SAVE
SHOCK & VIBRATION
EXCHANGE

TRAINING GUIDE
TUTORIALS & TRAININGS

SEPTEMBER 24 - 28, 2023
ATLANTA, GEORGIA
WWW.SAVECENTER.ORG

ABOUT OUR 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 $225 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 92ND 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 93RD 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 USE THE SAME WEBSITE WHILE FOLLOWING ADDITIONAL PROMPTS FOR TRAINING PACKAGE REGISTRATION.

TUTORIAL ABSTRACTS

MIL-DTL-901E SHOCK TRAINING
Instructors TBD

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.

FUNDAMENTALS OF CLASSIC SHOCK AND SRS SHAKER TESTING
Mr. Chris Sensor (Siemens)
Mr. Bob Metz (PCB Piezotronics)

This tutorial will cover the fundamental concepts of shaker shock testing, from field data acquisition to Classic Shock and Shock Response Spectrum (SRS) wavelet synthesis in a vibration controller. The tutorial will cover shock data acquisition and analysis, classic shock pulses, SRS concepts, SRS and Pseudo Velocity Shock Spectrum (PVSS) data analysis, Fatigue Damage Spectrum, a review of Classic Shock and SRS test methods in MIL-STD-810H (including the "new" method of Te and TE), shock test tailoring and SRS wavelet synthesis for shaker SRS testing. A segment covering specialty shock sensors and instrumentation will also be presented. Subjects will be accompanied by live demos of data acquisition and shaker tests, with opportunities for hands on participation by attendees.

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.

INTRODUCTION TO PYROSHOCK TESTING
Dr. Vesta Bateman (Mechanical Shock Consulting)

This course discusses the concepts of Near Field, Mid Field Pyroshock and Far Field Pyroshock and their criteria. Instrumentation used for measurement of pyroshock and structural response to pyroshock is described. The development of pyroshock specifications using primarily the Shock Response Spectra is discussed in detail, and various other analysis techniques are presented as well. Simulation techniques for near field, mid field and far field pyroshock are presented and include both pyrotechnic simulations and mechanical simulations. Examples of actual test specifications and the resulting laboratory test configuration and measured results are discussed. In addition, recent problems and issues in the pyroshock community are described and analyzed.

DATA INTEGRITY
Mr. John Hiatt (DEWESoft)

The data integrity training is designed as an overview of the data acquisition process and how each step in the measurement chain can affect your measured data. Primary focus of this session is on the data acquisition system (DAS). We will learn what happens in each step of the process and how to mitigate common measurement errors. The idea is to get the best possible data first time. Its hard to make good decisions with bad data. We also cover DAS specifications so users can be better prepared to compare system specifications.

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.

EFFECTIVE SOLUTIONS FOR SHOCK AND VIBRATION CONTROL
Mr. Alan Klembczyk (Taylor Devices)
Mr. Ken Lussky (BAE Systems)

Part 1 of this Tutorial 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.

Part 2 of this Tutorial addresses characterization of shock and vibration environments and finite element analysis (FEA) of shock and vibration isolation performance. Methods used to characterize shock and vibration responses and their application are defined. For shock these include spectral definitions (SRS shock response spectrum and PVSS pseudo velocity shock spectrum) and time-history definitions (peak velocity, peak acceleration, average acceleration and displacement). These are discussed with respect to their application to shock input severity, and equipment fragility and damage potential. Shock test qualification methods, their input definitions, and how they are represented in FEA are

discussed. Also addressed are the value of damping in shock isolation and how shock and vibration isolation systems are represented in FEA. For vibration the spectral definition of Acceleration Spectral Density (ASD) is discussed. Other topics addressed are the application of UERD Tools for shock characterization, and when to engage with the appropriate shock and vibration Technical Warrant Holders (TWH).

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.

DIGITAL SIGNAL PROCESSING - FILTERING AND THE FOURIER TRANSFORM (GOING FROM TIME TO FREQUENCY DOMAIN)
Mr. John Hiatt (DEWESoft)

Two of the most common Digital Signal Processing (DSP) techniques are filtering and transforming data from the time domain to the frequency domain with the Fourier transform (FFT). Both mathematical processes can create unwanted effects on the data. This session will examine these effects on your data and how they can be mitigated. For the Fourier transform, we will also discuss the assumptions, inputs to the FFT and possible reasons FFT's calculated with two different software packages do not match. This training is designed to help new users understand how these processes and how they work to help prevent data processing mistakes.

REMOVING THE BOUNDARY CONDITION HOBGOBLINS FOR BASE MOUNTED COMPONENTS IN VIBRATION QUALIFICATION TESTING
Mr. Troy Skousen (Sandia National Laboratories)
Mr. Randy Mayes (Consultant)

Mitigating the field-to-laboratory boundary condition impedance mismatch for base excitation testing by controlling the test article fixed base elastic modes through appropriate base inputs

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 degree of freedom (SDOF) shaker test specifications guarantees large response uncertainties when compared with the field environment responses due to the difference in laboratory boundary conditions. A brief review is provided showing how fixed-base 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 intuitive responses. This model demonstrates why 6DOF laboratory control can eliminate large uncertainties in traditional SDOF testing with a corresponding boost in qualification confidence. In fact, the model leads to modified base inputs for a greatly improved SDOF or 3DOF test.

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.

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.

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

This three-hour 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.

INTRODUCTION TO UNDERWATER EXPLOSION PHENOMENA WITH BASIC APPLICATIONS TO STRUCTURES
Mr. Fred Costanzo (Consultant)
(pending confirmation of participation)

This tutorial is divided into two major parts. The first segment consists of a brief primer in underwater explosion (UNDEX) fundamentals and shock physics. Included in this discussion are the features of explosive charge detonation, the formation and characterization of the associated shock wave, bulk cavitation effects, gas bubble formation and dynamics, surface effects and shock wave refraction characteristics. In addition, analyses of associated measured loading and dynamic response data, as well as descriptions of supporting numerical simulations of these events, are presented. The second segment involves basic applications of UNDEX-induced dynamic shock wave loadings to the estimation of both local and global responses of simple floating and submerged structures. Three primary well-documented methodologies are presented, including the Taylor Flat Plate analogy for estimating the responses of both air-backed and water-backed plates, the Peak Translational Velocity method for estimating the response of submerged cylindrical bodies, and the application of the conservation of momentum principle for estimating the vertical kickoff velocity of floating structures (Spar Buoy approach). Derivations of the governing equations associated with each of these solution strategies are briefly presented, along with a description of the appropriate ranges of applicability. Applications of each of these methodologies will be illustrated using simple examples. Finally, some case studies are presented that illustrate the power of applied numerical methods in the form of finite differences to obtain approximate solutions to some classical nonlinear mechanics problems.

PEAK RESPONSE OF LINEAR STRUCTURES IN RANDOM VIBRATION
Dr. Thomas Paez (Thomas Paez Consulting)

The main focus of fundamental studies in random vibration of linear structures is the characterization of the distribution of mean square signal content in the frequency domain. A basic development of random vibration theory starts with probability and random process theory (The latter requires an understanding of Fourier analysis.), the theory of deterministic structural dynamics, and then proceeds to establish the fundamentals of random vibration. Most important in random vibration are the concepts of the spectral density of stationary excitation and response random processes, and the fundamental relation of random vibration, i.e., the equation that expresses the spectral density of a linear response in terms of the spectral density of an excitation and a structural property. Most of the important experimental and analytical activities in random vibration are supported by the fundamental activities described here. However, there are many other more advanced facets to random vibration, and some of those can be developed directly. For example, the problems of low- and high-cycle fatigue, and the peak response of structures in random vibration are important. This tutorial develops the latter subject, peak response. The first half of the tutorial is a review of the basic ideas of linear random vibration. The spectral density and the fundamental relation of random vibration are developed. The second half of the tutorial deals with development of the probability distribution, mean and variance of peak response. These results are first obtained for a narrow-band random response and then generalized to the realistic case of wide-band response. Examples are included. MATLAB scripts and functions for establishing the probabilistic measures of peak response are provided to attendees. An electronic copy of the color slides is provided as well.

INTRODUCTION TO MIL-STD-461G- THE ELECTROMAGNETIC INTERFERENCE CONTROL REQUIREMENTS FOR DOD SUBSYSTEMS AND EQUIPMENT
Mr. Jeff Viel (NTS/Element)

This 3 hour tutorial provides a detailed technical overview of MIL-STD-461G addressing the electromagnetic interference (EMI) emission and susceptibility test methods and control requirements for subsystems and equipment and subsystems designed or procured for the Department of Defense (DoD). This tutorial starts from the very beginning discussing the basis for EMI control testing, including a historical case study, to the progressive development of test methods and requirements adapted to modern day technologies and electromagnetic environments. While the standard is broadly designed to address all DOD platforms, this tutorial is focused to specifically address shipboard and submarine application requirements.

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.

TRAININGS

SAMPLE TRAINING TOPICS (CONFIRMED TOPICS TO BE LISTED IN SUMMER 2023)

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?

CONTACT OUR OFFICE

BY PHONE: 434.581.3041

ASHLEY.SHUMAKER@SAVECENTER.ORG