Vehicular Digital Multimedia Evidence Recording System Standard
for Law Enforcement

NIJ Standard–xxxx.00

December 2010

NCJ xxxxxxx
The preparation of this standard was sponsored by the National Institute of Justice and was performed by the International Association of Chiefs of Police under Grant #xyz.
Special Technical Committee

This standard was developed by a Special Technical Committee of practitioners, technical experts and others with experience in standards development and conformity assessment. Committee members, their organizations and their professional affiliations are listed in Table 1 and Table 2.

Table 1. Practitioners

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Organization</th>
<th>Professional Affiliation</th>
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Table 2. Technical Experts and Others

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Organization</th>
<th>Expertise</th>
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Advisory Working Group

The work of the Special Technical Committee was reviewed by an Advisory Working Group (AWG) made up of senior-level representatives from stakeholder organizations and individuals with experience in standards development and conformity assessment. Members and their organizations are listed in Table 3 below.

Table 3. AWG Members

<table>
<thead>
<tr>
<th>Member</th>
<th>Organization</th>
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</table>

Steering Committee

The Steering Committee generally directed the effort and helped to ensure coordination among relevant federal programs. Members of the Steering Committee and their organizations are listed in Table 4 below.

Table 4. Steering Committee Members

<table>
<thead>
<tr>
<th>Member</th>
<th>Organization</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ellen Scrivner, Chair</td>
<td>U.S. Department of Justice, Office of Justice Programs, National Institute of Justice</td>
<td>Deputy Director</td>
</tr>
<tr>
<td>Bert Coursey</td>
<td>U.S. Department of Homeland Security, Science and Technology Directorate, Office of Standards</td>
<td>Director</td>
</tr>
<tr>
<td>Mark Stolorow</td>
<td>U.S. Department of Commerce, National Institute of Standards and Technology, Office of Law Enforcement Standards</td>
<td>Director</td>
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</table>
Foreword

This document is a voluntary performance standard for vehicular digital multimedia evidence recording systems (VDMERSs) for use by law enforcement. It defines both performance requirements and the test methods used to assess performance. In order for a VDMERS manufacturer or other entity to claim that a particular VDMERS model satisfies this National Institute of Justice (NIJ) standard, the model must be in compliance with this standard as determined in accordance with this document and the associated document, Law Enforcement Vehicular Digital Multimedia Evidence Recording Systems Certification Program Requirements, NIJ CR-xxxx.00. Both this standard and the associated certification program requirements document are produced as a part of the Standards and Testing Program of the U.S. Department of Justice, Office of Justice Programs, NIJ, as is a third associated document, the Law Enforcement Vehicular Digital Multimedia Evidence Recording Systems Selection and Application Guide, NIJ Guide–xxxx.00.

All requirements stated in this standard, including those that explicitly employ mandatory language (e.g., “shall”) are those necessary to satisfy the standard. Nothing in this document is intended to require or imply that commercially available VDMERS models for use by law enforcement must satisfy this standard.

This standard is based in part on a performance specification produced by the International Association of Chiefs of Police. Portions of the document are used in this standard and references to the document are cited using the letter symbol indicated below:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Cited Document</th>
</tr>
</thead>
</table>

NIJ standards are subject to continued research, development and testing and to review and modification as appropriate on an ongoing basis. Users of this standard are advised to check http://www.justnet.org on a regular basis to determine whether it has been revised or superseded.

Technical comments and recommended revisions are welcome. Please send all written comments and suggestions to Director, National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 810 Seventh St., N.W., Washington, DC, 20531.

Nothing in this document is intended to create any legal or procedural rights enforceable against the United States. Moreover, nothing in this document creates any obligation for manufacturers, law enforcement agencies or others to follow or adopt this voluntary law enforcement technology equipment standard.
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### Standard-Specific Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE</td>
<td>Commission Internationale de L’Eclairage (International Commission on Illumination)</td>
</tr>
<tr>
<td>DUT</td>
<td>Device Under Test</td>
</tr>
<tr>
<td>DME</td>
<td>Digital Multimedia Evidence</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
</tr>
<tr>
<td>ESSID</td>
<td>Extended Service Set Identification</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
</tr>
<tr>
<td>IACP</td>
<td>International Association of Chiefs of Police</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>LEVA</td>
<td>Law Enforcement and Emergency Services Video Association International</td>
</tr>
<tr>
<td>NATIA</td>
<td>National Technical Investigators’ Association</td>
</tr>
<tr>
<td>NIEM</td>
<td>National Information Exchange Model</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>RC4</td>
<td>Rivest Cipher 4</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
</tr>
<tr>
<td>SI</td>
<td>System Internationale</td>
</tr>
<tr>
<td>SIA</td>
<td>Security Industry Association</td>
</tr>
<tr>
<td>SSID</td>
<td>Service Set Identification</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories Inc.</td>
</tr>
<tr>
<td>VDMERS</td>
<td>Vehicular Digital Multimedia Evidence Recording System</td>
</tr>
<tr>
<td>WAI</td>
<td>Wisconsin Association for Identification</td>
</tr>
</tbody>
</table>
Common Measures of Light: Luminous

Note: Light can be measured in radiant or luminous units. The former are for scientific purposes and do not restrict the wavelength spectrum and the latter are specific to visual and photographic applications and use the spectral sensitivity visible to humans.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>SI unit</th>
<th>Abbreviation</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Luminous energy</td>
<td>lumen second</td>
<td>lm·s</td>
<td>Light energy flowing through a unit of space.</td>
</tr>
<tr>
<td>Luminous flux</td>
<td>lumen (cd steradian)</td>
<td>lm</td>
<td>Power associated with light flowing through a unit of space.</td>
</tr>
<tr>
<td>Luminous intensity</td>
<td>candela (lm/steradian)</td>
<td>cd</td>
<td>Intensity of light from a source in a given direction.</td>
</tr>
<tr>
<td>Luminance</td>
<td>candela per square meter</td>
<td>cd/m²</td>
<td>Intensity of light emanating from a unit area on the source.</td>
</tr>
<tr>
<td>Illuminance</td>
<td>lux (lm/m²)</td>
<td>lx</td>
<td>Power of light incident on a surface.</td>
</tr>
<tr>
<td>Luminous emittance</td>
<td>lux (lm/m²)</td>
<td>lx</td>
<td>Light emitted from a surface after correction for surface emissivity.</td>
</tr>
<tr>
<td>Luminous efficacy</td>
<td>lumen per watt</td>
<td>lm/W</td>
<td>Ratio of luminous flux to radiant flux, used to relate certain luminous units to radiant units.</td>
</tr>
<tr>
<td>Exposure</td>
<td>lux seconds</td>
<td>exp</td>
<td>Determines input to a sensor chip or film.</td>
</tr>
</tbody>
</table>
Commonly Used Symbols and Abbreviations

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>ampere</td>
</tr>
<tr>
<td>ac</td>
<td>alternating current</td>
</tr>
<tr>
<td>cd</td>
<td>candela</td>
</tr>
<tr>
<td>cm</td>
<td>centimeter</td>
</tr>
<tr>
<td>dB</td>
<td>decibel</td>
</tr>
<tr>
<td>dc</td>
<td>direct current</td>
</tr>
<tr>
<td>°C</td>
<td>degree Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>degree Fahrenheit</td>
</tr>
<tr>
<td>ft</td>
<td>foot</td>
</tr>
<tr>
<td>ft/s</td>
<td>foot per second</td>
</tr>
<tr>
<td>h</td>
<td>hour</td>
</tr>
<tr>
<td>Hz</td>
<td>hertz</td>
</tr>
<tr>
<td>in</td>
<td>inch</td>
</tr>
<tr>
<td>Lb</td>
<td>pound</td>
</tr>
<tr>
<td>V</td>
<td>volt</td>
</tr>
<tr>
<td>W</td>
<td>watt</td>
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<thead>
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<tbody>
<tr>
<td>A</td>
<td>lbf</td>
</tr>
<tr>
<td>lbf</td>
<td>pound force</td>
</tr>
<tr>
<td>lbf-in</td>
<td>pound force inch</td>
</tr>
<tr>
<td>lm</td>
<td>lumen</td>
</tr>
<tr>
<td>ln</td>
<td>logarithm (base e)</td>
</tr>
<tr>
<td>log</td>
<td>logarithm (base 10)</td>
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<tr>
<td>m</td>
<td>meter</td>
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<td>min</td>
<td>minute</td>
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<tr>
<td>mm</td>
<td>millimeter</td>
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<tr>
<td>mph</td>
<td>miles per hour</td>
</tr>
<tr>
<td>mphe</td>
<td>miles per hour equivalent</td>
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<tr>
<td>m/s</td>
<td>meter per second</td>
</tr>
<tr>
<td>rh</td>
<td>relative humidity</td>
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<tr>
<td>V</td>
<td>volt</td>
</tr>
<tr>
<td>W</td>
<td>watt</td>
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area = unit² (e.g., ft², in², etc.); volume = unit³ (e.g., ft³, m³, etc.)

Prefixes

<table>
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<tbody>
<tr>
<td>d</td>
<td>deci (10⁻¹)</td>
</tr>
<tr>
<td>c</td>
<td>centi (10⁻²)</td>
</tr>
<tr>
<td>m</td>
<td>milli (10⁻³)</td>
</tr>
<tr>
<td>µ</td>
<td>micro (10⁻⁶)</td>
</tr>
<tr>
<td>n</td>
<td>nano (10⁻⁹)</td>
</tr>
<tr>
<td>p</td>
<td>pico (10⁻¹²)</td>
</tr>
<tr>
<td>da</td>
<td>deka (10)</td>
</tr>
<tr>
<td>h</td>
<td>hecto (10²)</td>
</tr>
<tr>
<td>k</td>
<td>kilo (10³)</td>
</tr>
<tr>
<td>M</td>
<td>mega (10⁶)</td>
</tr>
<tr>
<td>G</td>
<td>giga (10⁹)</td>
</tr>
<tr>
<td>T</td>
<td>tera (10¹²)</td>
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Common Conversions

<table>
<thead>
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<th>Equivalent</th>
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<tr>
<td>0.30480 m = 1 ft</td>
<td>4.448222 N = 1 lbf</td>
</tr>
<tr>
<td>2.54 cm = 1 in</td>
<td>1.355818 J = 1 ft-lbf</td>
</tr>
<tr>
<td>0.4535924 kg = 1 lb</td>
<td>0.1129848 N.m = 1 lbf.in</td>
</tr>
<tr>
<td>0.06479891 g = 1 gr</td>
<td>14.59390 N/m = 1 lbf/ft</td>
</tr>
<tr>
<td>0.9463529 L = 1 qt</td>
<td>6894.757 Pa = 1 lbf/in²</td>
</tr>
<tr>
<td>3,600,000 J = 1 kW-h</td>
<td>1.609344 km/h = 1 mph</td>
</tr>
</tbody>
</table>
1. **Scope, Purpose and Application**

1.1 **Scope**

1.1.1 This document is a voluntary standard. All requirements stated in this standard, including those that explicitly employ mandatory language (e.g., “shall”) are those necessary to satisfy the standard. Nothing in this document is intended to require or imply that a commercially available vehicular digital multimedia evidence recording system (VDMERS) for use by law enforcement must satisfy this standard. In order for a manufacturer or other entity to claim that a particular VDMERS model satisfies this NIJ standard, however, the model must be found to comply with this standard as determined in accordance with this document and the associated document, *Law Enforcement VDMERS Certification Program Requirements*, NIJ CR-xxxx.00.

1.1.2 This standard specifies the minimum requirements for form and fit, performance, testing, documentation and labeling of VDMERS models used by law enforcement officers for recording events occurring in and around a law enforcement vehicle. (A VDMERS may also be referred to as a system within this document.)

1.1.3 This standard specifies requirements for new, unused systems.

1.1.4 The form and fit requirements and performance requirements of this standard shall be met for a complete base unit. If any of the components (e.g., laptop computer) of the base unit are not dedicated exclusively to supporting the functionality of the system, the ability of the component to share resources is not addressed under the scope of this standard.

1.1.5 Any optional accessories are not required to meet the form and fit requirements and performance requirements of this standard. The VDMERS manufacturer shall provide written documentation identifying optional accessories.

1.1.6 This standard does not address requirements for active or archival storage.

1.1.7 This standard shall not be understood as addressing all safety concerns associated with the use of systems. Users of this standard should be aware of all safety issues associated with their use. User information related to these issues is provided in the *Law Enforcement VDMERS Selection and Application Guide*, NIJ Guide-xxxx.00.

1.1.8 This standard shall not be understood as addressing the safety concerns (if any) associated with its use by testing facilities.

1.1.9 No manufacturer or other entity shall claim compliance with only selected portions of this standard. The VDMERS model shall meet all applicable stated requirements.

1.1.10 Nothing herein shall be understood to restrict any VDMERS manufacturer from exceeding the requirements of this standard.
1.1.11 As appropriate (e.g., for models that employ materials or forms of construction not anticipated when this standard was developed or are not addressed by this standard), NIJ may modify the test methods of the standard or establish new ones.

1.2 Purpose

1.2.1 The purpose of this NIJ standard is to specify a minimum level of performance for systems to enhance officer safety and the effectiveness of audio/video evidence.

1.2.2 The standard identifies test methods for verifying the minimum performance requirements are met.

1.2.3 The purpose of the test methods in this standard is to assess performance, and the test methods shall not be understood to specify performance levels for all situations in which systems may be used.

1.3 Application

1.3.1 This standard applies to systems that record video from at least two cameras and audio from at least two microphones.

1.3.2 This standard does not address performance classifications or levels of systems.

1.4 Units

1.4.1 All measurement units used in this document are metric. Where useful, English units are indicated in parentheses immediately following the metric units, such as “2.54 cm (one in).”
2. References

2.1 Associated Publications


2.2 Referenced Publications

The following references form a basis and provide support for the requirements and procedures described in this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies, including any amendments.

2.2.1 Federal Rules of Evidence


2.2.2 International Association of Chiefs of Police


2.2.3 International Electrotechnical Commission


2.2.4 International Organization for Standardization (ISO)

2.2.5 **National Institute of Justice**


2.2.6 **National Institute of Standards and Technology (NIST)**


2.2.7 **Society of Automotive Engineers (SAE)**

SAE J1113/1. *Electromagnetic Compatibility Procedures and Limits for Components of Vehicles, Boats (up to 15 m) and Machines, Except Aircraft*. October 2006. Warrendale, PA: Society of Automotive Engineers.


2.2.8 **Underwriters Laboratories Inc. (UL)**


2.2.9 **Other Publications**


CISPR 25

MIL-HDBK 217F
3. Definitions

3.1 General

3.1.1 The definitions contained in this chapter shall apply to these terms as used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings, unless the context unmistakably indicates otherwise.

3.2 Standard-Specific Definitions

3.2.1 Accessory: Any VDMERS manufacturer-offered item or software that may be used with the system but is not part of the base unit.

3.2.2 Accuracy: How close a measured value is to the true value or an established standard.

3.2.3 Active Mode: An operating condition of the remote wireless microphone and transmitter when it is transmitting audio data.

3.2.4 Active Storage: A location or device (e.g., server) to which Digital Multimedia Evidence (DME) is exported from the in-vehicle recorder using any method.

3.2.5 Archival Storage: A location or device to which DME is moved after a designated amount of time and where it resides for an extended period of time.\(^A\)

3.2.6 Audio Monitor: Device for listening to live and recorded audio.

3.2.7 Authentication: The process of affirming that the data fairly and accurately represents what it purports to show (see FRE Rule 901).

3.2.8 Base unit: The minimum set of hardware and software components of a model that are defined by the VDMERS manufacturer as necessary to meet the requirements of this standard.

3.2.9 Bit: The smallest amount of digital information. A bit is restricted to being either a one or a zero.

3.2.10 Capture: The process of producing or recording the DME from a natural event.\(^A\)

3.2.11 Circle of Blur: A grayish circle formed at the center of a star-type test target when it is photographed or recorded using a camera; the center portion of the star where the details are not resolved but are blurred together. (See 3.2.64, Star-Type Test Target)

3.2.12 Codec: A device/program capable of encoding and/or decoding digital data. Codecs encode a stream or signal for transmission, storage or encryption, and decode it for viewing and listening.\(^A\)
3.2.13 **Compliant:** The condition of a VDMERS model meeting or exceeding all applicable requirements of this standard, as determined pursuant and subject to the *Law Enforcement VDMERS Certification Program Requirements* (NIJ CR-xxxx.00).

3.2.14 **Component:** Any material, part or subassembly used in construction of a VDMERS.

3.2.15 **Compression:** The reduction of data used to represent DME.

3.2.16 **Correlated Color Temperature:** Characterization of a light source in terms of the temperature of a theoretical blackbody radiator that would have a color (spectral energy density) that most closely resembles that of the illuminating source.

3.2.17 **Data File:** A set of binary information representing DME.\(^A\)

3.2.18 **Date/Time Stamping:** A software feature that automatically inserts the current date/time into the data file.\(^A\)

3.2.19 **Default Settings:** Controls and settings established by the VDMERS manufacturer prior to delivery of a VDMERS (e.g., factory settings).

3.2.20 **Digital Image:** A picture represented by discrete numerical values organized in a two-dimensional array or video stream.

3.2.21 **Digital Multimedia Evidence (DME):** Data representing audio essence, video essence, metadata and any other information attached to a digital file.\(^A\) DME may be classified as follows:

3.2.21.1 **Compressed DME:** Data that has been transcoded from the original DME in an industry standard file format and resulting in a reduced amount of data required to represent the original data set.

3.2.21.2 **Original DME:** Data recorded and retrieved to media in its native file format (i.e., first usable form).

3.2.21.3 **Uncompressed DME:** A copy of the original DME with no further compression or loss of information that is in an industry standard file format.

3.2.22 **DME Audit Log on the Active Storage:** A National Information Exchange Model (NIEM)-compliant list of all import/export activities, including dates and times, type, affected files and hashes of affected files, which is used to provide integrity of files and detect tampering of said files.

3.2.23 **Digital Recorder:** Any device used to record DME.

3.2.24 **Digital Recording:** The storage of a stream of information as discrete bits.

3.2.25 **Display:** Synonymous with *video monitor*.

3.2.26 **Download:** The process of receiving data from another digital source.\(^A\)
3.2.27 **Duplicate**: An acceptably accurate and complete reproduction of all data objects independent of the physical media.

3.2.28 **Encryption**: The process of coding data so that a specific code or key is required to restore the original data.

3.2.29 **Essence**: Sound and/or picture information, not including metadata.

3.2.30 **Export**: To copy or move information from within a device or system to a physical or logical location outside that device or system.

3.2.31 **Field of View (FOV)**: The horizontal angular extent of a scene imaged by the video camera. FOV depends on the focal length of the camera lens and the size of the camera’s imager chip.

3.2.32 **Format**: The specific structure for the data in a file.

3.2.33 **Hash function**: A mathematical formula that generates a unique number based on the data in a file. Used to verify the data’s integrity.

3.2.34 **Illuminance**: A photometric quantity that expresses the luminous flux (i.e., the light level in lumens) per unit area. Measured in lumens per m² (also called lux).

3.2.35 **Industry Standard File Formats**: Formats that are viewable and playable without the need for proprietary codecs, players or viewers available only from the VDMERS manufacturer.

3.2.36 **Import**: To bring information from one system or program into another.

3.2.37 **Integrity**: (1) The reliability and accuracy of DME throughout its lifecycle. (2) The degree to which a system or component prevents degradation of, unauthorized access to or modification of DME.

3.2.38 **Interoperability**: The sharing of uncompressed and compressed DME among law enforcement agencies in an industry standard file format.

3.2.39 **Manufacturer**: A commercial enterprise engaged in fabricating a product.

3.2.40 **Metadata**: Data embedded within or associated with a file that describes information about, or related to, the file or its directory. This may include, but is not limited to, locations where the content is stored, dates, times, application-specific information and permissions. It is data about data.

3.2.41 **Model**: The manufacturer’s design, with unique specifications and characteristics, of a particular item.

3.2.42 **Modulation**: The ratio of the highest brightness portions of interest in a digital image to the lowest brightness portions of interest.
3.2.43 **National Information Exchange Model (NIEM):** A federal, state, local and tribal interagency initiative providing a foundation for seamless information exchange; an XML-based information exchange framework and reference model designed as a core set of building blocks used as a consistent baseline for creating exchange documents and transactions across government.

3.2.44 **Native File Format:** The original form of a file. This usually refers to a file format associated with, and unique to, a specific software application program. \(^A\)

3.2.45 **Network Topology:** Graphical representation of the arrangement of a network. \(^A\)

3.2.46 **Passive Mode:** An operating condition of the remote wireless microphone and transmitter when paired with the rest of the base unit but not transmitting audio data.

3.2.47 **Pixel:** A picture element. \(^A\)

3.2.48 **Primary Camera:** Camera and lens assembly intended to be forward facing when installed.

3.2.49 **Primary Microphone:** Wireless microphone, transmitter, battery and accessories (e.g., cords) intended to be worn by an officer.

3.2.50 **Product:** One unit of a particular model.

3.2.51 **Product Label:** A marking affixed by a manufacturer to each unit of a compliant model or to the compliant model package that contains required model information and the mark of conformity.

3.2.52 **Proprietary:** A characteristic of a technique, technology or device owned and controlled by a company or other party and thereby only usable or adaptable as allowed by that party. \(^A\)

3.2.53 **Record:** Process of writing DME to recording media.

3.2.54 **Recording Media:** Any object to which DME is written and can be retrieved.

3.2.54.1 **Non-Removable Recording Media:** Any data storage housed within a device that cannot be removed from said device without its disassembly.

3.2.54.2 **Removable Recording Media:** Any portable data storage device designed for removal from a system without disassembly of the system or the storage device.

3.2.55 **Reliability:** The extent to which a process can repeatedly produce the same effective output, with a central tendency and an acceptable dispersion, for consistent input settings. Information from such a system is said to be *reliable.*

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\(^1\) Refer to http://www.NIEM.gov.
3.2.56 **Resolution:** Measure of the output quality of an image; capability of distinguishing between two adjacent elements of an image such as lines (referred to as *spatial resolution*) or pixels (referred to as *pixel resolution*).

3.2.57 **Sample:** A base unit to be subjected to conditioning procedures as specified in this standard in preparation for subsequent testing. A sample is representative of a model.

3.2.58 **Secondary Camera:** Camera and lens assembly intended to be rear facing (i.e., to capture activities of the interior of the vehicle) when installed.

3.2.59 **Secondary Microphone:** A microphone intended to be installed within the passenger compartment of a law enforcement vehicle.

3.2.60 **Sensitometer:** A device to measure the response function of a photographic system.

3.2.61 **Shall:** Indicates a mandatory requirement for the purposes of this voluntary standard.

3.2.62 **Should:** Indicates a recommendation that is advised, but not required, for the purposes of this voluntary standard.

3.2.63 **Specimen:** (1) A piece or portion of a sample to be tested (following conditioning as specified in this standard) that is representative of the whole sample. (2) A complete sample to be tested (following conditioning as specified in this standard).

3.2.64 **Star-Type Test Target:** A pattern consisting of a series of thin triangles arranged in a circle, something like an asterisk. Alternating triangles are a dark color, usually black. Adjacent to these triangles are congruent triangle that are lighter in color, usually white. The dark and light triangles are arranged in a circle with the points all meeting in the center. (Refer to Appendix A, Figure 1.)

3.2.65 **Step Tablet:** A test target comprised of a series of progressively darker areas on either a reflective or a transparent substrate.

3.2.66 **System Audit Log:** A list of events used to track system events, such as bootup, diagnostic failures or status changes. (The DME Audit Log and System Audit Log are separate lists.)

3.2.67 **Transcoding:** The conversion of DME from one data file format to another.

3.2.68 **Vehicular DME Recording System (VDMERS):** System for recording DME to document events in and around a law enforcement vehicle. The system consists of a base unit and may or may not include accessories.

3.2.69 **VDMERS Manufacturer:** Supplier of a VDMERS who submits a VDMERS model for certification.
3.2.70 **Verification**: The process of confirming the accuracy of any copy of the DME compared to the original DME. This process normally includes the application of a type of hash function.

3.2.71 **Video Monitor**: Device for viewing live and recorded video.
4. **Form and Fit Requirements**

To be tested under the performance requirements of this standard, VDMERS models shall satisfy the requirements of this chapter.

4.1 **VDMERS Model Requirements**

4.1.1 VDMERS models shall meet or exceed the applicable requirements specified in this section.

4.1.2 The system shall consist of one primary camera, one secondary camera, one primary microphone (wireless), at least one secondary microphone (wired), a digital recorder, a video monitor and an audio monitor. The video monitor and audio monitor may be combined into a single video/audio monitor.

4.1.3 The system shall have the option to incorporate at least one additional wireless microphone. Such additional wireless microphones shall meet the requirements of the primary microphone.

4.1.4 The system shall have the capability of recording DME in digital file format to recording media and electronically exporting the DME.

4.1.5 The system shall be capable of recording a minimum of two video streams and a minimum of three synchronized audio streams, and the associated metadata.

4.1.6 The system shall be capable of allowing the user to input specific information required for the DME Audit Log and System Audit Log (refer to Sections 5.5.1.20 and 5.5.1.22).

4.1.6.1 The in-vehicle recording media shall be secured using a mechanism that prevents unauthorized removal of the media from the recorder.

4.1.6.2 If in-vehicle non-removable recording media is being used, it shall be housed inside the recorder to prevent tampering with, and/or destruction of, the media.

4.1.6.3 In-vehicle removable media shall contain the following items and markings:

- Tamper detection process.
- Damage protection.
- Exterior marking to include an identifying number (or markings) that identify each media and makes that media unique.

4.2 **Microphone Requirements for VDMERS Models**

4.2.1 Microphones shall meet or exceed the applicable requirements specified in this section.
4.2.2 The system shall incorporate as the primary microphone a remote wireless microphone and transmitter in a device to be worn by an officer.

4.2.3 The primary microphone shall contain an integrated antenna.\textsuperscript{A}

4.2.4 The primary microphone shall contain a memory-free rechargeable battery that may be replaced by the end user with commonly accessible tools.

4.2.5 The system shall incorporate, as the secondary microphone, a wired microphone intended to be mounted in the vehicle.

4.3 \textbf{Video and Audio Monitor Requirements for VDMERS Models}

4.3.1 Video and audio monitors shall meet or exceed the applicable requirements specified in this section.

4.3.2 The video monitor shall have a viewing screen with a diagonal of at least three in and shall be able to display color.\textsuperscript{A}
5. **Performance Requirements**

5.1 **Performance Requirements for VDMERS Models**

5.1.1 To declare conformity of a VDMERS model against this standard, all performance requirements defined in the following sections shall be met for each of the categories listed below:

- Camera features.
- Microphone.
- System functions.
- System operations.
- Interoperability.
- Security.
- Mechanical safety.
- Electrical safety.
- Electromagnetic compatibility.
- Environment.

5.1.2 All performance requirements are system-level requirements for a complete base unit of a model.

5.1.3 The system performance shall be evaluated by the test methods referenced within this section or as described in Section 1. All tests identified in Section 1 shall include the requirements of Section 6.1.

5.1.4 No specific test sequence is required, but the sequence indicated in the requirements list above is recommended.

5.2 **Camera Feature Requirements for VDMERS Models**

5.2.1 The system shall be tested as specified in Section 6.2 Camera Features Tests and shall meet the requirements below:

5.2.1.1 The cameras shall be switchable between autofocus and manual focus. The cameras shall default to autofocus on system startup.

5.2.1.2 The primary camera shall be able to provide a focused image with an FOV of 40 degrees horizontally.

5.2.1.3 The secondary camera shall be able to provide a focused image with an FOV of 50 in at an object distance of 30 in.
The primary camera shall be capable of being rotated 180 degrees on its mount in a horizontal plane or 90 degrees in either direction from its front-facing position, using only one hand. The camera position shall not shift without intentional intervention from the operator.

The secondary camera shall be capable of operation in low light. If the camera is operating in the near-infrared region, the requirements of Sections 5.2.2 and 5.2.3 shall not apply.

The cameras shall be tested for autoexposure as part of Section 6.3 Dynamic Range Measurement Test and shall function as specified by the VDMERS manufacturer.

The cameras shall be tested for automatic white balance as part of Section 6.4 Color Fidelity Test and shall function as specified by the VDMERS manufacturer.

Microphone Requirements for VDMERS Models

The system shall be tested as specified in Section 6.5 Wireless Microphone Battery Life and shall demonstrate a minimum battery life of 15 h in the passive mode and 3.5 h in active mode.\(^5\)

The system shall be tested as specified in Section 6.6 Wireless Microphone and Transmitter Assembly Test and each wireless microphone and transmitter assembly shall meet the requirements below:

The wireless microphone and transmitter assembly shall transmit within FCC-approved frequency bands.

The wireless microphone and transmitter assembly shall be capable of transmitting intelligible audio to the vehicle-mounted recorder and monitor at a range of 1,000 feet, line of sight, under unobstructed conditions and with no interference.\(^5\)

The remote wireless microphone and transmitter assembly shall be able to activate audio and video recording from the remote transmitter.\(^5\)

The system shall be tested as specified in Section 6.7 Microphone Test and all microphones shall be capable of capturing sounds greater than or equal to 50 dB sound pressure level at a distance of one m within the frequency range of 300 to 3,000 Hz to the minus six dB points.

System Functional Requirements for VDMERS Models

The system shall demonstrate the following system functional requirements when tested as specified below. These system functional requirements shall not apply if the camera is operating in the near-infrared portion of the electromagnetic spectrum.
5.4.2 The system shall be tested as specified in Section 6.3 Dynamic Range Measurement Test and shall have a range of 2.0 log exposure or more. 

5.4.3 The system shall be tested as specified in Section 6.8 Spatial Resolution Test and shall be capable of resolving bars that represent one-half of a line pair per inch (both lines of equal width, one black and one white) at a frame width of 24 ft. 

5.4.4 The system shall be tested as specified in Section 6.9 Aspect Ratio Test and shall have an aspect ratio that is within 2% of 1:1. 

5.4.5 The system shall be tested as specified in Section 6.4 Color Fidelity Test and shall have a mean squared error of less than 205.

5.4.6 The system shall be tested as specified in Section 6.10 Dynamic Modulation Test and shall meet the following requirements.

5.4.6.1 The relative modulation shall be at least 50% at 15 miles per hour equivalent (mphe) at both high and medium light levels. There shall be no dropped frames. The test shall capture a minimum of 29.97 frames per second and as determined by target motion used in Section 6.10. Each captured frame shall show the target progressing through the frame the expected number of pixels as determined by the target motion used in Section 6.10. 

5.4.6.2 The system shall have the capability of recording DME in digital file format to recording media and electronically exporting the DME. This export capability shall be assessed per Section 6.10.7 of the Dynamic Modulation Test.

5.5 System Operational Requirements for VDMERS Models

5.5.1 The system shall demonstrate the following operational requirements when tested according to Section 6.11 System Operational Test.

5.5.1.1 The system shall be capable of recording a minimum of two video streams, a minimum of three synchronized audio streams and the associated metadata. Synchronization error shall be less than 1/30-second when tested as specified in Section 6.6, Wireless Microphone and Transmitter Assembly Test (comparing audio signal through wireless microphone to the video and metadata).

5.5.1.2 The system shall have an illuminated record indicator for the purpose of indicating to the operator that the system is actively recording while the operator is outside the vehicle, at a distance of up to 35 feet. This indicator light shall be able to be disabled by the operator.

5.5.1.3 The system components shall be capable of being illuminated for ready identification during periods of darkness. The illumination level shall be capable of being controlled over a range from bright to dark. The illumination level shall be set by either a discrete control within the unit itself or by linking to vehicle dash illumination control.
5.5.1.4 Video and audio essence shall continue to be presented on the video and audio monitors during periods when the record function may not be initiated.

5.5.1.5 The video monitor viewing screen light level shall be user adjustable and shall be capable of being turned off independently from the rest of the system.

5.5.1.6 The system shall be capable of monitoring audio transmissions from the wireless microphone(s). The system shall also be capable of playing back previously recorded audio. The system shall contain control(s) to adjust the volume and enable and disable monitoring of audio.

5.5.1.7 Time stamping of DME elements (video essence, audio essence and metadata) shall be consistent within all system components.\(^A\)

5.5.1.8 The system shall have the ability to record and selectively display on the video monitor during playback at least the following data: date/time of DME creation, user identification information, emergency light indication, siren indication, crash indication and system status indicators (video recording on/off, microphone(s) on/off). This data shall be captured for each video frame in the metadata and shall not overwrite image information.

5.5.1.9 The system shall demonstrate proper operation of the following controls\(^A\):
   a) Power on/off.
   b) Play.
   c) Record start.
   d) Fast forward.
   e) Rewind.
   f) Stop.
   g) Pause.

5.5.1.10 The system shall provide the following indicators and displays\(^A\):
   a) System power on.
   b) Microphone on.
   c) Media not inserted or not operational.
   d) Recording.
   e) Fast forward.
   f) Rewind.
   g) Stop.
   h) Record time remaining.
i) Low record time remaining warning to activate when one h of recording time remains.

j) System Audit Log display.

k) DME Audit Log display.

5.5.1.11 The system’s recording functions shall demonstrate activation by any of the following methods:

a) User pushes the “record” button.

b) Activation of the emergency lights and/or sirens.

c) User activates the “record” button on the primary microphone.

5.5.1.12 The system shall incorporate an automatic trigger to stop recording when previously recorded DME will be overwritten.

5.5.1.13 The system will be capable of capturing and recording $30 \pm 0.033$ frames per second.

5.5.1.14 The system shall be capable of recording events uninterrupted for a minimum of 3.5 h at the lowest compression supported by the system.

5.5.1.15 The system shall automatically set the correct time and date following interruption of power.

5.5.1.16 The system shall have the ability of pre-event and post-event DME recording for a minimum of 30 s. The pre-event and post-event DME recording shall meet all requirements of Section 5.4, System Functional Requirements for VDMERS Models.

5.5.1.17 The system shall have the capability of enabling or disabling the pre-event and post-event audio capture capability while continuing to capture the remaining DME items.

5.5.1.18 If the system uses in-vehicle removable recording media, an integrity check shall be used to validate that the DME in the active storage is an exact duplicate of any data on the removable media prior to clearing the data on the removable media.

5.5.1.19 The recording device shall indicate when media is not inserted into the recorder.

5.5.1.20 The system shall be capable of exporting the System Audit Log and the DME Audit Log in a NIEM-compliant format.

5.5.1.21 The DME Audit Log shall contain the following items when the compressed DME export is performed:

a. Identification of person performing the export.

b. Identification of person or system receiving the export.

c. Time and date of the export.
d. Verification check per Section 6.22 shall be performed and logged to validate the DME immediately prior to the compressed DME export.

e. Hash or other verification shall be computed for the exported compressed DME using an industry-standard method and shall be defined and provided with the exported compressed DME.

f. The calculated hash of the exported data should be recorded as part of the audit log, as well as the hash of the original file when the target file format is different.

g. Identification of the source of the DME, including the vehicle identification, CPU, hardware ID, etc.

h. Frame rate.

5.5.1.22 The system shall provide a System Audit Log to record system-level details and events (including the following) at least each time status changes:

a. Date and time of event.

b. GPS location of event.

c. Vehicle identification.

d. Officer identification.

e. Product label information per Section 7.1 of this standard.

f. Recording device identification, including VDMERS manufacturer and model number.

g. Hardware identification, including VDMERS manufacturer and model number.

h. Software version.

i. System status change (e.g., bootup, power on).

j. Component status change indicators (e.g., DVR full, camera failure, component ready).

5.5.1.23 The system shall perform a diagnostic to detect malfunction or loss of functionality of the recorder, camera, displays and microphones. The diagnostic shall be performed on system startup and at least every 60 seconds. Any malfunction or loss of functionality shall be documented in the System Audit Log and indicated to the user immediately.

5.5.1.24 The system recorder clock and active storage system clock shall either maintain synchronization to, or be synchronized periodically with, a known external reference (e.g., U.S. Standard of Time). If synchronization is continually maintained to an external reference, it shall be maintained to that reference within 33 milliseconds. If time clock synchronization is initiated periodically (such as via interface with an archival storage device), the system recorder clock and active storage system clock shall not demonstrate a drift from the external time reference in excess of one second over a 24 h time period.
5.6 Interoperability Requirements for VDMERS Models

5.6.1 The following system interoperability requirements shall be demonstrated when tested according to Section 6.12, Interoperability Tests.

5.6.2 The system shall provide the original DME files. The file shall also include all metadata in an accessible format.

5.6.3 The system shall provide two interoperable formats for export of the DME: uncompressed DME and compressed DME. A The industry standard file formats shall include all metadata.

5.6.4 The uncompressed DME file shall be an exact copy of the original DME.

5.6.5 All export of the original DME shall have an automated verification mechanism. Using a 256-bit or greater Federal Information Processing Standards (FIPS) 140-2-compliant hash algorithm, the resulting hash value shall be attached to the original DME. The automated mechanism shall not introduce any visible or audible artifacts into the DME.

5.6.6 A verification report shall be included with the original DME export stating the calculated value of the DME hash. A

5.7 Security Requirements

5.7.1 The system shall be tested as specified in Section 6.13 Security Test to Demonstrate Restriction of Unauthorized Access and shall demonstrate that the date/time information stored during recording is only accessible to an administrator.

5.7.2 The system shall be tested as specified in Section 6.14 Security Test to Demonstrate Restriction of Unauthorized Access to Vehicle Information and shall demonstrate that the vehicle information is accessible only to an administrator.

5.7.2.1 The system shall be tested as specified in Section 6.15 Security Test to Demonstrate Restriction of Unauthorized Access to Audit Logs and shall demonstrate that the audit logs are accessible only to an administrator.

5.7.2.2 The system shall be tested as specified in Section 6.16 Security Test to Demonstrate Restriction of Unauthorized Clearing/Deleting of the System and DME Audit Logs and shall demonstrate that the audit logs may be cleared/deleted only by an administrator.

5.7.2.3 The system shall be tested as specified in Section 6.17 Security Test to Demonstrate Restriction of Unauthorized Access to Other Programming Functions and shall demonstrate that the configuration information is accessible only to an administrator.

5.7.2.4 The system shall be tested as specified in Section 6.18 Security Test to Demonstrate Restriction of Unauthorized Erasing, Altering and/or Recording over Previously
Recorded DME and shall demonstrate that the DME cannot be altered or destroyed by anyone other than an administrator.

5.7.2.5 For systems incorporating encrypted line wired and wireless security, evidence of a certificate of compliance for the validation of encryption algorithms (e.g., FIPS 197 or 46-3) or validation of security requirements for cryptographic modules (for example, FIPS 140-2) shall be provided. The system shall use 128-bit or greater encryption algorithms. The encryption would be level 2 or greater because it provides a built-in mechanism that can be used to detect tampering; hence, the transmission is secure from that aspect.

5.8 Mechanical Safety Requirements

5.8.1 The system shall be designed such that exposed edges and corners accessible to the test finger per figure 2A of IEC 60950-1, second edition, have a minimum 3.2mm (1/8-in) radius or chamfer or be padded with an energy-absorbing material to minimize the risk of injury.

5.9 Electrical Safety Requirements for VDMERS Models

5.9.1 The system shall comply with safety requirements as specified in IEC 60065-7:2001, Audio, Video and Similar Electronic Apparatus – Safety Requirements.

5.9.2 The system shall comply with safety requirements as specified in IEC 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements, second edition, including revisions through March 27, 2007.

5.9.3 Each system primary and secondary battery shall be tested in accordance with UL 1642, Lithium Batteries and/or UL 2054, Household and Commercial Batteries.

5.9.4 The system shall be tested as specified in Section 6.19 Electrical System Safety Tests and shall meet the requirements identified within the test method.

5.10 Electromagnetic Compatibility Requirements for VDMERS Models

5.10.1 The systems shall be tested as specified in Section 6.20 EMC Tests and shall meet the requirements of SAE J1113-1:2006, Electromagnetic Compatibility Procedures and Limits for Components of Vehicles, Boats (up to 15 m) and Machines, Except Aircraft.

2 The transmission stream that contains the DME shall also contain a separate hash (as described above) so that once the file is written to a storage medium such as a hard disk, tampering can be detected. This means that the transmission of the DME will also contain a DME audit record that contains the source and target hashes when possible. In cases where the camera provides a video feed directly to a PC, the program that encodes and stores the video must provide an algorithm that can be used to detect missing and/or tampered frames of video and the detection of disruption within any of the audio streams.
5.11 **Environmental Requirements for VDMERS Models**

5.11.1 The system shall be tested as specified in Section 6.21 Environmental Tests and shall meet the requirements below.

5.11.1.1 When subjected to the high and low temperature exposures, the system’s video monitor shall function properly, there shall be no missing DME data capture and there shall be no external system damage.

5.11.1.2 When subjected to the humidity exposure, the system’s video monitor shall function properly and there shall be no missing DME data capture.

5.11.1.3 When subjected to the mechanical vibration exposure, the system’s video monitor shall function properly, there shall be no missing DME data capture and there shall be no change in frame width greater than 10%.

5.11.1.4 When subjected to the mechanical shock exposure, the system’s video monitor shall function properly and there shall be no missing DME data capture.

5.11.2 The system shall comply with environmental requirements as specified in SAE J1455, *Recommended Environmental Practices for Electronic Equipment Designed in Heavy Duty Vehicle Applications*, June 2006.
6. Test Methods

6.1 General

6.1.1 Typically, the performance requirement pass/fail criteria shall be as stated in Chapter 5 Performance Requirements; however, in some cases, the pass/fail criteria are stated within the test method.

6.1.2 Samples

6.1.2.1 Each test shall be performed on one sample base unit representative of the model unless otherwise specified within the individual test procedure. A complete base unit consists of all components required for evaluation of the model.

6.1.2.2 All tests shall be conducted with the digital recorder set at a recording rate of 29.97 frames per second (FPS) at the highest compression setting specified by the VDMERS manufacturer for that model. Settings shall not be adjusted between tests for a single model.

6.1.3 Unless the performance requirement is specifically stated as an average result, any individual sample result’s not meeting the performance requirement shall constitute failing performance.

6.1.4 Unless specified otherwise within a test procedure, the primary camera shall be used in evaluation of the system.

6.1.5 All test data and observations shall be recorded and reported, including make, model, special settings and accessories tested.

6.1.6 All tests related to image quality shall be performed on both uncompressed DME and original DME.

6.1.7 The system shall be set up and operated according to the VDMERS manufacturer’s instructions.

6.1.8 In order to declare conformity for a particular model, the model must successfully complete all applicable tests within Chapter 6.

6.2 Camera Features Tests

6.2.1 Samples

6.2.1.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.2.1.2 All system controls and adjustment settings shall be documented and considered as part of the model designation.
6.2.1.3 Testing shall be conducted at ambient conditions within the temperature range of 16° C to 27° C (60° F to 80° F) and 20% to 60% rh.\textsuperscript{A}

6.2.2 Test Target

6.2.2.1 A star-type test target shall be used for the camera features tests. Refer to Appendix A, Figure 1 for a figure representing a star-type test target.

6.2.3 Initial Conditions

6.2.3.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image or lighting as specified in the specific test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.2.3.2 The test target shall be illuminated with 200 to 500 lux at a correlated color temperature of 2,800 to 3,200 K.

6.2.4 Procedure

6.2.4.1 Auto/Manual focus: The camera shall be tested to ensure that both the automatic and manual focus adjustments perform their respective functions. The camera shall be affixed to a stable mount, such as a tripod. The camera shall be verified to be operating properly by noting a video image on the display. The focus shall be set to autofocus. The test target shall be placed approximately six m (20 ft) from the camera. Recording shall be initiated for five to 10 s and then stopped. The focus shall be set to manual focus. Recording shall be performed while the focus is manually adjusted slowly; recording shall then be stopped. This process shall be repeated at a distance of two m (6.6 ft) between the camera and the test target. When the recorded video is played back, the circle of blur around the center of the test pattern shall be nominally the same for both the autofocus setting and the best setting of the manual focus adjustment series. During the manual focus testing, the size of the blur circle should change as the focus is changed. Best focus corresponds to the smallest blur circle. The circle of blur will not be the same for both distance settings. Document the results.

6.2.4.2 Primary Camera FOV: The camera shall be tested to ensure that the FOV and the focus ranges are capable of both proper operation at (1) object distance of 10.7 m (35 ft) and frame width of 7.3 m (24 ft) and (2) object distance of 76 cm (30 in) and frame width of 127 cm (50 in). The camera shall be affixed to a stable mount, such as a tripod. Ensure the camera is operating properly by noting a video image on the display. Place a test target, identified as the primary test target, at approximately 10.7 m (35 ft) from the camera such that the optical axis of the camera is nominally perpendicular to the surface of the primary test target. Place two additional test targets, one on either side of the primary test target and each separated from the primary target by approximately 3.7 m (12 ft), parallel to and in the plane of the primary test target. Adjust the lens to the normal frame width setting, 7.3 m ± 0.3m
(24 ft ± 12 in). Initiate recording and record for 10 seconds. Change the primary test target distance to approximately 76 cm (30 in) from the camera and place the additional test targets, one on either side of the primary test target and separated from the primary test target by approximately 127 cm (50 in). Record for at least 10 seconds and stop recording. Evaluate the recorded video to determine if all three test targets are visible in the video. Document the results.

6.2.4.3 Secondary Camera Low-Light Operation: The camera shall be tested to ensure that the camera is capable of low-light operation as available light decreases. The camera shall be affixed to a stable mount such as a tripod and a test target shall be placed in the view of the camera at a distance of 76 cm (30 in.). Adjust the lens so that the image is in focus if necessary. Ensure the camera is operating properly by noting a focused image on the display. Initiate recording and record at least 10 seconds of video. Adjust illumination of the test target to 0.1 lux and record for at least 10 seconds. Stop recording. Evaluate the recorded image and note that the visible image was obtained at the low light level. Document the results and observations.

6.2.4.4 Secondary Camera FOV: The camera shall be affixed to a stable mount, such as a tripod. Ensure the camera is operating properly by noting a video image on the display. At a distance of 76 cm (30 in.) from the camera, place a test target in the center of the image such that the optical axis of the camera is nominally perpendicular to the surface of the test target. From the center point, place an indicator at 64 cm (25 in) on each side of the center point. Adjust the lens so that the image is in focus. Initiate recording. Reposition the test target such that the far edge is at one of the indicators 64 cm to one side of the center point. Reposition the test target such that the far edge is at the indicator 64 cm to the other side of the center point. Stop recording. Evaluate the recorded video to determine if the entire test target is visible and in focus in the recorded video. Document the results and observations.

6.2.4.5 Test for Primary Camera Rotation. The camera on its mount shall be tested to ensure that it can turn at least 90° to both the left and the right sides of forward. Use a test platform that emulates the mounting location and procedures for a vehicle. Attach the camera to the test platform so that when the camera rotation angle is nominally at 0°, the camera is facing forward. Rotate the camera approximately 90° from this position and document any restrictions to this motion. Rotate the camera 180° from this last position and document any restrictions to this motion.

6.2.5 Report

6.2.5.1 Each trial result shall be documented and reported. The report shall document the camera make and model and all system settings at the time of testing.
6.2.6 Interpretation

6.2.6.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.3 **Dynamic Range Measurement Test**

6.3.1 The purpose of this test is to determine the degree to which the system under test will be able to record both light and dark contents in scenes. A

6.3.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.3.3 Initial Conditions

6.3.3.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. Nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.3.4 Procedure

6.3.4.1 Record several seconds of video of a step tablet, illuminated in a sensitometer, with a brightness range of 10,000 to one. A Use a step tablet approximately seven cm (2.8 in) by 20 cm (7.9 in) with at least 41 steps approximately one cm (0.4 in) wide and of increasingly darker increments of 0.1 transmission optical density per step starting at transmission optical density of nominally 0.05. Allow the camera to use its internal auto exposure and white balance functions.

6.3.4.2 The correlated color temperature of the light should be nominally 2,800 K to 3,200 K. A

6.3.4.3 Select any three frames from the recorded video from Section 6.3.4.1 as per the process provided by the system vendor and open the frames in professional editing software.

6.3.4.4 Using a sampling tool that can provide a brightness value for at least five contiguous pixels, measure the red, green and blue brightness values of each of the steps in each of the three randomly selected frames. A Compute the average for each step across the frames.

6.3.4.5 Using the data for the sensitometer, plot the brightness values for each color band for each optical density step of the step tablet as a function of its log (base 10) exposure value, A where exposure is in lux-s on the camera sensor but measured in cd/m² as seen by the camera lens and the camera shutter controls the number of seconds. Absolute values are less important than relative values since the camera will use its auto exposure function.
Determine the point on the log exposure axis at which the response curve becomes nominally flat with increasing exposure (decreased transmission optical density values on the step tablet). The curve becomes nominally flat at this point due to saturation of the camera and is called the *saturation point*.\textsuperscript{A} 

Determine the point on the log exposure axis of the response curve where the brightness value is approximately twice that of the noise. This is the *threshold point*.\textsuperscript{A} The noise value is determined by the nominally flat region of the response curve for small exposure (large transmission optical density values on the step tablet). 

Subtract the threshold point value from the saturation point value. This is the *dynamic range* in terms of log exposure. \textsuperscript{A} (See Appendix A, Figure 2.) 

Report 

Each trial result shall be documented and reported. 

Observations regarding functioning per VDMERS manufacturer specifications shall be documented and reported. 

Interpretation 

This task is evaluated on a pass/fail basis. Each sample shall meet the requirements of Chapter 5 in order for the final result to be considered a pass. 

**Color Fidelity Test** 

The purpose of this test is to determine the degree to which the system under test can capture colors accurately so that color can be reliably used to track activity of objects and persons during analyses of recorded video. \textsuperscript{A} 

A complete base unit with all components required for evaluation shall be used as the sample. 

Initial Conditions 

The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on. 

Procedure 

Record 30 to 60 frames of video of a Macbeth Corporation Color Checker\textsuperscript{TM}. The light should be illuminated by a source with a correlated color temperature of 5,000 to 6,000 K and between 300 and 400 lux illuminance.\textsuperscript{A}
Among its many uniform patches, the target (MacBeth Corpt. Color Checker™) has patches of the primary colors (red, green, blue, cyan, magenta and yellow) and six shades of gray. Only 12 patches will be used.

Determine the three CIELAB (Refer to CIE No. 15.2) dimensions for each patch in the test target and document for later comparison to values taken from captured video.

Select three frames at random from the video acquired in Section 6.3.4.1 and open them using professional editing software. Measure the three CIELAB dimensions for each patch using a sampling tool with a sampling size of at least five x five average.

Subtract the measured image CIELAB values from the respective target patch CIELAB values (see 6.10.2.2) for all 12 patches.

Square the individual differences of the CIELAB values and sum them.

Divide the previous result by 36 (the number of values), which gives the CIELAB mean squared error.

The Commission Internationale d’Eclairage (CIE) is an organization that in 1931 published a color space definition that was supposed to represent how humans see color. This was revised in 1976 to provide a more accurate representation. The new space is referred to as CIE 1976 (L*, a*, b*) color space, or more briefly as CIE/L*a*b*, or CIELAB. The L dimension gives the lightness of a color and runs from black through shades of gray to white. The “a” and “b” dimensions are mathematical constructions and give the hue and saturation of a particular color. All three dimensions are mathematically independent of each other.

Each trial result shall be documented and reported.

Observations regarding functioning per VDMERS manufacturer specifications shall be documented and reported.

This task is evaluated on a pass/fail basis. Each sample shall meet the requirements of Chapter 5 in order for the final result to be considered a pass.

A complete base unit with all components required for evaluation shall be used as the sample.
6.5.2 This test shall be performed with all microphones installed in the VDMERS and operating per the instructions below. Each wireless microphone and transmitter assembly shall be tested while all microphones are operational.

6.5.3 Initial Conditions

6.5.3.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.5.4 Procedure

6.5.4.1 Install in the wireless microphone and transmitter assembly new or fully charged batteries of the type specified by the VDMERS manufacturer. Turn the microphone on in the passive mode and allow it to remain on for a continuous 15 h ± 10 min period at a temperature between 19 °C and 23 °C (66 °F and 73 °F). Within the last 30 minutes of this period and without changing the batteries, test the microphone by performing the Microphone Test specified in Section 6.7.

6.5.4.2 Install in the wireless microphone and transmitter assembly new or fully charged batteries of the type specified by the VDMERS manufacturer. Turn the microphone on in the active mode and allow it to remain on for a continuous 3.5 h ± 10 min period at a temperature between 19 °C and 23 °C (66 °F and 73 °F). Within the last 30 minutes of this period and without changing the batteries, test the microphone by performing the Microphone Test specified in Section 6.7.

6.5.5 Report

6.5.5.1 Each trial result for each wireless microphone and transmitter assembly shall be documented and reported.

6.5.6 Interpretation

6.5.6.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.6 Wireless Microphone and Transmitter Assembly Test

6.6.1 The purpose of this test is to assess the following:

- Remote wireless microphone and transmitter assembly ability to activate audio and video recording from the remote.
- Audio, video and metadata synchronization.
- Audio system ability to deliver intelligible audio when the microphone is transmitting to the receiver at a distance of 1,000 feet.\textsuperscript{A}
6.6.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.6.3 Test Equipment

6.6.3.1 The following test equipment is required: CD of *Modified Rhyme Test With Babble* (Cosmos Dist. Inc.) or equivalent, audio stereo CD player (with capability of playing two tracks simultaneously), two matched microphones (one for reference and one for detecting signal from audio monitor), audio oscillator, oscilloscope, frequency independent delay line, audio signal inverter, signal mixer, true RMS voltmeter, 1,000-ft. three-conductor shielded microphone cable, laptop, high-quality headphones and answer sheets.

6.6.4 Initial Conditions and Set Up

6.6.4.1 The base unit shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.6.4.2 Connect the equipment as shown in the Microphone to Receiver Test Schematic provided in Appendix A, Figure 6. Items specified below are indicated in the figure.

6.6.4.3 Fix items 1, 2 and 3 so that they can be moved together without changing their relative positioning. Item 11 shall be positioned with items 1, 2 and 3. Connect item 11 to item 1 as an auxiliary input.

6.6.4.4 Place the sound source equipment (items 1, 2, 3 and 11) approximately 50 feet from the receiver (item 4). Connect 1,000 feet of microphone cable between item 3 and item 7, draping the cable in a sinusoidal pattern as opposed to leaving it on a coil to minimize any inductance effects.

6.6.4.5 Turn on the wireless microphone. Determine whether activation of the wireless microphone activates the digital recorder.

6.6.4.6 Send a sine wave from item 11 to item 1 at approximately 440 Hertz (A above middle C) and set the volume controls to ensure that there is no clipping visible on the oscilloscope (item 9) when sent from item 3 to item 6 through the reference channel.

6.6.4.7 Check the device under test (DUT) channel from item 2 to item 6 and readjust volume levels to ensure strong signal with minimal clipping.

6.6.4.8 Adjust the delay line (item 12) and the mixer gain on the reference track such that the oscilloscope indicates that the DUT channel and the reference channel signals are in phase.

6.6.4.9 Adjust the mixer gains for both channels so that they are close to the same level. Invert the reference channel polarity (item 7) and further adjust the gain controls to
minimize the now cancelled out signals. Using the meter (item 8), check to see that the polarity reversal reduces the signal by a factor of at least 8:1 (linear voltage).

6.6.4.10 Document the settings and do not change them.

6.6.4.11 Record audio and video of activation of a clapboard (for determining audio, video and metadata synchronization).

6.6.4.12 Place items 1, 2 and 3 a distance of 1,000 feet from item 4 with a nominally clear, line-of-sight pathway. There should be no large metallic structures (bridges, large overhead signs, marquees, etc.).

6.6.5 Intelligibility Procedure

6.6.5.1 Play the Intelligibility CD rhyming speech plus babble tracks and record at least 50 words simultaneously to the base unit digital recorder and the laptop, starting at some random point on the answer sheets. Repeat and record the reference signal channel.

6.6.5.2 Using the A above C frequency and the polarity switch, note the degree of cancellation.

6.6.5.3 Adjust the speech and babble track volume levels such that the combination is three db (sound pressure level) above the babble alone. Play the Intelligibility CD speech plus babble rhyming words tracks and record at least 50 words on the answer sheets. Record the signal on the laptop as this is done. Repeat and record the reference channel.

6.6.5.4 Download the signal from the base unit recorder to the laptop as a separate channel and, using high-quality earphones, score the intelligibility test.

6.6.5.5 Review recorded audio and video of clapboard and measure any perceived delay.

6.6.6 Report

6.6.6.1 Each trial for each procedure result shall be documented and reported.

6.6.7 Interpretation

6.6.7.1 The system should produce at least 45 out of 50 words intelligibly. This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.7 Microphone Test

6.7.1 A complete base unit with all components required for evaluation shall be used as the sample.
6.7.2 Initial Conditions

6.7.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.7.3 Test Equipment

6.7.3.1 The following test equipment is required for this test: CD of Modified Rhyme Test With Babble (Cosmos Dist. Inc.) or equivalent, audio stereo CD player (with capability to play two tracks simultaneously), two matched microphones (one for reference and one for detecting signal from audio monitor, audio oscillator, oscilloscope, frequency independent delay line, audio signal inverter, signal mixer, true RMS voltmeter, headphones and laptop for data collection.

6.7.4 Procedure

6.7.4.1 Place the microphone being tested a distance of one meter from the sound source.

6.7.4.2 Adjust the babble track to produce a sound pressure level of 50 db and adjust the balance control to give a combined speech and babble sound pressure level of 53 db.

6.7.4.3 Play the Intelligibility CD speech plus babble rhyming words tracks and record at least 50 words on the answer sheets. Record the signal on the computer as this is done.

6.7.4.4 The system should produce at least 45 out of 50 words intelligibly.

6.7.4.5 Connect an audio oscillator to an amplifier and speaker in order to produce a sound pressure level of 60 db.

6.7.4.6 Place the microphone under test four feet from the source.

6.7.4.7 Systematically adjust the oscillator to 300, 350, 440, 600, 1,200, 2,000, 2,500 and 3,000 Hz.

6.7.4.8 Place a sound pressure meter within six in of the system output speaker. Set it to measure A-filtration and at least one second integration time sound levels.

6.7.4.9 Record the measured sound levels as a function of input frequency. Average the values between 350 Hz and 2,500 Hz. This is the average output value. The values at 300 Hz and at 3,000 Hz can be no more than six db below the average output value.

6.7.4.10 Steps 6.7.4.3 through 6.7.4.9 shall be performed two additional times.
6.7.5 Report
6.7.5.1 Each trial result shall be documented and reported.
6.7.5.2 The average of the three trials shall be documented and reported.

6.7.6 Interpretation
6.7.6.1 This task is evaluated on a pass/fail basis. The average shall be $\geq 45$ correct words in order for the final result to be considered a pass.

6.8 Spatial Resolution Test
6.8.1 The purpose of this test is to determine if the system is able to capture images of small items of importance in the typical scenes it is likely to encounter in practice. A

6.8.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.8.3 Initial Conditions
6.8.3.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.8.4 Procedure
6.8.4.1 Work at an illuminance in the range from 500 lux to 2,000 lux and record 30 to 60 frames of video of a high-contrast, bar-type resolution test target$^A$ at the following frame width setting:

Normal setting, 7.3 m ± 0.3m (24 ft ± 12 in).

6.8.4.2 The settings can be accomplished by either moving the camera or by using optical zoom. The target shall have several bars of black interspersed with white. The white and black bars shall be of equal width and the width of each line pair shall be such that it appears to represent 0.5 line pairs/in [that is, the width of the white and black lines are each 2.5 cm (1 in)] at a horizontal FOV of 7.3 m (24 ft). The white bars shall be no darker than 0.1 in reflection density and the black bars shall be at least 1.9 in reflection density.$^A$ The test target shall also contain an additional set of bars, only these bars will be twice the width of the main set just described. The space surrounding the sets of bars should be medium gray, between 15% and 25% reflectance. In addition, there should be squares of black (optical density greater than 1.9) and white (optical density less that 0.1). These squares should be at least five cm (two in) on a side.
6.8.4.3 Evaluation of the images should be done after the images are converted to gray scale. Select any three video frames at random from each of the four frame width settings and examine them to determine that the bars are separated clearly enough to be counted correctly and that there are the correct number of them. If there are only one or two very dark or very light bars on an almost grayish background and there are not the right number of bars, there is an aliasing problem. If there is aliasing, those bars are not resolved. This should be done for both wider and thinner bar sets and all four settings. Visually, the wide bars at the close frame width must be unequivocally clear; that is, there must be dark bars separated by distinct white bars. If this is not the case, the system fails the test.

6.8.4.4 The target shall have bars that are within five degrees of parallel, perpendicular and 45 degrees with respect to either the rows or columns of the imaging array in the camera.

6.8.4.5 Equivalent geometry may be used.\(^A\)

6.8.5 Report

6.8.5.1 Each trial result shall be documented and reported.

6.8.6 Interpretation

6.8.6.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.9 Aspect Ratio Test

6.9.1 The purpose of this test is to determine if the system presents images to the user that have the correct aspect ratio (width to height) so that valid measurements can be made from recorded video.\(^A\)

6.9.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.9.3 Initial Conditions

6.9.3.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.9.4 Procedure

6.9.4.1 Record between 30 and 60 frames of video of a test target with a circle completely inside of a square and an ellipse completely inside of a rectangle. The rectangle shall have a width that is 1.1 times its height. The diameter of the circle shall equal the
width of the square. The minor axis of the ellipse shall equal half the height of the rectangle and the major axis of the ellipse shall equal half the width of the rectangle.

6.9.4.2 Select any three frames of the recorded video for capture. Measure the height and width of the circles, squares, rectangles and ellipses in these frames. Compute the frame average of the heights and widths for the circle, square, rectangle and ellipse. Compute the ratio of width to height for the circle and square and record these ratios. Compute the ratio of width to height for the rectangle and ellipse, divide these ratios by 1.1 and document the results.

6.9.5 Report

6.9.5.1 Each trial result shall be documented and reported.

6.9.6 Interpretation

6.9.7 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.10 **Dynamic Modulation Test**

6.10.1 The purpose of this test is to determine the ability of the system under test to reproduce portions of the scene that are moving as a function of their size, velocity and scene brightness. It invokes the system’s shutter function, compression function and image capture process.⁴

6.10.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.10.3 Initial Conditions

6.10.3.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.10.4 Procedure

6.10.4.1 The system shall be turned on. Move a test target across the FOV in a horizontal direction relative to the camera.³ If the target is accelerating as it moves, it will capture a series of frames in which the target is moving at increasing velocities. The range of velocities should vary from 0 mphe to at least 40 mphe. The equivalency is the actual target rate as it would be seen if it were at that velocity at an object distance of 10.7 m (35 ft) with a horizontal FOV of 7.3 m (24 ft). Record DME as the target

³ The target is moving vertically, but the camera is rotated 90° to achieve horizontal movement relative to the camera. Horizontal rows become pointed vertically.
moves from standstill to maximum velocity. Allow the camera to use its internal auto
exposure and white balance functions. (See Appendix A, Figure 3.)

6.10.4.2 The test target should move across the video frame and it should cover at least 40% of
the frame (vertical).\textsuperscript{A}

6.10.4.3 The test target should have two series of white and black bars that are the equivalent
of two and four in wide each, respectively.\textsuperscript{A} The white bars should have optical
reflection density of no more than 0.1 and the black bars should have optical
reflection density of at least 1.9. The white and black bars should be equally wide.

6.10.4.4 The test target will be illuminated at two illuminance levels: one level between 1,800
lux and 2,200 lux incident and the other level between 9,000 and 10,000 lux incident
at a correlated color temperature between 2,800 and 5,600 K.\textsuperscript{A}

6.10.4.5 Capture the frames from both the high and low light level runs and open them in
professional editing software.\textsuperscript{A}

6.10.4.6 Render the images as grayscale images from 0 to 255 brightness values.\textsuperscript{A}

6.10.4.7 Measure the brightness levels of the dark and light bars at their nominal centers using
a sampling tool.\textsuperscript{A}

6.10.4.8 Subtract the dark bar values from the light bar values for each frame to determine the
modulation for that frame.\textsuperscript{A} Calculate the equivalent velocity of the test target for
each frame. The equivalent velocity is computed by considering the size of the frame
and the distance to the test target. The formula for equivalent velocity (velocity of a
free-falling body as a function of distance) is provided in Equation 1.

\textbf{Equation 1}

\[ v = \sqrt{2 \times g \times d} \]

Where: \( v = \) velocity
\( g = \) acceleration due to gravity
\( d = \) distance

Since this test is done at one-quarter scale, the equivalent velocity will be one-quarter
times the value calculated in this equation. To calibrate the device, \( g = 32.17 \) feet per
second\textsuperscript{2}. The distance fallen, \( d \), is given in feet and the resulting velocity will be in
feet per second. This can be converted to mph using 5,280 feet per mile.

6.10.4.9 Normalize the modulation for each velocity by dividing it by the modulation of the
stationary test target\textsuperscript{A} (see Section 6.5).
6.10.4.10 Plot the relative modulation for each frame as a function of the velocity of the target for that frame. Connect the points and smooth the curve near its mid-point. Document the equivalent velocity at which the curve crosses the 50% modulation level. Do this for both the high and low light runs.

6.10.5 Report

6.10.5.1 Each trial result shall be documented and reported.

6.10.6 Interpretation

6.10.6.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.10.7 Export Capability Test

6.10.7.1 Using the system, record at least five minutes of video (the time is arbitrary).

6.10.7.2 Using the system, export the recorded video.

6.10.7.3 Using an industry standard program matching the exported format, open the exported DME Video file.

6.10.7.4 Using an XML Viewer, open the associated metadata file and verify its contents include the required information.

6.11 System Operational Test

6.11.1 The purpose of this test is to assess the system operations, controls, indicators and displays.

6.11.2 A complete base unit with all components required for evaluation shall be used as the sample.

6.11.3 Equipment:

- Computer with professional editing software.
- Analog clock with a sweep second hand. The second hand should have a visually smooth motion as opposed to one with noticeable step-wise advances. The clock should have distinct markers for each of the hour points. Test the clock’s accuracy by comparing it to a traceable standard clock for at least 24 hours (e.g., standard clock available at http://www.time.gov/timezone.cgi?Eastern/d/-5/java).

6.11.4 Initial Conditions

6.11.4.1 The system shall have empty recording media prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal
operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.11.5 Procedure

6.11.5.1 Disconnect system power for a minimum of five minutes. Reconnect power and turn the system on. Allow one minute for system to automatically set the correct time and date. Document whether the time and date are set within the allotted time frame.

6.11.5.2 Controls, Indicators and Displays: While performing the following steps, assess whether the following controls, indicators and displays function properly:

<table>
<thead>
<tr>
<th>Controls</th>
<th>Indicator or Display (Audible or Visible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power On</td>
<td>Power On (I)</td>
</tr>
<tr>
<td></td>
<td>Diagnostic display showing system level events (D)</td>
</tr>
<tr>
<td></td>
<td>Media not inserted or not operational (if removable media) (D)</td>
</tr>
<tr>
<td>Power Off</td>
<td>None</td>
</tr>
<tr>
<td>Microphone Activated</td>
<td>Microphone On (I or D)</td>
</tr>
<tr>
<td></td>
<td>Recording (I and D)</td>
</tr>
<tr>
<td></td>
<td>Time Remaining (D)</td>
</tr>
<tr>
<td></td>
<td>Low record time remaining – at ≤ one hour remaining (I)</td>
</tr>
<tr>
<td>Record</td>
<td>Recording (I and D)</td>
</tr>
<tr>
<td></td>
<td>Time Remaining (D)</td>
</tr>
<tr>
<td></td>
<td>Low record time remaining – at ≤ one hour remaining (I)</td>
</tr>
<tr>
<td>Play</td>
<td>Playing (D)</td>
</tr>
<tr>
<td>Fast Forward</td>
<td>Fast Forwarding (D)</td>
</tr>
<tr>
<td>Rewind</td>
<td>Rewinding (D)</td>
</tr>
<tr>
<td>Pause</td>
<td>Paused (D)</td>
</tr>
<tr>
<td>Stop</td>
<td>None</td>
</tr>
</tbody>
</table>

6.11.5.3 Observe that video and audio essences are presented on monitors when not recording.

6.11.5.4 Adjust the viewing screen light level and observe that the light level is adjustable and can be turned off independently of the rest of the system.

6.11.5.5 If the recording media is removable, remove it and verify that the “Media not inserted or not operational” indicator functions properly.
6.11.5.6 Press record button and record DME for five minutes, verifying that record indicator is on. Verify that the indicator is visible at a distance of 35 feet. Follow VDMERS manufacturer instructions for disabling the record indicator and verify whether indicator is disabled or not. Verify live audio during recording. Stop recording, rewind and playback DME. Verify playback of DME and display of date/time, user id and system status. Verify that the illumination of indicators is adjustable by the user from a level of bright to dark.

6.11.5.7 Pre-event and Post-event Recording. Position camera to view analog clock. Enable pre-event and post-event recording. Set up switches to simulate inputs for activation of emergency lights, siren and vehicle crash actuator and connect to system wiring harness. Activate each switch separately and verify for each switch activation that recording is initiated. Record for at least one minute and stop recording. Play back video and verify that (1) pre-event recording was performed for 30 seconds prior to activation of the record function and (2) post-event recording was performed for 30 seconds after recording was stopped.

6.11.5.8 Position camera to view an analog clock. Disable pre-event and post-event recording. Activate each switch separately and verify for each switch activation (see 6.11.5.6) that recording is initiated. Record for at least one minute and stop recording. Play back video and verify that (1) pre-event recording was not performed prior to activation of the record function and (2) post-event recording was not performed after recording stopped.

6.11.5.9 Initiation of Recording by Wireless Microphone. Activate wireless microphone and verify that record indicator is on. Record DME for 10 seconds. Play back video to verify that activation of the wireless microphone initiated recording.

6.11.5.10 Frames Per Second. Position camera to view analog clock and record at least one minute of DME. Select five noncontiguous segments of uncompressed DME and import the segments into an external tool (e.g., non-linear professional editing software). Count the number of unique frames between the start and end times. Document the result as number of frames per second.

6.11.5.11 Minimum Recording Time. Starting with empty recording media, record DME uninterrupted for at least 3.5 hours at the lowest compression (highest quality) supported by the system. Play back the recorded video. Selectively display the following on the video monitor: date/time, user identification information, emergency light indication, siren indication, crash indication and system status indicators (video recording on/off, microphone(s) on/off). Verify that the recorded audio playback is correct. Verify that the user can select between live audio and recorded audio during playback. Adjust volume control and verify correct operation.

6.11.5.12 Automatic Stop When Media Is Full. Record DME until system recording media is full and assess whether recording automatically stops to prevent previously recorded DME from being overwritten.
6.11.5.13 Frame Rate Verification. The frame rate shall be verified per the following steps:

- Record video of the clock face for at least six 30-second intervals.
- Import the recording into professional editing software capable of displaying frame count.
- Identify a frame near the start of the recording where the second hand is aligned with one of the marks on the clock face (e.g., when the second hand is aligned with the minute mark at the 3:00 position.) Note the frame number.
- Move to a frame six minutes further into the recording where the second hand is aligned at the same mark. Note the frame number.
- Subtract the starting frame number from the ending frame number. The difference is the number of frames recorded in six minutes.
- The number of frames should be at least 10,788. This is 29.97 frames per second times 60 seconds per minute times six minutes, plus or minus an allowance of 0.2 second for the normal “one fifth least count” on the clock for each reading.

6.11.6 Report

6.11.6.1 Each trial result and observations shall be documented and reported.

6.11.7 Interpretation

6.11.8 This task is evaluated on a pass/fail basis. Each sample shall meet the requirements of Chapter 5 in order for the final result to be considered a pass.

6.12 Interoperability Tests

6.12.1 The purpose of this test is to confirm that the uncompressed DME file is an exact copy of the original DME.

6.12.2 Test video

6.12.2.1 Original DME and uncompressed DME having at least 30 frames of video from any previous test within this standard may be used as the test video for interoperability.

6.12.3 Procedure

6.12.3.1 Import the recording into professional editing software capable of displaying frame count.

6.12.3.2 Select and compare corresponding frames from original DME and uncompressed DME. A minimum of 1% of the total frames selected from the beginning, middle and end shall be compared.

6.12.3.3 The frame rate shall be tested to ensure the videos are identical in FPS.
6.12.3.4 Frames shall be compared at the pixel level to ensure the following attributes are identical:
   - Luminance.
   - Pixel resolution.
   - Color fidelity.

6.12.4 Using appropriate software, calculate a hash value on the original DME and compare that value with the hash taken prior to export of original DME (i.e., during the automatic verification check).

6.12.5 Report

6.12.5.1 The results and observations shall be documented and reported.

6.12.6 Interpretation

6.12.6.1 This task is evaluated on a pass/fail basis. The test result shall be considered a pass if the values of the attributes are determined to be identical between frames.

6.13 Security Test to Demonstrate Restriction of Unauthorized Access

6.13.1 The purpose of this test is to ensure that the date/time information stored during recording can be set only by an administrator.

6.13.2 Initial Conditions

6.13.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.13.3 Procedure

6.13.3.1 Access the system as a non-administrator and attempt to set/change the date/time associated with the system, verifying that the information may not be altered. Ensure that an entry indicating an unsuccessful attempt to change the date/time setting is recorded in the System Audit Log.

6.13.3.2 Access the system as an administrator and attempt to set/change the date/time associated with the system, verifying that the information may be changed. On successful change, ensure that an entry in the System Audit Log is written that includes the user who made the change and the type of change made.

6.13.4 Report

6.13.4.1 Each trial shall be documented and reported.
6.13.5 Interpretation
6.13.5.1 This task is evaluated on a pass/fail basis.

6.14 Security Test to Demonstrate Restriction of Unauthorized Access to Vehicle Information

6.14.1 The purpose of this test is to ensure that the date/time information stored during recording can be set only by an administrator.

6.14.2 Initial Conditions

6.14.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.14.3 Procedure

6.14.3.1 Access the system as a non-administrator/non-service technician and attempt to set/change the vehicle information associated with the system, verifying that the information may not be altered. Ensure that an entry indicating an unsuccessful attempt to change the vehicle information is recorded in the System Audit Log.

6.14.3.2 Access the system as an administrator/service technician and attempt to set/change the vehicle information associated with the system, verifying that the information may be changed. On successful change, ensure that an entry in the System Audit Log is written that includes the user who made the change and the type of change made.

6.14.4 Report

6.14.4.1 Each trial shall be documented and reported.

6.14.5 Interpretation

6.14.5.1 This task is evaluated on a pass/fail basis.

6.15 Security Test to Demonstrate Restriction of Unauthorized Access to Audit Logs

6.15.1 The purpose of this test is to ensure that only authorized users may access the System and DME Audit Log.

6.15.2 Initial Conditions

6.15.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.15.3 Procedure
6.15.4 Access the system as a non-administrator and attempt to access the System and DME Audit Logs, ensuring that the logs are not accessible. Ensure that an entry indicating an unsuccessful attempt to download the System or DME Audit Logs is recorded in the System Audit Log.

6.15.5 Access the system as an administrator and attempt to access the System and DME Audit Logs, verifying that the information may be accessed. On successful access, ensure that an entry in the System Audit Log is written that includes the user who accessed the system or DME audit log and which log was accessed.

6.15.6 Report

6.15.6.1 Each trial shall be documented and reported.

6.15.7 Interpretation

6.15.8 This task is evaluated on a pass/fail basis.

6.16 Security Test to Demonstrate Restriction of Unauthorized Clearing/Deleting of the System and DME Audit Logs

6.16.1 The purpose of this test is to ensure that only authorized users may clear or delete the System and DME Audit Logs.

6.16.2 Initial Conditions

6.16.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.16.3 Procedure

6.16.3.1 Access system as a non-administrator and attempt to delete or clear the System and DME Audit Logs, ensuring that the logs are not accessible. Ensure that an entry indicating an unsuccessful attempt to clear/delete the System or DME Audit Logs is recorded in the System Audit Log.

6.16.3.2 Access the system as an administrator and attempt to delete or clear the System and DME Audit Logs, verifying that the information may be accessed. On successful completion of the requested action, ensure that an entry in the System Audit Log is written that includes the user who accessed the System or DME Audit Log and which log was accessed. If the System Audit Log was cleared, a new audit log is created that includes the vehicle information and the user who last cleared the system audit log, along with the date/time of the activity.

6.16.4 Report

6.16.4.1 Each trial shall be documented and reported.
6.17 **Security Test to Demonstrate Restriction of Unauthorized Access to Other Programming Functions**

6.17.1 The purpose of this test is to ensure that the configuration information may be changed only by an authorized user.

6.17.2 **Initial Conditions**

6.17.2.1 The system shall have an empty DME storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.17.3 **Procedure**

6.17.3.1 Access the system as a non-administrator and attempt to set/change the configuration associated with the system, verifying that the information may not be altered. Ensure that an entry indicating an unsuccessful attempt to alter system configuration is recorded in the System Audit Log.

6.17.3.2 Access the system as an administrator and attempt to set/change the configuration associated with the system, verifying that the information may be changed. On successful change, ensure that an entry in the System Audit Log is written that includes the user who made the change and the type of change made.

6.17.4 **Report**

6.17.4.1 Each trial shall be documented and reported.

6.17.5 **Interpretation**

6.17.6 This task is evaluated on a pass/fail basis.

6.18 **Security Test to Demonstrate Restriction of Unauthorized Erasing, Altering and/or Recording Over Previously Recorded DME**

6.18.1 The purpose of this test is to ensure that recorded DME cannot be altered or destroyed by an unauthorized user.

6.18.2 **Initial Conditions**

6.18.2.1 The system shall have recorded DME on the storage device prior to the beginning of this test. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.
6.18.3 Procedure

6.18.3.1 Access the system as a non-administrator and attempt to alter or delete the recording either directly using the system through normal use, or swapping recording media if the DME is recorded on removable media. Verify that the information is not altered or deleted. Ensure that an entry indicating an unsuccessful attempt to alter/delete DME is recorded in the System Audit Log.

6.18.3.2 Access the system as an administrator and attempt to alter and/or delete the recording either directly using the system through normal use, or by swapping media if the DME is recorded on removable media. On successful change or deletion, ensure that an entry is present in the DME Audit Log that includes the user and type of activity.

6.18.4 Report

6.18.4.1 Each trial shall be documented and reported.

6.18.5 Interpretation

6.18.6 This task is evaluated on a pass/fail basis.

6.19 Electrical System Safety Tests

6.19.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.2 Test Conditions

6.19.2.1 Unless otherwise specified within a given test method, the following conditions shall be established within the test environment and maintained throughout the test:
   a) Ambient temperature at 23 ± 3°C (73.4 ± 5°F).
   b) Relative humidity at 50 ±20%.
   c) Supply voltage, if applicable, adjusted to 100% of rated input voltage.

6.19.3 Electrical Supervision Test

6.19.3.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.3.2 This test is based on UL 2075, Standard for Safety for Gas and Vapor Detectors and Sensors, Section 17.

6.19.3.3 Power shall be applied to the system.

6.19.3.4 Malfunctioning of an electronic component, such as opening or shorting of a capacitor, shall either not impair the intended operation or shall be indicated by a
trouble signal, or the product shall be provided with a test feature as described in Section 6.19.3.6 below.

6.19.3.5 A surveillance camera unit shall be electrically supervised so that a malfunction of the power supply or loss of primary power shall result in the de-energization of a visual “power on” indicator.

6.19.3.6 A manual test method provided as a part of the operation of the system that effectively tests the capability of the critical components may be used in lieu of electrical supervision.

6.19.3.7 A critical component is one whose failure impairs the operation of the product or results in risk of fire or electric shock.

6.19.3.8 If failure of a critical, limited life electronic component, such as opening or shorting of an electrolytic capacitor, is not indicated by a trouble signal, then a reliable component shall be used. The reliable component shall fall within the reliability prediction described below:

- Component, Limited-life: A component expected to fail and be periodically replaced, and the failure of which is supervised when failure of the component affects the intended operation. Typical examples of such components include incandescent lamps, electronic tube heaters and functional heating elements.
- Component, Reliable: A component not expected to fail or be periodically replaced and not supervised. A reliable component shall have a predicted failure rate of 2.5 or less failures per million hours as determined for “Ground Fixed” (GF) environment by MIL-HDBK 217F or equivalent.

6.19.4 Report

6.19.4.1 Each trial result shall be documented and reported.

6.19.5 Interpretation

6.19.6 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.19.7 Current Protection Test

6.19.7.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.7.2 This test is based on UL 639, Standard for Safety for Intrusion-Detection Units, Section 24.

6.19.7.3 Internal damage to circuitry shall not result when field wiring terminals are unintentionally shorted or jumped to power supply terminals (see also below.)
6.19.7.4 A power source of rated voltage shall be connected between the terminal under test and ground.

6.19.7.5 All connections to power terminals and input and output lines shall be reversed as pairs or individually connected to any terminal adjacent to the correct one.

6.19.7.6 When damage results from the incorrect connection specified above, then markings clearly visible to the installer during installation shall warn of consequences of unintended connection. When correct polarity is required, then polarity markings shall appear immediately adjacent to wiring terminals.

6.19.8 Report

6.19.8.1 Each trial result shall be documented and reported.

6.19.9 Interpretation

6.19.9.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.19.10 Current Input Test

6.19.10.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.10.2 This test is based on UL 639, Standard for Safety for Intrusion-Detection Units, Section 25.

6.19.10.3 The input current of the system shall not exceed 110% of the unit’s marked input current, power or V-A rating while connected to a source of supply in accordance with the requirements below and operated under all conditions of intended use.

6.19.10.4 The test voltage for this test is to be the maximum rated voltage for the product. For a product having a single voltage rating, such as 115 V, maximum rated voltage is to be that single voltage. When the voltage is given in terms of a range of voltages, such as 110-120 V, the maximum rated voltage is the highest value of the range.

6.19.10.5 Power shall be applied to the system as specified above and the input current shall be measured.

6.19.10.6 All results shall be documented and reported.

6.19.11 Overvoltage Test

6.19.11.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.11.2 This test is based on UL 639, Standard for Safety for Intrusion-Detection Units, Section 29, with modifications as indicated.
6.19.11.3 Three units shall be subjected to this test.

6.19.11.4 The system shall operate as fully intended when connected to a supply source of 110% of the rated value. When the rated value is a voltage range, the overvoltage level shall be 110% of the higher limit of the range.

6.19.11.5 The system shall be tested for its intended operation with the minimum number of cameras and/or microphones connected, as specified by the installation instructions.

6.19.11.6 The system shall be energized in standby condition at the overvoltage level for a minimum of 16 h and then tested as specified in Section 6.4 Spatial Resolution Test.

6.19.12 Report

6.19.12.1 Each trial result shall be documented and reported.

6.19.13 Interpretation

6.19.13.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.19.14 Under Voltage Test

6.19.14.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.14.2 This test is based on UL 983, *Standard for Surveillance Camera Units*, Section 29 with modifications as indicated.

6.19.14.3 Three units shall be subjected to this test.

6.19.14.4 The system shall operate as fully intended when energized from a supply source of 85% of the test voltage specified by the VDMERS manufacturer. The system shall be tested for intended operation with the minimum number of cameras and/or microphones connected as specified by the installation instructions.

6.19.14.5 For devices provided with a standby battery, the test is to be conducted at 85% of the charged battery voltage. When the standby battery provides a trouble signal requiring replacement at higher than 85% of the charged battery voltage, the test is to be conducted at the battery trouble signal voltage level.

6.19.14.6 The system shall be energized at the rated voltage. After that, the voltage is to be reduced to 85% of this level and battery-operated devices are to be operated at the trouble level voltage. The systems shall then be tested for proper operation.

6.19.15 Report

6.19.15.1 Each trial result shall be documented and reported.
6.19.16 Interpretation

6.19.16.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.19.17 Static Discharge Test

6.19.17.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.17.2 This test is based on Safety for Gas and Vapor Detectors and Sensors, Section 25, with modifications as indicated.

6.19.17.3 Two samples shall be subjected to this test.

6.19.17.4 The test shall be conducted in an ambient temperature of $23 \pm 3 \, ^\circ C$ ($73.4 \pm 5 \, ^\circ F$), at a relative humidity of $10 \pm 5 \%$ and a barometric pressure of not less than 700 mm of mercury (93 kPa).

6.19.17.5 The system shall be mounted in its intended mounting position and connected to a source of supply at the rated level. If the system is intended to be installed on a metal junction box, the device is to be connected to earth ground. A 250-picofarad, low-leakage capacitor, rated 10,000 V dc, is to be connected to two three-foot (0.9-m) leads rated for more than 30 V. A 1,500-ohm resistor is to be inserted in series with one lead. The end of each lead is to be attached to a 12.7-mm ($\frac{1}{2}$-in) diameter metal test probe with a spherical end and mounted on an insulating rod. The capacitors are to be charged by touching the ends of the test leads to a source of 10,000 V DC for a minimum of two seconds for each discharge. One probe shall be touched to the system and the other probe shall then be touched to earth ground.

6.19.17.6 Ten discharges shall be applied to different points on the exposed surface of the device. The capacitors shall be recharged for each discharge. Five discharges of positive polarity shall be made with one lead connected to earth ground and the other lead probed on the system surface followed by five discharges with the polarity reversed.

6.19.17.7 For a VDMERS intended to be serviced by the user, ten additional discharges shall be applied as described above, except each lead shall be probed, in turn, on all internal parts capable of being contacted by the user.

6.19.17.8 Following all discharges, the system shall be tested for normal operation when tested as specified in Section 6.4 Spatial Resolution Test.

6.19.17.9 The results for each unit shall be documented and reported.
6.19.18 Dielectric Voltage-Withstand Test

6.19.18.1 This test is based on UL 639, Standard for Safety for Intrusion-Detection Units, Section 41, with modifications as indicated.

6.19.18.2 Power shall not be applied to the system during this test.

6.19.18.3 A product shall withstand for one minute, without breakdown, the application of an essentially sinusoidal AC potential of a frequency within the range of 40 to 75 hertz, or a DC potential, between live parts and the enclosure, between live parts and exposed dead metal parts and between live parts of circuits operating at different potential or frequencies. The test potential is to be as follows (see Section 6.19.18.4 below):

(a) For a unit rated 30 V AC rms (42.4 V DC or AC peak) or less: 500 V AC (707 V, when a DC potential is used).

(b) For a unit rated between 31 and 150 V AC rms: 1,000 V AC (1,414 V, when a DC potential is used).

6.19.18.4 Exposed dead metal parts are noncurrent-carrying metal parts capable of becoming energized and accessible from outside the enclosure during operation with the door of the enclosure closed.

6.19.18.5 For the application of a potential between live parts of circuits operating at different potentials or frequencies, the voltage is to be the applicable value specified in Section 6.19.18.3 (a) or (b) based on the highest voltage of the circuits under test instead of the rated voltage of the unit. Electrical connections between the circuits are to be disconnected before the test potential is applied.

6.19.18.6 When the charging current through a capacitor or capacitor-type filter connected across the line, or from line to earth ground, is sufficient to prevent maintenance of the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 6.19.18.3.

6.19.18.7 The test potential shall be obtained from any convenient source having sufficient capacity to maintain the specified voltage. The output voltage of the test apparatus is to be monitored. The method of applying the test voltage is to be such that there are no transient voltages that result in the instantaneous voltage applied to the appliance or circuit exceeding 105% of the peak value of the specified test voltage. The applied potential is to be:

(a) Increased from 0 at a uniform rate so as to arrive at the specified test potential in approximately five seconds, then

(b) Maintained at the test potential for one minute without an indication of a breakdown or leakage of greater than 0.5 mA. Control of the rate of rise shall be either manual or automatic.
6.19.18.8 A printed wiring assembly or other electric circuit component that would be damaged by, or would short-circuit, the test potential, is to be removed, disconnected or otherwise rendered inoperative before the test. A representative subassembly is then to be tested instead of an entire unit. Where applicable, rectifier diodes in the power supply are to be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

6.19.18.9 The system shall be powered and tested as specified in Section 6.4 Spatial Resolution Test.

6.19.19 Report

6.19.19.1 Each trial result shall be documented and reported.

6.19.20 Interpretation

6.19.20.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.19.21 Temperature Test

6.19.21.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.19.21.2 This test is based on UL 639, Standard for Safety for Intrusion-Detection Units, Section 43, with modifications as indicated.

6.19.21.3 Power shall be applied to the system during this test.

6.19.21.4 The values for temperatures in the table in Appendix B are based on an assumed ambient temperature of 25 ± 15°C (77 ± 27°F) and tests are to be conducted at an ambient temperature within that range. A temperature is determined to be constant when there is no change in three successive readings taken at intervals of 10% of the previously elapsed duration of the test but not less than five-minute intervals.

6.19.21.5 All values for temperature rises apply to equipment intended for use with ambient temperatures normally prevailing in occupiable spaces that usually are not higher than 25°C (77°F). When equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25°C (77°F), the test of the equipment is made with the higher ambient temperature and the allowable temperature rises specified in Table 38.1 are to be reduced by the amount of the difference between the higher ambient temperature and 25°C (77°F). A temperature is considered to be constant when three successive readings taken at intervals of 10% of the previously elapsed duration of the test, but not less than five-minute intervals, indicate no change.

6.19.21.6 Temperature measurements on equipment intended for recessed mounting shall be made with the unit installed in an enclosure of 19.1-mm (¾-in) wood having
clearances of 50.8 mm (two in) on the top, sides and rear, and the front extended to be flush with the unit’s cover.

6.19.21.7 Except at coils, temperatures are to be measured by thermocouples consisting of wire not larger than 0.21 mm² (24 AWG) or by the change-in-resistance method. The thermocouple method is not to be employed for a temperature measurement at any point where supplementary thermal insulation is employed.

6.19.21.8 Thermocouples consisting of 0.06 mm (30 AWG) iron and constantan wires and a potentiometer-type indicating instrument are to be used whenever referee temperature measurements by thermocouples are necessary.

6.19.21.9 The temperature of a coil winding may be determined by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the formula:

\[ \Delta t = \frac{R}{r(k + t_1) - (k + t_2)} \]

In which:
- \( \Delta t \) is the temperature rise to be determined in degrees C.
- \( R \) is the resistance in ohms at end of test.
- \( r \) is the resistance in ohms at start of test.
- \( k \) is 234.5 for copper or 225.0 for electrical conductor grade aluminum.
- \( t_1 \) is the room temperature at start of test in degrees C.
- \( t_2 \) is the room temperature at end of test in degrees C.

6.19.21.10 To determine compliance with the above requirements, the product is to be connected to a supply circuit of rated voltage and frequency and operated continuously under representative service conditions that will produce the highest temperature.

6.19.21.11 The duration of the test operating condition is to not be less than:

(a) Operation until constant temperatures are attained during the standby condition.

(b) Operation for one h of recording operation of a unit designed to operate continuously until it is restored to the standby condition.

6.19.21.12 All results shall be documented and reported.
6.19.22 Polymeric Materials Tests

6.19.22.1 Polymeric materials used as an enclosure, or for the support of current-carrying parts, shall comply with the applicable portion of UL 746C, *Standard for Polymeric Materials – Use in Electrical Equipment Evaluations*.

6.20 EMC Tests

6.20.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.20.2 Initial Conditions

6.20.2.1 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. The nominal operating power as described in the system manual shall be applied to the system and the system shall be turned on.

6.20.3 Procedure Conducted Emissions

6.20.3.1 This section details the procedure for measuring the electrical emissions applied back into the input power system.

6.20.3.2 SAE J1113-41 details the method and limits for this test. The Class 3 limits defined in Paragraph 6.2, Table 4 shall be applied.

6.20.4 Procedure Conducted Immunity

6.20.4.1 This section details the procedure for evaluating the ability of the system to reject signals that might be present on the input power system.

6.20.4.2 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. SAE J1113-11 details the method and limits for this test.

6.20.5 Procedure Radiated Susceptibility

6.20.5.1 This section details the procedure for evaluating the ability of the system to be operated while being exposed to radiated electrical signals.

6.20.5.2 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. SAE J1113-21 details the method and limits for this test. The Level 3 limits defined in Table B1 shall be applied.
6.20.6 Procedure Radiated Emissions

6.20.6.1 This section details the procedure for evaluating the amount of radiated electrical emissions that is generated by system.

6.20.6.2 The system shall have an empty DME storage device prior to the beginning of this test. There shall be sufficient light for the system to capture an image. CISPR 25 details the method and limits for this test.

6.21 Environmental Tests

6.21.1 Samples

6.21.1.1 A complete base unit with all components required for evaluation shall be used as the sample.

6.21.1.2 For each model being considered, one sample shall be submitted for testing.

6.21.1.3 Complete systems shall be furnished for evaluation. A complete system consists of all components required for evaluation.

6.21.2 Test Targets and Equipment

6.21.2.1 The high temperature, low temperature and humidity chamber test target shall be an analog clock with a diameter chosen in combination with the camera lens focal length and the distance to the clock such that the clock face fills at least 33% of the video frame’s area.

6.21.2.2 The mechanical vibration and mechanical shock test target shall be created as follows: Place numbered vertical black lines on a sheet as wide as indicated in Table 5 or on a linear interpolation of the chart. The sheet should be 75% the width in height. The lines should be centered vertically and on a white background. From two in above and two in below the lines, the background of the sheet should be gray with a reflectance between 15% and 25%.

Table 5. Dimensions for Test Target

<table>
<thead>
<tr>
<th>Distance from camera (ft)</th>
<th>Width of sheet (ft)</th>
<th>Separation of lines (ft)</th>
<th>Width of lines (in)</th>
<th>Height of lines (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.0</td>
<td>15.0</td>
<td>3.0</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
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<td>7.50</td>
<td>1.5</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>8.75</td>
<td>3.75</td>
<td>0.75</td>
<td>0.5</td>
<td>4</td>
</tr>
</tbody>
</table>
6.21.3 High Temperature Exposure Procedure

6.21.3.1 The system shall have an empty DME storage device and a fully charged battery for the primary microphone prior to the beginning of this test. The system shall be placed inside a chamber such that the camera is viewing the test target through a clear window. The system’s video monitor shall either be visible through the window or shall be recorded via video camera during this test. The test target shall have sufficient illumination to allow the system to capture an image. Power shall be applied to the system and the system shall be placed in the record mode.

6.21.3.2 The chamber temperature shall be increased from room temperature to 49°C over a one-h period. The chamber will stay at 49°C± 3°C for a period of one h. During this period, the system shall continue to record. The functionality of the video monitor shall be observed and recorded at the end of the one-h period.

6.21.3.3 After 30 min, obscure the window for one min. The chamber temperature shall then be decreased to room temperature over a one-h period. During this period, the system shall continue to record.

6.21.3.4 The stored data shall be examined for any missing DME data capture by performing the DME Verification Test specified in Section 6.22. The exterior of the system shall be inspected for any damage. The functionality of the video monitor shall be observed.

6.21.3.5 All results and observations shall be documented and reported.

6.21.4 Low Temperature Exposure Procedure

6.21.4.1 The system shall have an empty DME storage device and a fully charged battery for the primary microphone prior to the beginning of this test. The system shall be placed inside a chamber such that the camera is viewing the test target through a clear window. The system’s video monitor shall either be visible through the window or shall be recorded via video camera during this test. The test target shall have sufficient illumination to allow the system to capture an image. Power shall be applied to the system and the system shall be placed in the record mode.

6.21.4.2 The chamber temperature shall be decreased from room temperature to 30°F over a one-h period. The chamber will stay at 30°F± 5°F for a period of one h. During this period, the system shall continue to record. The functionality of the video monitor shall be observed and recorded at the end of the one-h period.

6.21.4.3 After 30 min, obscure the window for one min. The chamber temperature shall then be increased to room temperature over a one-h period. During this period, the system shall continue to record.

6.21.4.4 The stored data shall be examined for any missing DME data capture by performing the DME Verification Test specified in Section 6.22. The exterior of the system shall
be inspected for any damage. The functionality of the video monitor shall be observed.

6.21.4.5 All results and observations shall be documented and reported.

6.21.5 Humidity Exposure Procedure

6.21.5.1 The system shall have an empty DME storage device and a fully charged battery for the primary microphone prior to the beginning of this test. The system shall be placed inside a chamber such that the camera is viewing the test target through a clear window. The system’s video monitor shall either be visible through the window or shall be recorded via video camera during this test. The test target shall have sufficient illumination to allow the system to capture an image. Power shall be applied to the system and the system shall be placed in the record mode.

6.21.5.2 The chamber temperature shall be increased from room temperature to 100°F over a one-h period and the chamber humidity shall be increased to 90% rh over that same one-h period. The chamber will stay at these conditions for a period of one h. During this period, the system shall continue to record. The functionality of the video monitor shall be observed and recorded at the end of the one-h period.

6.21.5.3 The chamber temperature shall then be decreased to the initial temperature and humidity conditions over a one-h period. During this period, the system shall continue to record.

6.21.5.4 The stored data shall be examined for any missing DME data capture by performing the DME Verification Test specified in Section 6.22. The functionality of the video monitor shall be observed.

6.21.5.5 All results and observations shall be documented and reported.

6.21.6 Mechanical Vibration Exposure Procedure

6.21.6.1 The system shall have an empty DME storage device and a fully charged battery for the primary microphone prior to the beginning of this test. The system shall be mounted on a vibration plate using the system’s provided mounting hardware and the camera shall be aimed at the test target. If multiple mounting kits are provided with the unit, the test shall be performed with each mounting kit. The test target shall have sufficient illumination to allow the system to capture an image. Power shall be applied to the system and the system shall be placed in the record mode.

6.21.6.2 Prior to running the test, set the camera zoom to its longest focal length, but be sure there are at least three lines in the frame. Focus on the test target. Make sure that at least three vertical lines are in the frame. The system under test should be running at least a few seconds prior to, during the test and a few seconds after the vibration is applied. Extract a frame from before the application of vibration (“before frame”).

56
6.21.6.3 The system shall be subjected to a random vibration test detailed in SAEJ1445 as outlined in Paragraph 4.10. The vibration profiles depicted in figures 6, 7 and 8 of SAEJ1445 will be used. The system shall be exposed to these levels for a period of 15 min for each of the profiles for a total exposure time of 45 min. During the exposure to the random vibration, the system shall continue to capture DME data. Following each profile, the position of the camera shall be examined. A change of >10% of the frame width shall constitute a failure.

6.21.6.4 At the conclusion, the stored data shall be examined for any missing DME data capture by performing the DME Verification Test specified in Section 6.22. The functionality of the video monitor shall be observed.

6.21.6.5 Extract a frame after the vibration is turned off (“after frame”). Measure the number of pixels across the displayed frames for the system under test. Measure the number of pixels between lines from both the before and after frames. Any change over 3% indicates an unacceptable change in the zoom setting due to vibration. Compare the edges of the lines on both the before and after frames. Visually different sharpness indicates an unacceptable change in focus. Measure the number of pixels from the left edge of the before frame to the closest (to the left edge) vertical line and note the line’s number. Repeat this measurement for the after frame. Subtract the pixel count for the after frame from that of the before frame and divide this by the number of pixels across the frame to get the percent frame movement. The percent frame movement should be less than 10% in either direction (in magnitude).

6.21.7 Mechanical Shock Exposure Procedure

6.21.7.1 The system shall have an empty DME storage device and a fully charged battery for the primary microphone prior to the beginning of this test. The system shall be mounted on a vibration plate using the system’s provided mounting hardware and the camera shall be aimed at the test target. If multiple mounting kits are provided with the unit, the test shall be performed with each mounting kit. The test target shall have sufficient illumination to allow the system to capture an image. Power shall be applied to the system and the system shall be placed in the record mode.

6.21.7.2 Prior to running the test, set the camera zoom to its longest focal length, but be sure there are at least three lines in the frame. Focus on the test target. Make sure that at least three vertical lines are in the frame. The system under test should be running at least a few seconds prior to, during the test and a few seconds after the mechanical shock is applied. Extract a before frame and an after frame from before the application of vibration (“before frame”) and one from after the vibration is turned off (“after frame”).

6.21.7.3 The system shall be subjected to random tests detailed in SAEJ1445 as outlined in Paragraph 4.11.3.4. The mechanical shock profile is depicted in Figure 12. The mechanical shock shall be applied to each of the three mutually perpendicular axes. Each axis will subjected to three mechanical shock pulses. During the exposure to the mechanical shock pulses, the system shall continue to capture DME data. Following
each of the exposures, the stored data shall be examined for any missing DME data capture by performing the DME Verification Test specified in Section 6.22. The functionality of the video monitor shall be observed.

6.21.7.4 Extract a frame from after the exposure to shock (“after frame”). Measure the number of pixels across the displayed frames for the system under test. Measure the number of pixels between lines from both the before and after frames. Any change over 3% indicates an unacceptable change in the zoom setting due to vibration. Compare the edges of the lines on both the before and after frames. Visually different sharpness indicates an unacceptable change in focus. Measure the number of pixels from the left edge of the before frame to the closest (to the left edge) vertical line and note the line’s number. Repeat this measurement for the after frame. Subtract the pixel count for the after frame from that of the before frame and divide this by the number of pixels across the frame to get the percent frame movement. The percent frame movement should be less than 10% in either direction (in magnitude).

6.21.7.5 All results and observations shall be documented and reported.

6.21.8 Report

6.21.8.1 Each trial result shall be documented and reported.

6.21.9 Interpretation

6.21.9.1 This task is evaluated on a pass/fail basis. Each sample shall pass in order for the final result to be considered a pass.

6.22 DME Verification Test

6.22.1.1 Perform the Frame Rate Verification Test specified in Section 6.11.5.13 and measure total harmonic distortion.
7. Labeling and Information

7.1 General Product Label Requirements for VDMERS Models

7.1.1 For each compliant VDMERS model, the requirements of this section shall be met.

7.1.2 The system shall have a product label permanently and visibly attached to, stamped on or printed on the main housing of the recording unit of the system.

7.1.3 All text on the required product label shall be at least in English.

7.1.4 Symbols and other graphical information shall be permitted to be used to supplement text on the product label(s) and shall be explained in the user information.

7.1.5 The housing of the recording unit of the system shall have at least the following information printed legibly on the label(s) in letters at least 3.2 mm (1/8 in) high:

- Legal name and legal address of the VDMERS manufacturer.
- Manufacturing location address (city, state/province, country).
- Date of manufacture (i.e., month and year).
- VDMERS model number.
- Serial number.

7.2 User Information to Be Provided by VDMERS Manufacturer of VDMERS Model

7.2.1 In order for a VDMERS manufacturer to have a VDMERS model tested under this standard, the VDMERS manufacturer must agree that, if the model is found to be compliant, it will provide written user information including, but not limited to, warnings, information and instructions with each complete system (and with each component that may be acquired or provided separately).

7.2.2 The VDMERS manufacturer shall provide the required user information in such a manner as to make such information clear, prominent and immediately available to any VDMERS user.

7.2.3 The VDMERS manufacturer shall provide at least the following instructions and information with each system:

- Information from Sections 7.1.5.
- Components tested with the system. Components shall be identified by model number with allowable substitutions, their model numbers and their specifications included.
- Instructions for proper installation and use as intended by the VDMERS manufacturer, including safety considerations and user-definable settings.
- Warranty information.
- Proper care instructions, including maintenance, cleaning, inspection guidelines and frequency, recommended operating temperature range, recommended storage practices and storage life and cautions.
- If any of the components of the base unit are not dedicated exclusively to supporting system functionality, it shall be noted that system ability to share resources is not addressed under the scope of this standard. It is recommended that a risk analysis be conducted by the end user to ensure that the system is interoperable with other equipment.
- Guidelines on lifecycle and storage of removable media, if applicable.

7.2.4 Because software upgrades for the VDMERS model are anticipated, user information shall include a verification test by which it may be demonstrated that the product continues to function properly.

7.3 Technical Documentation to Be Provided by VDMERS Manufacturer

7.3.1 In order for a VDMERS manufacturer to have a VDMERS model tested under this standard, the VDMERS manufacturer must agree that, if the model is found to be compliant, it will provide technical documentation as set forth in this section for the system on request by the purchaser or prospective purchaser.

7.3.2 The technical data package shall contain all data showing compliance of the model with this standard.

7.3.3 The technical documentation shall include the VDMERS manufacturer trade name, model number, manufacturer-replaceable components, available options and accessories. Frequency response of microphone shall also be specified.

7.3.4 The technical documentation shall address accessories provided for use with the system. Any required accessories shall be considered to be tested as part of the system.
Appendix A. Figures

Figure 1. Star-Type Test Target
Figure 2. Schematic for Capturing Video for Measurement of Dynamic Range

Schematic for Capturing Video for Measurement of Dynamic Range
(not to scale)

Step tablet on platen

Light source

Sensitometer schematic

Camera from device under test
Figure 3. Device for Capturing Dynamic Modulation Video

Device for Capturing Dynamic Modulation Video
(not to scale)

- The test target is allowed to drop
- The drop distance is marked off on frame
- The field of view is $\frac{1}{4}$ of 24 feet
- The camera is placed $\frac{1}{4}$ of 35 feet away

Side view of drop frame with camera from the device under test mounted in portrait mode on a tripod

Front view of drop frame with test target
Figure 4. Brightness Values for Analog vs. Digital Video

Sample Cameras

Vertical axis is brightness value, 0 – 255
Horizontal axis is test target brightness in relative $\log_{10}(\text{Lux} - \text{seconds})$
Figure 5. Actual VDMERS Example

DR of 2.1 Log E
Figure 6. Microphone to Receiver Test Schematic

1. CD player
2. DUT microphone
3. Reference microphone
4. DUT Receiver
5. Pick up microphone
6. Mixer
7. Polarity switch
8. True RMS voltmeter
9. Oscilloscope
10. Computer
11. Oscillator
12. Delay line
Appendix B. UL 639, Standard for Safety for Intrusion-Detection Units, Table 43.

The table provided in this annex is taken from UL639:2007, Table 43.1

**Maximum temperature rises**

<table>
<thead>
<tr>
<th>Materials and components</th>
<th>Standby, °C</th>
<th>Operation under holdup condition, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td><strong>A. MOTORS</strong>&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Class A insulation systems on coil windings of alternating-current motors 7 inches (178 mm) or less in diameter (not including universal motors):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) In open motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple or resistance method</td>
<td>75</td>
<td>135</td>
</tr>
<tr>
<td>b) In totally enclosed motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple or resistance method</td>
<td>80</td>
<td>144</td>
</tr>
<tr>
<td>2. Class A insulation systems on coil windings of alternating-current motors more than 7 inches (178 mm) in diameter and of direct-current and universal motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) In open motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>65</td>
<td>117</td>
</tr>
<tr>
<td>Resistance method</td>
<td>75</td>
<td>135</td>
</tr>
<tr>
<td>b) In totally enclosed motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>70</td>
<td>126</td>
</tr>
<tr>
<td>Resistance method</td>
<td>80</td>
<td>144</td>
</tr>
<tr>
<td>3. Class B insulation systems on coil windings of alternating-current motors 7 inches (178 mm) or less in diameter (not including universal motors):</td>
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<td></td>
</tr>
<tr>
<td>a) In open motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple or resistance method</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>b) In totally enclosed motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple or resistance method</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>Materials and components</td>
<td>Standby,</td>
<td>Operation under holdup condition,</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>4. Class B insulation systems on coil windings of alternating-current motors more than 7 inches (178 mm) in diameter and of direct-current and universal motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) in open motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>85</td>
<td>153</td>
</tr>
<tr>
<td>Resistance method</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>b) in totally enclosed motors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>90</td>
<td>162</td>
</tr>
<tr>
<td>Resistance method</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>B. COMPONENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Capacitors:</td>
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<td></td>
</tr>
<tr>
<td>a) Electrolytic types</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>b) Other types</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>2. Rectifiers – at any point:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Germanium</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>b) Selenium</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>c) Silicon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Maximum 80 percent of rated volts</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>2) 61 percent or more of rated volts</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>3. Relay, solenoid, transformer and other coils with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Class 105 insulation system:</td>
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<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
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<td>45</td>
</tr>
<tr>
<td>Resistance method</td>
<td>35</td>
<td>63</td>
</tr>
<tr>
<td>b) Class 130 insulation system:</td>
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<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>46</td>
<td>81</td>
</tr>
<tr>
<td>Resistance method</td>
<td>55</td>
<td>99</td>
</tr>
<tr>
<td>c) Class 155 insulation system:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Class 2 transformers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>95</td>
<td>171</td>
</tr>
<tr>
<td>Resistance method</td>
<td>115</td>
<td>207</td>
</tr>
<tr>
<td>2) Power transformers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>110</td>
<td>198</td>
</tr>
<tr>
<td>Resistance method</td>
<td>115</td>
<td>207</td>
</tr>
<tr>
<td>d) Class 180 insulation system:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Class 2 transformers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>115</td>
<td>207</td>
</tr>
<tr>
<td>Resistance method</td>
<td>135</td>
<td>243</td>
</tr>
<tr>
<td>2) Power transformers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermocouple method</td>
<td>125</td>
<td>225</td>
</tr>
<tr>
<td>Resistance method</td>
<td>135</td>
<td>243</td>
</tr>
<tr>
<td>4. Resistors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Carbon</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>b) Wire wound</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>c) Other</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>5. Solid state devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Other components and materials:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Fiber used as electrical insulation or cord bushings</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Materials and components</td>
<td>Standby, °C</td>
<td>Operation under holdup condition, °C</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>b) Varnished cloth insulation</td>
<td>25  45</td>
<td>60  108</td>
</tr>
<tr>
<td>c) Thermoplastic materials</td>
<td>25  45</td>
<td>60  108</td>
</tr>
<tr>
<td>d) Phenolic composition used as electrical insulation or as parts where deterioration results in a risk of fire or electric shock</td>
<td>25  45</td>
<td>65  117</td>
</tr>
<tr>
<td>e) Wood or other combustibles</td>
<td>25  45</td>
<td>65  117</td>
</tr>
<tr>
<td>f) Sealing compound</td>
<td>25  45</td>
<td>65  117</td>
</tr>
<tr>
<td>g) Fuses</td>
<td>25  45</td>
<td>65  117</td>
</tr>
<tr>
<td><strong>C. CONDUCTORS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Appliance wiring material</td>
<td>25°C (45°F) less than the temperature limit of the wire</td>
<td></td>
</tr>
<tr>
<td>2. Flexible cord (for example, SJO, SJT)</td>
<td>35  63</td>
<td>35  63</td>
</tr>
<tr>
<td>3. Conductors of field-wired circuits to be permanently connected to the product</td>
<td>35  63</td>
<td>35  63</td>
</tr>
<tr>
<td><strong>D. GENERAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. All surfaces of the product and surfaces adjacent to or upon which the product may be mounted</td>
<td>65  117</td>
<td>65  117</td>
</tr>
<tr>
<td>2. Surfaces intended to be contacted by the user in operating the unit (control knobs, push buttons, levers, and the like):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Metal</td>
<td>35  63</td>
<td>35  63</td>
</tr>
<tr>
<td>b) Nonmetallic</td>
<td>60  108</td>
<td>60  108</td>
</tr>
<tr>
<td>3. Surfaces subjected to casual contact by the user (enclosure, grille, and the like):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Metal</td>
<td>45  117</td>
<td>45  117</td>
</tr>
<tr>
<td>b) Nonmetallic</td>
<td>65  117</td>
<td>65  117</td>
</tr>
</tbody>
</table>

- The motor diameter is to be measured in the plane of the laminations of the stator frame, excluding lugs, boxes, and the like, used solely for motor cooling, mounting, assembly, or connection.
- Coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting of these devices (for example, a coil immersed in sealing compound) or unless the coil wrap includes thermal insulation such as more than two layers, 1/32 inch (0.8 mm) maximum, of cotton, paper, rayon, or the like. For a thermocouple measured temperature of a coil of an alternating-current motor having a diameter of 7 inches (178 mm) or less, the thermocouple is to be mounted on the integrally applied insulation on the conductor. At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by a thermocouple may exceed the indicated maximum, if the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table.
- 1) 5°C (9°F) for Class A insulation on coil windings of alternating-current motors having a diameter of 7 inches (178 mm) or less, open type.
- 2) 10°C (18°F) for Class B insulation on coil windings of alternating-current motors having a diameter of 7 inches or less, open type.
- 3) 15°C (27°F) for Class A insulation on coil windings of alternating-current motors having a diameter of more than 7 inches (178 mm), open type.
- 4) 20°C (36°F) for Class B insulation on coil windings of alternating-current motors having a diameter of more than 7 inches (178 mm), open type.
- For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure shall not be more than 65°C (117°F).
- A capacitor that operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.
- The temperature rise of a resistor may exceed the values shown when the power dissipation is 50 percent or less of the manufacturer’s rating.
<table>
<thead>
<tr>
<th>Materials and components</th>
<th>Standby, °C (°F)</th>
<th>Operation under holdup condition, °C (°F)</th>
</tr>
</thead>
</table>

7 The temperature of a solid state device (for example, transistor, SCR, integrated circuits) shall not exceed 50 percent of its rating during the Normal Standby Condition. The temperature of a solid state device shall not exceed 75 percent of its rated temperature under the Holdup Condition or any other condition of operation that produces the maximum temperature dissipation of its components. For reference purposes 0°C (32°F) shall be 0 percent. For integrated circuits, the loading factor shall not exceed 50 percent of its rating under the Normal Standby Condition and 75 percent under any other condition of operation. Both solid state devices and integrated circuits may be operated up to the maximum ratings under any one of the following conditions:

1) The component complies with the requirements of MIL-STD-883E.
2) A quality control program is established by the manufacturer consisting of an inspection stress test followed by operation of 100 percent of all components, either on an individual basis, as part of a subassembly, or equivalent.
3) Each assembled production unit is subjected to a burn-in test, under the condition that results in the maximum temperatures, for 24 hours while connected to a source of rated voltage and frequency in an ambient of at least 49°C (120°F).

9 The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and rated for higher temperatures than those specified in Table 39.1.

h For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code, ANSI/NFPA 70. The maximum temperature rise in any case is 25°C (77°F) less than the temperature limit of the wire in question.