Equipment Reliability Institute

Experimentally Evaluating

a New Vibration Test Fixture

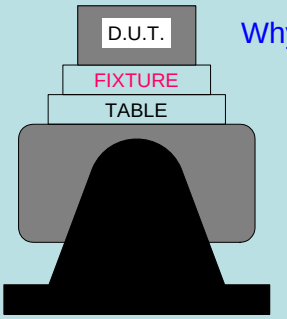
Wayne Tustin

Equipment Reliability Institute

tustin@equipment-reliability.com

IEST - Reno May, 2010

Figure 26-1 Function of Fixture



Why discuss fixtures?

Figure 26-3 Function of the Test Fixture

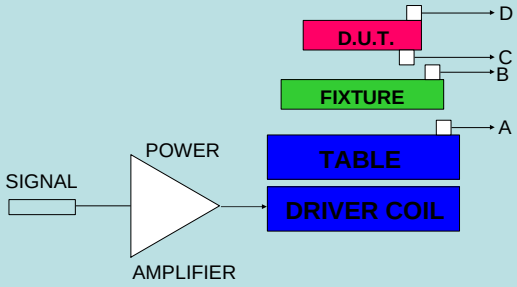


Figure 19-6B Digital control of sine vibration test

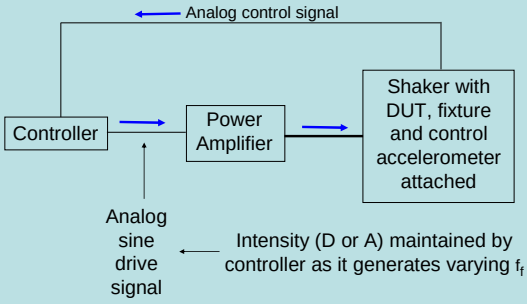


Figure 19-6B Digital control of random vibration test

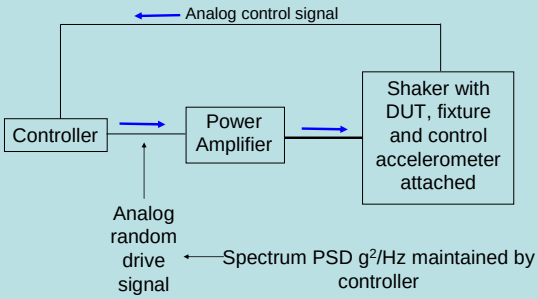


Figure 15-11A
Burned out driver coil

Hard way to learn I^2R.

$13,000 in repairs and 2 – 4 weeks shaker downtime.

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Figure 26-3 Where to Place the Control Accelerometer?

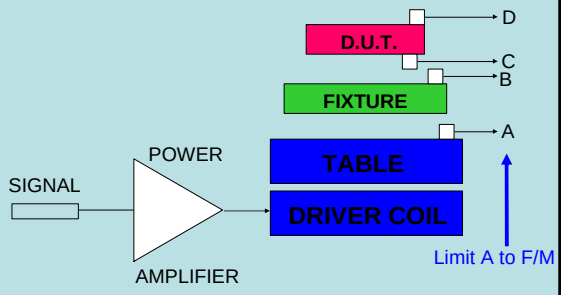


Figure 19-6A Digital control of sine vibration test

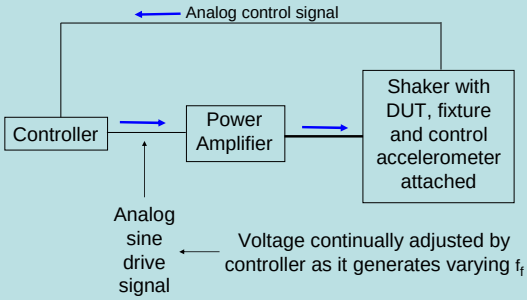


Figure 19-6A Digital control of random vibration test

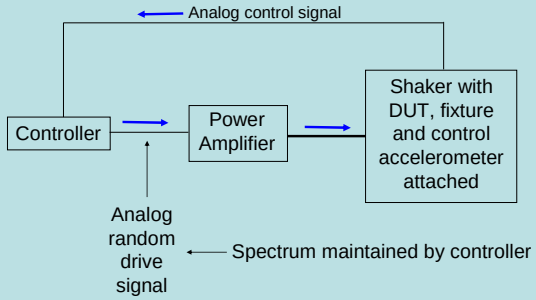
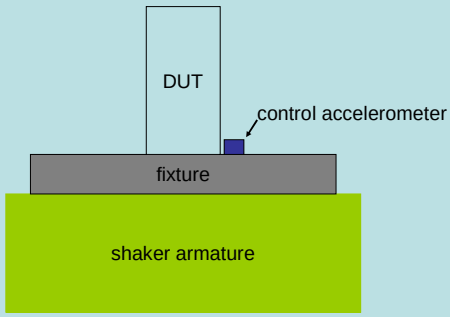


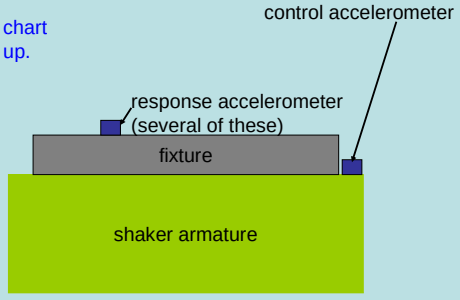
Figure 26-4A Most Common Location



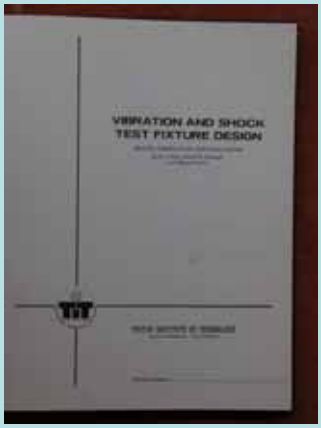
Evaluating the Fixture - presently empty

what criteria?

Criteria chart coming up.



Wayne's first text – 1971. 500 copies.



Wayne's first text – 1971. 500 copies.

See fixture criteria chart.

IEST document RP-DTE013-1

copyrighted 1998.

Section 5 Criteria

Section 8 Experimental evaluation of fixtures

8.2 Evaluation criteria

Wish new committee luck.

Wayne's current text – 2005, 3000 copies.

Criteria chart is on page 316. Let me know if you want a pdf of that page.

Let's look at the chart.

Table 26-3 Vibration Test Fixture Criteria

(1) Test Article Description	(2) Allowable Peaks in Z Tranmissibilty	(3) Allowable X, Y Orthognality Ratios re Z	(4) Allowable Variation Zmax: Zmin
Small components up to cigar size, to 2kg or 5 pounds	None < 1000 Hz. Max 3 resonances limited to 5:1	X and Y motions less than motion over test range to 2,000 Hz.	±20% up to 1,000 Hz, ±50% 1,000 to 2,000 Hz
Components up to 10-inch cube, to 7 kg or 15 lbs	None < 1,000 Hz Max 4 peaks 6:1 1,000 to 2,000 Hz	X and Y motions less than Z motion over test range to 2,000 Hz.	±30% up to 1,000 Hz, max 2:1 between points 1,000 to 2,000 Hz
Odd-shaped components (i.e. actuators, relief valves, inverters to 3 ft^3 volume) to 22 kg or 50 lbs	None < 800 Hz Max 4 peaks 6:1 800-1,500 Hz, max 3 peaks 8:1 1,500-2,000 Hz.	X and Y motions less than Z motion over test range to 1,000 Hz; to 3Z 1,000 to 2,000 Hz	±50% up to 1,000 Hz, max 2:1 between points 500 to 1,000 Hz and max 2.5:1 1,000 to 2,000 Hz
Larger equipment to 20 ft^3 volume, to 220 kg or 500 lbs	None < 500 Hz. Max 2 peaks 6:1 500 to 1,000 Hz, Max 3 peaks 8:1 1,000 to 2,000 Hz	X and Y motions less than Z motion over test range to 500 Hz; to 2Z 500 to 1,000 Hz; to 3Z 1,000 to 2,000 Hz	±50% up to 500 Hz, max 2:1 between points 500 to 1,000 Hz and 2.5:1 1,000 to 2,000 Hz
Large equipment to 24 inch minimum dimension, over 220 kg or 500 lbs. Not test > 1,000 Hz	None < 150 Hz. Max 1 peak 3:1 150 to 300 Hz, max 3 peaks 5:1 300 to 500 Hz, max 5 peaks 10:1 500 to 1,000 Hz	X and Y motions less than 1.5 Z motion over test range to 350 Hz; to 3 Z 350 to 1,000 Hz	±100% up to 400 Hz, max 3:1 between points 400 to 1,000 Hz

Figure 26-29H Design Criteria Chart

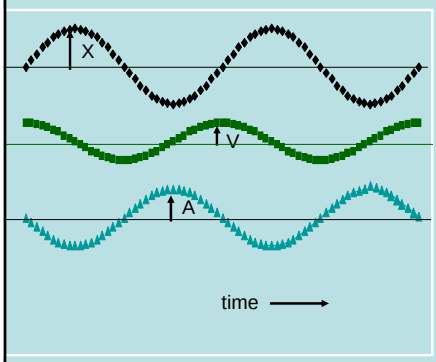
Page B3-12 (page 85 of pdf) 1989; also page 114 of 331C

MIL-STD-331B

Table B3-5. Design Criteria Chart for Various sizes of Fixtures for Vibration Testing.

Component Description	Allowable Transmissibility Peaks	Allowable Orthogonal Motion	Allowable Variation in Vibratory Input between Test Item Attachment Points
Fuzes in sizes up to a 5-in cube and weights up to 5 lb.	None below 1,000 Hz. Above 1,000 Hz, a maximum of 3 resonances, limited to 5:1 over 3 dB bandwidth of 1,000 Hz.	Y and Z motions less than X motion throughout the test range up to 2,000 Hz.	±20% allowable up to 1,000 Hz from 1,000 to 2,000 Hz. ±50%.
Fuzes in sizes up to a 10-in cube and weights up to 15 lbs.	None below 1,000 Hz. Maximum of 4 peaks above 1,000 Hz. 5:1. None to exceed a 3 dB bandwidth of 100 Hz.	Y and Z motions less than X motion throughout the test range up to 2,000 Hz.	±30% up to 1,000 Hz. 1,000 to 2,000 Hz not to exceed 2:1 between any pair of points.
Odd shaped fuzes with volumes up to 3 cu ft, weights 10 to 50 lbs.	None below 800 Hz. Maximum 4 peaks 6:1 over 3 dB bandwidth 100 Hz, 800 to 1500 Hz. Maximum 3 peaks 8:1 over 3 dB bandwidth of 125 Hz, 1,500 to 2,000 Hz.	Y and Z motions less than X motion up to 1,000 Hz. Above 1,000 Hz 2X, except that over a 3 dB bandwidth of 200 Hz, may be 3X.	±50% up to 1,000 Hz. From 1,000 to 2,000 Hz, 2:1, except that over a 3 dB bandwidth of 200 Hz, input variation may be 2.5:1 between any pair of points.
Larger fuzes with volumes over 3 cu ft and weights over 50 lb.	None below 500 Hz. Maximum 2 peaks 6:1 over 3 dB bandwidth 125 Hz, 500 to 1,000 Hz. Maximum 3 peaks 8:1 over 3 dB bandwidth 150 Hz, 1,000 to 2000 Hz.	Y and Z less than X to 500 Hz. 500 to 1,000 Hz, less than 2X, and 1,000 to 2,000 Hz, less than 2.5X, except over a 3 dB bandwidth of 200 Hz may be 3X.	±50% up to 500 Hz. From 500 to 1,000 Hz. 2:1 and 1,000 to 2000 Hz, 2.5:1, except over 3 dB bandwidth of 200 Hz, variation may be 3:1.

Your shaker, is sinusoidal vibration possible?



displacement

velocity

acceleration

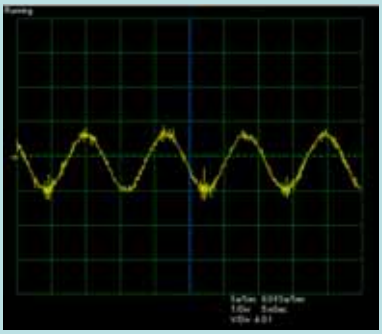
Figure 26-19 Too many Interfaces

courtesy Trace Laboratories

Figure 26-12A
Fixture for 19" panel electronics – should be welded as well as bolted.

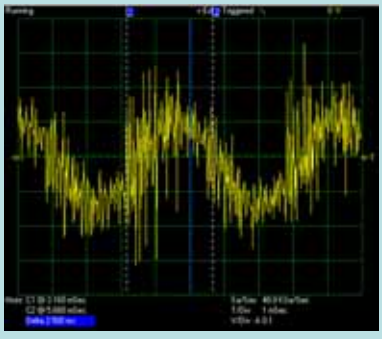
Courtesy NTS Boxborough

Figure 26-26B Slightly Loose Bolts



courtesy Unison Industries

Figure 26-26C Very Loose Bolts



courtesy Unison Industries

Figure 26-21 Welding Techniques

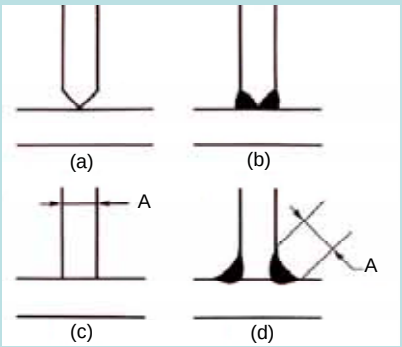


Figure 26-23 Cranking Motor on Shaker

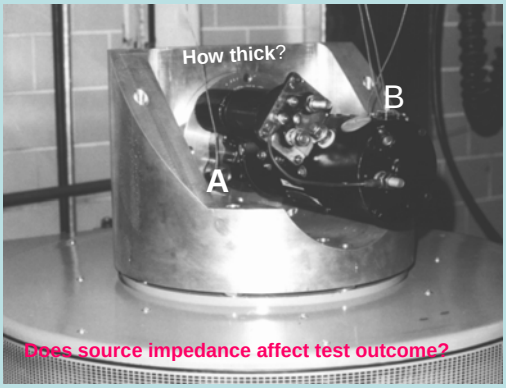


Figure 26-24 Cranking Motor on Diesel Engine

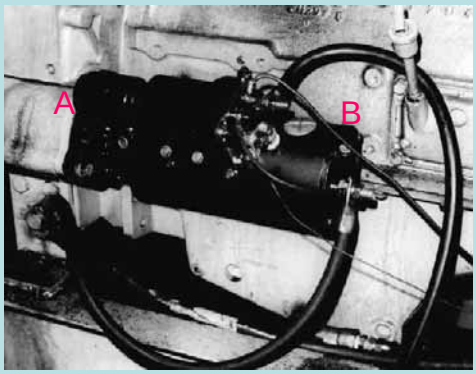
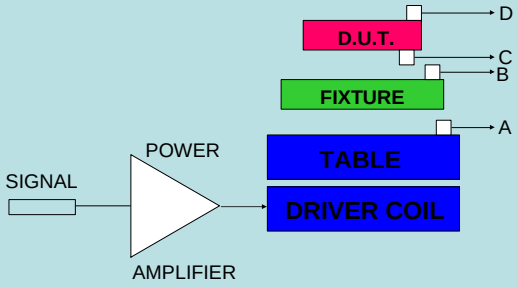


Figure 26-3 Function of the Test Fixture



Request chairman Harry Schwab permission to continue with a little discussion of slip plates, often used for horizontal shaking of large pieces of hardware.

DL 27 Sample

Figure 27-15 Slip Plate Axial Resonance

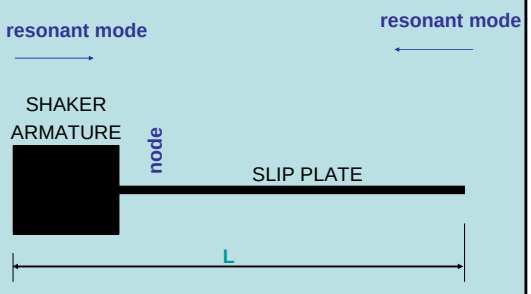


Figure 27-14 Another Slip Plate

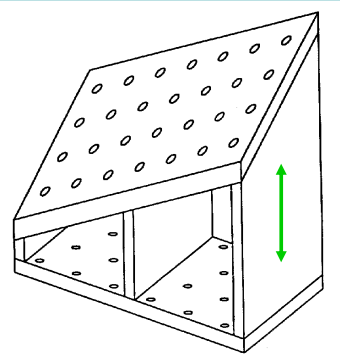
Figure 27-16 Questionable Use of Slip Plate

DL 27 Sample

Request chairman Harry Schwab permission to continue with a little discussion of *simultaneous* multiaxis shaking, which I maintain should replace "last century" *sequential* multiaxis shaking …….. 3 tests …….. 3 fixtures ….. 3 experimental evaluations.

A previous speaker told you about how his fixture tilts the test article relative to a single axis shaker and *calls* that a multiaxis test.

Figure 16-14 "Tilted" Fixture does not Multi-axis Test



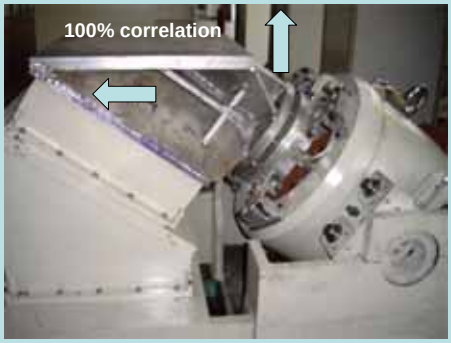
To me, the vibration is still single-axis, even though there is a component of that vibration is each of the DUT's axes.

Figure 25-15A "Tilt" (not Multi-Axis) Fixture

Figure 14 Tilted Shaker

Courtesy Quanta Labs

Figure 16-14B Tilted Shaker



Courtesy Quanta Labs

Army Research Lab experience.

DL 16 Sample

Video Clip 16-5

Courtesy DongLing

Click on the video above
to watch it on You Tube.

Yes, 3 shakers + 3 power amplifiers will cost more, but faster AND MORE EFFECTIVE. Does increasing warranty expense concern you?. Easily pay for 3-shaker system.

Is there a cheaper way to get multiaxis vibration? Yes – next slide.

Figure 25-45 Flexible Air Ducting

courtesy GHI

Figure 25-46 Screening Controls

courtesy GHI

Figure 25-37 Pneumatic RS Units Excite Platform

courtesy GHI

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