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3-D SEISMIC TIME HISTORIES FOR PRIVATE STORAGE FACILITY

by

HOLTEC INTERNATIONAL

CLIENT: CLIENT CONSORTIUM, PRIVATE FUEL STORAGE L.L.C

HOLTEC PROJECT 60531
HOLTEC REPORT HI-961556

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REVIEW AND CERTIFICATION LOG

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This document conforms to the requirements of the design specification and the applicable sections of the governing codes.

Note: Signatures and printed names are required in the review block.

* A revision of this document will be ordered by the Project Manager and carried out if any of its contents is materially affected during evolution of this project. The determination as to the need for revision will be made by the Project Manager with input from others, as deemed necessary by him.

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THE REVISION CONTROL OF THIS DOCUMENT IS BY A "SUMMARY OF REVISIONS LOG" PLACED BEFORE THE TEXT OF THE REPORT.

Form: RCL.02

REVISIONS LOG

HOLTEC REPORT HI-961556

Revision 1

Pages 2-5 replaced. Figures 1, 2, 4, 5 and 6 replaced. Changes in text and figures made to address comments in SWEC letter of December 18, 1996.

Revision 2

Revision 2 replaces Revision 1 in its entirety using final response spectra provided by SWEC.

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EXECUTIVE SUMMARY

A 3-D Dynamic analysis of the HI-STORM dry storage casks on the Private Storage ISFSI is to be performed. Because of the non linear model of the dry storage casks, an accurate evaluation of seismic integrity of dry storage casks on an ISFSI requires a 3-D time history analysis. Herein, a set of three time histories, appropriate to the dry storage pad location, is developed. This report presents the procedure used to develop such a time history set. The final set of three seismic events is shown to produce response spectra that bound the response spectra used to generate the set, and power spectral density (PSD) curves which bound a target PSD curve. Each time history in the seismic set is demonstrated to be statistically independent of both of the other time histories forming the set. Thus, the generated time history set meets the guidelines of NUREG-0800, SRP 3.7.1, Rev.2 and is established as the time history set of record for non-linear analysis of the dry storage casks at this location.

INTRODUCTION

HOLTEC INTERNATIONAL is currently performing analysis of the Private Storage Facility (PSF) with Holtec HI-STORM dry storage casks to demonstrate that they meet all requirements for seismic stability when in place on the ISFSI pad. To this end, a dynamic model of a representative assemblage of dry storage casks is being developed; the assemblage of casks is subject to a 3-D transient time history corresponding to an SSE event. The input loading for the casks is the seismic event appropriate to the site characteristics.

In this report, time histories are developed spanning a duration of 20 sec. and are shown to meet all applicable USNRC requirements for time histories used as driving loading for dry storage cask dynamic analysis. The developed time histories are based on final response spectra developed by the site engineers. This revision of the report supercedes the original issue of this report which developed time histories using a preliminary spectra set.

ACCEPTANCE REQUIREMENTS FOR SEISMIC TIME HISTORIES

Reference [1] provides acceptance criteria for judging the applicability of a time history event to a structure in a nuclear power station. The following criteria must be satisfied:

1. Each time history (2 horizontal and 1 vertical) must be statistically independent. This is demonstrated by calculating the cross correlation coefficient for each time history with each of the other two events. Each of the three coefficients must be less than .15

2. The time histories, generated from an appropriate response spectrum, must be shown to regenerate a response spectrum that generally bounds the spectrum originally used to generate the time history. No more than 5 check points on the regenerated spectrum can be below the original spectrum, and each point that is below the target must be no more than 10% below. Reference [1] (Table 3.7.1-1) establishes recommended frequencies to perform the checking. The recommended frequencies for checking are provided below for the frequency range above .2 Hz.

0.2 Hz - 3.0 Hz	every .10 Hz
3.0 Hz - 3.6 Hz	every .15 Hz
3.6 Hz - 5.0 Hz	every .20 Hz
5.0 Hz - 8.0 Hz	every .25 Hz
8.0 Hz - 15. Hz	every .50 Hz
15. Hz - 18. Hz	every 1.0 Hz
18. Hz - 22. Hz	every 2.0 Hz
22. Hz - 34. Hz	every 3.0 Hz

The procedure used is to check the re-generated spectrum after a smoothing operation is performed on the raw output, at the 75 frequency locations indicated by the above table.

3. The generated time histories must regenerate a power spectral density (PSD) function of frequency which bounds a target PSD in the frequency range of interest. There is no guidance given as to the definition of bounding; however, the bounding of the PSD target is considered as a secondary requirement to the bounding of the target spectra.

GENERATION OF TIME HISTORIES

Site Specific final response spectra (1 horizontal and 1 vertical) are provided in [3]. Using the provided response spectra as input, the appropriate three components of the earthquake, in the form of a time history for each direction, are developed using the Holtec QA validated code GENEQ [2]. A 20 sec. event duration is assumed using 5% damping which is appropriate to the input spectra provided in [3]. The duration of strong motion is set at 10 seconds minimum.

RESULTS

Figures 1-3 show the comparison between the design basis spectra for the slab elevation and the smoothed spectra regenerated from the developed time histories. Two time histories have been generated from the single horizontal spectrum provided in [3]. X,Y

represent horizontal directions, and Z represents the vertical earthquake. The time histories are baseline corrected.

It is concluded, by examination of the results, that the regenerated spectra bound the design basis spectra in the manner required by [1] and that the time histories meet the response spectra regeneration test in the frequency range expected for cask motion.

Figures 4-6 show the comparison between the PSD vs. frequency curves regenerated from the developed time histories and the target PSD which is generated by GENEQ. The target PSD functions are consistent with the target spectra and are internally generated by GENEQ. The regenerated PSD functions are such that an averaged function will bound the target PSD functions in the frequency range of interest below 33HZ which is the dominant range of response expected for casks. Curves of 80% of the target PSD are also plotted.

Finally, results for the correlation function of the three time histories developed are presented below as computed by the computer code CORRE [4]. Absolute values of the correlation coefficients are less than .15 indicating the desired statistical independence of the three data sets.

MAGNITUDES OF COEFFICIENT OF CORRELATION

H1 TO H2 =	0.00102
H1 TO VT =	0.00976
H2 TO VT =	0.04927

Figures 7-9 show the three time histories appropriate to 5% damping.

CONCLUSIONS

The seismic time history files, developed from the final response spectra provided, are suitable to simulate an SSE seismic event with 5% structural damping assumed for the Private Storage Facility. All governing acceptance criteria for development of time histories for use in seismic stability analysis involving non-linear system behavior are considered to be suitably satisfied by these time histories.

The developed time histories are acceptable for use in the study of the dynamics of multiple casks on a rectangular ISFSI. Pad.

REFERENCES

[1] NUREG-0800, Standard Review Plan 3.7.1, Seismic Design Parameters, Rev.2, 8/89.
[2] GENEQ, v1.3, a Holtec computer code for generation of time histories from a response spectrum; the code meets the QA requirements of 10CFR 50, Appendix B.
[3] SWEC transmittal to Holtec 3/31/97, LTR S-V-119, File No. PO 100 PR1.2C.
[4] CORRE, v. 1.3, a Holtec computer code for demonstrating statistical independence of three time history components of a seismic event; the code meets the QA requirements of 10CFR50, Appendix B.

FIGURE 1 -PSF H1 SEISMIC SPECTRAL MATCH - 5% DAMPING

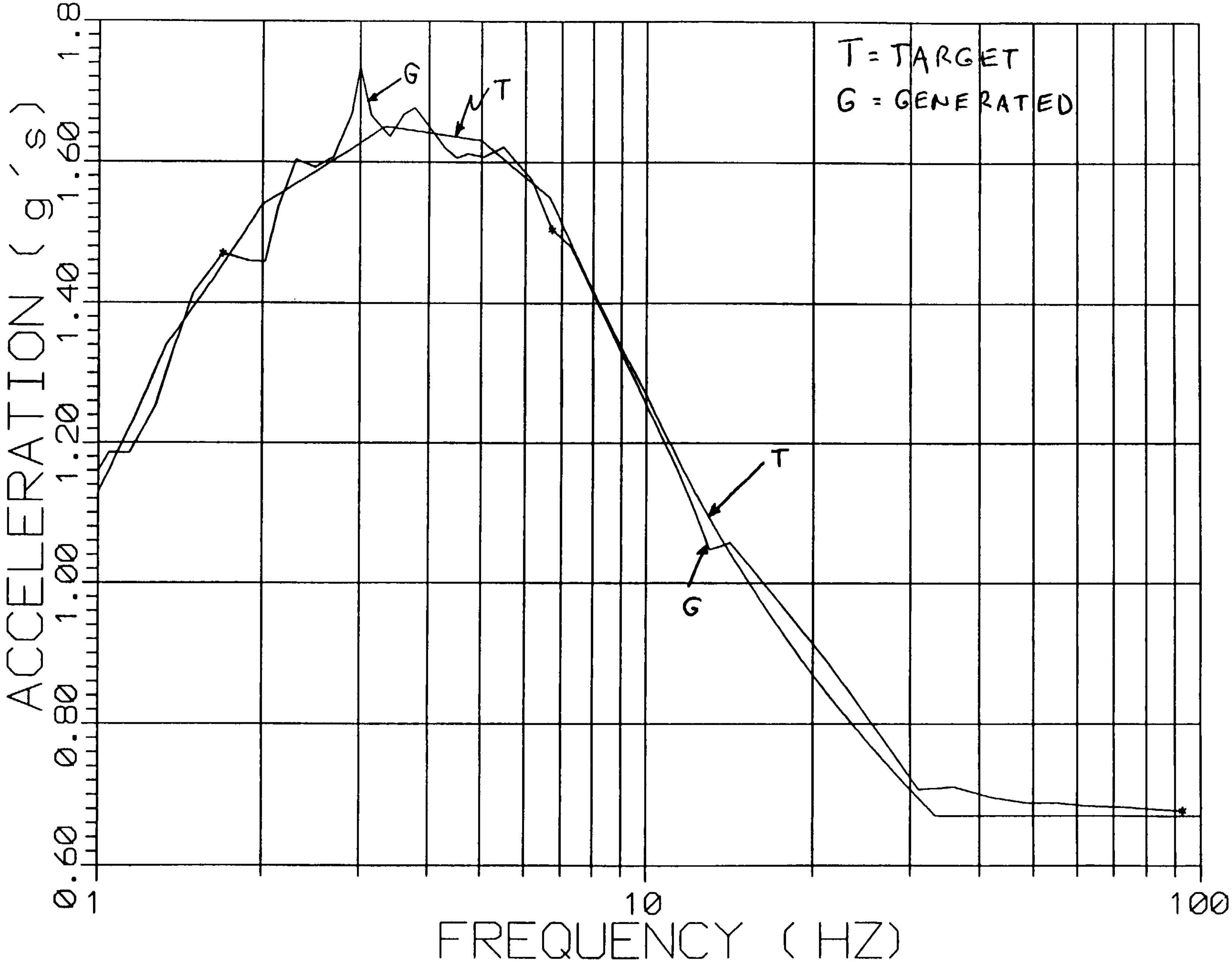

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FIGURE 2 PSF H2 SEISMIC SPECTRUM COMPARISON - 5% DAMPING

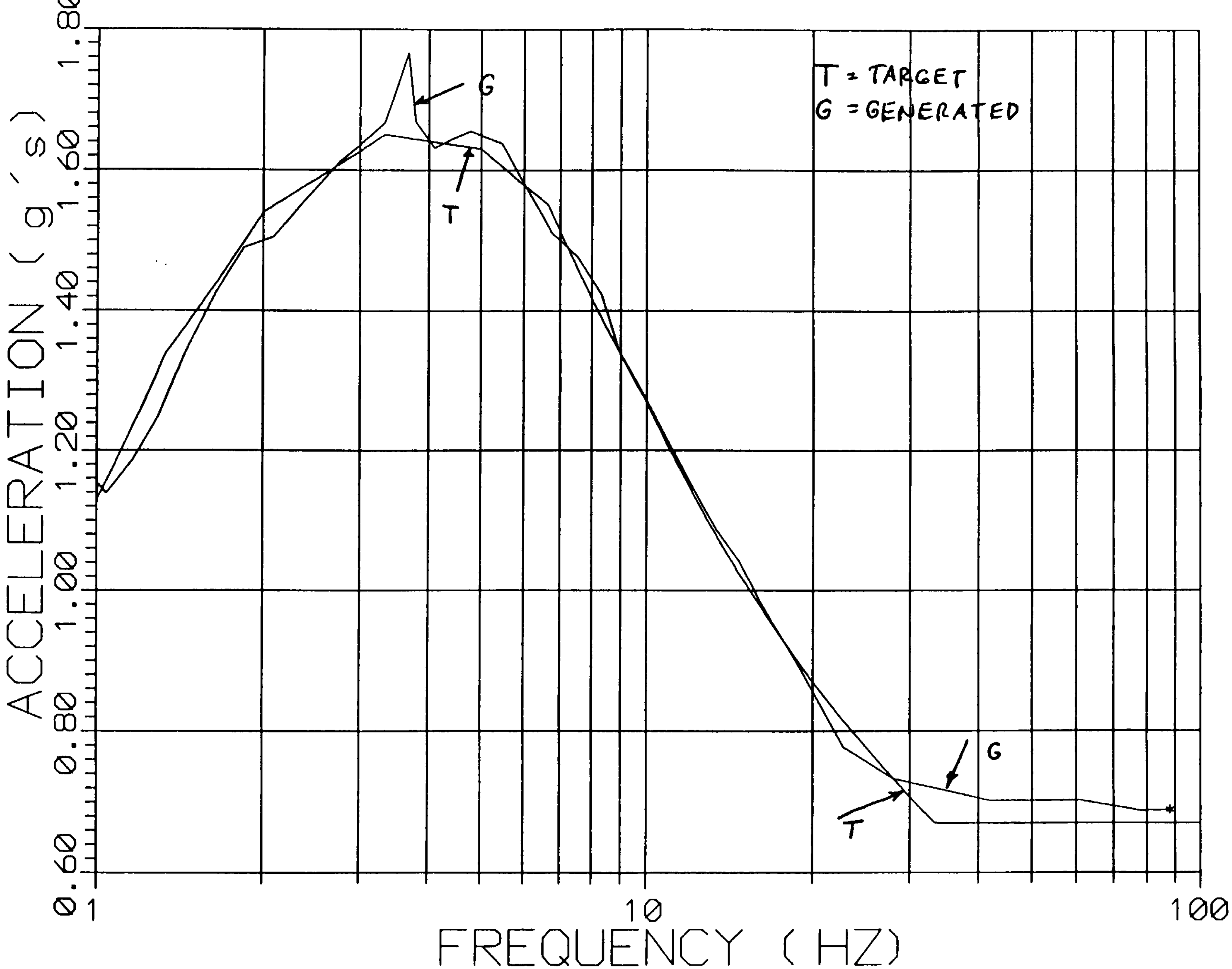

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FIGURE 3 PSF VT SPECTRUM COMPARISON - 5% DAMPING

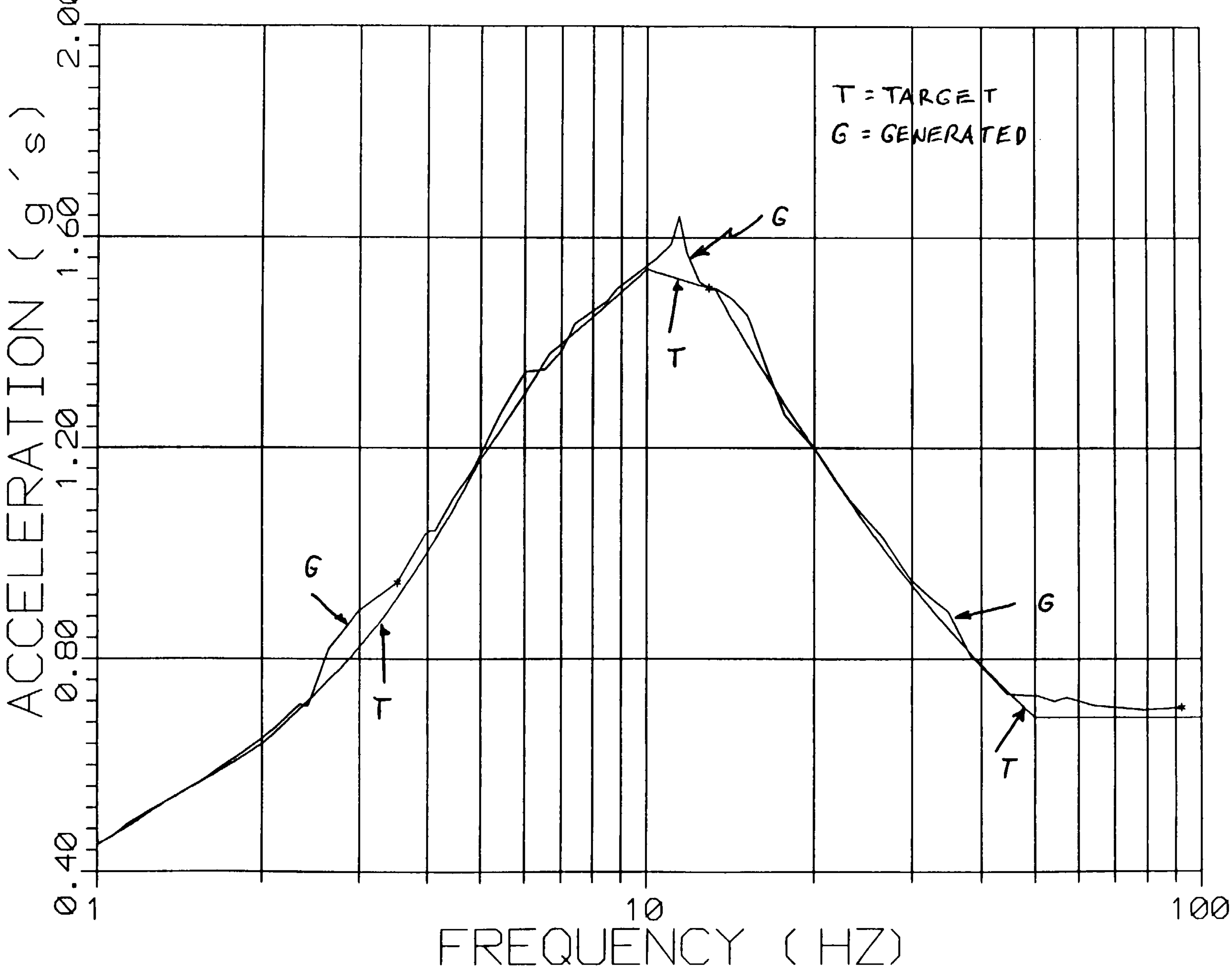

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FIGURE 4 PSF H1 SEISMIC POWER SPECTRAL DENSITY COMPARISON

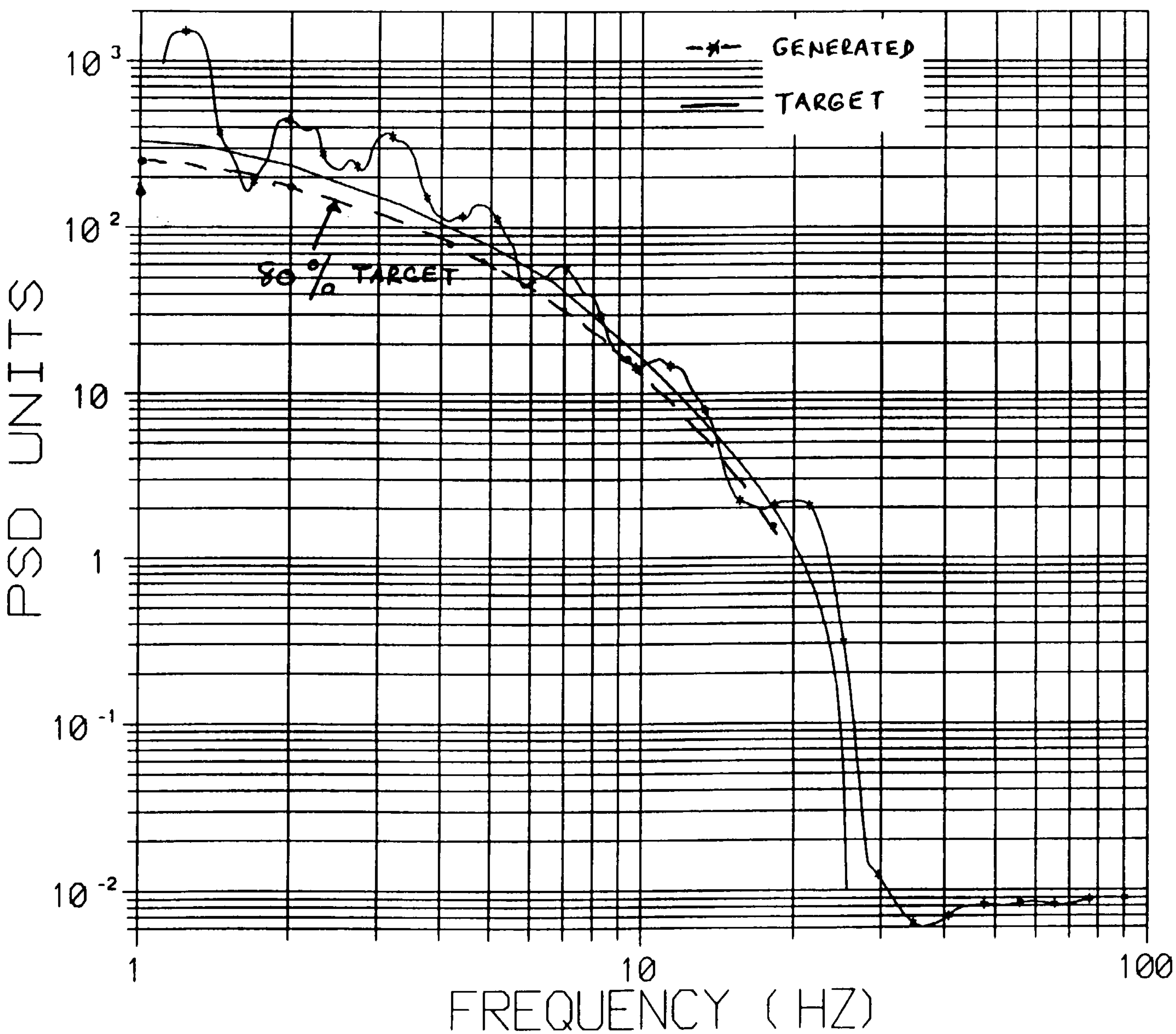

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FIGURE 5 - PSF H2 SEISMIC POWER SPECTRAL DENSITY COMPARISON

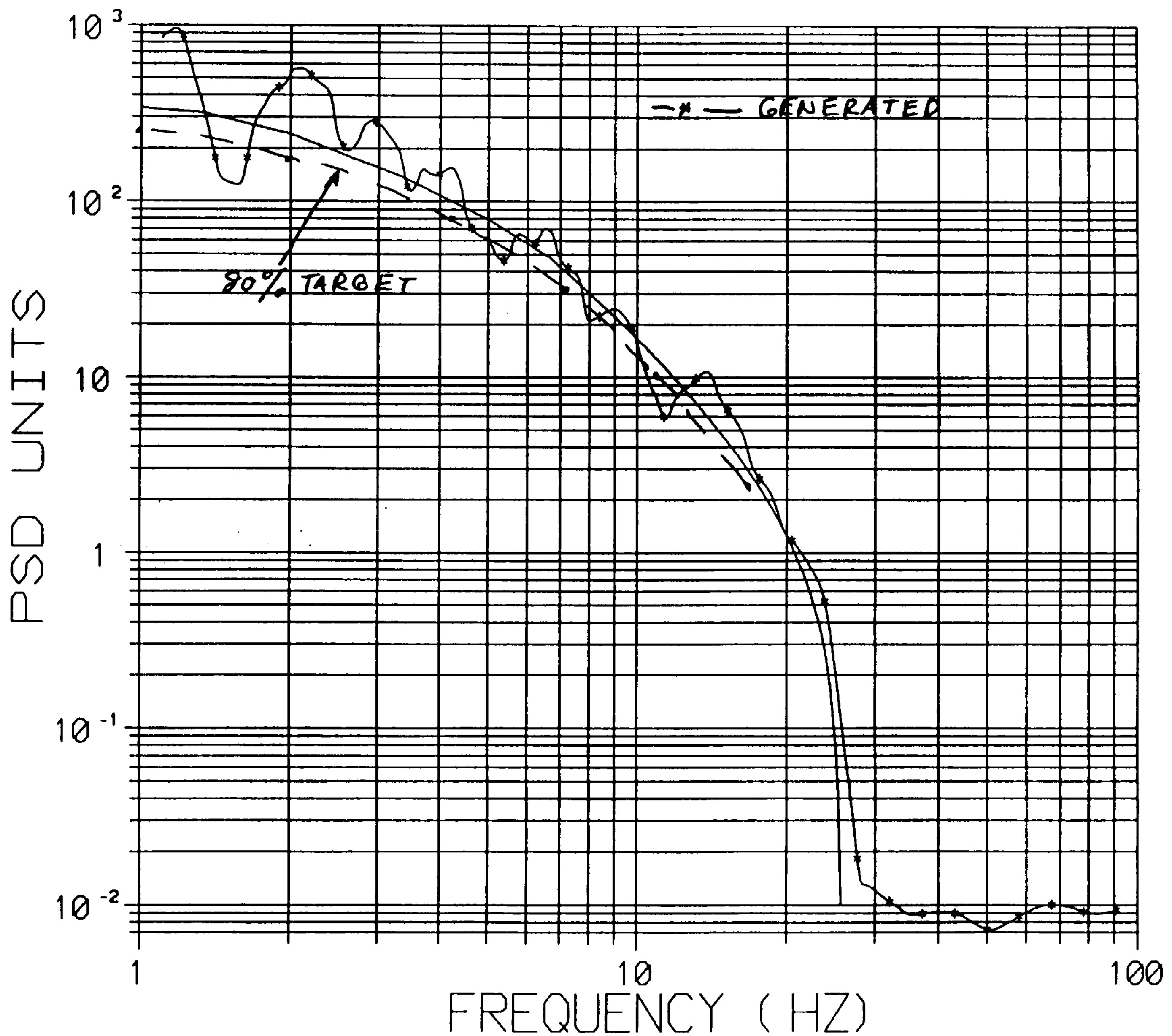

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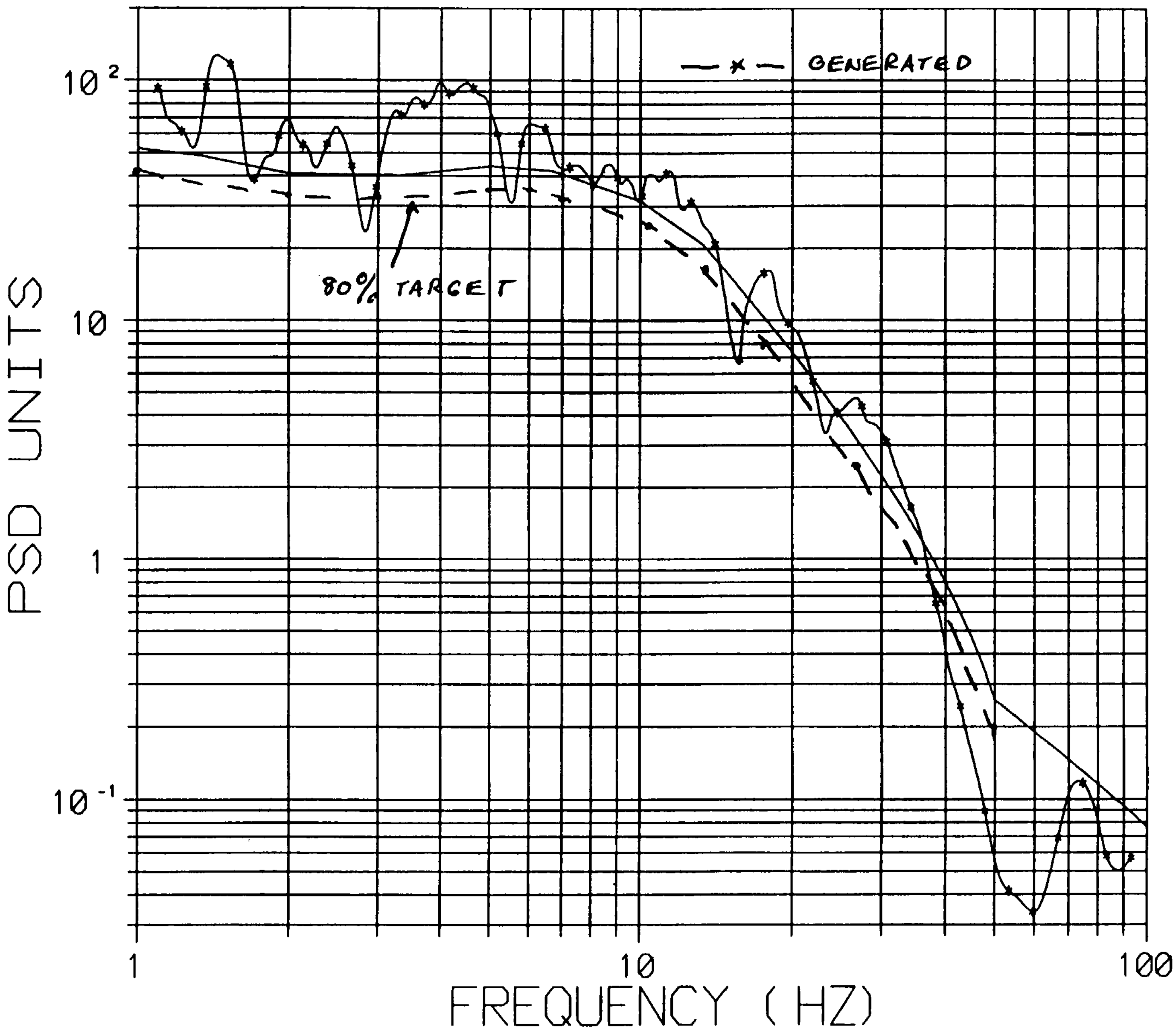
FIGURE 6 - PSF VT SEISMIC POWER SPECTRAL DENSITY COMPARISON



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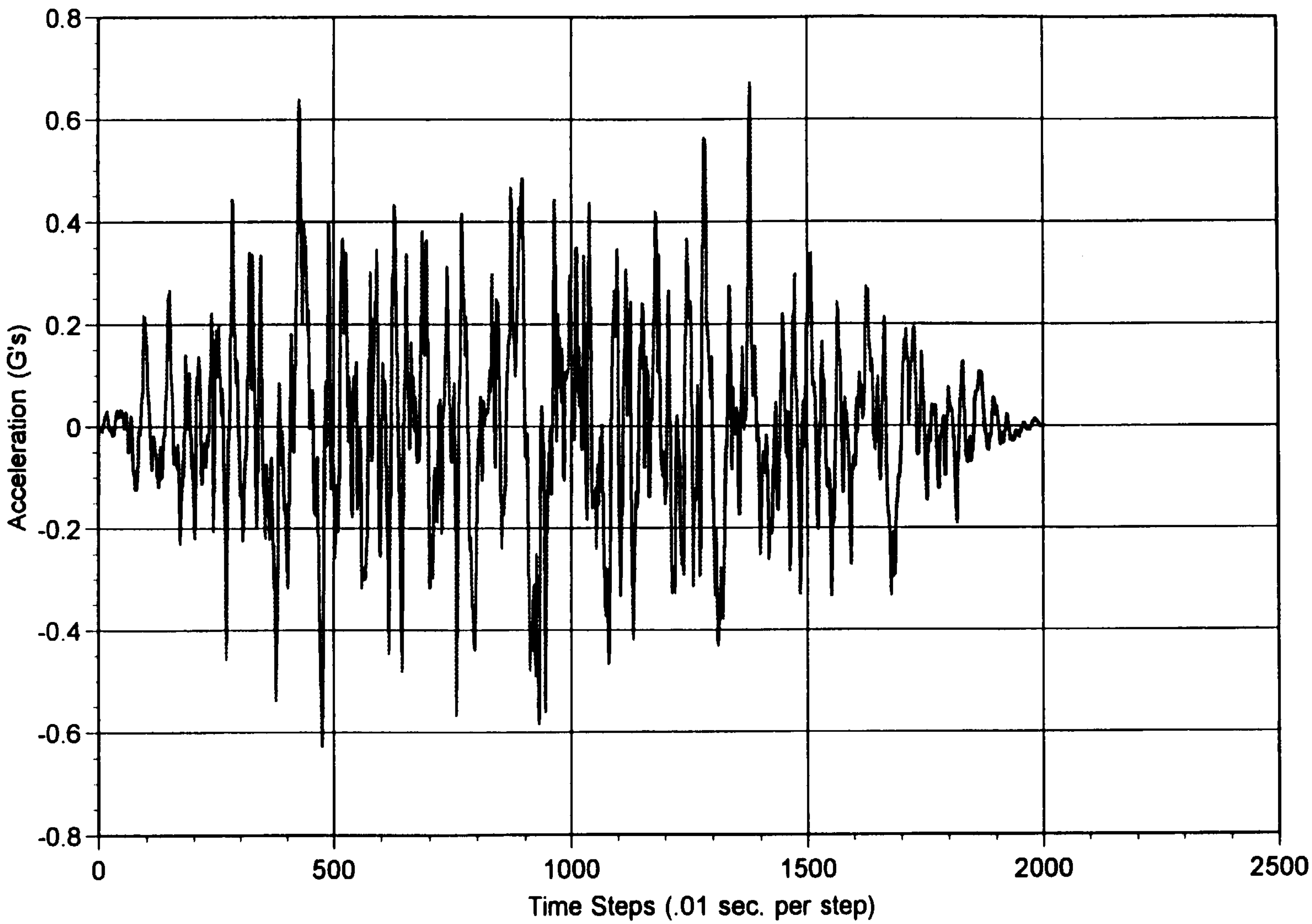

FIGURE 7 - PRIVATE STORAGE FACILITY - H1 (Horizontal) SEISMIC EVENT - 5% DAMPING

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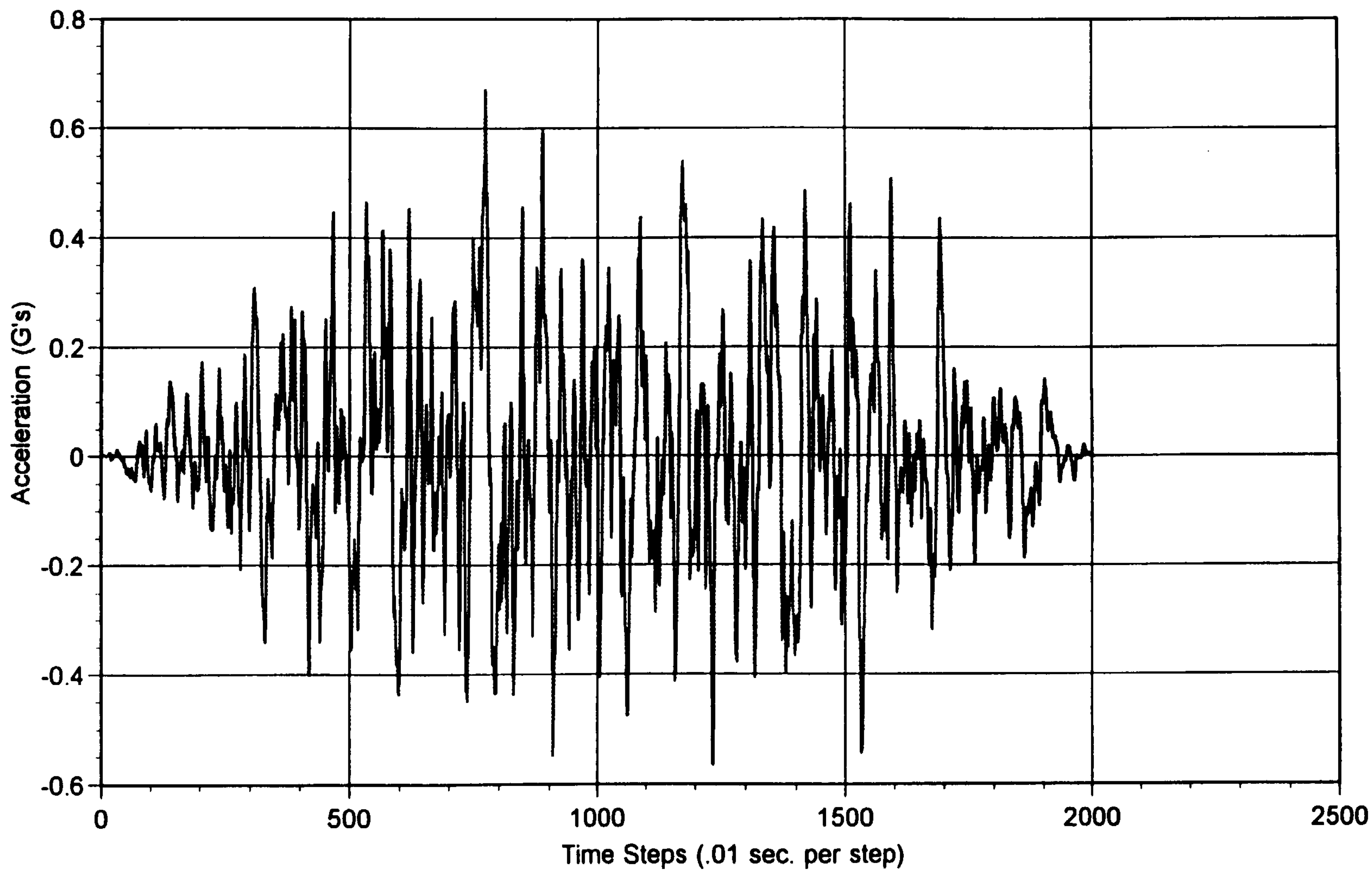

FIGURE 8 - PRIVATE STORAGE FACILITY - H2 (Horizontal) SEISMIC EVENT - 5% DAMPING

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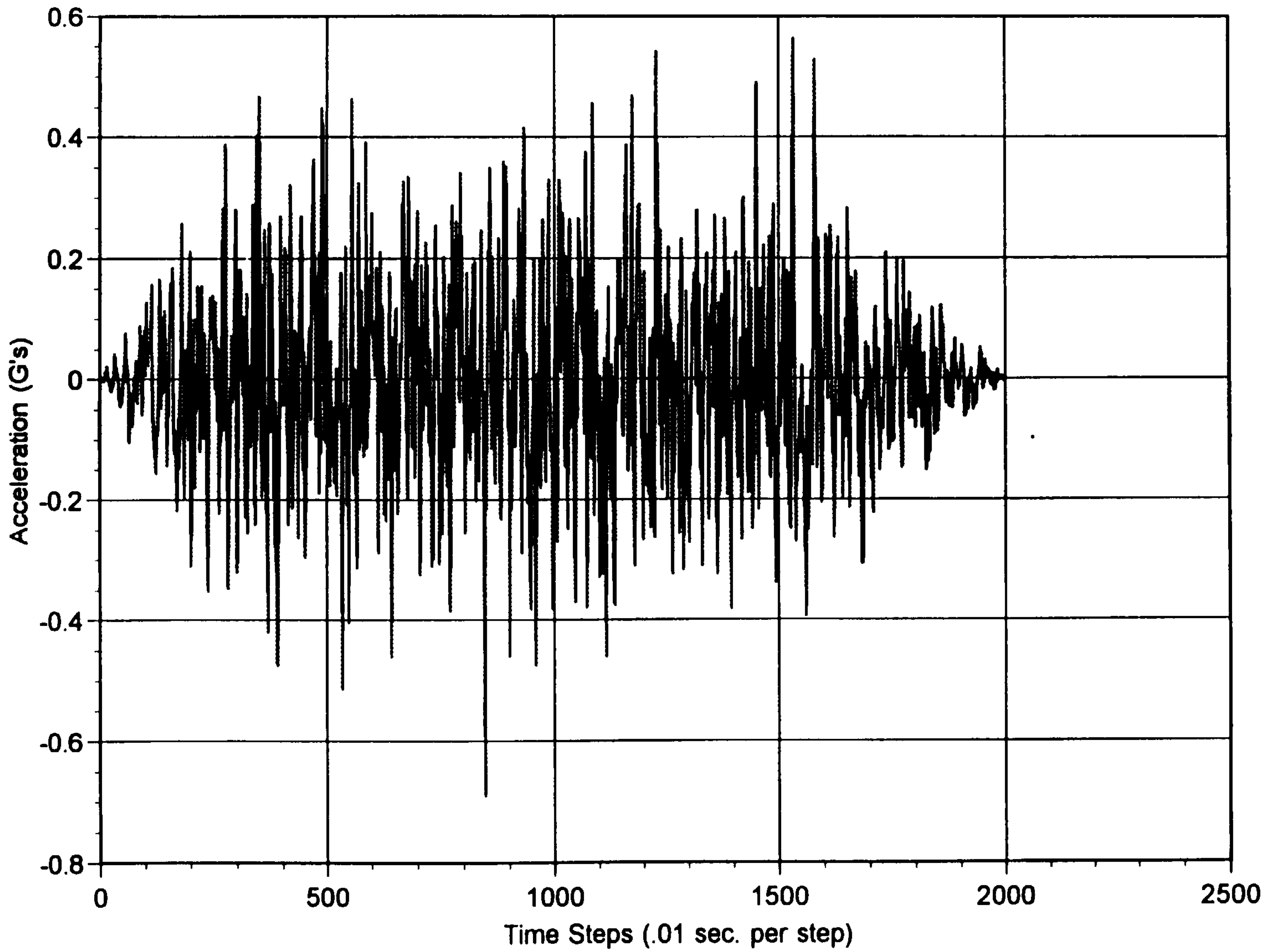

FIGURE 9 - PRIVATE STORAGE FACILITY - VT (Vertical) SEISMIC EVENT - 5% DAMPING

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