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Standard Performance Specification for Hand-Held Metal Detectors Used in Safety and Security¹

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1. Scope

1.1 This performance specification applies to all hand-held metal detectors (HHMDs) used to find metal contraband concealed or hidden on people or other objects with accessible surfaces. This performance specification describes baseline performance requirements, which includes metal object detection performance, safety (electrical, mechanical, fire), electromagnetic compatibility, environmental conditions and ranges, and mechanical durability. The requirements for metal detection performance are unique and, therefore, test methods for these parameters are provided, including the design of test objects. An agency or organization using this performance specification is encouraged to add their unique operationally-based requirements to those requirements listed in this baseline performance specification.

1.2 This performance specification describes the use of spherical test objects, instead of actual threat objects or exemplars of threat objects, to test the detection performance of hand-held metal detectors. Spherical test objects are used because the detectability of spherical test objects is not orientation dependent, whereas this is not true for non-spherical test objects. This orientation-dependent detectability of non-spherical test objects may allow a HHMD to be incorrectly attributed a higher performance capability than that HHMD is capable of providing. To aid agencies wishing to add specific threat objects to their detection performance requirements, included in **Annex A1** is the analysis of the probability of detection for different orientations of agency-specific threat objects.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ISO Standards:²

ISO 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories

ISO 10012:2003 Measurement Management Systems – Requirements for Measurement Processes and Measuring Equipment

ISO 14117:2012 Active Implantable Medical Devices – Electromagnetic Compatibility – EMC Test Protocols for Implantable Cardiac Pacemakers, Implantable Cardioverter Defibrillators, and Cardiac Resynchronization Devices

ISO 14708-1:2000 Implants for Surgery – Active Implantable Medical Devices – Part 1: General Requirements for Safety, Marking and for Information to be Provided by the Manufacturer

ISO 14708-2:2012 Implants for Surgery – Active Implantable Medical Devices – Part 2: Cardiac Pacemakers

ISO 14708-3:2008 Implants for Surgery – Active Implantable Medical Devices – Part 3: Implantable Neurostimulators

ISO 14708-4:2008 Implants for Surgery – Active Implantable Medical Devices – Part 4: Implantable Infusion Pumps

ISO 14708-5:2010 Implants for Surgery – Active Implantable Medical Devices – Part 5: Circulatory Support Devices

ISO 14708-6:2010 Implants for Surgery – Active Implantable Medical Devices – Part 6: Particular Requirements for Active Implantable Medical Devices Intended to Treat Tachyarrhythmia (Including Implantable Defibrillators)

ISO 14708-7:2013 Implants for Surgery – Active Implantable Medical Devices – Part 7: Particular Requirements for Cochlear Implant Systems

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² Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

2.2 IEC Standards:³

IEC 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements

IEC 61000-6-1 Electromagnetic Compatibility (EMC) Part 6: Generic Standards – Section 1: Immunity for Residential, Commercial, and Light-industrial Environments

IEC 61000-4-2 Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques – Section 2: Electrostatic Discharge Immunity Test

IEC 61000-4-3 Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques – Section 3: Radiated, Radio-frequency, Electromagnetic Field Immunity Test

IEC 61000-4-8 Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques – Section 8: Power Frequency Magnetic Field Immunity Test

IEC 60529 2001-2 Degrees of Protection Provided by Enclosures (IP Code)

IEC 60068-2-27:2008-2 Environmental Testing – Part 2-27: Tests – Test Ea and Guidance: Shock

IEC 60068-2-31:2008-05 Environmental Testing – Part 2:31: Tests – Test Ec: Rough Handling Shocks, Primarily for Equipment-type Specimens

CISPR 22 Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement, Class B, Radiated Disturbance

2.3 IEEE Standards:⁴

IEEE C95.1 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

IEEE Std 181-2011 IEEE Standard for Transitions, Pulses, and Related Waveforms

2.4 Military Standards:⁵

MIL-STD-810G Method 501.5 Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Method 501.5, High Temperature

MIL-STD-810G Method 502.5 Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Method 502.5 Low Temperature

MIL-STD-810G Method 507.5 Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Method 507.5, Humidity

2.5 ANSI Standards:⁶

ANSI S1.4-1983 Specification for Sound Level Meters

2.6 CIE Standards:⁷

CIE Standard S 014-1/E:2006 Colorimetry – Part 1: CIE Standard Colorimetric Observers

3. Terminology

3.1 Definitions:

3.1.1 *alarm*—an indication (which may be audible, visual, or vibratory, or combinations thereof) that informs the operator of an event, such as metal detection or a detector (HHMD) status change.

3.1.2 *body simulant*—a material engineered to simulate the average electrical conductivity and magnetic permeability of the human body. The average electrical conductivity is 0.8 S/m \pm 0.2 S/m and the average magnetic permeability is 1.26×10^{-6} H/m \pm 5×10^{-7} H/m.

3.1.3 *detector*—the hand-held metal detector (HHMD) that is held in one hand and is used for finding metal objects concealed on a person or other object.

3.1.4 *detector axis*—an imaginary line passing through and perpendicular to the detector plane that is located within the detector plane such that the magnetic field around the detector axis has the maximum symmetry. The detector axis is labeled as the “z” axis. The location of the detector axis relative to the HHMD shape and geometry is specified by the manufacturer. The detector axis is the reference for positioning in the detection performance tests. See Fig. 1.

3.1.5 *detector holder*—a device used to hold the HHMD in place during testing. The detector holder is constructed of non-ferromagnetic and non-electrically conductive materials.

3.1.6 *detector plane*—an imaginary plane (two-dimensional surface) that is tangential to the plane, line, or point on the HHMD surface that is closest to the object being scanned under typical HHMD use. The detector plane contains two orthogonal axes labeled as the “x” axis and as the “y” axis. See Fig. 1.

3.1.7 *detection sensitivity setting*—an adjustment that can be made to the HHMD that affects its ability to sense metal objects.

3.1.8 *measurement coordinate system*—a mutually orthogonal three-dimensional Cartesian coordinate system referenced to the detector axis and the detector plane. The three axes are labeled “x,” “y,” and “z,” where the z axis is parallel to the detector axis and the x axis and the y axis are in the detector plane. The orientation of the test objects is referenced to the measurement coordinate system. See Fig. 2.

3.1.9 *measurement plane*—an imaginary two-dimensional surface over which the HHMDs are tested. There may be more than one measurement plane. The measurement plane(s) is (are) referenced from the detector plane. See Fig. 2. There is a measurement plane for each size class of the HHMD, as shown in Table 1.

3.1.10 *size class*—a classification method based on grouping exemplars of commonly encountered objects that may be

³ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, <http://www.iec.ch>.

⁴ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, <http://www.ieee.org>.

⁵ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

⁶ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁷ Available from U.S. National Committee of the CIE (International Commission on Illumination), C/o Alan Laird Lewis, 282 E. Riding, Carlisle, MA 01741, <http://www.cie-usnc.org>.

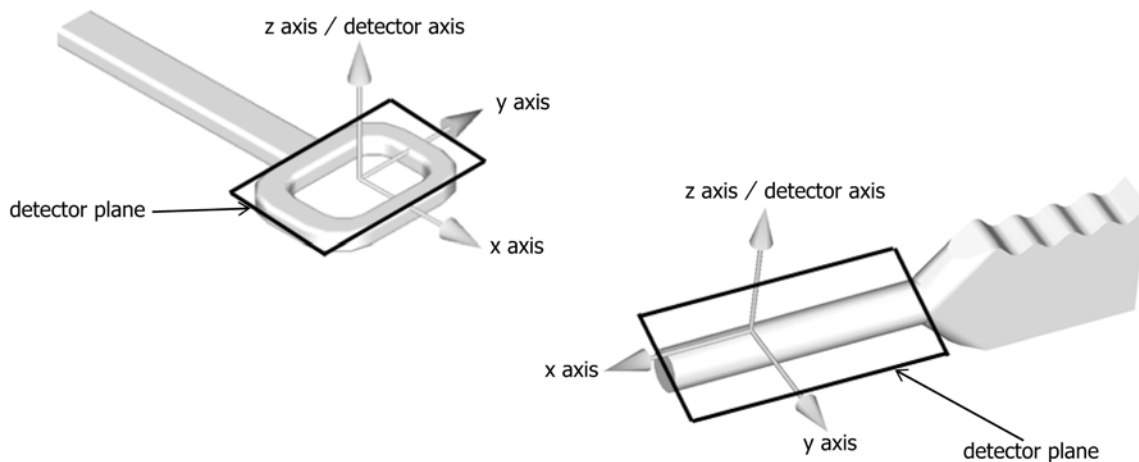


FIG. 1 Diagram of Hand-held Metal Detector Showing the Detector Plane (Labeled and Represented by a Rectangle) and the Detector Axis (Labeled z)

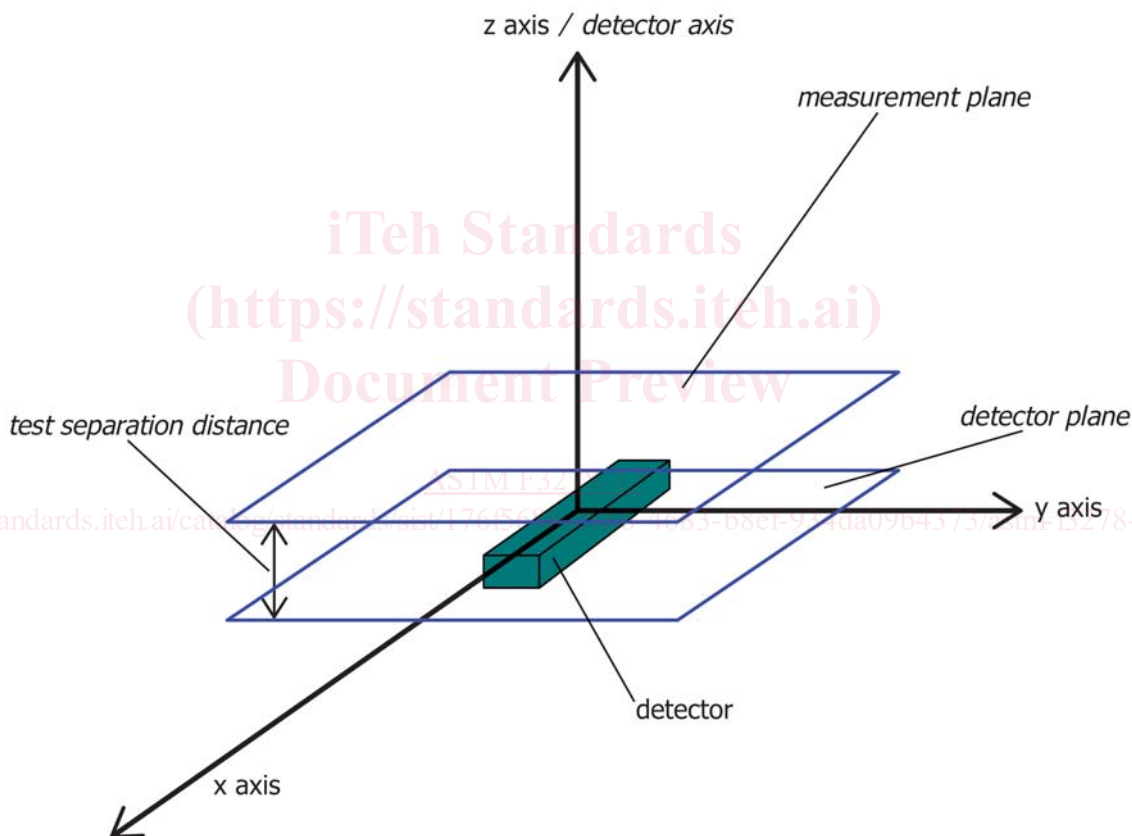


FIG. 2 A Diagram of the Measurement Coordinate System Showing the Measurement Coordinate System Axes, One Measurement Plane, and the Detector Plane. The x axis Points Along the User's Arm

either commercially available or readily fabricated from available materials and that are related to customer applications and object sizes. A HHMD may meet the requirements for one or all size classes, as defined below.

3.1.10.1 *large*—represents threat items such as handguns, and similarly sized objects, or larger, constructed of ferromagnetic or nonferromagnetic metal, or both.

3.1.10.2 *medium*—represents threat items such as knives having blade lengths exceeding 7.5 cm, and similarly sized

TABLE 1 Distance Between Measurement Plane and Detector Plane for the Different HHMD Size Classes

Size Class	Distance Between Measurement Plane and Detector Plane (cm)
Large	8.0 – 0/+ 0.2
Medium	4.0 – 0/+ 0.2
Small	2.0 – 0/+ 0.2
Very Small	0.5 – 0/+ 0.2

objects, up to the size of a large object, constructed of ferromagnetic or nonferromagnetic metal, or both.

3.1.10.3 *small*—represents threat items such as, but not limited to, knives having blade lengths less than or equal to 7.5 cm, handcuff keys, handgun rounds, and similarly sized objects, up to the size of a medium object, constructed of ferromagnetic or nonferromagnetic metal, or both.

3.1.10.4 *very small*—represents threat items such as t razor blades, hypodermic needles and similarly sized objects, up to the size of a small object, constructed of ferromagnetic or nonferromagnetic metals, or both.

3.1.11 *test object*—an item that is used to test the HHMD detection performance. Test objects accurately simulate the electromagnetic properties of an actual threat or contraband item, such as a weapon or an item that can be used to defeat security devices. The test objects are described in Section 6.

3.1.12 *test object axis*—the imaginary line passing through the center of the test object that is referenced to and has a one-to-one correspondence with the axes of the measurement coordinate system.

3.1.13 *x-axis scan range*—the segment of line along the x axis of the measurement coordinate system that is centered on the detector axis that extends equally on either side of the detector axis.

4. Requirements for Acceptance

NOTE 1—The HHMD shall meet or exceed the requirements and specifications stated in this section.

4.1 General Test Conditions and Requirements:

4.1.1 *Testing and Calibration Laboratories*—Laboratories performing testing and calibration of the HHMD or its components, or both, shall meet the requirements of ISO 17025, as amended.

4.1.2 *Measurement Equipment and Processes*—All measurement equipment and processes shall be certified to ISO 10012, as amended.

4.2 Safety Specifications and Requirements:

4.2.1 *Electrical*—The HHMD shall comply with IEC 61010-1, Section 6, “Protection Against Electrical Shock,” as amended.

4.2.2 *Mechanical*—The HHMD shall meet the requirements of IEC 61010-1 Section 7, “Protection Against Mechanical Hazards,” as amended.

4.2.3 *Thermal*—The HHMD shall meet the requirements of IEC 61010-1 Section 10, “Equipment Temperature Limits and Resistance to Heat,” as amended.

4.2.4 Human Exposure:

4.2.4.1 *General*—The magnitude of the electromagnetic field generated by the HHMD at a distance of approximately 5 mm from any surface of the HHMD shall be less than the

exposure limits specified for general public exposure in the ICNIRP⁸ guideline and IEEE C95.1.

4.2.4.2 *Active Implanted and Body-worn Medical Devices*—The magnitude of the electromagnetic field generated by the HHMD shall not cause an active implanted or body-worn medical electronic device to be adversely affected as described in ISO 14117:2012, ISO 14708-1, ISO 14708-2, ISO 14708-3, ISO 14708-4, ISO 14708-5, ISO 14708-6, and ISO 14708-7 and tested in accordance with the same. If adherence to the requirement in 4.2.4.2 has not been demonstrated, the manufacturer shall provide a warning with the HHMD instructions that states “This device has not been demonstrated as being safe for use on people with active implanted or body-worn medical devices, or both.”

4.3 Power Requirement:

4.3.1 *Battery Life*—The HHMD shall operate for at least 10 h as tested in accordance with 5.5 and while using a battery of the type and model recommended by the manufacturer.

4.4 *Detection Performance Specifications*—The ability of the HHMD to sense the presence of a test object will vary with the material and geometry of the test object and the distance between the test object and the HHMD. In this performance specification, the test objects are spherical to avoid the possibility of incorrectly attributing a higher performance capability to a HHMD than that HHMD is capable of providing. The test objects are grouped according to their size class and the HHMDs are tested for their ability to detect test objects from within these different size classes. The detection performance specifications shall be tested using the detection sensitivity setting, if applicable, that is specified by the manufacturer to be appropriate for each test object size class. All the tests of 5.2, 5.3, and 5.4 requirements shall be performed within an 8 h ± 0.5 h period without adjusting the detector sensitivity setting between tests. The detector sensitivity setting shall not be readjusted during testing, or after changing the battery. The test objects are given in Section 6.

4.4.1 *Detection Sensitivity*—The HHMD shall exhibit an average probability of detection, $p_{d,sens}$, ≥ 0.95 with an average confidence level of 0.95 for the test objects in each size class, when each object in the size class is positioned in the appropriate measurement plane (see Table 1) over the appropriate x-axis scan range (see Table 2) with the test object moving at a speed of 0.5 m/s ± 0.05 m/s and tested in accordance with 5.2.2. This requirement is met when $p_{LB} \geq p_{d,sens}$ as computed per 5.2.2.

4.4.2 *Detection Speed*—The HHMD shall exhibit an average probability of detection, $p_{d,sp-sens}$, ≥ 0.95 with an average confidence level of 0.95 for the test objects in each size class, when each object in the size class is positioned in the appropriate measurement plane (see Table 1) over the appropriate x-axis scan range (see Table 2) for each required orientation (see Table 2) of the test object axes with respect to the measurement coordinate system, with the test object

TABLE 2 X-axis Scan Range for the Different HHMD Size Classes

Size Class	X-axis Scan Range	
	lower limit (cm)	upper limit (cm)
Large	-7.5 ± 0.1	7.5 ± 0.1
Medium	-6.0 ± 0.1	6.0 ± 0.1
Small	-5.7 ± 0.1	5.7 ± 0.1
Very small	-5.4 ± 0.1	5.4 ± 0.1

⁸ ICNIRP “Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz),” International Commission on Non-Ionizing Radiation Protection (ICNIRP), *Health Physics*, April 1998, Volume 74, No. 4, pp. 494–522.

moving at a speed of 0.05 m/s \pm 0.01 m/s, 0.2 m/s \pm 0.01 m/s, 0.5 m/s \pm 0.01 m/s, and 1.0 m/s \pm 0.01 m/s as tested in accordance with 5.2.2 under the following conditions: (1) the delay between subsequent tests of a given test object shall be no more than 5 s \pm 0.5 s; and (2) the detector sensitivity setting shall not be readjusted between tests of a given test object or between tests of the test objects of a given size class. This requirement is met when $p_{LB,sp} \geq p_{d,sp-sens}$ as computed per 5.2.3.

4.5 Interference Specifications and Requirements:

4.5.1 Electromagnetic Emission:

4.5.1.1 *Radiated Disturbance*—The HHMD, when adjusted to meet the requirements of 4.4, shall meet the requirements of CISPR 22, Class B, radiated disturbance.

4.5.2 *Electromagnetic Susceptibility/Immunity*—The HHMD shall be tested in accordance with the requirements listed in Table 1 of IEC 61000-6-1, as amended, according to the following procedures:

4.5.2.1 *Contact Discharge*—The HHMD, after being adjusted to meet the requirements of 4.4, shall be tested in accordance with IEC 61000-4-2, as amended, for Level 2, contact discharge, and ten trials; and shall subsequently meet the requirements of 4.4 without further adjustment and using the limited set of test objects listed in Section 6.

4.5.2.2 *Radiated RF Electromagnetic Field Immunity*—The HHMD, when adjusted to meet the requirements of 4.4, shall not produce an alarm when tested in the absence of a test object and in accordance with IEC 61000-4-3, as amended, for Level 2.

4.5.2.3 *60 Hz and 50 Hz Radiated Magnetic Field*—The HHMD, when adjusted to meet the requirements of 4.4, shall not produce an alarm when tested in the absence of a test object and in accordance with IEC 61000-4-8, as amended, for testing at 60 Hz and 50 Hz, Level 2, and continuous exposure for 30 min \pm 5 min.

4.5.3 *Body Interference*—The HHMD, without adjusting the detection sensitivity settings used for the tests given in 4.4, shall exhibit a probability of false alarm, $p_{fa,b} \leq 0.05$ with a confidence level of 0.95 when operating near the body or body simulant, as tested in accordance with 5.3. This requirement is met when $p_{UB} \leq p_{fa,b}$ as computed per 5.3.2 and meets, without adjustment of the detector sensitivity, the requirements given in 4.4.

4.5.4 *Metal Interference*—The HHMD, without adjusting the detection sensitivity settings used for the tests given in 4.4, shall exhibit a probability of false alarm, $p_{fa,m} \leq 0.05$ with a confidence level of 0.95 when operating near a large metal plate, as tested in accordance with 5.4. This requirement is met when $p_{UB} \leq p_{fa,m}$ as computed per 5.4.2.

4.6 *Environmental Ranges and Conditions*—The HHMD or all of its components and their interconnections shall meet all of the requirements listed in this section. The HHMD performance requirements of 4.2 and 4.4 shall not be affected by the tests described in this section as demonstrated by subsequent testing per the requirements of 4.2 and 4.4. The requirements given in this section shall be applied appropriately for either indoor or indoor/outdoor HHMD models. The tests for the requirements listed in this section shall be performed on the

same unit. The HHMD, if tested for any of the requirements listed in 4.4, shall exhibit no observable changes in the detection performance specification given in 4.4 using the limited set of test objects listed in Section 6.

4.6.1 Temperature Stability and Range:

4.6.1.1 *Indoor*—The HHMD shall operate over the ambient temperature range of at least 0 to 46°C. The HHMD shall be tested in accordance with MIL-STD-810G Method 501.5, as amended, Procedure II, Steps 1 through 6, relative humidity 6 % \pm 3 %, at 46°C \pm 3°C. The HHMD then shall be cooled to 0°C \pm 3°C within 4 h \pm 0.5 h and tested in accordance with MIL-STD-810G Method 502.5, as amended, Procedure II, Steps 1 through 7.

4.6.1.2 *Indoor/Outdoor*—The HHMD shall operate over the ambient temperature range of at least –21°C to 65°C. The HHMD shall be tested in accordance with MIL-STD-810G Method 501.5, as amended, Procedure II, Steps 1 through 6, relative humidity 6 % \pm 3 % at 65°C \pm 3°C. The HHMD then shall be cooled to –21°C \pm 3°C within 4 h \pm 0.5 h and tested in accordance with MIL-STD-810G Method 502.5, as amended Procedure II, Steps 1 through 7.

4.6.2 *Relative Humidity Stability and Range*—The HHMD shall be tested in accordance with the requirements of MIL-STD-810 G Method 507.5, as amended, Procedure I, ten cycles of Cycle B1, as amended.

4.6.3 Environmental Protection:

4.6.3.1 *Indoor*—The HHMD shall meet or exceed the requirements for compliance with IEC 60529, as amended, classification IP54.

4.7 *Mechanical Specifications and Requirements*—The HHMD or all of its components and their interconnections shall meet the requirements of the following standards. The requirements of 4.2 and 4.4 shall not be affected by the tests described in this section. All tests listed in this section shall be performed on the same unit. The HHMD, if tested for any of the tests listed in 4.4, shall exhibit no observable changes in the detection performance specification given in 4.4 using the limited set of test objects listed in Section 6.

4.7.1 *Shock*—The HHMD shall be tested in accordance with the requirements of IEC 60068-2-27:2008, as amended, using 100 \pm 5 half-sine shock pulses applied to the HHMD along the six directions (1, 0, 0), (0, 1, 0), (0, 0, 1), (–1, 0, 0), (0, –1, 0), and (0, 0, –1) of the measurement coordinate system and with each shock pulse having a nominal peak acceleration of 40.0 g (392 m/s²) and a nominal pulse duration of 6 ms.

4.7.2 *Free Fall*—The detector shall be tested in accordance with the requirements of IEC 60068-2-31, Procedure 1, as amended, for each direction of the detector axes, a fall height of 1 m, and for two drops for each direction of the orthogonal axes depicted in Fig. 2.

4.8 *Alarm Requirements*—At least one alarm type, vibratory, audible, or visual, shall be provided and any alarm provided shall meet the applicable requirement given in this section.

4.8.1 *Vibratory Alarm*—The vibratory alarm shall produce an acceleration in the range of 0.2 m/s² to 1.0 m/s² over a frequency range of 10 Hz to 300 Hz as measured in accordance with 5.6.1.

4.8.2 *Audible Alarm*—The audible alarms (other than an earphone), if provided, shall produce an alarm-state sound pressure level of $75 \text{ dB}_{\text{SPL}} \pm 5 \text{ dB}$ (where $0 \text{ dB}_{\text{SPL}} = 20 \text{ } \mu\text{Pa}$ root-mean-square in air) at $0.8 \text{ m} \pm 0.08 \text{ m}$ from the HHMD as measured in accordance with 5.6.2. The audible alarm shall be either a frequency-proportional audible alarm or, optionally, a two-state audible alarm: active (alarm state) and inactive (nonalarm state).

4.8.2.1 *Frequency Range*—The frequency range of the audible alarm shall be $\geq 100 \text{ Hz}$ and $\leq 4 \text{ kHz}$ as tested in accordance with 5.6.3.

4.8.3 *Visual Alarm*—The visible alarm, if provided, shall produce an alarm-state light level $\geq 10 \text{ lx}$ when tested in accordance with 5.6.4. The visual alarms shall be a two-state visual alarm: active (illuminating) and inactive (nonilluminating).

4.8.4 *Alarm Delays*—The maximum delay between activation of all alarms (visual, audible, and vibratory) shall be 200 ms and the maximum difference in duration among all alarms shall be 200 ms, as tested in accordance with 5.7.

5. Performance Testing Procedures

5.1 General Test Conditions:

5.1.1 *Test Location*—The distance between any metal object other than a test object (see Section 6) and the closest part of the HHMD shall be greater than 1.0 m.

5.1.2 *Environment*—At the time of the tests, the ambient temperature shall be in the range specified in 4.6 for the appropriate application (indoor or indoor/outdoor); the relative humidity shall be noncondensing.

5.1.3 *Preparations*—New or fully-charged batteries of the type listed in the operator’s manual shall be installed at the beginning of the tests and as instructed in any test method. Any setup or calibration adjustments specified in the operator’s manual shall be performed if required. In any stand-by feature is available on the HHMD, this feature shall be disabled.

5.2 *Detection Performance Tests*—The detection performance test methods described in this section are based on the use of a computer-controlled three-axis positioning system to control the motion and displacement of the test object relative to the HHMD. Other means of controlling this motion and displacement are acceptable if the positioning and speed values are within the tolerances specified in these test methods. If the HHMD can be adjusted to provide an alarm for more than one size class, the detection performance test shall be performed for each size class. The detection performance shall be evaluated by the test methods described in this section. The distinction in testing between the different size classes is the difference in the test separation distance of the measurement plane and the detector plane.

5.2.1 *Measurement System*—The measurement system shall contain the components necessary to perform the tests described herein. A diagram of the measurement system showing the electrical and mechanical connections between its components shall be provided.

5.2.2 Detection Sensitivity Test:

5.2.2.1 Initial Procedures:

(1) Turn on the measurement system and verify proper operation of the measurement system.

(2) Ensure that the HHMD is securely fixed to the detector holder and that the detector holder is fixed in position and secured to the measurement system.

(3) Attach the test object to the positioning component of the measurement system.

(4) Turn on the HHMD and ensure that its output is functioning properly by noting a change in the alarm output as a metal object is brought near the HHMD.

(5) Ensure that the test object does not hit the detector holder or any other objects while in motion.

(6) There is a minimum number of repeats of a given measurement that must be performed to meet the performance requirements for a given confidence interval. This minimum number of measurements, N_T , is given by:

$$N_T = \text{ceil} \left\{ \frac{z_c^2 p_0}{1 - p_0} \right\} \quad (1)$$

where p_0 is equal to the probability of detection specified in 4.4.2; z_c is the critical point of a standard normal distribution and is fixed for a given confidence interval; and $\text{ceil}\{x\}$ is a function that returns the smallest integer value that is greater than x . The value of N_T includes the number of test objects of a given test object class, and the number of scans performed. For example, when $p_0 = 0.95$ and the confidence level = 0.95, $N_T = 52$. Values of N_T are provided for convenience in Annex A3.

(7) Determine the number, $n_{s,k}$, of y-axis scans to perform at each x-axis position for a given test object and given the number, n_x , of practicable x-axis positions, and the total number of required scans, N_T . The values of $n_{s,k}$ is computed using:

$$n_{s,k} = \max \left\{ \frac{N_T}{n_x}, 10 \right\}, \quad (2)$$

where the function $\max\{x,y\}$ returns the maximum value of x and y .

5.2.2.2 Performing the Measurement:

(1) Prepare the measurement system to perform an x-y scan in the specified measurement plane at the specified speed. The center for the y-axis scans shall be the detector axis and the y-axis scans shall each be no less than $40 \text{ cm} \pm 1 \text{ cm}$ long.

(2) Set the x-axis position to the specified lower x-axis scan range limit.

(3) Scan the y axis and record any alarm as the y-axis scan is being performed.

(4) Repeat Step (3) $n_{s,k}$ times to perform a total of $n_{s,k}$ scans for the current x-axis scan position.

(5) Compute the probability of alarm, $p_{d,sens,obj_k,x_i}$, where x_i is the x-axis scan position and i is the x-axis scan index, and obj_k represents the test object of the given test object size class with index k , using:

$$p_{d,sens,k,i} = \frac{1}{n_{s,k}} \sum_{j=1}^{n_{s,k}} A_{Pos-sens,k,i,j} \quad (3)$$

where the index abbreviations: $k = obj_k$, and $i = x_i$ are used