

ENCLOSURE

MULTIPLE LEVEL RESPONSE SPECTRA ANALYSIS
WITH
PVRC VARIABLE DAMPING

JANUARY 7, 1985

8603120330 860310
PDR ADDCK 05000206
P PDR

MULTIPLE LEVEL RESPONSE SPECTRA ANALYSIS
WITH
PVRC VARIABLE DAMPING

INTRODUCTION:

Impell has qualified SONGS 1 piping to long term service (LTS) criteria, by using Multiple Level Response Spectra (MLRS) analysis methods in conjunction with PVRC variable damping. However, the Nuclear Regulatory Commission (NRC) has raised concerns about the conservatism of analysis results when the two are considered together.

The NRC has approved the use of PVRC damping for enveloped response spectra analysis. Because the analytical differences between multiple level and enveloped response spectra methodologies are independent of spectral damping, it is logical to conclude that PVRC damping may be used for MLRS analysis, as well. Thus, in order to exhibit the acceptability of the MLRS/PVRC damping combination, this study explores the nuclear power industry's opinion of PVRC damping and compares the MLRS and enveloped response spectra methods of analysis.

ANALYTICAL EVALUATION:

The purpose of this evaluation is to compare piping analysis results of MLRS to those of enveloped response spectra. The approach and results of this study are independent of damping and are applicable to Regulatory Guide damping as well as PVRC damping.

Piping behavior is investigated, primarily, in an "overlap" region between two independent structures. The overlap region includes piping that may be influenced by more than one origin of spectral excitation. Piping behavior is also examined in regions influenced only by the excitation of the structure to which it is attached.

Impell has selected SONGS 1 large bore piping problem SI-05 for this study. It was qualified as a part of the LTS scope with enveloped response spectra. SI-05 piping is routed through the turbine building and into the adjacent yard. Yard piping is supported from the ground and experiences lower accelerations than does piping supported in the Turbine Building.

In order to perform a comparison of MLRS and enveloped spectra results, the following four seismic inertia cases are considered. (Note that multiple level results are combined by absolute summation, in accordance with LTS piping analysis procedures.)

- (1) Ground Spectra - Uniform excitation at all locations with Ground spectra.
- (2) Turbine Building Spectra - Uniform excitation at all locations with enveloped Turbine Building spectra.

- (3) MLRS Ground /Turbine Building - Multiple level excitation with Ground spectra applied at support locations in the yard (level 1) and with enveloped Turbine Building spectra applied at support locations within the Turbine Building (level 2).
- (4) MLRS Turbine Building/Turbine Building - Multiple level excitation with Turbine Building spectra applied, independently, at supports in the Turbine Building (level 2) as well as at supports in the yard (level 1).

The first of two studies is performed to demonstrate the interaction between multiple levels and to compare these interactive results to local acceleration results. An MLRS analysis with two unique spectra applied at their respective levels is compared to uniform excitation analysis with the greater of the two spectra applied at all locations and, again, to uniform excitation analysis with the lesser of two spectra applied at all locations. A comparison of pipe stress results for analyses (1), (2), and (3) is displayed in Figure 2. Considering multiple levels with different spectra, this graph demonstrates the following:

- o MLRS results (3) are greater than uniform excitation results for the lower spectra (1) at all locations.
- o MLRS results (3) are approximately equal to uniform excitation results for the higher spectra (2) within the "overlap" region.
- o MLRS results (3) are greater than uniform excitation results for the higher spectra (2) beyond the "overlap" region and well into the Turbine Building.

Thus, the MLRS analysis method predicts a realistic progression of loads in the "overlap" region (i.e., from areas subjected to lower accelerations to areas of higher accelerations). It also predicts conservative loads, in areas well away from the "overlap" region, when compared to uniform excitation results with local accelerations applied.

A second study is performed to demonstrate the differences in mathematical methods of data combination. An MLRS analysis with a single spectra applied at each of two levels is compared to a uniform excitation analysis with this same spectra applied at all locations. A comparison of pipe stress results for analyses (2) and (4) is displayed in Figure 3. Considering multiple levels with identical spectra, this graph demonstrates the following:

- o MLRS results (4) are always greater than uniform excitation results (2) in the "overlap" region.
- o MLRS results (4) approach, but never become less than, uniform excitation results (2) in areas beyond the "overlap" region and well into the Turbine Building.

Thus, the MLRS analysis method predicts conservative loads in the "overlap" region when compared to enveloped response spectra results. These results are accounted for by considering the mathematical methods of data combination employed by the SUPERPIPE program (i.e., the results from each level of excitation are summed with those from other levels in MLRS analysis).

PVRC TASK GROUP POSITION:

In December of 1984, the Task Group on Damping Values (under the direction of the Pressure Vessel Research Committee of the Welding Research Council) issued its technical position on recommended damping values to be used in performing seismic analysis of nuclear power plant piping systems, in WRC Bulletin 300. The results of the Task Group study clearly provides support for the use of variable damping with response spectra methods of analysis. The ASME B&PV Code, Section III has incorporated the PVRC recommended damping values in Code Case No. N411.

Impell has solicited the opinion of all four members of the PVRC Task Group, regarding the application of variable damping to MLRS analysis. Each of the members stated that the intent of their publication was to recommend this combination. Copies of Impell Records of Conversations are presented in the attached Appendix.

These statements represent the opinion of the most highly informed group of professionals, on this subject, in the Nuclear Power Industry; and, their opinions are strongly supported by the analytical evaluation described herein.

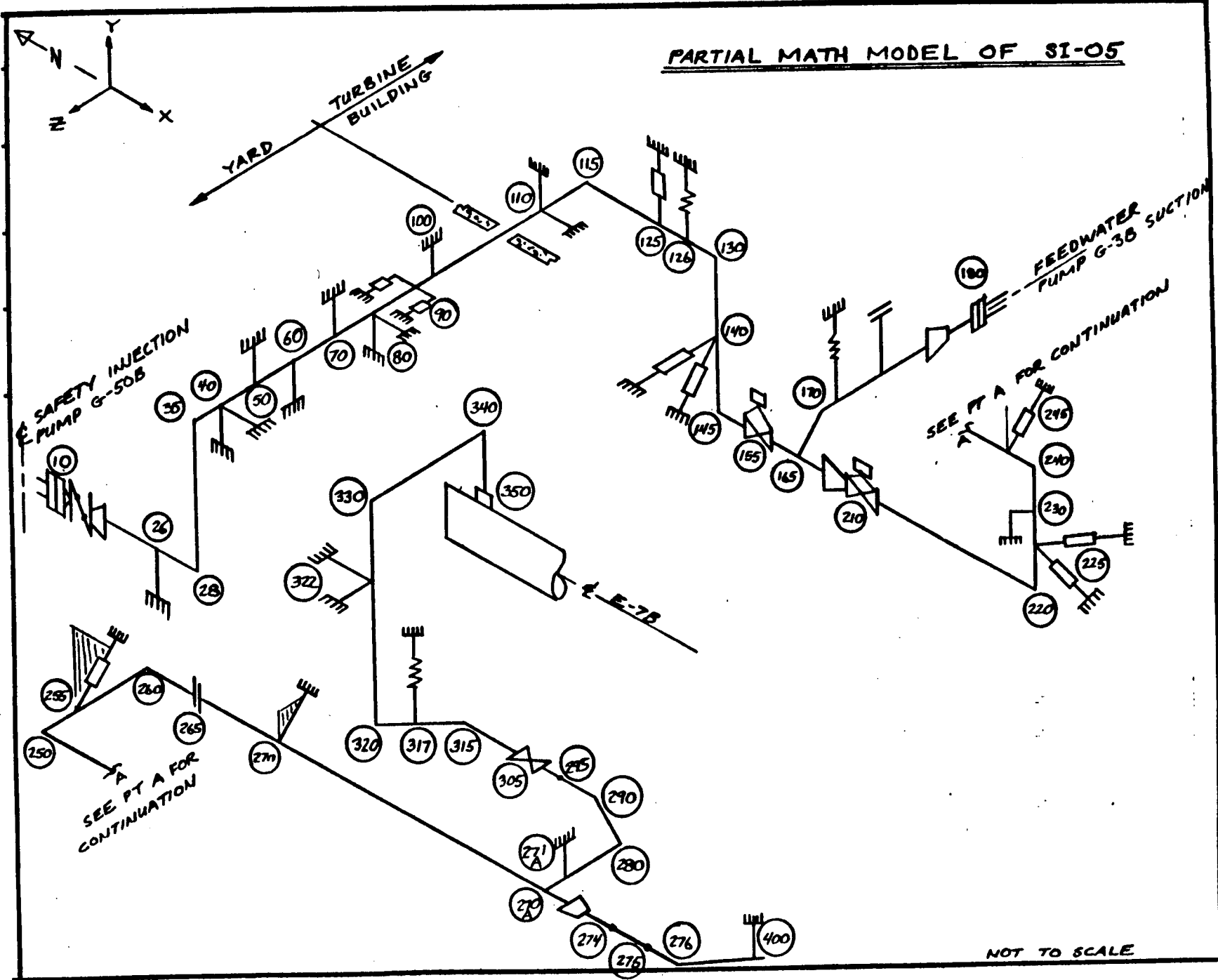
CONCLUSION:

Southern California Edison and Impell Corporation conclude that the variable damping values recommended by the PVRC are applicable to Multiple Level Response Spectra analysis based upon the following:

- o PVRC damping is acceptable for the enveloped response spectra method of analysis.
- o The analytical differences between MLRS and enveloped response spectra methods of analysis are independent of damping values.
- o The MLRS method of analysis is mathematically more conservative than is the enveloped response spectra method.

APPENDIX

PARTIAL MATH MODEL OF SI-05



NOT TO SCALE

Figure 1: SUPERPIPE MODEL

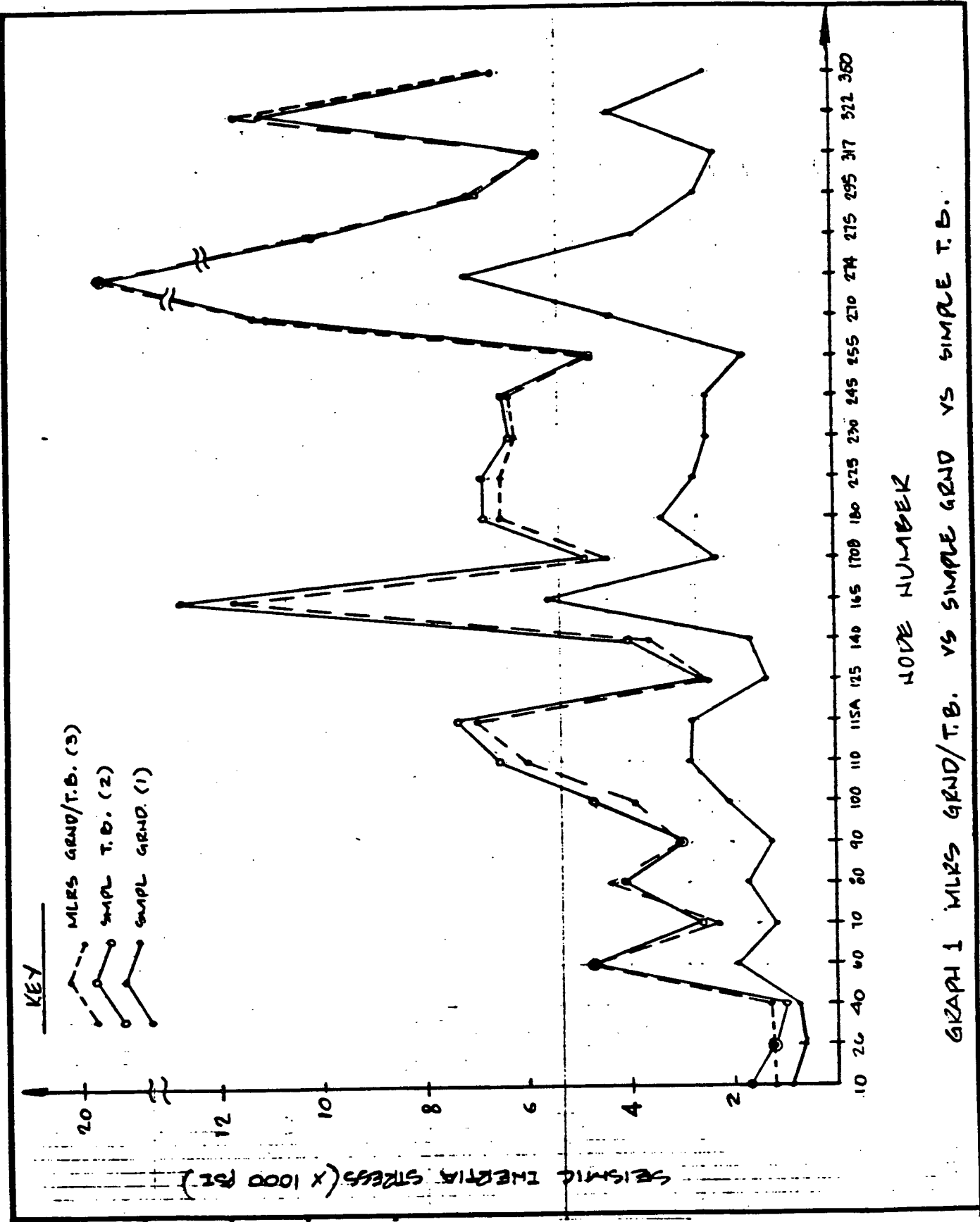


Figure 2: Multiple Levels with Different Spectra

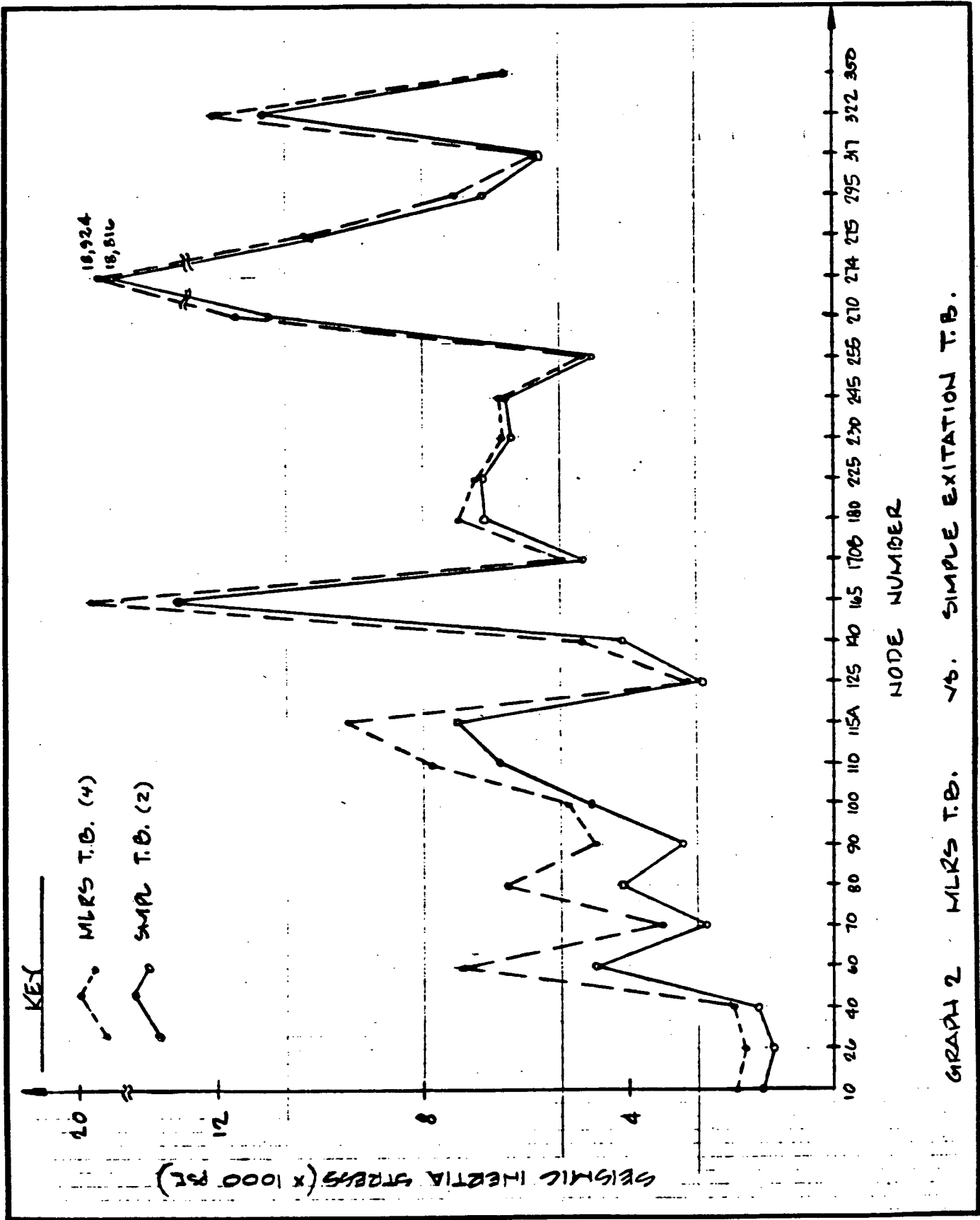


Figure 3: Multiple Levels with Identical Spectra

APPENDIX

IMPELL CORPORATION

RECORD OF CONVERSATION

File: 0310-054-1352

Copy: WD Gallo
HT Ying
M Swatta
K Barkle
G Hau

[X] Telephone [] Meeting [] Other _____

TO: J. L. Bitner FROM: Bruce Myatt *BEM*

COMPANY: Westinghouse Electric Corp. PHONE: 412-825-6398 DATE: 5/16/85

SUBJECT: PVRC Damping and MLRS Seismic Analysis

Summary of Conversation:

Mr. Bitner served as Chairman of the Task Group on Damping Values of the Technical Committee on Piping Systems under the guidance of the Steering Committee on Piping Systems of the Pressure Vessel Research Committee. This task group authored the "Technical Position on Damping Values for Piping - Interim Summary Report" which was issued in WRC Bulletin 300, dated December 1984.

Mr. Bitner is of the opinion that the intent of the technical position was to recommend the use of the variable damping values for all presently-accepted forms of piping analysis, including MLRS and time-history methods. He explained that PVRC damping values should be applicable to any "building-filtered" response, particularly to those of a seismic origin.

Mr. Bitner has recently met with the Nuclear Regulatory Commission and found that their task group has taken a position that would not allow the use of PVRC damping values with time-history methods. NRC concerns regarding MLRS applications are that no detailed study has been performed to verify analysis accuracy. An extension of activities has been initiated at Lawrence Livermore Lab to address these questions.

Mr. Bitner pointed out that the position of the NRC task group does not reflect the opinion of the Task Group on damping values.

IMPELL CORPORATION

RECORD OF CONVERSATION

File: 0310-055-1355

Copy: WD Gallo
HT Ying
M Swatta
K Barkle
G Hau

[X] Telephone [] Meeting () Other _____
TO: W. J. Kagay FROM: Bruce Myatt *BM*
COMPANY: Tennessee Valley Authority PHONE: 615-632-2101 x-3690 DATE: 5/16/85
SUBJECT: PVRC Damping and MLRS Seismic Analysis

Summary of Conversation:

Mr. Kagay serves as a member of the Task Group on Damping Values of the Technical Committee on Piping Systems under the guidance of the Steering Committee on Piping Systems of the Pressure Vessel Research Committee. This task group authored the "Technical Position on Damping Values for Piping - Interim Summary Report" which was issued in WRC Bulletin 300, dated December 1984.

Mr. Kagay is of the opinion that PVRC variable damping values are applicable to MLRS methods of seismic piping analysis. In fact, TVA has issued proposals to the Nuclear Regulatory Commission which would allow them to apply PVRC damping values to MLRS analyses performed for their Bellefonte and Watts Bar nuclear plants. The NRC has not expressed any concern, with regard to these proposals, about the combined effects of variable damping and MLRS excitation.

Mr. Kagay further explained that the issued technical position was to provide a good analytical structural solution, regardless of the method of analysis.



Record of Conversation

File: 0310-054-1355

Copy: W. D. Gallo
H. T. Ying
W. R. Bak
M. Swatta
K. Barkle
A. Billy
B. Myatt

Telephone

Meeting

Other _____

To: W. F. Anderson

From: G. Hau *GH*

Company: NRC and a member of the Task Group
on Damping Values of the Technical
Committee on Piping Systems of the PVRC Phone No.: 301/492-4819 Date: 5/14/85

Subject: PVRC Damping Values for Piping (Code Case N411)

Summary of Conversation:

I asked Mr. W. F. Anderson of the NRC if there are any restrictions in applying PVRC damping values to various seismic analysis techniques, such as time-history and Multiple Level Response Spectra analyses. Mr. Anderson said that restrictions, if any, are listed in the back-up document WRC Bulletin 300. He does not recall any discussions related to the MLRS application during the PVRC meetings.

Mr. Anderson further stated that plant specific applications of any Code Cases should be reviewed and approved by the NRC.

GH/jb
5/16/85



Record of Conversation

File: 0310-054-1353

Copy: W. D. Gallo
H. T. Ying
W. R. Bak
M. Swatta
K. Barkle
A. Billy
B. Myatt

Telephone

Meeting

Other

To: Shou-Nien Hou

From: G. Hau *GH*

Company: NRC and a member of the Task Group
on Damping Values of the Technical
Committee on Piping Systems of the PVRC

Phone No.: 301/443-7988 Date: 5/16/85

SUBJECT: PVRC Damping Values for Piping (Code Case N411)

SUMMARY OF CONVERSATION:

I asked Mr. Shou-Nien Hou of the NRC if there are any restrictions in applying PVRC damping values to various seismic analysis techniques, such as time-history and Multiple Level Response Spectra analysis. Mr. Hou's responses are summarized as follows:

- o No restriction on the response spectra method, including the MLRS technique.
- o There are two concerns on the time-history analysis:
 - (1) Insufficient test data for damping values in high frequency region (>33 hz)
 - (11) Overall safety margin for time-history analysis.

GH/jb
5/21/85