The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

BOEING

February 3, 2000
G-9000-JIM-00-003

Document Control Desk
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: a) Boeing Letter G-1151-RSO-92-365 dated August 31, 1992; R. S. Orr to the NRC Operations Center

b) NRC Letter Docket No. 99901227 dated August 12, 1992; L. J. Norrholm to R. S. Orr; Subject: Response to 10 CFR 21 Inquiry

Dear Sir or Madam:

In accordance with the reference correspondence and 10 CFR 21, Boeing is sending the NRC the attached error notice(s) received from our former software suppliers. Due to unknown current addresses, the following former customers were not notified:

Reactor Controls, Inc.

Echo Energy Consultants, Inc.

Nuclear Applications and Systems Analysis Company (Japan)

Nuclear Power Services

Error notices have been sent to our other former customers.

Very truly yours,

John Maughan

John I. Maughan
Nuclear Administrator
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Enclosure(s): GTSTRUDL Program Report Form 2000.01

IE20

Georgia Institute of Technology

GT STRUDL®

January 26, 2000

Attention: Nuclear Administrator
Boeing Shared Services Group
P.O.Box 3707, MC 7A-33
Seattle, Washington 98124-2207

RE: GT STRUDL

Dear Sir or Madam:

Enclosed please find copies of GTSTRUDL PROGRAM REPORT FORM 2000.01, and a GTSTRUDL QA CUSTOMER ACKNOWLEDGEMENT FORM. Please sign and return the GTSTRUDL QA CUSTOMER ACKNOWLEDGEMENT FORM to acknowledge receipt of the GTSTRUDL Program Report.

Thank you for reviewing the Program Report and for returning the Acknowledgement Form.

Best regards,
CASE Center

David C. Key

David C. Key
Configuration Control Manager

Enclosures

Computer Aided Structural Engineering Center
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GTSTRUDL Program Report Form

GPRF No.: 2000.01

DATE: 1/26/2000

FROM: Computer-Aided Structural Engineering Center
Georgia Institute of Technology
Atlanta, Georgia 30332-0355

SEVERITY LEVEL:

X URGENT	Problem results in incorrect answers which may not be apparent or job aborts and cannot be recovered within the session or job.
_ SERIOUS	Problem results in incorrect answers which are obvious or problem prevents completion of a particular user's task.
_ MINOR	Problem can be worked around or problem poses high frustration factor.
_ INFORMATIVE	Documentation error, program usage tip, user inconveniences.

Date Problem Confirmed January 25, 2000

Date Notification Sent 1/26/2000

Computers All

Operating System All

Version All versions up to and including 99.01

Target Release for Correction Version 99.02

Michael H Swanger
Signature
R & D Division

Mgr. ASD
Title

Michael H. Swanger
Typed or Printed Name

1/25/2000
Date of Signature

David C. Key
Signature
Professional Services Division

Configuration Control Manager
Title

David C. Key
Typed or Printed Name

1/26/2000
Date of Signature

Rev. 2.2

GTSTRUDL Program Report Form
(Continued)

GPRF No.: 2000.01

DATE: 1/26/2000

DESCRIPTION:

The use of response spectrum files defined by response (acceleration, velocity, displacement) vs period may produce incorrect response spectrum analysis results which may not be readily apparent. The problem is due to the fact that the period input values from the STORE RESPONSE SPECTRUM command are converted to frequency (f = 1/period) before being stored. Then, instead of response spectrum curve interpolation calculations being performed with the input period values, they are actually performed using the converted frequency values. This problem is clearly illustrated by the typical design response spectrum curve shown in Figure 1 below, where the short-period linear portions of the curve can be easily defined by the intersection points of the linear segments of the curve, and where the response and period curve points are input by the STORE RESPONSE SPECTRUM command using the LINEAR scaling option.

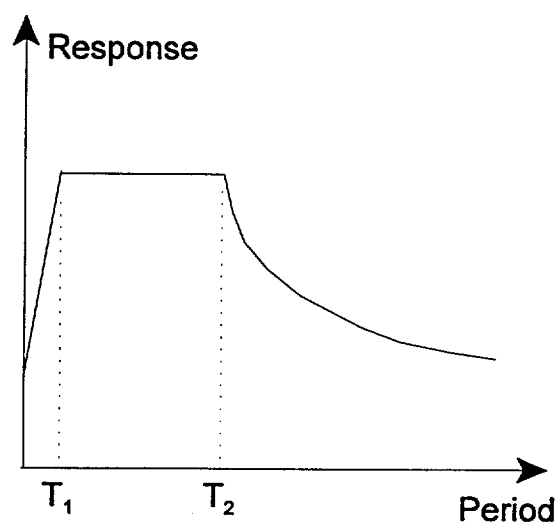

Figure 1 Typical Design Response Spectrum Curve with Linear Segments

Taking the maximum response value as 2.5, the 0-period response as 1.0, T_1 = 0.15 sec., and T_2 = 0.6 sec., an acceleration-period response spectrum curve of the form shown in Figure 1 could be defined using the following STORE RESPONSE SPECTRUM command:

```
UNITS FEET SECONDS CYCLES
STORE RESPONSE SPECTRA ACCEL LINEAR VS PERIOD LINEAR 'Example 1'
DAMPING 0.0 FACTOR 1.0
     1.0   0.0
     2.5   0.15
     2.5   0.6
     1.986 0.8
     1.661 1.0
     1.436 1.2
     1.347 1.3
     1.269 1.4
     1.141 1.6
```

Taking an input period T = 0.1, the corresponding acceleration should obviously be

$$1.0 + \left(\frac{2.5 - 1.0}{0.15 - 0.0}\right)(0.10) = 2.0 \qquad \text{Eq. 1}$$

However, because the period values are inverted prior to storage, the above acceleration-period points are stored as the following acceleration-frequency points:

Acceleration	Frequency
1.414	0.6250
1.269	0.7143
1.347	0.7692
1.436	0.8333
1.661	1.0000
1.986	1.2500
2.5	1.6667
2.5	6.6667
1.0	$1x10^{30}$

Maintaining the specified LINEAR-LINEAR relationship, now between acceleration and frequency, the acceleration corresponding to T = 0.1 (f = 10.0) is now computed as

$$1.0 + \left(\frac{2.5 - 1.0}{6.6667 - 10^{30}}\right)(10.0 - 10^{30}) = 2.5 \qquad \text{Eq. 2}$$

The linear relationship between acceleration and period is clearly violated by the conversion and storage of the input period values as frequency values.

Note that this problem applies only to response spectrum curves stored as response vs *period.* Response spectrum curves stored as response vs frequency do not exhibit this problem. The CREATE RESPONSE SPECTRUM command produces only response vs frequency curve data.

Work-around

A work-around is to use more points (say 10+) to define all segments of the response-period response spectrum curves as follows:

```
UNITS FEET SECONDS CYCLES
STORE RESPONSE SPECTRA ACCEL LINEAR VS PERIOD LINEAR 'Example 1'
DAMPING 0.0 FACTOR 1.0
        1.0     0.0
        1.15    0.015
        1.30    0.030
        1.45    0.045
        1.60    0.060
        1.75    0.075
        1.90    0.090
        2.05    0.105
        2.20    0.120
        2.35    0.135
        2.5     0.15
         .
         .
         .
```

Note, however, that this is an approximation which merely allows the result of Eq. 1 to be approached as the number of additional points becomes large.

After programming modifications were made to correct the processing of response vs period response spectrum curves, subsequent testing revealed that for response spectrum curves of the form illustrated in Figure 1, the greatest differences occurred when the high-participation modes had periods less than T_1, the trend being that existing response spectrum force results tended to be greater than the corrected results. When the response spectrum curve segment between $0.0 \leq T \leq T_1$ was modeled by only the two extreme points and linear-linear interpolation was specified, old base shear results were observed to be greater than the corrected base shear results on the order of 10%. Similar differences were observed for response spectrum member forces as well. When this response spectrum curve segment was modeled with nine additional points as shown immediately above, and linear-linear interpolation maintained, a difference of .06% was observed. When the structural natural period spectrum was shifted such that the high-participation modes had periods greater than T_1,the differences between old results and corrected results tended to be much less than 1%.

GTSTRUDL User Reference Manual Sections:

Storing Response Spectra	Section 2.4.4.3, Volume 3, Rev. Q