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14. ABSTRACT The 2017 Technical Information paper (TIP) refers to the recommendations in an attached Memo for the interim medial criterion for impulse noise equipment design assessments. The initial TIP was finalized with a 2015 Memo that described a modification of the Design Limit published in MIL STD 1474D. The recommended criterion was based on limited and extrapolated data. The MIL STD 1474D version was replaced by MIL STD 1474E in April 2015. Since that time a review of the medical criterion was conducted and largely reaffirmed, though additional details were documented in an updated June 2020 version of the Memo. This TIP captures both the 2015 and 2020 versions of the Memo as attachments. The Memo as dated reflect the technical details as to the criterion related decisions made at time of their publications.			
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INTERIM IMPULSE NOISE DAMAGE RISK CRITERION

TECHNICAL INFORMATION PAPER No. 51-072-0317

PURPOSE. To document the interim medical criterion used to assess the risk of hearing damage due to exposure to impulse noise.

REFERENCES.

Military Standard (MIL-STD) 1474D, Department of Defense Design Criteria Standard Noise Limits, 12 February 1997

MIL-STD 1474E Department of Defense Design Criteria Standard Noise Limits, 15 April 2015

POINTS OF MAJOR INTEREST AND FACTS.

The D version of the MIL-STD design standard was originally published in 1997 and was replaced by a new version E in 2015. The new version replaces the impulse noise criterion with two novel criteria, neither of which are fully accepted by the Army medical community. Research is underway to investigate technical aspects of the new criteria that are contentious.

An interim medical criterion, described in the attached memo, has been socialized and accepted by the Army medical community and is being used as a risk assessment tool for use in preparing Health Hazard Assessments of new Army materiel. It is based on the MIL-STD 1474D criteria (which had been used as both a design and medical criterion), but modified to incorporate latest findings about health risk.

CONCLUSION

An interim medical criterion for assessing risk has been established and will be used until the current research is completed and assimilated into a new criterion.

Prepared by: Army Hearing Program

Dated: March 2017

ATTACHMENT 1

February 2015 Memorandum

MEMORANDUM THROUGH ^{15 FEB 2015} ~~18 FEB 2015~~ ^{DMB 8 APR 15}

Portfolio Director, Occupational and Environmental Medicine
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FOR Program Manager, Health Hazard Assessment

SUBJECT: Interim Impulse Noise Damage Risk Criterion

1. The current medical risk criterion has been adopted directly from the MIL STD 1474D Design Limit that has been used since the early 1970s. The design limit had been developed based on very limited knowledge of health effects of intense impulse noise exposure, and was basically an extrapolation of the results of some rifle noise exposure studies to weapon systems in general. Since then it has become abundantly clear that the extrapolation misrepresents actual effects of noise from large caliber weapons, significantly overestimating them. Work has been conducted since the early 1990s on finding a more acceptable criterion, but the scientific community has been unable to come to a consensus on the matter. The main conclusion that has been reached to date is that the current limit overstates the hazard by at least 10 dB for impulse sounds that represent the more energy-intense weapon systems in the inventory: shoulder fired systems, howitzers, and mortars.
2. In recent years a partial solution evolved that was applicable to certain outdoor waveforms. This has become known as the free-field criterion that we apply mostly to howitzer firing. It is based on analysis conducted on the 5-meter portion of the Albuquerque study data. The intention was to do a similar analysis on the 1- and 3-meter Albuquerque study data, but that particular analysis was never completed.
3. Although the lack of consensus about what to do persists, the design standard has been rewritten by the original organization that wrote the standard to incorporate the risk assessment tool known as AHAH as the criterion (for the Army). A different criterion has been incorporated for the Air Force. MEDCOM does not support the new design criterion as a replacement medical criterion. Instead, it is working through its own research path to develop a better and better validated criterion, but the end product is years away. In the meantime once the new design standard is published (latest advisory is towards the end of the first quarter of 2015), the current MIL STD will disappear, leaving the medical community without an acceptable replacement impulse noise criterion. An interim criterion is necessary to extend the free-field criterion, and has been decided on as reported below.

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SUBJECT: Interim Impulse Noise Damage Risk Criterion

4. The new impulse noise criterion will be based on the same equation used in the current MIL STD 1474D. That is, the allowable number of rounds that can be fired in a 24 hour period when wearing single hearing protection equals:

$$10^{((177+6.64*\text{LOG}(200/\text{Tb})-\text{Lp})/5)} \quad \text{equation 1}$$

Tb=B-duration in milliseconds

Lp=peak sound pressure level, Lp in dB re:20microPa Log=log with base 10

The calculated number is multiplied by 20 if double hearing protection is used.

5. The new criterion accepts all the new MIL STD 1474E requirements for making the basic impulse noise measurement, and the provisions which apply to steady-state noise, but replaces the determination of risk for impulse noise using AHAAH. In accordance with the latest research conclusions it will modify the MIL STD 1474D equation for 3 classes of weapon systems: shoulder fired weapons, howitzers, and mortar systems, relaxing the limits for them by 10 dB. This effectively multiplies the allowable number of rounds per day by 100. This factor will be applied to the results of equation 1 when these weapon systems are used outdoors, the noise neither exceeds 190 dBP or has a B-duration above 60 ms, and there are no more than two significant peaks in the waveform (a peak is significant when it equals or exceeds 50% of the amplitude of the highest peak, with the peaks each occurring in separate portions of the waveform determined from first to last crossing of the baseline). These last requirements are needed to make sure we do not exceed the bounds of what the studies have demonstrated. Should the weapon noise characteristics consist sometimes of waveforms that satisfy the new criterion, and sometimes not, the procedure outlined in Technical Guide 338 will be used to weight individual sample test results to come up with a proportional dose assessment of the allowable number of daily rounds.

6. Point of Contact, on this matter, is Mr. Chuck Jokel, Army Hearing Program, he may be reached at (410) 436-3797.



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ATTACHMENT 2

June 2020 Memorandum



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30 June 2020

MEMORANDUM THRU

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SUBJECT: Interim Impulse Noise Damage Risk Criterion Reaffirmation

1. AUTHORITIES AND REFERENCES.

- a. DOD Instruction 6055.12, Hearing Conservation Program, 25 October 2017.
- b. MIL STD 1474D, Noise Limits, 12 February 1997.
- c. MIL STD 1474E, Design Criteria Noise Limits, 15 April 2015.
- d. USAARL Contractor Report 94-2, Blast Overpressure Studies With Animals and Men: A Walk-up Study, Dan Johnson, September 1994.
- e. Evaluation of Impulse Noise Criteria Using Human Volunteer Data, Philemon Chan et.al., Journal of the Acoustical Society of America, Vol. 110, No. 4, October 2001.

2. The subject medical risk criterion is a modification of the Design Limit published in MIL STD 1474D, which was adopted as a medical risk criterion, and used as such until the D version was replaced by MIL STD 1474E in April 2015. The scientific community developed the medical risk criterion in MIL STD 1474D based on a very limited knowledge of health effects of intense impulse noise exposure, which basically extrapolated the results of rifle noise exposure studies to all other weapon systems in general. Studies since the release of the initial criteria in the early 1970's clearly show that this extrapolation misrepresents the actual effects of noise from large caliber weapons, significantly overestimating them. Since the early 1990's, the scientific community has worked to validate a more acceptable criterion, but is still unable to

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come to a consensus on the medical risk criterion. They have concluded that for energy-intense weapons systems like shoulder fired weapons (LAW, AT-4, M3 MAAWS), artillery, and mortar systems, the MIL STD 1474D limit overestimates the hazard by at least 10 dB. The MIL STD 1474E criteria are not acceptable as medical criteria.

3. After publication of MIL STD 1474D, a partial supplemental solution evolved that was applicable to certain outdoor waveforms. This has become known as the free-field criterion and it mostly applied to exposures when firing artillery weaponry (e.g., howitzers). This medical risk criterion is based on analysis of the Albuquerque study data conducted at 5-meters. The intention was to do a similar analysis on the 1- and 3-meter Albuquerque study data, but the scientific medical community did not complete this particular analysis.

4. In 2015, despite the lack of scientific consensus, the U.S. Army Human Research and Engineering Directorate rewrote the Army's design standard incorporating a risk assessment tool known as the Auditory Hazard Assessment Algorithm for Humans. The U.S. Air Force and U.S. Navy incorporated a different optional criterion. The U.S. Army medical community does not support either criteria as a replacement medical risk criterion and U.S. Army Medical Command is working through its own research path to develop a better scientifically validated medical risk criterion. In the meantime, the U.S. Army cannot continue to field weaponry using outdated and un-validated design medical risk criterion. Therefore, the U.S. Army needs and supports implementing an interim criterion to extend the free-field criterion, augmenting MIL STD 1474D.

5. The basis for the recommended interim impulse noise criterion is the same equation used in MIL STD 1474D. This equation determines medical risk based on the allowable number of rounds (ANOR) fired within a 24 hour timeframe when wearing properly sized and fitted single hearing protection (earplugs or noise muffs). The equation in MIL STD 1474D is:

$$10^{((177+6.64*\log(200/Tb)-Lp)/5)}$$

Tb = B-duration in milliseconds

Lp = Peak sound pressure level, Lp in dBP re: 20MicroPascal

Log = log with base 10

The calculated number is multiplied by 20 if wearing double hearing protection (earplugs AND noise muffs).

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6. The interim criterion accepts all the new MIL STD 1474E requirements for making the basic impulse noise measurements and the provisions which apply to steady-state noise, but replaces the standard's determination of allowable number of rounds for impulse noise. It modifies the above equation for 3 classes of weapon systems: shoulder fired weapons, artillery, and mortar systems, relaxing the limits by 10 dB if the noise generated by the weapon system meets the following five requirements:

- a. The weapon systems are fired outdoors verses confined or enclosed firing positions.
- b. The noise does not exceed 190 dBP.
- c. The noise has a B-duration no greater than 60 milliseconds.
- d. There are no more than two significant peaks in the waveform (a peak is significant when it equals or exceeds 50% of the amplitude of the highest peak, with the peaks each occurring in separate portions of the waveform determined from first to last crossing of the baseline), and
- e. The impulse has an A-duration (duration of the principal peak) of 2 – 6 milliseconds.

7. These requirements ensure the interim criterion does not exceed the investigational bounds of the Albuquerque study (which is the basis of this interim criterion). In the event the weapon noise characteristics do not meet the new firing restrictions, noise control engineers can use the procedures outlined in Technical Guide 338 to weight individual noise sample tests and determine a proportional dose assessment of the ANORS. If a system qualifies for use of the modified equation, it effectively multiplies the allowable number of rounds per day by a factor of 100.

8. The modified equation is:

$$10^{((187+6.64*\log(200/Tb)-Lp/5))}$$

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9. Point of Contact, on this matter, is Mr. Chuck Jokel, Army Hearing Program, available at (410) 436-3797.

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