SAVIAC
Shock and Vibration Information Analysis Center
Current Awareness
April 2004

# Introduction to Air Blast Measurements

## Part II

*Editor's Note: This is the second in a series of articles high-lighting one of this year's featured commercial organizations, PCB Piezotronics. This article was written by Patrick Walter, PhD, of PCB.*

Part I of this series described the physics of air blast from both a theoretical and practical viewpoint. It also provided a brief, historical perspective of the development of transducers in government and industry laboratories to measure air blast phenomena. Part II, presented here, deals exclusively with appropriate methods of interfacing the blast pressure transducer to the measurand (the blast environment).

Figure 4 showed a Model 137A ICP® blast pressure transducer in a pencil probe configuration for side-on pressure measurements. In application, its axis must be aligned incident (perpendicular) to the incoming air blast wave. Its size should be small relative to the highest frequency of interest in the shock front. For example, assume a shock front is moving at 3,300 feet per second. The wavelength ($\lambda$) corresponding to a spectral frequency (f) of 20,000 Hz in the front would be:

**$\lambda f = c = 3300(12)$ inches per second**
**or**
**$\lambda = 1.98$ inches.**

Looking at the dimensions of the pencil probe in Figure 6 relative to the preceding value of $\lambda$, it is clear that the probe has the potential to act as a reflecting body to high frequencies in the approaching shock front.

In order to minimize reflections, the probe is tapered over approximately its first two-inches of length. It then transitions into a cylindrical body with a flat surface on one side. This flat surface

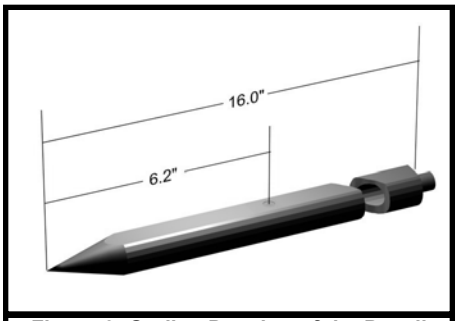



**Figure 6: Outline Drawing of the Pencil Probe in Figure 4 (inches)**

eliminates discontinuities between an embedded, disc-shaped, radial facing, quartz sensing element and the transducer housing. Ideally, the velocity of the shock front and the spatial averaging of the disc as the front traverses across it will control the measured rise time. The averaging effect associated with any pressure transducer can be envisioned as the distortion that a sine wave would encounter as it passes at right angles to the radial axis of the circular diaphragm sensing surface of the transducer. The diaphragm would cause distortion through spatial averaging of the wave, which results in attenuation of it.

The analysis of the spatial averaging effect of the diaphragm of pressure transducers has been performed[1]. Results are shown in Figure 7. When using these results, the velocity (inches/second) of the gas passing over the transducer must be applied as a multiplier to the abscissa (x-axis) to convert its units to Hz. As an example of the application of Figure 7, at 1100 feet/second (13,200 inches/second) in dry air, a 0.3-inch diameter diaphragm would nominally produce a five-percent amplitude error at 9,200 Hz, and a 0.1-inch diameter diaphragm would produce the same error at 24,000 Hz.

For reflected pressures at a stationary barrier, the averaging effects due to flow at normal incidence are not a consideration provided that the diaphragm of the transducer is flush with the reflecting surface. If the diaphragm is flush, the structural properties of its sensing element control its dynamic performance. However, in some instances, deviations from flush mounting might be required.

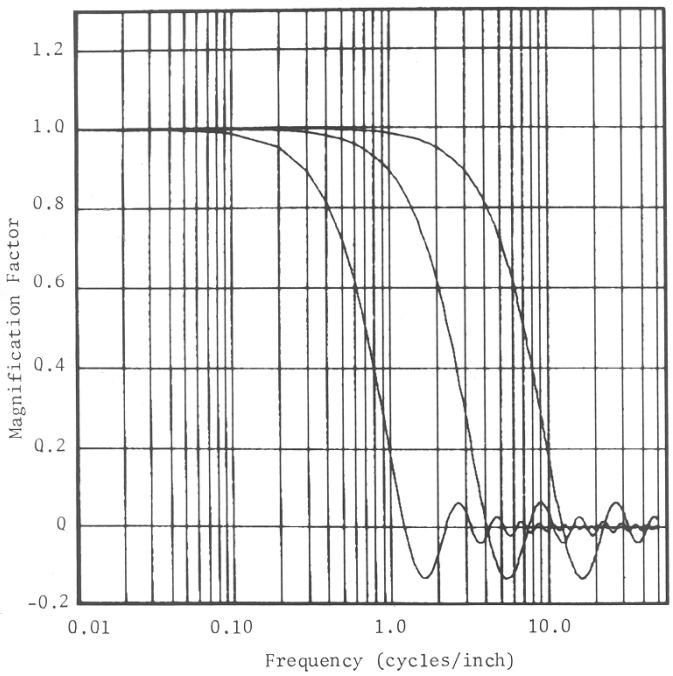



**Figure 7: Frequency Response of Spatial Averaging Pressure Transducers**

**Air Blast, con't on Page 2**

These deviations could be needed to isolate the transducer from high temperature or some other harsh environment. In this situation, the transducer could be coupled to the process by a length of tubing or other intermediate fitting. The resultant passageway could even be filled with a porous material of high specific heat capacity to further reduce the temperature of the gaseous explosion products, thus lessening their effect on transducer performance. However, this recess mounting of the transducer severely degrades its ability to measure the initial reflected blast pressures accurately. On occasion, this compromise may be justified in an attempt to quantify the total pressure impulse, which requires a longer measurement time, or, in the case of an enclosed explosive, the residual contained pressure in the enclosure after the blast occurs.

Acoustic theory, while not exact, provides us with guidance to estimate this degradation in transducer performance. In Figure 8 we see a transducer mounted with an associated volume in front of its sensing face. A long cavity or equivalent tube provides the interconnection to this volume. Based on the assumption that all dimensions are much less than the wavelength of sound at the frequency at which this system is designed to operate, an analysis of this cavity as a second-order-single-degree-of-freedom system can be performed. For a short tube, the Helmholtz resonator model[2] yields a natural frequency in Hz of:

$$f_n = c/(4\pi)[\pi d^2/(V(L + .85d))]^{1/2} \quad (1)$$

In this equation, c is the velocity of sound of the gas being measured (≅ 1100 feet/second for room-temperature air), V is the volume of the lower cavity, L is the length of the entrance tube, and d is the diameter of this tube.

If the entrance tube in Figure 8 is lengthened to cause the lower volume V to become less significant relative to the volume of the tube (Figure 9), and if the tube is sufficiently narrow that the displacement of the gas at any instant is the same at all points on its cross

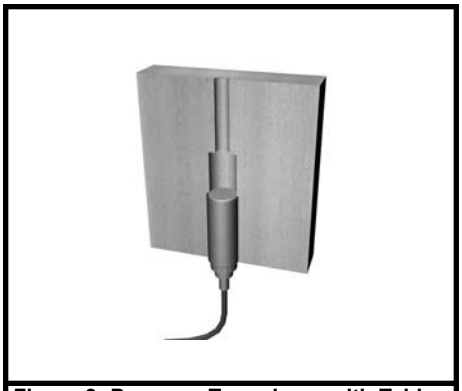


**Figure 8: Pressure Transducer with Tubing and Associated Volume Interconnect**

section, it can be modeled by the wave equation[2]. Results are:

$$f = [(2n-1)c]/4L \quad (2)$$

where n = 1 corresponds to the first natural frequency; c and L have the same meaning as before. It's been suggested that the Helmholtz resonator model (equation #1) should transition to the wave equation model (equation # 2) when the volume of the tube is about one-half the volume of the chamber.

It is interesting to make a representative calculation using one of these equations. Assume that a pressure transducer with a resonant frequency of 100 KHz is mounted at the end of a standpipe of length 1.5-inches measuring reflected blast pressures at 500 degrees Fahrenheit (F). The sound velocity in air is proportional to the square root (√) of the absolute temperature. Therefore, 1100 feet/second at room temperature (70$^{O}$F or 530$^{O}$R (Rankine)) would scale to $\sqrt{960}/\sqrt{530}$ or about 1480 feet/second at 500$^{O}$F or 960$^{O}$R. Using equation (2), the effective resonance of the transducer/tube

**Figure 9: Pressure Transducer with Tubing Interconnect**



combination would be lowered from 100 KHz to 2,960 Hz! Equations (1) and (2) then enable calculation of an approximate value as to how much the dynamic response of a pressure transducer is reduced when coupled through a gas-filled cavity.

When performing explosively driven blast pressure measurements, these equations may yield somewhat imprecise results because gas composition and temperature, and thus sound velocity, are often unknown. However, when comparing the speed of sound for gases such as methane, air, and carbon dioxide, it can be concluded that an acceptable starting point for most calculations is to assume air to be the gas in the cavity at a temperature of 500 degrees Fahrenheit.

1. Walter, P. L., Limitations and Corrections in Measuring Dynamic Characteristics of Structural Systems, Ph. D. Thesis, Arizona State University, pp. 140-141 and 205-208, Dec. 1978.

2. Morse, P. M., Vibration and Sound, McGraw Hill, NY, ch. 22, pp. 221-235, 1948.

*Author's note: Part I in this series introduced the topic of blast pressure measurement and provided background. This part has discussed errors attributable to interfacing the transducer to the blast environment. The next part will deal with still other challenges in managing this interface.*

## QUESTIONS OR COMMENTS?

If you would like to comment about this article or have questions for the author, please e-mail SAVIAC at lauren.yancey@saviac.org.

Your comments may be placed in our newsletter at the end of the *Blast Measurement* series.

# FREE
# Summer Shock & Vibration Seminar

SAVIAC invites you to attend a FREE seminar on Shock & Vibration. The course will be held on Wednesday, June 30, 2004 at The Cavalier Hotel in Virginia Beach, VA, the day before the 75th Shock & Vibration Symposium Program Committee Meeting. SAVIAC and the featured experts in their disciplines have organized this seminar to introduce you to the SAVIAC community, while providing a valuable educational experience.

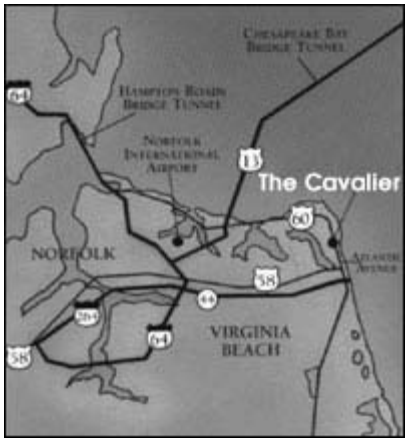
## Agenda

| | | |
|---|---|---|
| 8:00 - 8:30 | Registration & Continental Breakfast | |
| 8:30 - 8:45 | Introduction to SAVIAC | Joel Leifer, SAVIAC |
| 8:45 - 9:00 | Using SAVIAC to Address Your S&V Problems | Joel Leifer, SAVIAC |
| 9:00 - 9:30 | MIL-S-901 Requirements/Approval Process | Kurt Hartsough, NSWC/Carderock |
| 9:30 - 10:00 | Overview of Hazard Assessment Testing (HAT) per MIL-STD-2105 | Jamie Howell, NSWC/Dahlgren |
| 10:00 - 10:15 | Break | |
| 10:15 - 10:45 | TBD | Jay Warren, NG-NNS |
| 10:45 - 11:15 | Shock & Vibe from A to Z | Dan Worth, NASA Goddard |
| 11:15 - 11:45 | Wavelets | Tim Edwards, NSWC/Dahlgren |
| 11:45 - 1:00 | Lunch | Hosted by NTS |
| 1:00 - 1:30 | TBD | TBD |
| 1:30 - 2:00 | Blast Pressure Measurements | Pat Walter, PCB Piezotronics |
| 2:00 - 2:30 | Aluminized Explosive Modeling | Eric Rinehart, Defense Threat Reduction Agency |
| 2:30 - 3:00 | Shock Response Spectrum | Howard Gaberson, Consultant |
| 3:00 - 3:15 | Break | |
| 3:15 - 3:45 | Seakeeping & Slam Effects on Combatant Craft | Tim Coats, NSWC/Carderock |
| 3:45 - 4:15 | Transportation Vibration | Skip Connon, US Army Aberdeen Test Center |
| 4:15 - 4:45 | Effect of Internal Fluid Pressure Vessel And Piping Shock Stresses | Rudy Scavuzzo, Consultant |
| 4:45 - 5:00 | Wrap-up & Questions | All |

**Please feel free to forward this invitation to anyone you know who may be interested in attending this program.**

The seminar is free, but you must register to attend and **space is limited**. You may register online at **www.saviac.org/75th_Symposium/seminar_registration_form.htm**, or RSVP to Lauren Yancey, (703) 892-0060 or **lauren.yancey@saviac.org** to assure your space and note packet. SAVIAC reserves the right to substitute topics and/or instructors when necessary. This schedule is subject to change. For more information about SAVIAC, or for a list of area hotels and directions to The Cavalier, please visit our website at http://www.saviac.org/s&v_seminar.htm. SAVIAC has NOT made any arrangements with the Cavalier Hotel for special rates to attend this seminar.

## AREA MAP



# Call For Papers

## 75th Shock and Vibration Symposium
## October 17-22, 2004
## The Cavalier
## Virginia Beach, VA

Planning for the 75th Shock and Vibration Symposium is underway. NSWC/Dahlgren Division is the Government Featured Organization and Northrop Grumman Newport News and PCB Piezotronics are the Commercial Featured Organizations. The Cavalier Hotel in Virginia Beach is the location.

The Shock & Vibration Symposium is the oldest continuously held meeting dealing specifically with the shock and vibratory response of air, sea, space, and ground vehicles and structures and blast effects. The Symposium was established as a mechanism for the exchange of information among Government activities, private industry, and academia on current work and new developments. Presentations on work in progress are encouraged. Separate sessions are held for presentation of classified or limited-distribution material.

Presentations in the following subject areas are welcomed:

| | | |
|---|---|---|
| 901D Case Studies | Dynamic Scale Modeling | Product Announcement/Facility Description |
| Active Vibration Control | Dynamic Testing | Pyrotechnic Shock |
| Air Blast | Environmental Databases | Seismic Shock |
| Anti-Terrorist Technologies | Finite Element Analysis | Shock Characterization |
| Ballistic Shock | Fluid-Structure Interaction | Shock Hardening |
| Biodynamics | Ground Shock | Shock Qualification by Extension |
| Blast Design | Homeland Defense | Shock Response Spectrum |
| Blast Effects | Impact/Penetration Mechanics | Shock Test/Equipment Failure Modes |
| Combined Environments | Infrastructure Protection | Simulation Methods |
| Computational Structural Dynamics | Instrumentation | Specifications and Standards |
| COTS | Isolation Systems | Structural Hardening |
| Crash Dynamics | Large Structures | System Identification |
| Damage Identification | Live Fire Testing | Test Criteria |
| Damping | Machinery Diagnostics | Test Tailoring |
| Data Analysis | Machinery Vibration | Underwater Shock Testing |
| Dynamic Analysis Methods | Material Dynamic Properties | Vibroacoustics |
| Dynamic Measurement | Modal Analysis and Testing | |

Two categories of presentations will be accepted: full papers, suitable for publication in the Symposium Proceedings; and short discussion topics, consisting of viewgraphs with no written paper. Full papers will have a 15 minute technical presentation time plus 5 minutes for questions, while short discussion topics will have a 10 minute presentation time with no question period.

Presentations will be accepted on the basis of their abstracts, which must be submitted by June 3, 2004. You are encouraged to submit online at www.saviac.org, click on 75th S&V Symposium Abstract Submittal. The Program Committee will review the abstracts during the July Program Committee meeting and authors will be notified of acceptance by July 16, 2004. The full paper presentations must meet the following standards: They must be previously unpublished and unpresented, must be appropriate to community interests and must not be overtly commercial, except for papers in the Product/Facility session. Standards for short discussion topics are similar except that they may include previously presented or published material.

The Proceedings will be published on CD-ROM.
**The paper due-date is October 8, 2004.**
Questions should be directed to Joel Leifer, 301.596.0100 or joel.leifer@saviac.org.

# INDUSTRY NEWS

### Dual Sensitivity Charge Converter

**Depew, NY** - New Model 422M147 Dual Sensitivity Charge Converter from the Electronics Division of PCB Piezotronics, Inc. converts high impedance charge sensor signals to low impedance voltage signals for operation with ICP® sensor input. Device is designed for use with high temperature sensors with as low as 10k ohm resistance.

Unit offers operating temperature range to 250°F (121°C). Devices permit user to jumper select between two fixed sensitivities, and allow for use of inexpensive coaxial cable at output. Ground isolated aluminum enclosure mounts easily to equipment. Custom sensitivities and connectors are available; TEDS (Transducer Electronic Data Sheet) capabilities are optional.

For additional information, contact the Electronics Division of PCB Piezotronics, Inc., toll-free in USA and Canada at 800-828-8840 or call 16-684-0001; E-mail: electronics@pcb.com; fax 716-684-0987; or visit www.pcb.com.

### Acoustical Calibration Laboratory Accredited by NIST

**Columbia, MD** — Scantek, Inc. is pleased to announce that the Scantek Calibration Laboratory (SCL) has been granted accreditation by National Institute for Standards and Technology (NIST) under the national Voluntary Laboratory Accreditation Program (NVLAP). Designated as Laboratory Code 200625-0, Scantek is accredited for ISO 17025 and ANSI/NCSL Z-540 for the Scope of Accreditation that includes microphones, calibrators, sound level meters, dosimeters, sound and vibration FFT and real-time analyzers, filters, and preamplifiers. In addition SCL calibrates tapping machines, accelerometers, vibration meters, and other instruments.

As a NVLAP accredited laboratory, SCL offers traceable, high quality, and prompt calibration for many instruments of all brands. SCL has applied for accreditation for accelerometer calibration and expects approval shortly.

### Personal Noise Warning Device

**Columbia, MD** — Scantek, Inc. now offers a new device that notifies individuals when they are exposed to excessive noise. Worn like a badge on or near the shirt pocket, the device will show a hyper-bright light or, optionally, will vibrate when the noise exposure is greater than a selected level (75, 80, 85, or 90 dBA). The meter, meeting Type 2 requirements, has a built in microphone and uses ordinary batteries that last about 80 hours.

This device is affordable and is ideal when machines do not operate all the time or the operator goes from quiet to noisy areas during his or her shift. It eliminates the need to always wear hearing protection, to unnecessarily wear protection, or to leave control to individual judgment.

For more information, call (800) 224-3813 or visit www.scantekinc.com.

### Peak Monitoring System Combines Amplifier and Peak Meter

**Depew, NY -** The Pressure Division of PCB Piezotronics, Inc., introduces new Model 400B20 Peak Monitoring System for measuring peak shock, pressure, force, or impact phenomena. System combines a dual mode amplifier for conditioning signals from ICP® and charge output piezoelectric sensors, and a peak meter.

Dual mode amp features continuous gain. Resetting or zeroing may be accomplished manually or remotely. Peak meter displays peak voltage, with values directly correlating to peak input. In addition to peak hold, unit is capable of being used as a digital voltmeter and for measuring the bias of ICP® sensors.

Two alarms monitor voltage and provide the ability to set two separate threshold levels. Other features include sensor output normalization, overload detection, built-in calibration reference signal, an output jack for connection to readout devices, and three selectable discharge time constants for static sensor calibration.

For additional information, contact the Pressure Division of PCB Piezotronics, Inc., toll-free at 888-684-0011, Email: pressure@pcb.com. Fax 716-686-9129, or visit our web site at www.pcb.com.

### Quartz Force Rings

**Depew, NY -** The Force/Torque Division of PCB Piezotronics, Inc. offers a broad range of ICP® and charge output piezoelectric force rings for rapidly changing dynamic compression and impact tests from 10 to 100,000 lb (45 to 450,000 N). Applications include clamping, punching, and stamping operations, machinery studies, and material testing.

Sensors are designed for accurate measurement of fast, transient forces, and are capable of monitoring low level dynamic force fluctuations over higher static loads. Units offer amplitude linearity of 1% FS, and upper frequency limits to 90k Hz. Additional features include heretically sealed stainless steel construction, low weight, and high stiffness. For additional information, contact the Force/Torque Division of PCB Piezotronics, Inc., toll-free at 888-684-0004; E-mail: force@pcb.com, Fax 716-684-8877, or visit PCB's web sit at www.pcb.com.

**The 74th S&V Symposium Proceedings will be mailed to the attendees shortly. SAVIAC apologizes for the delay, but felt it necessary in order to include papers that were delayed by the approval process.**

# Conference Announcements

**Be sure to check www.saviac.org for more information on upcoming events.**

### 21st Transducer Workshop

*Vehicular Instrumentation/Transducer Committee of the Range Commanders Council Telemetry Group*

**June 22-23, 2004**
**Lexington Park, MD**

The Twenty-First Transducer Workshop, sponsored by the Vehicular Instrumentation / Transducer Committee, Telemetry Group, of the Range Commanders Council, will be held June 22-23, 2004 at the J. T. Daugherty Conference Center in Lexington Park, MD. This committee develops and implements standards and procedures for transducer applications. Attendees are working level people who must solve real-life hardware problems and are strongly oriented to the practical approach. Test and project people who attend will benefit from exposure to the true complexity of transducer evaluation, selection, and application.

A block of rooms has been reserved for the workshop at the Fairfield Inn in Lexington Park, MD, with a limited number of rooms available on a first come first serve basis. Since there is also limited seating available at the Transducer Workshop attendees are encouraged to register as early as possible. With your registration please include a $100.00 registration fee payable to the Transducer Workshop, and mail to the Workshop Treasurer by June 1, 2004.

### 75th Anniversary (147th) Meeting of the Acoustical Society of America

*ASA*

**May 24 - 28, 2004**
**New York, NY**

This meeting marks the 75th Anniversary of the Acoustical Society of America and will include the usual meeting events plus a variety of special events to celebrate this milestone in the Society's history. All Technical Sessions will be held at the Sheraton New York Hotel and Towers. Some special events will be held at the Sheraton and others will be held in various locations as described at the website, http://asa.aip.org/newyork/information.html. The registration fee is $400 for members of the Acoustical Society of America; $450 for nonmembers, $75 for Emeritus members of ASA (Emeritus status pre-approved by ASA); $75 for nonmember invited speakers, $35 for students with current id cards and $75 for accompanying persons. One-day registration is available at $200 for members and $225 for nonmembers. Nonmembers who pay the $450 nonmember registration fee and simultaneously apply for Associate Membership in the Acoustical Society of America will be given a $50 discount off their dues payment for 2004 dues (Full price for dues: $100). For more information and/or online registration visit http://asa.aip.org/newyork/information.html.

### ASNE Day 2004
### Naval Engineering: Transforming Maritime Defense and Sea Power

*American Society of Naval Engineers*

**June 28-29, 2004**
**Arlington, Virginia**

The last couple of years have clearly demonstrated the need for transformational change in our nation's Navy and Coast Guard. The direction of change in the Navy is guided by the CNO's vision for Sea Power 21 and the future of the Coast Guard is centered on the Integrated Deepwater System Program. At the same time, increased emphasis on Homeland Defense and Homeland Security are prompting a quest for greater synergy between the Navy and Coast Guard.

As always, the ASNE Day Exhibit Hall will feature many interesting displays highlighting the key roles that leading defense system vendors, system support contractors and government acquisition, technology and support organizations all play in developing, deploying and sustaining these vital capabilities.

For more information about attending or exhibiting this event, please visit http://www.navalengineers.org/Events/ADAY2004/AD04Index.html.

## ***Make sure your events get into the 2005 SAVIAC Calendar!***

**The 2005 SAVIAC Calendar is being compiled for distribution among the 75th Shock & Vibration Symposium attendees, as well as hundreds of other SAVIAC community members around the globe! Don't miss your opportunity to have your event placed in our calendar. Contact Lauren Yancey with your event dates and details at *lauren.yancey@saviac.org*.**

## CLEAN UP IN 2004!!

**Join SAVIAC's 2004 ListServ and have Current Awareness delivered straight to your Inbox! Every month! Paper-Free and interactive! Click on the articles you want to read, pass the ones you don't. E-mail Lauren Yancey at lauren.yancey@saviac.org to have yourself added to our mailing list.**

# Short Course Announcements

**Be sure to check www.saviac.org for more information on upcoming events.**

### Smart Structures and Nanotechnologies

**May 17-18, 2004**
**Virginia Tech, Blacksburg, VA**

Research in the field of smart structures has produced vast quantities of information and knowledge, and research in nanotechnologies is progressing at a fast pace. The practicing engineer or beginning researcher may find that synthesizing the broad array and disparate sources of information in a form useful for creating smart structures solutions to design problems is difficult.

This course will classify and present the broad array of information needed to perform systems design which uses active materials. The course covers active materials, nanostructures, multifunctional materials, actuation and sensing devices, technologies for incorporating these devices into structural design codes, measurement technologies, and technologies for vibration and acoustic control. The active materials covered include piezoelectric ceramics, piezoelectric polymers, electrostrictive ceramics, magnetostrictive ceramics, electro-and magneto-rheological fluids, fiber optic sensors, and shape memory alloys.

The course fee is $995, or $675 for graduate students, and includes refreshment breaks, certificate for 1.6 continuing education units (CEUs), and course materials. Registration deadline is May 3, 2004.

Engineers interested in designing structures/structural elements, e.g., precision production equipment, electronic circuit boards, machine tools, drive trains, submarine hulls, where noise cancellation and/or vibration suppression is desirable. Participants are expected to have already earned a B.S. or an equivalent degree in an engineering field. For more information or to register online please visit http://www.conted.vt.edu/smartstructures/.

### Process For Designing and Assessing Shock Mounted Systems using the 6 DOF Shock Isolation Mount Prediction and Loading Estimate (SIMPLE) Software

**June 4, 2004**
**Norfolk, VA**

This course will provide a process for designing and assessing shock mounted systems with special emphasis on applications related to the design of ship structures and equipment for shock loads produced by underwater explosions utilizing the analytical software tool "Shock Isolation Mount Prediction And Loading Estimate" (SIMPLE). Copies of the SIMPLE software are available free to anyone and may be downloaded at http://users.erols.com/michael-talley/. The course will be presented by Dr. Michael A. Talley of Shock Analysis & Testing (Michael-Talley@erols.com) and Bob Krezel of ROG Consulting (Bob_Krezel@hotmail.com).

The registration fee is $500, which includes the cost of all sessions, related course information, continental breakfast, coffee breaks, and lunch. A CD with the SIMPLE software will be provided. Early registration is suggested because enrollment is limited. Please send email or phone call requesting a registration form from Bob Krezel, (757) 484 8387, (bob_krezel@hotmail.com). Registration should be completed by 28 May 2004. Each participant should bring a laptop computer having Windows 95 or higher and a CD or Zip drive.

### Practical Shock Analysis & Design Short Course

*MFPT Society*
**July 26-30, 2004**
**Seattle, Washington**

This course will provide a comprehensive treatment of practical shock design and analysis with special emphasis on applications related to the design of ship structures and equipment for shock loads produced by underwater explosions. Participants in this course will have an opportunity to increase their knowledge and understanding of the analytical and experimental tools that are available for shock design and qualification particularly with respect to requirements that are imposed for shipboard equipment. The lectures will provide a basic review of vibration and shock theory and will present the analytical and experimental methodology in the context of particular design applications. Analytical lectures will emphasize the physical significance of the results. Examples and case histories will be used as illustrations of design approaches; workshop problems that involve class participation will be used to advantage throughout the course. Class members will be encouraged to propose real design problems. The instructors will provide guidance for solutions or the problems may be used as class exercises. Although this course is aimed primarily at shock design applications on ships, the analysis and design techniques presented are equally applicable to problems related to design for seismic loads or blast induced ground shock. Thus, engineers in these related areas may find the course to be useful. For all who participate, the course will provide a comprehensive coverage of shock design practice and a solid basis for further exploration of shock technology. For more information and to download the registration form, visit http://www.saviac.org/Shock%20Course.htm.

**Be sure to get your short course events into the 2005 SAVIAC calendar. E-mail Lauren Yancey at lauren.yancey@saviac.org to find out how.**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# *In the April 2004 Current Awareness Newsletter*

***Introduction to Air Blast Measurements, Part II***
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***Short Course Announcements***

The Current Awareness newsletter is published by the Shock and Vibration Information Analysis Center, which is operated by HI-TEST Laboratories, Inc., under contract to the U.S. Army Engineer Research and Development Center.

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