



**Department of the Interior  
and  
United States Forest Service**

# **Aviation Helmet Standard**

**November, 12, 2019  
Version 4.3**

## **FOREWARD**

### **Developing the Civilian Aviation Helmet Standard**

As with so many other aspects of aviation, the Office of Aviation Services (OAS) uses established industry and government standards to guide our selection for safe and cost effective products that reduces risk to injury. Occupational Safety and Health Administration (OSHA) and the American National Standards Institute (ANSI) have established many standards that enable us to select equipment that will protect the heads, eyes, and ears of employees. Hard hats, Safety Goggles, and hearing protection are easily identified as a means of meeting an acceptable mitigation to various types of risk to personal injury.

In revising the Aviation Life Support Equipment (ALSE) Handbook (or ALSE Handbook), it was clear that we needed to identify criteria that will provide an acceptable performance level for aviation helmets. Adopting the military's extensive institutional knowledge and expertise was once the only pragmatic option until now as the marketplace of aviation helmets is much different from what it was a few years ago.

### **Problem: The civil aviation community is void of any guidance on aviation helmet standards.**

Government regulatory agencies (such as OSHA) have not provided any guidance and the helmet manufacturers have made no effort in establishing industry standards. An alternative that is used widely for motorcycle helmets is DOT FMVSS 218, but fails to provide the desired parameters and performance measures required for the aviation environment. Aviation helmets provide multiple levels of protection and need to be evaluated for many properties including (but not limited to) crown and side impact, sound attenuation, retention, and weight.

Although military approved helmets will remain authorized, simply adopting military specifications as our own standard was eliminated as some of those specifications include areas that are not applicable to DOI. Some of these areas include the Department of Defense (DoD) purchase process, design elements involving ballistic protection, and packaging/delivery. Additionally, some military helmet models were built to an American National Standards Institute (ANSI) standard (ANSI Z90.1) which is no longer supported by ANSI. As such, these obsolete standards are unusable for ISO 9001 certified or ISO 17025 accredited testing labs.

### **Solution: Acquire expertise that can develop modern, cost effective, proven performance standards and testing methodologies.**

OAS contracted with the Southwest Research Institute (SwRI), a well-regarded and recognized organization with expertise in the area of helmet testing, on April 27, 2017 to provide technical, scientific systems engineering and human factors subject matter expertise to develop modern, cost effective civilian aviation helmet performance standards and testing methodologies.

### **Alternate Aviation Helmets**

The DOI/USFS Aviation Helmets Standard Specification will provide an avenue to allow non-military approved helmets to be considered for acquisition within our aviation communities. Both manufacturers and distributors can test their helmets using an ISO certified laboratory to the DOI/USFS Aviation Helmet Standards. Those meeting or exceeding these standards can be issued a certificate of compliance by the laboratory. These helmets will be identified by the manufacturer and model type on the OAS website ([www.doi.gov/aviation/safety/helmet](http://www.doi.gov/aviation/safety/helmet)) within 30 days of receiving the certificate.

**0 RELEASE CONTROL RECORD****Table 0.1. Revision Table**

<b>Date</b>	<b>Version</b>	<b>Description</b>	<b>Author</b>
September 1, 2017	1.0	Initial release	OAS
September 24, 2018	2.0	Editorial changes to all pages. Section 5.1, Page 11 – Modified bullet list to be consistent with document. Section 5.1.1, Page 11, replaced “test line” with “extent of coverage line”. Section 5.1.7, Page 15, modified bullet list of items to be included in certificate to be consistent with document. Section 6, Page 16, added Helmet E to Table 6.1. Section 6.6, Pages 17 and 18, Removed Test Line from Figure 6.1 and changed text to identify that testing can be done to the extent of coverage line. Section 6.10.1, Page 21, Added Section 6.10.1 to require a system check before and after impact testing. Deleted Section 6.10.2 Offset Distance to remove requirement from document. Section 7, Page 24, Removed section numbers TOC for report.	SwRI
February 14, 2019	3.0	Changed Section 5.0 to clarify helmet sizes and combinations to be tested. Changed Section 6.0 to clarify the number of helmets to be tested. Changed Section 6.2 to define the test line and provided a table with test lines for each ISO headforms. Changed 6.10.3 distance between all impact locations shall not be less than one-seventh the maximum circumference of the helmet.	SwRI
February 26, 2019	4.0	Changed Figure 6.1 to reflect previous changes to the Test line definition.	SwRI
May 22, 2019	4.1	Editorial changes to the referenced sections for the Positional Stability and Static Strength Retention System Testing requirements. Removed Visor Testing requirements and its associated section (Section 6.6). Added text in Section 6.10 to include language on securing the helmet during impact drops. Added text in Section 6.2 to clarify ear cup impact location allowances. Changed text in Section 6.5 to remove test requirements on helmets without shell edge coverings and to clarify descriptions for unbonded shell edge coverings. Changed text in Section 6.9 to adjust the initial position of the helmet on the headform. Reordered Section 6 to better group similar sections.	SwRI

<b>Date</b>	<b>Version</b>	<b>Description</b>	<b>Author</b>
October 22, 2019	4.2	<p>Added reference document relating to helmet weight.</p> <p>Corrected misspelling in Figure 4.1.</p> <p>Updated Section 5.4 by changing weight requirements to test objectives and removed Table 5.7.</p> <p>Updated text in Section 6 and added Table 6.2 to more accurately identify the quantity of test helmets required.</p> <p>Reduced the number of sound attenuation and communication system tests required per helmet model when this equipment is the same across multiple helmet sizes.</p> <p>Updated section 6.5.3 to prohibit impacts directly on the visor rails, and change impact locations identified in Table 6.4 and Table 6.5 to objectives.</p>	SwRI
November 12, 2019	4.3	Corrected Nominal Helmet Size for Headform Sizes J, M, and O in Table 6.3.	SwRI

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# DOI/USFS Aviation Helmet Standard

## 1 PURPOSE

The purpose of this document is to identify the minimum requirements and elements that should be tested or evaluated to demonstrate that a given helmet conforms to the level of performance required by the Department of the Interior (DOI) and the United States Forest Service (USFS) for aviation use<sup>1</sup>. Helmets are one of the key elements of a personal protective profile that personnel conducting aviation operations can use to mitigate higher risk mission profiles. The helmet is an effective means to prevent serious injury and death to pilots and crewmembers that may result from aircraft mishaps.

## 2 SCOPE

This document specifies the minimum physical, functional, and performance requirements for both helicopter and airplane (non-ejection seat) helmets for interagency use by pilots and crewmembers conducting aviation activities. This specification is applicable for use by the Department of the Interior and the United States Forest Service for aviation use. The tests and conditions specified in this document are based on well established procedures within the industry and have a long history within military helmet development. These currently include helicopter (SPH<sup>2</sup>-5, HGU<sup>3</sup>-84 and HGU-56/P) and airplane (SPH-4B and HGU-55/E) helmets.

This specification is a performance standard and is not intended to restrict design. In addition, the standard includes requirements specifically applicable to aviation helmets and requirements to prevent helmets from coming off during an accident. The standard contains inspection, testing and recordkeeping requirements to ensure that helmets meet the standard's requirements. The standard establishes requirements derived from one or more of the military standards applicable to helicopter and airplane helmets.

The intended audience for this document is the helmet manufacturers, distributors and third party ISO 9001 certified or ISO 17025 accredited testing labs. This document provides the specific inspection and qualification testing criteria. Helmets meeting the standards specified in this document can be issued a certificate of conformity by a third-party accredited lab. Partial utilization of this specification is prohibited. Any statement of compliance within this specification shall be a certification that the product meets all of the requirements of the specification in its entirety. A product that fails to meet any one of the requirements of this specification is considered to have failed the standard and should not be sold with any indication that it meets part(s) of the standard.

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<sup>1</sup> Acknowledgements: This standard is a commitment provided by a number of stakeholders from a number of agencies, including Bureaus and Office within the Department of the Interior and the United States Forest Service.

<sup>2</sup> Sound Protective Helmet (SPH)

<sup>3</sup> Head Gear Unit (HGU)

### 3 REFERENCED DOCUMENTS

The following documents are referenced within this standard and are included as part of this specification:

- AFRL-RH-WP-TR-2008-0096, Neck Muscle Fatigue Resulting from Prolonged Wear of Weighted Helmets, Oak Ridge Institute for Science and Education, June 2008.
- ANSI/ASA S12.6–2016, Measurement of the Real-Ear Attenuation of Ear Protectors at Threshold, American National Standards Institute, Inc.
- ANSI/ASA 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, American National Standards Institute, Inc.
- ANSI/ASQ Z1.4–2008, Sampling Procedures and Tables for Inspection by Attributes.
- ASTM F1446-15b, Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear.
- ASTM F2220-15, Specification for Headforms.
- US DOT, Federal Motor Vehicle Safety Standard No. 218 FMVSS No. 218, 49 CFR 571.218, U.S. Department of Transportation, National Highway Traffic Safety Administration.
- US DOT, TP–218-07, Laboratory, Test Procedure for FMVSS No. 218, Motorcycle Helmets, U.S. Department of Transportation, National Highway Traffic Safety Administration.
- MIL–DTL–27467B, Detail Specification, Headset, Electrical H-154A/AIC, 27 March 2015.
- MIL–DTL–87174A, Detail Specification, Helmet, Flyer’s HGU–55/P, Department of the Air Force, 30 October 1998.
- MIL–H–27856D, Military Specification, Helmet, Flying HGU–7/P, Department of the Air Force, 08 May 1981 (Canceled).
- MIL–H–43925D, Military Specification, Helmet, Flyer’s, Protective, SPH-4, Department of the Army, 27 April 1988 (Inactive).
- MIL–PRF–27542F, Performance Specification, Microphone, and Microphone Assemblies, Dynamic General Specification for, 18 May 2017.
- MIL–STD–1916, DoD Preferred Methods for Acceptance of Product.
- USAARL Report No. 2012-14, Williams, Robert, Assessment of the Applicability of ANSI S12.42-2010 as a General Measure of Protection from impulsive Noise by Measurement of Impulsive and Continuous Noise Insertion Loss of the HGU-56/P and CEP, September 2012.

In the event of a conflict between the text of this specification and referenced standards, the text of this document shall take precedence.

## 4 DEFINITIONS

**Basic Plane:** An anatomical plane (Frankfort Horizontal Plane) that includes the superior rim of the external auditory meatus (upper edge of the external opening of the ear) and inferior margin of the orbit (the lowest point of the floor of the eye socket), Figure 4.1.

**Chin Strap:** The part of the retention system consisting of a strap that passes under the wearer's jaw to keep the helmet in position.

**Comfort Padding:** Material provided for the wearer's comfort.

**Coronal Plane:** An anatomical plane perpendicular to both the basic and midsagittal planes and passing through the superior rims of the right and left auditory meatuses, Figure 4.1.

**Discrete Helmet Size:** The size of the helmet that corresponds to standard industry convention for measuring hat size. The American designation gives the diameter of an equivalent circle in inches. The European designation gives the circumference of an equivalent circle in centimeters.

**Ear Cup(s):** The cup-like sections of a pair of headphones that enclose the user's ears.

**Easily Read Label:** A label is considered easily read if the label is visible to the user without removing any part and can be exposed, if necessary, so the user can read the required information.

**Field of Vision:** Peripheral angle and vertical opening of vision as measured on the reference headform (upward, downward, and peripheral).

**Headforms:** Reference or test headforms that correspond to the physical dimension defined in ASTM F2220<sup>4</sup>.

**Helmet (protective headgear):** A protective device worn on the head in an effort to reduce or minimize injury to that portion of the head that is within the areas of the test line.

**Helmet Positioning Index (HPI):** The vertical distance from the brow of the helmet to the basic plane when the helmet is firmly and properly seated on a reference headform. For a given helmet, the manufacturer shall specify the size of the headform and the HPI.

**Liner:** Material used to absorb impact energy.

**Midsagittal Plane:** An anatomical plane perpendicular to the basic plane and containing the midpoint of the line connecting the notches of the right and left inferior orbital ridges and the midpoint of the line connecting the superior rims of the right and left external auditory meatus, Figure 4.1.

**Permanent Label:** A label is considered permanent if it cannot be removed without the aid of tools or solvent, is attached by a seam, tears into at least three or more pieces when removed, or damages the surface to which it was attached when removed.

**Reference Plane:** A plane marked on the headforms at a specified distance above and parallel to the basic plane.

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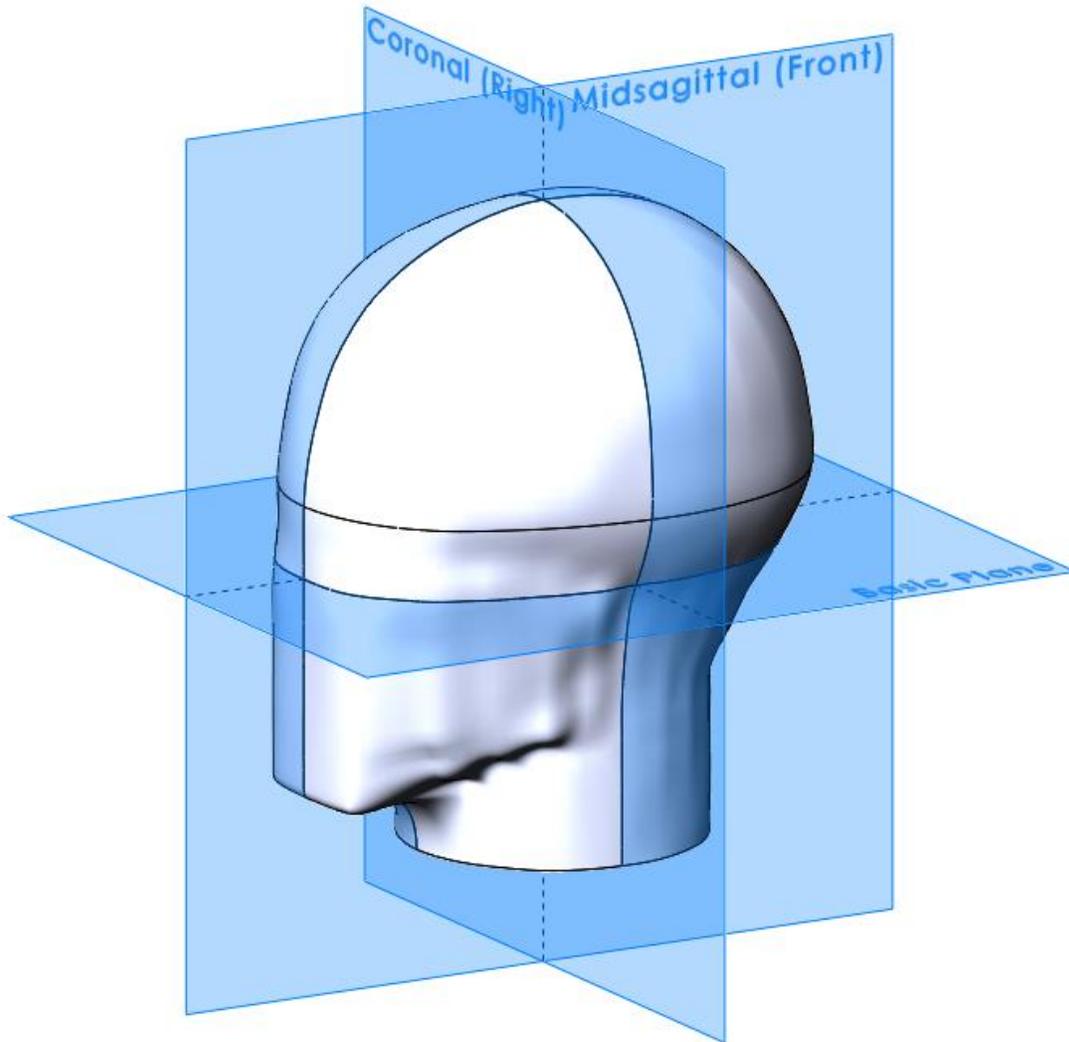
<sup>4</sup> EN960:2006 Headforms may be used as an alternative. Note that there are differences between ASTM F2220 and EN960:2006 geometries; these differences are such that the results will be comparable.

**Retention System:** The complete assembly that secures the helmet in a stable position on the wearer's head.

**Shell:** The hard part of the helmet which gives it its general shape.

**Test Line:** A line drawn on the helmet that identifies the area of the helmet subject to impact testing. The helmet shall provide as uniform impact protection in this area as is practicable.

**Visor:** A transparent protective screen extending over the eyes and covering all or part of the face.



**Figure 4.1. Anatomical Planes**

## 5 GENERAL REQUIREMENTS FOR ALL HELMETS

These general requirements are associated with the helmets used by Department of the Interior and the United States Forest Service for aviation, for use in both helicopters and airplanes.

The manufacturer/distributor is responsible for<sup>5</sup>:

- Establishing their own manufacturing and process controls to produce helmets in accordance with requirements.
- Performing or having performed all inspections and testing.
- Generating and maintaining sufficient evidence of conformance.
- Submitting helmets and supporting deliverables that conform to requirements.
- Using recognized corrective action and process improvement practices.

One or more of the following methods shall be used for verification that the helmets meet the requirements of this standard:

- **Inspection Verification** without the use of special laboratory appliances or procedures. May include visual examination, simple physical manipulation, and/or mechanical and electrical gauging and measurement.
- **Analysis Verification** that utilizes established technical or mathematical models or simulations, algorithms, charts, graphs, or other scientific principles and procedures.
- **Demonstration Verification** that involves actual operation, adjustment, or reconfiguration of an item under specific scenarios. Items may be instrumented and quantitative limits of performance measured.
- **Test Verification** that involves thorough exercising of an item under specified conditions with instrumentation and data analysis accomplished in accordance with a set of applicable test procedures.

Sampling for inspection and testing shall be performed in accordance with MIL-STD-1916 or ANSI/ASQ Z1.4.

Testing is required on the supplied range of sizes for a given model of helmet. Table 5.1 gives the range of sizes that accommodate 98% of the male and 98% of the female population with 90% confidence of the remaining population being fitted with minor modifications to the existing sizes. Testing shall be performed on each model combination of shell size and liner provided by the manufacturer/distributor. Note that there may be differences in fit based on size for different models of helmets.

**Table 5.1. Typical Helmet Size Designation<sup>6</sup>**

Size of Helmet	S	M	L	XL	XXL
Head size (cm)	54 – 55	56 – 57	58 – 59	60 – 61	62 – 63
Hat Size	6 3/4 – 6 7/8	7 – 7 1/8	7 1/4 – 7 3/8	7 1/2 – 7 5/8	7 3/4 – 7 7/8

<sup>5</sup> Based on MIL-STD-1916.

<sup>6</sup> Note that head and hat size measurement is more of an art than a science.

The following identifies the sequence for testing:

1. Inspection
  - a. Configuration and Associated Inspections, §5.1
  - b. Labeling, §5.2
  - c. Vision, §5.3
  - d. Weight, §5.4
2. Headform Selection, §6.1
3. Test Line, §6.2
4. Conditioning, §6.3.
5. Testing shall be performed in the following order:
  - a. Retention System, Positional Stability Testing, §6.4
  - b. Impact Attenuation Testing, §6.5
  - c. Retention System, Static Strength Testing §6.6
  - d. Heat Exposure Testing, §6.7
  - e. Adhesion of Shell Edge Covering Testing as necessary, §6.8
  - f. Sound Attenuation Testing as necessary, §6.9
  - g. Communication Equipment Talk-Listen Testing as necessary, §6.10

#### 5.1 Configuration and Associated Inspections

Helmets shall include the following components:

- Helmet System with Shell, Optional Edge Covering, Liner, and Comfort Padding
- Visor System
- Retention System
- Ear Cup and Sound Attenuation System
- Communication Equipment

Periodic inspection tasks for the helmets by the operator/user shall be sufficient to ensure they are free from all defects which would affect proper functioning in service as identified in §5.1.1 to §5.1.5. The periodic inspection intervals shall not be greater than one (1) year. The helmet shall be examined from a distance of no greater than 0.6 meters.

##### 5.1.1 Helmet System

The helmet shall include a shell, liner, ear cups with optional edge covering necessary to provide impact protection, noise attenuation, and support for the retention system, visor(s), and communication equipment. The optional edge covering is required if the edge of the shell where it may contact the user is sharp<sup>7</sup>. Each helmet shall have a protective surface (shell) of continuous contour at all points on or above the test line<sup>8</sup>. The helmet shall be inspected in accordance with Table 5.2 to ensure that all components are present and free from all defects which would affect proper functioning in service.

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<sup>7</sup> A sharp edge shall be defined as something likely to cut the skin if contacted.

<sup>8</sup> Based on FMVSS No. 218 S5.4

**Table 5.2. Helmet Inspection Classification**

<b>Component</b>	<b>Defect</b>	<b>Critical</b>	<b>Major</b>	<b>Minor</b>
Shell	Visibly warped or distorted	X		
	Cracked	X		
	Scratched, scuffed, or abraded			X
	Mounting holes are damaged		X	
	Unauthorized patching or repair		X	
	Sharp edges		X	
Label	Missing, illegible, or not of a permanent type		X	
Edge Covering if Present	Not properly secured to shell		X	
	Significant cracks, holes or tears			X
Energy Absorbing Liner	Liner not properly aligned in shell	X		
	Liner not uniformly bonded to shell		X	
	Gaps between liner and shell greater than 3mm		X	
Comfort Pads	Significant holes, tears, or soiled areas			X

### 5.1.2 *Visor System*

The helmet shall include one or two polycarbonate visors. The visor assembly shall provide for the visor lens to remain in position when placed in either the fully deployed or fully stored position. When deployed, the visor shall provide the wearer an unobstructed view of the aircraft instrumentation while providing glare protection for the view outside the aircraft. The visor shall be inspected in accordance with Table 5.3 to ensure that all components are present and it is free from all defects which would affect proper functioning in service.

**Table 5.3. Visor Inspection Classification**

<b>Component</b>	<b>Defect</b>	<b>Critical</b>	<b>Major</b>	<b>Minor</b>
Visor	Visibly warped or distorted	X		
	Significant cracks, scratched, scuffed, or abraded			X
	Identification label missing or illegible		X	
	Pile fastener not securely adhered to visor			X
	Sharp edges		X	
Edge Covering if present	Not properly secured to visor		X	
	Significant cracks, holes or tears			X
Attachment	Buckle missing, webbing routed through buckles incorrectly, or ends of webbing not seared		X	
	Snap fastener and/or rivet components missing or incorrectly set		X	
Lens Stop	Significant cracks, holes, or tears			X
	Missing components			X

**5.1.3 Retention System**

The helmet will have a retention system for positioning of the ear cups and securing the helmet to the wearer. The retention system shall be inspected in accordance with Table 5.4 to ensure that all components are present and free from all defects which would affect proper functioning in service.

**Table 5.4. Retention System Inspection Classification**

<b>Component</b>	<b>Defect</b>	<b>Critical</b>	<b>Major</b>	<b>Minor</b>
Chin Strap and/or Nape Strap	Grommet/rivet/snap fastener incorrectly installed or damaged	X		
	Loose or damaged stitching, skipped stitches, or not back-stitched			X
	Ends of webbing not seared			X
	Lacing cord not seared properly or improperly laced			X
	Fastener damaged or not functional	X		
	Adjustment hardware damaged or not functional		X	

**5.1.4 Ear Cup/Sound Attenuation System**

The helmet shall have a system to provide sound attenuation to the wearer. The acoustic protection system is typically made up of ear cups with headphones and soft ear pads for comfort. The ear cups ensure correct acoustic protection and are fixed inside the helmet shell. The ear cup/sound attenuation system shall be inspected in accordance with Table 5.5 to ensure that it is free from all defects which would affect proper functioning in service.

**Table 5.5. Ear Cup/Sound Attenuation Inspection Classification**

<b>Component</b>	<b>Defect</b>	<b>Critical</b>	<b>Major</b>	<b>Minor</b>
Ear Cup Components	Improperly located in ear cup section		X	
	Not secured properly to inside of helmet			X

**5.1.5 Communication Equipment**

The communication equipment includes a headset and microphone assemblies. The communication equipment shall be inspected in accordance with Table 5.6 to ensure that all components are present and free from all defects which would affect proper functioning in service.

**Table 5.6. Communication Equipment Inspection Classification**

<b>Component</b>	<b>Defect</b>	<b>Critical</b>	<b>Major</b>	<b>Minor</b>
Microphone <sup>9</sup>	Visible damage that would cause malfunction	X		
	Cable assembly damaged	X		
	Visible damage to the boom or attachment to helmet		X	
Headset <sup>10</sup>	Visible damage that would cause malfunction	X		
	Cable assembly damaged	X		

### 5.1.6 *Instruction Manual*

An instruction manual shall be furnished by the manufacturer/distributor with each helmet. This manual shall provide operation and maintenance instructions for the helmet.

### 5.1.7 *Certifications*

The manufacturer shall furnish a document certifying that the helmet model and size was tested in accordance with and meets this specification, and that the sample is tested is a true representation of the helmet model purchased, to include construction, materials and components.

Upon successful completion of the testing in the standard, the test lab shall issue a certificate of compliance to this standard. The certificate of compliance shall include:

- Applicant Name and Address
- Manufacturer Name and Address
- Product Description
  - Helmet Information: Brand, Model, Manufacturer, Size, Type (Helicopter/Airplane), and Manufacture Date
  - Visor Information: Brand, Model, Manufacturer, Manufacture Date
  - Ear Cup/Sound Attenuation Information: Brand, Model, Manufacturer, Manufacture Date
  - Communication Equipment Information: Brand, Model, Manufacturer, Manufacture Date
- Test Information: Date of Test, Test Lab Project ID, Test Standard(s) Version and Date
- Compliance Statement: This document certifies that the item listed above was tested in accordance with the requirements of DOI/USF Aviation Helmets Standard Specification, and that the specific helmet model evaluated complied with all of the requirements.
- Test Lab Information: Name, Controlling Quality Program, Address
- Test Lab Certification Number, signature, and/or stamp

## 5.2 *Labeling*

Each helmet shall have a permanent type identification label applied to the helmet or liner that includes: manufacturer, date of manufacture, model type, and discrete size similar to the

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<sup>9</sup> Reference MIL-PRF-26542F

<sup>10</sup> Reference MIL-DTL-27467B

requirements in FMVSS No. 218 S5.6.1<sup>11</sup>. The helmet shall be inspected to determine if the required label is present, permanent, legible, easily read, and contains the required information.

### 5.3 Vision

The field of vision of the user shall not be significantly altered when wearing the helmet. With the visor fully retracted, the helmet shall provide peripheral vision clearance of at least 105° to each side of the mid-sagittal plane when the helmet is seated on the proper headform according to the requirements of FMVSS No. 218 S5.4. The brow opening shall be at least 25 mm above all points in the basic plane that are within the angles of peripheral vision according to the requirements of FMVSS No. 218 S5.4.

### 5.4 Weight Objective

The weight of the complete aviation helmet assembly ready for use including visors, sound attenuation, and communication equipment should not exceed the recommended helmet system weight of 2.27 kg (5 lbs.) as specified in AFRL-RH-WP-TR-2008-0096 to prevent neck strain and fatigue. Expected maximum weight of a single visor system is 0.25 kg. Expected maximum weight of a dual visor system is 0.35 kg. Expected maximum weight of the ear cups and communication equipment is 0.35 kg.

The weight of each helmet assembly shall be measured prior to the beginning of testing.

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<sup>11</sup> See also TP-218-07, Laboratory, Test Procedure for FMVSS No. 218, Motorcycle Helmets §12.5.4

## 6 TESTING

All helmets, including Type I Helicopter and Type II Airplane, shall be tested under the methods and testing standards outlined within this Section. Helmets that successfully complete testing to Type I Helicopter requirements are also covered for use as Type II Airplane helmets. However, helmets tested to Type II Airplane requirements are not also covered for use as Type I Helicopter helmets. Helmet testing is required for each model of helmet with respect to each combination of shell size and liner provided. Sound attenuation and communication equipment testing is required only when those components or their manufacturing process, including materials and/or suppliers, is changed.

For each size of helmet selected for testing, a minimum of four (4) helmets in total are required for testing. Three (3) helmets, Helmets A, B and C, are required for the impact and retention testing. A single (1) helmet, Helmet D, is required for the heat exposure and adhesion of shell edge beading testing.

When sound attenuation and/or communications equipment talk-listen testing is required, an additional (1) helmet, Helmet E, is required for each variation in size of ear cup, sound attenuation hardware, and communication system hardware provided in the helmet model. For example, testing standard speaker and noise cancellation communication systems would require two helmets for Helmet E and if the ear cups are available in multiple sizes, then each size of ear cup shall require a separate helmet for Helmet E. This may be a determining factor in helmet size selection for testing. Note that when necessary to test larger helmet sizes, it is acceptable to use spacers between the helmet liner and ear cups to allow larger helmets to be fitted to test subject with a smaller hat size.

Table 6.1 provides a break-down of which test items are required for each test sequence and Table 6.2 provides an example test quantity identification matrix for a single helmet model offered in various sizes. Actually test quantity matrices may vary slightly for helmet models offered in fewer sizes than shown in Table 6.2.

**Table 6.1. Test Sequence**

Test	Helmet				
	A	B	C	D	E
6.1 Headform Selection	X				
6.2 Test Line	X				
6.3 Conditioning	Ambient	Low	High		
6.4 Positional Stability	X				
6.5 Impact Attenuation	X	X	X		
6.6 Static Strength Testing, Retention System	X	X	X		
6.7 Heat Exposure Testing				X	
6.8 Adhesion of Shell Edge Covering				X	
6.9 Sound Attenuation					X <sup>+</sup>
6.10 Communication Equipment Talk-Listen*					X <sup>+</sup>

\* Required when helmet is equipped with a communication system.

<sup>+</sup> Requires one (1) additional helmet for each variation in size of ear cup, sound attenuation hardware, and communication system hardware offered in the helmet model to be tested.

**Table 6.2. Test Quantity Identification**

Size of Helmet	Number of Helmets Required		
	Impact Tests (Helmets A, B, and C)	Heat Exposure and Edge Liner Adhesion Tests (Helmet D)	Sound Attenuation and Coms System Tests (Helmet E)
S	3	1	1 <sup>+</sup>
M	3	1	
L	3	1	
XL	3	1	
XXL	3	1	

<sup>+</sup> Requires one (1) additional helmet for each variation in size of ear cup and communication system offered in the helmet model to be tested.

### 6.1 Headform Selection

The helmets shall be tested on the appropriate headform size based on the discrete size and fit on the headform. The headforms used for this testing will be ISO headforms in accordance with the requirements of ASTM F2220 and ASTM F1446. Variable mass headforms will be used as reflected in Table 6.3.

**Table 6.3. Test Headform Mass and Size Specifications**

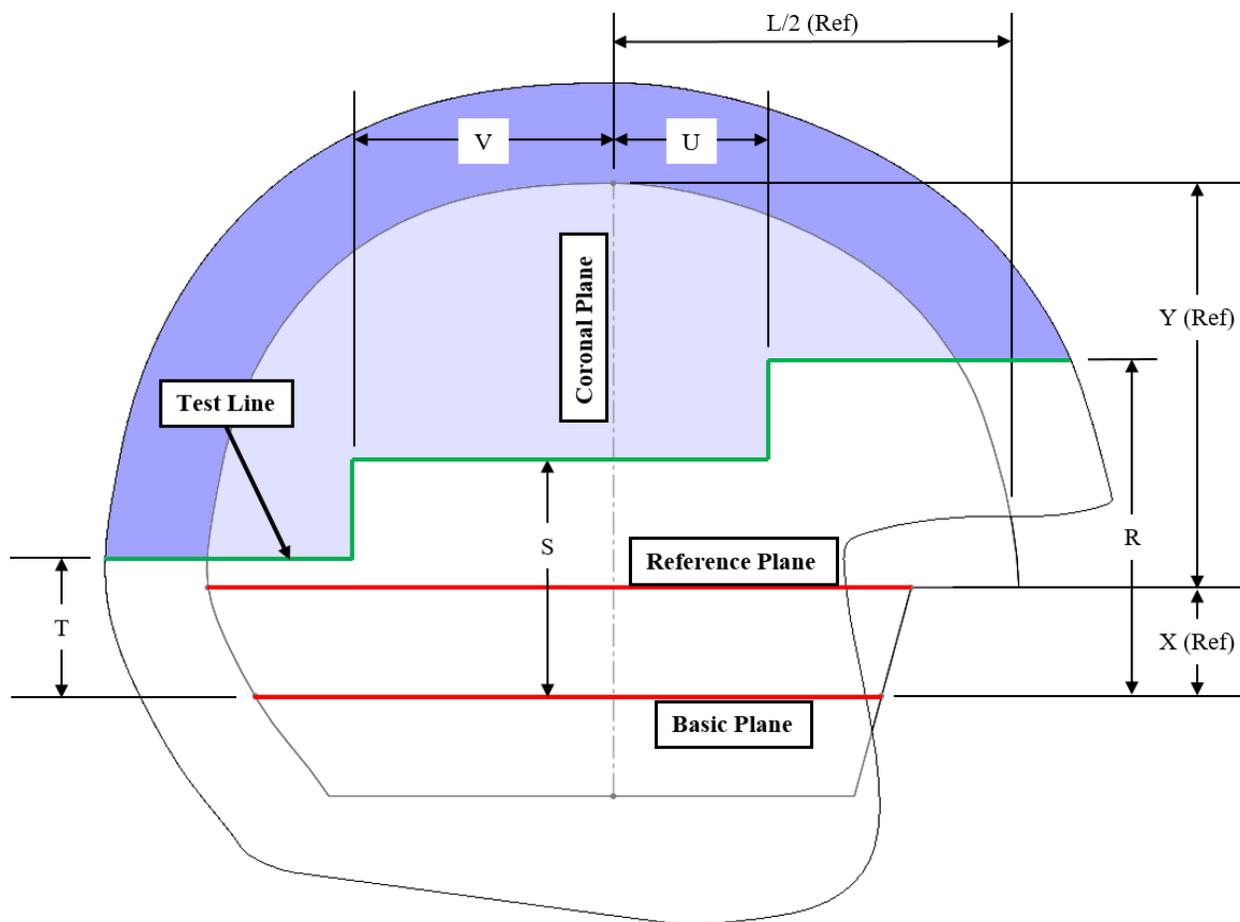
Headform Size	Drop Assembly Mass	Size Designation (cm)	Nominal Helmet Size (cm)
<b>A</b>	3.1 ± 0.10 kg	49.5	50
<b>C</b>	3.6 ± 0.10 kg	51.5	52
<b>E</b>	4.1 ± 0.12 kg	53.5	54
<b>J</b>	4.7 ± 0.14 kg	57.5	58
<b>M</b>	5.6 ± 0.16 kg	60.5	61
<b>O</b>	6.1 ± 0.18 kg	62.5	63

The determination of which headform is appropriate to use with a specific helmet is based on the specified smallest and largest head circumferences for the helmet, Table 5.1, in relation to the headform size, Table 6.3. The smallest and largest head circumferences will be taken directly from the helmet label or obtained from the manufacturer/distributor. The headform to use during testing is the largest of the headforms whose circumference is no greater than the manufacturer's specified largest circumference. If the helmet does not fit the largest headform, the next smaller headform should be selected. If it is determined that the helmets are too small even for the smallest appropriate headform as indicated by the manufacturer's discrete size specification, the samples shall be rejected for testing.

During testing, helmets will be positioned on the selected test headform according to the manufacturer's specified helmet positioning indices. If the manufacturer fails to provide positioning information with the certification samples, the helmets will be positioned according to the best judgment of experienced test personnel.

## 6.2 Test Line

The test line, Figure 6.1, shall be marked on the helmet (Helmet A) in accordance with the procedures identified in FMVSS No 218. To mark the test line, the helmet shall be placed on the headform in the position that conforms to the helmet positioning index (HPI) supplied by the manufacture/distributor. Each helmet shall have a protective surface of continuous contour at all points on or above the test line. The center of all impacts, except impacts at the ear cup locations, can be positioned such that they are on or above the test line. Impacts at the ear cup locations are to be performed regardless of their proximity to the test line.



Headform Size	X	L/2	Y	R	S	T	U	V
A	24.0	88.0	89.7	78.5	56.5	34.5	32.0	58.5
C	25.0	91.5	93.0	80.5	57.5	34.5	33.5	60.0
E	26.0	94.5	96.0	82.5	58.5	34.5	35.5	62.0
J	27.5	101.0	102.5	85.5	60.0	34.5	38.5	65.0
M	29.0	106.0	107.0	88.0	61.5	34.5	40.0	66.5
O	30.0	108.5	110.0	89.5	62.5	34.5	42.0	68.5

Dimensions in mm  
**Figure 6.1. Test Line**

### 6.3 Conditioning

Conditioning of the helmets prior to testing shall be in accordance with FMVSS No. 218, paragraph S6.4 with the following exceptions.

- Ambient Temperature:  $21^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (Helmet A)
- Ambient Relative Humidity:  $50\%RH \pm 20\%$
- Low Temperature:  $-10^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (Helmet B)
- High Temperature:  $50^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (Helmet C)

Low and high temperature conditioning shall be for a minimum duration of four hours and no more than twenty-four hours prior to testing. Note that the water immersed conditioning requirements of FMVSS No. 218 are not included in this specification.

### 6.4 Positional Stability Testing, Retention System

The retention system of the ambient helmet (Helmet A) shall be subjected to the positional stability (roll-off) test in accordance with ASTM F1446 §7.2.1 using a 4 kg drop mass from a height of 0.6 m. The headform shall comply with the dimensions of the full chin reference headforms of ASTM F2220. The headform size shall be the same as that used for impact attenuation testing. Testing of the helmet in the face-up and face-down configurations shall be performed. The retention system shall remain intact, the helmet shall remain on the headform and displacement shall not be excessive. Excessive displacement is observed when those parts of the coronal plane that were covered by the helmet before the test become exposed after testing in either orientation. Any test failure shall be cause for rejection of the lot.

### 6.5 Impact Attenuation Testing

The ambient (Helmet A), cold temperature (Helmet B), and high temperature (Helmet C) helmets shall be impact tested in accordance with FMVSS No. 218, Paragraph S5.1 with the following deviations and modifications:

- The helmet shall be fitted to the appropriate sized variable mass ISO headform. (See Table 6.3)
- For all impacts, the helmet assembly shall be fully assembled, less mic/boom assembly, and positioned in the "as worn" condition with the outer visor lowered as far as possible.
- Only single impacts will be conducted at each location.

#### 6.5.1 System Check

Pre-test and post-test system check drops will be performed as part of the impact series for each set of helmets under test to identify possible faults in the system in accordance with the requirements of US DOT, TP-218-07. The series of check drops will be made using only the test headform and drop assembly. The headform shall be bare and the point of impact near the crown with the accelerometer axis vertically aligned. During the post-test, the headform shall be aligned in a manner that is consistent with the pre-test check drop.

The drop height and standardized impact media (a 2.54 cm open blue Modular Elastomer Programmer (MEP) Calibration Pad has proven suitable for this purpose) for these checks shall be chosen to demonstrate the system's capability to produce and record an acceleration vs. time history of (nominally) 400 g with a minimum 1 msec duration above 200 g.

A systems check shall consist of 6 drops. The first 3 drops are considered "warm-up" drops. Permanent recording of data is not required for these impacts. The acceleration time histories for the second 3 drops shall be recorded and the results of these drops shall become part of the test data presented in the final report. In addition, immediately prior to the first pre-test system check drop, an accurate ( $\pm 0.1\%$  voltage) calibration signal shall be injected into the system. The output produced by this signal shall be recorded and retained on file.

If either of the following conditions exists, the impact system check shall be considered invalid. A system level root cause shall be identified and fixed prior to additional testing:

- (1) None of the three pre-test or post-test recorded accelerations are greater than 375 g, or
- (2) The average of pre-test and post-test checks (recorded drops only) differs by more than 15 g.

### 6.5.2 Anvils

Anvils to be used for impact tests in this specification are described as follows:

- Flat Anvil, as described in FMVSS No. 218 S7.1.10.
- Hemispherical Anvil, as described in FMVSS No. 218 S7.1.10.

### 6.5.3 Impact Locations

As identified in TP-218-07 S12.6.2, the centers of impacts on the shell of the helmet can be anywhere on or above the test line. The impact locations shall be the same for the three environmentally conditioned helmets (Helmets A, B and C). The distance between all impact locations shall not be less than one-seventh the maximum circumference of the helmet at the test line. Impacts at the ear cup locations shall be required regardless of their proximity to the test line and all other impact locations. Impacts on the visor assembly are acceptable, but impacts directly on the visor rails or components located directly over the visor rails shall be avoided.

Since the ISO headforms for impact testing do not provide a chin area for a chin strap to interface with, proper engagement of the retention system when fully tightened may not be achieved resulting in rotation of the helmet on the headform prior to impact drop. If so, it may be necessary to provide additional restraint to prevent slippage between the helmet and the headform, and to insure that an impact occurs at its intended impact location. The mass of all additional restraints used must be included in the total drop mass assembly, shall not interfere with the helmet's impact attenuation performance, and shall be described in detail on the final test report with supporting photographs.

The following are permissible restraint methods:

- (1) A simulated chin (i.e. - block, foam, bar, etc.) between the chin area of the headform and the helmet's chin strap, or
- (2) A minimal amount of adhesive tape at the helmet-headform interface.

#### 6.5.3.1 Type I Helicopter Helmets

Each helmet tested shall be impacted with a single impact at each of seven impact sites; front, rear, left and right sides, crown, and left and right ear cups. The headform orientations given in Table 6.4 identify impact location objectives that satisfy these impact location requirements and are consistent with historical military flight helmet locations. However, at the discretion of the test

lab, actual test impact sites may vary from the stated objectives provided each test impact site remains above the test line, utilizes the appropriate anvil, and are greater than the minimum distance requirement for any two impact locations.

The impact locations at the "center" of each ear cup are with the coronal plane of the headform vertically and the basic plane oriented such that the line of impact is perpendicular to the helmet shell<sup>12</sup>. The ear cups shall be fitted with an equal number of fitting pads on each side. The number of fitting pads shall be such that a uniform and approximately 50 percent compression of the ear seal results on each side to simulate the as-worn condition.

**Table 6.4. Impact Location Objectives for Type I Helicopter Helmets**

<b>Location</b>	<b>Basic Plane from Vertical</b>	<b>Rotation about Z-Axis<sup>13</sup></b>	<b>Anvil</b>
Front	35° ± 10°	± 35°	Flat or Hemi
Rear	15° ± 10°	± 35°	Flat or Hemi
Sides	20° ± 10°	± 35°	Flat or Hemi
Crown	90° ± 35°	± 180°	Flat or Hemi
Ear Cups	5° ± 10°	± 10°	Flat

#### 6.5.3.2 *Type II Airplane Helmets*

Each helmet tested shall be impacted with a single impact at each of five impact sites: front, rear, left and right sides, and crown. The headform orientations given in Table 6.5 identify impact location objectives that satisfy these impact location requirements and are consistent with historical military flight helmet locations. However, at the discretion of the test lab, actual test impact sites may vary from the stated objectives provided each test impact site remains above the test line, utilizes the appropriate anvil, and are greater than the minimum distance requirement for any two impact sites.

**Table 6.5. Impact Location Objectives for Type II Aircraft Helmets**

<b>Location</b>	<b>Basic Plane from Vertical</b>	<b>Rotation about Z-Axis<sup>14</sup></b>	<b>Anvil</b>
Front	35° ± 10°	± 35°	Flat or Hemi
Rear	15° ± 10°	± 35°	Flat or Hemi
Sides	20° ± 10°	± 35°	Flat or Hemi
Crown	90° ± 35°	± 180°	Flat or Hemi

#### 6.5.4 *Impacting Schedule*

The type of anvil used at each of the impact sites are given in Table 6.4 and Table 6.5. The impact sites and associated anvils can be performed in any sequence.

For Type I Helicopter Helmets two or three of the shell impact sites shall use the flat anvil, and the remaining shell impact sites shall use the hemispherical anvil. The ear cup sites will use the flat anvil.

For Type II Airplane Helmets, two or three of the shell impact sites shall use the flat anvil, and the remaining shell impact sites shall use the hemispherical anvil.

<sup>12</sup> Note that the modified Medium FMVSS No. 218 headform with extended sides is not required for this testing.

<sup>13</sup> Z-Axis is the intersection of the coronal and midsagittal planes.

<sup>14</sup> Z-Axis is the intersection of the coronal and midsagittal planes.

#### 6.5.5 Impact Velocities

Impact velocity measurements and requirements are in accordance with FMVSS No. 218 S5.1 with the following exceptions:

- The helmet shall be dropped onto the flat anvil from a height sufficient to produce an impact velocity (terminal velocity) of  $6.0 \pm 0.2$  meters per second.
- The helmet shall be dropped onto the hemispherical anvil from a height sufficient to produce an impact velocity (terminal velocity) of  $5.2 \pm 0.2$  meters per second.
- The impact velocity shall be measured during the last 40 mm of free-fall for each test.

#### 6.5.6 Peak Acceleration Requirements

The acceleration time histories and peak acceleration ( $g_{\max}$ ) during each impact shall be measured with equipment described in FMVSS No. 218. The peak acceleration of any impact on the shell of the helmet shall not exceed 300 g. The peak acceleration of any impact on the ear cup of the helmet shall not exceed 190 g, and the average acceleration of ear cup impacts shall not exceed 175 g.

#### 6.6 Static Strength Testing, Retention System

The retention system of the helmets conditioned at ambient (Helmet A), cold temperature (Helmet B), and high temperature (Helmet C) conditions shall be subjected to the static strength retention system requirements of FMVSS No. 218 S7.3 with the following exceptions:

- The headforms shall be the ISO headforms of ASTM F2220.

The headform size shall be the same as that used for impact attenuation testing. The helmet shall be mounted in a system identified in FMVSS No. 218 that provides an adjustable load mechanism with simulated chin, a means for holding the test headform and helmet stationary, and a system to measure chin strap extension. During setup, the helmet is placed on the headform and allowed to rotate in order to compensate for variations in the load paths between the test apparatus and in-service conditions, which will reduce rotation of the helmet and chinstrap elongation measurement errors when the retention system is under load. The retention system is fastened to the simulated jaw, and preload of 22.7 kg is applied and held for 30 seconds. The load is then gradually increased to 136 kg and held for not less than 2 minutes. There shall be no separation of components at 136 kg of applied force. Chinstrap elongation shall be no greater than 32mm between the 22.7 kg preload and 136 kg load conditions. Any test failure shall be cause for rejection of the lot.

#### 6.7 Heat Exposure Testing

The helmet shall satisfy the performance requirements of §3.4.2 of MIL-DTL-847474A, excluding the measurement between reference dimples. The helmet assembly (Helmet D) shall be at ambient test conditions for at least one (1) hour prior to testing. The helmet assembly shall then be weighed and then shall be placed on its crown in an air-circulating oven at a temperature of  $70^{\circ}\text{C} \pm 5^{\circ}\text{C}$  for a 4-hour ( $\pm 15$  minutes) period. The helmet assembly shall then be removed from the oven and conditioned at ambient test conditions for 1 hour ( $\pm 15$  minutes). The helmet assembly shall then be weighed, and any change in weight following the exposure shall not exceed 1% of the original weight. Following the heat exposure test, there shall be no distortion of helmet components, defects in finish, or separation of adhesive bonds that would impair performance of the helmet.

### 6.8 Adhesion of Shell Edge Covering Testing

The helmet shall be equipped with a shell edge covering or otherwise demonstrate that the shell edge is not sharp as defined in Section 5.1.1. When the helmet is equipped with a shell edge covering it shall satisfy the performance requirements of §3.5.2 and §3.5.3 of MIL-H-43925D using acceptance requirements identified below. The helmet assembly (Helmet D) shall be at ambient test conditions for at least 1 hour prior to the initial check of adhesion. The same helmet shall then be aged on its crown in an air-circulating oven at 70°C ± 5°C for a period of four to twenty-four hours. The helmet assembly shall then be removed from the oven and conditioned at ambient test conditions for 1 hour (± 15 minutes), followed by the final adhesion check shall be performed.

Prior to and after aging of the helmet, the edge covering shall remain bonded to the shell. The beading shall be considered un-bonded when the covering can be rolled back on itself and away from the shell edge by applying force with the ball of the thumb. Up to a total length of 50mm of un-bonded length is acceptable if:

- No individual un-bonded length is more than 15mm
- There is at least 10mm between any two un-bonded lengths

The bonding shall be checked at a minimum of three locations on the helmet shell: front, side and rear.

### 6.9 Sound Attenuation Testing

Sound attenuation components shall be installed on the helmets for all testing where it does not interfere with the performance of the test. Sound attenuation testing to establish noise attenuation values is required only during initial certification and when the related components or their manufacturing process, including materials and/or suppliers, are changed. Sound attenuation for the helmet (Helmet E) shall be determined in accordance with ANSI/ASA S12.6 or ANSI/ASA S12.42. Historically, ANSI/ASA S12.6 testing has been used and includes real-ear attenuation at threshold (REAT) methods for the measurement of the noise attenuation of hearing protection devices using test subjects. REAT procedures are considered the best way to measure the amount of protection that a sound attenuation system provides<sup>15</sup>. ANSI/ASA S12.42 includes acoustic test fixture test procedures for measurement of insertion loss of hearing protection devices. If ANSI/ASA S12.42 insertion loss is used in lieu of ANSI/ASA S12.6, a correction factor for bone conduction, occlusion effects, and physiological masking must be included.

The sound attenuation feature shall provide sufficient attenuation such that exposure does not exceed 100% of the Acoustic Dose. Total daily exposure is defined as 85 dBA for 8 hours. To accomplish this, the target helmet noise attenuation target values given in Table 6.6 are used. All sound attenuation testing shall be performed with proper compression of the ear cups. Any test failure shall be cause for rejection of the lot.

**Table 6.6. Helmet Noise Attenuation Targets**

Hertz	125	250	500	1000	2000	3150	4000	6300	8000
Decibels	17	14	20	21	26	38	37	46	42

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<sup>15</sup> USAARL Report No 2012-14

#### 6.10 Communication Equipment Talk-Listen Testing

Communication equipment testing is required during initial certification or only when the components or their manufacturing process, including materials and/or suppliers, are changed. The system shall be compatible with or replace current communications devices designed for use with aircrew helmets. The system shall be compatible with or include a boom microphone. Communication equipment testing shall be performed in accordance with MIL-DTL-27467B §3.5.2.1 and §3.5.2.2. Helmet E assembly shall be tested by connecting the headset assembly, including a microphone, to a suitable test system. The testing will be a simple talk-listen test. When the microphone is spoken into, there must be side tone in each earphone of the headset. There shall be no buzzes, rattles, or voice distortion during testing. All communication equipment testing shall be performed with proper compression of the ear cups. Any test failure shall be cause for rejection of the lot.

## **7 REPORT**

The final report and associated documentation are relied upon as the chronicle of the helmet testing performed and must be capable of standing by itself. The final report shall describe in detail any test events that deviate from this document. The report and Table of Contents shall include at least the following:

Purpose of Helmet Testing

Helmet Testing Data Summary

Configuration and Associated Inspections

Labeling

Vision

Weight

Headform Selection

Test Line

Conditioning

Positional Stability Testing, Retention System

Impact Attenuation Testing

Static Strength Testing, Retention System

Heat Exposure Testing

Adhesion of Shell Edge Covering Testing

Sound Attenuation Testing (if applicable)

Communication Equipment Talk Listen Testing (if applicable)

Test Failure Details (if applicable)

Appendix A —Interpretations or Deviations from this Standard

Appendix B —Test Equipment List and Calibration Information

## **8 KEYWORDS**

Helmet, protective headgear, aviation, helicopter, airplane