Session 5pNSd

Noise, ASA Committee on Standards, Psychological and Physiological Acoustics, and Animal Bioacoustics: Impulsive Noise Exposure Metrics: Development and Validation

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Invited Papers

3:00

5pNSd1. Comparative study of military impulse noise criteria currently in use and identification of research needs. Steve Goley (Mechanical Engineering, University of Cincinnati, Cincinnati, OH 45221-0072, steve.goley@gmail.com), and Jay Kim (Mechanical Engineering, University of Cincinnati, OH 45221-0072)

Impulse noise criteria currently being in use, such as MIL-STD 1474D, Pfander, Smoorenburg and LAeq8hr, employ respectively a different noise metric to estimate the exposure risk to military noises. In these criteria, the risk is assessed based on the characteristics of the noise such as the peak level or equivalent energy. Recently a new approach that utilizes a simulation program of the auditory system called AHAAH is advocated as an alternative, which considers characteristics of not only the noise but the auditory system response in assessing the risk. In this work, underlying assumptions and analytical structures of widely used impulse noise criteria and AHAAH are examined to understand their relative strengths and shortcomings. Then, performances of the criteria are compared by utilizing an existing animal data obtained by exposing chinchillas to various impulse noises. Linear correlations of the noise metric with the PTS at 0.5, 1,2,4 K-Hz inflicted in chinchillas are used as the basis of the comparison which indicates that LAeq8hr and AHAAH show better performance. Research needs to enable improvement of existing criteria and development of a new improved criterion are discussed. Acknowledgment: Travel for this invited presentation was supported by the Air Force Research Laboratory

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5pNSd2. Changes in distortion product oto-acoustic emissions after exposure to continuous and impulsive noise. Miguel Angel Aranda de Toro (GN ReSound; Lautrupbjerg 7, DK-2750 Ballerup, Denmark, maadtoro@gnresound.dk), Rodrigo Ordoñez, and Dorte Hammershøi (Acoustics, Department of Electronic Systems, Aalborg University; Fredrik Bajers Vej 7-B5, DK-9220 Aalborg Ø, Denmark)

Temporary changes in the hearing of human subjects were monitored with distortion product otoacoustic emissions (DPOAEs) after control sound exposures in a laboratory. The objectives of the experiment were to investigate whether the +5~dB penalty for impulsiveness used in international standards and legislation correlates to a higher risk of hearing damage. Subjects were exposed to two types of binaural recordings consisting of a continuous broad-band noise-exposure normalized to $L_{EX,8h}$ = 80~dB and the interaction of the previous stimulus with a noise of impulsive character normalized to $L_{EX,8h}$ = 75 + 5~dB penalty = 80~dB. The results show that the effects on DPOAE levels from the two stimuli could be compared in terms of their total acoustic energy.

3:40

5pNSd3. Scientific basis and shortcomings of EU impulse noise standards. Karl Buck, Véronique Zimpfer, and Pascal Hamery (French-German Research Institute, 5 rue du Général Cassagnou, BP 70034, 68301 Saint-Louis, France, karl.buck@isl.eu)

In 2003 the Directive 2003/10/EC has been published by the European Union. It defines the maximum noise exposure levels for workers and the related necessities for hearing protection and for conservation programs. The limits for continuous noise are based on A weighted exposure levels as defined by ISO 1999:1990. For impulse noise the Directive limits the maximum peak pressure level to 140 dB including hearing protection. This single value limit which does not take into account any frequency or duration information is not adequate to evaluate the hazard of an impulse noise and lacks any scientific validation. Although it may not present many problems in industry, for the armed forces it has become a major problem, as it limits training and bans the use of some weapon. Therefore Germany has not implemented this Directive for its forces but uses the Damage Risc Critera (DRC) designed by Pfander. In other countries which have implemented the Directive "As-is", other criteria based on A-weighted energy (LAex,8h) proposed by Dancer or the AHAAH proposed by Price are taken into consideration for being used. The presentation will discuss scientific basis of the different DRCs for impulse noise in use or being candidate in Europe.

4:00

5pNSd4. A case for using A-weighted equivalent energy as a damage risk criterion for impulse noise exposure. William J. Murphy (National Institute for Occupational Safety and Health, Hearing Loss Prevention Team, 4676 Columbia Parkway, Mailstop C-27, Cincinnati, OH 45226-1998, wjm4@cdc.gov), and Richard L. McKinley (Air Force Research Laboratory, 2610 Seventh Street, Wright-Patterson Air Force Base, OH 45433-7901)

Damage risk criteria (DRCs) for continuous noise rely upon epidemiologic analyses of populations of persons exposed over several years to noise in occupational environments. In 2006, the U.S. Army proposed to update the MIL-STD 1474D to use the Auditory Hazard Assessment Algorithm for Humans (AHAAH) and discontinue using the peak sound pressure level, envelope duration and number of impulses. The National Institute for Occupational Safety and Health has conducted two separate evaluations of the data used to justify the AHAAH methodology and found that the use of the A-weighted equivalent energy L_{Aeq8} was more suitable for the purposes of predicting the effects of temporary threshold shifts (TTS) both in humans and in chinchillas. The L_{Aeq8} method provided best fit for the TTS outcomes and demonstrated the greatest discrimination (ability to predict TTS) when compared to AHAAH, MIL-STD 1474D and two other proposed DRCs. Similarly, L_{Aeq8} was found to give the best-fit and greatest discrimination for the chinchilla impulse noise exposures. The L_{Aeq8} affords the best sensitivity and specificity for discrimination of potential hazards and has the greatest level of integration with present occupational exposure standards and prospective hearing protection labeling regulations.

4:20

5pNSd5. Using impulsive peak insertion loss of hearing protectors with impulsive damage risk criteria. Richard McKinley (Air Force Research Laboratory, 2610 Seventh St., AFRL/11HPW/RHCB, WPAFB, OH, 45433-7901, richard.mckinley@wpafb.af.mil), Hilary Gallagher (Air Force Research Laboratory, 2610 Seventh St., AFRL/11HPW/RHCB, WPAFB, OH 45433-7901), and William Murphy (National Institute for Occupational Safety and Health, 4676 Columbia Parkway, MS C-27, Cincinnati, OH 45226-1998)

Impulsive noise presents special challenges for hearing conservation. The scientific community continues to search for an impulsive noise exposure criterion which accurately assesses the hearing damage risk for both short and long duration impulses. Other factors, such as the use of hearing protectors, earmuffs and earplugs, also affect the hearing damage risk but the current criteria do not address methods for using the attenuation of hearing protectors in impulsive noise. The relatively new ANSIS12.42-2010 "Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures" describes methods for measuring the peak insertion loss of a hearing protector in impulsive noise. This paper will describe a method to apply the peak insertion loss data to impulsive noise damage risk criteria for an estimate of allowable impulsive noise exposure when using hearing protection.

Contributed Paper

4:40

5pNSd6. A hybrid model for predicting the sound level of shooting noise from recoilless rifles. Byunghak Kong (School of Mechanical and Aerospace Engineering, Seoul National University 301-1214, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Korea, bhgong03@snu.ac.kr), Kyuho Lee (School of Mechanical and Aerospace Engineering, Seoul National University 311-105, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Korea), and Soogab Lee (Institute of Advanced Aerospace Technology and School of Mechanical and Aerospace Engineering, Seoul National University 311-105, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Korea)

In the present study, acoustic signals from M40A1 recoilless rifle were measured according to recommendations of International Organization of Standardization (ISO) using B&K 2250 sound analyzers. Contrary to expectations from previous studies about shooting noise, the signal recorded at each point shows different waveform in comparison with the others. This means that an additional acoustic source was present, and there was no doubt that it was located at a tail nozzle of the weapon through temporal and geometric relations between the microphone arrays. Spectral analysis and frequency band filter were used to find out what kind of acoustic source there was, and it was concluded that acoustic properties of the additional source was much close to those of jet noise rather than blast noise. Based on these results, consequently, a hybrid model has been developed to predict the sound pressure level of shooting noise from recoilless rifles using predicting algorithms applicable to acoustic sources, blast noise and jet noise, relatively.