METRIC

MIL-PRF-62546C
26 January 2010

SUPERSEDING
MIL-PRF-62546B(AT)
5 January 1998

PERFORMANCE SPECIFICATION

SENSOR, FIRE, OPTICAL

This specification is approved for use by the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC), Research, Development and Engineering Command (RDECOM), Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers two types of optical fire sensor assemblies (OFSAs), components of the Halon 1301 automatic fire extinguishing systems used in military vehicles. The OFSA detects and signals the presence of a hydrocarbon fire requiring a system response (see 6.1).

1.2 Classification. OFSAs will be of the following types, as specified (see 6.2):

Type I	-	Discriminatory
Type II	-	Non-discriminatory

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

Comments, suggestions, or questions on this document should be addressed to U.S. Army RDECOM, Tank Automotive Research, Development and Engineering Center, ATTN: RDTA-EN/STND/TRANS MS#268, 6501 E. 11 Mile Road, Warren, MI 48397-5000 or emailed to DAMI_STANDARDIZATION@conus.army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

AMSC N/A FSC 6665

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (See 4.3.1)
MIL-STD-810	-	Environmental Test Methods and Engineering Guidelines

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

U.S. ARMY TACOM DRAWINGS

12343265	-	Connector, Electrical Receptacle (Interface)
12370458	-	Optical Fire Sensor Assembly (Interface)

TEST PROCEDURES

Nuclear Survivability Criteria	-	Nuclear Survivability Criteria for the Automatic Fire Extinguishing System (AFES) (U). Document is classified “Confidential”. (see 6.9)

(Copies of these documents are available from DAMI_STANDARDIZATION@conus.army.mil or U.S. Army RDECOM, Tank Automotive Research, Development and Engineering Center, ATTN: RDTA-EN/STND/TRANS MS #268, 6501 E. 11 Mile Road, Warren, MI 48397-5000.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

ASTM INTERNATIONAL

ASTM G21 - Determining Resistance of Synthetic Polymeric Materials to Fungi, Standard Practice for

(Copies of these documents are available from www.astm.org or ASTM International, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2 and 6.3), a sample shall be subjected to first article inspection in accordance with 4.1.1.

3.2 Design, materials, and manufacturing processes. Unless otherwise specified (see 6.2), the design, materials, and manufacturing process selection is the prerogative of the contractor as long as all items fully meet the operating, interface, ownership and support, and operating environment requirements specified.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials shall be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Operating requirements. The OFSA shall be designed to function in a military vehicle automatic fire extinguishing system. The OFSA shall optically detect and signal the presence of a hydrocarbon fire. The OFSA shall provide signals in response to the built-in-test-equipment (BITE), indicating its functional condition. Each OFSA shall provide the following functional, operational, and performance capabilities.

3.3.1 BITE. The OFSA shall conduct a total electronic check (see 3.3.3.1.3) when it receives a BITE activation signal on pin E (see table III). Each OFSA shall generate optical stimuli causing the OFSA to generate both a small fire and a large fire signal. The stimuli source may be external to the OFSA protective window(s). A check for dirty sensor windows shall be included (see 4.3.3.1).

3.3.2 Voltage characteristics. The OFSA shall conform to appendix A without loss of effectiveness and without causing damage or malfunction to interfacing components. The OFSA shall not false alarm before, during, or after testing (see 4.3.3.1 and 6.6.3).

3.3.3 Performance. The OFSA shall be capable of detecting hydrocarbon mist or surface fires, differentiating between large and small fires and providing an appropriate output response. Response to a large or small fire shall be an output signal "A" at connector pin C and/or D (see table III). Signal "A" is defined as 10 to 30 volts direct current (Vdc), source output impedance less than or equal to 2000 ohms, load output impedance less than or equal to 20,000 ohms; Quiescent conditions: 1 Vdc maximum, input impedance (source and load) greater than or equal to 20,000 ohms. Specific response requirements are given in subsequent paragraphs.

3.3.3.1 Response characteristics. The OFSA shall respond to radiation stimuli as indicated in the following paragraphs.

3.3.3.1.1 Field of view (FOV). The FOV of the OFSA shall be, as a minimum, a 90 degree (°) solid cone. Anywhere within the FOV the OFSA shall meet the response characteristic requirements specified herein. (see 4.3.3.2)

3.3.3.1.2 Thresholds. The OFSA shall respond to two discrete energy threshold levels: A lower energy threshold, small fire, and a higher energy threshold, large fire.

3.3.3.1.2.1 Small fire. The OFSA shall generate a SMALL FIRE SIGNAL on pin D (see table III) within 5 seconds (s) and as long as fire exceeds threshold (see 4.3.3.3).

3.3.3.1.2.2 Large fire. The OFSA shall generate a LARGE FIRE SIGNAL on pins C and D (see table III) within 5 s and for as long as fire exceeds threshold (see 4.3.3.4).

3.3.3.1.3 BITE characteristics. Upon receipt of a BITE signal on pin E (see table III), the OFSA shall generate optical stimuli to perform a complete functional self test (see 3.3.1). If the OFSA is functioning properly and the optical window(s) does not require cleaning, the OFSA shall generate FIRE signals for less than 5 millisecond (ms) on pins C and D within 5 s after start of BITE signal. If the OFSA is not functioning properly or requires window cleaning, it shall not generate output FIRE signals from a BITE signal (see 4.3.3.5).

3.3.3.1.4 Response time. At all temperatures between -17 and 71 °C (1 and 160 °F), the OFSA shall respond to radiation and provide the appropriate signal(s) within the following times (see 4.3.3.6):

	Time (ms)
a. Type I OFSA	4
b. Type II OFSA	3

3.3.3.1.5 Penetration response time. The OFSA shall respond within the time specified in 3.3.3.1.4, to a hydrocarbon fire ignited subsequent to and resulting from penetration of steel and aluminum armor by threat munitions (see 4.3.3.8).

3.3.3.2 False alarm susceptibility. The OFSA shall respond to radiation stimuli as indicated in the following paragraphs.

3.3.3.2.1 Radiation stimuli. The OFSA shall not respond at distances equal to or greater than the immunity distance when exposed to the radiation sources of table I throughout the FOV of the OFSA (except for chopped light requirements) (see 4.3.3.7 through 4.3.3.7.15).

3.3.3.2.2 Penetrating munitions. Type I OFSAs shall not respond to the high intensity, short duration emissions (in relation to hydrocarbon fires) caused by munition penetration of aluminum and steel armors. The OFSA shall demonstrate a minimum discrimination level (not generate large fire signals on pin C) as shown in table II (see 4.3.3.8).

3.3.3.2.3 Nuclear hardening. Requirements for nuclear survivability shall be as specified in a separate classified (confidential) document entitled "Nuclear Survivability Criteria for the Automatic Fire Extinguishing System (AFES)" (U) (see 4.3.3.9 and 6.9).

3.3.3.2.4 Slow growth pan-fire. The OFSA shall generate output signal "A" on pins C and D when exposed to a slow growth pan-fire (4.3.3.10 and 4.3.3.10.1).

3.3.3.3 Start-up. The OFSA shall not false alarm upon the application of 15 to 30 Vdc step inputs across pins A and B (initial power-on condition) (see 4.3.3.11).

3.3.3.4 Power. The OFSA shall be effective over an input voltage range of 15 to 30 Vdc, in accordance with appendix A, and shall not require more than 150 milliamperes (mA) when active. The OFSA shall not draw more than 15 mA nor less than 7.5 mA during quiescent operation (see 4.3.3.12).

3.3.3.4.1 Input voltage decay. The OFSA shall not false alarm (produce small or large fire output signals) when undergoing input voltage decays resulting from prolonged operation without recharging of the battery (see 4.3.3.13).

3.3.3.4.2 Steady state voltage extremes. The OFSA shall sustain no damage from the application of any steady state voltage up to 40 Vdc. Subsequently, the OFSA shall meet the requirements of 3.3.3.1 and 3.3.3.2 (see 4.3.3.14).

3.3.3.5 Electromagnetic interference (EMI). The OFSA shall meet the requirements specified below (see 4.3.3.15).

3.3.3.5.1 Conducted emissions (30 Hz to 50 kilohertz (kHz)). Electromagnetic emissions shall not appear on dc power lead (primary or secondary) in excess of the values shown in figure 1.

3.3.3.5.2 Conducted emissions (10 kHz to 50 megahertz (MHz)). Electromagnetic emissions shall not appear on ac or dc power leads in excess of the values shown in figures 1 through 4.

TABLE I. False alarm susceptibility.

Radiation source description	Immunity distance mm 1/ (in. 1/)	
	Small fire	Large fire
Sunlight	IAD 2/	IAD
Incandescent frosted glass light, 100 Watt (W)	150 (6)	25 (1)
Incandescent clear glass light, rough service, 100 W	225 (9)	50 (2)
Fluorescent light with white enamel reflector, standard office or shop, 40 W (or two 20 W)	150 (6)	IAD
Electrical arc [12 mm (15/32 in.) gap at 4000 V 1/ alternating current, 60 Hz 1/]	25 (1)	25 (1)
Ambient light extremes (vehicle darkness to bright light with snow, water, rain, desert glare and fog)	IAD	IAD
Bright color clothing, including red and safety orange at 1500 mm (60 in.) and to near zero	IAD	IAD
Electronic flash (180 watt-seconds minimum output)	450 (18)	225 (9)
Movie light, 625 W quartz DWY lamp (Sylvania S.G.-55 or equivalent)	1200 (48)	600 (24)
Red vehicular dome light	IAD	IAD
Blue-green vehicular dome light 24 V of direct current (dc)	IAD	IAD
Flashlight	IAD	IAD
Indirect or reflected sunlight	IAD	IAD
Chopped light - individual sources	3/	3/
Chopped light - combination of sources	4/	4/
Radiation heater, 1500 W	900 (36)	450 (18)
Radiation heater, 1000 W with fan	600 (24)	300 (12)
Arc welding 4 mm (5/32 in.) rod; 300 A 1/	1500 (60)	300 (12)
Acetylene welding 00 tip, 16 x 150 mm (5/8 by 6 in.) flame	1500 (60)	300 (12)
Rifle flash from M16 rifle	250 (10)	50 (2)
Muzzle flash from 105 mm gun	5/	5/
Lit cigar	100 (4)	25 (1)
Lit cigarette	100 (4)	25 (1)
Match, wood, including flare up	300 (12)	100 (4)
Match, paper, including flare up	200 (8)	100 (4)

1/ Abbreviations as follows:

mm	millimeters	in.	inches
V	volts	A	amperes
Hz	hertz		

2/ Immune at Any Distance (IAD). Includes the case when stimuli is physically as near the sensor as possible.
3/ To be the same immunity distance as when not chopped.
4/ The immunity distance of the combination indicated when not chopped, for instance, 300 and 50 mm (12 and 2 in.), the immunity distance is 300 mm (12 in.) for combination.
5/ Distances to be observed.

TABLE II. Discrimination performance.

Armor	Munition	Discrimination requirement
32 mm (1.25 in.) aluminum	25 mm (1 in.) kinetic energy	90%
51 mm (2 in.) steel	38 mm (1.5 in.) chemical energy	90%
32 mm (1.25 in.) steel applique over 25 mm (1 in.) aluminum with spall liners	89 mm (3.5 in.) chemical energy	90%

3.3.3.5.3 Conducted susceptibility (30 Hz to 50 kHz). Performance characteristics shall not degrade beyond the tolerances given herein when subjected to electromagnetic energy injected on its dc power leads equal to or less than the values shown in figure 5.

3.3.3.5.4 Conducted susceptibility (50 kHz to 400 MHz). Performance characteristics shall not degrade beyond the tolerances given herein when subjected to the specified power levels on figure 6 are applied to the equipment power input terminals.

3.3.3.5.5 Conducted susceptibility. There shall be no degradation of performance or malfunction when the spike shown in figure 7 is applied to the ac or dc power input lines.

3.3.3.5.6 Radiated emissions. Field emissions in the frequency range of 14 kHz to 10 gigahertz (GHz) shall not be generated and radiated in excess of the values shown in figure 8 at the test distances of 3 meters (m) on each face of the enclosure with the door and hatches open.

3.3.3.5.7 Radiated susceptibility. There shall be no malfunction, degradation of performance, or deviation from specified indications beyond tolerances given herein when subjected to the spike shape shown in figure 7, where E=100 V across 10 ohms, or the following radiated fields:

10 kHz to 400 MHz	Sheltered	Nonsheltered
10 kHz - 1.9 MHz	10 volt/meter (V/m)	1 V/m
2.0 MHz - 29.99 MHz	20 V/m	5 V/m
30 MHz - 400 MHz	50 V/m	10 V/m

2 MHz - 12 GHz	Nonsheltered
2 MHz - 29.9 MHz	5 V/m
30 MHz - 299 MHz	10 V/m
300 MHz - 1999 MHz	10 V/m
2000 MHz - 12.4 GHz	5 V/m

In addition, the Narrowband Conducted Emissions shall be in accordance with the limits of figure 9.

3.4 Interface requirements (see 4.3.4).

3.4.1 Electrical interface. Electrical interface shall be provided through the use of a connector conforming to the interface and envelope dimensions of Drawing 12343265-1. Pin assignments shall be as specified in table III.

TABLE III. OFSA connector pin definition index.

PIN	Function	In/Out
A	POWER	IN
B	RETURN	IN/OUT
C	LARGE FIRE SIGNAL	OUT
D	SMALL FIRE SIGNAL	OUT
E	BUILT IN TEST	IN
F	CODE PIN F	
G	CODE PIN G	
H	UNUSED	

3.4.2 Configuration. The OFSA shall conform to the interface and envelope dimensions of Drawing 12370458.

3.4.3 Vehicle armor type coding. The OFSA shall be capable of operating in either a steel or an aluminum armored vehicle. The vehicle wiring harness will provide coded information as to which type of armor by way of two connector pins at each OFSA. Pins F and G (see table III) will be connected within the harness for aluminum armored vehicles and will not be used for steel armored vehicles. This coded information may be used by the OFSA manufacturer to modify sensor logic for steel or aluminum applications. If the OFSA logic is independent of armor type, the two code pins shall not be used.

3.5 Ownership and support requirements (4.3.5).

3.5.1 Reliability. The OFSA shall have not less than 100 000 operating hours between failures. A failure shall be defined as any OFSA malfunction which prevents the component from responding as specified.

3.5.2 Dissimilar metals. Dissimilar metals shall not be used in intimate contact without protection from galvanic corrosion.

3.5.3 Encapsulation. Encapsulation, if used, shall be of the kind that allows for removal for repair.

3.5.4 Safety. The transmission shall not produce any hazards to personnel or the environment resulting from the use of asbestos, cadmium, or other radioactive material.

3.5.5 Finish. All component exterior surfaces of the OFSA, except lens windows, mounting surfaces, and electrical connector, shall be painted according to manufacturer's standard practices.

3.5.6 Identification marking. Markings shall be permanent and legible and shall be on a nameplate which shall be firmly attached to the OFSA in a conspicuous location. The nameplate shall have the following minimum information:

a. Manufacturer's identification
b. Serial number
c. Military part number
d. Part or identifying number (PIN)
e. Federal stock number

3.6 Operating environment requirements. The OFSA shall produce no false alarms during or after exposure to the following environments. The OFSA shall function properly, evidence no deterioration, and meet the requirements of 3.3.3.1 and 3.3.3.2.1 after exposure. The OFSA shall also demonstrate the ability to detect fires and meet the requirements of 3.3.3.1.3 during exposure to the environments of 3.6.1.1 through 3.6.1.3, 3.6.2, and 3.6.8 (see 4.3.6).

3.6.1 Temperature.

3.6.1.1 High temperature. The OFSA shall meet the requirements of 3.6 during and after extended exposure to a temperature of 125 degrees Celsius (°C) (257 degrees Fahrenheit (°F)) (4.3.6.1.1).

3.6.1.2 Low temperature. The OFSA shall meet the requirements of 3.6 during and after extended exposure to a temperature of -51 °C (-60 °F) (see 4.3.6.1.2).

3.6.1.3 Temperature shock. The OFSA shall meet the requirements of 3.6 when exposed to rapid changes of temperature between -51 and +71 °C (-60 and +160 °F) (see 4.3.6.1.3).

3.6.2 Vibration. The OFSA shall meet the requirements of 3.6 when exposed to severe vibration (see 4.3.6.2).

3.6.3 Shock. The OFSA shall meet the requirements of 3.6 when subject to severe shock (4.3.6.3).

3.6.4 Leakage.

3.6.4.1 Water immersion. The OFSA shall meet the requirements of 3.6 and shall not leak when immersed in water (4.3.6.4.1).

3.6.4.2 Diesel fuel immersion. The OFSA shall meet the requirements of 3.6 and shall not leak when immersed in diesel fuel (4.3.6.4.2).

3.6.4.3 Water jet. The OFSA shall meet the requirements of 3.6 and shall not leak when exposed to water jet cleaning (4.3.6.4.3).

3.6.5 Salt fog. The OFSA shall meet the requirements of 3.6 and shall show no evidence of corrosion after prolonged exposure to a salt laden atmosphere (4.3.6.5).

3.6.6 Fungus. The OFSA shall meet the requirements of 3.6 following prolonged exposure, in a non-operating mode, to an environment favorable to fungus growth (see 4.3.6.6).

3.6.7 Sand and dust. The OFSA shall meet the requirements of 3.6 after exposure to air driven sand and dust (4.3.6.7).

3.6.8 Humidity. The OFSA shall meet the requirements of 3.6 when operated in a high humidity environment (see 4.3.6.8).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.1.1)
b. Conformance inspections (CI) (see 4.1.2)

4.1.1 First article inspection. First article inspection shall consist of all the examinations and tests of this specification, as specified in table IV (see 6.3).

4.1.2 CI. CI shall include the examinations and tests listed in table IV as defined by the contract (see 6.4).

4.2 Order of inspection. Perform tests in any order.

4.3 Verification methods. Acceptable verification methods shall include visual and tactile inspection, functional manipulation, measurement, sample tests, full-scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

TABLE IV. Verification methods.

Title	Require-ment	Verifica-tion	Title	Require-ment	Verifica-tion
Operating requirements	3.3	4.3.3	Radiated susceptibility	3.3.3.5.7	4.3.3.15
BITE	3.3.1	4.3.3.1	Interface requirements	3.4	4.3.4
Voltage characteristics	3.3.2	4.3.3.1	Electrical interface	3.4.1	4.3.4
FOV	3.3.3.1.1	4.3.3.2	Configuration	3.4.2	4.3.4
Small fire	3.3.3.1.2.1	4.3.3.3	Vehicle armor type coding	3.4.3	4.3.4
Large fire	3.3.3.1.2.2	4.3.3.4	Ownership and support	3.5	4.3.5
			Reliability	3.5.1	4.3.5
BITE characteristics	3.3.3.1.3	4.3.3.5	Dissimilar metals	3.5.2	4.3.5
Response time	3.3.3.1.4	4.3.3.6	Encapsulation	3.5.3	4.3.5
Penetration response	3.3.3.1.5	4.3.3.8	Safety	3.5.4	4.3.5
Radiation stimuli	3.3.3.2.1	4.3.3.7 -	Finish	3.5.5	4.3.5
		4.3.3.7.15	Identification	3.5.6	4.3.5
Penetrating munitions	3.3.3.2.2	4.3.3.8	Environmental	3.6	4.3.6
Nuclear hardening	3.3.3.2.3	4.3.3.9	requirements		
Slow growth pan-fire	3.3.3.2.4	4.3.3.10,	High temperature	3.6.1.1	4.3.6.1.1
		4.3.3.10.1	Low temperature	3.6.1.2	4.3.6.1.2
Start-up	3.3.3.3	4.3.3.11	Temperature shock	3.6.1.3	4.3.6.1.3
Power	3.3.3.4	4.3.3.12	Vibration	3.6.2	4.3.6.2
Input voltage decay	3.3.3.4.1	4.3.3.13	Shock	3.6.3	4.3.6.3
Steady state voltage	3.3.3.4.2	4.3.3.14	Leakage	3.6.4	4.3.6.4
EMI	3.3.3.5	4.3.3.15	Water immersion	3.6.4.1	4.3.6.4.1
Conducted emissions	3.3.3.5.1,	4.3.3.15	Diesel fuel immersion	3.6.4.2	4.3.6.4.2
	3.3.3.5.2		Water jet	3.6.4.3	4.3.6.4.3
Conducted susceptibility	3.3.3.5.3,	4.3.3.15	Salt fog	3.6.5	4.3.6.5
	3.3.3.5.4,		Fungus	3.6.6	4.3.6.6
	3.3.3.5.5		Sand and dust	3.6.7	4.3.6.7
Radiated emissions	3.3.3.5.6	4.3.3.15	Humidity	3.6.8	4.3.6.8

4.3.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost effective sampling procedures to verify performance. See the contract (see 6.2) for alternatives that replace verification methods required by this specification.

4.3.2 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature: 23 ± 10 °C (73 ± 18 °F)
b. Barometric pressure: 725 (+50, -75) mm [28.5 (+2, -3) in.] of mercury (Hg)
c. Relative humidity: 50 ± 30 percent (%)

4.3.2.1 Test temperature stabilization. Tests shall be conducted after the test sample has been allowed sufficient time for temperature stabilization. Test temperature stabilization is the point at which the test sample will not vary in temperature more than 2 °C (3.6 °F) per hour.

4.3.3 Operating requirements verification.

4.3.3.1 Features. To determine conformance to 3.3.1 and 3.3.2, exercise and qualitatively observe the OFSA to determine that specified characteristics and features are present and functional.

4.3.3.2 FOV. To determine conformance to 3.3.3.1.1, the OFSA shall meet the specified requirements throughout its FOV. The OFSA shall be tested directly facing the stimulus, shall be repeated with the stimulus at ±45 degrees (°) from straight ahead (in one plane) and then at ±45° in another plane approximately 90° to the first. The test shall then be repeated while the OFSA is facing directly into the sun and after the OFSA has been immersed in diesel fuel three times (air dried between each immersion without cleaning the optical surfaces).3.3.3.1.1

4.3.3.3 Small fire. To determine conformance to 3.3.3.1.2.1, the OFSA shall output a fire signal at pin D within specified time in response to a 130 mm (5 in.) diameter pan-fire, 76 mm (3 in.) minimum depth containing 840 cubic centimeters (cm^3) (51 cubic inches (in^3)) of diesel fuel (see 6.8), at a distance of 1200 mm (48 in.) from the OFSA. No large fire signal shall be generated on pin C. The FOV shall be checked in accordance with 4.3.3.2 by repeating this procedure four times. The test shall be repeated while the OFSA is facing directly into the sun and after the OFSA has been immersed in diesel fuel three times (air dried between each immersion without cleaning the optical surfaces).

4.3.3.4 Large fire. To determine conformance to 3.3.3.1.2.2, the procedure of 4.3.3.3 shall be repeated except that the pan-fire shall be 380 mm (15 in.) from the OFSA. The OFSA shall respond within specified time by producing signal “A” at pins C and D as shown in table III. The test shall be repeated while the OFSA is facing directly into the sun and after the OFSA has been immersed in diesel fuel three times (air dried between each immersion without cleaning the optical surfaces).

4.3.3.5 BITE. To determine conformance to 3.3.3.1.3, the OFSA shall be provided with a BITE signal as specified in table III. Examine for proper voltage, current, and duration of signal. The test shall be repeated simulating a dirty OFSA window(s). The test shall then be repeated with the optical lens or window facing directly into the sun.

4.3.3.6 Response time. To determine conformance to 3.3.3.1.4, the OFSA shall be placed at a distance of 380 mm (15 in.) to the centerline of the pan from a 250 mm (10 in.) diameter pan-fire, 76 mm (3 in.) deep, containing 3100 cm^3 (188 $in.^3$) of diesel fuel (see 6.8), and checked for performance requirements. The test shall be repeated four times in accordance with 4.3.3.2 to check response at the FOV limits. The tests shall be repeated at -17 and 71 °C (1 and 160 °F) at the FOV limits. The tests shall then be repeated at 15 and 30 Vdc at the FOV limits.

4.3.3.7 Radiation stimuli. To determine conformance to 3.3.3.2.1, the threshold immunity distance of the OFSA shall be tested to determine the small fire and the large fire sensitivity limits so that the system can be operated safely without concern of false alarms

(see 6.6.3). Unless otherwise specified herein, three types of tests shall be conducted with each non-transient radiation source listed in table I: system on, source turned on and off; source on, system turned on and off (see 4.3.3.7.15); and, chopped light. The FOV shall be checked in accordance with 4.3.3.2 during all tests except for ballistic tests and chopped light tests which shall be conducted only in the straight ahead sensor position. Unless otherwise specified herein, during chopped light tests the OFSA shall be exposed for a period of not less than 20s total exposure time at each 200 cycle/minute increment over the range of near 0 to 1600 cycles/minute (where one cycle consists of an exposure time followed by an equal non-exposure time). The chopped light tests shall be conducted as specified in 4.3.3.7.1 through 4.3.3.7.3, 4.3.3.7.5, 4.3.3.7.6, 4.3.3.7.8, and 4.3.3.7.9.

4.3.3.7.1 Headlight. A 24 V, double filament, vehicular, low-beam headlight shall be placed directly in front of the OFSA so that the beam directly hits the OFSA at a distance of 300 mm (12 in.). The headlight shall be connected to a 28 Vdc power source. The light shall twice be turned on by means of an in-line switch, left on for not less than 5 s, and then turned off for not less than 5 s. The light shall then be turned on and left on, and the OFSA shall be turned on and off twice with 5 s between each switching action. This test shall be repeated four times in accordance with 4.3.3.2 to check the 90° FOV of the OFSA. The distance between the OFSA and light source shall be changed to the large fire immunity distance 100 mm (4 in.), and the test shall be repeated. The chopped light test shall be conducted at speeds from near zero to 1600 cycles/minute in 200 cycles/minute increments. The small and large fire thresholds shall meet the requirements of 3.3.3.2.1 and the vehicular headlight and the chopped light (individual sources) requirements as specified in table I.

4.3.3.7.2 Sun. The OFSA shall be positioned to directly face the sun. The OFSA shall be turned on and off twice with 10 s between each switching action. Then the OFSA shall be switched on and rotated for 20 cycles in a 90° arc within the FOV at a rate of approximately 90° per second. The chopped light simulator tests, straight ahead only, as indicated in 4.3.3.7, shall be conducted. The OFSA shall meet the requirements in 3.3.3.2.1 and the sunlight requirements as specified in table I.

4.3.3.7.3 Simulated hatch opening. The procedure in 4.3.3.7.9 shall be conducted, except the light sources shall be replaced by direct sunlight simulating an ambient light extreme with vehicle hatch covers open and/or ramp down. The OFSA shall be placed in a horizontal position with the following foreground, at separate times:

a. Green grass
b. Desert sand, simulating desert glare
c. Snow
d. Fresh (sweet) water

The OFSA shall meet the ambient light extremes and the chopped light (combination of sources) requirements as specified in table I.

4.3.3.7.4 Bright clothing. The following colored materials shall be placed, at separate times, directly in front of the OFSA at a distance of 300 mm (12 in.):

a. Fluorescent orange: (heat treated, plain weave, single yarn, nylon cloth) US Army shade 230.
b. Fluorescent red: (heat treated, plain weave, single yarn, nylon cloth) US Army shade 229.
c. Bright yellow: Commercial grade.

A 40 W fluorescent light with white enamel reflector, placed 300 mm (12 in.) above and 300 mm (12 in.) behind the OFSA, shall be beamed at the material in such a manner that the highest reflected light intensity shall be seen by the OFSA. The fluorescent light shall be switched on and off for 5 s each, 10 times. The light shall then be turned on and remain on while the OFSA is turned on and off 10 times with 5 s between each switching action. The OFSA or material will be moved inward in increments of 50 mm (2 in.) until 50 mm (2 in.) distance is reached. The test shall be repeated at each increment including the 50 mm (2 in.) distance. The chopped light simulator test indicated in 4.3.3.7 shall be conducted at each increment from 300 to 50 mm (12 to 2 in.) distance while the light is turned on. The entire test shall then be repeated with the following combination of light sources replacing the fluorescent light: Headlight (double filament, 24 V, low-beam) and a flashlight with a red filter (see 4.3.3.7.6); headlight and incandescent light (frosted, 100 W); headlight and movie light (625 W DWY quartz); and a movie light and incandescent light. The OFSA shall meet the bright color clothing requirement as specified in table I.

4.3.3.7.5 Colored material. The colored material of 4.3.3.7.4 shall be placed in front of the OFSA in the same manner as the headlight in 4.3.3.7.1, except the light source shall be bright sunlight. The OFSA shall be placed so that the sun is above and behind the OFSA at 45 to 60° from the horizontal. The OFSA shall be moved from side to side and rotated in view of the material and then out of view, as rapidly as possible for 30 s. The 90° FOV shall be checked in accordance with 4.3.3.2. The chopped light simulator test as indicated in 4.3.3.7.1 shall be repeated. The OFSA shall meet the requirements of 3.3.3.2.1 and the bright color clothing requirements as specified in table I.

4.3.3.7.6 Flashlight. The flashlight shall be a commercial standard right-angle 2-D cell flashlight with the addition of a red filter lens fixed over the clear lens. The filter lens shall be aviation red (see 6.10). The flashlight, using the red lens over the clear lens, shall be positioned directly in front of the OFSA so that the beam hits the OFSA directly at near zero distance. The flashlight shall twice be turned on for not less than 5 s and then turned off. The flashlight shall then be turned on and remain on while the OFSA is turned on and off twice with 5 s between switching actions. This test shall be repeated to check the FOV limits in accordance with 4.3.3.2. A test shall be conducted with the flashlight in the on position continuously using the chopped light simulator as indicated in 4.3.3.7. The OFSA shall meet the flashlight and chopped light (individual sources) requirements as specified in table I.

4.3.3.7.7 Reflected light. A white enamel reflector, measuring 600 by 600 mm (24 by 24 in.) square, shall be placed vertically in front of the OFSA at a distance of 600 mm (24 in.). The following light sources, simultaneously, shall be placed 300 mm (12 in.) above and 300 mm (12 in.) behind the OFSA in an area not greater than 1200 by 1200 mm (48 by 48 in.):

a. Vehicle headlight (24 V, double filament, low-beam).
b. Vehicle IR light, 24 V, low-beam.
c. Incandescent light, frosted glass, standard household, 100 W.
d. Incandescent light, clear glass, 100 W.
e. Fluorescent light, 40 W.
f. Electronic flash (intermittent).
g. Movie light.

The light sources shall be switched on for 5 s and off for 5 s, 10 times. The lights shall then be turned on and remain on while the system is turned on and off 10 times with 5 s between each switching action. The tests shall be repeated to check the 90° FOV in accordance with 4.3.3.2. The light sources shall be moved in to a distance of 150 mm (6 in.) from the reflector and the test repeated. After the last sequence, the chopped light simulator test, as indicated in 4.3.3.7, shall be conducted using the light sources indicated in this paragraph. The OFSA shall meet the indirect or reflected sunlight and the chopped light (individual sources) requirements as specified in table I.

4.3.3.7.8 Miscellaneous light sources. The light sources listed below shall be separately placed directly in front and facing the OFSA at the small fire and then the large fire immunity distances, as indicated in 3.3.3.2.1 and table I, and switched on for 5 s and then off for 5 s, 10 times. The source, if applicable (see 4.3.3.7.15), shall then be turned on and left on while the OFSA is turned on and off twice with 5 s between switching actions. The OFSA FOV shall be checked in accordance with 4.3.3.2 at both distances. The light sources while in the on-position (except for the electronic flash which shall be operated intermittently), shall be exposed to the chopped light simulator as indicated in 4.3.3.7.1. The OFSA shall meet the requirements of 3.3.3.2.1 and the requirements for the following light sources as specified in table I:

a. Incandescent, standard house hold, 100 W, frosted glass light.
b. Incandescent, 100 W, clear glass light.
c. Commercially available fluorescent light with enamel reflector,
a. 40 W (or two 20 W).
d. Headlight-Infrared, double filament, low-beam, 24 V.
e. Red and blue vehicular dome lights.
f. Electrical arc, 12 mm (0.47 in.) gap at 4000 Vac.
g. Electronic flash (180 watt-second minimum output).
h. Movie light, 625 W quartz DWY lamp, (Sylvania S.G.-55 or equivalent).

4.3.3.7.9 Incandescent and IR light sources. The following light sources, simultaneously, shall be placed at a distance of 600 mm (24 in.), in an area that is not beyond the 90° FOV of the OFSA:

a. Headlight-Infrared, double filament, low beam, 24 V.
b. Vehicle headlight, double filament, low beam, 24 V.
c. Incandescent light, frosted glass, standard household, 100 W.
d. Fluorescent light, standard office or shop with white enamel reflector, 40 W.
e. Incandescent light, clear glass, 100 W.

The OFSA shall be shielded from the light sources. The shield shall be removed as rapidly as possible by hand, leaving the OFSA exposed to the sources for 1 s and then the shield shall be replaced in the same manner. This procedure shall be repeated nine times. The shield shall next be removed and the OFSA shall be turned on and off 10 times with 5 s between each switching action. Then the lights shall be left on and the chopped light simulator test in 4.3.3.7 shall be conducted, using the light sources listed above. The OFSA shall meet the ambient light extremes and the chopped light (combination sources) requirements as specified in table I.

4.3.3.7.10 Heaters. A 1500 W radiation heater shall be placed in front of the OFSA at a distance of 900 mm (36 in.) for the small fire and 450 mm (18 in.) for the large fire immunity distance. The 90° FOV shall be checked in accordance with 4.3.3.2. At each position, orientation and distance, the OFSA shall be turned on and off twice with a 10 s between each switching action. The test shall be repeated with a 1000 W radiation heater with a fan placed in front of the heater blowing towards the OFSA, with the distance of 600 mm (24 in.) for the small fire and 300 mm (12 in.) for the large fire threshold. The OFSA shall meet the radiation heater requirements as specified in table I.

4.3.3.7.11 Welding. Two of the following plate sets listed below, (a) and either (b) or (c), shall be welded by both the arc and acetylene methods in a vertical or horizontal lap-weld forming a 12 mm (0.469 in.) bead, 300 mm (12 in.) long. The material shall be centered directly in front of the OFSA at the arc welding and the acetylene welding distances specified in table I. The test shall be repeated while the OFSA is turned on and off with 5 s between switching actions. The OFSA shall meet the arc welding and the acetylene welding requirements as specified in table I.

a. Two armor steel plates, 4130 steel, measuring 300 by 100 by 25 mm (12 by 4 by 1 in.), welded with Number 307 or 308 stainless steel rod having a 4 mm (0.156 in.) diameter and using 300 A (00 tip, 16 by 150 mm (0.625 by 6 in.) flame).
b. Two armor aluminum plates, 5083 measuring 300 by 100 by 25 mm (12 by 4 by 1 in.), welded with Number 5356 rod having a diameter of 2.4 mm (0.0938 in.) (00 tip, 16 by 150 mm (0.625 by 6 in.) flame).
c. Two armor aluminum plates, 7039 measuring 300 by 100 by 25 mm (12 by 4 by 1 in.), welded with Number 5356 rod having a diameter of 2.4 mm (0.0938 in.) (00 tip, 16 by 150 mm (0.625 by 6 in.) flame).

4.3.3.7.12 Ballistics.

a. A M16 rifle shall be placed in a horizontal position with the OFSA located 250 mm (10 in.) from the end of the barrel and facing the rifle flash along a line 53 ±5° from the path of the projectile. While in this position, the M16 rifle shall be fired at least 10 times for the small fire threshold. For the large fire threshold, the OFSA shall be 50 mm (2 in.) beside and facing directly at the M16 rifle. The M16 rifle shall be fired at least 10 times. The OFSA shall meet the rifle flash requirements as specified in table I.
b. The OFSA shall be exposed to a 105 mm (4 in.) muzzle flash 6000 mm (236 in.) from the OFSA while the OFSA is facing the point (area) of muzzle flash. The OFSA shall then be reoriented by 40 to 45° such that the muzzle flash is seen by the edge of the required FOV. The OFSA shall again be exposed to the 105 mm (4 in.) muzzle flash at 6000 mm (236 in.) distance. If either test produces on OFSA large fire signal, the tests shall be repeated at 7000 mm (276 in.). Otherwise, the tests shall be repeated at 5000 mm (197 in.). The OFSA shall be in compliance with 105 mm muzzle flash requirements as specified in table I.
c. The OFSA shall be exposed to a 50 caliber muzzle flash at 1000 mm (40 in.). Five, four-shot rapid fire bursts shall be fired while covering the 90° FOV as specified in 4.3.3.2. The test shall be repeated at 600 mm (24 in.) and at 1400 mm (56 in.). The OFSA shall be in compliance with the 50 caliber machine gun muzzle flash requirements as specified in table I.

4.3.3.7.13 Cigarette and cigar. A lit cigarette shall be placed directly in front of the OFSA at a distance of 100 mm (4 in.) and then at 25 mm (1 in.) and the OFSA shall be moved from side to side in approximately a 150 mm (6 in.) arc as rapidly as possible for 10 s. Then the OFSA shall be turned on and off twice with 5 s between each switching action while the OFSA continues to be moved in the same manner. This procedure shall be repeated with a lit cigar. The OFSA shall meet the cigar and cigarette requirements in table I.

4.3.3.7.14 Matches. A paperbook match shall be lit at a distance of 300 mm (12 in.) and then at 100 mm (4 in.) directly in front of, exposing the match flare-up to the OFSA. After lighting, the OFSA shall be moved from side to side as rapidly as possible, without the match going out, for at least 5 s. This procedure shall be repeated with a wooden match. The OFSA shall meet the wood and paper match requirements as specified in table I.

4.3.3.7.15 Cycle. Tests where the source is kept on while the OFSA is cycled on and off shall be conducted as required in the preceding paragraphs. An exception, however, is made for source indicated in the electronic flash, chopped light (individual and combination of sources), rifle flash, 105 mm muzzle flash, 50 caliber muzzle flash, and wood and paper match requirements as specified in table I. Where these excepted sources are cited in paragraphs requiring this test (for example, combinations of sources which include an excepted source), those particular sources shall be deleted while the source-on, OFSA cycled on-and-off tests are performed.

4.3.3.8 Penetrating munitions. To determine conformance to 3.3.3.1.5 and 3.3.3.2.2, the OFSA, under actual or simulated installation conditions, shall be verified by the tests specified below, during and subsequent to armor protection.

4.3.3.8.1 Target enclosure. A reusable target enclosure shall be designed and fabricated for the accomplishment of these tests. Government approval shall be obtained for the enclosure design. The enclosure shall be rectangular in shape and have an interior volume of 5.7 ±0.6 cubic meters (m^3) [200 ±20 cubic feet (ft^3)]. It shall contain a square projectile entrance opening in one side and a square exit opening directly opposite the entrance opening. It shall have provisions for attaching removable entrance armor plates on the outside of the enclosure and exit armor plates on the inside. The enclosure shall incorporate a removable 38 liter (L) [(10 gallon (gal)] minimum capacity fuel tank. The tank shall be located between the penetration entrance and exit plates, at a distance of not less than 1000 mm (40 in.) and not more than 1500 mm (60 in.) from the point of munition penetration. The OFSAs shall be mounted with a full view of the munition path. The OFSAs shall be no closer than 380 mm (15 in.) to the fuel tank, and no further than 1800 mm (71 in.) from the point of munition penetration.

4.3.3.8.2 Armor. The aluminum target plates, entrance and exit, shall be 32 mm (1.25 in.) thick of either 5083 or 7039 material. The steel target plates shall be 51 mm (2 in.) thick rolled homogenous armor (RHA). The steel/aluminum applique entrance and exit plates shall consist of 32 mm (1.25 in.) thick RHA over 25 mm (1 in.) thick 5083 or 7039 aluminum, an air gap of 90 mm (3.5 in.), and then a 19 mm (0.75 in.) thick Kevlar spall liner.

4.3.3.8.3 Discrimination (type I OFSAs only). A maximum number of OFSAs shall be tested simultaneously by subjecting them to the armor/threat penetrations as specified in table I. For each test, large and small fire output signals shall be recorded for each OFSA. The tests shall be repeated until a minimum of 20 OFSA large fire data points (response or no response) are collected for each armor/threat profile. After each shot, inoperable OFSAs shall be replaced. Data from damaged OFSAs shall not be scored.

4.3.3.8.4 Penetration response time. The OFSA(s) shall be tested simultaneously by subjecting them to the stimuli specified below. An 89 mm (3.5 in.) chemical energy munition shall be shot through each of the armor configurations described in 4.3.3.8.2 and then through a fuel tank containing diesel fuel (see 6.8) preheated to sufficient volatility to assure a fire. For each test, the time from start of munition penetration to ignition of the fire, to OFSA large and small fire output signals for each OFSA shall be recorded. After each test, inoperative OFSAs shall be replaced. The tests shall be repeated with a 105 mm (4 in.) chemical energy round and preheated synthetic, hydrocarbon based, hydraulic fluid (see 6.8).

4.3.3.9 Nuclear hardening. To determine conformance to 3.3.3.2.3, nuclear hardening requirements shall be determined on the basis of circuit analysis or component testing and by inspection of contractor records providing certification that the OFSA has been fabricated in accordance with the design verified and approved for qualification.

4.3.3.10 Slow growth fire. To determine conformance with 3.3.3.2.4, with 840 cm^3 (51 in^3) of diesel fuel (see 6.8) at room temperature in a 130 mm (5 in.) diameter pan, 76 mm (3in.) deep, placed 380 mm (15 in.) to the centerline of the pan from the OFSA, a fire shall be lit that results in a slow growth rate. The air flow shall not exceed 300 millimeters per second (mm/s) (12 inches per second (in/s)). The OFSA shall not generate a large fire signal until the flame engulfs at least 50% of the full pan diameter.

4.3.3.10.1 Extended distance. To determine conformance with 3.3.3.2.4, the test procedures in 4.3.3.10 shall be repeated except the distance from the OFSA to the centerline of the pan shall be 1200 mm (48 in.). The small fire warning shall respond, and no large fire signals shall be generated.

4.3.3.11 Start-up. To determine conformance to 3.3.3.3, the OFSA shall stand in an inactive mode for a minimum of 5 min. Power shall be applied to pins A and B according to table III. There shall be no output signal at pins C or D. The test shall be conducted at 15, 20, 24, 28, and 30 Vdc.

4.3.3.12 Input power. To determine conformance to 3.3.3.4, the OFSA shall be connected to a variable power supply set at 24 Vdc. Voltage and current draw shall be observed during quiescent operation, during BITE, and during exposure of the OFSA to a large fire stimulus. The test shall be repeated at 15, 28, and 30 Vdc.

4.3.3.13 Input voltage decay. To determine conformance to 3.3.3.4.1, the OFSA shall be connected to a variable power supply. With the OFSA in the quiescent mode, set the power supply at 30 Vdc. Gradually decrease the voltage over five to ten min. There shall be no large or small fire output signals. The test shall be repeated three times.

4.3.3.14 Steady state voltage extremes. To determine conformance to 3.3.3.4.2, the OFSA shall be connected to a variable power supply. The voltage shall be set at 5 Vdc for 3 min of OFSA quiescent operation. It shall then be increased in 5 Vdc increments for 3 minute intervals until reaching 40 Vdc. The OFSA shall subsequently pass the tests of 4.3.3.3, 4.3.3.4, 4.3.3.5, 4.3.3.6 (at ambient temperature), and 4.3.3.7.8 (using light sources (a), (b), (g), and (h) in 4.3.3.7.8).

4.3.3.15 EMI. To determine conformance to 3.3.3.5 through 3.3.3.5.7, the OFSA shall be subjected to the corresponding test procedures in MIL-STD-461, or equivalent (see 4.3.1), and meet the specified performance requirements. The OFSA shall not false alarm or cause any EMI problem for other vehicle components.

4.3.4 Interface requirements verification. To determine conformance to 3.4 through 3.4.3, interface and envelope dimensions shall be verified using one or more of the methods as specified in 4.2.

4.3.5 Ownership and support requirements verification. To determine conformance to 3.5 through 4.5.6, ownership and support requirements shall be verified using one or more of the methods as specified in 4.2.

4.3.6 Operating environment requirements verification. To determine conformance to 3.6, the OFSA shall be tested as specified below and meet the specified performance requirements. The OFSA shall be operated in the quiescent mode, except as otherwise specified herein. The OFSA shall demonstrate the ability to detect fires and pass the test of 4.3.3.5 during exposure to the environments of 4.3.6.1.1 through 4.3.6.1.3, 4.3.6.2, and 4.3.6.8. Unless otherwise specified herein, the OFSA shall subsequently pass the tests of 4.3.3.3, 4.3.3.4, 4.3.3.5, 4.3.3.6 (at ambient temperature), and 4.3.3.7.8 (using light sources (a), (b), (g), and (h) in 4.3.3.7.8).

4.3.6.1 Temperature.

4.3.6.1.1 High temperature. To determine conformance to 3.6.1.1, the OFSA shall be tested in an oven maintained at 125 °C (257 °F). The OFSA shall have 24 Vdc power connected across pins A and B. The oven shall be maintained at high temperature for a period of 200 ±24 hours. There shall be no false alarms. Record voltage across pins C and D continuously during the test for indications of any false alarms. The sample(s) shall be inspected at least two times per working day, at least 4 hours apart, and the inspection shall be noted on the recorder trace. During these inspections, the OFSA shall be activated by exposing it to an appropriate radiation source, and outputting a BITE activation signal on pin E.

4.3.6.1.2 Low temperature. To determine conformance to 3.6.1.2, the OFSA shall be placed in a low temperature chamber. The test conditions and instrumentation requirements of 4.3.6.1.1 shall apply except that the temperature shall be lowered and maintained at −51 °C (−60 °F).

4.3.6.1.3 Temperature shock. To determine conformance to 3.6.1.3, the OFSA shall be put through three high temperature to low temperature cycles as described below. The instrumentation requirements shall be identical to the preceding paragraph as to type(s) and location(s). The OFSA shall be set up and checked with a radiation source which shall activate the large and small fire signals and by inputting a BITE activation signal on pin E. The OFSA shall be exposed to ambient temperature for no more than 5 minutes during transfer. The procedures of 4.3.6.1.1 and 4.3.6.1.2 apply except:

Step 1. The OFSA and appropriate electrical harnesses shall be placed in an oven preheated to 71 °C (160 °F) and maintained for 24 ±2 hours. While at this high temperature the OFSA shall be tested as described above.

Step 2. Immediately following step 1 the test sample shall be transferred to a precooled low temperature chamber and maintained at -51 °C (-60 °F) for a period of 24 ±2 hours. While at low temperature the OFSA shall be tested as described above.

Step 3. Repeat step 1.

Step 4. Repeat step 2.
Step 5. Repeat step 1.
Step 6. Repeat step 2. Fifteen minutes after transfer, the false alarm tests of 4.3.3.7.8, using the light sources (a), (b), (g), and (h) of 4.3.3.7.8, shall be conducted. At the end of Step 6 the OFSA shall be returned to ambient temperature and meet the requirements of 4.3.6.

4.3.6.2 Vibration. To determine conformance to 3.6.2, the OFSA shall be mounted in a production installation configuration, or equivalent, to a vibration exciter capable of producing and transmitting the specified vibrations. The vibration acceleration level shall be in accordance with figure 10, applied in 15 min sweep times in accordance with figure 11. Resonant search and dwell of 30 min at each of the four most severe resonant frequencies shall be part of the total cycle time of 3 hours. The OFSA shall pass the tests specified in 4.3.6 during and after exposure.

4.3.6.3 Shock. To determine conformance to 3.6.3, the OFSA shall be subjected to saw tooth shock pulses of 100 ±10 gravity units, with a duration of 11 ±1.1 ms, three times in each direction of three mutually perpendicular axes. The OFSA shall pass the tests specified in 4.3.6 during exposure.

4.3.6.4 Leakage. The OFSA shall not be operated during the following tests. The OFSA shall not evidence any damage or leakage. Subsequent to each of these tests, the OFSA shall pass the tests specified in 4.3.6.

4.3.6.4.1 Water immersion. To determine conformance to 3.6.4.1, the OFSA shall be submerged in water by one of the two methods below. Bubbles coming from within the OFSA shall be considered leakage. However, bubbles which result from trapped air on external surfaces of the OFSA shall not be considered leakage.

a. The temperature of the water and the OFSA shall be 23 ±10 °C (73 ±18 °F). The OFSA shall be immersed in water so that the uppermost part of the OFSA is 50 ±25 mm (2 ±1 in.) below the surface of the water. The initial air pressure above the water shall be reduced to 480 mm (19 in.) Hg absolute and maintained for 1 min or until bubbles substantially cease to be given off by the water, whichever is longer. The air pressure above the water shall then be increased to 510 mm (20 in.) Hg absolute and maintained for 60 min.
b. The OFSA shall be tested in accordance with MIL-STD-810, method 512.3, procedure I, or equivalent (see 4.3.1). The OFSA shall be heated 27 °C above the water temperature of 23 ±10 °C (73 ±18 °F) and submerged to a depth of 1 meter (m) (39.4 in.).

4.3.6.4.2 Diesel fuel immersion. To determine conformance to 3.6.4.2, prior to immersion in diesel fuel (see 6.8), the temperature of the OFSA shall be 45 ±3 °C (113 ±5 °F); the temperature of the diesel fuel shall be 18 ±5 °C (64 ±9 °F). The container shall be of sufficient capacity so that immersion of the OFSA shall not raise the fuel temperature more than

3 °C (5 °F). The uppermost point of the OFSA shall be a minimum of 50 mm (2 in.) below the surface. The OFSA shall remain immersed for 120 ±5 min. Upon completion, remove the OFSA from the fuel and wipe the exterior surfaces only. The OFSA shall be weighed before and after the test. The weight shall not vary more than 0.5 gram (g) [0.02 ounce (oz.)].

4.3.6.4.3 Water jet. To determine conformance to 3.6.4.3, the OFSA shall be subjected to a water jet spray applied at right angles to the surfaces of the non-operating OFSA at a distance of not less than 300 mm (12 in.) from the jet. The surface shall be cleaned at not less than 0.02 square meters per minute (m^2/min) [0.2 square feet per minute (ft^2/min)]. The water jet shall be derived from a nozzle having an orifice diameter of not more than 6 mm (0.25 in.) and a nozzle pressure of 345 ±105 kPa (50 ±15 psi). The OFSA shall not leak and the optical window(s) shall not be damaged. Following the test, the OFSA shall be wiped dry. The OFSA shall be weighed before and after this test. The weight shall not vary more than 0.5 g (0.02 oz).

4.3.6.5 Salt fog. To determine conformance to 3.6.5A non-operating OFSA shall be subjected to the test of MIL-STD-810, method 509.3, or equivalent (see 4.3.1), except that the test shall last 200 hours. The OFSA shall subsequently pass the tests specified in 4.3.6

4.3.6.6 Fungus. To determine conformance to 3.6.6, a non-operating OFSA shall be subjected to the applicable fungal incubation as specified in ASTM G21. Subsequently, the OFSA shall show no evidence of biological growth that could result in the operation of the OFSA falling outside of the performance requirements specified herein. The OFSA shall subsequently pass the tests specified in 4.3.6 without cleaning.

4.3.6.7 Sand and dust. To determine conformance to 3.6.7, an OFSA with connector attached shall be tested in accordance with MIL-STD-810, method 510.3, procedure I, or equivalent (see 4.3.1). During this test, the OFSA shall be rotated so that the optical window(s) and the connector receive equal blast time. The high temperature portion of testing shall be conducted at 71 °C (160 °F). The OFSA shall subsequently pass the tests specified in 4.3.6.

4.3.6.8 Humidity. To determine conformance to 3.6.8, the OFSA shall pass the tests specified in 4.3.6 during and after exposure to warm, high relative humidity in accordance with the applicable conditioning procedure for ground electronic equipment of MIL-STD-810, method 507.3, or equivalent (see 4.3.1). After conditioning, the OFSA shall be exposed to five continuous 48-hour cycles in accordance with figure 12. Prior to post exposure operation, the OFSA shall be conditioned for 24 hours at 23 ±3 °C (73 ±5 °F) and 50 ±10% relative humidity.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the

managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The OFSA is the sensing element of Halon 1301 fire extinguishing systems used in military ground combat and tactical vehicles (such as the M992 Field Artillery Ammunition Support Vehicle (FAASV)). The OFSA responds to optical radiation from exploding atomized or vaporized hydrocarbons and energizes the fire extinguishing system within 3 to 4 ms, depending on the OFSA type (see 3.3.3.1.4), when an energy level equal to or greater than the large fire threshold is attained. The systems are intended for use in personnel areas and other compartments such as engine spaces. These systems are designed to protect against the potential danger of detonations, deflagration, and slow growth fires due to the presence of highly combustible fuels or other liquid hydrocarbons or flammable debris.

6.2 Acquisition requirements. Acquisition documents must specify the following:

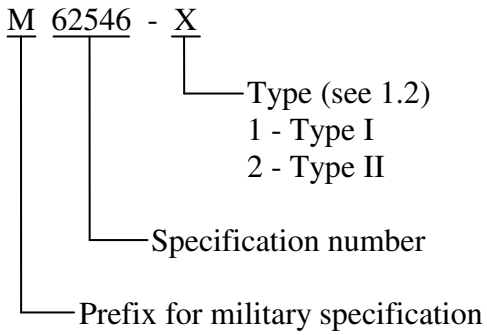
a. Title, number, and date of this specification.
b. PIN indicating type (see 1.2 and 6.5).
c. If required, the specific issue of individual documents referenced (see 2.2.1, 2.2.2, and 2.3).
d. If first article inspection is required (see 3.1 and 6.3).
e. If materials, design, or manufacturing is other than as specified (see 3.2).
f. If there are any alternative verification methods (see 4.3.1).
g. Inspection conditions, if other than as specified (see 4.3.2).
h. Packaging requirements (see 5.1).
i. Which conformance tests are required (see 6.4).

6.3 First article. When requiring a first article inspection (see 3.1, 4.1.1, and 6.2), contracting documents should provide specific guidance to offerors. This guidance should cover whether the first article is a first article sample, a first production item, and the number of test items. These documents should also include specific instructions regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Pre-solicitation documents should provide Government waiver rights for samples for first article inspection to bidders offering a previously acquired or tested product. Bidders offering such products who wish to rely on such production testing must furnish evidence with the bid that prior Government approval is appropriate for the pending contract.

6.4 Conformance inspection. Affordable conformance inspection with confidence varies depending upon a number of procurement risk factors. Some of these factors include: Contractor past performance, government schedules and budget, product material and design maturity, manufacturing capital equipment and processes applied, the controlled uniformity of those

processes, labor skill and training, and the uniformity of measuring processes and techniques. During the solicitation, contracting documents (see 4.1.2 and 6.2) should indicate those tests desired from table IV and their designated frequency based on a risk assessment for the procurement.

6.5 Part or Identification Number (PIN). The PIN to be used for optical fire sensors acquired to this specification are created as follows:



6.6 Definitions.

6.6.1 Discriminatory OFSA (type I). A discriminatory OFSA is described as one that meets the following:

a. All requirements of Section 3.
b. The OFSA will not respond (see 3.3.3.2.2) to the penetration and flash of a threat munition that passes into or through steel or aluminum armored vehicles without initiating a hydrocarbon fire.

6.6.2 Non-discriminatory OFSA (type II). A non-discriminatory OFSA is described as one that will meet the requirements of Section 3 except for 3.3.3.2.2

6.6.3 False alarm. A false alarm exists when either an OFSA large or small fire signal is produced without proper input stimuli.

6.6.4 Proximity switch. The units used here are solid state proximity switches which are integral units containing both sensing and switching elements. The unit senses and measures any ferrous metal object at distances as given by the manufacturer. These are used in several places in the test circuits. Units respond at a rate of 40,000 pulses per second with output rise and fall times of 0.005 ms; the output current is not less than 100 mA.

6.6.5 Recovered materials. “Recovered materials” means materials that have been collected or recovered from solid waste (see 6.6.6).

6.6.6 Solid waste. “Solid waste” means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other

discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation returns flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.). (Source: Federal Acquisition Regulations, section 23.402).

6.7 Pressure. All pressures specified in this document are gage, unless otherwise specified.

6.8 Emission spectra. Shown for reference in figures 13 and 14 are characteristic optical emission spectra for an open diesel fuel (No. 2D per A-A-52557) fire. Figures 15 and 16 are characteristic optical emission spectra for an open hydraulic fluid (MIL-PRF-46170) fire. These spectra should be considered typical of optical emissions for which the OFSA will respond.

6.9 Nuclear survivability criteria. Vendors requesting the nuclear survivability criteria, which is classified confidential, will possess the proper security clearance and a demonstrated need to know (see 2.2.2 and 3.3.3.2.3).

6.10 Aviation colors. Standards for aviation colors are based on the International Commission on Illumination (C.I.E.) and can be found in SAE-AS25050.

6.11 Supersession data. This military specification supersedes MIL-S-62546A(AT), and that portion of purchase description ATPD-2070, Edition 6, revision A, 29 February 1984; Sensor, Fire, Optical: System with Amplifier, Standard Control, Electronic, which pertains to the OFSA.

6.12 Subject term (key word) listing.

Built-in-test-equipment (BITE)
Halon 1301 automatic fire extinguisher
Hydrocarbon fire
Optical radiation
Radiation
Sensing element

6.13 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

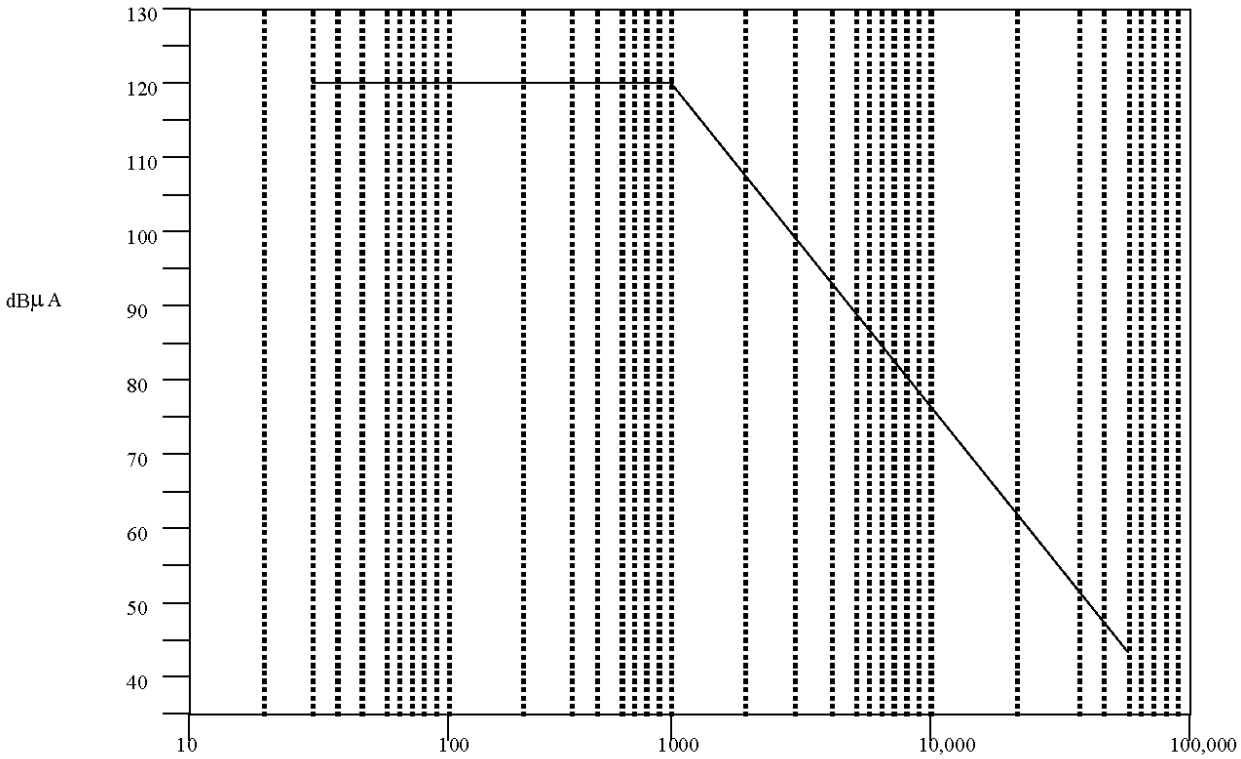


FIGURE 1. Conducted emissions (30 Hz to 50 kHz) - bandwidth limit.

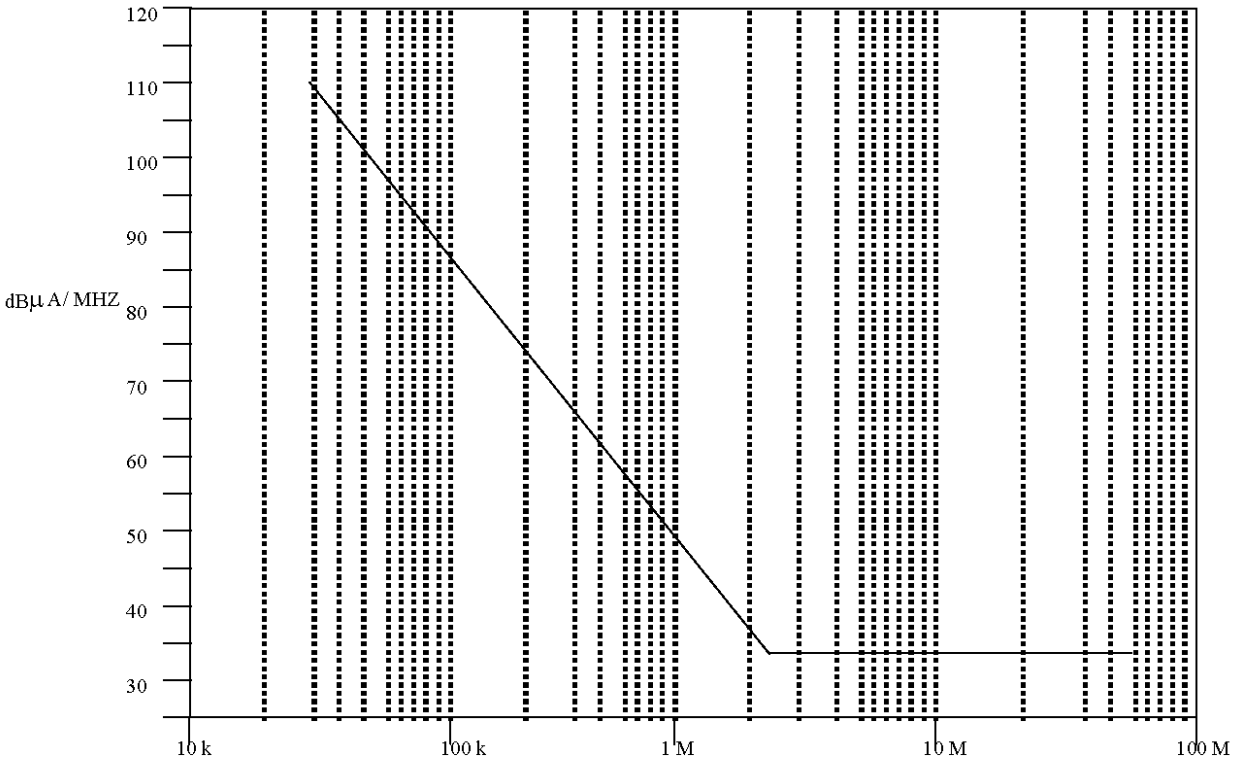


FIGURE 2. Conducted emissions (30 Hz – 50 kHz) - broadband emissions.

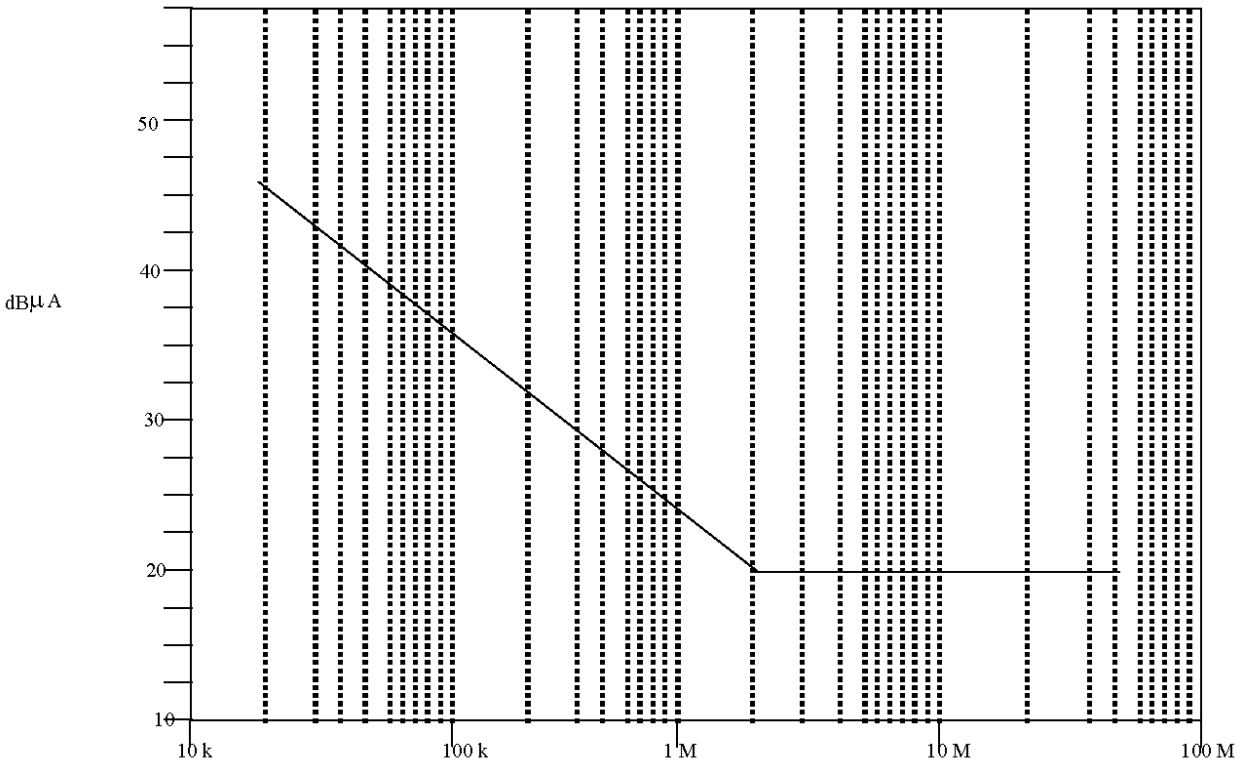


FIGURE 3. Conducted emissions (10 kHz to 50 MHz) - narrowband emissions.

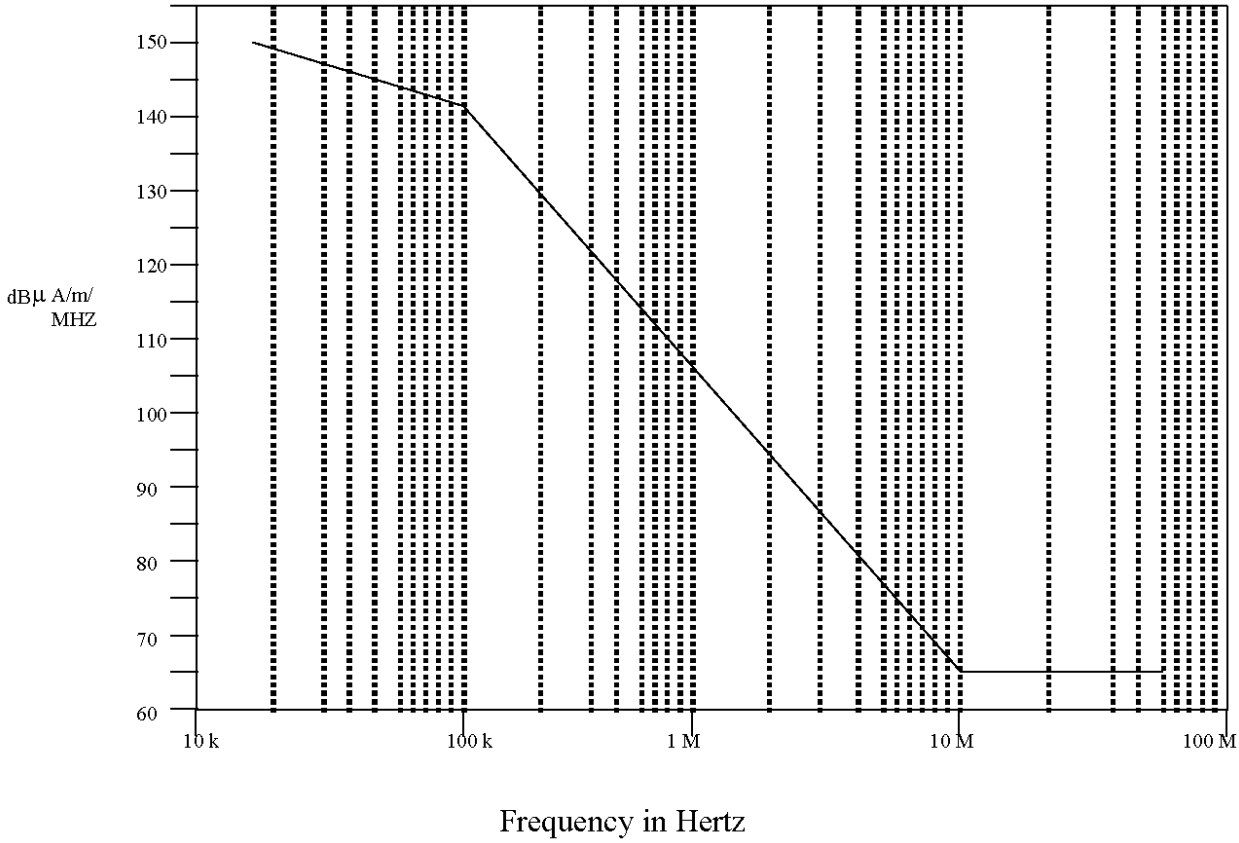


FIGURE 4. Conducted emissions (10 kHz to 50 MHz) - broadband emissions.

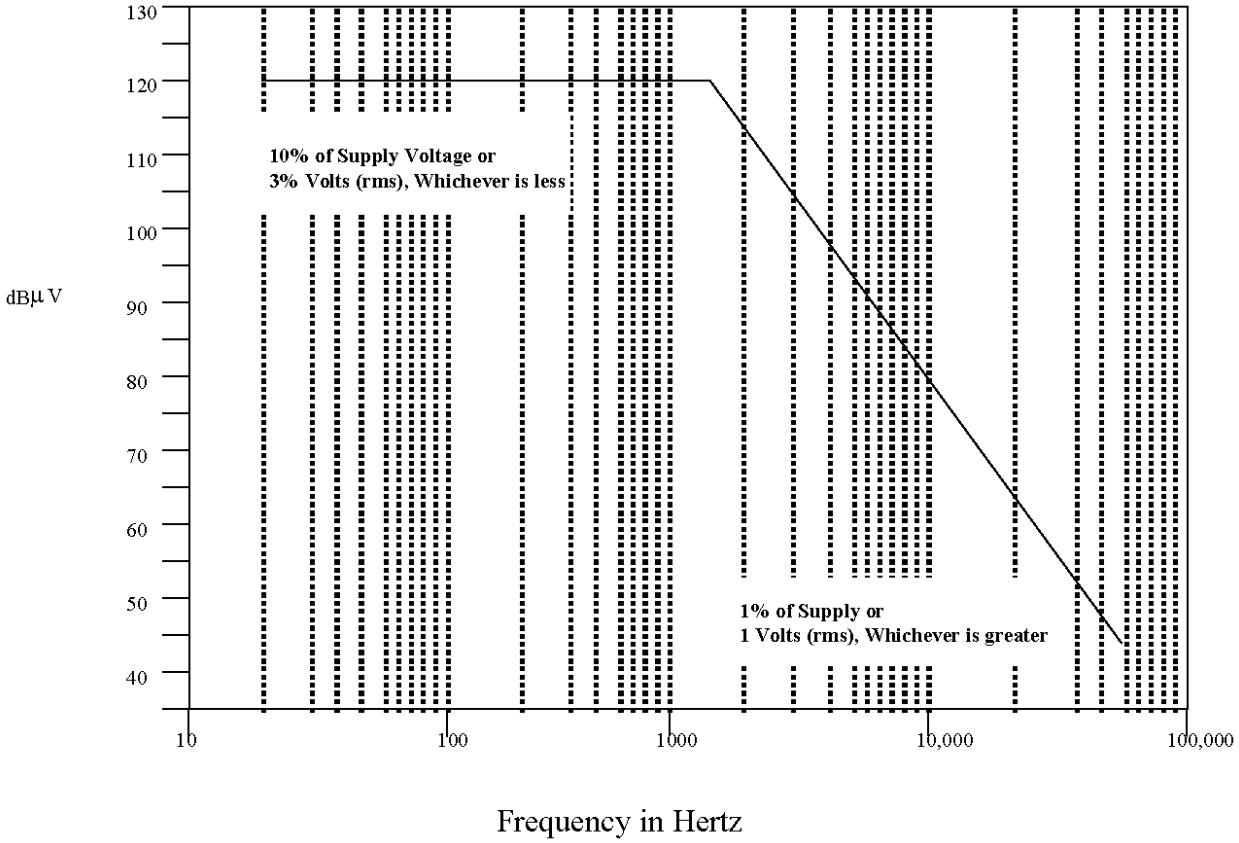


FIGURE 5. Conducted susceptibility (30 Hz to 50 KHz) - voltage limit.

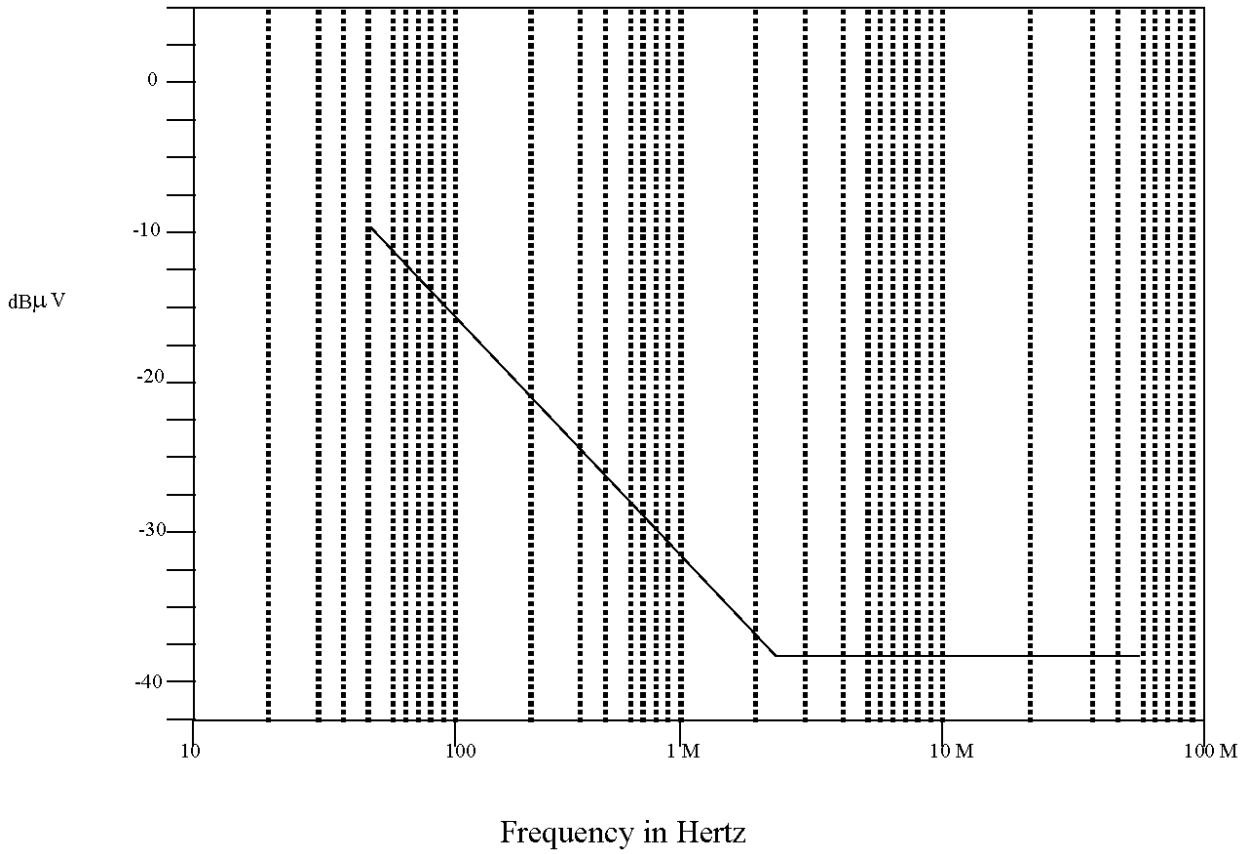


FIGURE 6. Conducted susceptibility (50 kHz to 400 MHz) - voltage limit.

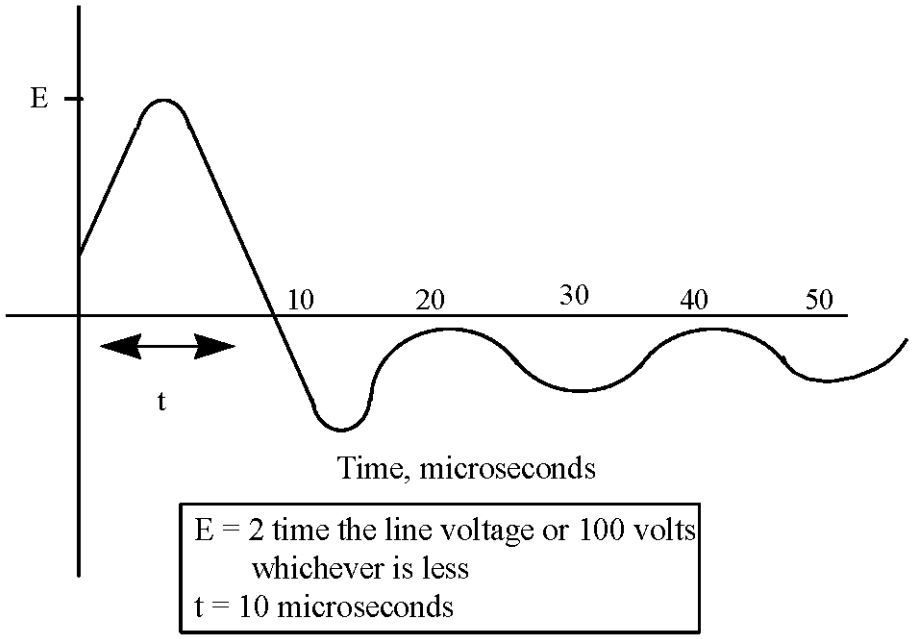


FIGURE 7. Spike - voltage limit.

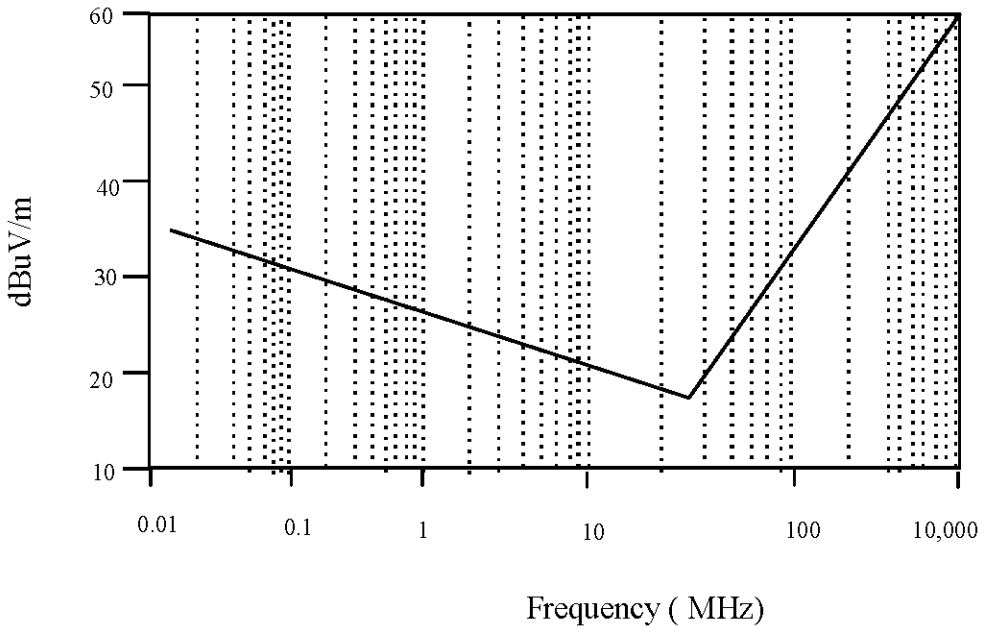


FIGURE 8. Radiated emissions (14 kHz to 10 GHz) - limit for narrowband emissions.

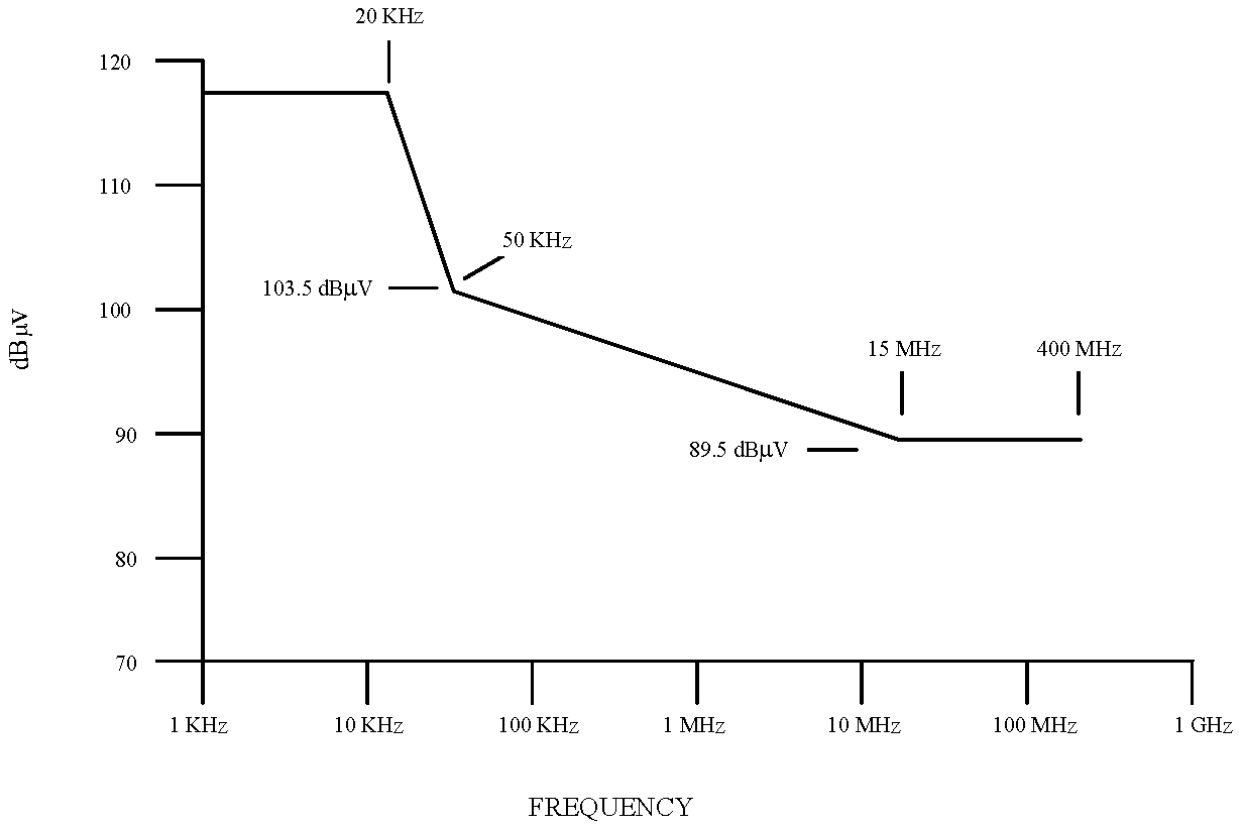


FIGURE 9. Radiated susceptibility - narrowband conducted emissions limit.

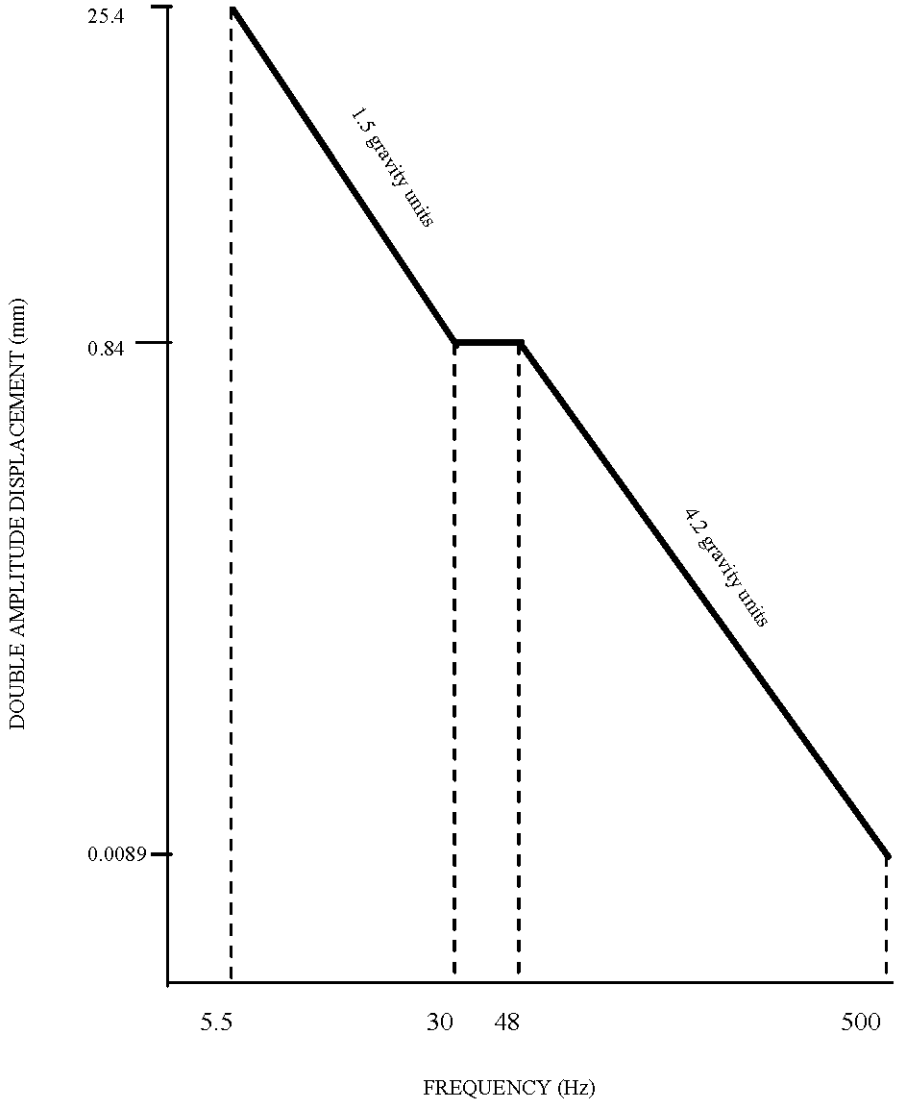


FIGURE 10. Vibration test curve.

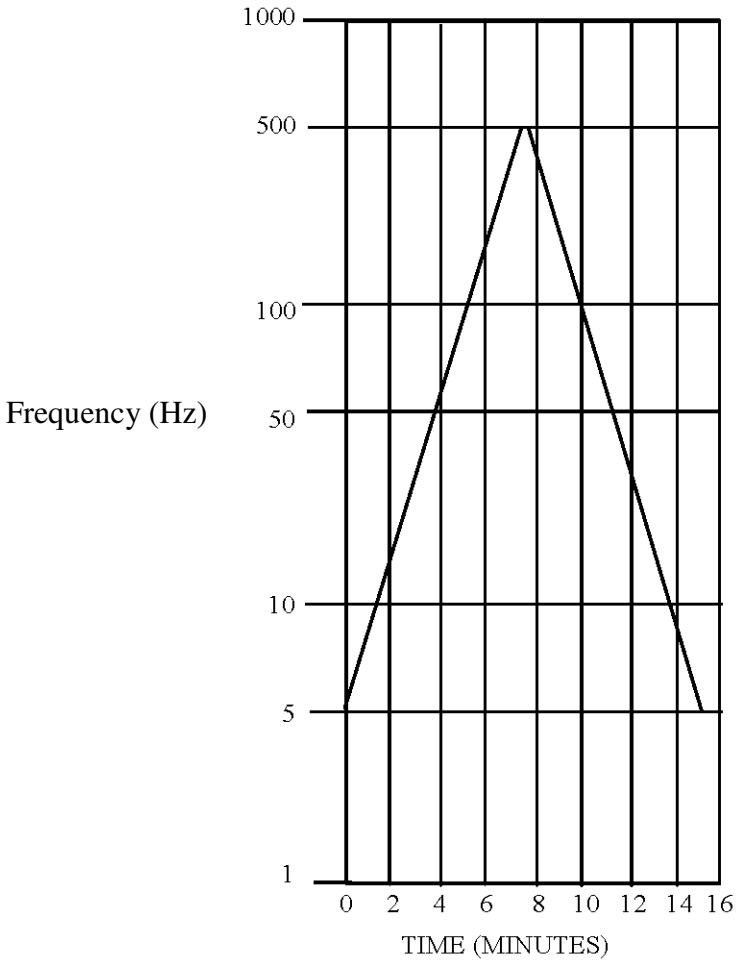
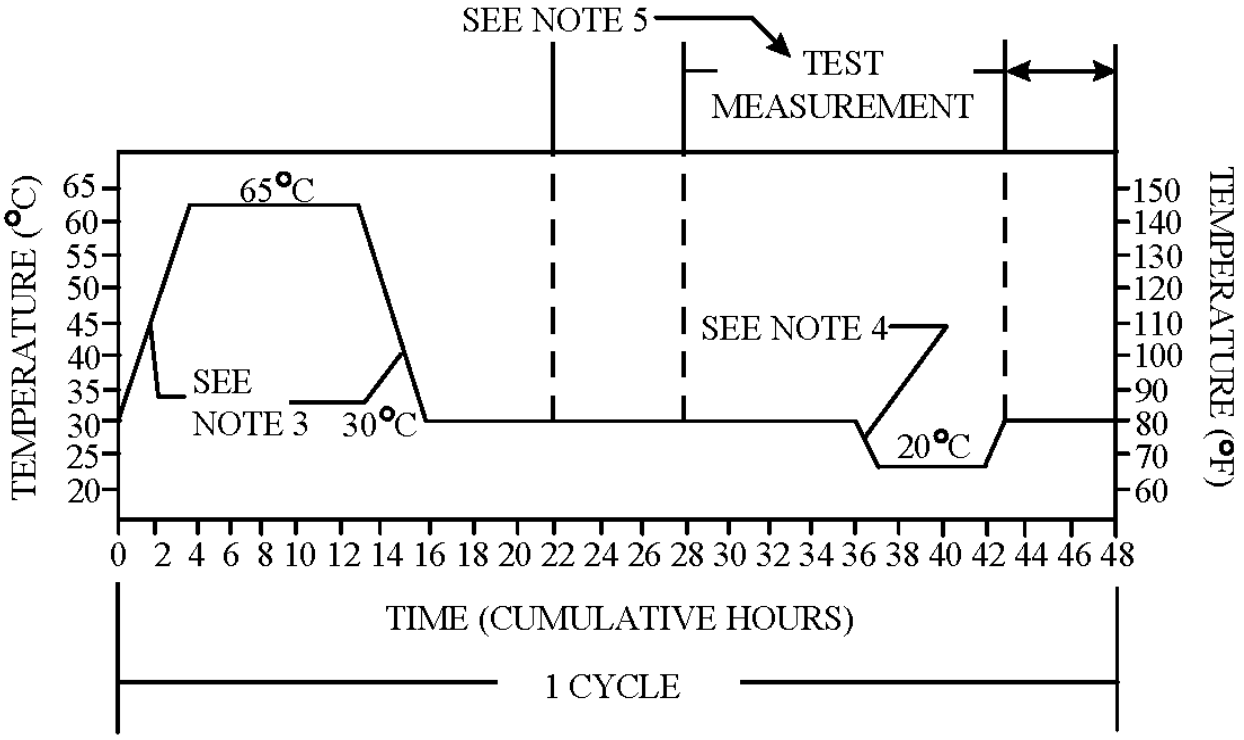


FIGURE 11. Vibration acceleration level.



NOTES:
1. Tolerance during temperature change shall be not greater that 3 °C (5 °F).
2. Relative humidity shall be maintained at 94 ±4% at all times, except that during the descending temperature period, the relative humidity may be permitted to drop as low as 85%.
3. Rate of temperature change between 30 and 60 °C (86 and 149 °F) shall be not less than 8 °C (14.4 °F) per hour.
4. The temperature change in this portion of the curve shall be not less than 10ºC (18ºF).
5. Test measurements shall be taken only at the period specified in the applicable equipment or system specification.

FIGURE 12. Humidity cycle.

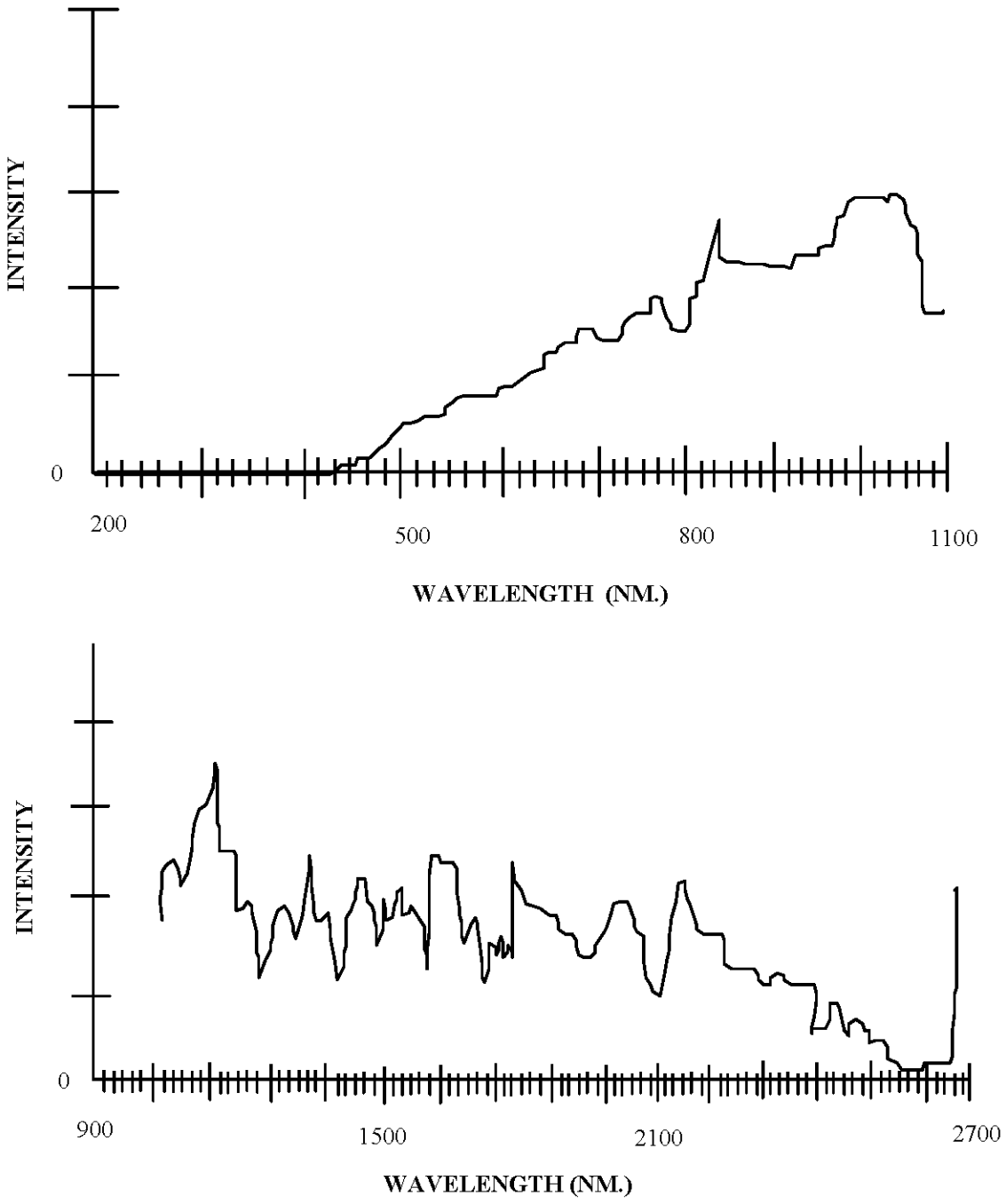
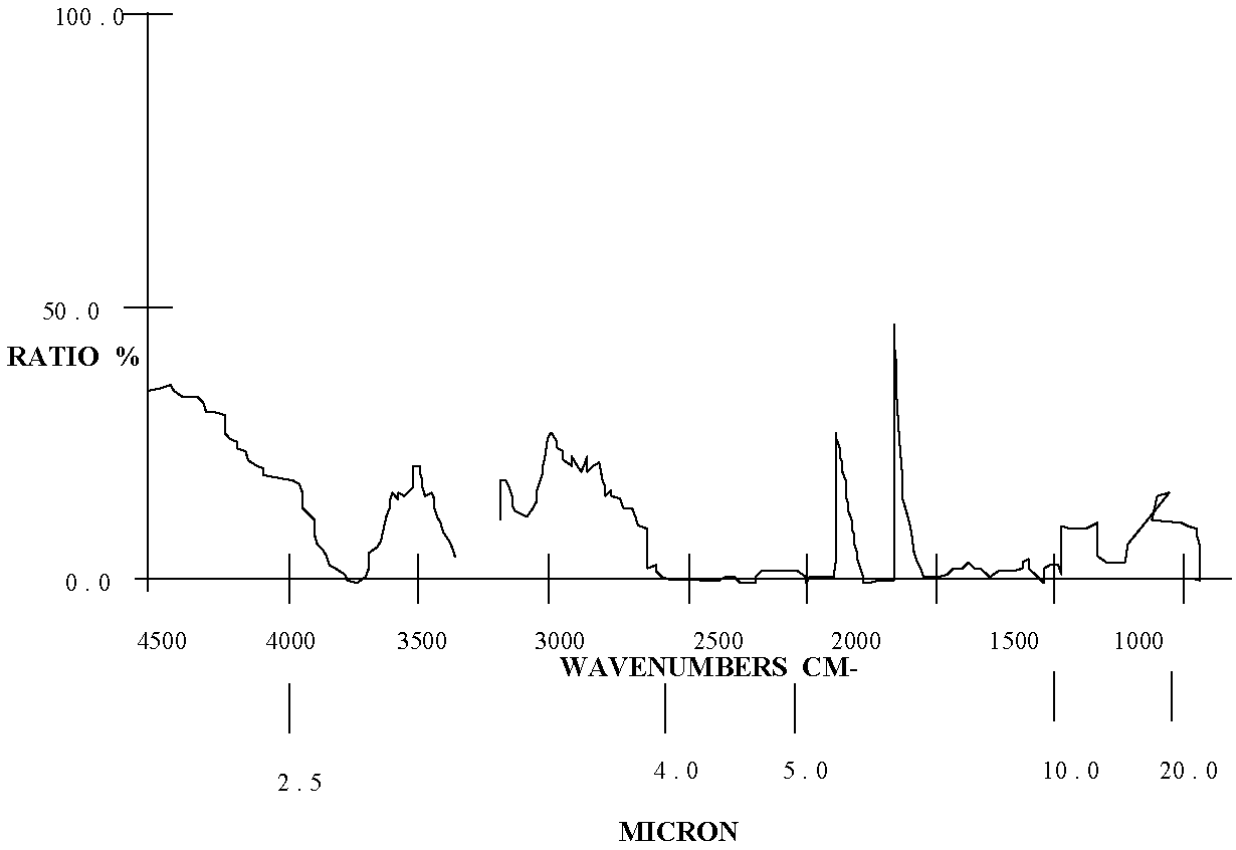
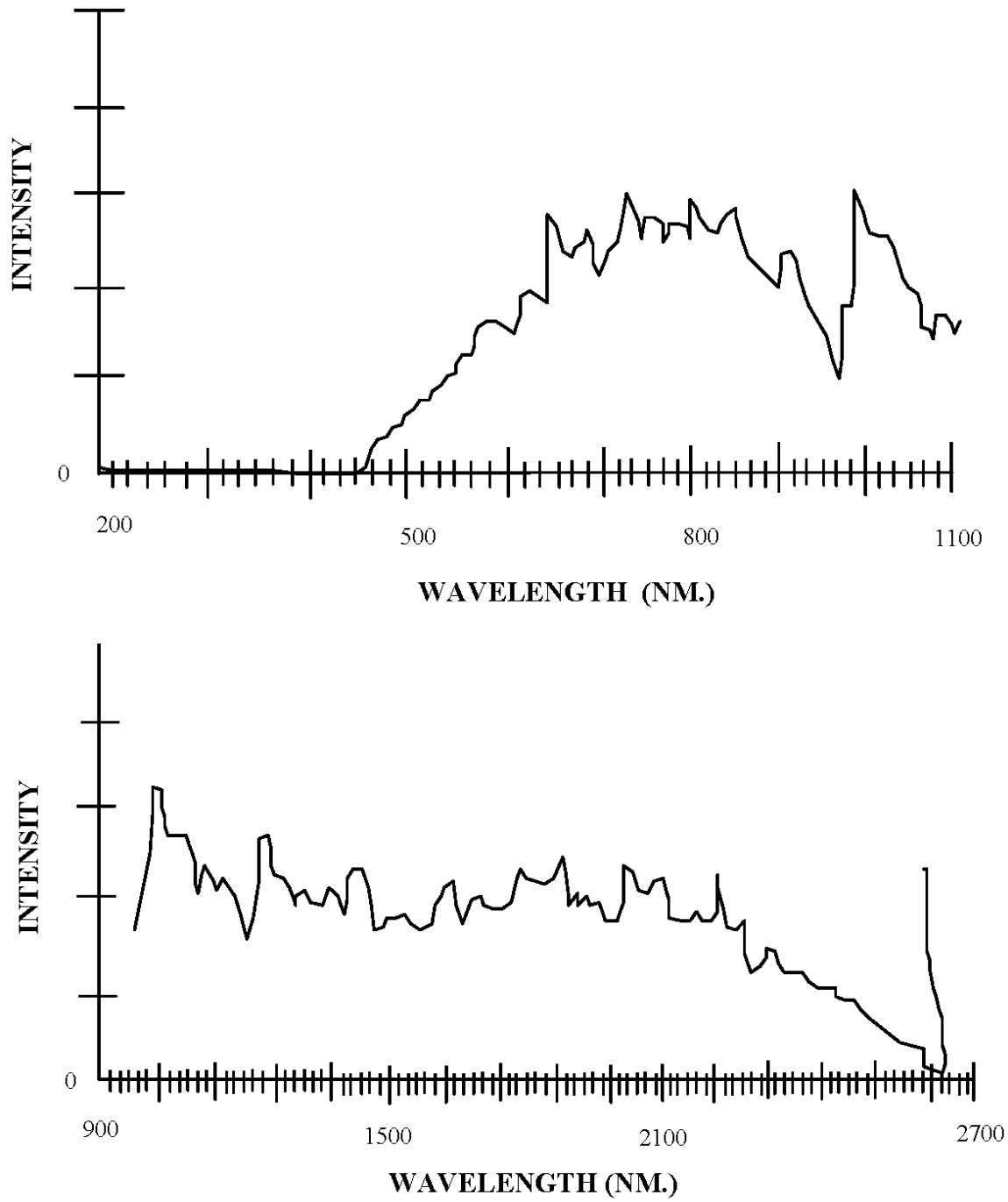


FIGURE 13. Spectra of diesel fuel, A-A-52557 No. 2D, in the UV, visible, and near IR.



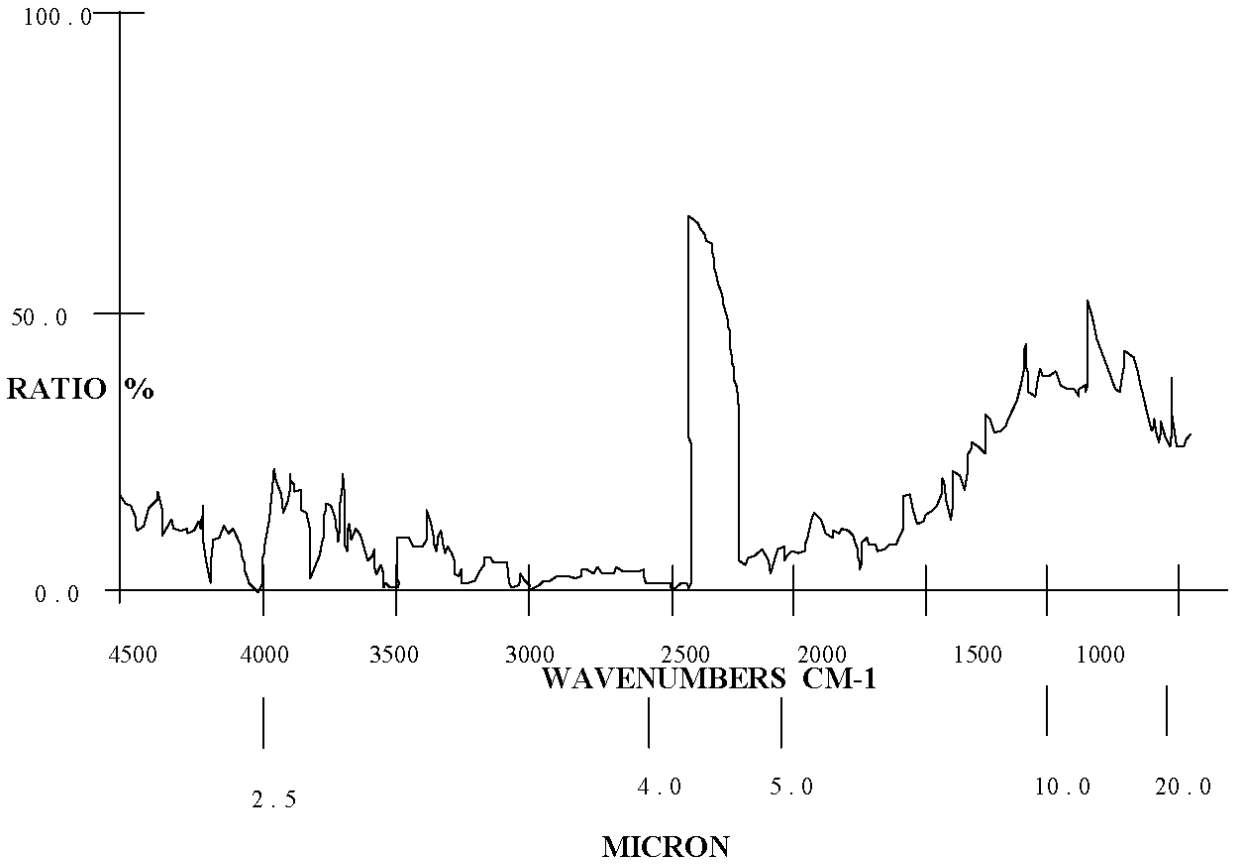
(FT-IR Spectra against a blackbody source; ratio: percent vs wavelength.)

FIGURE 14. Spectra of diesel fuel, A-A-52577, No. 2D in the infrared region from 2.7 to 20 um.



(Plot is in w / cm^2 - sr-nm Vs wavelength, nm.)

FIGURE 15. Spectra of hydraulic fluid, MIL-PRF-46170, in the UV, visible, and near infrared.



(FT - IR data ratioed against the globar (blackbody source);
(plot is ratio: percent Vs wavelength.)

FIGURE 16. Spectra of hydraulic fluid, MIL-PRF-46170, in the infrared 2.7-20 um.

APPENDIX A

VOLTAGE CHARACTERISTICS REQUIREMENTS OF OFSA

A.1 GENERAL

A.1.1 Scope. This appendix establishes the voltage characteristics requirements for the OFSA (see 3.3.2). This appendix is a mandatory part of the specification.

A.2 APPLICABLE DOCUMENTS. No applicable documents are cited in this appendix.

A.3 REQUIRMENTS

A.3.1 Fault free condition.

A.3.1.1 Combined generator-battery power supply.

A.3.1.1.1 Steady-state voltage. Circuit steady state voltage shall be between 25 and 30 V.

A.3.1.1.2 Ripple. The upper and lower peaks of ripple voltage (see figure A-1) shall each be less than 2 V. The frequency components of the ripple shall be within the range of 50 Hz to 200 kHz.

A.3.1.1.3 Surges. All surges resulting from system operation shall fall within the loci shown in figure A-2.

A.3.1.1.4 Spikes. All spikes resulting from system operation shall fall within the loci shown in figure A-3.

A.3.1.1.5 Starting disturbances. Fully charged battery shall be used (battery drawing less than 5 A from a 28 V charging source with electrolyte temperature between 27 and 38 °C (-3 and 3 °F)).

A.3.1.1.5.1 Initial engagement surges. During this disturbance, the voltage shall not be below 6 V and the duration shall not exceed 6 s.

A.3.1.1.5.2 Cranking level. The steady cranking voltage shall not be below 16 V (no more than 3 cranking attempts of 30 s each with 2-minute cranking level pauses between attempts). This characteristic applies to starting the second engine of a multi-engine vehicle, or slave starting another vehicle.

A.3.1.2 Battery only condition.

A.3.1.2.1 Steady-state voltage. Circuit steady-state voltage shall be between 20 and 27 V.

A.3.1.2.2 Ripple. The upper and lower peaks of ripple (see figure A-1) shall each be less than 2 V. The frequency components of the ripple shall be within the range of 50 Hz to 200 kHz.

A.3.1.2.3 Surges. Any switching action resulting in a surge which takes the voltage outside steady-state limits will be considered as a fault condition for the duration of the excursion.

A.3.1.2.4 Spikes. All spikes resulting from system operation shall fall within the loci shown in figure A-3.

A.3.1.2.5 Starting disturbances. Fully charged battery shall be used (battery drawing less than 5 A from a 28 V charging source with electrolyte temperature between 27 and 38 °C (-3 and 3 °F)).

A.3.1.2.5.1 Initial engagement surges. During this disturbance the voltage shall not fall below 6 V and the duration shall not exceed 1 second.

A.3.1.2.5.2 Cranking level. The steady voltage during cranking shall not be below 16 V (no more than 3 cranking attempts of 30 s each with 2-minute cranking level pauses between attempts).

A.3.2 Single fault condition. (Vehicle system operates with generator only, i.e., no battery.)

A.3.2.1 Steady-state voltage. The voltage shall be less than 33 V.

A.3.2.2 Ripple. The upper and lower peaks of ripple voltage (see figure A-1) shall each be less than 7 V. The frequency components of the ripple shall be within the range of 50 Hz to 200 kHz.

A.3.2.3 Surges. All surges resulting from system operation shall fall within the loci shown in figure A-4. (A lower steady-state limit of 23 V shall be used to establish the recovery time of negative-going surges.)

A.3.2.4 Spikes. All spikes resulting form system operation shall fall within the loci shown in figure A-5.

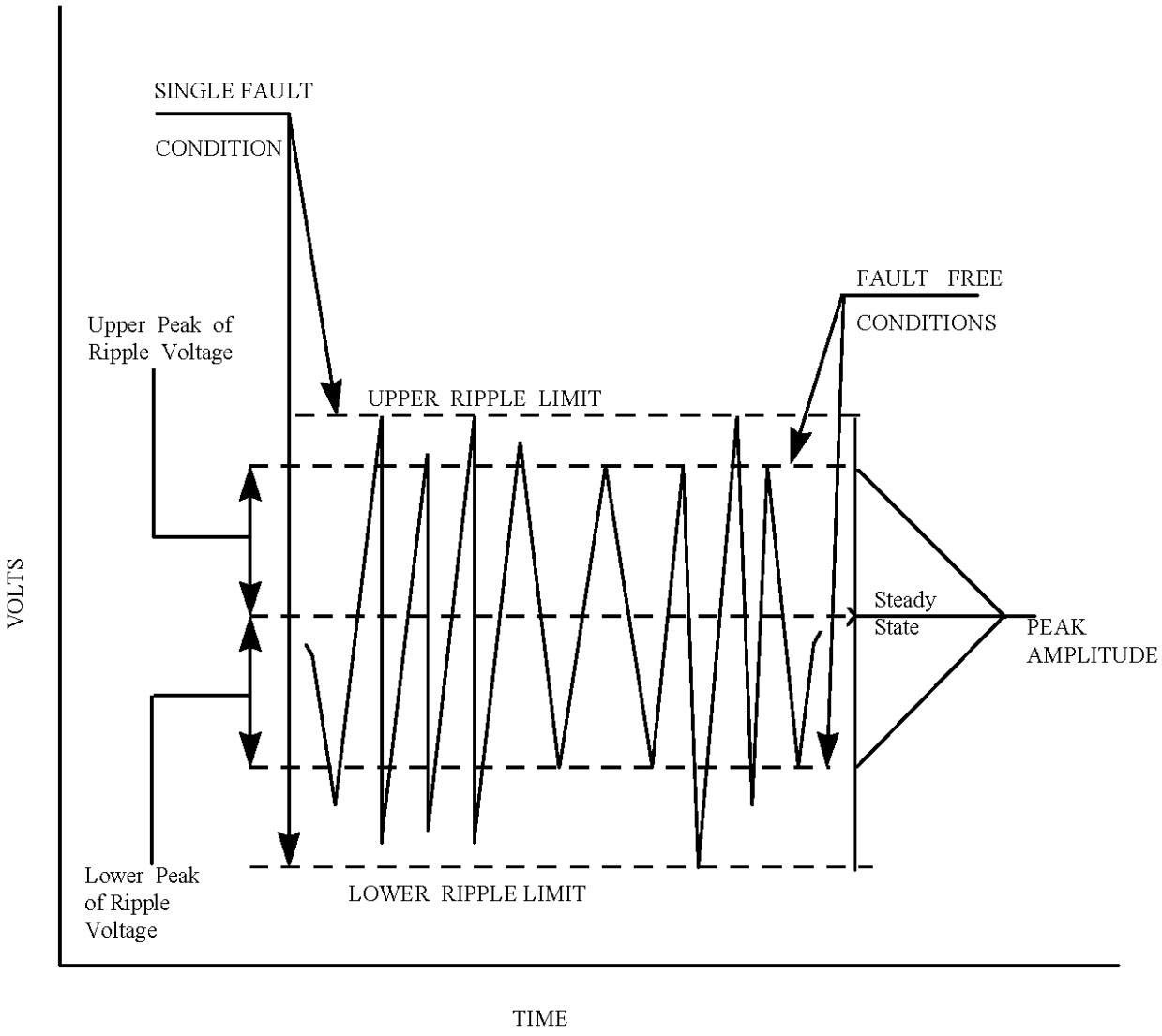


FIGURE A-1. Enlarged view of ripple.

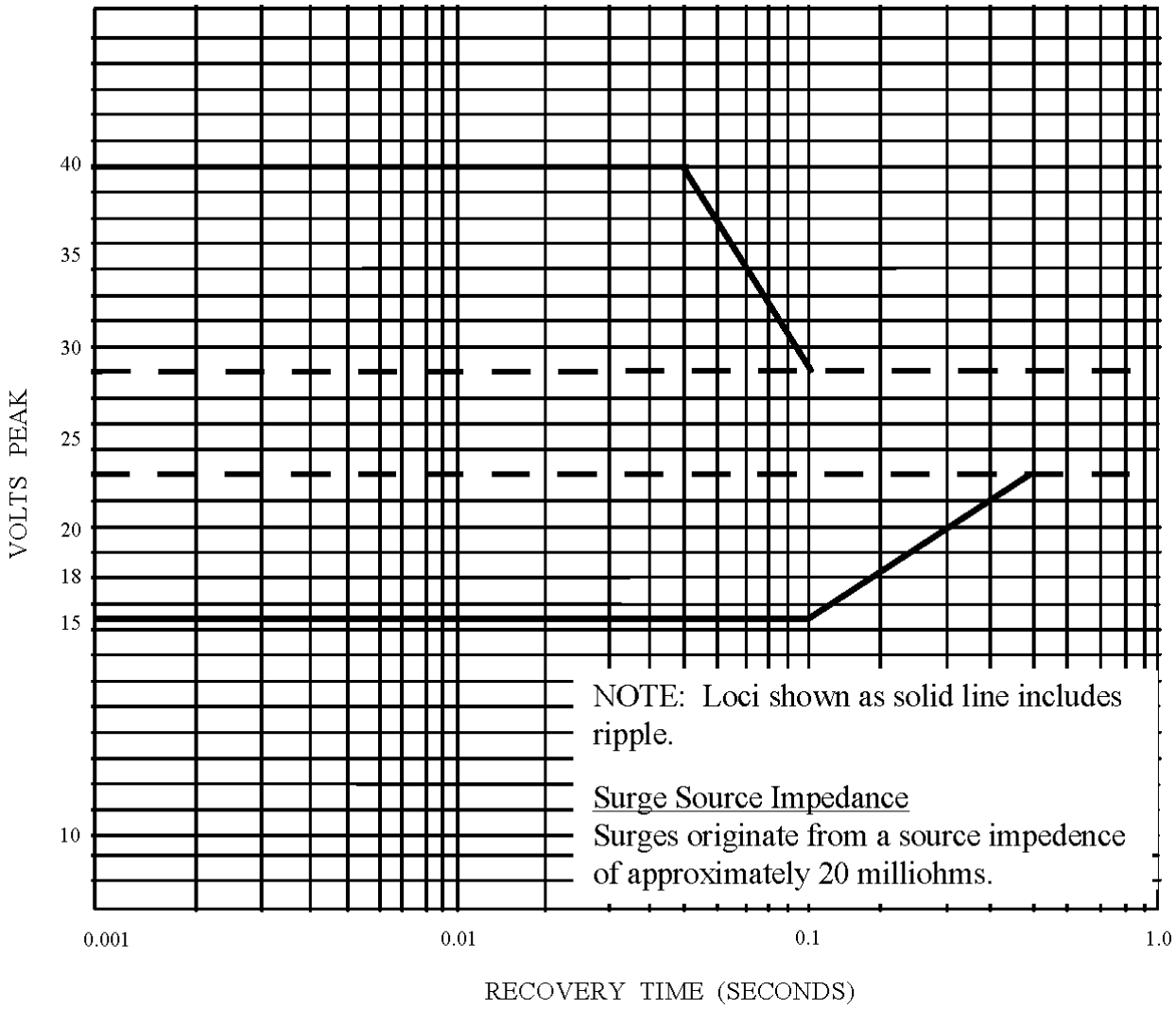


FIGURE A-2. Loci of surges - fault free condition.

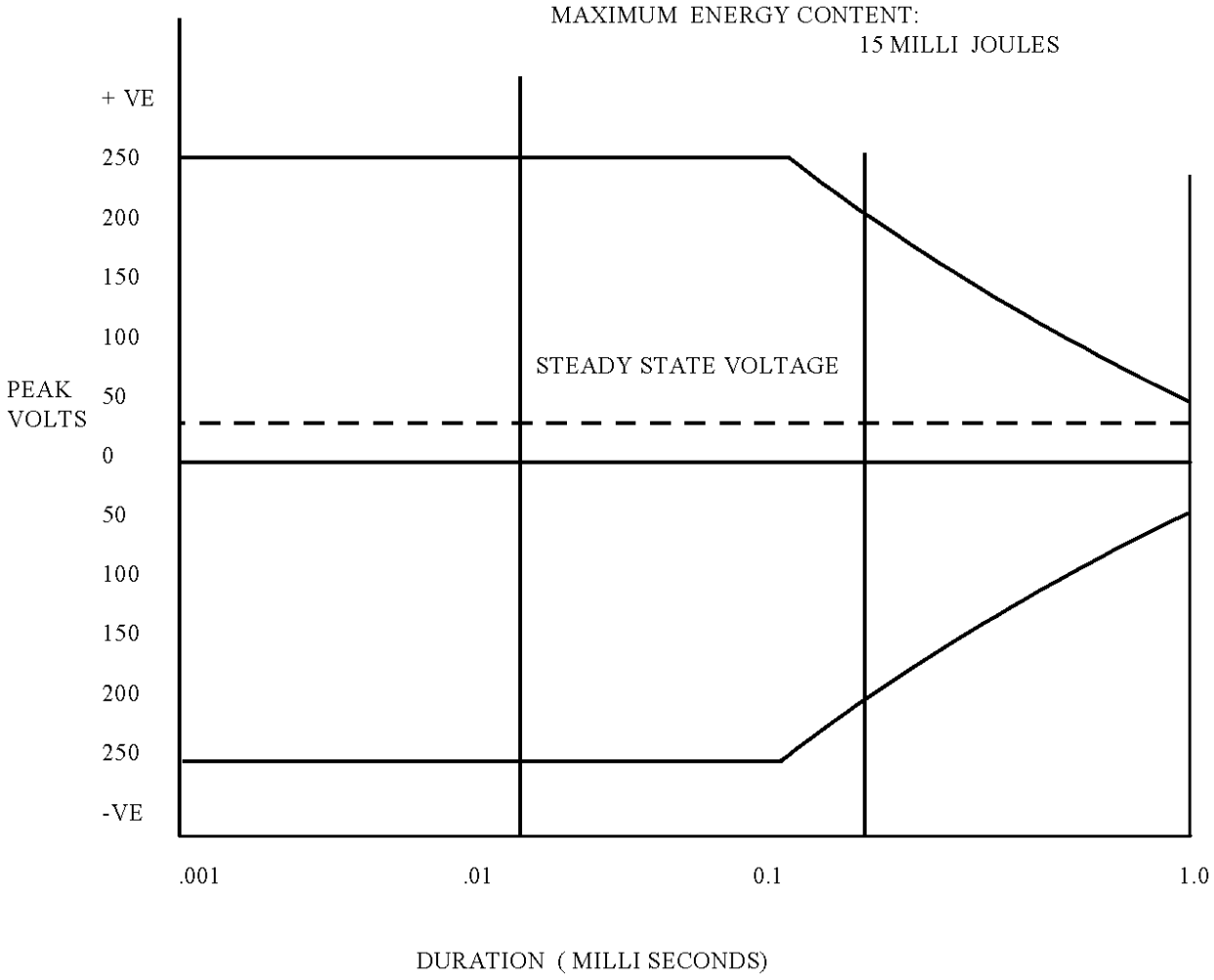


FIGURE A-3. Loci of spikes - fault free conition.

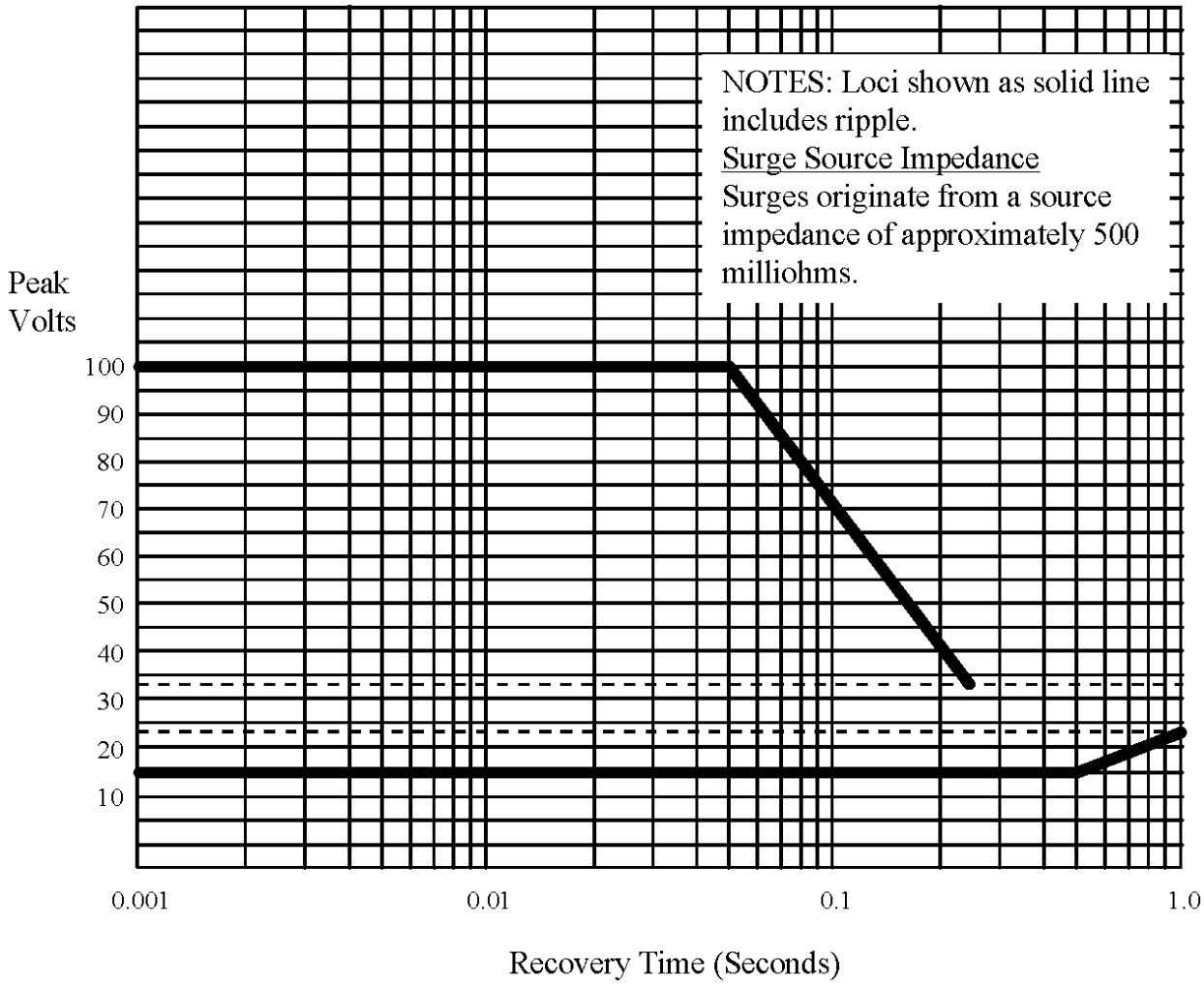


FIGURE A-4. Loci of surges - single fault condition.

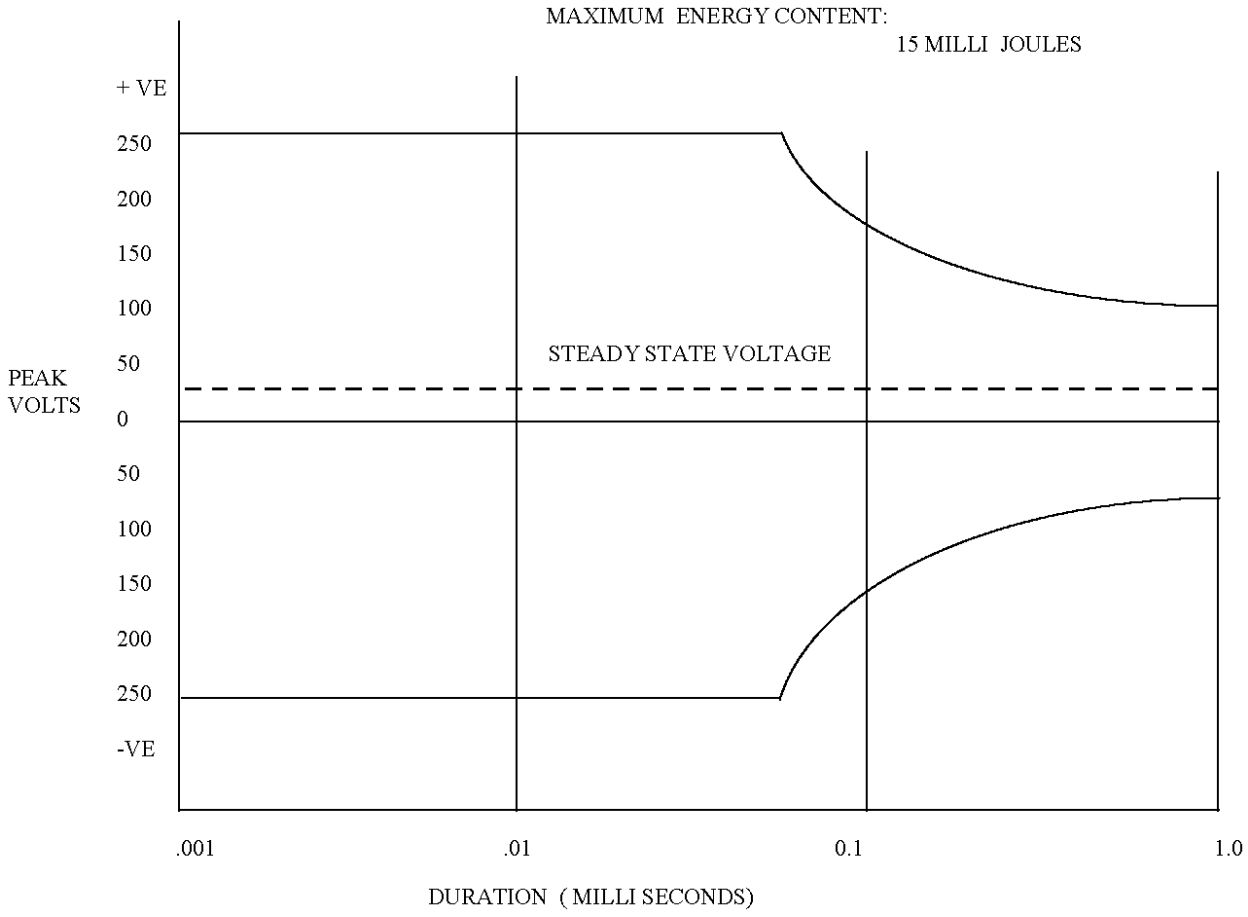


FIGURE A-5. Loci of spikes - single fault condition.

Custodian:
Army - AT

Review activity:
DLA - GS

Preparing Activity:
Army - AT

(Project 6665-2010-004)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.daps.dla.mil.