
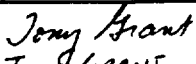
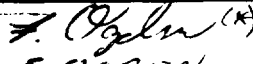


CLIENT & PROJECT PRIVATE FUEL STORAGE FACILITY-PRIVATE FUEL STORAGE, LLC				PAGE 1 OF 17 PLUS 0 PGS OF ATTACHMENTS	
CALCULATION TITLE DEVELOPMENT OF PFSF ARTIFICIAL TIME HISTORIES				QA CATEGORY (X) <input checked="" type="checkbox"/> I - NUCLEAR SAFETY RELATED <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> OTHER	
CALCULATION IDENTIFICATION NUMBER					
J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.	
05996.02	STRUCTURAL	SC-3	NA	NA	
APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC. NO.	SUPERSEDES CALC. NO. OR REV. NO.	CONFIRMATION REQUIRED (X)
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES
 S. Chen 6/17/98	 Tony GRANT 6/24/98	 F. O. O'Brien 6/18/98	0	NA	X
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J.O./W.O./CALCULATION NO.

05996.02-SC-3

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PAGE

3

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SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY CODE CLASS

I

HISTORICAL DATA - REVISION 0**Page No.****Description**

None

Original Issue

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

05996.02-SC-3

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0

PAGE

4

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F. (Signature)

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY/CODE CLASS

I

OBJECTIVE:

The purpose of this calculation is to generate artificial time histories simulating the Stansbury 84th percentile spectra (ref. 1) for use in structural analysis of Private Fuel Storage Facility.

CALCULATION METHOD & ASSUMPTIONS:

The response spectra curves given on page 4-18 and digitized on page 4-11 of reference 1 were used as target spectra for conversion to acceleration time histories. Computer program Stardyne (ref. 2) was used to produce preliminary time histories. Baseline correction was performed using Computer program INTBSL (ref. 3).

The baseline corrected time histories were used to generate response spectra (TIMHIS6, ref. 4), which were then compared with the target spectra to ensure that they meet the requirements of section 2.3.1 of "Standard for Seismic Analysis of Safety-Related Nuclear Structures" (ref. 6). The statistical independence of the time histories was also verified through the use of computer program CORREL (ref. 5)

SOURCES OF DATA AND EQUATIONS:

See the next page for a list of references used in this calculation.

CONCLUSION:

Artificial time histories have been developed for structural analysis of Private Fuel Storage Facility (PFSF). The time histories plots are shown on pages 14 through 16, and the digitized data are given in microfiches associated with the output of computer runs INTBSL. These time histories are converted from 84th percentile response spectra given in PSFS Design Criteria (ref. 1). To meet the requirements of section 2.3.1 of reference 6 and Standard Review Plan, section 3.7.1 (ref.7) , the time histories need to be multiplied by the factors or normalized to the values given below:

	Multiplied by the factor	Normalized to the value
x time history	1.07	0.67 g
y time history	1.15	0.69 g
z time history	1.12	0.67 g

These time histories are stored on the SWEC mainframe computer under the data set name "STRUCTRL.AEG.REFUND", in the order x (N-S), y (Vert), z (E-W).

CALCULATION SHEET

J.O./W.O./CALCULATION NO. 05996.02-SC-3		REVISION 0	PAGE 5
PREPARER/DATE S. Chen 6/17/98	REVIEWER/CHECKER/DATE J. Grant 6-24-98	INDEPENDENT REVIEWER F. O'Brien	
SUBJECT/TITLE Development of PFSF Artificial Time Histories		QA CATEGORY/CODE CLASS I	

References:

1. Private Fuel Storage Facility Design Criteria, Revision 2, June 20, 1997, Stone & Webster Engineering Corporation, Denver, Colorado.
2. Computer program "Stardyne" for Windows, Version 4.10.
3. SWEC computer program INTBSL, ST-307, Ver-00, Level-02
4. SWEC computer program TIMHIS6, ST-239, Ver-01, Level-01
5. SWEC computer program CORREL, ST-308 Ver-00, Level-02.
6. ASCE-4, Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety-Related Nuclear Structures, 1986, ASCE.
7. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, Section 3.7.1, NUREG-0800, July 1989.

CALCULATION SHEET

J.O./W.O./CALCULATION NO. 05996.02-SC-3		REVISION 0	PAGE 6
PREPARER/DATE S. Chen 6/17/98	REVIEWER/CHECKER/DATE J. Grant 6-24-98	INDEPENDENT REVIEWER F. O'Brien	
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ANALYSIS

The preliminary time histories converted from the Stansbury 84th percentile spectra contain 15 second duration with time interval of 0.005 second. Stardyne program was used for this conversion. The baseline corrections were performed with computer program INTBSL (ref. 3), and the corrected time histories were plotted and attached on pages 14-16. The digitized data are shown in microfiches.

The response spectra from the corrected time histories were calculated (using TIMHIS6, ref. 4) at frequency intervals suggested in Table 2300-1 of ref. 6 and a damping of 5 % of critical. The outputs are given in microfiches. Comparison of the calculated spectra values with the target values at the suggested frequencies are shown on the following pages.

As indicated from the tables on the following pages, the average values of the ratios of the time histories spectra to the target spectra are 1.001, 0.999 and 1.002, respectively, for x, y and z direction time histories, and no one point of the time history's spectra falls more than 10 % below the target spectra. However, the maximum time history acceleration values are less than the corresponding design ground acceleration values as shown below:

	x	y	z
Design ground acceleration (ZPA)	0.67 g	0.69 g	0.67 g
Max. T. H. acceleration (ZPA)	0.628 g	0.6 g	0.597 g
Design/ T. H. acceleration	1.067	1.15	1.12

To meet the requirements of section 2.3.1 of reference 6, the time histories need to be multiplied by the factors shown above. The resulting time histories after multiplication also meet the intent of Standard Review Plan (ref. 7) section 3.7.1.

The statistical independence of time histories in x, y and z directions are verified with program CORREL (ref. 5), and the computer outputs are shown in microfiches. The correlation coefficients are less than 0.3 as shown below:

0.141 for x and y time histories

0.167 for x and z time histories

0.117 for y and z time histories

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

REVISION

PAGE

05996.02-SC-3

0

7

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SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY CODE CLASS

I

Comparison of X acceleration values between time histories spectra and design spectra

Frequency Hz	x accel. from targe g	x accel. from T. H. g	TH/Target		Period sec	period	target values
				*1.07			
0.50	0.540				2.000	2	0.540
0.60	0.676	0.701	1.037	1.109	1.667		0.676
	0.770					1.5	0.770
0.70	0.806	0.800	0.992	1.062	1.429		0.806
0.80	0.915	0.986	1.078	1.153	1.250		0.915
0.90	1.023	1.011	0.988	1.058	1.111		1.023
1.00	1.130	1.159	1.026	1.097	1.000	1	1.130
1.10	1.196	1.124	0.940	1.006	0.909		1.196
1.20	1.259	1.316	1.045	1.119	0.833		1.259
1.30	1.320	1.262	0.956	1.023	0.769		1.320
	1.340					0.75	1.340
1.40	1.363	1.382	1.014	1.085	0.714		1.363
1.50	1.395	1.404	1.006	1.077	0.667		1.395
1.60	1.426	1.421	0.996	1.066	0.625		1.426
1.70	1.456	1.321	0.907	0.970	0.588		1.456
1.80	1.485	1.515	1.020	1.091	0.556		1.485
1.90	1.513	1.638	1.083	1.158	0.526		1.513
2.00	1.540	1.648	1.070	1.145	0.500	0.5	1.540
2.10	1.550	1.415	0.913	0.977	0.476		1.550
2.20	1.560	1.625	1.042	1.115	0.455		1.560
2.30	1.569	1.609	1.025	1.097	0.435		1.569
2.40	1.578	1.702	1.078	1.154	0.417		1.578
2.50	1.587	1.590	1.002	1.072	0.400		1.587
2.60	1.596	1.551	0.972	1.040	0.385		1.596
2.70	1.604	1.636	1.020	1.092	0.370		1.604
2.80	1.612	1.552	0.963	1.030	0.357		1.612
2.90	1.619	1.621	1.001	1.071	0.345		1.619
3.00	1.627	1.652	1.016	1.087	0.333		1.627
3.15	1.637	1.606	0.981	1.049	0.317		1.637
3.30	1.648	1.722	1.045	1.118	0.303		1.648
	1.650					0.3	1.650
3.45	1.648	1.629	0.988	1.057	0.290		1.648
3.60	1.646	1.610	0.978	1.046	0.278		1.646
3.80	1.644	1.699	1.034	1.106	0.263		1.644
4.00	1.641	1.687	1.028	1.100	0.250		1.641
4.20	1.639	1.643	1.003	1.073	0.238		1.639
4.40	1.636	1.663	1.016	1.087	0.227		1.636
4.60	1.634	1.550	0.949	1.015	0.217		1.634
4.80	1.632	1.643	1.007	1.077	0.208		1.632
5.00	1.630	1.666	1.022	1.094	0.200	0.2	1.630
5.25	1.616	1.674	1.036	1.108	0.190		1.616
5.50	1.603	1.626	1.014	1.085	0.182		1.603
5.75	1.591	1.574	0.990	1.059	0.174		1.591

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

REVISION

PAGE

05996.02-SC-3

0

8

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J. Grant 6-24-98

INDEPENDENT REVIEWER

F. Ogden

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

Q/CATEGORY/CODE CLASS

I

Comparison of X acceleration values between time histories spectra and design spectra

Frequency Hz	x acel. from targe g	x acel. from T. H. g	TH/Target		Period sec	period	target values
				*1.07			
6.00	1.579	1.602	1.015	1.086	0.167		1.579
6.25	1.568	1.555	0.992	1.061	0.160		1.568
6.50	1.557	1.542	0.990	1.060	0.154		1.557
	1.550					0.15	1.550
6.75	1.541	1.449	0.941	1.006	0.148		1.541
7.00	1.513	1.528	1.010	1.080	0.143		1.513
7.25	1.487	1.411	0.949	1.015	0.138		1.487
7.50	1.463	1.486	1.016	1.087	0.133		1.463
7.75	1.439	1.489	1.034	1.107	0.129		1.439
8.00	1.417	1.413	0.997	1.067	0.125		1.417
8.50	1.376	1.266	0.920	0.985	0.118		1.376
9.00	1.337	1.356	1.014	1.085	0.111		1.337
9.50	1.302	1.305	1.002	1.072	0.105		1.302
10.00	1.270	1.272	1.002	1.072	0.100	0.1	1.270
10.50	1.236	1.183	0.957	1.024	0.095		1.236
11.00	1.204	1.174	0.975	1.044	0.091		1.204
11.50	1.174	1.178	1.004	1.074	0.087		1.174
12.00	1.146	1.127	0.983	1.052	0.083		1.146
12.50	1.120	1.114	0.995	1.064	0.080		1.120
13.00	1.096	1.160	1.059	1.133	0.077		1.096
	1.080					0.075	1.080
13.50	1.073	1.062	0.990	1.059	0.074		1.073
14.00	1.052	0.951	0.904	0.967	0.071		1.052
14.50	1.033	1.000	0.968	1.036	0.069		1.033
15.00	1.014	1.014	1.000	1.070	0.067		1.014
16.00	0.980	0.968	0.988	1.057	0.063		0.980
17.00	0.949	0.959	1.011	1.082	0.059		0.949
18.00	0.920	0.961	1.044	1.117	0.056		0.920
20.00	0.870	0.828	0.952	1.018	0.050	0.05	0.870
22.00	0.829	0.853	1.029	1.101	0.045		0.829
25.00	0.776	0.759	0.978	1.046	0.040		0.776
28.00	0.732	0.741	1.012	1.082	0.036		0.732
31.00	0.695	0.735	1.057	1.131	0.032		0.695
	0.670					0.03	0.670
34.00	0.670				0.029		0.670
					0.010	0.01	0.670

Average ratios

1.001

1.071

Points below target

30

4

Max. T.H. acceleration (ZPA)

0.628

Design ground acceleration/max. T. H. acceleration (0.67/0.628) =

1.067

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

REVISION

PAGE

05996.02-SC-3

0

9

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Tony Grant 6-24-98

INDEPENDENT REVIEWER

F. Ogden

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY/CODE CLASS

I

Comparison of Y acceleration values between time histories spectra and design spectra

Frequency Hz	y accel. from targe g	y accel. from T. H. g	TH/Target *1.15	Period sec	period	target values
0.50	0.240			2.000	2	0.240
0.60	0.294	0.310	1.056	1.667		0.294
	0.330				1.5	0.330
0.70	0.343	0.369	1.077	1.429		0.343
0.80	0.379	0.373	0.983	1.131		0.379
0.90	0.415	0.402	0.968	1.114		0.415
1.00	0.450	0.412	0.916	1.053	1	0.450
1.10	0.475	0.498	1.048	1.206		0.475
1.20	0.499	0.487	0.976	1.122		0.499
1.30	0.522	0.534	1.022	1.175		0.522
	0.530				0.75	0.530
1.40	0.542	0.501	0.924	1.063		0.542
1.50	0.560	0.559	0.998	1.148		0.560
1.60	0.577	0.583	1.011	1.162		0.577
1.70	0.593	0.607	1.024	1.178		0.593
1.80	0.609	0.551	0.904	1.040		0.609
1.90	0.625	0.665	1.064	1.224		0.625
2.00	0.640	0.668	1.044	1.200	0.5	0.640
2.10	0.660	0.656	0.994	1.143		0.660
2.20	0.679	0.714	1.051	1.209		0.679
2.30	0.698	0.706	1.011	1.163		0.698
2.40	0.717	0.667	0.930	1.070		0.717
2.50	0.736	0.732	0.995	1.144		0.736
2.60	0.754	0.802	1.064	1.224		0.754
2.70	0.772	0.812	1.052	1.210		0.772
2.80	0.789	0.780	0.988	1.136		0.789
2.90	0.807	0.727	0.901	1.036		0.807
3.00	0.824	0.833	1.011	1.162		0.824
3.15	0.850	0.871	1.025	1.179		0.850
3.30	0.875	0.835	0.955	1.098		0.875
	0.880				0.3	0.880
3.45	0.902	0.906	1.004	1.155		0.902
3.60	0.930	0.923	0.992	1.141		0.930
3.80	0.968	0.996	1.029	1.184		0.968
4.00	1.004	1.002	0.998	1.148		1.004
4.20	1.040	1.045	1.005	1.155		1.040
4.40	1.076	1.063	0.988	1.136		1.076
4.60	1.111	1.098	0.988	1.137		1.111
4.80	1.146	1.177	1.027	1.181		1.146
5.00	1.180	1.110	0.941	1.082	0.2	1.180
5.25	1.212	1.248	1.030	1.184		1.212
5.50	1.243	1.265	1.018	1.171		1.243
5.75	1.273	1.308	1.027	1.181		1.273

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

05996.02-SC-3

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0

PAGE

10

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F. Ogilvie

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY/CODE CLASS

I

Comparison of Y acceleration values between time histories spectra and design spectra

Frequency Hz	x accel. from targe g	x accel from T. H. g	TH/Target		Period sec	target values
				*1.15		
6.00	1.303	1.316	1.010	1.161	0.167	1.303
6.25	1.332	1.287	0.966	1.111	0.160	1.332
6.50	1.361	1.341	0.985	1.133	0.154	1.361
	1.380					1.380
6.75	1.385	1.454	1.059	1.218	0.148	1.385
7.00	1.398	1.466	1.002	1.152	0.143	1.398
7.25	1.412	1.401	1.004	1.155	0.138	1.412
7.50	1.425	1.418	1.033	1.188	0.133	1.425
7.75	1.437	1.472	1.034	1.189	0.129	1.437
8.00	1.450	1.486	1.025	1.179	0.125	1.450
8.50	1.474	1.531	1.039	1.195	0.118	1.474
9.00	1.497	1.447	0.967	1.112	0.111	1.497
9.50	1.519	1.515	0.998	1.147	0.105	1.519
10.00	1.540	1.505	0.977	1.124	0.100	1.540
10.50	1.533	1.527	0.996	1.145	0.095	1.533
11.00	1.527	1.406	0.921	1.059	0.091	1.527
11.50	1.520	1.614	1.062	1.221	0.087	1.520
12.00	1.515	1.481	0.978	1.125	0.083	1.515
12.50	1.509	1.423	0.943	1.085	0.080	1.509
13.00	1.503	1.414	0.940	1.082	0.077	1.503
	1.500					1.500
13.50	1.490	1.503	1.009	1.160	0.074	1.490
14.00	1.460	1.488	1.019	1.172	0.071	1.460
14.50	1.432	1.428	0.997	1.147	0.069	1.432
15.00	1.406	1.351	0.961	1.105	0.067	1.406
16.00	1.357	1.334	0.983	1.131	0.063	1.357
17.00	1.312	1.243	0.947	1.089	0.059	1.312
18.00	1.272	1.332	1.047	1.205	0.056	1.272
20.00	1.200	1.218	1.015	1.167	0.050	1.200
22.00	1.133	1.121	0.990	1.138	0.045	1.133
25.00	1.049	1.038	0.990	1.138	0.040	1.049
28.00	0.979	0.946	0.966	1.111	0.036	0.979
31.00	0.921	0.925	1.004	1.155	0.032	0.921
34.00	0.871				0.029	0.871
					0.010	0.690
					0.01	0.690

Average ratios

0.999

1.148

Points below target

34

0

Max. T. H. acceleration (ZPA)

0.6

Design ground acceleration/max. T. H. acceleration (0.69/0.6) =

1.15

CALCULATION SHEET

J.O./W.O. CALCULATION NO.

REVISION

PAGE

05996.02-SC-3

0

11

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J. Grant 6-24-98

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F. O'Brien

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY CODE CLASS

I

Comparison of Z acceleration values between time histories spectra and design spectra

Frequency Hz	z accel. from targe g	z accel. from T. H. g	TH/Target		Period sec	period	target values
				*1.12			
0.50	0.540				2.000	2	0.540
0.60	0.676	0.679	1.004	1.125	1.667		0.676
	0.770					1.5	0.770
0.70	0.806	0.797	0.988	1.107	1.429		0.806
0.80	0.915	0.875	0.956	1.071	1.250		0.915
0.90	1.023	1.035	1.012	1.133	1.111		1.023
1.00	1.130	1.101	0.974	1.091	1.000	1	1.130
1.10	1.196	1.189	0.994	1.114	0.909		1.196
1.20	1.259	1.264	1.004	1.125	0.833		1.259
1.30	1.320	1.417	1.073	1.202	0.769		1.320
	1.340					0.75	1.340
1.40	1.363	1.369	1.005	1.125	0.714		1.363
1.50	1.395	1.388	0.995	1.114	0.667		1.395
1.60	1.426	1.491	1.045	1.171	0.625		1.426
1.70	1.456	1.413	0.970	1.087	0.588		1.456
1.80	1.485	1.403	0.945	1.058	0.556		1.485
1.90	1.513	1.549	1.024	1.147	0.526		1.513
2.00	1.540	1.520	0.987	1.105	0.500	0.5	1.540
2.10	1.550	1.597	1.030	1.154	0.476		1.550
2.20	1.560	1.587	1.017	1.139	0.455		1.560
2.30	1.569	1.436	0.915	1.025	0.435		1.569
2.40	1.578	1.637	1.037	1.162	0.417		1.578
2.50	1.587	1.620	1.021	1.143	0.400		1.587
2.60	1.596	1.536	0.963	1.078	0.385		1.596
2.70	1.604	1.681	1.048	1.174	0.370		1.604
2.80	1.612	1.632	1.013	1.134	0.357		1.612
2.90	1.619	1.608	0.993	1.112	0.345		1.619
3.00	1.627	1.649	1.014	1.135	0.333		1.627
3.15	1.637	1.739	1.062	1.189	0.317		1.637
3.30	1.648	1.618	0.982	1.100	0.303		1.648
	1.650					0.3	1.650
3.45	1.648	1.593	0.966	1.082	0.290		1.648
3.60	1.646	1.683	1.022	1.145	0.278		1.646
3.80	1.644	1.646	1.002	1.122	0.263		1.644
4.00	1.641	1.643	1.001	1.121	0.250		1.641
4.20	1.639	1.681	1.026	1.149	0.238		1.639
4.40	1.636	1.756	1.073	1.202	0.227		1.636
4.60	1.634	1.515	0.927	1.038	0.217		1.634
4.80	1.632	1.646	1.009	1.130	0.208		1.632
5.00	1.630	1.666	1.022	1.145	0.200	0.2	1.630
5.25	1.616	1.660	1.027	1.150	0.190		1.616
5.50	1.603	1.579	0.985	1.103	0.182		1.603
5.75	1.591	1.493	0.939	1.051	0.174		1.591

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

REVISION

PAGE

05996.02-SC-3

0

12

PREPARER/DATE

S. Chen 6/17/98

REVIEWER/CHECKER/DATE

J. Grant 6-24-98

INDEPENDENT REVIEWER

F. Ogden

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

QA CATEGORY CODE CLASS

I

Comparison of Z acceleration values between time histories spectra and design spectra

Frequency Hz	z accel. from targe g	z accel. from T. H. g	TH/Target	Period sec	Target values
				*1.12	
6.00	1.579	1.714	1.096	1.216	0.167
6.25	1.568	1.674	1.068	1.196	0.160
6.50	1.557	1.512	0.971	1.088	0.154
	1.550				0.15
6.75	1.541	1.471	0.955	1.069	0.148
7.00	1.513	1.562	1.032	1.156	0.143
7.25	1.487	1.495	1.005	1.126	0.138
7.50	1.463	1.424	0.973	1.090	0.133
7.75	1.439	1.415	0.983	1.101	0.129
8.00	1.417	1.441	1.017	1.139	0.125
8.50	1.376	1.364	0.992	1.111	0.118
9.00	1.337	1.321	0.988	1.106	0.111
9.50	1.302	1.258	0.966	1.082	0.105
10.00	1.270	1.309	1.031	1.154	0.100
10.50	1.236	1.280	1.036	1.160	0.095
11.00	1.204	1.227	1.019	1.142	0.091
11.50	1.174	1.109	0.945	1.058	0.087
12.00	1.146	1.119	0.976	1.094	0.083
12.50	1.120	1.178	1.052	1.178	0.080
13.00	1.096	1.178	1.075	1.204	0.077
	1.080				0.075
13.50	1.073	1.152	1.074	1.203	0.074
14.00	1.052	1.093	1.039	1.163	0.071
14.50	1.033	1.002	0.970	1.087	0.069
15.00	1.014	0.952	0.939	1.051	0.067
16.00	0.980	0.994	1.014	1.136	0.063
17.00	0.949	0.906	0.955	1.070	0.059
18.00	0.920	0.909	0.988	1.106	0.056
20.00	0.870	0.842	0.968	1.084	0.050
22.00	0.829	0.784	0.946	1.060	0.045
25.00	0.776	0.793	1.022	1.144	0.040
28.00	0.732	0.732	0.999	1.119	0.036
31.00	0.695	0.681	0.979	1.097	0.032
	0.670				0.03
34.00	0.670			0.029	0.01
				0.010	0.01
Average ratios			1.002	1.122	
Points below target			33	0	
Max. T. H. acceleration (ZPA)					0.597
Design ground acceleration/max. T. H. acceleration (0.67/0.597)=					1.122

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

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PAGE

05996.02-SC-3

0

13

PREPARER/DATE

S. Chen 6/17/98

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J. Grant 6-24-98

INDEPENDENT REVIEWER

F. Ogden

SUBJECT/TITLE

Development of PFSF Artificial Time Histories

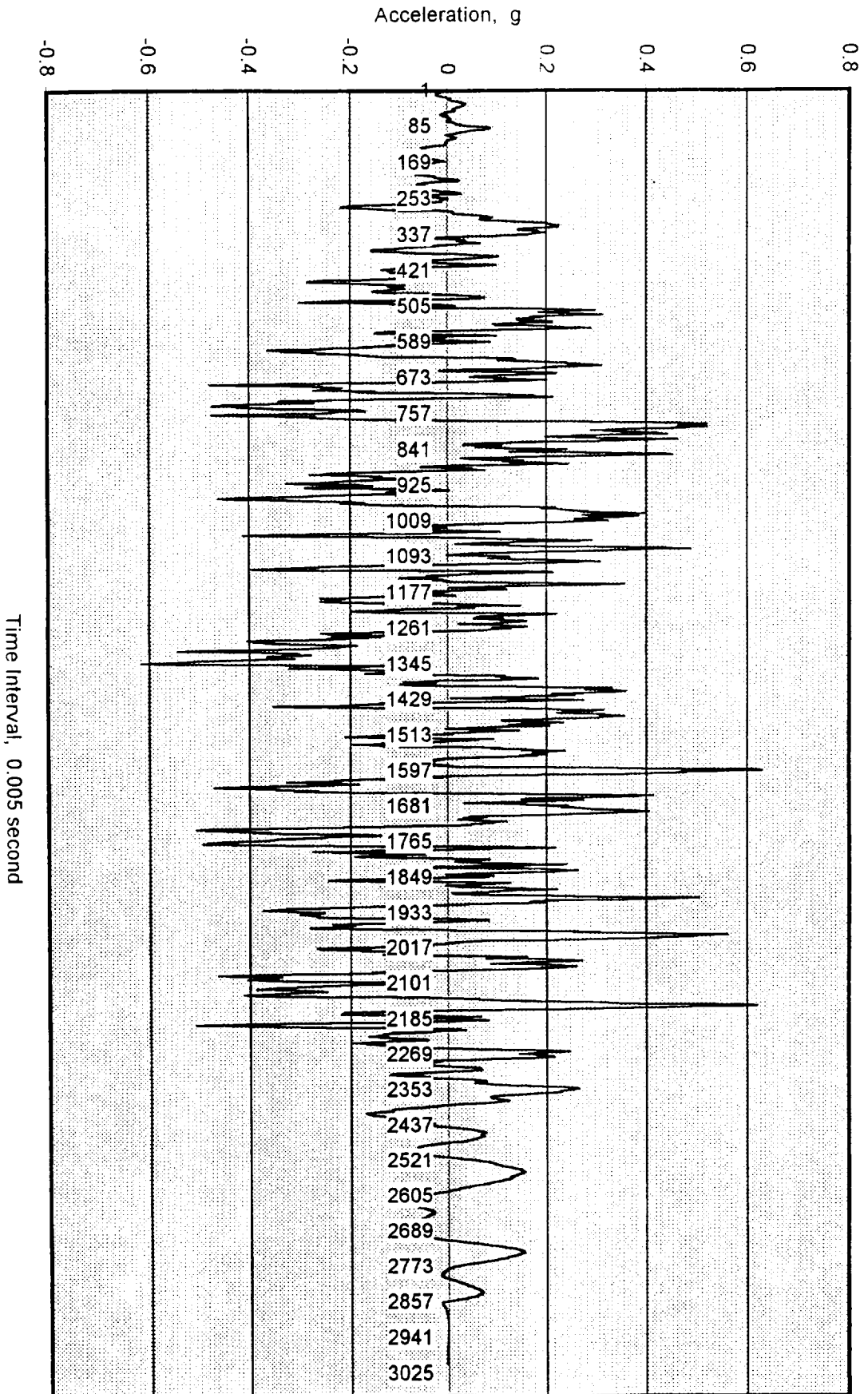
QA CATEGORY/CODE CLASS

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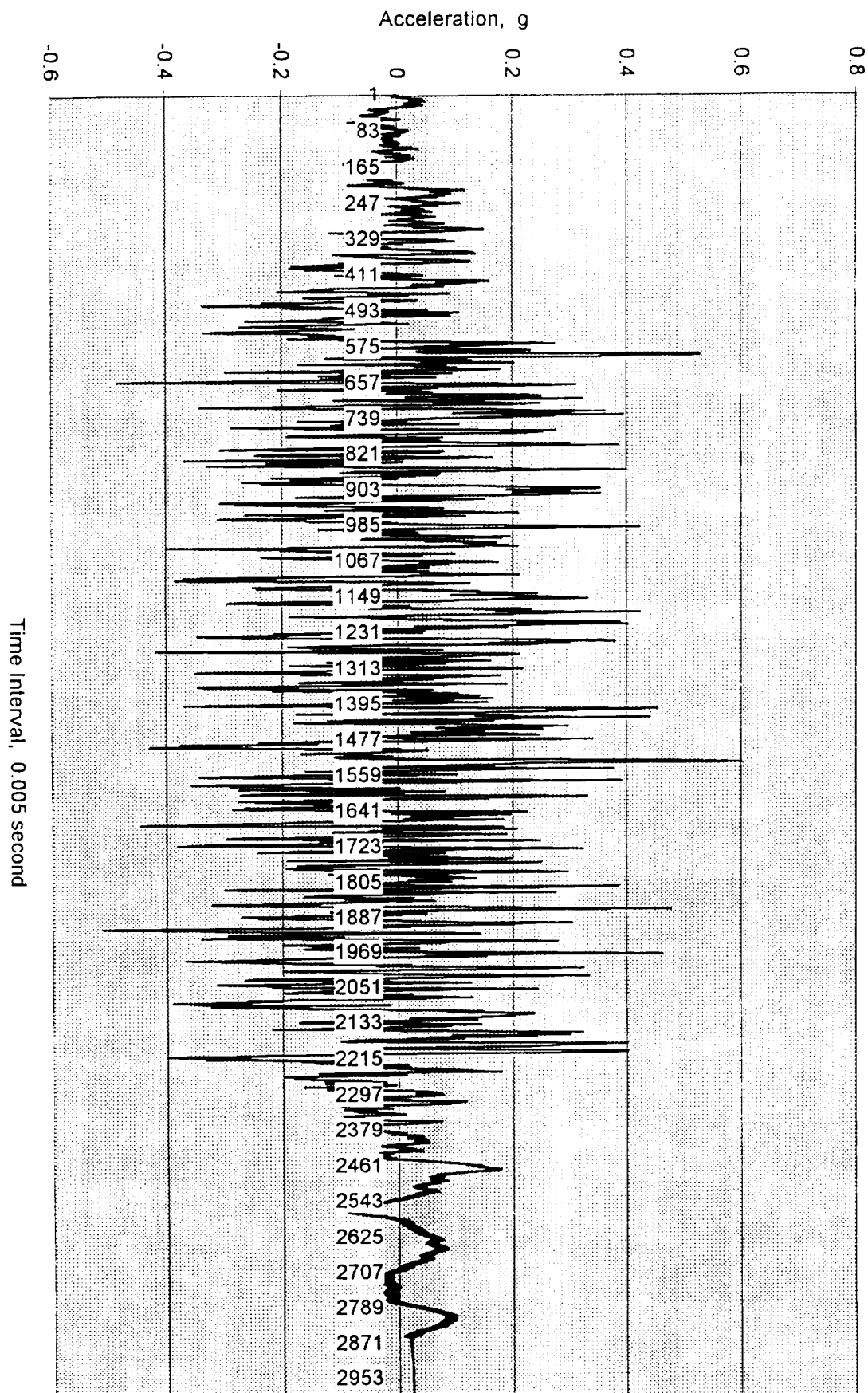
Computer Log

Program name	Library ref. No.	Ver./Level	Job Number	Run date	Fiche location	Comments
TIMHIS6	ST-239	01/01	6010	6/5/98	page 17	To generate ARS from x T. H.
			6067	6/5/98		To generate ARS from y T. H.
			6093	6/5/98		To generate ARS from z T. H.
CORREL	ST-308	00/02	6109	6/5/98		To calculate correlation coefficients
INTBSL	ST-307	00/02	4011	6/15/98		Baseline correction for x T. H.
			4965	6/16/98		Baseline correction for y T. H.
			4973	6/16/98		Baseline correction for z T. H.

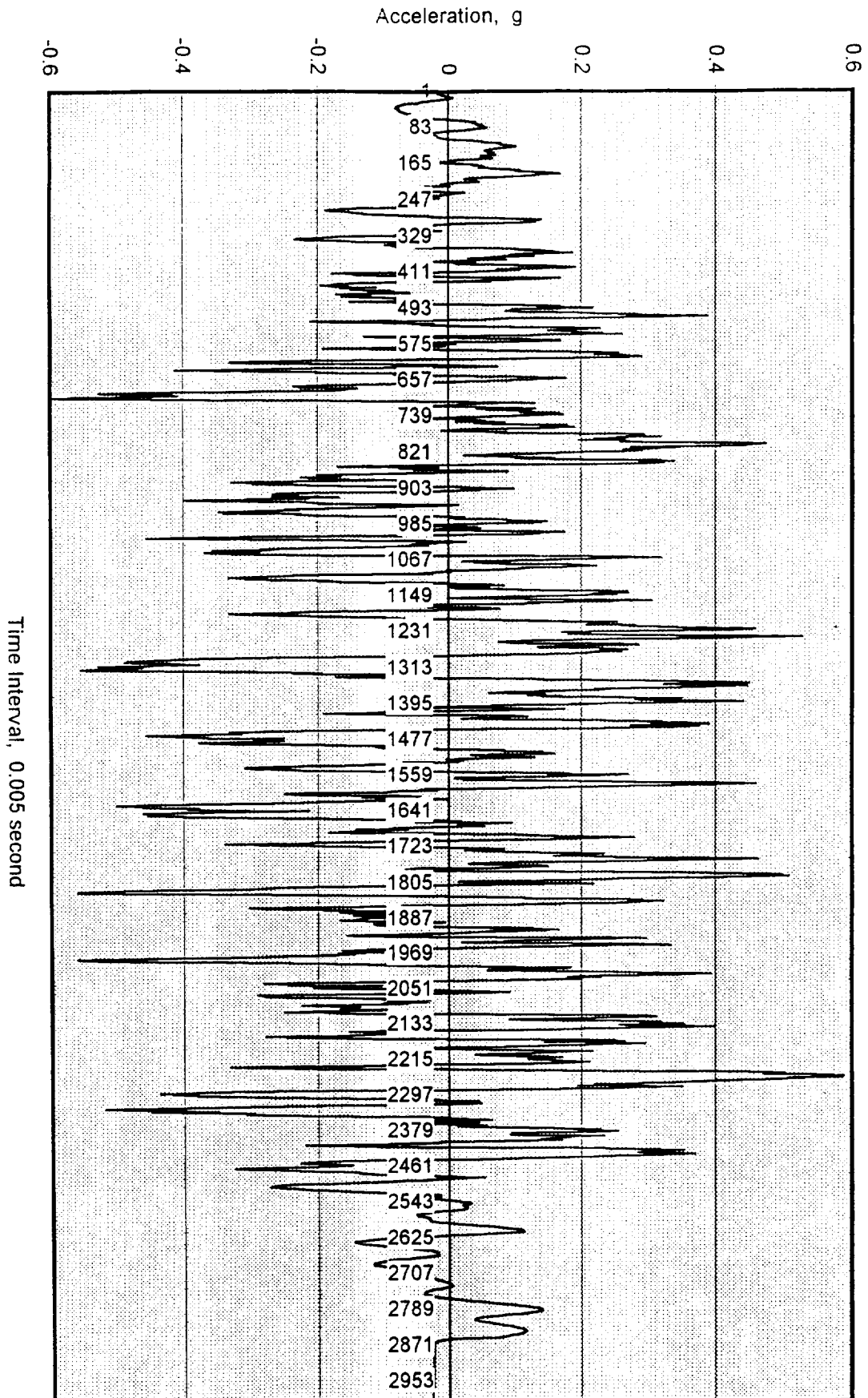
X Direction PFSF Time History



Y Direction PFSF Time History



Z Direction PFSF Time History



COMPUTER RUNS

for

Calculation No. 05996.02 STRUCTURAL-SC-3

DEVELOPMENT OF PFSF ARTIFICIAL TIME HISTORIES