TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

JUN 11 1990

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328

SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2 - NRC INSPECTION REPORT NOS. 50-327, 50-328/88-12 - UNRESOLVED ITEM (URI) 88-12-04

Reference: TVA letter to NRC dated November 9, 1989, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - NRC Inspection Report Nos. 50-327, 328/88-12 - Unresolved Item (URI) 88-12-04"

The referenced letter provided NRC with TVA's response to URI 88-12-04. This URI addressed NRC's concern with the double differentiation technique used to generate the containment design basis accident spectra.

During a meeting held at SQN between TVA and NRC on April 12, 1990, NRC requested that TVA formally submit supplemental information concerning URI 88-12-04. In response to this request, the supplemental information is enclosed.

No commitments are contained in this submittal. Please direct questions concerning this issue to Bruce S. Schofield at (615) 843-6172.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

for E. G. Wallace, Manager
Nuclear Licensing and
Regulatory Affairs

Enclosures
cc: See page 2

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JUN 11 1990

cc (Enclosure 1 only):
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Region II
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Atlanta, Georgia 30323

ENCLOSURE 1

SUPPLEMENTAL INFORMATION ON UNRESOLVED ITEM (URI) 88-12-04

BACKGROUND

The results of a study undertaken to answer specific concerns raised by NRC reviewers during the SQN Integrated Design Inspection (IDI) were submitted by TVA letter to NRC dated November 9, 1989, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - NRC Inspection Report Nos. 50-327, 328/88-12 - Unresolved Item (URI) 88-12-04." Specifically, these concerns dealt with the numerical algorithm used in calculating an acceleration-time history from a displacement-time history and the duration of the pressure-time functions used in the design basis accident (DBA) analysis. These concerns are more completely elaborated in an NRC letter to TVA dated June 24, 1988, "Inspection Report Nos. 50-327/88-12 and 328/88-12," and have been designated by the NRC as URI 88-12-04.

On January 20, 1990, during a telephone conference call between TVA and NRC, NRC requested additional information to supplement TVA's November 9, 1989, letter. The information re uested was:

1. Provide the theoretical basis for the algorithm used in the SUPRPOS computer code to double differentiate the displacement-time histories calculated by the SUPERSHELL computer program.

2. Provide a statement concerning the occurrence of spectra peaks beyond 10 Hertz in the original DBA spectra after reviewing all available spectra at Elevation 763.58.

3. Provide an explanation of how vertical stiffeners were incorporated into the axisymmetric model used in the DBA analysis.

4. Provide a quantitative assessment of the steel containment vessel (SCV) response beyond 0.90 second.

Items 1, 2, and 3 were informally provided to NRC prior to a TVA and NRC meeting at SQN on April 12, 1990, and these items were discussed at the meeting.

In addition, Item 4 also was discussed with NRC reviewers at this meeting, and the results were presented. Based upon further TVA and NRC interactions on April 12, TVA agreed to formally submit the requested information with the following clarification and additions.

1. Item 1 will include the completion of a sample problem suggested by NRC, defining how the computer code SUPRPOS double differentiates a function.

2. Item 2 will provide three DBA plots available at Elevation 763.58 demonstrating the peaks beyond 10 Hertz. It will also provide the comparison table of peaks that was previously submitted to NRC.

3. Item 3 will define how Young's modulus was increased to incorporate the vertical stiffener effects.

4. Item 4 will provide the calculation that has been developed to demonstrate effects on DBA spectra beyond 0.9 second to include a digitized comparison of the acceleration response spectrum (ARS) curves.

Items 1 through 4 are individually discussed below. Attachments A through D correlate directly with Items 1 through 4.

ITEM 1 - ADDITIONAL SUPRPOS DOCUMENTATION

To provide additional information on the numerical algorithm of SUPRPOS, the user's manual for the SUPRPOS IMSL routines is included as Attachment A. Pages DCSEVU-1 to DCSEVU-4 describe the double-differentiation routine and provide a simplified sample problem. In addition, Attachment A.1 provides the solution to an NRC suggested sample problem and compares the hand calculated values with those from the IMSL routines. As shown, very good correlation exists.

ITEM 2 - SECONDARY PEAKS ABOVE 10 HERTZ

Attachment B to this enclosure provides a summary of the acceleration response spectra curves available at Elevation 760.4, the closest elevation with available ARS plots to Elevation 763.58. Additionally, ARS plots upon which the table is based are provided as visual aids.

ITEM 3 - VERTICAL STIFFENER EFFECTS

In the DBA analysis of the SQN SCVs, the circumferential stiffeners were modeled as discrete elements. Since the SCV finite element model was axisymmetric, the vertical stiffeners could not be modeled discretely and were included by "smearing" their effect (extensional stiffness only) onto the SCV shell. Because the vertical stiffeners are effective only in the vertical direction and have negligible circumferential stiffness contribution, the actual thickness of the containment shell was modeled to provide correct circumferential and shear stiffness. The modulus of elasticity of the shell in its vertical orientation was increased to reflect the increase in the shell extensional stiffness from the external vertical stiffness. Attachment C provides additional discussion of this technique.

ITEM 4 - CONSIDERING PRESSURE EFFECTS BEYOND 0.90 SECOND

A qualitative assessment of the significance of truncating the pressure-time functions at 0.90 second was provided in the TVA letter to NRC dated November 9, 1989, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - NRC Inspection Report Nos. 50-327, 328/88-12 - Unresolved Item (URI) 88-12-04." This assessment was based upon a review of the shape of the curves and the expected response of what was essentially a ramp function. Revision 1 to TVA Calculation SGG-2S-89-143 provides a supplemental quantitative assessment of the significance of this pressure function truncation. In this study the pressure time curves previously used in Revision 0 to TVA Calculation SGG-2S-89-143 were digitized to 3.0 seconds. The response of the SCV to this redigitation (0.0 to 3.0 seconds) was calculated, and comparisons (both time history and response spectra) with the original time interval (0.0 to 0.90 second) were made. Attachment D more completely describes the current time duration study and provides the calculation that serves as the basis of all comparisons.

ENCLOSURE 2

Attachments A through D

(B25 900501 002)

ATTACHMENT A [redacted]

STATEMENT OF PROBLEM

Given a set of data representing maximum/minimum displacements vs time, calculate an acceleration time history. A cubic spline representation is chosen to represent the displacement data. Consistent with the behavior of vibrating structures, the cubic spline approach will produce a continuous function over all time steps with continuous first and second derivatives.

IMSL (Reference 1) cubic spline interpolation routine ICSICU is used to generate a set of cubic coefficients (C_1, C_2, C_3) over each time step which satisfies the following the following equation:

$$S(t) = C_3(t - t_i)^3 + C_2(t - t_i)^2 + C_1(t - t_i) + S(t_i)$$

where: t = time point being evaluated (such that: $t \leq t < ti$)
t_i = time point at the ith interval (see Table 1)
$S(t_i)$ = displacement at time t_i

IMSL (Reference 1) routine DCSEVU is used to double differentiate the cubic displacement equation such that accelerations satisfy:

$$\frac{d^2S}{dt^2} = 6(C_3)(t - t_i) + 2(C_2)$$

The following set points is used to represent the given displacement time history:

TIME (t)	DISPLACEMENT S(t)
.00	.00
.10	.50
.20	1.00
.40	.00
.60	1.00
.80	.00
.90	.50
1.00	1.00

RESULTS

Computer generated cubic spline displacement curve is plotted against input displacement data (FIGURE 1). Displacement and acceleration time histories are tabulated in TABLE 2. Specific time points are compared to hand calculations using the displacement and acceleration equations with the cubic spline coefficients tabulated on TABLE 2.

Figure 1	Plot of the cubic spline displacement curve (dashed line) overplayed with the original displacement values (solid line).
Table 1	Displays the cubic spline coefficients generated by IMSL routine ICSICU.
Table 2	Computer generated displacements and accelerations

REFERENCES

(1) IMSL Library Fortran Subroutines for Mathematics and Statistics, User's Manual. Edition 9.2 IMSL LIB-0009.

(2) Ahlberg, J., Nilson, E., and Walsh, J., The Theory of Splines and Their Applications, Academic Press, New York, 1967.

FIGURE 1

———————— Plot of displacement data input

-------- Cubic Spline plot of displacement data

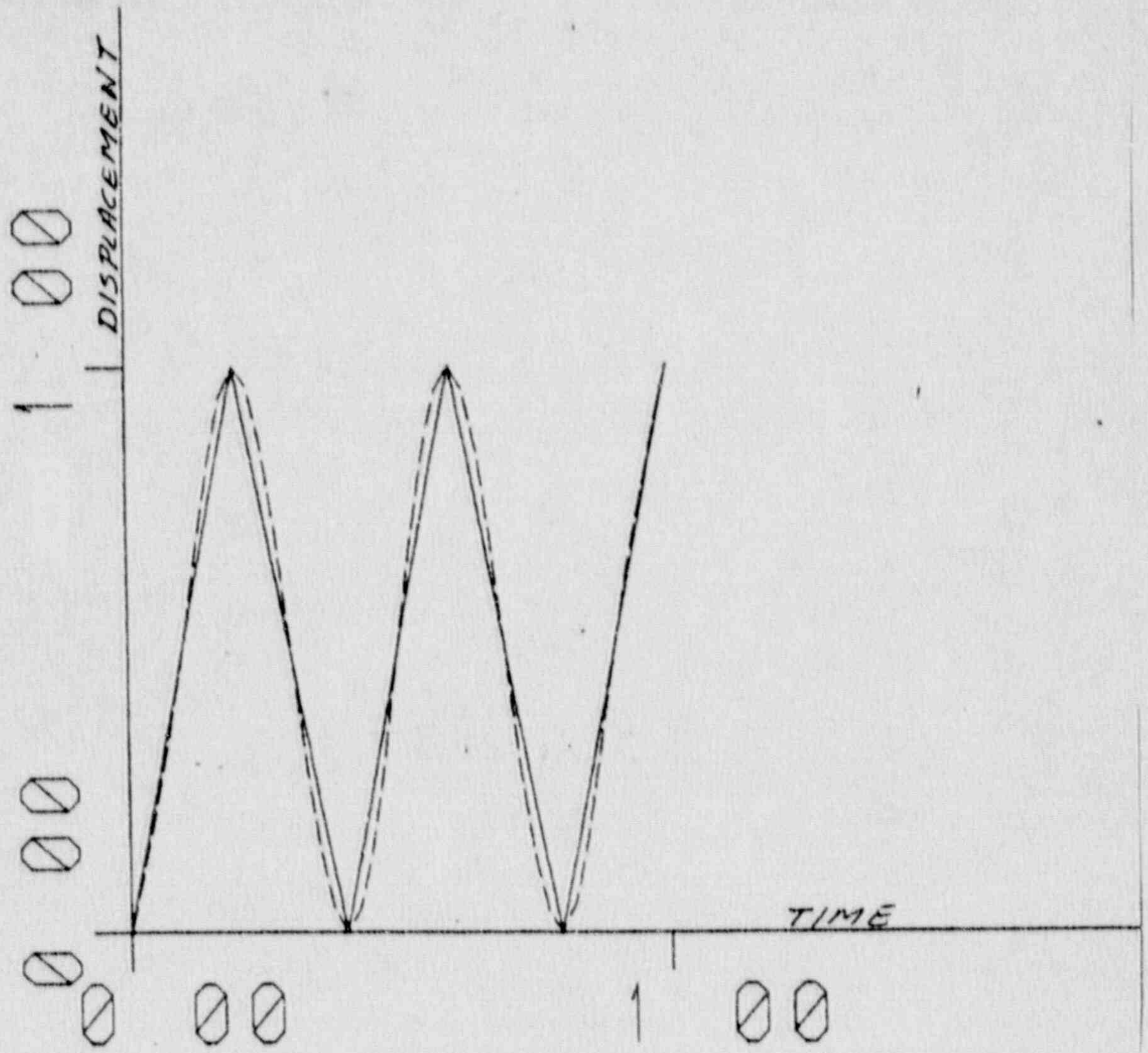


TABLE 1

***** CUBIC SPLINE COEFFICIENTS *****
***** per IMSL routine ICSICU *****

$$S(t) = C_3(t - t_i)^3 + C_2(t - t_i)^2 + C_1(t - t_i) + S(t_i)$$

$$\frac{d^2S}{dt^2} = 6(C_3)(t - t_i) + 2(C_2)$$

where: t = time point being evaluated
(such that: $t \le t < ti$)
t_i = time point at the ith interval (see Table 1)
$S(t_i)$ = displacement at time t_i

Interval	Range of t	C_1	C_2	C_3
1	$0.0 \le t < 0.1$	4.3443	.0000	65.5738
2	$0.1 \le t < 0.2$	6.3115	19.6721	-327.8689
3	$0.2 \le t < 0.4$	.4098	-78.6885	258.1967
4	$0.4 \le t < 0.6$	-.0820	76.2295	-254.0984
5	$0.6 \le t < 0.8$	-.0820	-76.2295	258.1967
6	$0.8 \le t < 0.9$	.4098	78.6885	-327.8689
7	$0.9 \le t < 1.0$	6.3115	-19.6721	65.5738

Table 2

Computer Generated Displacements and Accelerations

t	S(t)	d^2S/dt^2
.0000	.0000	.0000
.0250	.1096	9.8361
.0500	.2254	19.6721
.0750	.3535	29.5082
.1000	.5000	39.3443
.1250	.6650	-9.8361
.1500	.8238	-59.0164
.1750	.9457	-108.1967
.2000	1.0000	-157.3770
.2250	.9651	-118.6475
.2500	.8560	-79.9180
.2750	.6970	-41.1885
.3000	.5123	-2.4590
.3250	.3260	36.2705
.3500	.1624	75.0000
.3750	.0457	113.7295
.4000	.0000	152.4590
.4250	.0416	114.3443
.4500	.1547	76.2295
.4750	.3154	38.1148
.5000	.5000	.0000
.5250	.6846	-38.1148
.5500	.8453	-76.2295
.5750	.9584	-114.3443
.6000	1.0000	-152.4590
.6250	.9543	-113.7295
.6500	.8376	-75.0000
.6750	.6740	-36.2705
.7000	.4877	2.4590
.7250	.3030	41.1885
.7500	.1440	79.9180
.7750	.0349	118.6475
.8000	.0000	157.3770
.8250	.0543	108.1967
.8500	.1762	59.0164
.8750	.3350	9.8361
.9000	.5000	-39.3443
.9250	.6465	-29.5082
.9500	.7746	-19.6721
.9750	.8904	-9.8361
1.0000	1.0000	.0000

SUBJECT: COMPARE COMPUTER GENERATED DISPLACEMENTS AND ACCEL TO HAND CALCS. PROJECT: SQN

COMPUTED BY: CDD DATE: 4-24-90 CHECKED BY: JDS DATE: 4-25-90

Evaluate Displacements and Accelerations for 4 time steps

$t = 0.375$
$t = 0.525$
$t = 0.625$
$t = 0.975$

$t = 0.375$ (interval 3, per Table 1) $t_i = 0.2$

$C_1 = .4098$ $S(t_i) = 1.0$

$C_2 = -78.6885$

$C_3 = 258.1967$ $t - t_i = (.375 - .2) = .175$

$$S(t) = C_3 (t - t_i)^3 + C_2 (t - t_i)^2 + C_1 (t - t_i) + S(t_i)$$

$$= 258.1967(.175)^3 + (-78.6885)(.175)^2 + .4098(.175) + 1.0$$

$\Rightarrow S(t) = 0.0457$ compares w/ TABLE 2

$$d^2S/dt^2 = 6 C_3 (t - t_i) + 2 C_2$$

$\Rightarrow d^2S/dt^2 = 6(258.1967)(.175) + 2(-78.6885) = 113.7295$ COMPARES w/ TABLE 2

$t = 0.525$ (interval 4 per Table 1) $t_i = .4$

$C_1 = -.0820$ $S(t_i) = 0.00$

$C_2 = 76.2295$

$C_3 = -254.0984$ $(t - t_i) = (.525 - .4) = 0.125$

$$S(t) = C_3 (t - t_i)^3 + C_2 (t - t_i)^2 + C_1 (t - t_i) + S(t_i)$$

$$= -254.0984(.125)^3 + 76.2295(.125)^2 + (-.0820)(.125) + 0.0$$

$\Rightarrow S(t) = 0.6846$ COMPARES w/ TABLE 2

$$d^2S/dt^2 = 6 C_3 (t - t_i) + 2 C_2$$

$$= 6(-254.0984)(.125) + 2(76.2295)$$

$\Rightarrow d^2S/dt^2 = -38.1148$ COMPARES w/ TABLE 2

SUBJECT COMPARE COMPUTER GENERATED DISPLACEMENTS AND ACCEL. TO HAND CALCS PROJECT

COMPUTED BY CDD DATE 4-24-90 CHECKED BY JDS DATE 4-25-90

$t = 0.625$ (interval 5 per Table 1) $t_i = 0.6$

$C_1 = -0.0820$ $S(t_i) = 1.00$

$C_2 = -76.2295$

$C_3 = 258.1967$ $(t-t_i) = (.625 - .6) = .025$

$$S(t) = C_3(t-t_i)^3 + C_2(t-t_i)^2 + C_1(t-t_i) + S(t_i)$$

$$= 258.1967(.025)^3 + (-76.2295)(.025)^2 + (-.0820)(.025) + 1.0$$

$\Rightarrow S(t) = 0.9543$ COMPARES w/ TABLE 2

$$d^2S/dt^2 = 6C_3(t-t_i) + 2C_2$$

$$= 6(258.1967)(.025) + 2(-76.2295)$$

$\Rightarrow d^2S/dt^2 = -113.7295$ COMPARES w/ TABLE 2

$t = 0.975$ (interval 7 per Table 1) $t_i = 0.9$

$C_1 = 6.3115$ $S(t_i) = 0.5$

$C_2 = -19.6721$

$C_3 = 65.5738$ $(t-t_i) = .975 - .9 = 0.075$

$$S(t) = C_3(t-t_i)^3 + C_2(t-t_i)^2 + C_1(t-t_i) + S(t_i)$$

$$= 65.5738(.075)^3 + (-19.6721)(.075)^2 + (6.3115)(.075) + .5$$

$\Rightarrow S(t) = 0.8904$ COMPARES w/ TABLE 2

$$d^2S/dt^2 = 6C_3(t-t_i) + 2C_2$$

$$= 6(65.5738)(.075) + 2(-19.6721)$$

$d^2S/dt^2 = -9.8360$ TABLE 2 $= -9.8361$ ok

ATTACHMENT B

ATTACHMENT B

A review of the original DBA dynamic analysis results (CEB report 86-20-C R0) for the Steel Containment Vessel elevation 760.4 (the elevation with available spectra closest to elevation 763.58) and all available plots of the above report has shown that no primary peaks occur above 10 Hertz. Although there is a secondary peak at approximately 14.5 Hertz, the magnitude of this peak is approximately 2.6 times less than the magnitude of the primary peak. The following table compares the magnitude of the primary peak, the secondary peak, and the ZPA of radial spectra at this elevation.

Elevation 760.4

Azimuth (Degree)	Direction	Acceleration (g) Primary	Secondary	ZPA
255	Radial	13.3	*	4.9
285	Radial	15.3	*	5.3
300	Radial	16.8	6.5	3.5

* Although these spectra (envelop of six hot leg breaks) show no secondary peak at 14.5 Hertz, the accelerations at this frequency are greater than the 6.5g at azimuth 300 degrees.

Figures B.1 to B.3 (attached) are the source of the data in the above table and are provided as visual aids.

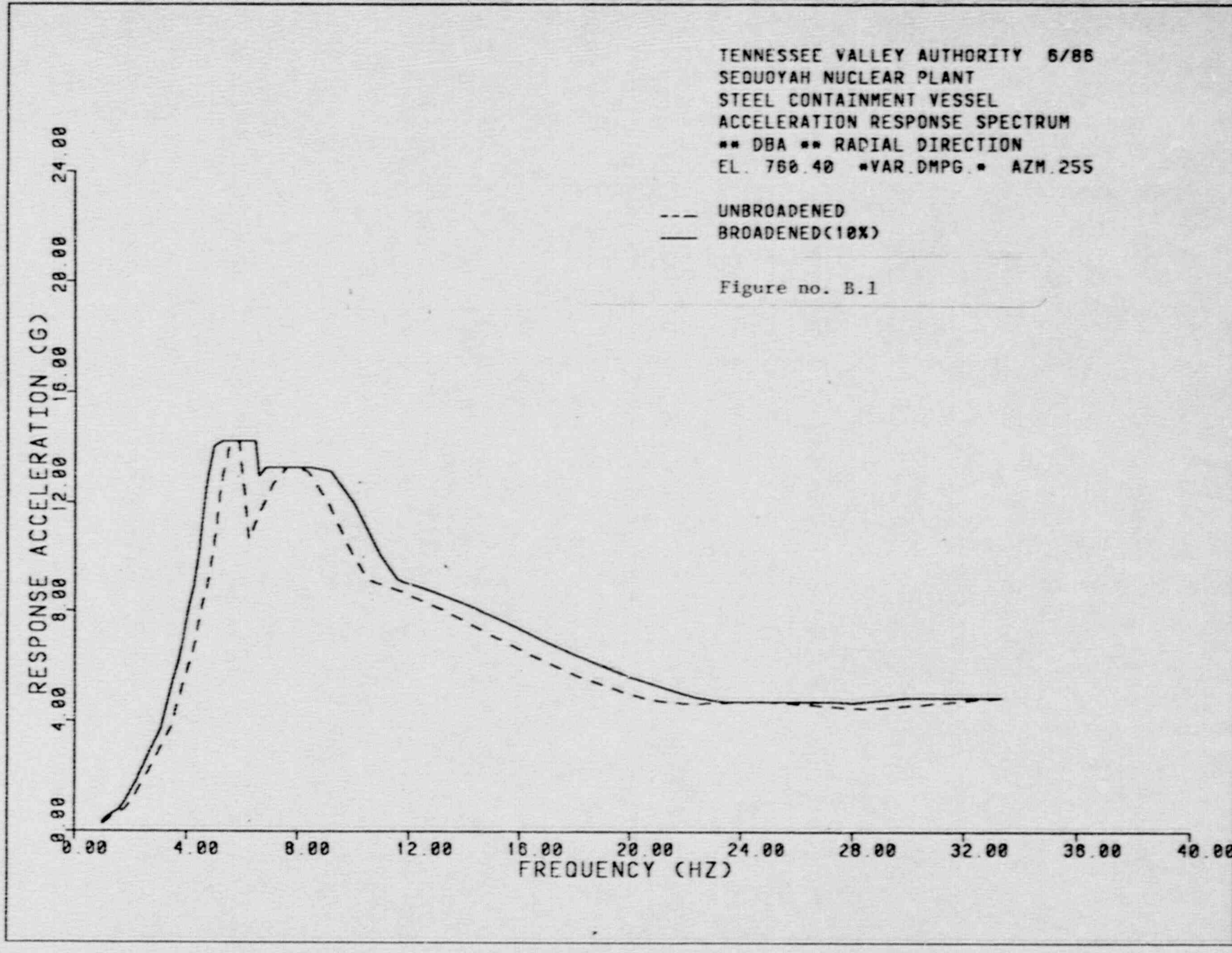

TENNESSEE VALLEY AUTHORITY 6/86
SEQUOYAH NUCLEAR PLANT
STEEL CONTAINMENT VESSEL
ACCELERATION RESPONSE SPECTRUM
** DBA ** RADIAL DIRECTION
EL. 760.40 *VAR.DMPG.* AZM.255
UNBROADENED
BROADENED(10%)
RESPONSE ACCELERATION (G)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
FREQUENCY (HZ)

Figure no. B.1

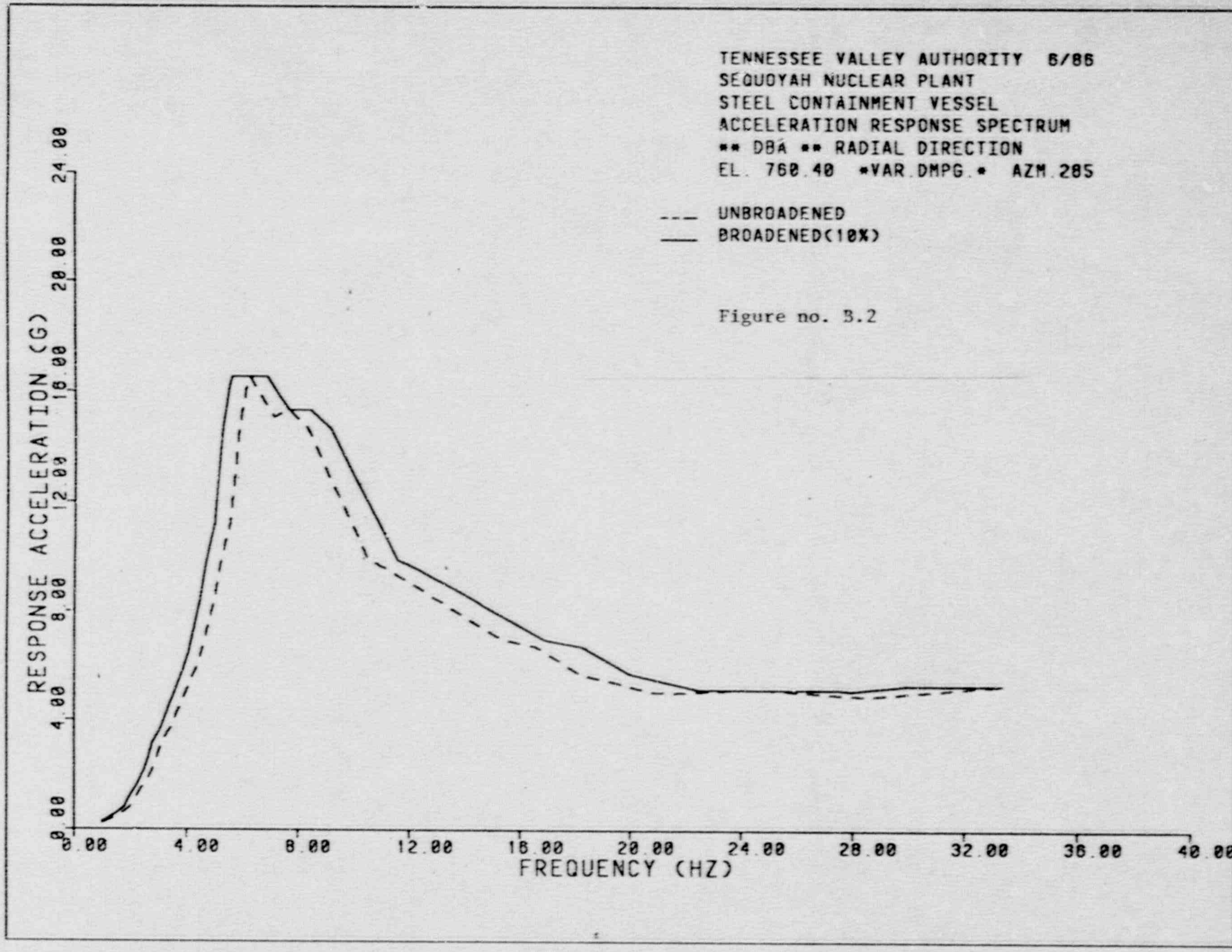

TENNESSEE VALLEY AUTHORITY 6/86
SEQUOYAH NUCLEAR PLANT
STEEL CONTAINMENT VESSEL
ACCELERATION RESPONSE SPECTRUM
** DBA ** RADIAL DIRECTION
EL. 760.40 *VAR.DMPG.* AZM.285
UNBROADENED
BROADENED(10%)
RESPONSE ACCELERATION (G)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
FREQUENCY (HZ)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00

Figure no. B.2

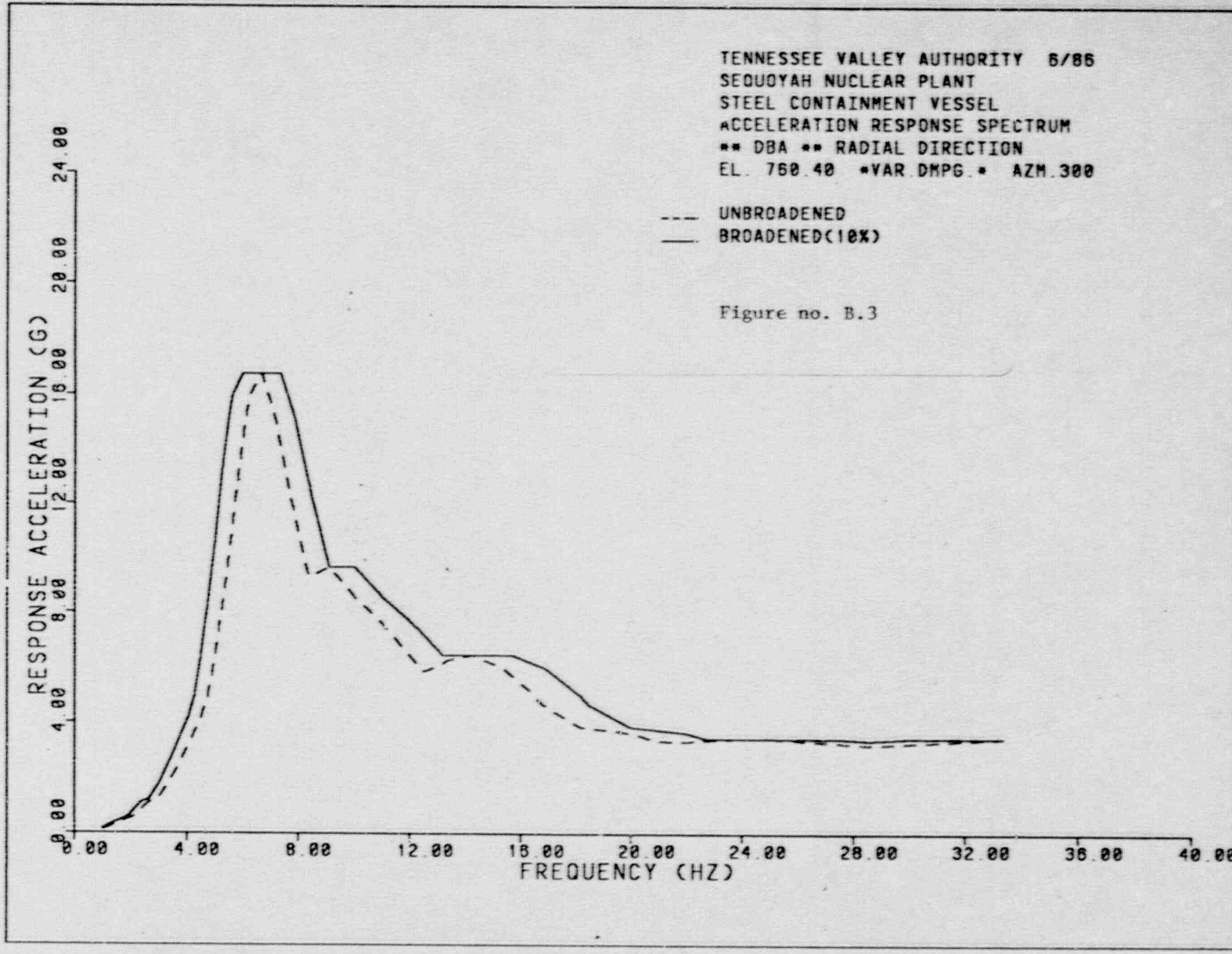

TENNESSEE VALLEY AUTHORITY 6/86
SEQUOYAH NUCLEAR PLANT
STEEL CONTAINMENT VESSEL
ACCELERATION RESPONSE SPECTRUM
** DBA ** RADIAL DIRECTION
EL. 760.40 *VAR.DMPG.* AZM.300
UNBROADENED
BROADENED(10%)
RESPONSE ACCELERATION (G)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
FREQUENCY (HZ)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00

Figure no. B.3

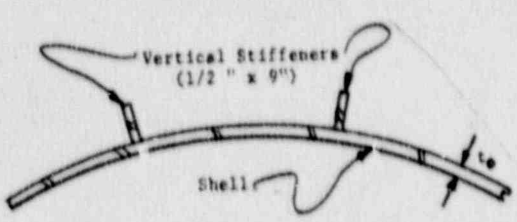
ATTACHMENT C

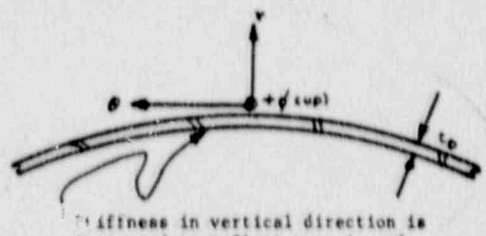
SEQUOYAH NUCLEAR PLANT
STEEL CONTAINMENT VESSELS

MODELING OF HORIZONTAL AND VERTICAL STIFFNERS

The steel containment vessels are thin shell structures consisting of 115 feet diameter cylindrical segments with a hemispherical dome. The shell thickness varies from 1 3/8 inch at the base to 1/2 inch at the intersection of the cylinder and dome. The vessels are stiffened with 18 circumferential (horizontal) ring stiffeners. Vertical stiffeners are located at 4 degrees on center over most of the shell. The vessel geometry and stiffener location are shown in figure 1.

The ring (horizontal) stiffeners were modeled as discrete elements in the axisymmetric finite element model (see for example node 8 to 9 on figure 1). The vertical stiffeners have been "smeared" onto the shell and incorporated into the finite element model as illustrated below.





Stiffness in vertical direction is increased to reflect smearing of vertical stiffeners.

The vertical stiffeners were considered to contribute to the extensional rigidity in the vertical direction only (i.e. bending neglected) and the increase in stiffness is proportional to the ratio of the cross sectional area of the vertical stiffeners to the cross sectional area of the shell at a given elevation. Therefore, the extensional stiffness of the shell in the vertical direction is given by

$$K_{\phi} = \frac{A_{(stiff)} + A_{(shell)}}{A_{(shell)}} \left(\frac{Et_o}{1-\nu^2} \right)$$

The effect of the vertical stiffeners on the extensional rigidity is to add the equivalent of 0.10 inches to the shell thickness.

In the circumferential direction the stiffness of the shell is given by

$$K_\theta = \left(\frac{E\ t_o}{1 - v^2} \right)$$

where

$E = 29000000$ psi
$v = 0.30$
$t_o =$ shell thickness

This formulation is consistent with that outlined on page 139 of The Finite Element Method in Structural and Continuum Mechanics by O. C. Zienkiewicz

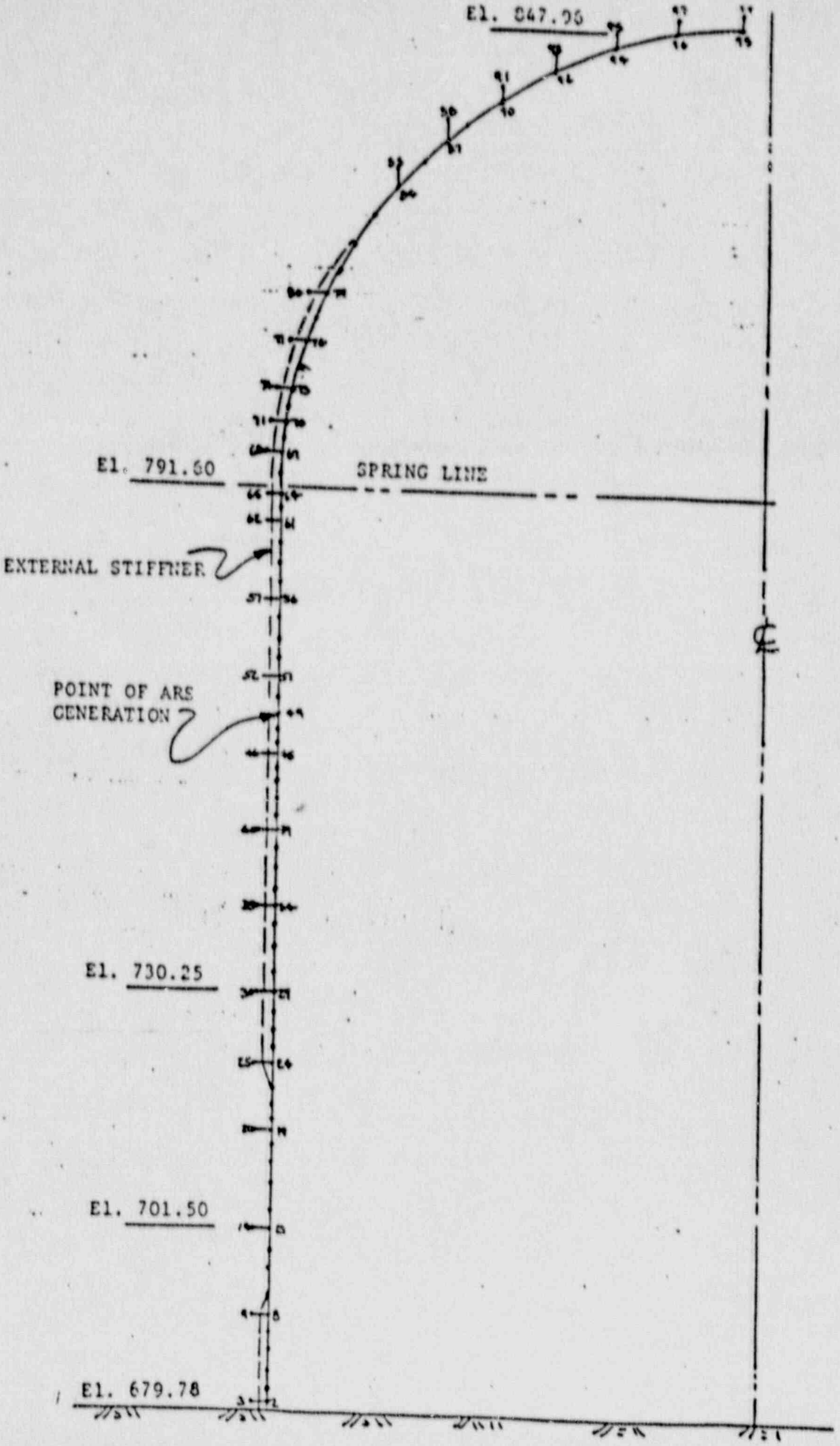

El. 847.96
El. 791.60
SPRING LINE
EXTERNAL STIFFNER
POINT OF ARS
GENERATION
El. 730.25
El. 701.50
El. 679.78

Figure 1

ATTACHMENT D

ATTACHMENT D

QUANTITATIVE EVALUATION OF PRESSURE-TIME HISTORY TRUNCATION AT 0.9 SECOND

INTRODUCTION

To provide a rigorous or quantitative assessment of the impact of truncating at 0.90 second the pressure-time histories that excite the Sequoyah Nuclear Plant (SQN) steel containment vessels (SCV), an additional transient dynamic analysis of the SCV was performed. In this further evaluation, the same model and double-ended pipe break (main steam line) of the previous evaluation were used.

ANALYTICAL APPROACH

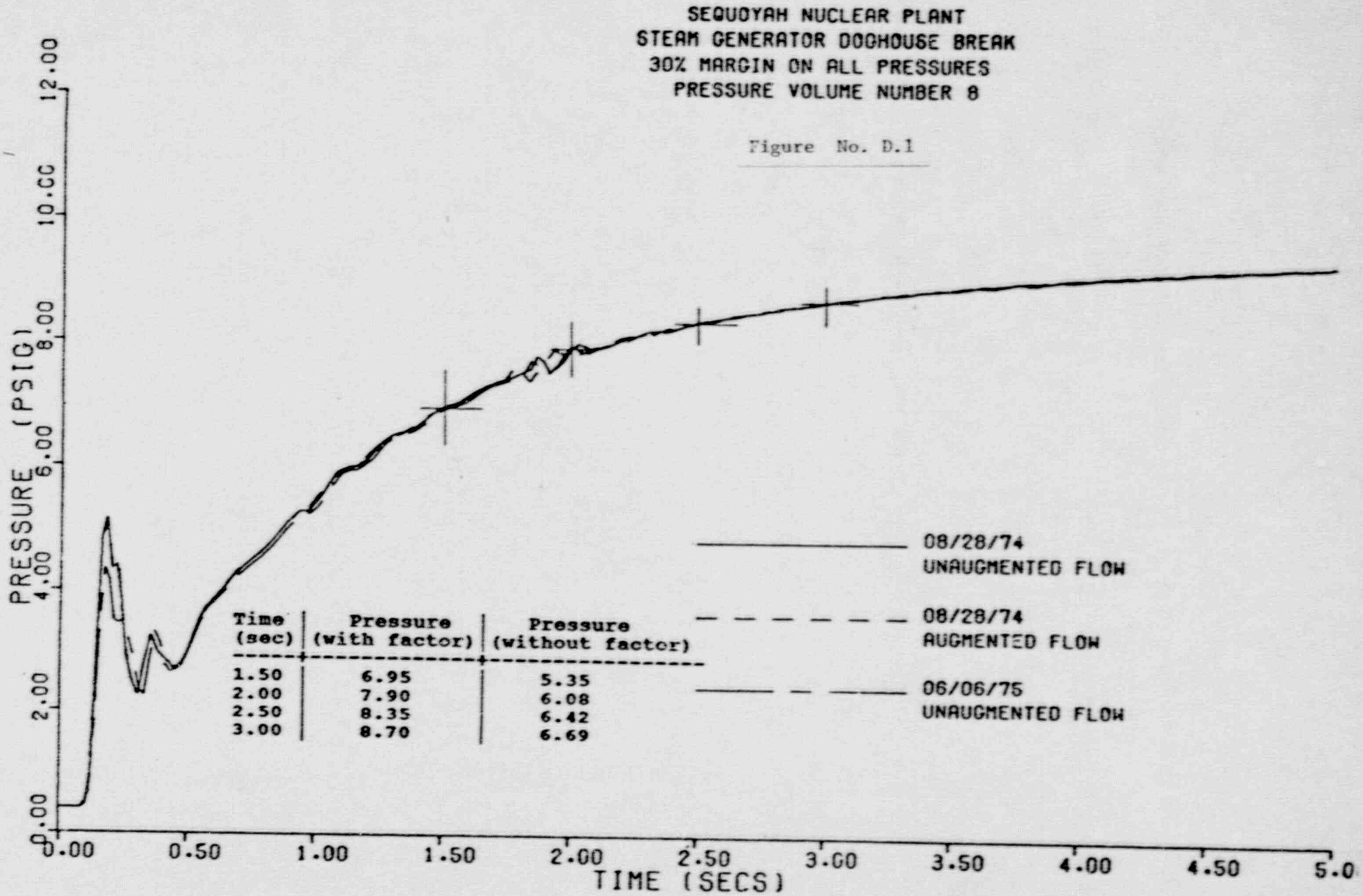
The pressure-time curves for the main steam line break were digitized to 3.0 seconds using as a basis the pressure data previously provided to TVA by Westinghouse Electric Corporation (Westinghouse letter TVA-5278 dated June 6, 1975). These data were plotted by TVA and a representative sample is shown on Figures D.1 to D.4. Figure D.5 presents a logic diagram defining how this analysis was performed and the basis of comparison.

SUMMARY OF RESULTS

Figure D.6 is a comparison at Elevation 763.50 and 0 degrees Fahrenheit azimuth of the SCV acceleration response versus time for an analysis with a duration of 0.90 seconds and an analysis with a duration of 2.5 seconds (although the pressure-time input was 3.0 seconds, 2.5 seconds was used in the analysis). As shown, the two curves are identical for a 0.9 second duration. The curve for 2.5 seconds duration shows a decrease in amplitude from 0.9 to 2.5 seconds. Figure D.7 is a comparison of acceleration response spectra generated from the two time histories of figure D.6. Table D.1 is a digitized form of the curves of Figure D.6. The data of this table show that the two curves are essentially identical and indicate that the times of occurrence of the spectral values are less than 0.90 seconds. The calculation (SCG-2S-89-143) that is the basis of all comparisons is attached.

CONCLUSION

The comparison of the results from the two analyses show that the acceleration time history records are identical in the 0.0 to 0.90 seconds range and that between 0.90 second and 2.50 seconds the record decreases in amplitude. Additionally, the comparison of acceleration response spectra shows that the dynamic response of the steel containment vessel is unchanged by the addition of pressure data beyond 0.90 seconds.



Time (sec)	Pressure (with factor)	Pressure (without factor)
1.50	6.95	5.35
2.00	7.90	6.08
2.50	8.35	6.42
3.00	8.70	6.69

Figure No. D.1

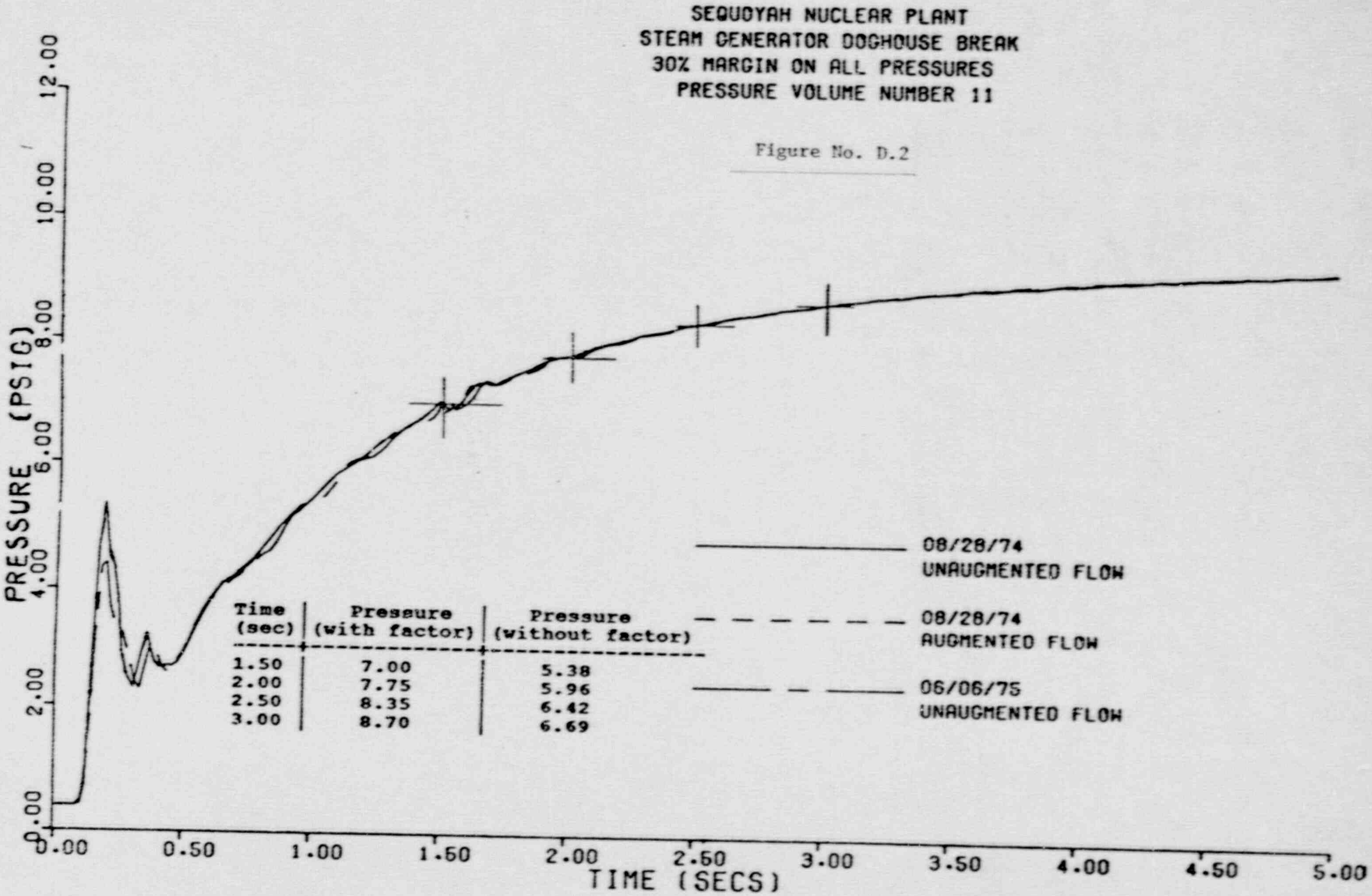
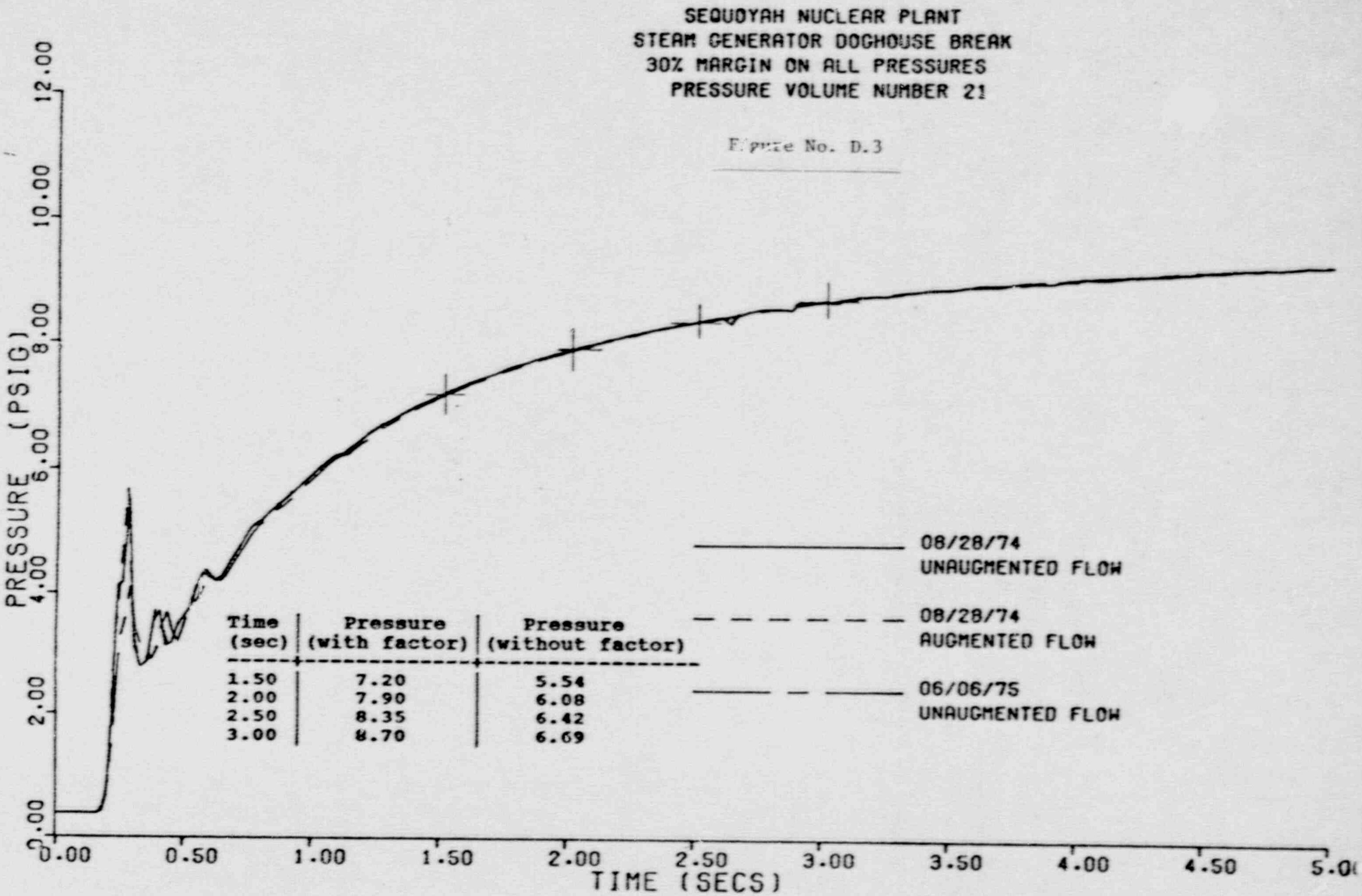


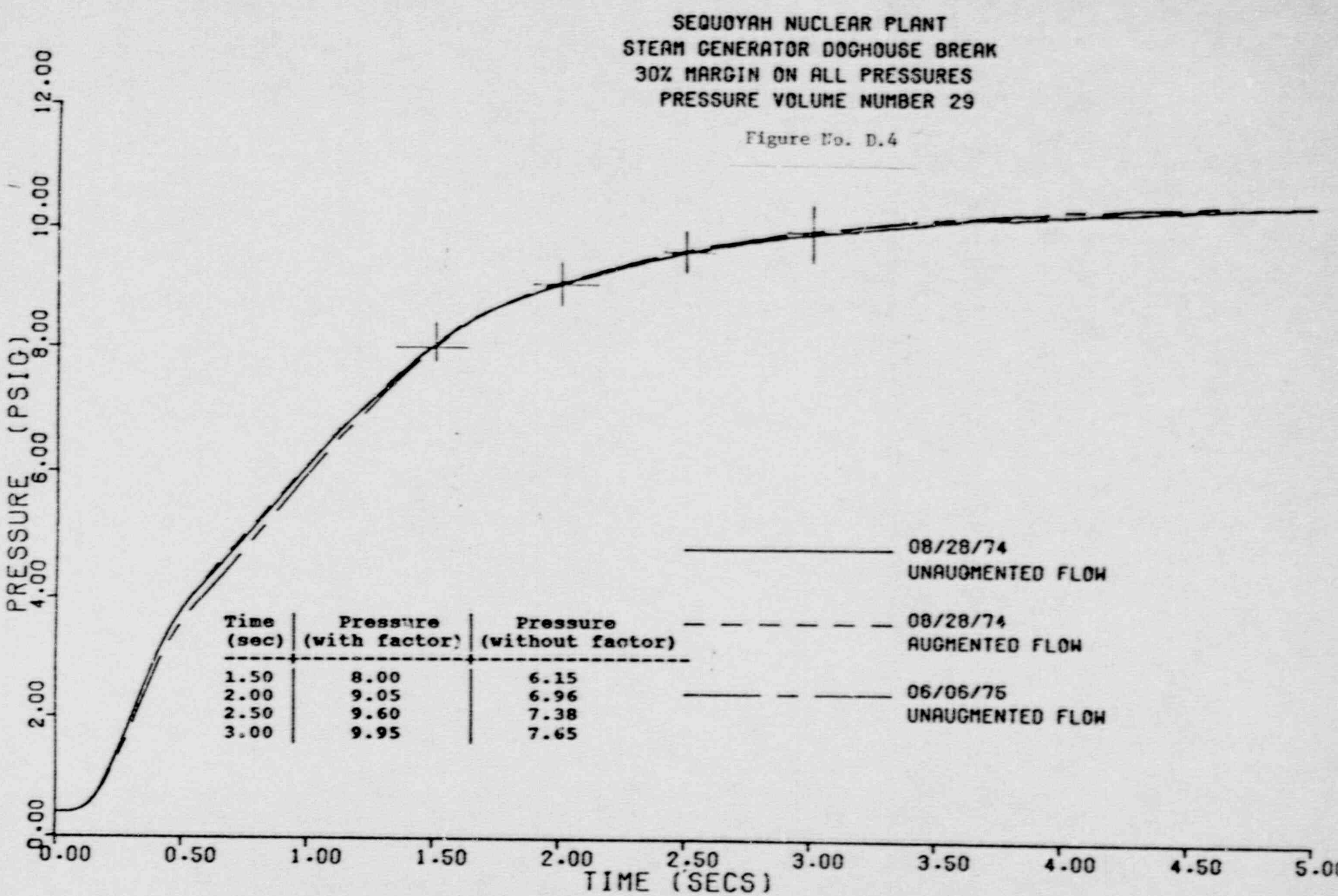
Figure No. D.2

Time (sec)	Pressure (with factor)	Pressure (without factor)
1.50	7.00	5.38
2.00	7.75	5.96
2.50	8.35	6.42
3.00	8.70	6.69



Time (sec)	Pressure (with factor)	Pressure (without factor)
1.50	7.20	5.54
2.00	7.90	6.08
2.50	8.35	6.42
3.00	8.70	6.69

Figure No. D.3



Time (sec)	Pressure (with factor)	Pressure (without factor)
1.50	8.00	6.15
2.00	9.05	6.96
2.50	9.60	7.38
3.00	9.95	7.65

Figure No. D.4

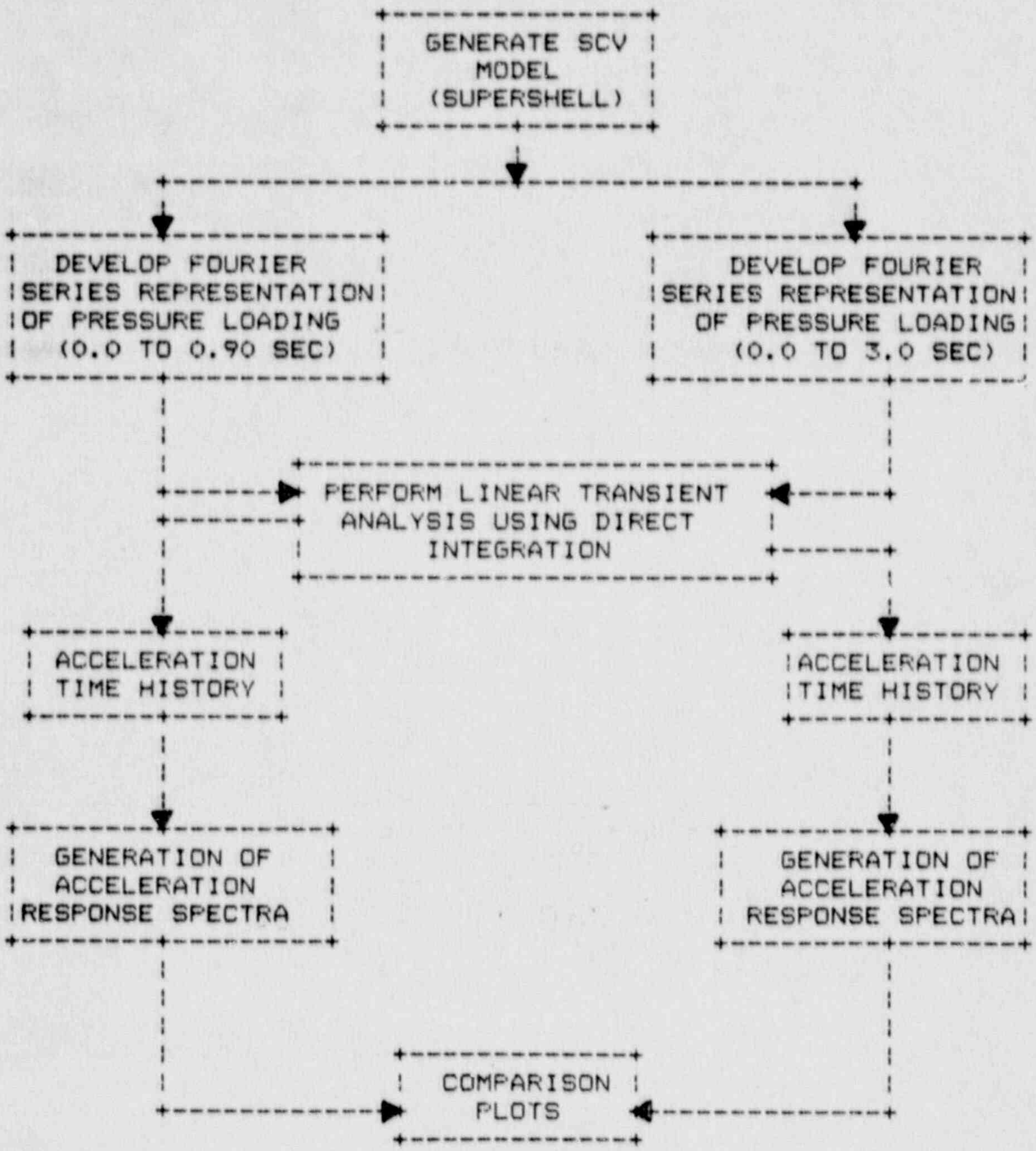
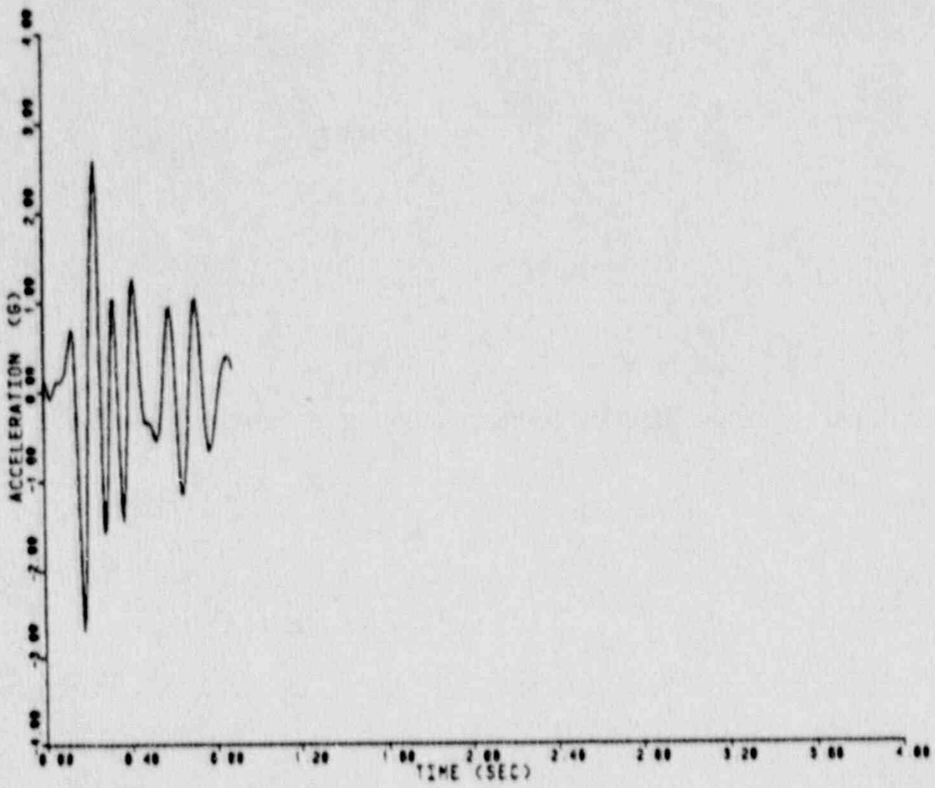


FIGURE D.5 DETAIL LOGIC DIAGRAM FOR LINEAR TRANSIENT ANALYSIS

Figure No. D.6

Time History Comparison

CCTS - SUPERSHELL



CCTS - SUPERSHELL

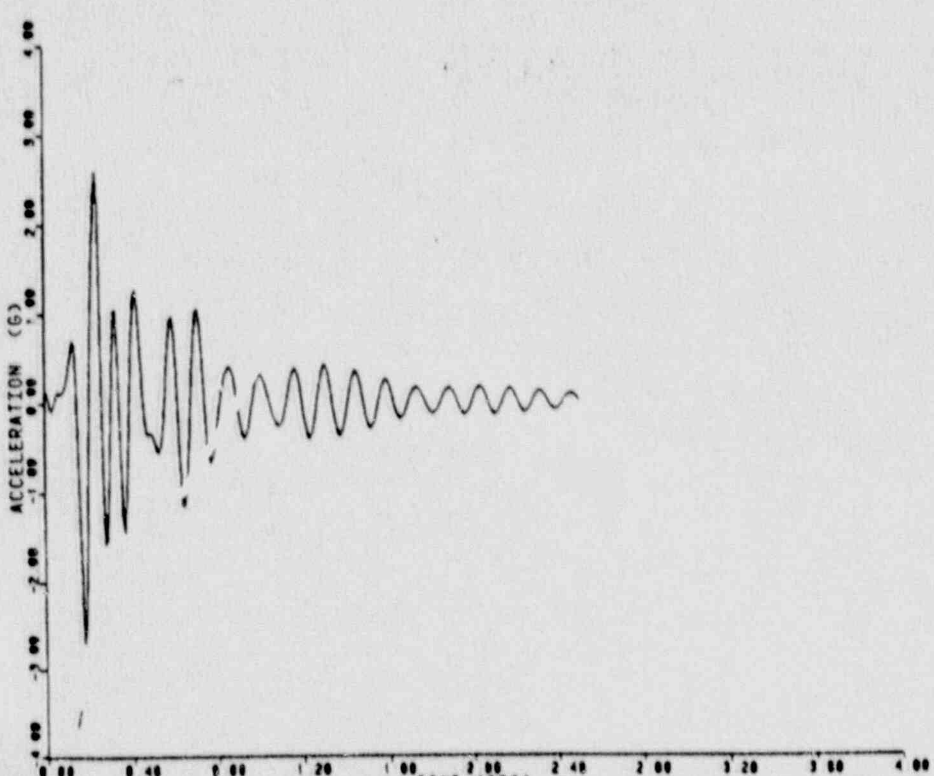
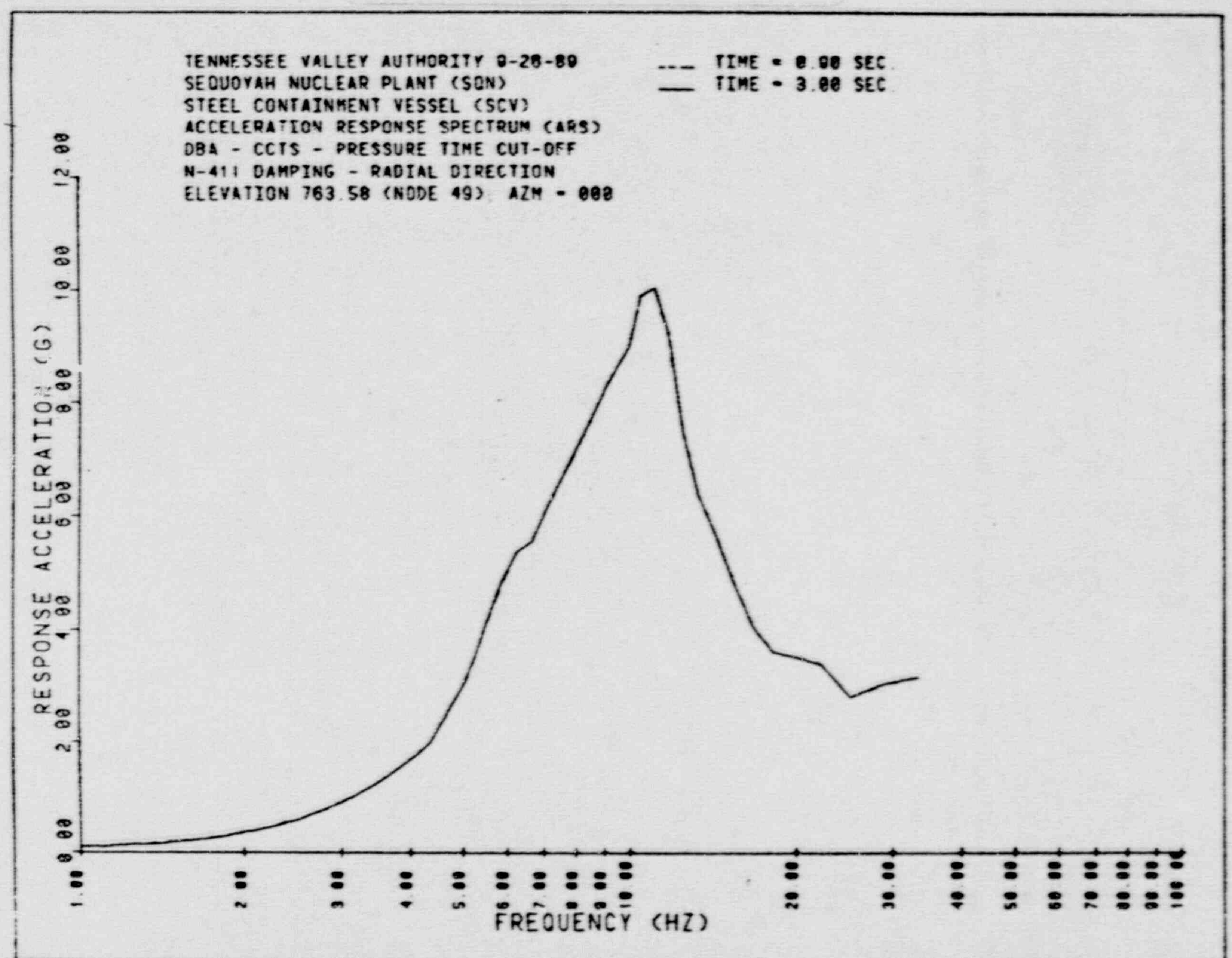


Figure No. D.7
Acceleration Response Spectra
Comparison



SQN SCV CCTS WORK FOR DOUBLE DIFFERENTIATION-RAD(NP 49)AZ000 SUPERSHEL 89/09/26
AZMUITH 000
MASS POINT 49 VARIABLE DAMPING

Time Interval 0.0 to 0.90 second

MAXIMUM ACCELERATIONS(G)PERIOD(SEC) AND TIME(SEC)

J=	PERIOD	OMEGA	MAX ACC		TIME OF MAX ACC
1	.10000E+01	.62832E+01	.73233E-01		.23000E+00
2	.95000E+00	.66139E+01	.80990E-01		.23000E+00
3	.90000E+00	.69813E+01	.90231E-01		.23000E+00
4	.85000E+00	.73920E+01	.10155E+00		.23200E+00
5	.80000E+00	.78540E+01	.11542E+00		.23200E+00
6	.75000E+00	.83776E+01	.13264E+00		.23200E+00
7	.70000E+00	.89760E+01	.15464E+00		.23400E+00
8	.65000E+00	.96664E+01	.18297E+00		.23400E+00
9	.60000E+00	.10472E+02	.22017E+00		.23400E+00
10	.55000E+00	.11424E+02	.27057E+00		.23600E+00
11	.50000E+00	.12566E+02	.34024E+00		.23600E+00
12	.48000E+00	.13090E+02	.37556E+00		.23600E+00
13	.46000E+00	.13659E+02	.41641E+00		.23600E+00
14	.44000E+00	.14280E+02	.46386E+00		.23600E+00
15	.42000E+00	.14960E+02	.51927E+00		.23600E+00
16	.40000E+00	.15708E+02	.58428E+00		.23600E+00
17	.38000E+00	.16535E+02	.66089E+00		.23600E+00
18	.36000E+00	.17453E+02	.75153E+00		.23600E+00
19	.34000E+00	.18480E+02	.85908E+00		.23600E+00
20	.32000E+00	.19635E+02	.98836E+00		.23400E+00
21	.30000E+00	.20944E+02	.11427E+01		.23400E+00
22	.29000E+00	.21666E+02	.12306E+01		.23400E+00
23	.28000E+00	.22440E+02	.13279E+01		.23200E+00
24	.27000E+00	.23271E+02	.14343E+01		.23200E+00
25	.26000E+00	.24166E+02	.15497E+01		.23200E+00
26	.25000E+00	.25133E+02	.16778E+01		.23000E+00
27	.24000E+00	.26180E+02	.18168E+01		.22900E+00
28	.23000E+00	.27318E+02	.19685E+01		.22800E+00
29	.22000E+00	.28560E+02	.22878E+01		.41800E+00
30	.21000E+00	.29920E+02	.26451E+01		.41200E+00
31	.20000E+00	.31416E+02	.29723E+01		.40600E+00
32	.19000E+00	.33069E+02	.35145E+01		.57400E+00
33	.18000E+00	.34907E+02	.41680E+01		.56200E+00
34	.17000E+00	.36960E+02	.48140E+01		.63000E+00
35	.16000E+00	.39270E+02	.53648E+01		.69200E+00
36	.15000E+00	.41888E+02	.55487E+01		.28000E+00
37	.14000E+00	.44880E+02	.61978E+01		.27600E+00
38	.13000E+00	.48332E+02	.67932E+01		.27200E+00
39	.12000E+00	.52360E+02	.74724E+01		.32200E+00
40	.11000E+00	.57120E+02	.82776E+01		.31400E+00
41	.10000E+00	.62832E+02	.89857E+01		.45200E+00
42	.95000E-01	.66139E+02	.98802E+01		.44400E+00
43	.90000E-01	.69813E+02	.10011E+02	**MAX**	.43600E+00
44	.85000E-01	.73920E+02	.92032E+01		.42800E+00
45	.80000E-01	.78540E+02	.74486E+01		.42000E+00
46	.75000E-01	.83776E+02	.63582E+01		.24000E+00
47	.70000E-01	.89760E+02	.56978E+01		.23600E+00
48	.65000E-01	.96664E+02	.48788E+01		.23200E+00
49	.60000E-01	.10472E+03	.40601E+01		.23000E+00
50	.55000E-01	.11424E+03	.36152E+01		.18600E+00
51	.50000E-01	.12566E+03	.35241E+01		.18600E+00
52	.45000E-01	.13963E+03	.33973E+01		.18200E+00
53	.40000E-01	.15708E+03	.28020E+01		.18000E+00
54	.35000E-01	.17952E+03	.30189E+01		.24600E+00
55	.30000E-01	.20944E+03	.31533E+01		.23900E+00

Table D.1

SQN SCV CCTS WORK FOR DOUBLE DIFFERENTIATION-RAD(NP 49)AZ000 SUPERSHEL 90/03/31
AZMUITH 000
MASS POINT 49 VARIABLE DAMPING
Time Interval 0.0 to 2.5 sec.
MAXIMUM ACCELERATIONS(G)PERIOD(SEC) AND TIME(SEC)

J=	PERIOD	OMEGA	MAX ACC		TIME OF MAX ACC
1	.10000E+01	.62832E+01	.73233E-01		.23000E+00
2	.95000E+00	.66139E+01	.80990E-01		.23000E+00
3	.90000E+00	.69813E+01	.90231E-01		.23000E+00
4	.85000E+00	.73920E+01	.10155E+00		.23200E+00
5	.80000E+00	.78540E+01	.11542E+00		.23200E+00
6	.75000E+00	.83776E+01	.13264E+00		.23200E+00
7	.70000E+00	.89760E+01	.15464E+00		.23400E+00
8	.65000E+00	.96664E+01	.18297E+00		.23400E+00
9	.60000E+00	.10472E+02	.22017E+00		.23400E+00
10	.55000E+00	.11424E+02	.27057E+00		.23600E+00
11	.50000E+00	.12566E+02	.34024E+00		.23600E+00
12	.48000E+00	.13090E+02	.37556E+00		.23600E+00
13	.46000E+00	.13659E+02	.41641E+00		.23600E+00
14	.44000E+00	.14280E+02	.46386E+00		.23600E+00
15	.42000E+00	.14960E+02	.51927E+00		.23600E+00
16	.40000E+00	.15708E+02	.58428E+00		.23600E+00
17	.38000E+00	.16535E+02	.66089E+00		.23600E+00
18	.36000E+00	.17453E+02	.75153E+00		.23600E+00
19	.34000E+00	.18480E+02	.85908E+00		.23600E+00
20	.32000E+00	.19635E+02	.98836E+00		.23400E+00
21	.30000E+00	.20944E+02	.11427E+01		.23400E+00
22	.29000E+00	.21666E+02	.12306E+01		.23400E+00
23	.28000E+00	.22440E+02	.13279E+01		.23200E+00
24	.27000E+00	.23271E+02	.14343E+01		.23200E+00
25	.26000E+00	.24166E+02	.15497E+01		.23200E+00
26	.25000E+00	.25133E+02	.16778E+01		.23000E+00
27	.24000E+00	.26180E+02	.18168E+01		.22900E+00
28	.23000E+00	.27318E+02	.19685E+01		.22800E+00
29	.22000E+00	.28560E+02	.22878E+01		.41800E+00
30	.21000E+00	.29920E+02	.26451E+01		.41200E+00
31	.20000E+00	.31416E+02	.29723E+01		.40600E+00
32	.19000E+00	.33069E+02	.35145E+01		.57400E+00
33	.18000E+00	.34907E+02	.41680E+01		.56200E+00
34	.17000E+00	.36960E+02	.48140E+01		.63000E+00
35	.16000E+00	.39270E+02	.53648E+01		.69200E+00
36	.15000E+00	.41888E+02	.55487E+01		.28000E+00
37	.14000E+00	.44880E+02	.61978E+01		.27600E+00
38	.13000E+00	.48332E+02	.67932E+01		.27200E+00
39	.12000E+00	.52360E+02	.74724E+01		.32200E+00
40	.11000E+00	.57120E+02	.82776E+01		.31400E+00
41	.10000E+00	.62832E+02	.89857E+01		.45200E+00
42	.95000E-01	.66139E+02	.98802E+01		.44400E+00
43	.90000E-01	.69813E+02	.10011E+02	**MAX**	.43600E+00
44	.85000E-01	.73920E+02	.92032E+01		.42800E+00
45	.80000E-01	.78540E+02	.74486E+01		.42000E+00
46	.75000E-01	.83776E+02	.63582E+01		.24000E+00
47	.70000E-01	.89760E+02	.56978E+01		.23600E+00
48	.65000E-01	.96664E+02	.48788E+01		.23200E+00
49	.60000E-01	.10472E+03	.40601E+01		.23000E+00
50	.55000E-01	.11424E+03	.36152E+01		.18600E+00
51	.50000E-01	.12566E+03	.35241E+01		.18600E+00
52	.45000E-01	.13963E+03	.33973E+01		.18200E+00
53	.40000E-01	.15708E+03	.28020E+01		.18000E+00
54	.35000E-01	.17952E+03	.30189E+01		.24600E+00
55	.30000E+01	.20944E+03	.31533E+01		.23900E+00

Table D.1 (continued)

ATTACHMENT D

QUANTITATIVE EVALUATION OF PRESSURE-TIME HISTORY TRUNCATION AT 0.9 SECOND

INTRODUCTION

To provide a rigorous or quantitative assessment of the impact of truncating at 0.90 second the pressure-time histories that excite the Sequoyah Nuclear Plant (SQN) steel containment vessels (SCV), an additional transient dynamic analysis of the SCV was performed. In this further evaluation, the same model and double-ended pipe break (main steam line) of the previous evaluation were used.

ANALYTICAL APPROACH

The pressure-time curves for the main steam line break were digitized to 3.0 seconds using as a basis the pressure data previously provided to TVA by Westinghouse Electric Corporation (Westinghouse letter TVA-5278 dated June 6, 1975). These data were plotted by TVA and a representative sample is shown on Figures D.1 to D.4. Figure D.5 presents a logic diagram defining how this analysis was performed and the basis of comparison.

SUMMARY OF RESULTS

Figure D.6 is a comparison at Elevation 763.50 and 0 degrees Fahrenheit azimuth of the SCV acceleration response versus time for an analysis with a duration of 0.90 seconds and an analysis with a duration of 2.5 seconds (although the pressure-time input was 3.0 seconds, 2.5 seconds was used in the analysis). As shown, the two curves are identical for a 0.9 second duration. The curve for 2.5 seconds duration shows a decrease in amplitude from 0.9 to 2.5 seconds. Figure D.7 is a comparison of acceleration response spectra generated from the two time histories of figure D.6. Table D.1 is a digitized form of the curves of Figure D.6. The data of this table show that the two curves are essentially identical and indicate that the times of occurrence of the spectral values are less than 0.90 seconds. The calculation (SCG-2S-89-143) that is the basis of all comparisons is attached.

CONCLUSION

The comparison of the results from the two analyses show that the acceleration time history records are identical in the 0.0 to 0.90 seconds range and that between 0.90 second and 2.50 seconds the record decreases in amplitude. Additionally, the comparison of acceleration response spectra shows that the dynamic response of the steel containment vessel is unchanged by the addition of pressure data beyond 0.90 seconds.

Calculation SCG-2S-89-143 follows this