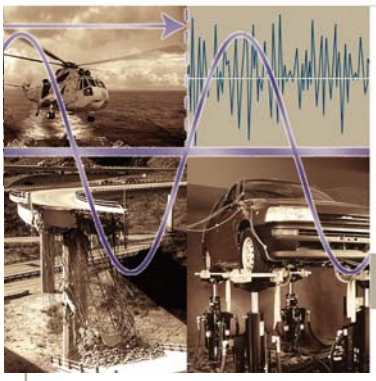

ERI News

your reliability newsletter

November 2005 | Equipment Reliability Institute | Volume 21

In this anniversary issue...

Wayne Tustin

Voice of the President

I believe that the upcoming "G" revision to MIL-STD-810 should provide for and should encourage simultaneous multiaxis shaking. Why? Because "real world" vibration usually contains motions in three orthogonal and three rotational motions.

Present military hardware is often undertested by the 50-year-old practice of aligning the specimen's X axis (then later its Y axis and finally its Z axis) with the shaker axis. Three tests when one would be better.

Field failures sometimes cannot be explained with single-axis-at-a-time shaking but have been explained by failures during simultaneous multiaxis shaking.

Please note that simultaneous multiaxis shaking is common in all automobile manufacturing plants, worldwide. Also in most earthquake laboratories.

The foregoing is approximately what I said by telephone recently to

How to Select the Right Vibration Testing Service

by Wayne Tustin and Rick Smilth

Selecting a laboratory to perform your vibration test can be daunting. Let's consider a hypothetical case where a "newcomer" needs a vibration test performed. (For a shock temperature, altitude or humidity test, his questions would be somewhat different.) Here, his "To Whom It May Concern" inquiry to several candidate labs might resemble this:

I'm seeking your advice. My company makes flight (or shipboard or land vehicle or commercial) hardware that I'll call "widgets". Our contract with our customer states that widgets will be vibration tested to a standard. My company doesn't want to invest capital in nor devote space to shaker, power amplifier and controls, and doesn't want to pay for operator training. Rather, my company wants to employ a commercial testing lab. We have already taken ordinary business precautions such as checking with the Better Business Bureau. Candidate labs are ISO (International Standards Organization) certified and several belong to A2LA (American Association for Laboratory Accreditation). Several are somewhat active in the IEST (Institute for Environmental Sciences and Technology).

I'm assigned to evaluate candidate labs for these tests. What should I look for during a visit to each lab? What questions should I ask?

Thanks for your assistance.

Sincerely, Joe Labseeker

The authors suggest the following questions. They urge Joe to visit each lab to (1) discuss his test, (2) discuss his questions (and any the lab may suggest), and (3) tour the facility. Before each visit, he should get information about each facility and its operations.

1. Does the lab have a website Joe can visit for general information? Hopefully the website will describe the lab's history and pertinent experience.

2. Does the candidate lab seem willing and able to help Joe understand his test requirements? Many of the words and phrases in standards (such as PSD in g^2/Hz) confuse readers. Some terms seem open to interpretation.

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3. Is the lab able to communicate directly with Joe's customer at Joe's request? What if something unforeseen needs to be clarified before the test starts?

4. Have test personnel documented any formal training in vibration testing, measurement and analysis?

5. Have test personnel shown Joe, in their personal (or the lab's) library, texts that answer Joe's many questions? Joe wants his company library to obtain those texts.

6. Is the lab able to prepare a Test Plan or a Test Procedure that Joe and Joe's customer can review and approve well before the test?

7. Does the lab have a sufficient number of shakers that the lab can match Joe's probable schedule? These must be sufficiently large (adequate force, adequate table area, adequate frequency range) to do Joe's job.

8. Joe's customer may call for widget vibration tests at temperature extremes. Can the eligible lab combine environments?

9. Can the potential lab perform other types of environmental tests, if required?

10. Can the aspirant lab help Joe organize complex test programs?

11. Does the hopeful lab have the resources to design, manufacture and experimentally evaluate before use (against what standards?) the fixture(s) that attach widgets to the shaker? Or will an outside service be needed?

12. Can the candidate lab safely machine and weld magnesium (which has been recommended to Joe) and install threaded inserts to firmly attach our widgets?

13. Will the competing lab provide and attach accelerometers and measurement instrumentation systems, including the display and recording systems, not only to measure and record vibration input to Joe's DUT (device under test) but also DUT vibratory responses?

14. Does the contesting lab have a significant inventory of accelerometer channels?

15. Will the lab assist in selecting accelerometer locations?

16. Beyond the specified test, Joe's structural analysts and design engineers want to correlate and validate their mathematical widget models, and so may ask for additional accelerometer channels. Can the lab accommodate this?

17. Can the candidate lab provide instrumentation to monitor widget operations during tests?

18. Some widgets require special power supplies, at 400 Hz, for example. Others require 28 volts DC. Does the eligible lab provide various power sources?

19. Some widgets require hot air or other gas flow. Others require hydraulic oil, gasoline and/or diesel fuel. Some require pressurization. Some require static structural loading. Which of these can the aspirant lab provide?

20. In addition to ASCII and EXCEL formats, in what other formats can the hopeful lab provide data?

21. If DUT resonances result in test failure, will lab personnel help Joe (and Joe's designers) learn from those failures?

22. Can the potential lab respond on short notice, in case of sudden need for testing?

23. Shortly after Joe's visit, Joe hopes to receive from several possible labs several written proposals for the anticipated vibration testing, with fixture design, manufacture and evaluation shown separately.

24. Are Joe's colleagues, and other witnesses that may be required, welcome to observe tests?

25. Joe has learned that there are government agencies established that require their representatives to witness certain tests. Does the lab have familiarity and close contact with government

Faustino Zapata at Wright-Patterson AFB in Ohio. He asked me to e-mail my thoughts to him, which I did.

Then I heard from Ken Thompson at Aberdeen Proving Ground in Maryland, who is considering the inclusion of multiaxis shaker control and test procedures for the "G" revision. He seems receptive to private industry input. He plans a working group session at the next IEST Symposium in Spring 06 at Phoenix. Who wants to join in?

If any readers would like to join in this discussion, please contact me. I'll be at the Phoenix meeting.

Note from the Webmaster

As you can see, ERI News has changed its look. It's been 5 years since the first issue was released and it was about time to give it a new format. We have gone from our previous text format and HTML versions to a PDF version. We provide a format that you can read on your computer or you can print it to read later. You can also forward copies to your colleagues.

We hope you enjoy this new version of ERI News, and look forward to sharing future newsletters in this new format with you!

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ERI News
your reliability newsletter
Equipment Reliability Institute
November 2005
Volume 21

witnessing agencies? Does the lab have a standard procedure to timely notify the government witness (to avoid test delay)?

26. Is the suggested lab authorized to handle sensitive information? Do lab personnel have government security clearances, and does the candidate lab have a Facility Security Officer?

27. Joe will need a report to show the results of each test. What kinds of reports does the recommended lab offer?

28. In addition to digital photographs of each setup, what else does a typical test report include?

29. How quickly can Joe get reports (after each test is completed)?

30. Can the competing lab submit reports electronically, as well as on paper?

31. Can the contesting lab provide preliminary test data for review as tests progress?

32. The final report should list all equipment used. The measurement equipment used must have been calibrated with records traceable to NIST (the National Institute of Standards Technology).

33. Finally, what is each lab's hourly rate? Or have the labs other ways to provide estimates for their services? To what services do those rates apply? For what services will Joe's firm not be charged?

This article has earlier been published in The BestTest Newsletter, September 1, 2005. Reproduced by permission of A.T.E. Solutions, Inc., developers of the BestTest Directory at www.BestTest.com.

Wayne Tustin, ERI's president, can be reached by e-mail or phone (805) 564-1260. Read more about Wayne at ERI's website. Rick Smith works for Wyle Laboratories and can be contacted at RSmith@els.wyle.com.

Naturally Cooled Vented (Chimney) Enclosures

by Joel Newberger

A most prevalent electronic packaging fantasy is to thermally condition all enclosures, regardless of size and power dissipation, with a single, inexpensive "Muffin type" fan. This brief article describes a simple-to-use procedure to enable the enclosure designer to go one step beyond this packaging fantasy by utilizing the dissipated heat to induce an enclosure ("chimney") air draft up to 3 FT/SEC. Most desk top plastic electronic enclosures and telephone racks utilize this method of cooling.

When enclosure volume efficiency is of primary importance, fan cooling should be considered, since naturally cooled equipment requires greater package volume. The down side of fan cooling is the resulting package acoustical signature. This will be discussed in a future newsletter article. Packaging volume efficiency is higher when fans are used since the induced air velocity can be up to five times higher than the air draft associated with natural cooling. It should be stated that fan cooled enclosures can induce air velocities much higher than 15 FT/SEC.

Printed circuit board pitch that varies from ½ to ¾ of an inch is commonly encountered with fan cooled designs; however, circuit boards when "chimney cooled" in serially-stacked card cages may require a pitch (center-center line space) up to1.5 inches. Since the heated air flows between circuit boards, the flow impedance (*i.e.,* pressure drop), even at these relatively low air velocities, must be

Vibration and Shock courses coming up

Wayne will teach short courses in vibration testing, shock testing, measurement, analysis, calibration, HALT, ESS and HASS at the following locations:

December 6-8, 2005
Detroit, Michigan

2006 Courses

January 24-26, 2006,
Cape Canaveral, Florida

February 13-15, 2006,
Las Vegas, Nevada

March 13-15, 2006,
Baltimore, Maryland

April 18-20, 2006,
Huntsville, Alabama

May 2-4, 2006,
Middletown, Rhode Island

July 18-20, 2006,
Hillsboro, Oregon

Attention!

Course fees will raise on January 1st, 2006. Registrations and payments received by Dec 31 will be charged the current price: $1995 less discounts (early-bird and 3+ participants from the same company) whenever appropriate. So register now and save !

On-the-Job Training

Is the trainer talented? Effective?

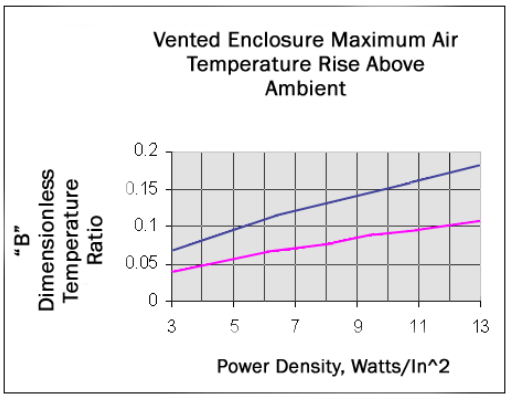
Is he given some "company" time to prepare?

ERI News
your reliability newsletter
Equipment Reliability Institute
November 2005
Volume 21

limited to levels consistent with the available buoyancy pressure developed by changes in vertical column density.

In order to minimize pressure drop, cross-sectional flow areas must be maximized to within reasonable packaging limits. Similarly, the card holder design must be configured for minimum drag. High drag card holder designs, when used in a serial stack, may produce up to fifty percent of the enclosure flow impedance.

The ideal chimney-cooled inlet/outlet opening locations are the lower and upper horizontal surfaces of the enclosure. In this manner, the draft flow direction is vertically maintained and flow impedance is minimized.



The use of dust filters in this type of application is extremely difficult because of their high flow impedance when compared to the enclosure flow impedance. Generally, filters are not used in these applications.

The methodology used for quantifying the chimney's induced air flow is shown in the attached figure. The attached curve shows the dimensionless temperature ratio "B" versus the power density P.D. (watts/in^2) defined as the total enclosure dissipation divided by the vent open area. The graphical solution presented is based on inlet vent opening equal to exhaust vent opening. The basic methodology developed permits solutions when vent openings are unequal, atmospheric pressure at any altitude, and non-uniform heat dissipation. Detailed methodology is presented at ERI seminars. In order to simplify this article's example, the following assumptions are made:

1. The vented enclosure's flow impedance is mainly due to inlet/exhaust perforation contraction and expansion losses. Enclosure internal flow impedance are neglected.

2. Uniform heat dissipation.

3. Convection and radiation cooling from enclosure external surfaces are neglected.

4. Inlet perforation opening = exhaust perforation opening

5. Sea level operation

6. Vent openings (perforations) are located on top and bottom enclosure surfaces.

The maximum enclosure air temperature rise above ambient (ÄT) is given by the following algorithm, ÄT = B x (273 + AMBIENT). B is shown in the attached figure. The upper curve is for an enclosure 12 inches in height, while the lower curve is for an enclosure 60 inches high. As an example, a one foot high vented enclosure when operating at 30C, dissipates 50 watts with an inlet and outlet vent opening each equal to 10 in^2. Therefore, the power density, P.D., is equal to 50 watts/10in^2 = 5.0 watts/in^2. At a P.D. of 5.0, and an enclosure height of 12 inches, the dimensionless temperature ratio, B, is 0.097. Therefore, the maximum air temperature rise above ambient, ÄT = 0.097 x (273 + 30) = 29.4C. The maximum ambient is 59.4C (30+29.4).

The draft velocity at the vent opening is given by the following algorithm.

DRAFT VELOCITY = 0.86 x P.D./B = 0.86 x 5.0/ 0.097 = 44.3 FT/MIN =0.74 FT/SEC

Estimating enclosure maximum and normal ambient internal temperature levels is only the beginning of evaluating internal package thermal profiles. Ultimately, reliability levels are estimated at normal environments, while estimated component maximum temperature levels are compared to manufacturer specified limits

Is training scheduled?

Or is it the last thing requested of him on his last day before leaving?

What visuals does he have available?

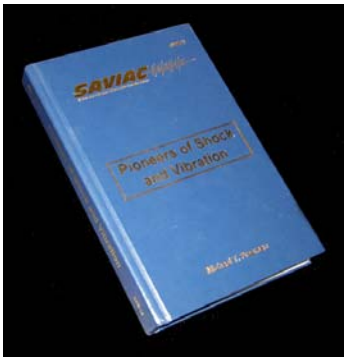
What illustrations and text materials does the trainee receive? keep?

Are the trainees ready for training? Motivated to learn?

If the all the above questions can be answered "Yes," then OJT or on-the-job training can be very successful. If not, it's better to "go outside" to obtain training. If the needed training relates to the reliability of equipment, please consider ERI, Equipment Reliability Institute.

SAVIAC Book

When I "stumbled" into the "vibration world," around 1950, I had no idea that I would be a pioneer. However, that's what Michael T. Freeman called me in 1996, when SAVIAC published Mike's "Pioneers of Shock and Vibration,"



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when operating at the maximum temperature. For this reason, it is imperative to be able to estimate both normal and worst case ambient temperature levels (during the program engineering design phase) in order to assess local internal ambient and component temperature profiles in order to provide a high quality and reliable product.

Joel is President of Thermalogics, Inc., and a principal in SNA Engineering. SNA specializes in mechanical design/packaging and in thermal/structural analysis of electronic equipment. More about consultant/instructor Joel at his page at ERI. Contact Joel.

Test Lab Musings (part 10)

by Robert L. Renz

- If you have used adhesive to mount a small response accelerometer on your UUT, remember to only remove it with the small wrench that is usually furnished with the accelerometer. If you use an adjustable wrench instead, you might destroy a very expensive accelerometer.
- After you wrap up a test, immediately take time to clean up your accelerometers before you return them to their storage locations – that way, you will be able to put them back in their correct location, and you'll also be able to read their serial numbers when you are setting up for your next test.
- If you have a growing pile of dead accelerometers, think about sending them back to the manufacturer for rebuilding. At least one accelerometer manufacturer offers to rebuild used accelerometers at a considerable saving over new.
- Different controllers react differently to a lack of control signal – I have two different brands of controller, and both will shut down if they don't see any control signal - if there is a signal, they will drive the shaker to meet the profile, but they both recognize that a total lack of signal usually means that an accelerometer cable has failed, the accelerometer has come off, or the accelerometer failed.

I imagine that this became standard with them after a few shaker armatures went into orbit after an accelerometer failed....

Check with your controller manufacturer to see how their system is set up, if you aren't sure. It is well worth knowing the answer.

Robert L. Renz of General Dynamics - Advanced Information Systems at Bloomington, Minnesota.

Vibration course in Italy - 2006

Steve Brenner, who has been working in the field of environmental simulation and reliability testing for over 30 years, will teach "Fundamentals of Random Vibration and Shock Testing" on March 22-24, 2006, at Angelantoni Industrie, in Massa Martana (PG), Italy. Please visit http://www.equipment-reliability.com/course11.htm for more details about the course and registration.

ISBN No. 0-9646940-1-8. Arranged alphabetically, I'm in Chapter 23, between Vernon A. Tauscher (founder of Team Corporation) and Karl Unholtz, (a founder of Unholtz-Dickie Corporation.)

A few $30 copies of the book remain at SAVIAC, www.saviac.org, The Shock and Vibration Information Analysis Center, a central information resource for Government activities, contractors, and academics concerned with structural dynamics design, analysis, and testing, and shock physics and weapon effects, in Columbia, Maryland.

How much effort?

How much effort, how many engineer-hours, did you spend in finding "the right" test lab? Perhaps you used our Web page as a portal. You clicked on "Links" and pulled down to "Commercial Environmental Test Labs" or to "HALT/HASS Labs", and found "hot links" to numerous labs by name. Clicking on each, you found yourself visiting the home page of each. THEN you had to find what kinds of tests each lab offers and where they are located.

Please send me an e-mail, to tustin@equipment-reliability.com, and complain to me about your difficulties and frustrations. I'm working on an idea to ease that kind of search.

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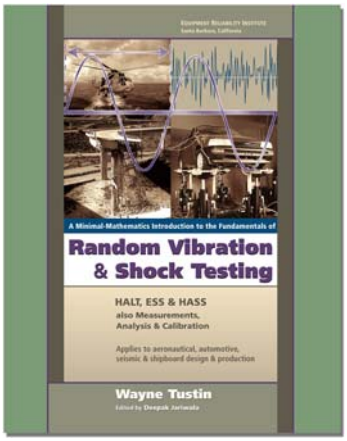
your reliability newsletter

Equipment Reliability Institute
November 2005
Volume 21

Instruction Manual Stories Contest



You are invited to enter Equipment Reliability Institute's "Instruction Manual Stories" Contest, featuring 3 top prizes with Wayne's just released "**Random Vibration & Shock Testing -** HALT, ESS & HASS, also Measurements, Analysis and Calibration**"** text (see picture of front cover).

The submitted stories must present real life experiences and should emphasize the presence and usefulness of the following items:

- ♦ Table of contents
- ♦ Index
- ♦ Glossary
- ♦ Existence and quality of illustrations
- ♦ Help section
- ♦ Help assistance (e-mails, 1-800 numbers, etc.)
- ♦ Help response speed as <1 hour, <5 hours, <24 hours, etc.

The contest is open worldwide. Participants may submit only one entry each. Entries must be received by December 23, 2005. ERI judges will choose the three best "Instruction Manual" stories and winners will be published at ERI News February 06 issue.

Visit our websites for the rules and more information.

Vibration course in Australia coming up - last chance to enroll

Deepak Jariwala, an ERI specialist, will be teaching "Fundamentals of Random Vibration and Shock Testing" at Maribyrnong, Australia, on November 22-24, 2005.

This course applies to builders and users of equipment demanding high reliability, whether or not subject, in service, to vibration and shock. This includes aerospace, land and sea vehicles and commercial products. Increasingly multiaxis random vibration is used for HALT, ESS and HASS.

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Test Engineer Becomes Designer

That's a possible headline. Can any reader supply "the story?"

I have one or two vague recollections of hearing about test engineers moving into their organization's design departments. I'd expect that, having seen failures, such people would do very well in design. Can any reader identify a specific designer who has made such a change, hopefully with the designer's e-mail address?

Announcements

Accelerated Testing

ERI's Wayne Tustin has agreed to present a two-hour session on "Accelerated Testing" at the 2006 annual meeting of the IEST (Institute of Environmental Sciences & Technology), to be held at Phoenix, Arizona, May 7-10.

Failure Analyst

Are you a failure analyst? Could you teach a short course on failure analysis, relating to failures that occur during HALT and HASS? Please e-mail Wayne.

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