BASIC DIFFERENCES BETWEEN

QRS™ AND RS TYPE

VIBRATION SYSTEMS

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Screening Systems, Inc. ™

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Two Unique Categories of Pneumatic Vibration Tables

- **Repetitive Shock (RS)**
  - **Rigid Tables which directly transmit vibrator shocks to the Unit Under Test**
    - **Low Damping, High Frequency, High Crest Factors**
    - **High Sine-Over-Random Spectral Content**
- **Damped, Segmented (QRS)**
  - **Modally rich, highly damped tables which respond to vibrator shocks and, in turn, transmit the table's resonant responses to the Unit Under Test**
    - **High Damping, Low Frequency, Low Crest Factors**
    - **Very Little Sine-Over-Random Spectral Content**

The data relied upon by the author from third party sources has not been subjected to independent verification by the author.

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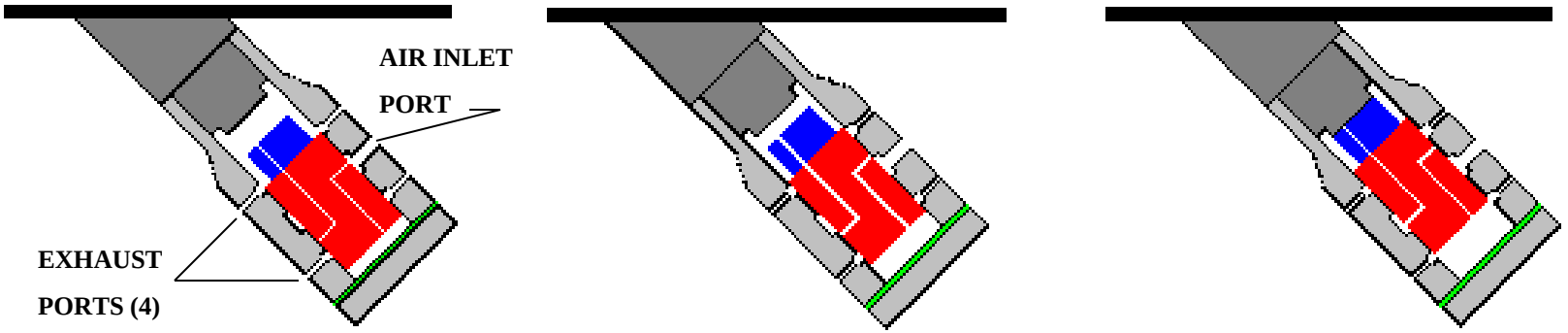
QRS Vibrator Energy Generation



PISTON FULL AFT | **PISTON AT CENTER** | **PISTON FULL FORWARD**

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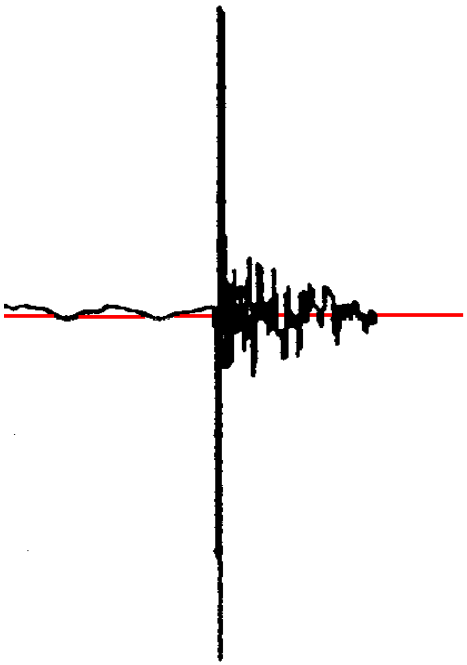
Typical Vibrator Shock Pulse

- **Time History of a Single Vibrator Impact**
  - **(Acceleration vs. Time)**



Source: Accelerated Reliability Test Results, Shams Jawaid, IEEE R&M Symposium, 2000 Proceedings

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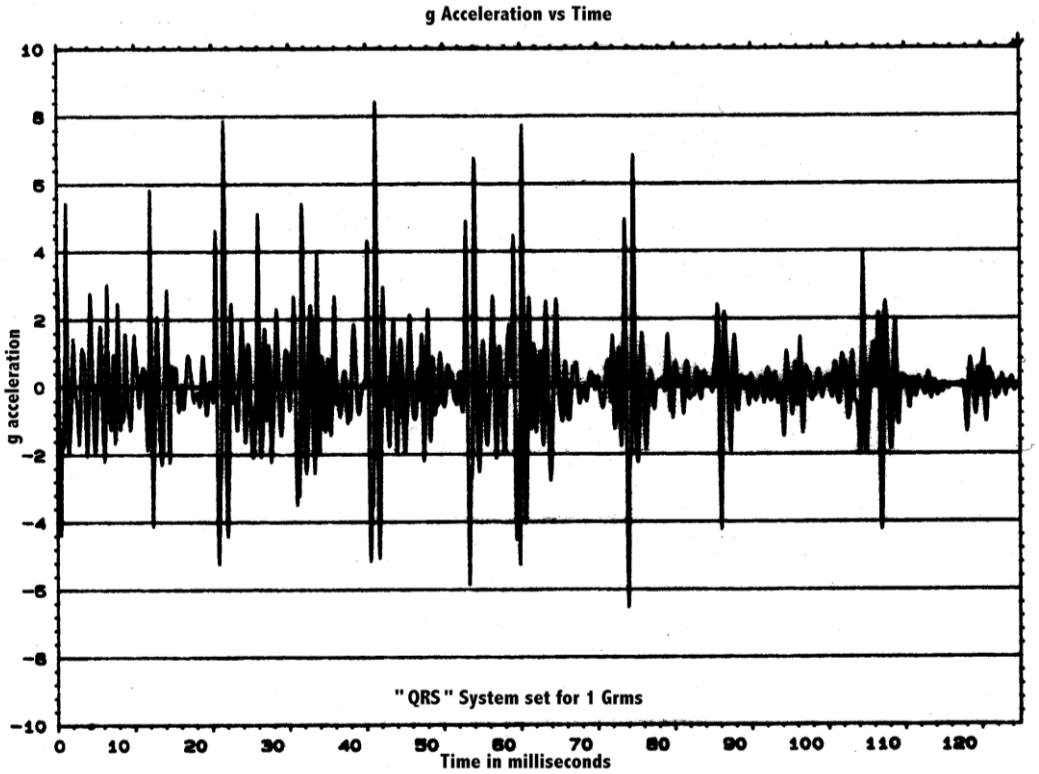
Time History for QRS Type Tables



Proven to Successfully HALT and HASS Hard Drives Up to 12.0 g_{RMS} Without Causing Damage while Quickly Surfacing Manufacturing Flaws

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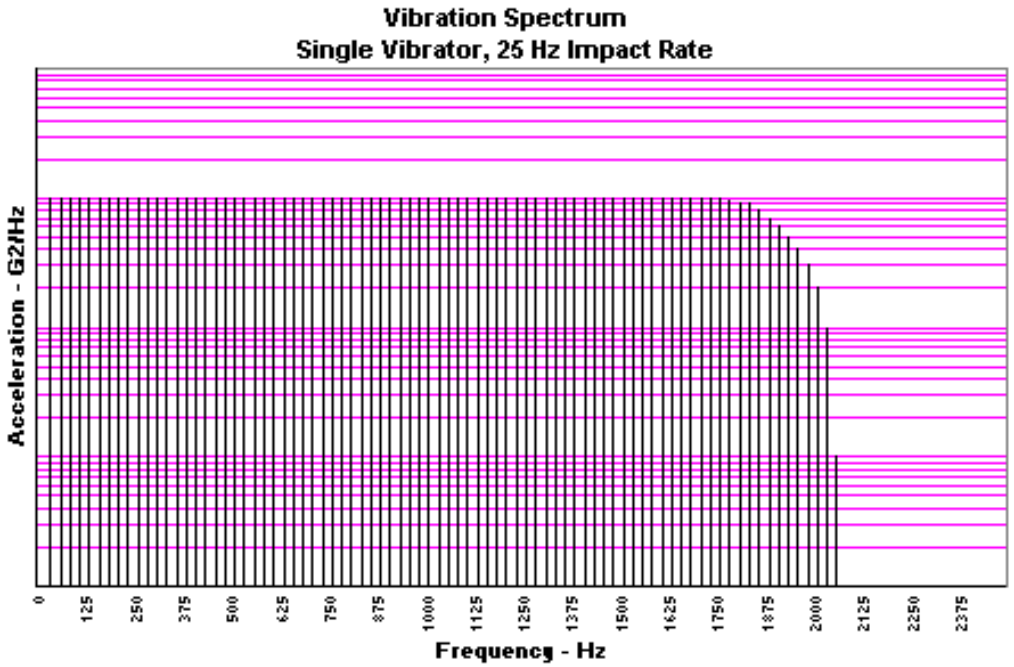
Vibration Spectra from a Single Vibrator

- **Frequency Domain** (Acceleration vs. Frequency)



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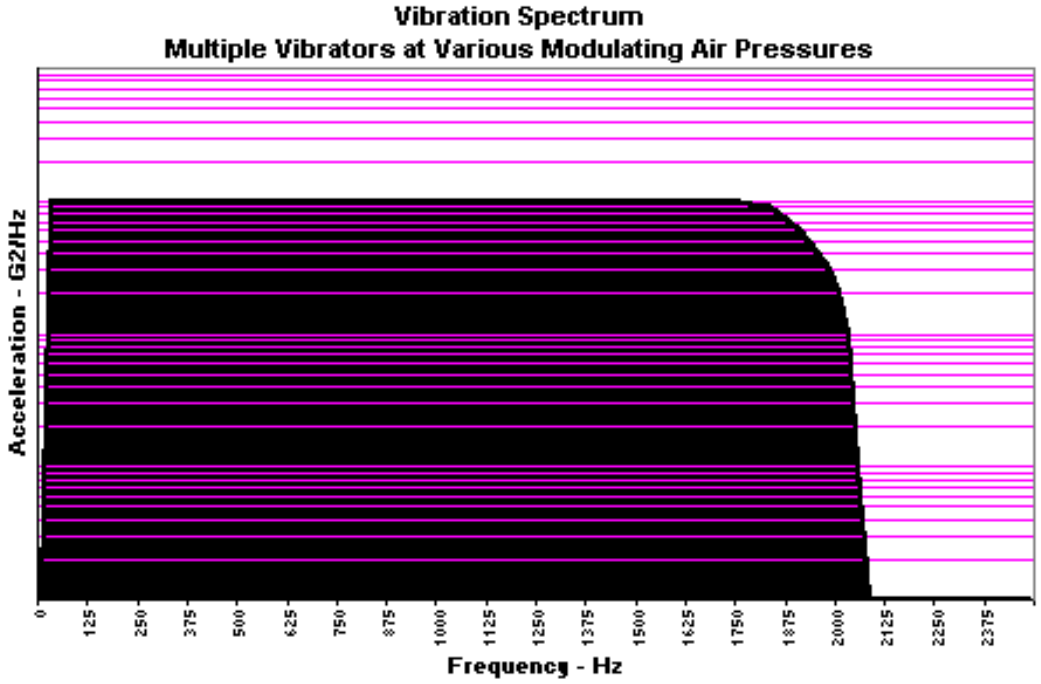
Vibration Spectra from Multiple Vibrators

- **Frequency Domain** (Acceleration vs. Frequency)



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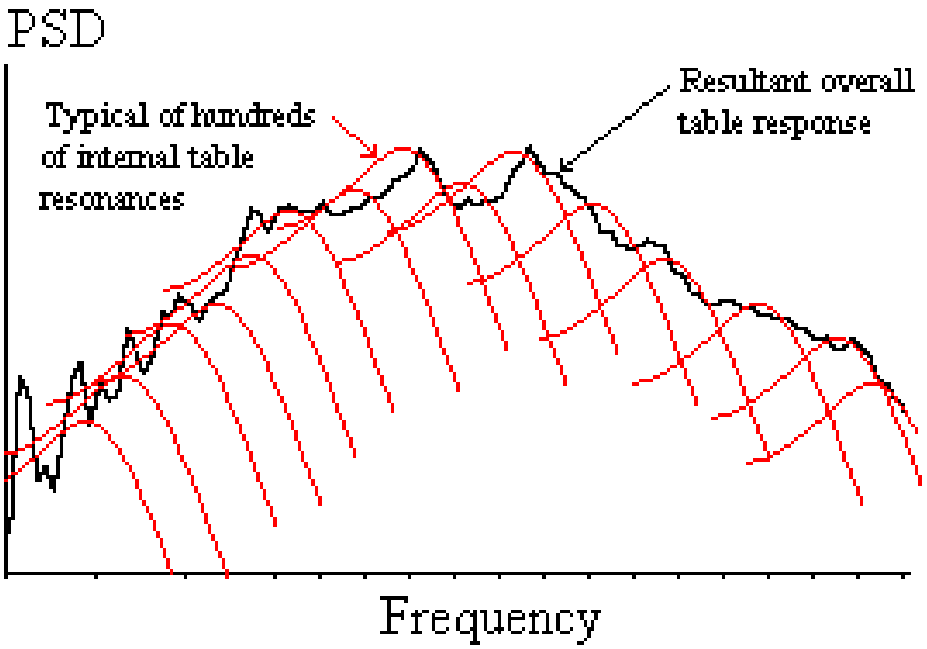
QRS System Table Damped Resonances

Higher Random Vibration Energy at Low Frequencies

Few Sine-Over-Random Peaks Throughout Spectrum



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RS Table Resonant Plate Modes

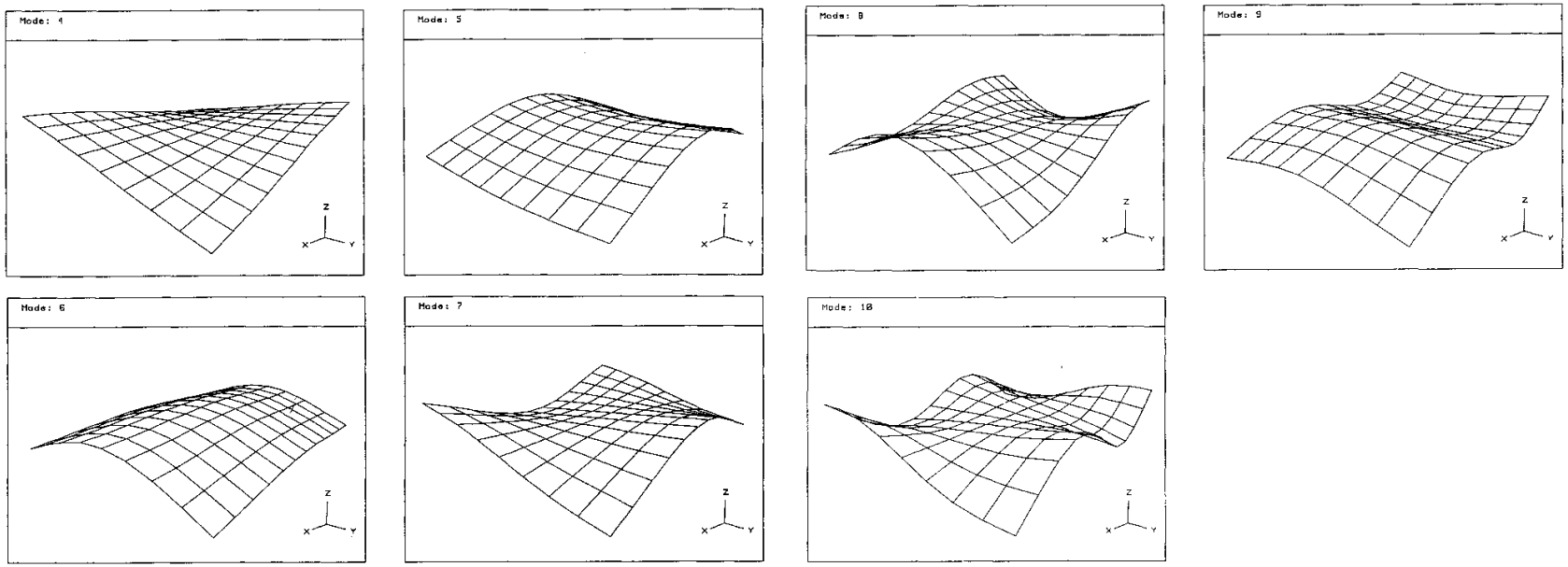

Figure 5. Analytical mode shapes of the flat plate.

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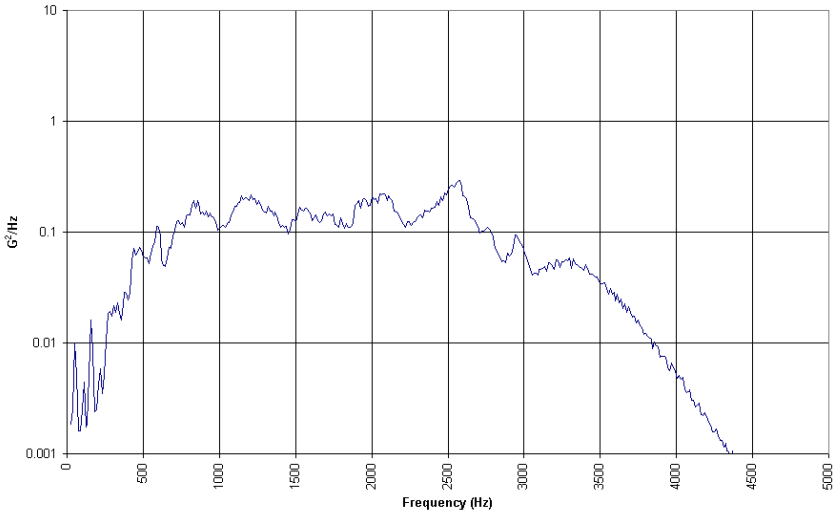
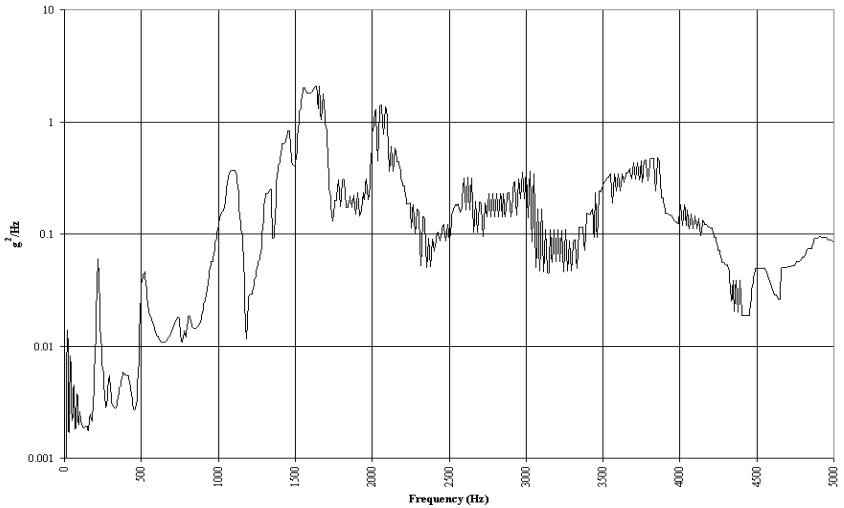
Comparison of Power Spectral Density



QRS Type Tables



RS Type Tables

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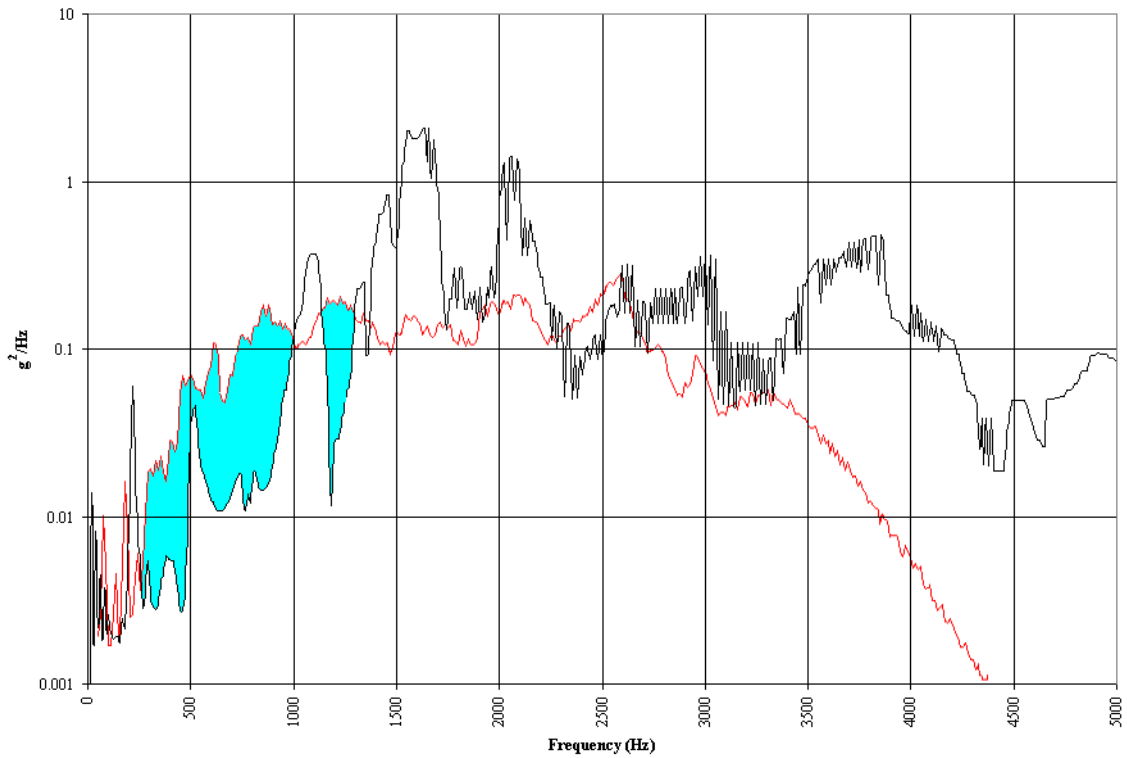
Comparison of Effective Table Energy



RS Type Tables

QRS Type Tables

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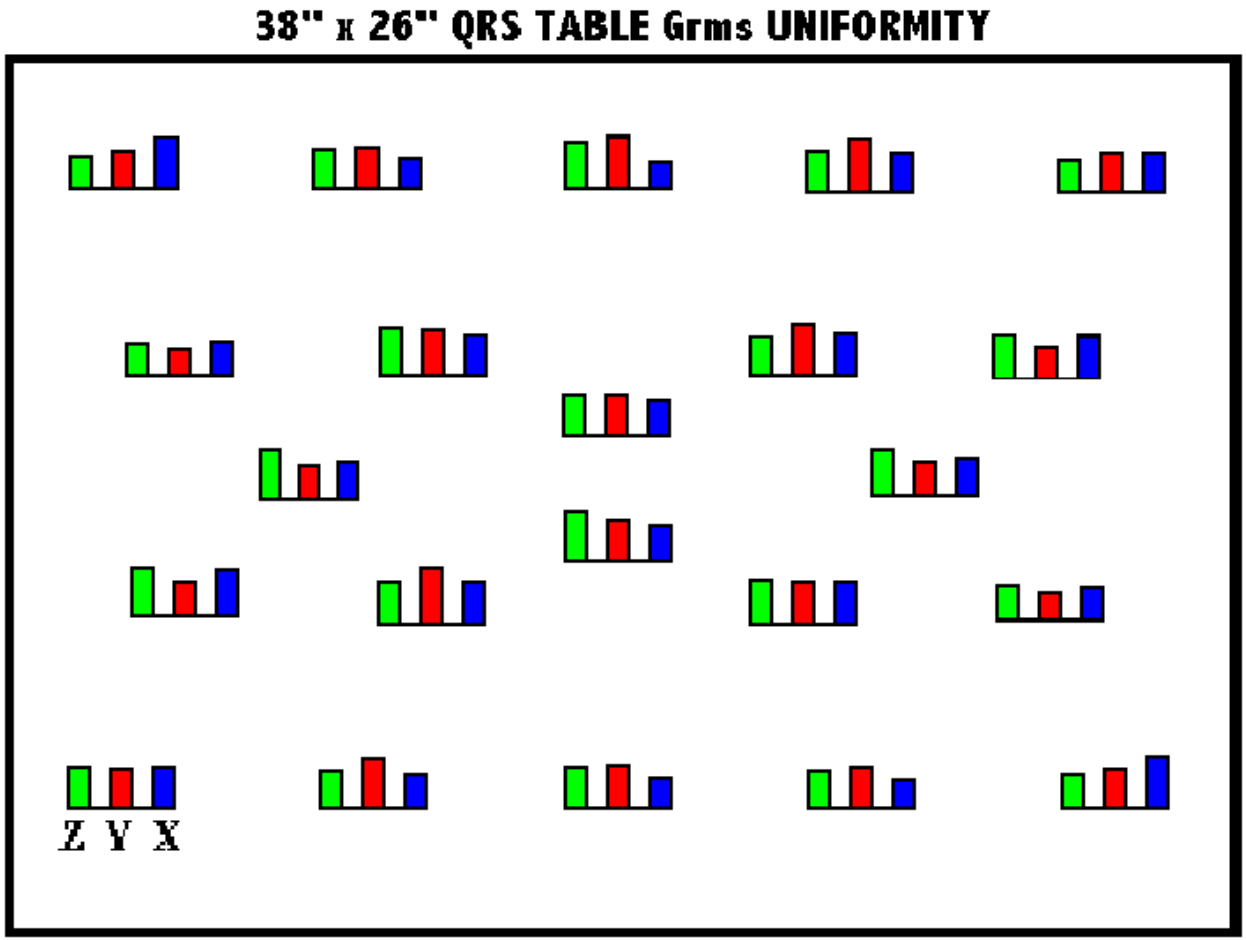
QRS Table g_{RMS} Uniformity



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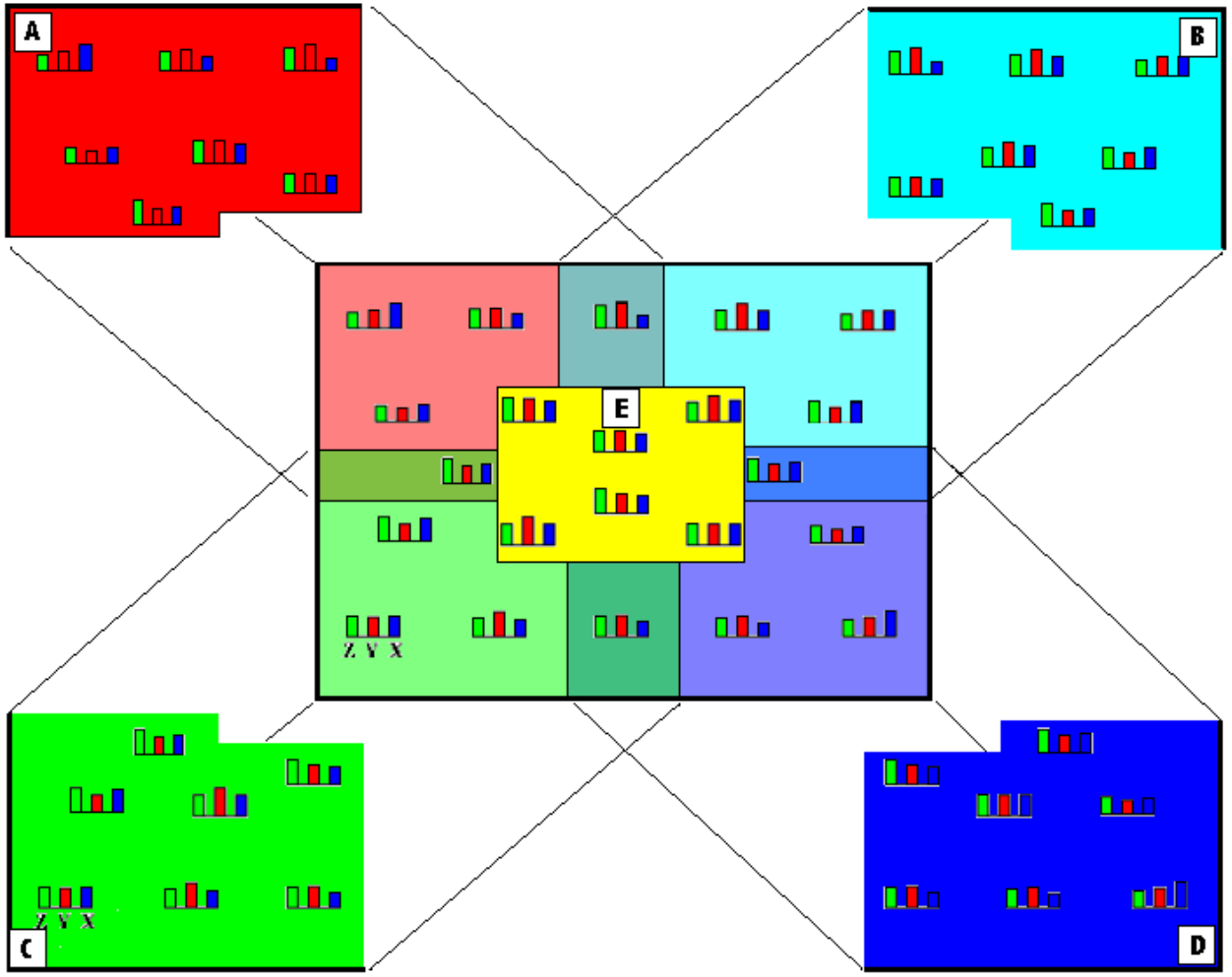
QRS Table Zones



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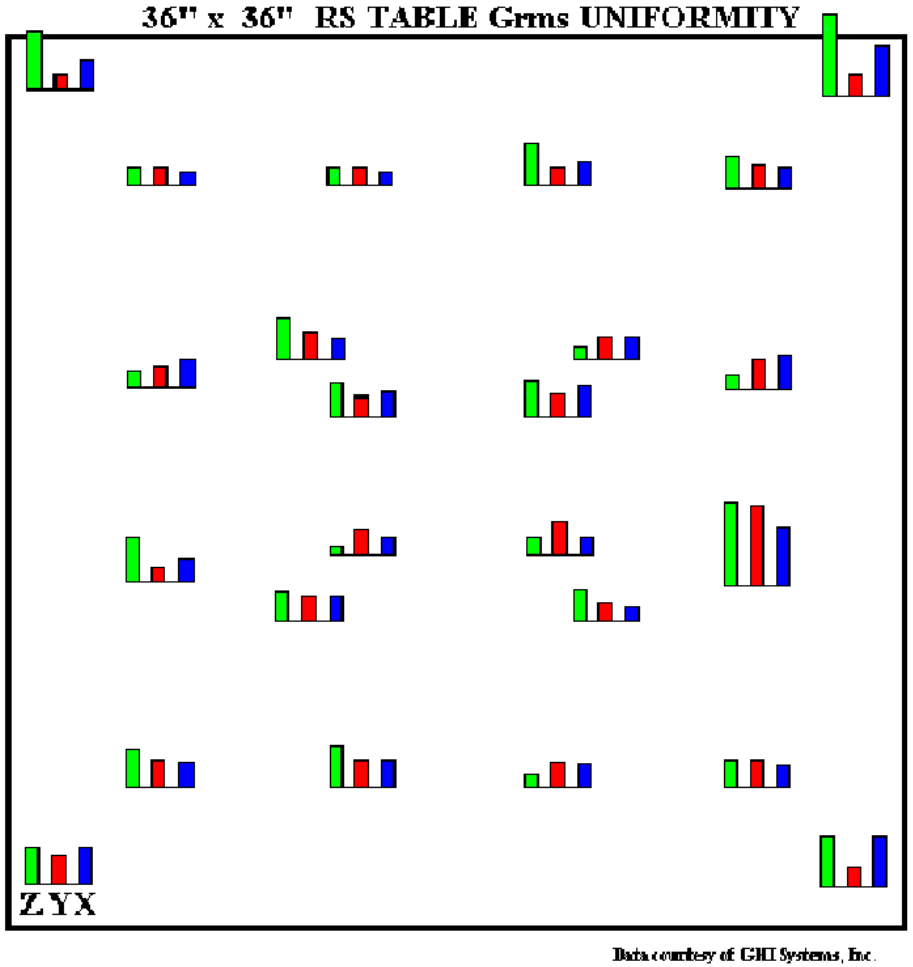
RS Table g_{RMS} Uniformity



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RS Table Zones

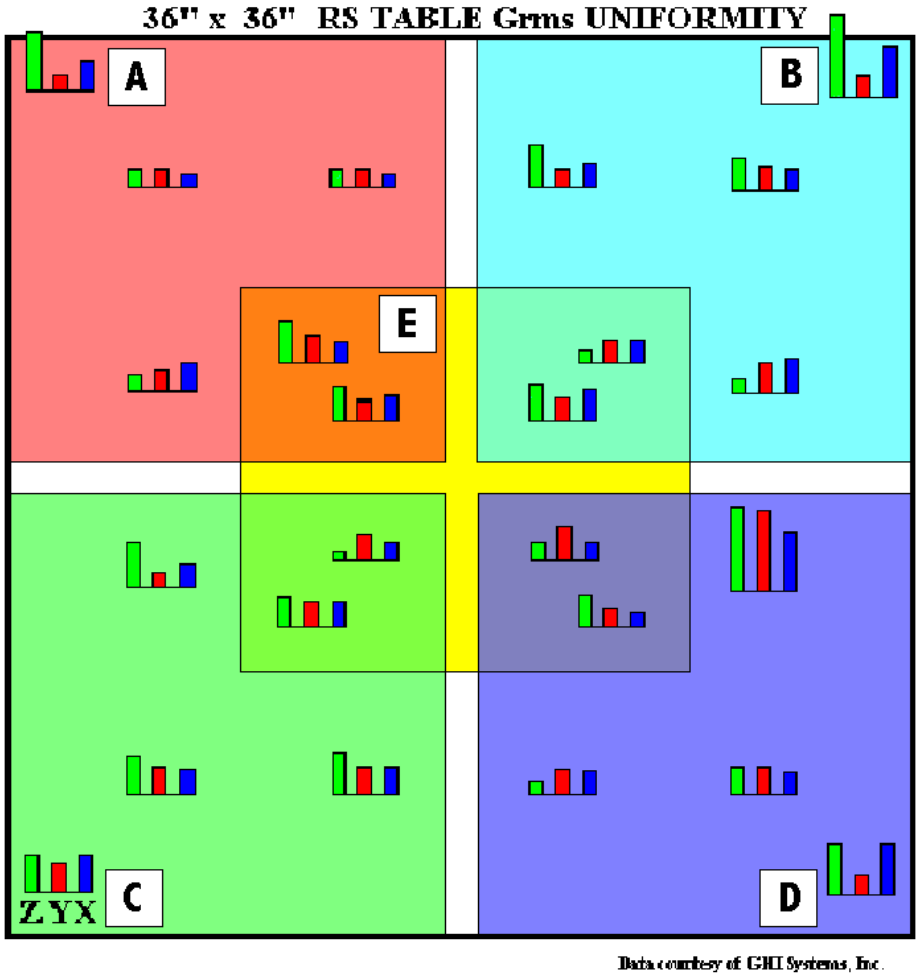

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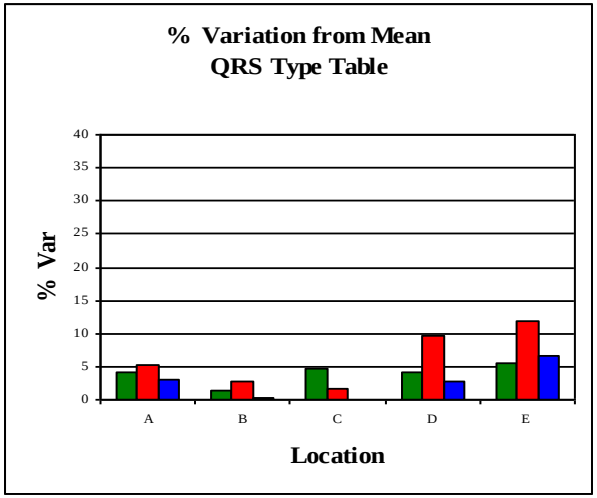
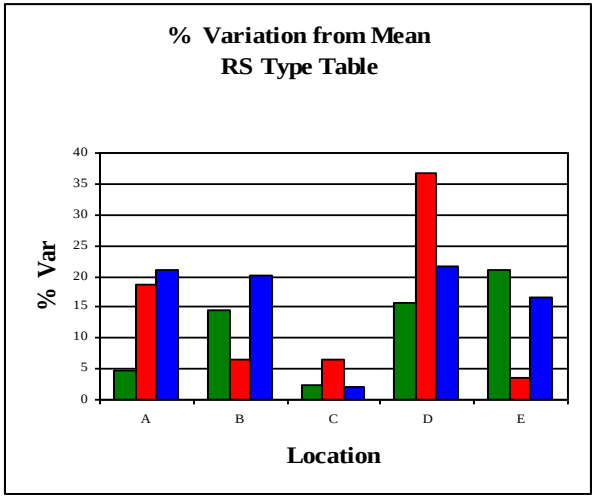
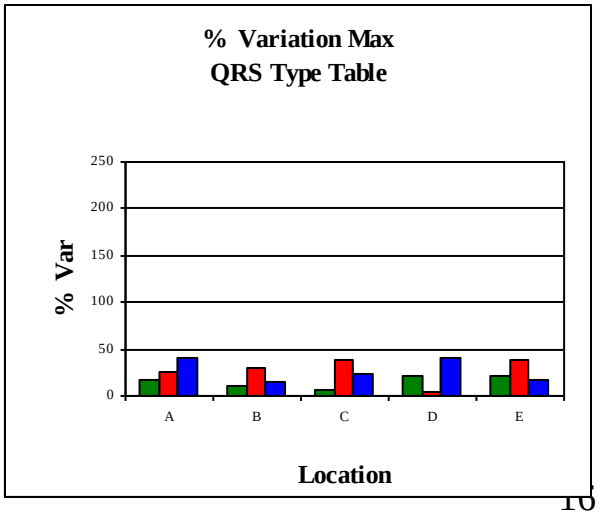
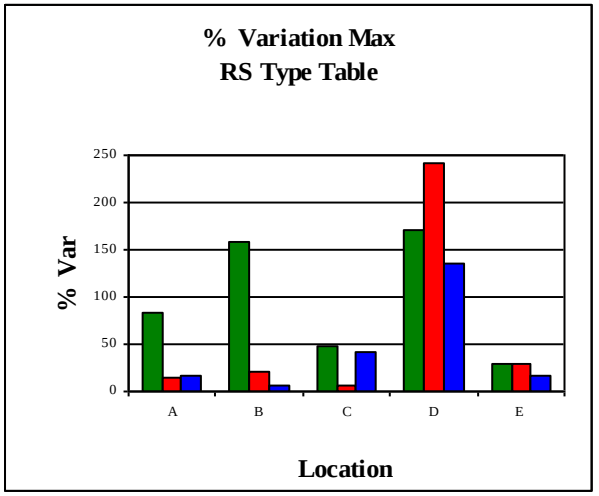
Table Uniformity Comparison









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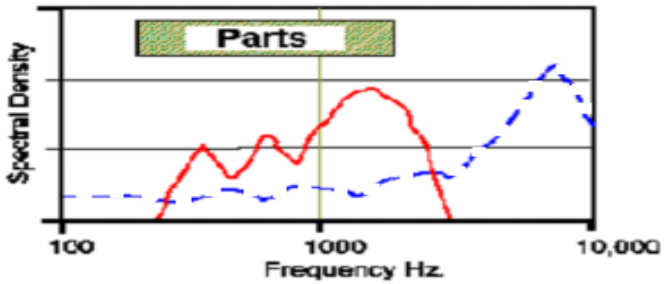
Efficacy Comparison

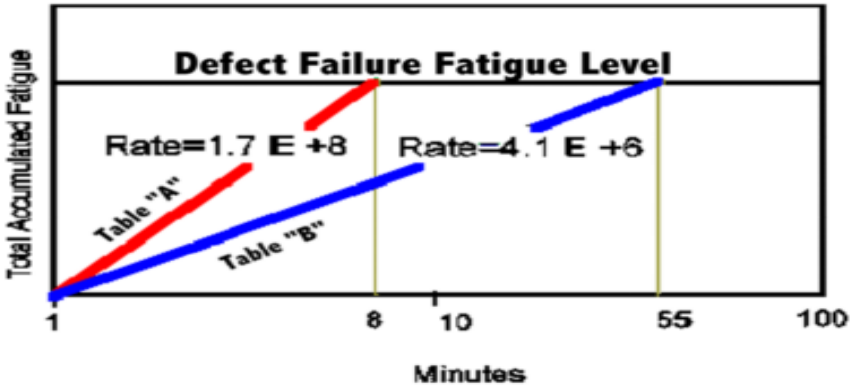
PSD Relationships, Ford Case History*



- Machine A - Damped, Segmented
- Machine B - Undamped, Solid
- Part Resonance Span, 200-2KHz
- Input Loading, Both Cases = 10gRMS.

*PSD's From Dissimilar Machines When Screening 'Computer Boxes' With Identical Defect.

Tracking Fatigue Explains Scatter



For identical defects, and the same gRMS Intensity, different fatigue rates will precipitate the defect at different times, producing screen scatter.

Presented at 1999 Accelerated Stress Testing Workshop October 26-28, 1999 Boston Massachusetts
Source: George Henderson, President, GHI Systems, Inc.
"Get A Handle On Fatigue to Improve Results from HALT-HASS Stress Screening Machines

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Summary

- **QRS and RS Type Pneumatic Vibration Systems are Vastly Different When Comparing:**
  - **Vibration Generation Methods**

QRS	RS
Thousands of Damped Low "Q"	Several Undamped High "Q"
Table Resonances	Plate Resonances
Few Sine-Over-Random Pks	Many Sine-Over-Random Pks
Acceleration Sigma =< 9	Acceleration Sigma > 12

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Summary (cont.)

- **QRS and RS Type Pneumatic Vibration Systems are Vastly Different When Comparing:**
  - **Power Spectral Density**

QRS	RS
Focused Energy 5 to 3000 Hz	Wide Band 5 to 10000 Hz
Crest Factor +/- 3dB	Crest Factor + 15/ -9 dB
g_{RMS} Energy Generated by Low Frequency Random Vibration	g_{RMS} Energy Generated by High Frequency Sine-Over-Random Peaks

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Summary (cont.)

- **QRS and RS Type Pneumatic Vibration Systems are Vastly Different When Comparing:**
  - **Vibration Uniformity**

	QRS	RS
X, Y, Z Balance Deviation	<3dB	6dB
Worst Case Zone Mean %		
Variation from Table Mean	12%	37%
Worst Case Zone Maximum %		
Variation from Table Mean	40%	241%

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Summary (cont.)

- **QRS and RS Type Pneumatic Vibration Systems are Vastly Different When Comparing:**
  - **Efficacy**

	QRS	RS
Time to Find Identical Defects at the Same g_{RMS} Intensity	**8 Minutes**	**55 Minutes**

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Summary (cont.)

- **Because of all these differences:**
  - **QRS Type Systems <u>Should Not</u> be included in the RS Category, they should have their own Unique Category**
  - **QRS Type Systems <u>Should Not</u> be confused with RS Type Systems when performing technical comparisons between Systems for Screening**

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