



AFRL-RH-WP-TP-2014-0041

**Noise Attenuation Performance of the David Clark H10-76 Headset
with and without the M53 Hood**

**Melissa A. Theis
Oak Ridge Institute for Science and Education**

**Billy J. Swayne
Ball Aerospace and Technologies Corporation**

**Hilary L. Gallagher
Battlespace Acoustics Branch Warfighter Interface Division**

August 2014

Interim Report

Distribution A: Approved for public release; distribution unlimited.

STINFO COPY

**AIR FORCE RESEARCH LABORATORY
711 HUMAN PERFORMANCE WING,
HUMAN EFFECTIVENESS DIRECTORATE,
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE**

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the 88th Air Base Wing Public Affairs Office and is available to the general public, including foreign nationals. Copies may be obtained from the Defense Technical Information Center (DTIC) (<http://www.dtic.mil>).

AFRL-RH-WP-TP-2014-0041 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

//signed//

Richard L. McKinley
Work Unit Manager
Battlespace Acoustics Branch

//signed//

Robert C. McKinley
Chief, Battlespace Acoustics Branch
Warfighter Interface Division

//signed//

William E. Russell, Acting Chief
Warfighter Interface Division
Human Effectiveness Directorate
711 Human Performance Wing

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

| | | | | | |
|--|--------------------|----------------------------------|-----------------------------------|--|--|
| 1. REPORT DATE (DD-MM-YYYY) 29-08-2014 | | 2. REPORT TYPE Interim | | 3. DATES COVERED (From - To) 1 August 2014-29 August 2014 | |
| 4. TITLE AND SUBTITLE Noise Attenuation Performance of the David Clark H10-76 Headset with and without the M53 Hood | | | | 5a. CONTRACT NUMBER FA8650-08D-6801-0027 | |
| | | | | 5b. GRANT NUMBER | |
| | | | | 5c. PROGRAM ELEMENT NUMBER | |
| 6. AUTHOR(S) Melissa A. Theis*, Billy J. Swayne **, Hilary L. Gallagher | | | | 5d. PROJECT NUMBER | |
| | | | | 5e. TASK NUMBER | |
| | | | | 5f. WORK UNIT NUMBER 71841620 (H03P) | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Ball Aerospace Technologies 2875 Presidential Drive Fairborn, OH 45324 | | | | 8. PERFORMING ORGANIZATION REPORT NUMBER | |
| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Materiel Command *Oak Ridge Institute for Science and Air Force Research Laboratory Education 711 Human Performance Wing Oak Ridge, TN 37831 Human Effectiveness Directorate **Ball Aerospace Technologies Warfighter Interface Division 2575 Presidential Drive Battlespace Acoustics Branch Fairborn, OH 45324 Wright-Patterson AFB OH 45433 | | | | 10. SPONSOR/MONITOR'S ACRONYM(S) 711 HPW/RHCB | |
| | | | | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-RH-WP-TP-2014-0041 | |
| 12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution A: Approved for public release; distribution unlimited. | | | | | |
| 13. SUPPLEMENTARY NOTES 88 ABW/PA Cleared 12/04/2014; 88ABW-2014-5772. | | | | | |
| 14. ABSTRACT Noise attenuation performance was measured on the David Clark H10-76 headset and the M53 hood at the Air Force Research Laboratory's (AFRL) Acoustics facilities at Wright-Patterson Air Force Base in August 2014. American National Standards Institute (ANSI) S12.42-2010 was used to measure the passive insertion loss performance of the systems. The objective of this study was to measure the noise attenuation performance and determine if the performance requirements were met as defined in the performance specification. The addition of the M53 hood to the headset degraded the noise attenuation performance by more than 3 dB across all frequencies when compared to the David Clark H10-76 headset alone using the objective (ANSI S12.42) passive insertion loss measurements. | | | | | |
| 15. SUBJECT TERMS M53, David Clark H10-76, noise attenuation, insertion loss, hearing protection, headset, chemical/biological, protection, MIRE | | | | | |
| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | Richard L. McKinley |
| U | U | U | SAR | 11 | 19b. TELEPHONE NUMBER (include area code) |

THIS PAGE IS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

| | | |
|------------|--|----------|
| 1.0 | INTRODUCTION..... | 1 |
| 2.0 | METHODS | 2 |
| 2.1 | Subjects | 2 |
| 2.2 | Passive Insertion Loss Measurements..... | 3 |
| 3.0 | RESULTS | 3 |
| 3.1 | MIRE- Passive Insertion Loss | 4 |
| 4.0 | DISCUSSION | 4 |
| 5.0 | CONCLUSIONS | 5 |
| 6.0 | REFERENCES..... | 5 |

LIST OF FIGURES

| | |
|--|----------|
| Figure 1. M53 chemical/biological hood | 1 |
| Figure 2. David Clark H10-76 headset | 2 |
| Figure 3. Subjects wearing test articles in MIRE facility | 2 |
| Figure 4. MIRE facility at AFRL..... | 3 |
| Figure 5. Passive insertion loss of the David Clark H10-76 with and without the M53 hood..... | 4 |

EXECUTIVE SUMMARY

Noise attenuation performance measurements were collected on the David Clark H10-76 headset with and without the M53 hood at the Air Force Research Laboratory's (AFRL) acoustics facilities at Wright-Patterson Air Force Base in August 2014. American National Standards Institute (ANSI) S12.42-2010¹ Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear (MIRE) or Acoustic Test Fixture Procedures was used to measure the passive insertion loss of the headset with and without the M53 hood. The performance specification requirement defined that when integrated, no more than a 3 dB degradation of the measured one-third octave band hearing attenuation shall result when compared to the original (headset only) configuration. The results showed that the addition of the M53 hood degraded the noise attenuation of the headset by more than 3 dB across all frequencies from 125 to 8000 Hz.

1.0 INTRODUCTION

The M53 hood, shown in Figure 1 below, provides “above-the-shoulder” chemical/biological (CB) protection for the respiratory system in an actual or perceived CB warfare environment. The M53 is programmed for utilization in United States Air Force, United States Navy, United States Marine Corp, and United States Coast Guard strategic aircraft. The system was designed to be worn with all the current below-the-neck ensembles. Air and ground crewmembers don the M53 hood based on current threat and operational requirements. Personnel also perform extended ground duties such as pre-flight, post-flight, rearming, refueling and cargo loading of aircraft while wearing the M53 hood and emergency actions such as ground escape and evasion. This system was developed to replace the currently used protective mask. The David Clark H10-76 headset (Figure 2), a typical headset worn by aircraft maintainers and flight crews, was tested with the M53. The headset has active noise reduction (ANR) capabilities. However, ANR was not assessed during these measurements; the measurements were passive performance only.



Figure 1. Person wearing M53 (left) and schematic drawing of M53 (right)



Figure 2. David Clark H10-76 Headset

2.0 METHODS

2.1 Subjects

Ten paid volunteer subjects (6 male, 4 female) participated in the attenuation measurements on the David Clark H10-76 headset worn with and without the M53 hood (Figure 3). The ten subjects ranged in age from 18 to 34 with a mean age of 21 years. All subjects were expertly fitted by a trained program representative. The hood size distribution was as follows: two subjects were fitted with size large, five subjects were fitted with size medium, and three subjects were fitted with size small.



Figure 3. Subject wearing David Clark H10-76 headset (left) and subject wearing David Clark H10-76 headset with the M53 hood (right) for MIRE measurement

2.2 Passive Insertion Loss Measurements

The AFRL MIRE facility was used to measure the passive insertion loss of hearing protectors (Figure 4). Insertion loss was defined as the algebraic difference in dB between the sound pressure levels (SPL) measured at a reference point with and without the hearing protection device in place. The facility and measurements were operated in accordance with ANSI S12.42-2010.¹ Miniature microphones (Knowles model BT-1759) were used to simultaneously measure the SPL at the entrance of both ear canals. 115 dB overall SPL was generated and two objective measurements were collected to complete one trial: open ear and occluded ear. Three trials were collected per subject. For each subject, the mean insertion loss of the three trials was computed. Average insertion loss for the ten subjects was then calculated for each configuration.

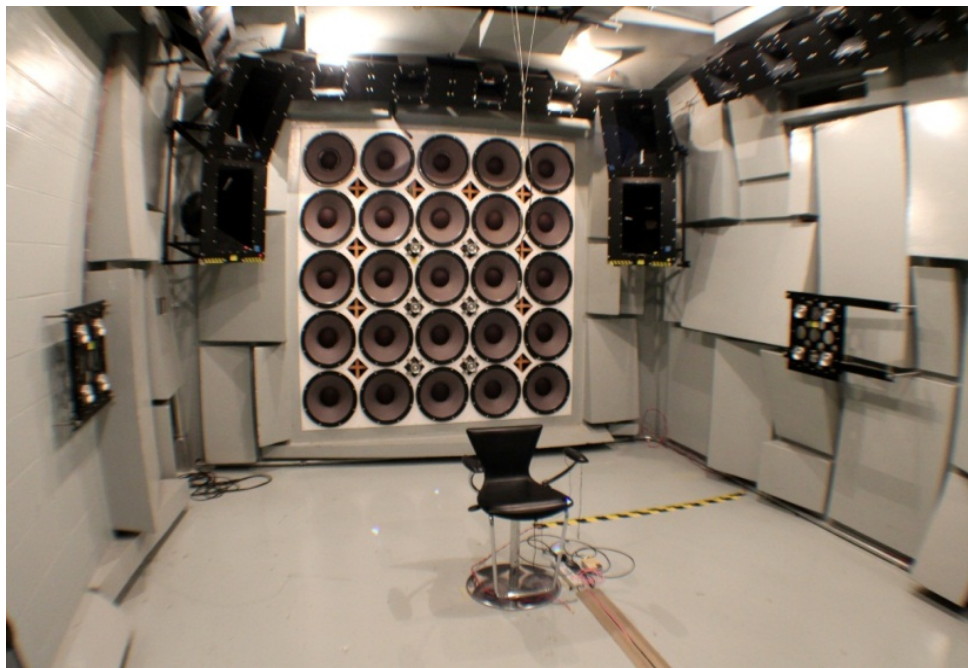


Figure 4. MIRE facility at AFRL

3.0 RESULTS

ANSI S12.42 measurements of the David Clark H10-76 headset were collected with and without the M53 hood (Table 1, Figure 5). The results were analyzed to compare the noise attenuation performance of the headset with and without the M53 hood in order to understand the effect the hood has on the noise attenuation performance of the headset. The requirement states that the addition of the M53 hood shall not degrade the noise attenuation of the headset by more than 3dB.

3.1 MIRE – Passive Insertion Loss

Passive insertion loss data were collected in the MIRE facility at AFRL on David Clark H10-76 headset (passive only, no ANR) with and without the M53 hood. Mean and standard deviation data from 125-8000 Hz are shown numerically in Table 1 and graphically in Figure 5. The addition of the M53 hood degraded the noise attenuation greater than 3 dB across all frequencies.

Table 1. Mean passive insertion loss results from MIRE measurements comparing the David Clark H10-76 headset with and without the M53 hood

| | | Frequency (Hz) | | | | | | |
|------------------------|------|----------------|------|------|------|------|------|------|
| | | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| DC H10-76 headset only | Mean | 7.6 | 12.0 | 17.9 | 25.3 | 30.2 | 36.5 | 39 |
| | SD | 2.2 | 2.5 | 3.4 | 4.8 | 4.6 | 5.7 | 3.4 |
| DC H10-76 headset/M53 | Mean | -2.0 | -0.8 | 2.6 | 6.7 | 15.0 | 23.6 | 23.2 |
| | SD | 1.4 | 2.0 | 3.4 | 2.8 | 3.7 | 6.3 | 5.1 |

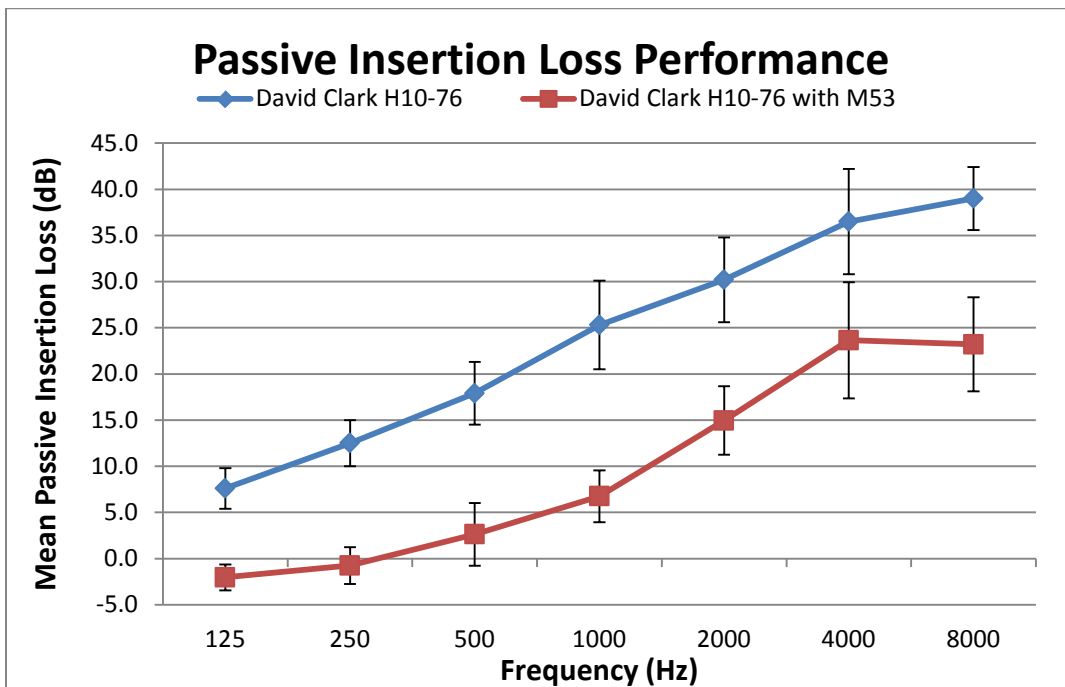


Figure 5. Passive insertion loss of the David Clark H10-76 with and without the M53 hood

4.0 DISCUSSION

It is well known that the noise attenuation performance of a headset may be degraded when worn in combination with a CB hood like the M53. Any material or cable that breaks the seal of an earcup in a headset or helmet has the potential to create an acoustic leak. The requirement was set so that the M53 hood, worn in combination with a headset such as the David Clark H10-76, would degrade the noise attenuation performance of the headset by no more than 3 dB across all frequencies when compared to the headset alone.

ANSI S12.42 methods were used to collect passive insertion loss data for the David Clark H10-76 headset. The headset has ANR capability; however, the measurements were conducted with the ANR powered off for the passive performance only. It is clear from the results that the passive performance of the headset is severely degraded by the addition of the M53 hood, therefore it was not deemed productive to evaluate the active capabilities of the headset. ANSI S12.42 methods are objective measurements and were developed for engineering controls and product development/assurance. When comparing the performance of the David Clark H10-76 headset with and without the M53 hood, the M53 negatively affects the noise attenuation performance at all frequencies by more than 3 dB.

Recommended solutions to the attenuation requirement would be to add communication earplugs under the headset/hood, or to incorporate the earcup into the design of the hood. These hearing protection configurations have the potential to provide the necessary noise attenuation and communication needs when the M53 hood is required by personnel. Noise attenuation and speech intelligibility measurements must be conducted to understand the performance capabilities.

5.0 CONCLUSIONS

Passive insertion loss data were collected on the David Clark H10-76 headset with and without the M53 hood. The M53 hood degraded the attenuation by more than 3 dB across all frequencies, and therefore does not meet the performance specification requirement in this configuration.

6.0 REFERENCES

1. ANSI S12.42-2010 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