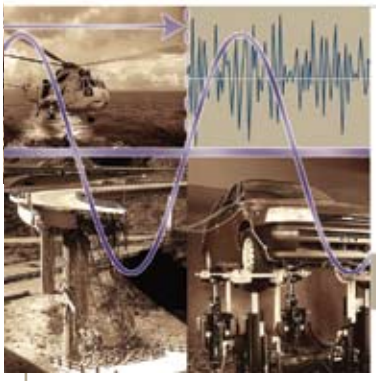

ERI News

your reliability newsletter

February 2006 | Equipment Reliability Institute | Volume 22

In this issue...

New Air Force Testing Method for No Fault Found (NFF) Proves Highly Successful

by Brent Sorensen

Total Quality Systems (TQS) of Ogden, Utah is experiencing significant improvements in the diagnosis and resolution of No Fault Found (NFF) phenomena - one of the military and commercial airline's worst maintenance issues. Rather than blaming pilots for misreporting problems or line technicians for misdiagnosing and removing the wrong avionics boxes, they are focusing on low level intermittence detection and isolation in the chassis box electrical interconnections. More importantly, they are proving why traditional testing equipment increasingly fails to find intermittent circuit defects as on-board systems age. Their results to-date should serve as a major wake-up call to the entire testing industry, and they are just getting started.

Outside Figure 1 - Intermittent Fault Detection and Isolation System (IFDIS) from TQS/ Universal Synaptics, Ogden, Utah. IFDIS continuously monitors all 700+ circuit interconnections within this "black box" that is being temperature and random vibration stressed for screening. IFDIS is watching for any otherwise undetectable low-level nano intermittencies.

Background…
Traditionally, suspect "black boxes" are pulled from Aircraft (AC) based on

Wayne Tustin

Voice of the President

Retire? Again? Why? No, thanks. I'm having too much fun. I was retired for about five years (1990-1995) after we sold our first institute. Somewhat bored, sensing that the need for practical reliability training would continue, and returning to Santa Barbara, Shirley (my wife) and I started Equipment Reliability Institute (ERI) in 1995. Between 1990 and 1995, we had started ERG (Equipment Reliability Group), a loose affiliation of reliability consultants. Some consultants teach an occasional short course.

Oh, in the back of my mind hovers the occasional thought that this fun won't go on forever. Friends die, reminding me that I won't live forever. And I occasionally think about what will happen to ERI and ERG if "something" happens to me. Two individuals have said, casually, "I'm interested in owning ERI." Is there interest among other readers?

As to what's in this issue.... Brent Sorensen's firm has

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pilot reported malfunctions and on the advice of on-board diagnostic and AC health monitoring systems. These boxes are then sent to depot repair facilities for more in-depth testing and analysis, which often result in no fault or problem ever being found. Meanwhile, the latent intermittent that caused the original malfunction remains hidden in the system (avionics box or AC), just waiting for the right environmental conditions to retrigger the defect and endanger future flights. While NFF rates vary for each system, overall they are estimated to be around 50 percent of all reported malfunctions. *Try not to think about that next time you board a commercial aircraft*. In addition, manufacturers of other electronic devices see high NFF rates in their product returns, even after extensive in-house reliability and product assurance testing prior to their design release. The costs of dealing with and recycling these intermittents are staggering when all the associated operational and logistical issues are considered.

Universal Synaptics Corporation, developer and manufacturer of intermittent fault detection and isolation technology, has teamed with TQS and the Air Force in this expanding effort. Universal Synaptics has long said that digital based and / or test point scanning and measurement equipment is skipping over intermittent / NFF problems. The results from these efforts appear to confirm it.

Intermittent conditions rarely caught
Both active and passive electronic components tend to drift out of tolerance with age, while the electromechanical connectivity elements (connectors, contacts, cables, crimps, splices, ground lugs, solder joints, relays, motherboards, back-planes, flex cables, circuit board traces and vias, circuit breakers, etc.) become increasingly intermittent over time. Virtually all testing concentrates on the measurement of operational and component parameters and not on the actual intermittent failure mode. A hard-failing defective component is virtually impossible to miss with today's ATE testing and diagnostic algorithms. Conversely, if the problem is intermittent, ATE's one circuit, or one test point at a time, scanning test and fixed-sampling measurement philosophy, coupled with the process of digital averaging to obtain higher levels of measurement accuracy, practically guarantees that these mostly low-level, random events will not be observed when they do occur.

Similar problem with HALT/HASS
HALT/HASS or other environmental stress testing, as in Figure 1, may help to find some components that are prone to early hard failures. Unfortunately, monitoring with digital based test and measurement systems fails to identify when these components or systems **first** become intermittent or unreliable. Thus many products leaving testing labs are not as robust as published data may indicate. In addition to measurement difficulties in detecting intermittent events, powered systems tend to filter out much of the low-level intermittency due to good engineering design. Normally inconsequential microsecond intermittency, under powered conditions, can, under the right environmental circumstances, easily turn into a much wider problem (open or shorting condition) and anomalous system failures. When any level of intermittency is present, the unit's stability is totally unpredictable and risky to ignore. Don't let it pass.

For more information on the intermittency/ NFF problem, see The Achilles Heel of Modern Electronics, Evaluation Engineering magazine, June 2004.

The Recipe for Success
Understanding these failure modes and measurement limitations, TQS has developed a three-pronged approach to intermittency and NFF that includes

1. Serialized data tracking of aircraft and Line Replaceable Unit's (LRU's), developed some useful solutions to the dilemma of the "black box" (or the aircraft or ship or land vehicle) whose electrical behavior is intermittent and/or unpredictable. His solution works for USAF. Perhaps it will work for you.

Some in-flight vibratory misoperations are better investigated in reverberant acoustic test facilities (RATF) than on shakers, says "Wes" Mayne. The test article, inside a hard-walled, highly reverberant room, is bathed from all directions with intense sound. Structural vibratory responses, especially on thin elements such as printed wiring boards, can lead to mechanical damage and intermittent electrical behavior.

Our friend Bob Renz has mused further about practical problems that our readers may encounter.

Come on, readers, you've all been disappointed by some instruction manual for a new automobile, a new lawnmower, a new dishwasher or, closer to home, a new shaker, power amplifier or controller. What was the most pitiful or the most anger-producing or the funniest item you've seen in an instruction manual? The contest closes February 28, 2006.

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ERI News
your reliability newsletter
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2. Test platform data comparisons, and

3. Environmentally profiled intermittency testing, as in Figure 1.

TQS's Defense Repair Information Logistics System (DRILS) first identifies LRUs coming in for depot repair as possible NFF suspects, based on their failure history. These suspect black-boxes are then given special treatment with an ATE functional test and a test-data inspection process called ATE Insight. ATE Insight compares presently tested parameters against testing norms, looking for any failing or even borderline failure values. Those suspect boxes which pass this test successfully (NFF) are then tested for any intermittent conditions in the chassis interconnections, wiring, or flex cables, using TQS' **Intermittent Fault Detection and Isolation System (IFDIS)**. IFDIS is composed of an array of three IFD-3000's from Universal Synaptics, but not visible in Figure 1.

Each of the three IFDs can simultaneously monitor 256 circuit interconnections, watching for any otherwise undetectable low-level nano intermittencies. The Unit Under Test (UUT) is being subjected in Fig. 1 to thermal and vibrational stimulus while the healths of all the chassis interconnections are simultaneously monitored.

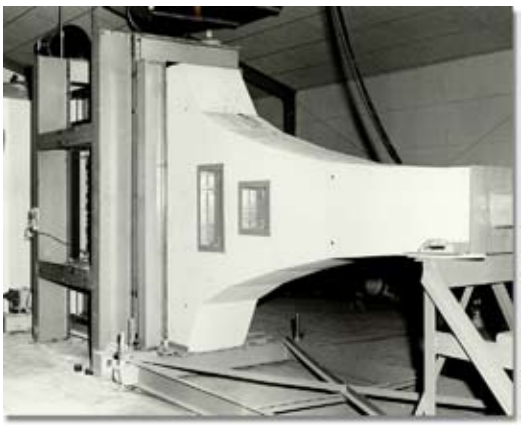
Preliminary success using this IFDIS system has been excellent, with multiple latent intermittencies being found in nearly 100% of the suspect boxes tested to date. TQS continues to improve and further develop this process. More on IFDIS.

Brent Sorensen is president and founder of Universal Synaptics. Previously, he spent 29 years in various U.S. Air Force capacities involved with testing and researching the CND/NFF problem. Mr. Sorensen has written and published a number of papers and worked with a variety of high-level government and commercial organizations regarding the effects of the NFF/aging phenomenon. Universal Synaptics, 1801 W. 21st St., Ogden, UT 84401, 801-731-8508, e-mail. TQS - Total Quality Systems, Inc., (801) 731-2150.

What's in an RATF?

by Wes Mayne

Reverberant Acoustic Test Facilities (RATF) and Progressive Wave Tubes (PWT) are both used to subject flight hardware to high sound pressure levels (130 to 170+ dB). A PWT, shown in Figure 1, includes a duct of constant cross section. Here a shaped spectrum of acoustic waves sweeps over the test article in a continuous stream. These waves are approximately flat geometrically and are perpendicular to the duct axis.



A large RATF built on-site is shown in Figure 2 (next page). This hard-walled room exposes a test article to a shaped spectrum of acoustic waves that impinge on the test article randomly from all directions. Large RATFs, designed to test satellites under the simulated acoustic field of a rocket launch, compose the most common type of high level acoustic test facility.

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:

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

May 19-21, 2006, El Segundo (Los Angeles), California

July 18-20, 2006, Hillsboro, Oregon

August 22-24, 2006, Santa Barbara, California

September 19-21, 2006, Montreal, Canada

Does this describe our situation?

Is your organization in this situation? Having used commercial testing laboratories for several years, you are considering purchase of a used electrodynamic shaker system. Can you hire an ERG consultant to assist you in the negotiations? Would you want him to visit you, see your products and review some test reports from commercial labs? Would you want him to see your facility and help you to plan shaker installation?

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ERI News
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Equipment Reliability Institute
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Volume 22

This article examines the topics that specify a large RATF. Acoustic test facilities are less common than vibration test systems and are less well understood. The best way to develop your specific requirements for these topics is to work with a company experienced in the design, construction, and use of acoustic test facilities. Here are the most important RATF topics:

- Chamber Purpose: What are the types of test articles? Will the chamber be used to support only a specific set of tests or will it be a general purpose facility?
- Location and Altitude: These parameters are used to determine the type and size of the HVAC (heating, ventilating and air conditioning) system and to provide the most accurate spectrum predictions.
- Available Room for Construction: How much land is available for construction? Are there any restrictions on the overall, finished height of the facility?
- Soil Conditions: The soil conditions at the proposed construction site are a critical design parameter that is often overlooked during the initial definition of a facility.
- Seismic Considerations: Is the proposed location subject to earthquakes and corresponding building construction requirements?
- Chamber Support: Should the chamber be supported on vibration isolators?
- Chamber Volume: The chamber volume will typically be set by other requirements rather than specified independently, but large satellite RATFs will usually fall in the range of 1000 m^3 to 2000 m^3.
- Test Article Size and Weight: What are the anticipated ranges of test article sizes and weights? This information helps determine the chamber volume, specimen door dimensions and floor bearing capacity.
- Specimen (Test Article) Door: Make this door as large as possible during construction, because it is not practical to expand the size of the specimen door later.
- Personnel Doors: How many personnel doors are desired and where should they be located? RATFs typically have 1 or 2 personnel doors.
- Low Frequency Performance: What is the lowest 1/3 octave band of interest? Large RATFs are commonly designed to test down to the 31.5 Hz 1/3 octave band. What is the minimum number of acoustic modes acceptable in the lowest 1/3 octave band of interest? Seven modes is a common goal.
- Acoustic Test Spectra: What acoustic test spectra must be produced in the RATF? These spectra may come from a general purpose standard, but for satellite RATFs they will more likely be actual acoustic spectra for the launch vehicles that will be used. Consider the acoustic absorption of the test article when estimating the necessary sound power.

Figure 2

Would you want him, on your behalf, to inspect a few candidate systems? What you buy must meet your shaker needs for the next 12-24 months.

If your answer to each is “Yes”, you need ERG, Equipment Reliability Group, a loose affiliation of specialists. Contact Wayne.

EMI Test and Fix

“Hey, neighbor, my TV reception is poor when you operate your “ham” transmitter. I want to understand what’s happening, before I report you to the Federal Communications Commission (FCC).

Might the trouble be in my radio receiver? Is it inadequately immune to interference?

Or is the trouble in your transmitter? Are you, perhaps inadvertently, putting out illegal “dirty” signals?

Either way, a problem exists. Let’s both take Bill Parker’s short course at Las Vegas June 12-15 and learn about EMC/EMI/RFI testing and the curing of problems that tests reveal. You know, we might learn some things that would help us on our workday projects.”

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Equipment Reliability Institute
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- Spectral Tolerances: What are the desired sound pressure level tolerances over the 1/3 octave bands? Plus or minus 3 dB (or somewhat better) over the range in which the noise sources are directly controllable is generally achievable for common spectrum shapes. At the highest and lowest frequencies, the tolerances are typically relaxed.
- Test Duration: What is the longest anticipated test duration? The duration sets the size of the gas supply.
- External Noise Levels: What are the allowable, external noise levels during a test?
- Gas Supply for Noise Sources: Is there an existing gas supply? Is there a preference between an air system and a nitrogen system (both have advantages)? Large RATFs require 3 to 12 kg/s of gas at 276 kPa.
- Cleanliness Level: What is the required cleanliness level of the chamber and surrounding areas? Class 100,000 is commonly required for satellite RATFs.
- EMI Shielding Requirements: Is the chamber or any auxiliary room required to have EMI shielding? To what level?
- Future Requirements: What physical or performance upgrades are anticipated in the future? If identified during the original construction, upgrades can be accommodated by leaving room for additional components, incorporating unused horn penetrations, etc.

Other important topics that are not discussed here include: Closed Loop Controller, Data Acquisition System, Test Article Support Structure, Crane, Floor and Wall Anchors, Special Purpose Penetrations, Flammable Liquid and Vapor Monitoring System, Test Article Support Equipment, Auxiliary Rooms, and Security Features and Systems.

Clearly, most companies with an interest in a large RATF or other type of acoustic test facility, but with limited experience in the field, would have a difficult time assembling a complete set of requirements for the topics listed above. This is a typical circumstance and the way to resolve it is to develop answers to the items most easily addressed, answer other items as well as possible, and leave out the items for which there is no readily available information. Then work with a company that has experience with acoustic test facilities and that can help complete the specifications. Hopefully this article has provided some insight into the wide range of topics that must be addressed in order to specify an RATF.

W. "Wes" Mayne III is a project manager and engineer for the Test, Engineering and Research Group at Wyle Laboratories in Huntsville, Alabama. Mr. Mayne's work is primarily involved with the design and construction of special test systems and with high intensity acoustic test facilities in particular. Mr. Mayne has been involved with the design and construction of twelve large RATFs all over the world and with numerous other RATF modification and upgrade projects.

Additional biography is posted on the web at http://www.vibrationandshock.com/spec14.htm. He plans to begin teaching short courses in intense acoustic noise testing.

Upcoming courses taught by ERG teachers

Steve Brenner, who has been working in the field of environmental simulation and reliability testing for over 30 years, will teach:

Last chance to enroll for Fixture course

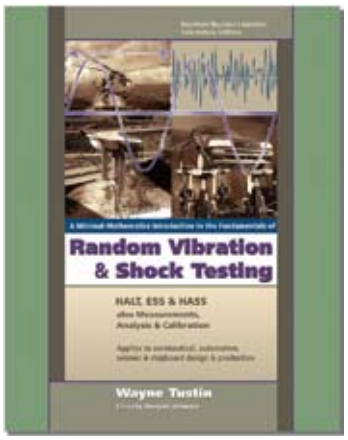
Steve Brenner's"Vibration and Shock Test Fixture Design" will meet next Feb 20-22, in Las Vegas, Nevada.

This course will emphasize the fixtures needed for sinusoidal and random vibration testing; shock testing, vibration and shock test. Details of fixture design, materials, fabrication techniques, evaluations and utilization are the focus of this short course.

Free Chapter 1

You can request a sample of chapter 1 - "What are vibration and shock?", totally free, of Wayne's new text "Random Vibration & Shock Testing - HALT, ESS & HASS, also Measurements, Analysis and Calibration". Visit our site, complete the form and hit submit.

In case you would like more information about other chapters, e-mail Wayne for sample pages of a specific chapter. The table of contents can be found here.



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Equipment Reliability Institute
February 2006
Volume 22

► "Fundamentals of Random Vibration and Shock Testing" on March 22-24, 2006, at Angelantoni Industrie, in Massa Martana (PG), Italy.
► "Vibration and Shock Test Fixture Design" on February 20-22, 2006, at Las Vegas, NV.

Ignacio "Mel" Mella, who's been working in environmental testing for over 25 years, will teach:

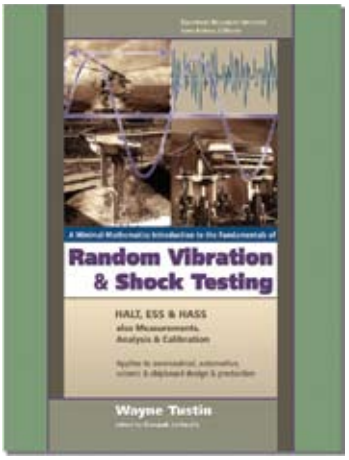
► "Fundamentals of Random Vibration and Shock Testing" on December 5-7, 2006, at Orlando, Florida

William H. ("Bill") Parker, who is a registered electrical engineer in California, as well as a NARTE (National Association of Radio and Telecommunication Engineers) certified EMC (ElectroMagnetic Compatibility) engineer, will teach:

► Four Day Practical EMI (Electromagnetic Interference) Test and Fix Seminar on June 12-15, 2006, at Las Vegas, Nevada.

Instruction Manual Stories Contest - last chance to participate!

The "Instruction Manual Stories" Contest's deadline is next **February 28**. So, hurry up and submit one or as many entries as you wish for a chance to win Wayne's just released "**Random Vibration & Shock Testing** - HALT, ESS & HASS, also Measurements, Analysis and Calibration**"** text (picture shows 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.

ERI judges will choose the three best "Instruction Manual" stories and winners will be published in ERI News May 2006 issue.

Visit the Contest page for the rules and more information.

Test Lab Musings (part 11)

by Robert L. Renz

If your accelerometer trace seems to show a resonance at about 50 - 60 Hz, take a closer look – if its at exactly 60 Hz in North America, 50 Hz elsewhere, you probably have a ground loop caused by a shorted accelerometer cable. These cables are delicate, and someone stepping on one can destroy a $150+ cable. Don't leave unused cables

Announcements

Accelerated Testing

ERI's Wayne Tustin will 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.

Harry Schwab's new courses

Visit our online course outlines page for Harry Schwab's new courses in "Stress Analysis" and "Developing Random Vibration Tests from Field Data"

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connected to your equipment – remove them, coil them carefully, and store them. If you find a bad cable, be sure its defective, then destroy it. Otherwise, someone might recover it and put it back in the drawer. If you want to save it for some reason, tag it as defective – or it will be used in another test and come back to haunt you (Not another ground loop!!!) – and here we go again.

I prefer to use a 10-32 mounting stud for the control accelerometer, but I will use an adhesive if there isn't a 10-32 hole. Customer-supplied fixtures sometimes have this problem, and customers can be angry if I drill their fixtures. We also sometimes encounter this with a new fixture if the designer isn't sure where to put the hole. We then test the fixture with a dummy load to see how the fixture behaves under vibration and to verify that the planned location is correct. We usually select a location close to one of the fixture mounting bolts and close to the shaker table axis.

After you upgrade your shaker with new cables, controller, signal conditioners, or software, run a gentle vibration test to verify proper action before you commence product testing. Check the settings on your signal conditioners, verify that cables are connected properly, check everything - but run a gentle vibration test to be positive.

Check with your controller manufacturer to see how your system should be set up.
Robert L. Renz of General Dynamics - Advanced Information Systems at Bloomington, Minnesota.

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