SAVE
SHOCK & VIBRATION EXCHANGE

Tutorials & Training

September 19 - 23, 2021

Orlando, Florida

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TRAINING TYPES & COSTS

TUTORIALS

DESCRIPTION:
THREE HOUR COLLEGE LEVEL COURSES (UNLESS OTHERWISE DESIGNATED) ON A SPECIFIC TOPIC. AVAILABLE TUTORIALS ARE LISTED HEREIN WITH A BRIEF DESCRIPTION OF THE MATERIAL TO BE COVERED.

WHAT'S INCLUDED?
REGISTERED ATTENDEES WILL RECEIVE A SET OF NOTES AND A CERTIFICATE OF COMPLETION. SOME STATES MAY AWARD CEUs/PDHs BASED ON THIS CERTIFICATE OF COMPLETION. ALL NOTES PROVIDED ARE PROPRIETARY TO THE PRESENTER. PERMISSION FOR DUPLICATION OR DISPERSION MUST BE ACQUIRED BY THE PRESENTER.

COST:
EACH THREE HOUR COURSE COSTS $195 OR ONE COURSE PER AVAILABLE TIME SLOT IS INCLUDED IN THE TRAINING PACKAGE. ATTENDEE MUST PRE-REGISTER TO ENSURE AVAILABILITY OF SPACE AND NOTES.

TRAININGS

DESCRIPTION:
COURSES RANGE IN DURATION FROM 45 MINUTES TO 120 MINUTES. ENTRY LEVEL PROFESSIONAL COURSES ON A SPECIFIC TOPIC. AVAILABLE TRAININGS ARE LISTED HEREIN WITH A BRIEF DESCRIPTION OF THE MATERIAL TO BE COVERED.

WHAT'S INCLUDED?
NO CERTIFICATE OF COMPLETION IS AWARDED FOR THESE COURSES. AVAILABILITY OF NOTES FOR EACH TOPIC DEPENDS ON INSTRUCTOR AVAILABILITY. ALL NOTES PROVIDED ARE PROPRIETARY TO THE PRESENTER. PERMISSION FOR DUPLICATION OR DISPERSION MUST BE ACQUIRED BY THE PRESENTER.

COST:
TRAININGS ARE PROVIDED TO PAID SYMPOSIUM ATTENDEES AT NO ADDITIONAL FEE. FOR ATTENDEES NOT ATTENDING THE TECHNICAL PROGRAM FOR THE 91ST SHOCK AND VIBRATION SYMPOSIUM, THE TRAINING PACKAGE MUST BE SELECTED AND PAID IN ADVANCE OF TRAINING ATTENDANCE. THERE IS, HOWEVER, NO NEED TO REGISTER IN ADVANCE FOR EACH SELECTED TRAINING TOPIC.

HOW TO REGISTER

TO REGISTER IN CONJUNCTION WITH THE 91ST SHOCK AND VIBRATION SYMPOSIUM, PLEASE VISIT WWW.SAVECENTER.ORG/SYMPOSIUM AND FOLLOW THE LINKS FOR REGISTRATION.

TO REGISTER FOR THE TRAINING PACKAGE WITHOUT ATTENDANCE TO THE SHOCK AND VIBRATION SYMPOSIUM, PLEASE REGISTER USING THE LINK ON OUR HOMEPAGE.

SPECIAL TUTORIAL SESSION
10:00AM - 4:00PM

OPTIONAL FIVE-HOUR COURSE WITH ONE-HOUR LUNCH BREAK. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

MIL-DTL-901E SHOCK TRAINING

Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

MIL-DTL-901E, signed out in June of 2017, replaces MIL-S-901D (1989). The MIL-DTL-901E is the integration of MIL-S-901D-IC2 and all of the MIL-S-901D clarifications letters (2001-2012) and standardization of the Deck Simulating Shock Machine (DSSM) as an approved test platform for shock isolated deck mounted equipment. The full day training will cover, in depth, the new MIL-DTL-901E test requirements, including all of the cost reduction areas critical to a cost effective shock hardening test program. In addition, the Navy's shock qualification policy, OPNAVINST 9072.2A (2013) and NAVSEA Tech Pub T9072-AF-PRO-010 (Shock Hardening of Surface Ships) will be covered. NAVSEA Tech Pub T9072-AF-PRO-010 (Shock Hardening of Surface Ships) replaces the cancelled NAVSEAINST 9072.1A.

MIL-DTL-901E SHOCK QUALIFICATION TESTING
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD-SSES) Code 333 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-DTL-901E Surface Ship Shock. As the DAA, Code 333 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Code 333 will be presenting the requirements for shock qualification testing as detailed in MIL-DTL-901E and interpreted by NAVSEA 05P1. Shock testing theory, MIL-DTL-901E shock test devices and facilities, detailed specification requirements, cost avoidance and clarification and MIL-DTL-901E IC#2 will be covered. Attendees should include anyone involved in the acquisition, specification, review and approval of Navy shipboard equipment including PARMs and LCMs and contracting officers, contractors having to deal with the Navy and wishing to supply shock qualified equipment to the Navy, Ship Program Managers and Ship Logistic Managers responsible for the acquisition & maintenance of shock hardened Navy ships and shock qualification test facilities.

THE MEASUREMENT & UTILIZATION OF VALID SHOCK AND VIBRATION DATA
Dr. Patrick Walter (TCU / PCB Piezotronics)

Significant focus is often provided to applying sophisticated analysis techniques to data resulting from shock and vibration tests. However, inadequate focus is often provided to assuring that valid shock and vibration data are acquired in the first place. This tutorial attempts to correct this deficiency. For the instrumentation novice it will provide an introduction to shock and vibration measurements, the physics of piezoelectric and silicon based accelerometers, and motion characterization. For the experienced test technician or engineer it will provide additional insight into topics such as optimized measurement system design, accelerometer and measurement system calibration, accelerometer mounting effects, analog filtering, data validation, data utilization, and more. For the analyst or designer it will pro-vide a series of simple observations and back of the envelope calculations that he/she can make on data to validate its credibility before using it in product design.

AIR BLAST AND CRATERING: AN INTRODUCTION TO THE ABC'S OF EXPLOSION EFFECTS IN AIR AND ON LAND
Mr. Denis Rickman (USACE ERDC)

This course introduces the effects of explosions in air and on land. Topics covered include airblast, soil/rock/pavement cratering, and ground shock phenomena produced by explosive detonations. There is a little math, but for the most part, the focus is on aspects and principles that are of practical use to those conducting (and utilizing) blast-related research. Most researchers in the blast arena have some grasp of explosion effects fundamentals, but very few have a good, broad-based understanding of how it all works. The goal is to provide the participants with enough of an understanding that they can appreciate the various explosion phenomena and those parameters that affect blast propagation and blast loading of objects in a terrestrial setting.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 6]

TUTORIAL SESSION 1
8:00 - 11:00AM
(CONTINUED)

INTRODUCTION TO DESIGNING SHOCK MOUNTED SYSTEMS USING SIMPLE SOFTWARE
Mr. Dave Callahan (HII - Newport News Shipbuilding)

This course will introduce a process for designing and assessing shock isolation systems with special emphasis on applications related to the design of shipboard equipment for shock loads produced by underwater explosions utilizing the analytical software tool "Shock Isolation Mount Prediction & Loading Estimates" (SIMPLE). This process is split into two parts: 1) initial analysis using classis Shock Response Spectrum (SRS) and 2) assessment, confirmation, iteration or comparison of isolation system designs using SIMPLE simulation methods. Attendees will learn how to building six Degree of Freedom (DOF) SIMPLE models of isolated systems, select shock mounts and modify mount properties, select shock inputs, evaluate the isolation system performance and iterate designs rapidly. This course is intended for anyone who desires validation and assurance that shock and vibration mounts are properly selected for equipment racks, consoles, cabinets and other structures using SIMPLE software. Examples of SIMPLE users are: engineers, program and project managers, equipment integrators, shock/vibration analysts, mount vendors and shock qualification reviewers/approvers.

PREPARING SPECIFICATIONS FOR MULTI AXES MULTI SHAKER VIBRATION TESTING - STATIONARY & NON STATIONARY CONDITIONS
Mr. Zeev Sherf (Consultant)

Part 1 Stationary Conditions . The use and application of the Multi Axes Multi Shaker Vibration Testing Technology that was included in MIL STD 810 G (Method 527) is expanding slowly but constantly. Its implementation requires the handling of several tasks. The assembling of the Vibration System from a set of shakers that simultaneously excite in several directions, the attachment of the tested item to the shakers using and appropriate set of hydro spherical bearings' the operation of an appropriate control system(hardware and software) that will control the simultaneous excitation work of the shakers and last but not least a methodology for the preparation of appropriate multi axes vibration testing specifications. These specifications

MIL-DTL-901E SHOCK QUALIFICATION TESTING EXTENSIONS
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD SSES) Code 333 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-DTL-901E Surface Ship Shock. As the DAA, Code 333 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Codes 333 will be presenting the requirements for shock qualification extensions as detailed in MIL-DTL-901E and interpreted by NAVSEA 05P1. Shock extension specification requirements, MIL-DTL-901E design guidelines and shock design lessons learned will be covered. Attendees should include anyone involved in the acquisition, specification, review and approval of Navy shipboard equipment including PARMs and LCMs and contracting officers, contractors having to deal with the Navy and wishing to supply shock qualified equipment to the Navy, Ship Program Managers and Ship Logistic Managers responsible for the acquisition & maintenance of shock hardened Navy ships and shock qualification test facilities.

AN INTRODUCTION TO ALIASING, FFT, FILTERING, SRS & MORE FOR FEA USERS AND TEST ENGINEERS
Dr. Ted Diehl (Bodie Technology)

Working with either physical test data and/or numerical simulations related to severe mechanical shock, impact, failure, etc. is extremely challenging. Some of the biggest challenges in this type of work are 1) properly collecting the initial raw data while avoiding aliasing [especially from numerical simulations], 2) utilizing robust methods to identify and separate the “noise & distortions” from the “true” frequency-rich content in the data, and 3) determining what portion of the “true” frequency-rich content is meaningful and what does it tell you. For a given problem, the initial appearance of raw time-domain data in this class of work may be vastly different between physical testing and data derived from transient simulation codes (LS-Dyna, Abaqus/Explicit, RADIOSS…). While the data might look different, the rules of DSP (Digital Signal Processing) are the same. Most importantly, understand and utilizing DSP properly is a critical requirement to success in BOTH types of approaches, especially to obtain correlation between physical tests and simulation of the same specific problem.

The 3-hour seminar provides guidance to both simulation analysts and test engineers on how to properly collect and process such data; ultimately uncovering significantly improved results. The course covers highlights of DSP theory in the language of Mechanical Engineering pertinent to simulation analysts and test engineers. This seminar introduces key aspects of working with transient data – specifically, clearly explaining time-domain and frequency domain analysis (DFS, FFT, PSD); data collection (sampling, up-sampling, decimation, and aliasing); filtering (lowpass, highpass, IIR, and FIR), how to avoid aliasing, calculating Shock Response Spectrum (Accel SRS & PVSS) from transient data, and numerous unique aspects related to explicit dynamics FEA data (non-constant time increments, massively over-sampled data, short transient signals with non-zero end conditions, and more). Simplified demonstrations are presented to solidify key DSP aspects, along with many relevant real-world examples. Both FEA users and experimentalists will benefit from this training.

AN OVERVIEW OF THE MIL-STD-461G ELECTROMAGNETIC INTERFERENCE CONTROL REQUIREMENTS FOR SUBSYSTEMS AND EQUIPMENT DEPLOYED ON SURFACE SHIPS AND SUBMARINES
Mr. Jeff Viel (National Technical Systems - NTS)

This college level tutorial addresses the essentials of the MIL-STD-461G standard including a brief history of the standard, test applicability, hardware configuration setup requirements, test procedures development and Test methodologies including basic formulas and calculations. This tutorial discusses some of the most common product compliance issues encountered during EMI testing, and provides insight into practical mitigation and design techniques. It is suited for students, technicians, engineers, and project managers, and anyone seeking a thoughtful understanding of these requirements, and guidance on practical application of test limits levels and ranges.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 8]

TUTORIAL SESSION 2
NOON - 3:00PM
(CONTINUED)

EFFECTIVE SOLUTIONS FOR SHOCK AND VIBRATION CONTROL

Mr. Alan Klembczyk (Taylor Devices)
Dr. J. Edward Alexander (Consultant)

This presentation provides an outline of various applications and methods for implementing isolation control of dynamic loads and damping within a wide array of dynamic systems and structures. Photos, videos, and graphical results are presented of solutions that have been proven effective and reliable in the past. Design examples are given and typical applications are reviewed Additionally, key definitions and useful formulae are presented that will provide the analyst or systems engineer with the methods for solving isolation problems within the commercial, military, and aerospace sectors. A wide range of isolation mounts and systems are covered including liquid dampers, elastomer and wire rope isolators, tuned mass dampers, and engineered enclosures. Engineering guidelines are presented for the selection and evaluation of isolation control products. Protection of COTS electronic equipment and probable damage levels are reviewed for the preparation of design and test specifications. Applications involve shipboard, off-road vehicles and airborne projects. Included also are industrial equipment and seismic control of structures and secondary equipment. Field and test data such as MIL-DTL-901E barge test measurements are presented. The use of Shock Response Spectra (SRS) for equipment assessment as well as isolator analysis is discussed. Details and examples of shock and vibration analyses are presented including case studies with step by step description of engineering calculations. The shock and vibration environment and corresponding equipment response is characterized primarily in terms of the peak response of a single degree of freedom (SDOF) system. This includes peak equipment acceleration response given by the SRS (shock response spectrum), the peak equipment velocity response given by the PVSS (pseudo-velocity shock spectrum) and the maximum total energy input to the equipment given by the energy input spectrum (EIS). An example is presented where the peak energy input to both linear and nonlinear base excited MDOF (multi-degree of freedom) systems is strongly correlated to the SDOF EIS. Examples of the vibration environment are discussed in terms of a power spectral density (PSD) and correlation of a PSD input and the maximum equipment RMS acceleration response, based on Miles equation. Matlab functions for SDOF equipment response based on characteristics of various shock isolators are described where example results are correlated to test data.

HOW MODAL INFORMATION CAN IMPROVE CONFIDENCE IN VIBRATION QUALIFICATION

Mr. Troy Skousen (Sandia National Laboratories)
Mr. Randy Mayes (Contractor)

Random vibration laboratory testing is used to qualify components to survive in-service responses to system environments. Using realistic research hardware and an analytical rocket system, we show that traditional single input (SDOF) base excitation laboratory test specifications generate large response uncertainties when compared with the field environment responses. A brief review is provided showing how mode shapes are derived from test data. A model utilizing fixed base and rigid body modes of the component on its vibration test fixture is used to decompose the component field motion into a few insightful modal responses. This model is used to develop a greatly improved SDOF base input test. It is used to develop 6DOF laboratory control that eliminates large uncertainties with a corresponding boost in qualification confidence. The same model can also be used to address unit-to-unit variability simply based on a laboratory random survey before the component qualification test is executed.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

MIL-DTL-901E SUBSIDIARY COMPONENT SHOCK TESTING & ALTERNATIVE TEST VEHICLES
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

The MIL-DTL-901E Subsidiary Component Shock Testing and Alternate Test Vehicles course will cover the following areas: NAVSEA 05P1's current policy for testing subsidiary components, description of test environment requirements, examples of recent successful test programs, alternate test vehicle descriptions, alternate test vehicle limitations, discussions on shock spectra, Multi-Variable Data Reduction (MDR) and various shock isolation systems. This course is intended to give the necessary information to equipment designers and program managers who intend to shock qualify COTS equipment that will require frequent upgrades due to obsolescence, equipment upgrades, change in mission, etc. Although not required, it is recommended that those attending this course also attend courses on Shock Policy, MIL-DTL-901E testing and particularly MIL-DTL-901E extensions offered by the same instructors (Urzillo and Kurt Hartsough).

INTRODUCTION TO WEAPONS EFFECTS AND SHIP COMBAT SURVIVABILITY ANALYSIS
Mr. Jan Czaban (Zenginworks Limited)

This short course provides a practical understanding of naval ship combat survivability and methods to assess the effects of various weapons. The introduction will review terminology, concepts and current practice involved in setting, achieving and verifying survivability requirements. Naval threats and weapon types will be reviewed and methods for predicting their resultant loads and damage mechanisms explained. Primary weapons effects will include attacks from underwater explosions, above water explosions, internal blast, fragments and ballistic projectiles. Sample problems will be provided to demonstrate how to estimate the extent of damage sustained by ship structures and how to apply and interpret damage using standard terms of capability degradation. Methods for hardening ship systems and structures will be reviewed with an introduction provided to explain dynamic load effects tolerance, armour systems and simplified pass/fail global design assessment techniques. The course material will be entirely based on public domain sources and includes a comprehensive list of references and applicable military standards.

DDAM 101
Mr. George D. (Jerry) Hill (SERCO)

The U.S. Navy Dynamic Design Analysis Method (DDAM) has been in general use since the early 1960s. It is a method of estimating peak shock response of equipment and outfitting on naval combatants using normal mode theory, originally extended from earthquake analysis methods. The DDAM requires linearelastic model behavior and employs a statistical method of modal superposition yet has persisted to today as the U.S. Navy required method for shock qualification by analysis. This, in spite of the rapid advancement of dynamic transient simulation technology and techniques for representing nonlinearities including material plasticity and contact behavior. The tutorial will address: how the method works, how the shock spectral input values are presented in DDS-072-1, what is the role of modal weights and participation factors, why has the method persisted including what are its strengths and also what are its weaknesses. The tutorial will provide a basic understanding of the method, requirements, and procedures to those who expect to be involved in shock analysis and will demystify the procedure for many who are current users.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 10]

TUTORIAL SESSION 3
4:00 - 7:00PM
(CONTINUED)

ENVIRONMENTAL SIMULATION AND TESTING TASKS TO BE FULFILLED DURING A PROJECT IN THE ACHIEVEMENT OF A PRODUCT'S DYNAMIC ENVIRONMENTAL ROBUSTNESS
Mr. Zeev Sherf (Consultant)

A project is a system, the input of which is the requirement for a new product and the output of which is the respective product. The project operates through three subsystems respectively: the design, manufacturing and the testing and evaluation. This presentation relates to the testing and evaluation subsystem, trying to elucidate the tasks to be performed in the evaluation of a product's dynamic environmental robustness. The main two tasks are the characterization and the simulation. In the frame of the characterization task, features of the field regime are identified to be replicated in the laboratory simulation of the field environment, as a basis to a realistic laboratory testing. The laboratory environment is "tailored" , meaning that it represents the specific loads, of a specific system on a specific platform and a specific interaction between the system and the loading environment. The main and best data source in the tailoring process are field measurements. These methods shall be used for the analysis of the in the laboratory simulated data also. The results for the field and laboratory data shall be compared as a mean for the equivalence between the field and laboratory evaluation.(Method 525 of MIL STD 810G). If measured data are not available, data supplied by standards (Method 514 of MIL STD 810G or other relevant sources.) can be used.

OPEN-SOURCE STRUCTURAL DYNAMICS WITH JULIA
Dr. Robert Browning (Browning Solutions, LLC)

Vibration and structural dynamics problems are frequently analyzed using commercial off-the-shelf (COTS) software, such as MATLAB®. Applications of this range from developing and running customized programs to post-processing and visualizing data. Oftentimes, however, the infrequent or difficult-to-anticipate nature of such work makes justifying the cost of such software difficult, especially when additional specialized packages are required. Open-source software provides businesses and government agencies of all sizes with a much more cost-effective solution. One such free open-source tool is the programming language Julia. Julia was designed from the ground up for high-performance technical computing and is currently employed around the world by universities, government agencies, and industry for everything from data science to web development. The scripting/syntax of Julia feels very familiar to MATLAB users and the plethora of packages makes pre- and post-processing straightforward.

This tutorial will provide an overview of the Julia language and its most relevant tools for the engineer/analyst working in the field of structural dynamics. This will include a summary of various programming tools, where/how to obtain Julia, and where to go for support. The course will also provide a review of fundamental structural dynamics principles with a focus on numerical single-degree-of-freedom (SDOF) methods. Example problems will be analyzed using Julia programs constructed for this tutorial. The examples will demonstrate methods of handling data and visualizing results.

The course is intended for anyone interested in learning more about the advantages of open-source software, specifically Julia, and for engineers and scientists working in the field of structural dynamics.

TUTORIAL SESSION 4
8:00 - 11:00AM

CHANGES FROM MIL-S-901D TO MIL-DTL-901E EXPLAINED
Mr. Kurt Hartsough (NSWC Philadelphia)

The intent of this tutorial is to cover the changes between MIL-S-901D and MIL-DTL-901E. This tutorial will provide an opportunity to discuss specific situations related to shock qualification testing with NAVSEA 05P1's Delegated Approval Authorities for Surface Ships and Submarines. Areas covered include: updated and new definitions, reduce shock test schedules, shock isolation, use of standard and non-standard fixtures, reduced hammer blows, reduced multiple operating mode requirements, reduced retesting, Shock Response Frequency (SRF) and more.

MIL-DTL-901E ENGINEERING TOPICS
Mr. Domenic Urzillo (NSWC Carderock)

MIL-DTL-901E Engineering topics is a follow-on course to the MIL-DTL-901E Test and Extension training courses and is aimed at providing the NAVSEA acquisition and engineering communities with a more in-depth review of engineering mathematics routinely used in equipment shock qualification. Topics covered include shock spectrum as it relates to MIL-DTL-901E testing, digital data filtering, shock response frequency, shock test fixture design fundamentals and FSP deck simulation fixtures.

COMMON ROADBLOCKS/MISTAKES FROM SHOCK QUALIFICATION; PRACTICAL GUIDANCE & CASE STUDIES
Mr. Patrick Minter (HII - Newport News Shipbuilding)

This course will focus on errors and missteps common to the shock qualification process and how they can be avoided by walking attendees through qualification efforts for several real-life examples. The instructor will provide details on the issues that were faced, the utilized testing/analysis methodologies, related 901 requirements and lessons learned. The end-goal of the training is to provide attendees with a better practical understanding of shock qualification by test and extension. This course is aimed at those who are or will be responsible for shock qualifying naval equipment per 901 requirements. This course assumes the attendees have at least a base understanding that attendees have participated in the NSWC (Hartsough and Urzillo) 901 trainings or at least have a basic understanding of 901 requirements. There will also be a portion of the tutorial set aside for specific attendee questions and hypothetical scenarios.

SOME MODERN FRAMEWORKS FOR SHOCK MODELING
Dr. Tom Paez (Thomas Paez Consulting)

Accurate specification of mechanical shock tests has long been a fundamental goal of environment analysts. The de-facto standard for shock test specification, today, is the method of shock response spectra (SRS), first developed in 1932. The method has its shortcomings. Although it is possible to specify tests that somewhat accurately reflect field environments, practical implementations tend to yield over-tests that do not accurately resemble the field environments they are meant to represent. Yet many alternatives to the method of SRS are available. This presentation discusses four data-based alternatives for modeling oscillatory shocks, alternatives for which tolerance limit-based test time histories can be specified. These are: (1) The Karhunen-Loeve Expansion; (2) Continuous Wavelet Transform; (3) The Priestley Model for Nonstationary Random Processes; and (4) Least Favorable Response. The methods are all data-based; they permit the use of small or large ensembles for the specification of tolerance limit-based, test time histories. Some are more mathematically complex than the others, but software can be written that permits the simple specification of test time histories. This presentation develops the methods in as much detail as possible during a limited-duration exposition. Examples of the use of the four methods will be presented. MATLAB programs for the implementation of the four methods will be distributed to those who wish to have them.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 12]

TUTORIAL SESSION 4
8:00 - 11:00AM
(CONTINUED)

A PRIMER ON VIBRATION TESTING AND DATA ANALYSIS
Dr. Luke Martin (NSWC Dahlgren)

The tutorial will begin with an understanding of a typical laboratory vibration test setup, followed by a deeper dive of the fundamental components. Specifically, a typical single DOF vibration test will be decomposed into its pieces: amplifier, shaker, slip table, test item, vibration controller, and reference profiles. Once the components of the control loop are understood, the tutorial will focus on data analysis required by both the vibration controller to conduct a test and by a user who wishes to use measured field data to develop a tailored vibration test profile. Along the way concepts that will be covered are: electrodynamic shakers, servo-hydraulic shakers, single degree of freedom testing, MDOF testing, control vs measurement transducers, Miner's Rule, sinusoidal testing, random testing, mixed mode testing, MIL-STD-167, MIL-STD-810, need for tailored vibration data, and digital signal processing used for data analysis.

TUTORIAL SESSION 5
3:30 - 6:30PM

SHOCK TEST FAILURE MODES

Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

This tutorial will cover examples of shock test failures typically experienced by equipment exposed to MIL-DTL-901E shock levels. MIL-DTL-901E provides guidance for designers responsible for meeting the requirements of MIL-DTL-901E. This tutorial will show how and why equipment failures occur and show how minor design changes can prevent shock failures. Hands on demonstrations, real time high speed video and analysis will be used to demonstrate both failures and corrective actions.

OVERVIEW OF UNDERWATER EXPLOSION PHENOMENOLOGY AND BULK CHARGE WEAPON EFFECTS

NOTE: LIMITED DISTRIBUTION D (SECURITY PAPERWORK REQUIRED)

Mr. Greg Harris (Consultant)

This tutorial will provide an overview of underwater explosion (UNDEX) phenomenology relevant to bulk charge underwater warheads. The phenomenology discussion includes UNDEX shock wave propagation, bulk cavitation effects, and UNDEX bubble dynamics. UNDEX testing and analysis procedures for characterizing the shock wave and bubble performance of explosive compositions will be described. Finally, a brief discussion of the damage mechanisms used by bulk charge underwater weapons such as mines and torpedoes will be given using illustrative examples from UNDEX testing programs and recent naval encounters.

This talk contains Controlled Unclassified Information (CUI) / Distribution Statement D: Distribution authorized to DOD agencies and US DOD contractors.

QUANTITATVE METHODS FOR HIGH-G ELECTRONICS SURVIVABILITY

NOTE: LIMITED DISTRIBUTION D (SECURITY PAPERWORK REQUIRED)

Mr. Curtis Mckinion (Air Force Research Laboratory)
Dr. Matthew Neidigk (Air Force Research Laboratory)

The design of high-g electronics remains more of an art than a science. Ensuring the correct operation of an electronics assembly undergoing dynamic loading can be challenging in practice. This tutorial will introduce quantitative methods useful for the design and evaluation of high-g electronics. This tutorial will focus on the design of electronics with loadings that result from a sudden change in velocity (velocity shock). In general the presented methods were developed for applications with accelerations greater than 10,000 g. Emphasis will be placed on the mechanical and thermal aspects of the design process.

The tutorial presentation will be Distribution D. Specifics about electrical components and their survivability in laboratory scale testing will be discussed. Weapon systems, their electrical components, and their high-g performance will not be discussed at the tutorial. A list of attendees will be collected during the presentation. Co-authors can choose to share none, some, or all of their presentation materials with attendees.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 14]

TUTORIAL SESSION 5
3:30 - 6:30PM
(CONTINUED)

ANALYSIS FOR A MEDIUM WEIGHT SHOCK TEST
Mr. Josh Gorfain (Applied Physical Sciences)

While a shock test is essentially the bottom line for a shock qualification, a lot of analysis often goes into the mix before the test. The reasons for this are many: The equipment manufacturer wants his equipment to pass and will often commission some kind of pre-test prediction to maximize the likelihood of success or to high-light design problems. Since the weight and frequency of the tested equipment can affect the response of the test significantly, the system may need to be examined to assure that the tested environment is correct. This tutorial will first review the Medium Weight Shock Machine (MWSM) and its use in shock qualification testing, followed by presentation of the test environment. Next, the types of analysis that can be performed to estimate the test environment experienced by a given piece of equipment will be described. The intention of these analyses is to provide an assessment of equipment response subject to a MWSM test in an effort to assure a successful test. Additionally, the merits and limits of these methods are discussed so the most appropriate method may be rationally selected for a given application. Examples will be presented that illustrate the different types of analyses and how they may be applied.

THE SEA (STATISTICAL ENERGY ANALYSIS METHOD) - A METHOD FOR THE DYNAMIC ANALYSIS OF A MECHANICAL SYSTEM EXPOSED TO RANDOM EXCITATION
Mr. Zeev Sherf (Consultant)

With the advancement of the space and aeronautic industry, the need of dynamic behavior evaluation of mechanical systems in the high frequency domain (above the fundamental structural frequencies) increased significantly. The classical analysis methods didn't answered to these needs. The modes are very dense and much more of them must be considered High frequency modes (of shorter length scale) are more sensitive to small unavoidable structural changes, so that, the by the classical method predicted responses lack reliability. Even if a reliable prediction is achieved , in the high frequency range , the computer generated data is so vast, that is difficult to handle the results. Under these limitations the proposed method was to adopt a statistical attitude according to which the question to answer is: "What is the average dynamic response (in terms of the mean square value), while the averaging is over time and over space?". The SEA (Statistical Energy Analysis) methodology was created. According to R. Lyon this is a branch of the dynamic systems' research. Statistical – stresses the fact that the studied system belongs to a population of systems of known distribution of the dynamic parameters. Energy- the parameter of main interest in the dynamic analysis is Energy. Mechanical parameters as: displacement, pressure, acceleration and force are evaluated from the Energy. Analysis – stresses the fact that SEA is a frame of research and not a particular technique

According to the SEA the behavior of structural elements is characterized by averages from the start of the analysis, instead of a detailed analysis, followed by calculation of averages. The dynamic analysis is in terms of energy flow between the subsystems of a mechanical system, for a certain frequency band, or the spatial distribution of the vibratory energy in the structure. The SEA method doesn't solve the motion equations. It analyses the energy distribution in the system and relates it to average response parameters. In the SEA analysis process the systems is divided into subsystems that interact each with another. By applying the SEA method the mean square response of the subsystems is evaluated. The parameters required in the calculation can be identified partly by calculations and partly experimentally. In the tutorial the principles of the SEA Method will be described. The building of the dynamical structure's system of energy flow equations will be exemplified. Analytical and measurement methods to be applied in the determination of the elements required in the building of the system of equations are presented. The application of the SEA method in the dynamic analysis of a system exposed to acoustic excitation is exemplified. Numerical tools used in the application of the method are discussed. Several summarizing remarks conclude the presentation.

CONFIRMED TRAINING TOPICS:

INTRODUCTION TO MEDIUM WEIGHT SHOCK TESTING	**120 MINUTES**
SHOCK RESPONSE SPECTRUM PRIMER	90 MINUTES
USING SUPERVISED LEARNING (PYTHON) TO QUANTIFY UNCERTAINTIES ABOUT A SHOCK EVENT	**45 MINUTES**
INTRODUCTION TO HEAVYWEIGHT SHOCK TESTING	**120 MINUTES**
INTRODUCTION TO UNDERWATER EXPLOSION PHENOMENA WITH BASIC APPLICATIONS TO STRUCTURES	**90 MINUTES**
CAN METHODS FOR NUMERICAL TIME INTEGRATION IN COMMON USE BE REPLACED BY EQUIVALENT DIGITAL FILTERS?	**120 MINUTES**
DSSM SHOCK TESTING (MIL-DTL-901E TOPIC)	**60 MINUTES**

QUESTIONS?

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