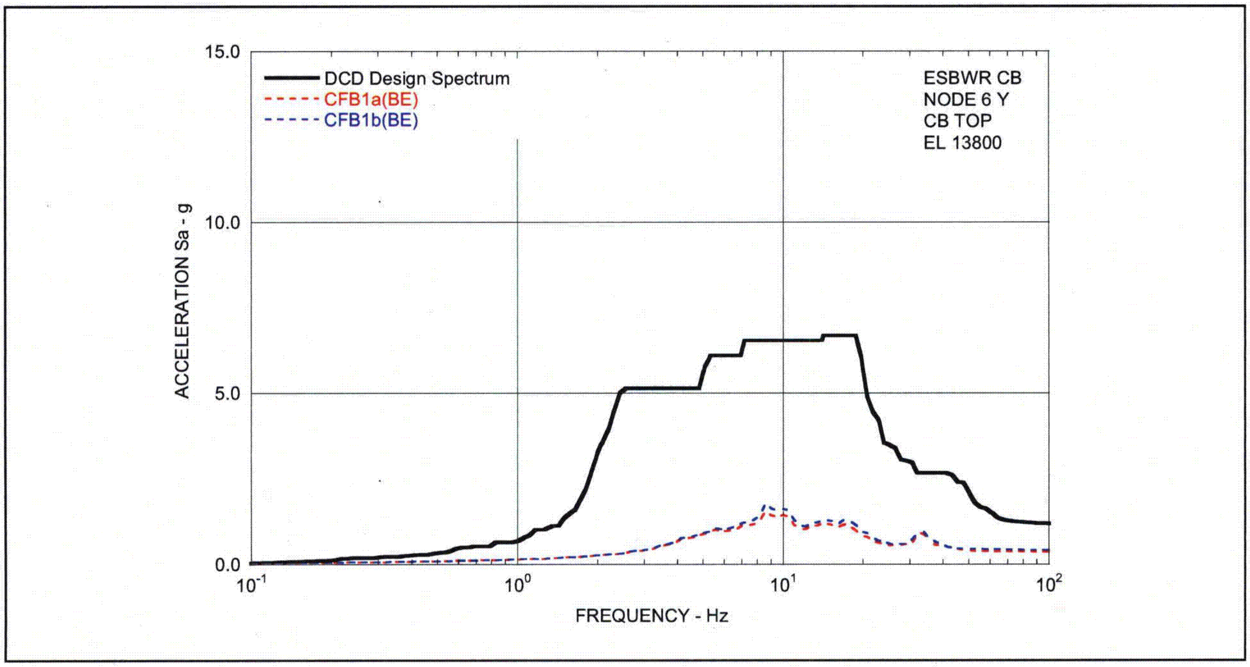


Figure 5.1-2a Comparison of Floor Response Spectra - CB Top in Y-Direction

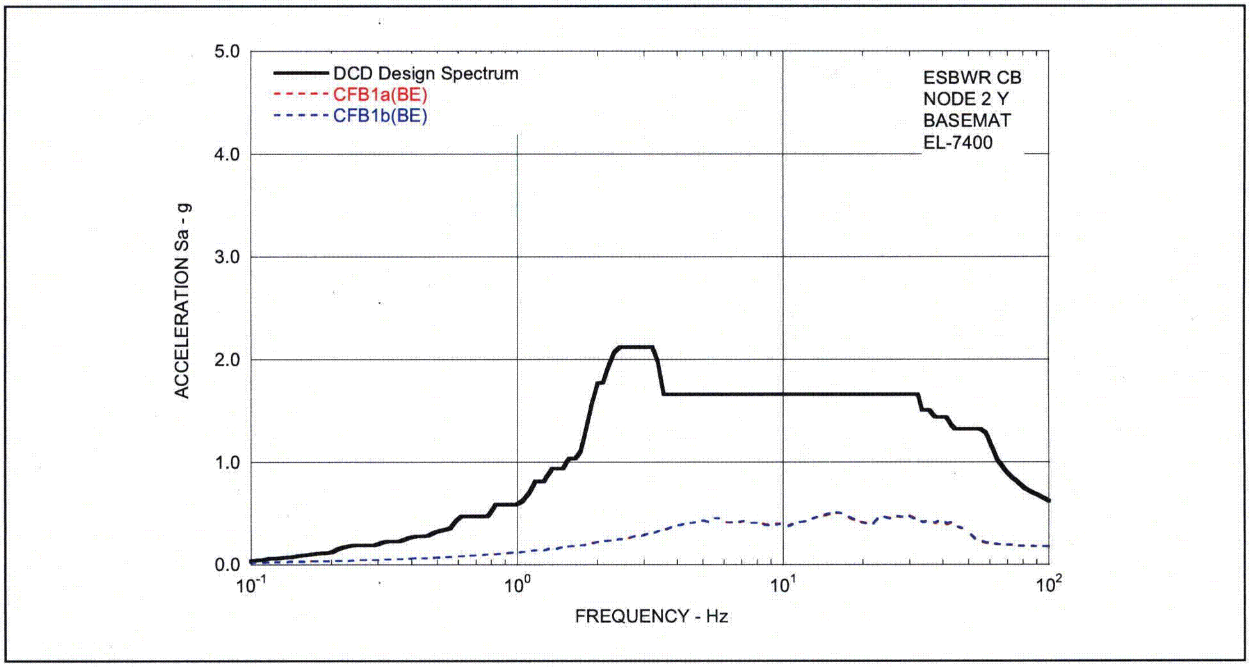


Figure 5.1-2b Comparison of Floor Response Spectra - CB Basemat in Y-Direction

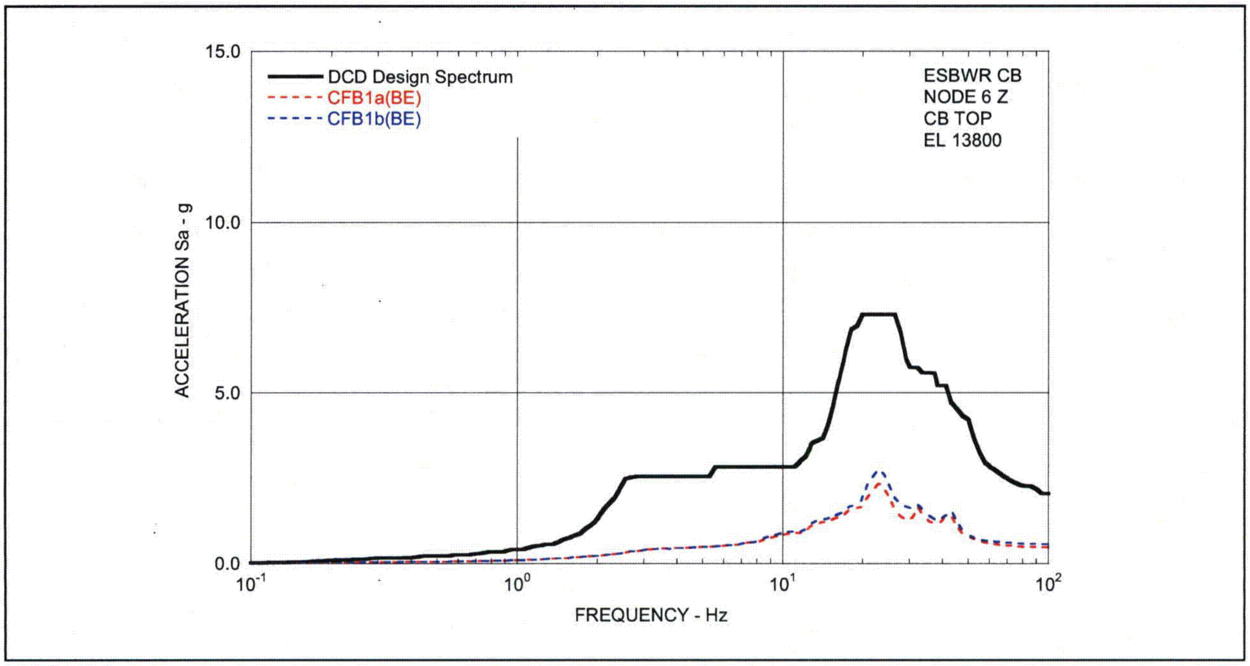


Figure 5.1-3a Comparison of Floor Response Spectra - CB Top in Z-Direction

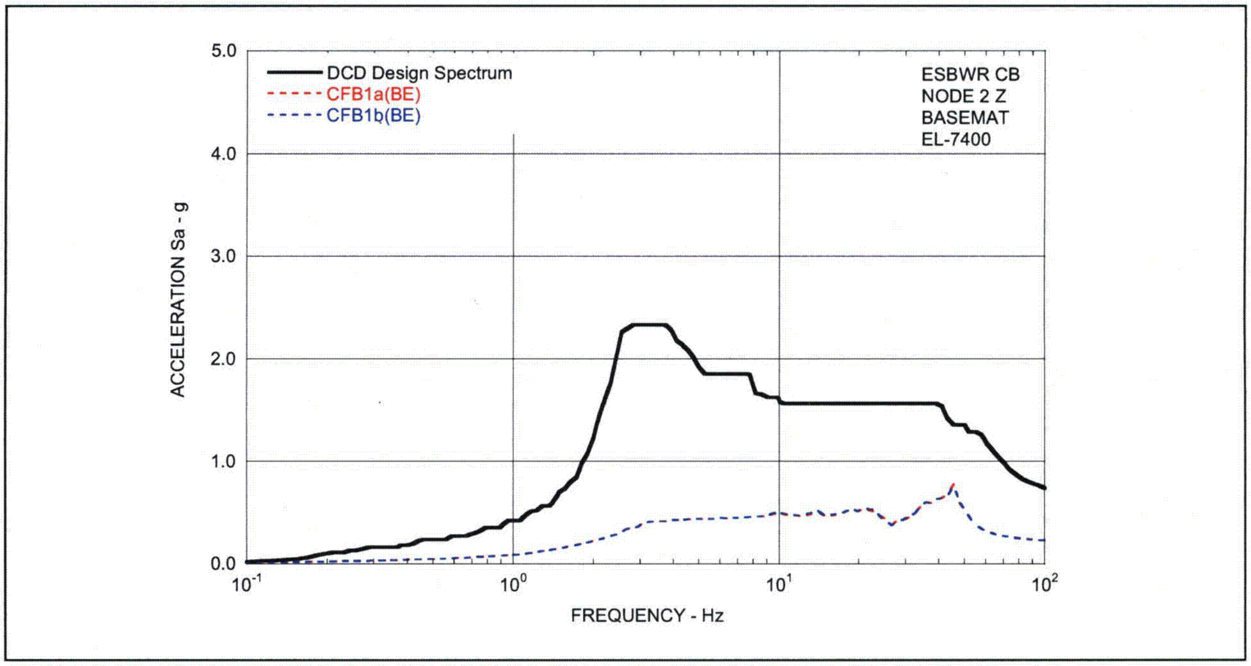


Figure 5.1-3b Comparison of Floor Response Spectra - CB Basemat in Z-Direction

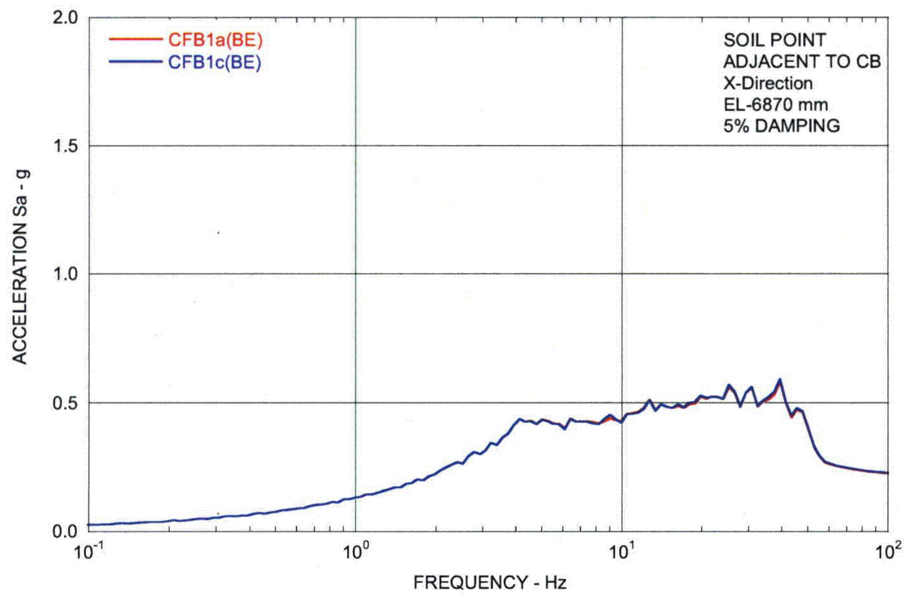


Figure 5.2-1a Comparison of Point Response Spectra – Center of FWSC in X-Direction

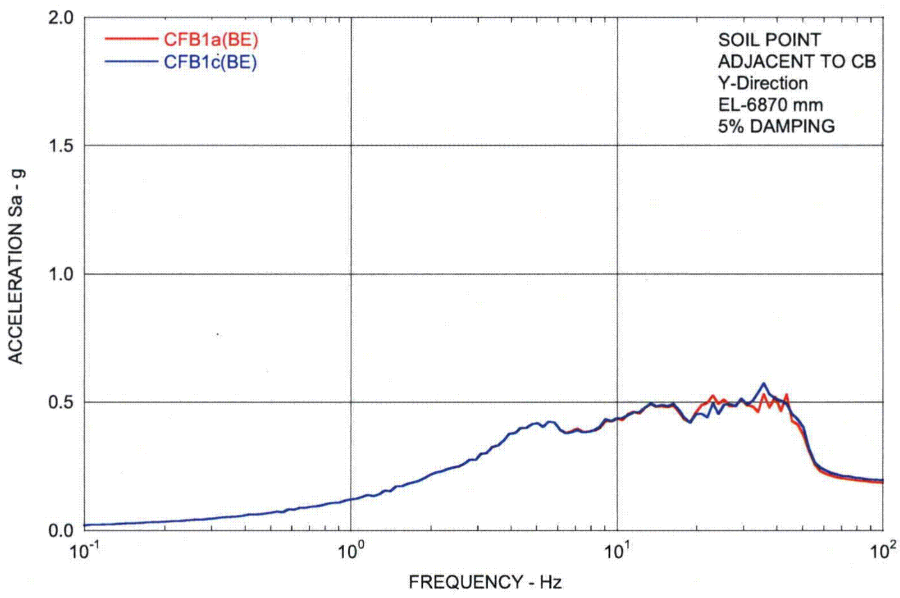


Figure 5.2-1b Comparison of Point Response Spectra – Center of FWSC in Y-Direction

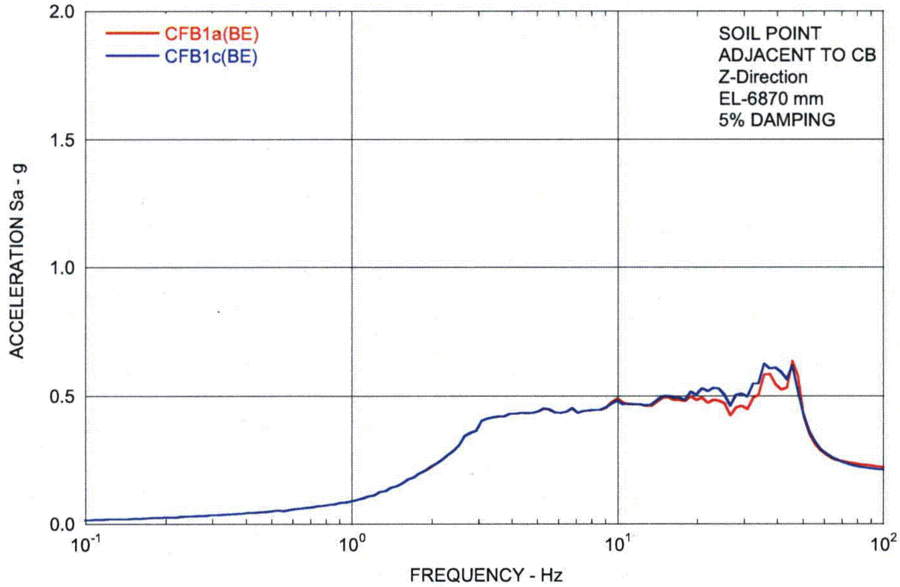
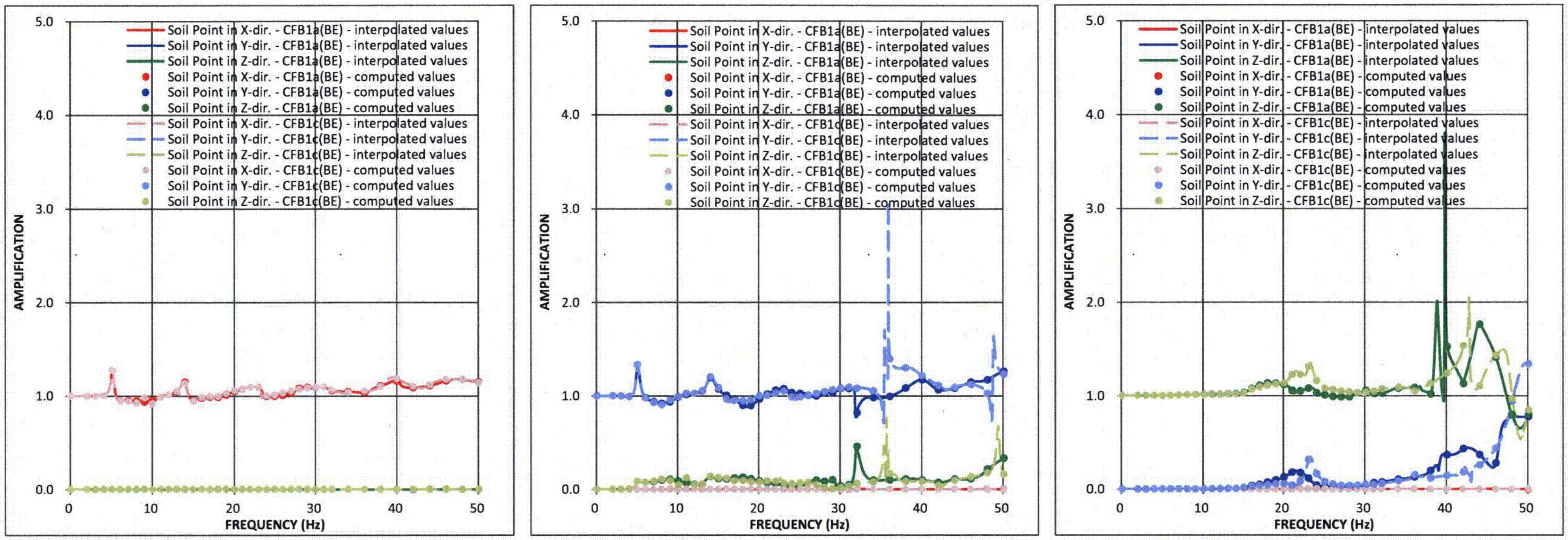


Figure 5.2-1c Comparison of Point Response Spectra – Center of FWSC in Z-Direction



(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure 5.2-2 Transfer functions - Point Center of FWSC - Comparison between SASSI2000 Direct (CFB1a) and Subtraction (CFB1c) Methods

APPENDIX A Confirmation of Subtraction Method

The site-specific SSI analysis cases are summarized in Table A-1. Case CFB1a is performed using the SASSI2000 direct method for this report. Case CFB1 was performed in Reference 2-d using the SASSI2000 subtraction method. These analysis cases use different bedrock properties and input motions.

Figures A-1 through A-3 show comparisons of FRS with the DCD design spectra for the direct (CFB1a) and subtraction (CFB1) methods at the following locations:

Location	Node Number
CB Top	6
CB Basemat	2

Figures A-1 through A-3 demonstrate that there are no significant differences between FRS of the direct (CFB1a) and subtraction (CFB1) methods, and that both response spectra are enveloped by the DCD design spectra.

Figure A-4 shows the transfer functions for the direct (CFB1a) and subtraction (CFB1) methods at the locations listed above. The transfer functions are plotted with computed values and interpolated values.

There are some differences in the transfer functions between the direct and subtraction methods. For example, there is a single peak near 10 Hz in the CB top transfer function obtained by the direct method (CFB1a) for both X-direction and Y-direction inputs. This peak is divided into two peaks in the transfer function obtained by the subtraction method (CFB1). In addition, in the X-direction input transfer function, one of the peaks at the higher frequency is considerably increased due to the spike, which is generated from the interpolation process of SASSI2000 computer program. This spike is not real transfer function.

Even if the peaks near 10 Hz have different shapes, the FRS in Y-direction is almost same for both methods, as seen in Figure A-2a. On the other hand, the FRS in X-direction has a minimal effect of the spike in the transfer function, as seen in Figure A-1a. However, the FRS would be even more similar, if the transfer function did not have the spike. Therefore, the FRS are essentially the same and still well below the DCD values.

The lateral soil pressures obtained by the SASSI2000 direct method are plotted on Figures A-5 for Case CFB1a along with the lateral soil pressures for the subtraction method (CFB1). These pressures are compared with the lateral soil pressures computed from the equivalent static pressure analysis listed in ASCE 4-98.

The lateral soil pressure loads for the exterior walls are calculated by averaging the lateral soil pressures from the SASSI2000 model for each wall. The calculated lateral soil pressures

for the SASSI2000 direct method (CFB1a) are provided in Table A-2, along with the DCD design soil pressures.

The SASSI2000 soil pressures for both the direct method (CFB1a) and the subtraction method (CFB1) are generally bounded by the ASCE 4-98 soil pressures; however, at the elevation close to the engineered granular backfill to bedrock transition (EL -6,870 mm), the SASSI2000 soil pressures exceed the ASCE 4-98 soil pressures. However, when evaluated using the averaged soil pressure for both the methods shown in Table A-2, the SASSI2000 lateral soil pressures are confirmed to be less than the DCD design soil pressures.

Figure A-5 shows that SASSI2000 direct method (CFB1a) lateral soil pressures are similar in trend and magnitude to the subtraction method (CFB1) lateral soil pressures, but that the lateral soil pressures for the two methods do not correspond exactly. The variations are not only due to the difference of the two methods, but also including the effect of the difference of the input motions and the subsurface properties.

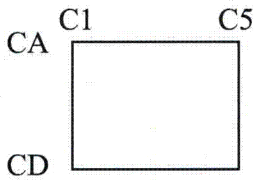
Table A-1 CB SSI Analysis Cases

Building	Case	Reference Report	SASSI2000 Analyis Method		Engineered Backfill		Bedrock Properties		Input Motions		Structural Damping	
			Subtraction	Direct	Neglect	Consider*1	TDI-0002*2	TDI-0003*3	TDI-0002*2	TDI-0003*3	7%	4%
CB	CFB1a			X		X		X		X	X	
	CFB1	SER-DTF-008*4	X			X	X		X		X	

Note: *1: Engineered granular backfill properties are based on TODI LC1-3-A25-TDI-0005, Rev. 0.
*2: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0002, Rev. 0.
*3: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0003, Rev. 1.
*4: The analysis case was described in reference report. (Reference 2-d)

Table A-2 Comparison of Lateral Soil Pressure – CB – SASSI2000 Direct Method (CFB1a)

Floor Level (m)	Averaged Soil Pressure (MPa)				DCD Design Soil Pressure (MPa)	
	CFB1a		CFB1			
	C1 and C5 Wall	CA and CD Wall	C1 and C5 Wall	CA and CD Wall	C1 and C5 Wall	CA and CD Wall
4.65						
Slab						
3.95 – -2.00	0.12	0.12	0.12	0.12	0.22	0.22
Slab						
-2.50 – -7.40	0.13	0.13	0.14	0.16	0.18	0.18



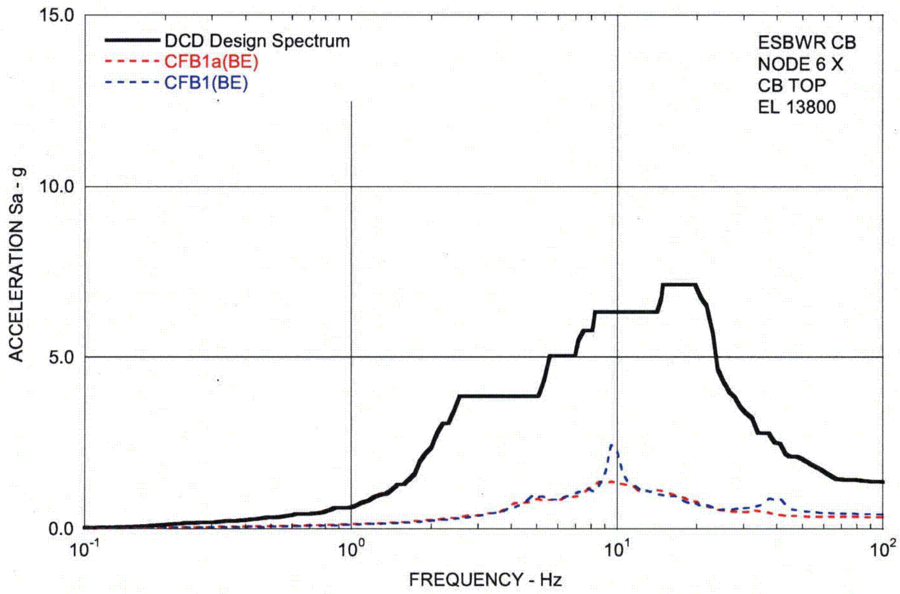


Figure A-1a Comparison of Floor Response Spectra - CB Top in X-Direction

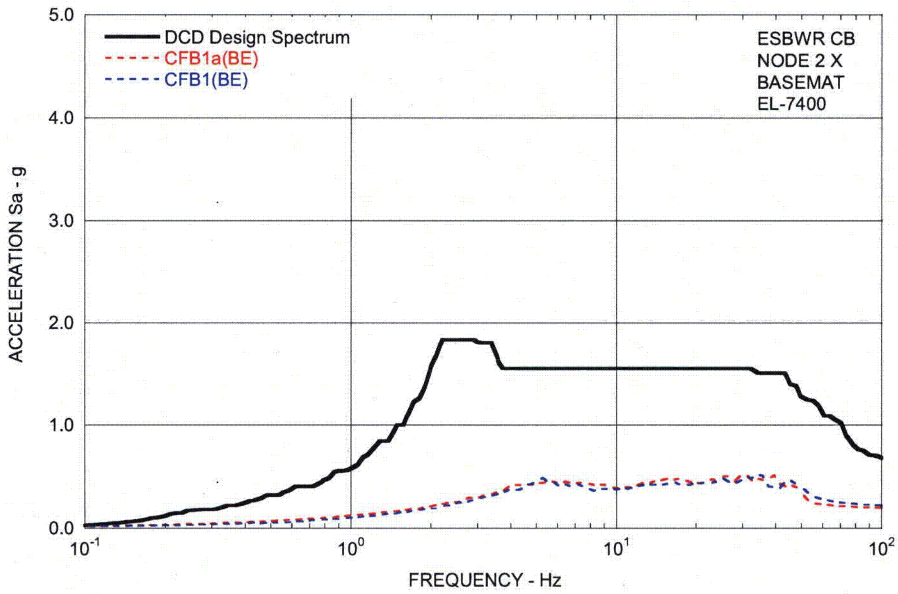


Figure A-1b Comparison of Floor Response Spectra - CB Basemat in X-Direction

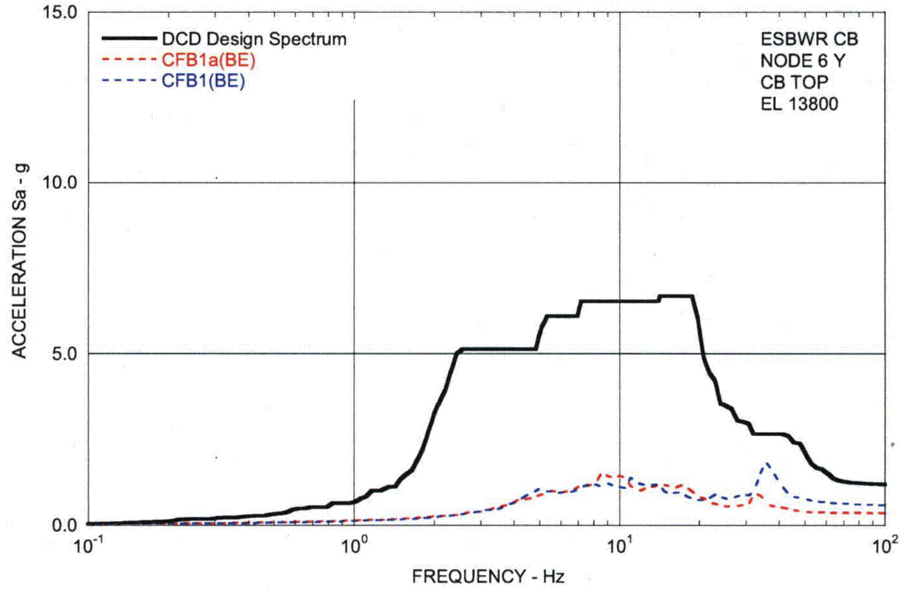


Figure A-2a Comparison of Floor Response Spectra - CB Top in Y-Direction

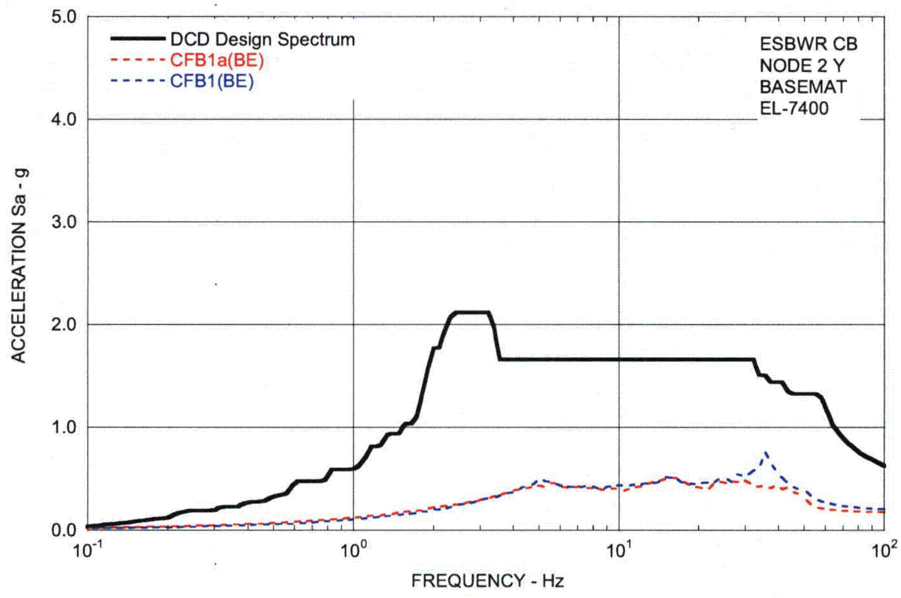


Figure A-2b Comparison of Floor Response Spectra - CB Basemat in Y-Direction

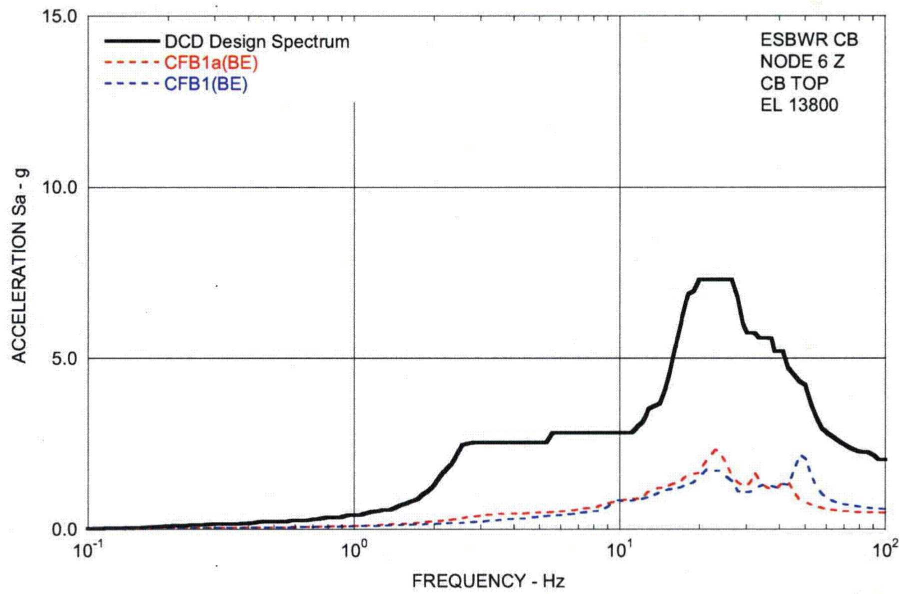


Figure A-3a Comparison of Floor Response Spectra - CB Top in Z-Direction

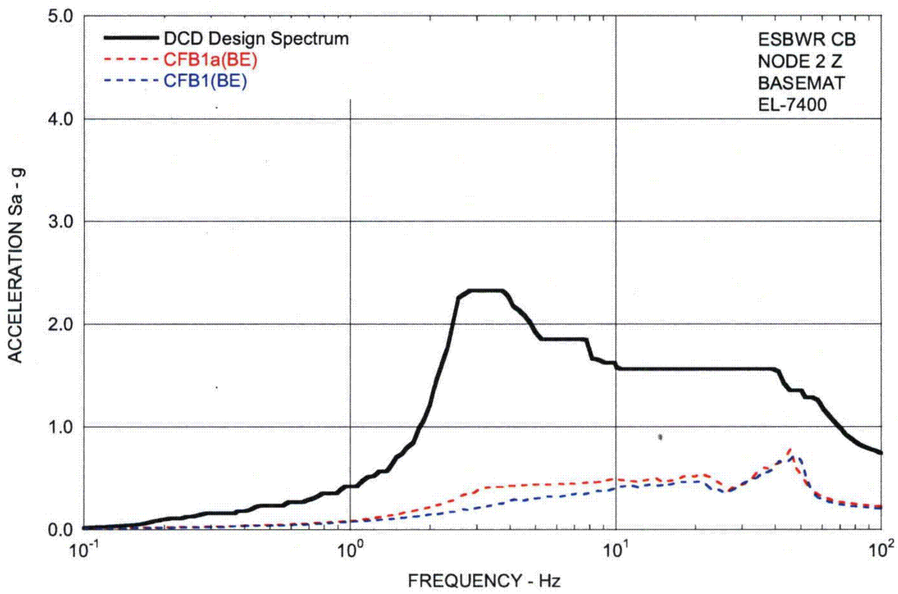
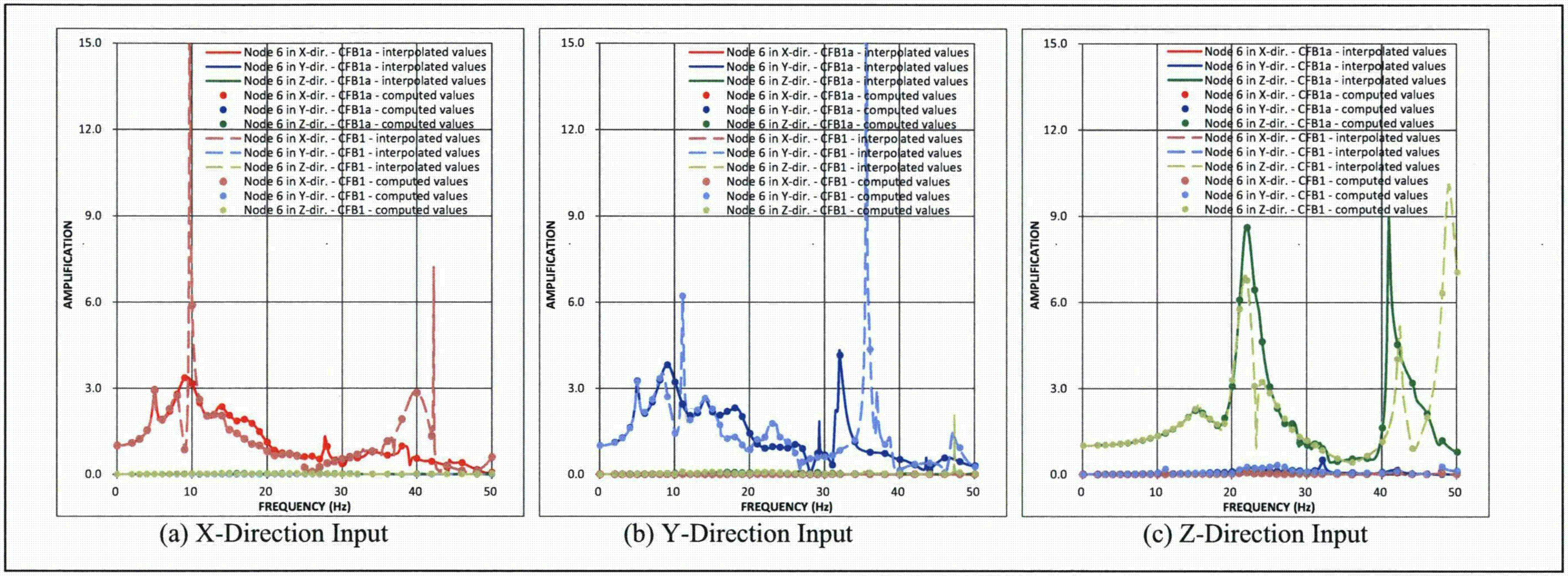
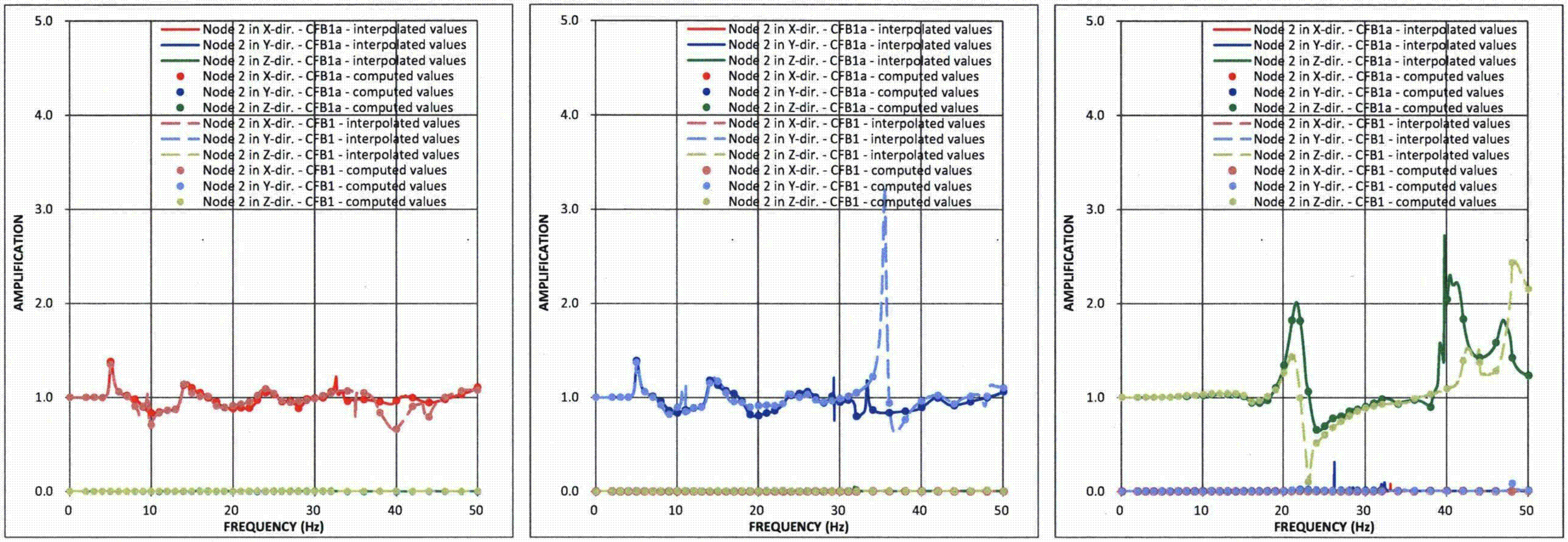


Figure A-3b Comparison of Floor Response Spectra - CB Basemat in Z-Direction



(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure A-4a Transfer functions - CB Top - Comparison between SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods



(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure A-4b Transfer functions - CB Basemat - Comparison between SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods

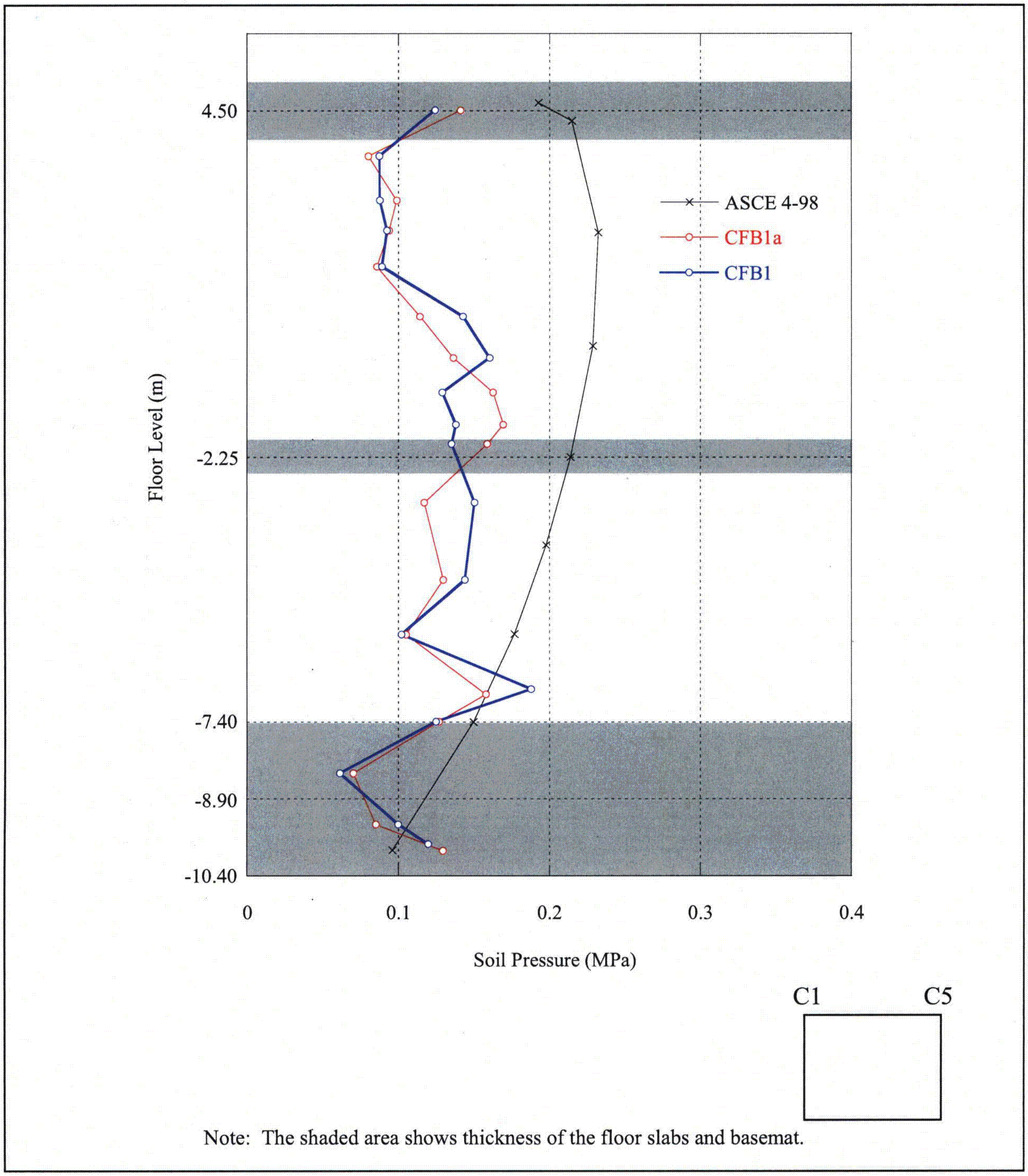
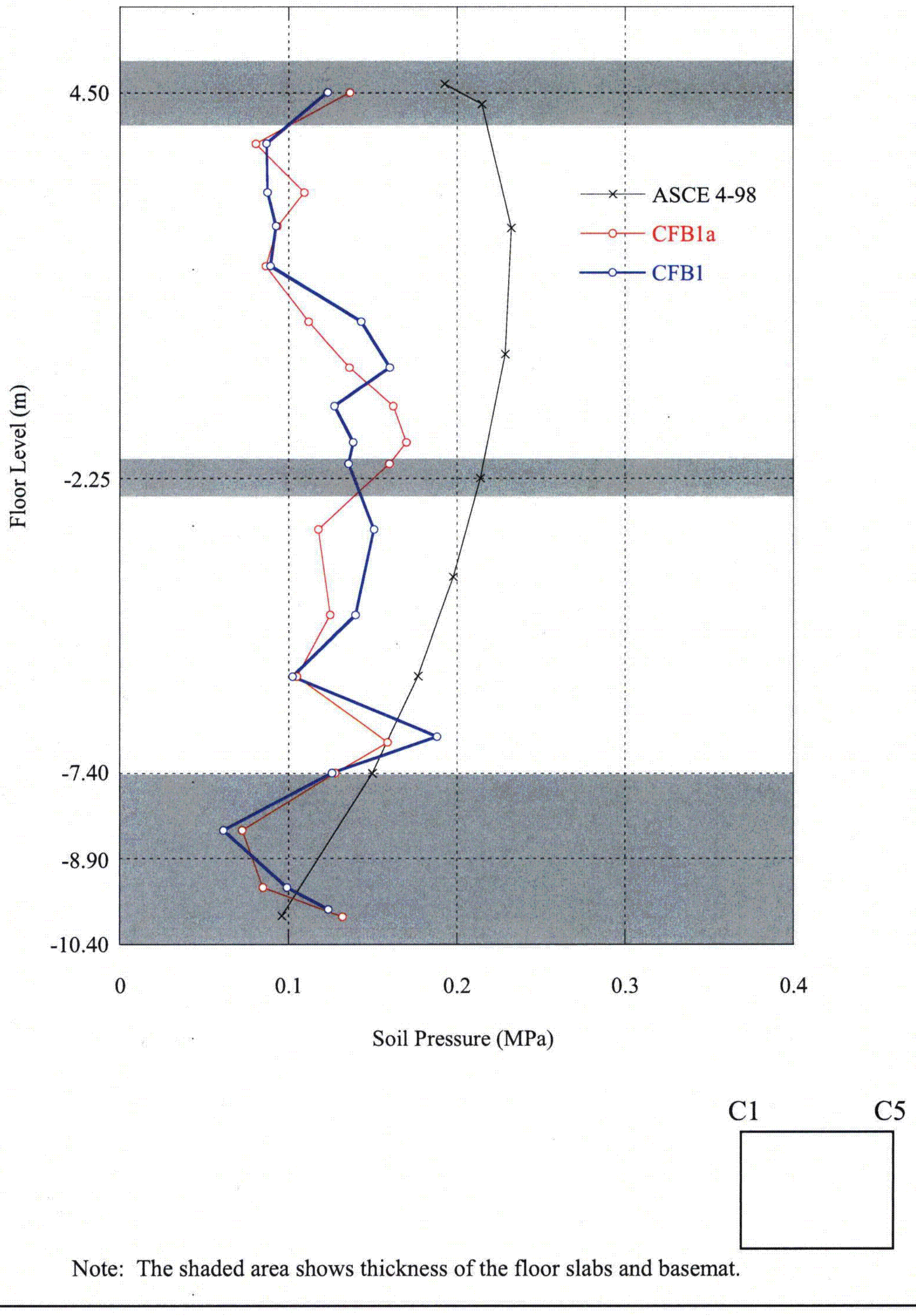
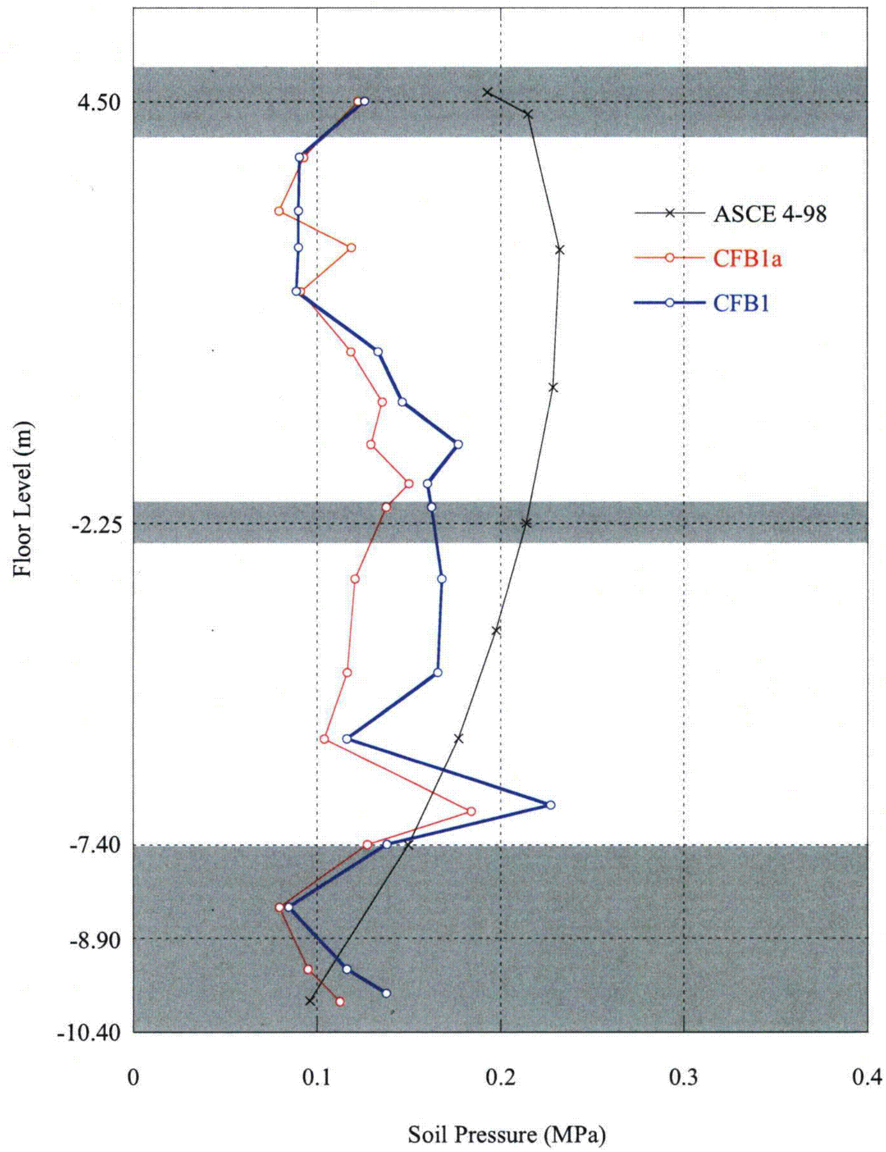


Figure A-5a Lateral Soil Pressures - CB C1 Wall – SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods



Note: The shaded area shows thickness of the floor slabs and basemat.

Figure A-5b Lateral Soil Pressures - CB C5 Wall – SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods

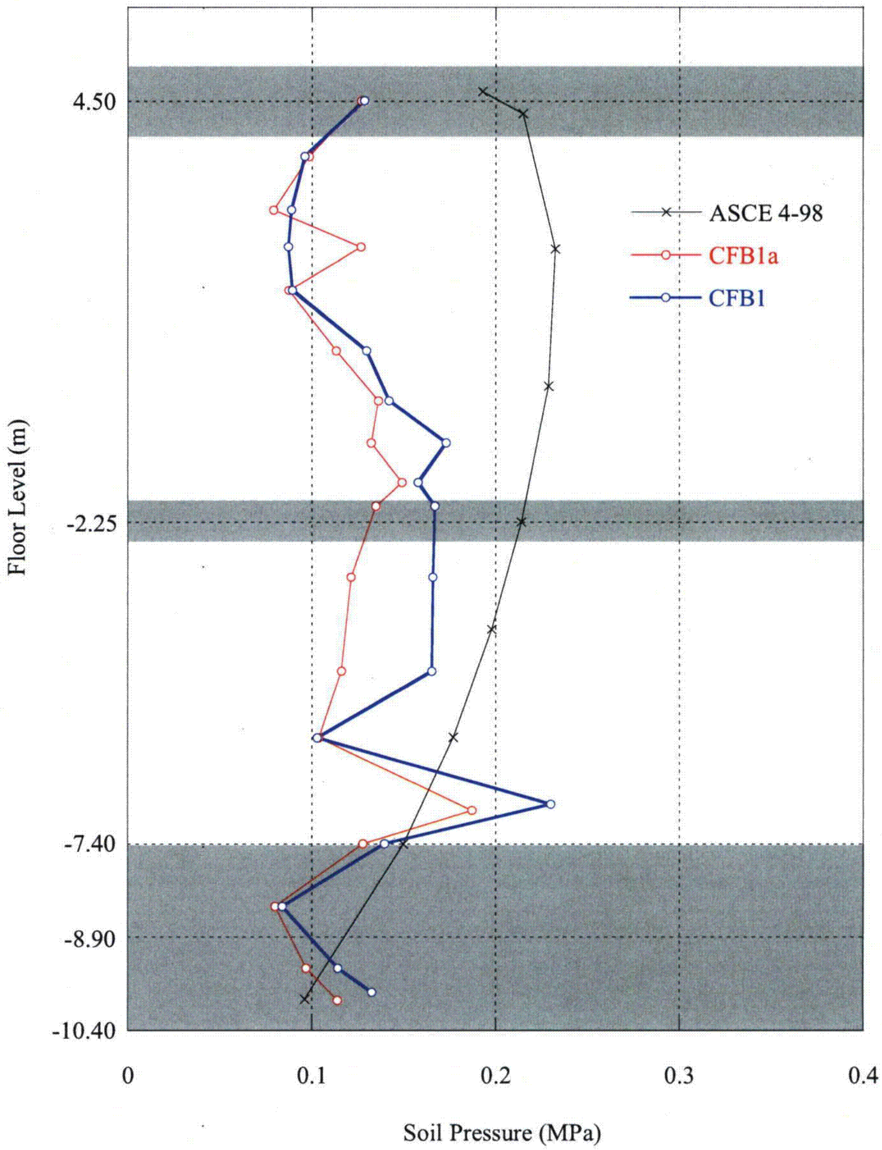


CA

CD

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure A-5c Lateral Soil Pressure - CB CA Wall – SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods



CA

CD

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure A-5d Lateral Soil Pressure - CB CD Wall – SASSI2000 Direct (CFB1a) and Subtraction (CFB1) Methods

APPENDIX B Effect of Engineered Granular Backfill on Transfer Functions

The site-specific SSI analysis cases are summarized in Table B-1. Case CFB1a considers the engineering granular backfill and is performed using the SASSI direct method for this report. Cases CFI1 and CFI2 were performed previously in the reference reports listed in Table B-1. Soil above the bedrock was not considered in both cases. Cases CFI1 and CFI2 used the subsurface profiles and input motions based on References 2-e and 2-f, respectively. The subsurface profiles and input motions provided in Reference 2-f was the updated version of those in Reference 2-e.

Figures B-1 and B-2 show the transfer functions of Case CFB1a (fully embedded direct method) along with the transfer functions for Cases CFI1 (partially embedded initial subsurface profile and input motions) and CFI2 (partially embedded updated subsurface profile and input motions), respectively, for following locations:

Location	Node Number
CB Top	6
CB Basemat	2

The transfer functions are plotted with computed values and interpolated values.

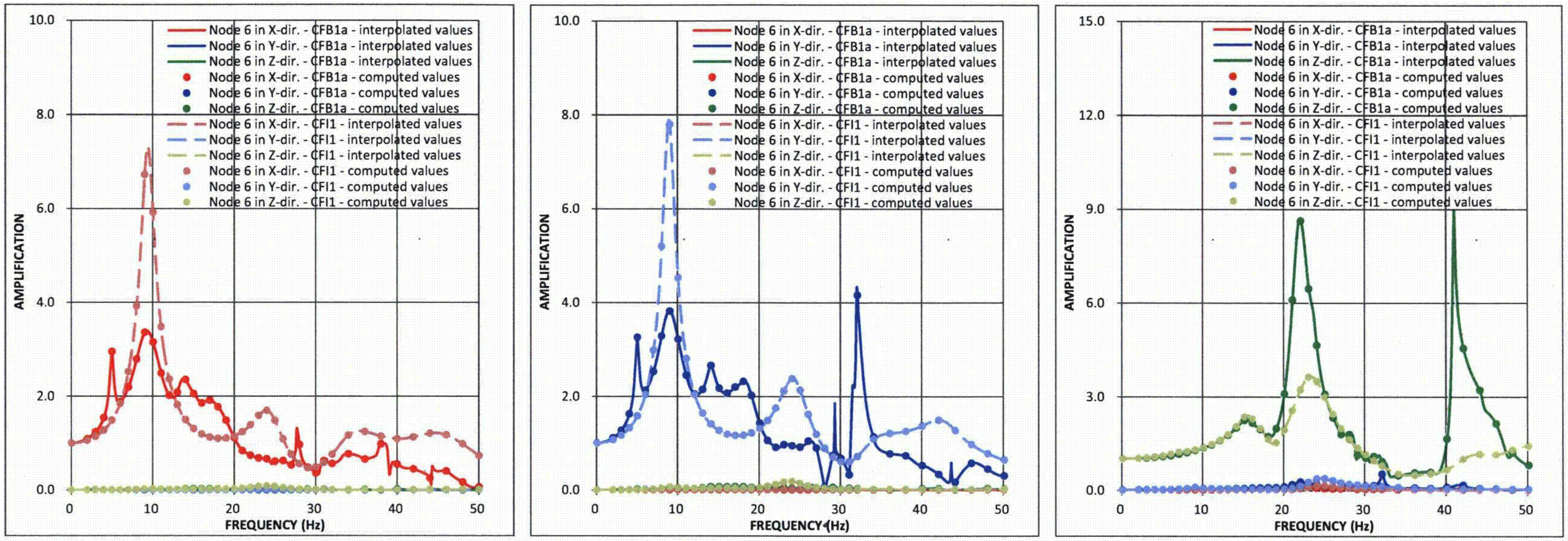
Figures B-1 and B-2 demonstrate that there are significant differences between the fully embedded model and the partially embedded model in the transfer functions. The partially embedded model has a large peak near 10 Hz for horizontal direction inputs, which is the fundamental frequency of the CB stick model. On the other hand, the fully embedded model has a smaller peak near 10 Hz because of the embedment effect and another peak near 5 Hz which is corresponding to the dominant frequency of the engineered backfill above the bedrock. ($f = Vs/(4h) = 240/4/11.3 = 5.3$ Hz)

Figure B-3 show the transfer functions for the locations listed above, comparing between Cases CFI1 and CFI2. It is found from Figure B-3 that transfer functions for both cases are almost identical. It means that the differences of the subsurface profiles do not affect their transfer functions significantly.

Table B-1 CB SSI Analysis Cases

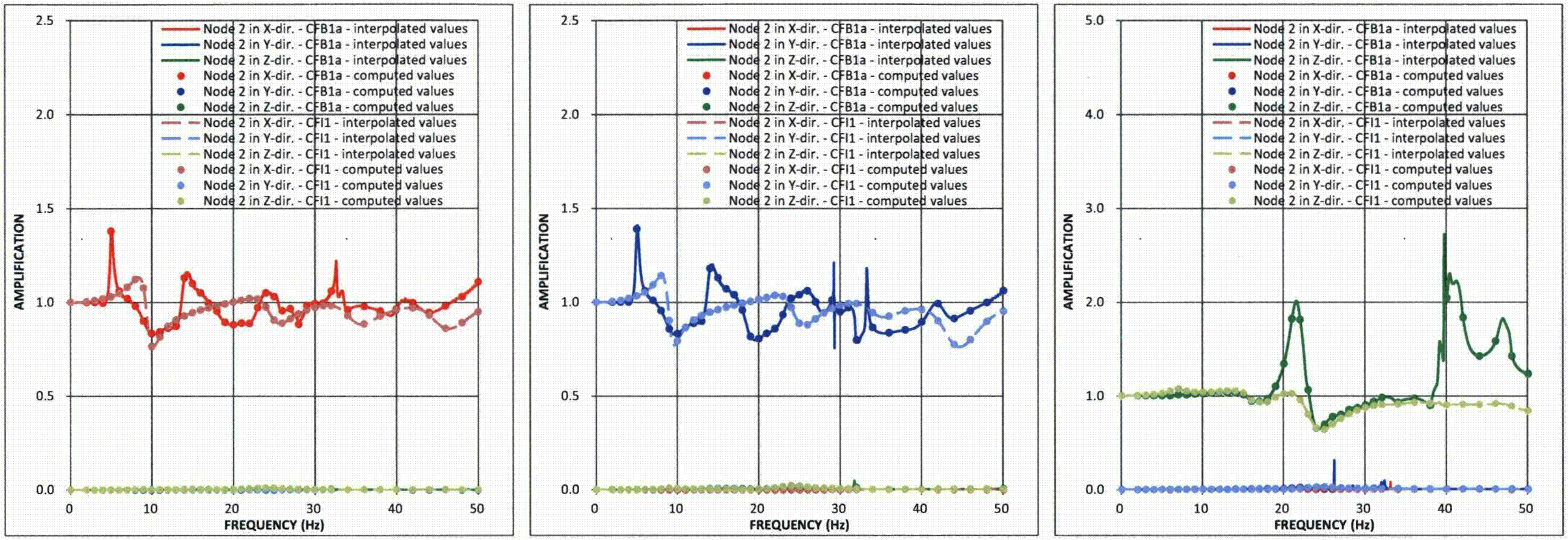
Building	Case	Reference Report	SASSI2000 Analyis Method		Engineered Backfill		Bedrock Properties		Input Motions		Structural Damping	
			Subtraction	Direct	Neglect	Consider*1	TDI-0002*2	TDI-0003*2	TDI-0002*2	TDI-0003*3	7%	4%
CB	CFB1a			X		X		X		X	X	
	CFI1	SER-DTF-003*4		X	X		X		X		X	
	CFI2	SER-DTF-006*4		X	X			X		X	X	

Note: *1: Engineered granular backfill properties are based on TODI LC1-3-A25-TDI-0005, Rev. 0.
*2: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0002, Rev. 0.
*3: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0003, Rev. 1.
*4: The analyses cases were described in reference reports. (Reference 2-a and 2-c).



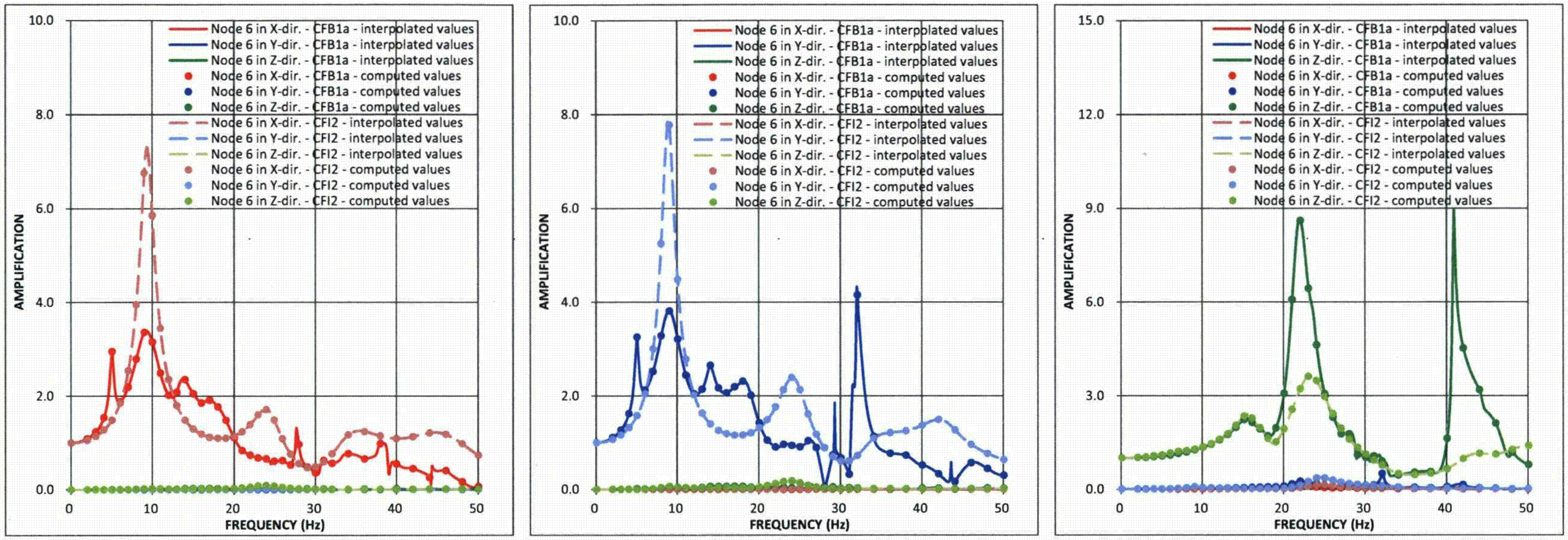
(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-1a Transfer functions - CB Top - Comparison between Fully Embedded Direct Method (CFB1a) and Partially Embedded Direct Method using Initial Subsurface Profile and Input Motions (CFI1)



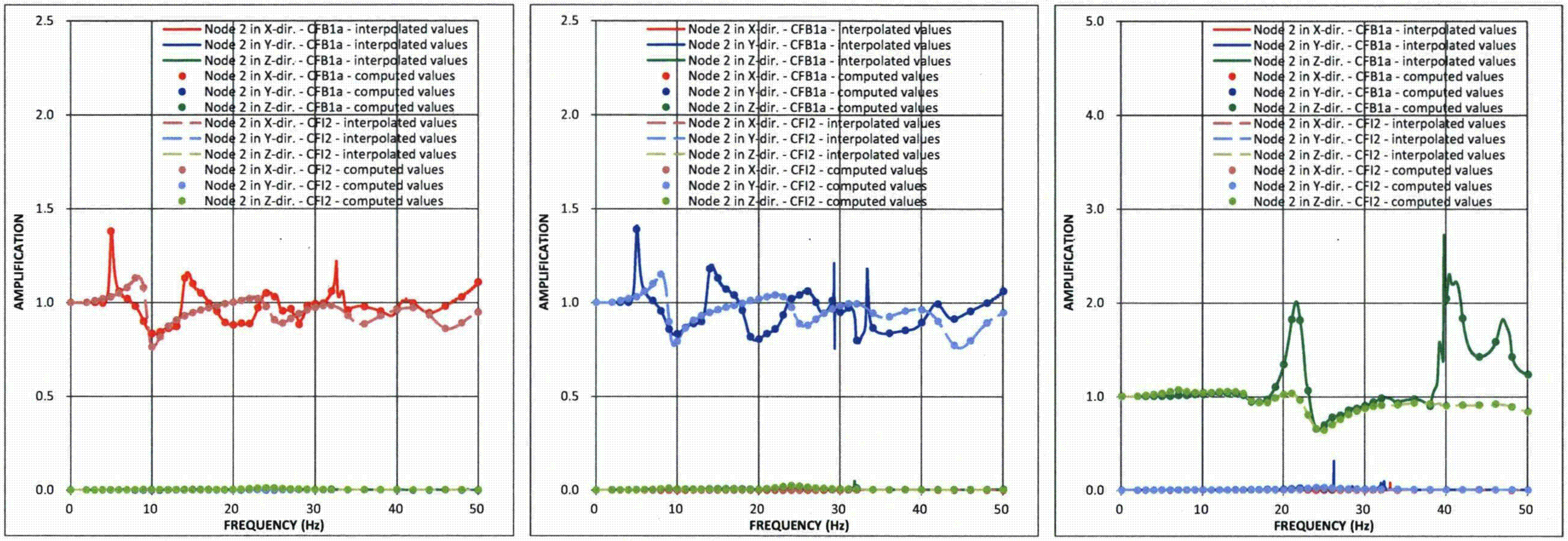
(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-1b Transfer functions - CB Basemat - Comparison between Fully Embedded Direct Method (CFB1a) and Partially Embedded Direct Method using Initial Subsurface Profile and Input Motions (CFI1)



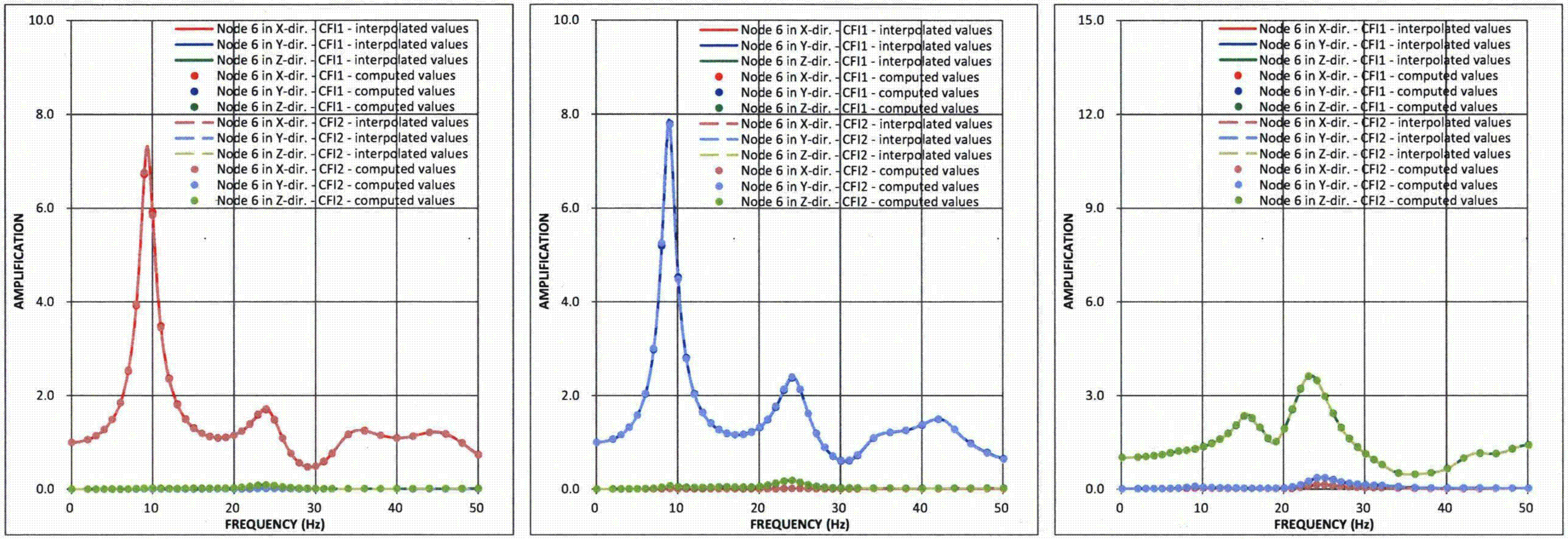
(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-2a Transfer functions - CB Top - Comparison between Fully Embedded Direct Method (CFB1a) and Partially Embedded Direct Method using Updated Subsurface Profile and Input Motions (CFI2)



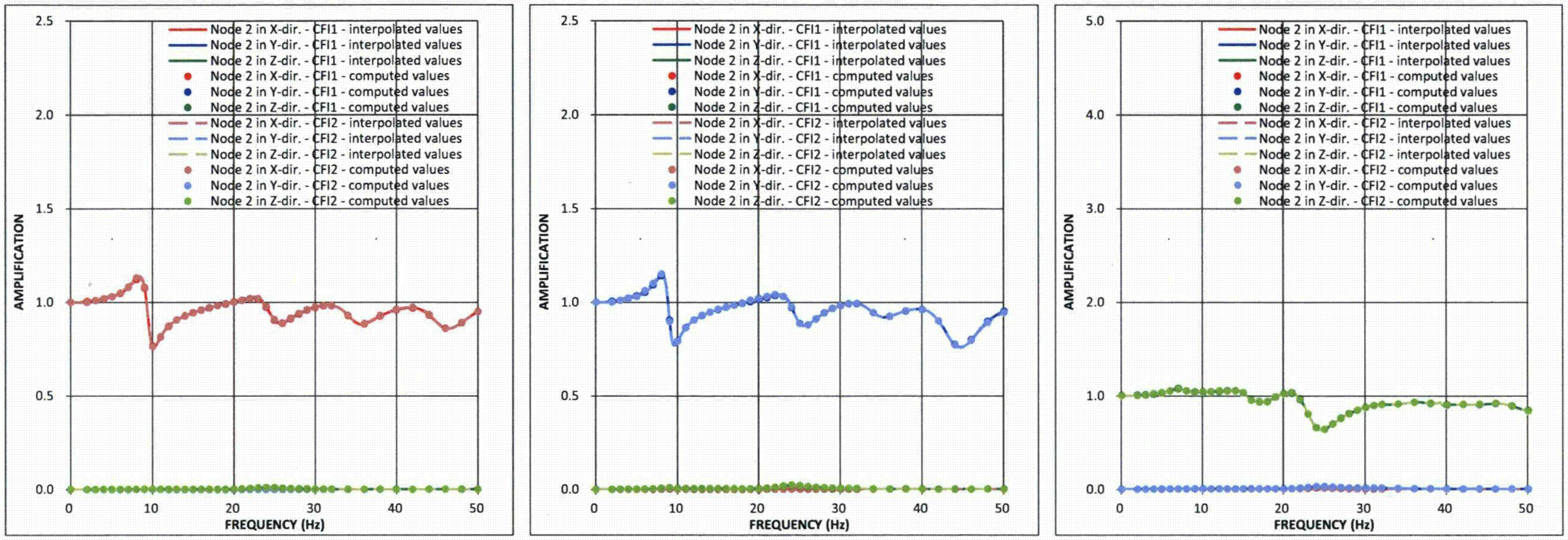
(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-2b Transfer functions - CB Basemat - Comparison between Fully Embedded Direct Method (CFB1a) and Partially Embedded Direct Method using Updated Subsurface Profile and Input Motions (CFI2)



(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-3a Transfer functions - CB Top - Comparison between using not Update (CFI1) and Updated (CFI2) Subsurface Profile and Input Motions - Partially Embedded Direct Method



(a) X-Direction Input (b) Y-Direction Input (c) Z-Direction Input

Figure B-3b Transfer functions - CB Basemat - Comparison between using not Update (CFI1) and Updated (CFI2) Subsurface Profile and Input Motions - Partially Embedded Direct Method

APPENDIX C Resultant Lateral Wall Deflections

To evaluate the resultant lateral wall deflections of the Fermi 3 RB/FB and CB toward each other, relative displacements in the west - east direction of the RB/FB and CB floor levels within the elevation of the excavated volume were calculated. The reference point of the relative displacement is at the top of basemat for each building as shown in Figure C-1.

The site-specific SSI analysis cases used are summarized in Table C-1. All the cases were performed in the reference reports listed in Table C-1.

Tables C-2 and C-3 show the relative displacements of the RB/FB and CB, respectively for the fully embedded and the partially embedded cases.

Table C-1 CB SSI Analysis Cases

Building	Case	Reference Report	SASSI2000 Analyis Method		Engineered Backfill		Bedrock Properties		Input Motions		Structural Damping	
			Subtraction	Direct	Neglect	Consider*1	TDI-0002*2	TDI-0003*3	TDI-0002*2	TDI-0003*3	7%	4%
RB/FB	RFI2	SER-DTF-006*4		X	X			X		X	X	
	RFB	SER-DTF-008*4	X			X	X		X		X	
CB	CFI2	SER-DTF-006*4		X	X			X		X	X	
	CFB2	SER-DTF-008*4	X			X	X		Xs*5		X	

Note: *1: Engineered granular backfill properties are based on TODI LC1-3-A25-TDI-0005, Rev. 0.
*2: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0002, Rev. 0.
*3: Bedrock properties and input motions are based on TODI LC1-3-A25-TDI-0003, Rev. 1.
*4: The analyses cases were described in reference reports. (Reference 2-c and 2-d)
*5: Input motion is generated from Case RFB.

Table C-2 Relative Displacement of RB/FB & CB– Fully Embedded

(a) RB/FB - Case RFB

Elevation (m)	Relative Displacement (mm)					
	BE		LB		UB	
	W-dir.	E-dir.	W-dir.	E-dir.	W-dir.	E-dir.
4.65	1.22	1.06	1.24	1.19	0.94	0.94
-1.00	0.64	0.67	0.70	0.67	0.57	0.57
-6.40	0.29	0.27	0.21	0.22	0.19	0.20
-11.50	Reference Point (top of building basemat)					

(b) CB - Case CFB2

Elevation (m)	Relative Displacement (mm)					
	BE		LB		UB	
	W-dir.	E-dir.	W-dir.	E-dir.	W-dir.	E-dir.
4.65	1.06	1.15	0.90	0.89	2.02	2.09
-2.00	0.53	0.52	0.37	0.45	0.96	0.98
-7.40	Reference Point (top of building basemat)					

Table C-3 Relative Displacement of RB/FB & CB – Partially Embedded

(a) RBFB - Case RFI2

Elevation (m)	Relative Displacement (mm)					
	BE		LB		UB	
	W-dir.	E-dir.	W-dir.	E-dir.	W-dir.	E-dir.
4.65	0.95	1.03	1.10	0.91	1.05	0.82
-1.00	0.52	0.53	0.61	0.50	0.51	0.50
-6.40	0.12	0.18	0.21	0.19	0.19	0.14
-11.50	Reference Point (top of building basemat)					

(b) CB - Case CFI2

Elevation (m)	Relative Displacement (mm)					
	BE		LB		UB	
	W-dir.	E-dir.	W-dir.	E-dir.	W-dir.	E-dir.
4.65	0.69	0.79	0.60	0.84	0.73	0.84
-2.00	0.26	0.30	0.29	0.27	0.29	0.31
-7.40	Reference Point (top of building basemat)					

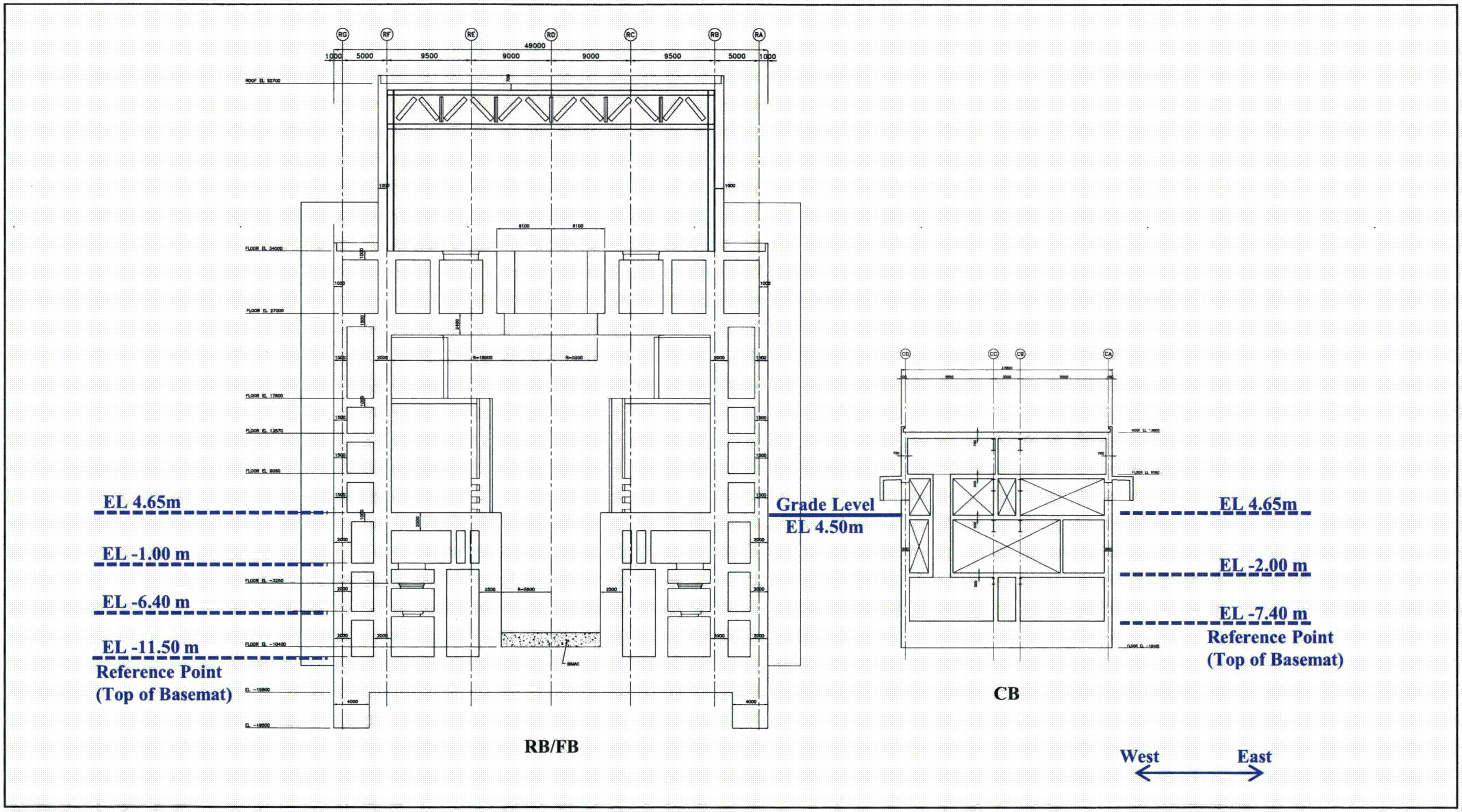


Figure C-1 Section of the RB/FB and CB – Floor Levels where Relative Displacements Calculated

Attachment 9
NRC3-12-0019
(3 pages)

COLA Markups

Table 2.5.4-227 Results of Bearing Capacity Analysis

[EF3 COL 2.0-29-A]

Structure	Terzaghi Approach			Uniform Building Code	Required Maximum Bearing Demand		
	Bearing Capacity				From Referenced DCD		From Fermi 3 Site-Specific SSI
	Ultimate	Allowable Under Static Loading Condition(1)	Allowable Under Dynamic Loading Condition(2)	Allowable Loading Condition(3)	Static Loading Condition(4)	Dynamic Loading Condition(5)	Dynamic Loading Condition(6)
	(ksf)	(ksf)	(ksf)	(ksf)	(ksf)	(ksf)	(ksf)
Reactor/Fuel Building	281	94	125	259	14.6	23.0	26.4 ~~25.9~~
Control Building	879	293	391	374	6.1	8.8	11.3 ~~12.5~~
Firewater Service Complex	96	32	43	43	3.45	25.1	N/A

Note:

1. Allowable static bearing capacity using factor of safety of 3.
2. Allowable dynamic bearing capacity using factor of safety of 2.25.
3. Method 2 only allowed determination of allowable bearing capacity under static loading condition.
4. Criterion from Referenced DCD; (1) and (3) were used to check against (4); (1) and (3) are greater than (4), therefore satisfy the Referenced DCD criterion.
5. Criterion from Referenced DCD; (2) was used to check against (5); (2) is greater than (5), therefore satisfies the Referenced DCD criterion.
6. Fermi 3 site-specific SSI; (2) was used to check against (6); (2) is greater than (6), therefore satisfies Fermi 3 site-specific SSI dynamic loading condition.

ksf = kips per square foot
N/A = Not Applicable (No Site-Specific SSI analysis performed for the FWSC)

Table 3.8.5-203 Maximum Soil Dynamic Bearing Pressure Demand for RB/FB and CB [EF3 SUP 3.8-1]

	Dynamic Bearing Pressure Demand			
	RB/FB		CB	
Subsurface Condition	**Fermi 3 Site-Specific SSI (Static + FIRS[(1)])**	**Referenced DCD, (Static + SSE[(2)])**	**Fermi 3 Site-Specific SSI (Static + FIRS[(1)])**	**Referenced DCD, (Static + SSE[(2)])**
Fermi 3 Lower Bound Subsurface Profile	1,160 ~~1,120~~ KPa 24,300 (~~23,400~~ lbf/ft^2)	NA	490 ~~520~~ KPa 10,300 (~~10,900~~ lbf/ft^2)	NA
Fermi 3 Best Estimate Subsurface Profile	1,040 ~~1,190~~ KPa 21,800 (~~24,900~~ lbf/ft^2)	NA	520 ~~560~~ KPa 10,900 (~~11,700~~ lbf/ft^2)	NA
Fermi 3 Upper Bound Subsurface Profile	1,260 ~~1,240~~ KPa 26,400 (~~25,900~~ lbf/ft^2)	NA	540 ~~600~~ KPa 11,300 (~~12,500~~ lbf/ft^2)	NA
Referenced DCD, Hard Soil Site	NA	1,100 kPa (23,000 lbf/ft^2)	NA	420 kPa (8,800 lbf/ft^2)

Notes:

(1) FIRS is the SSI FIRS developed ~~based on full soil column~~ in Subsection 3.7.1
(2) SSE is the Referenced DCD CSDRS

KPa = kilopascal
NA = Not applicable