INCH-POUND

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PERFORMANCE SPECIFICATION

SMOKE SENSORS, IONIZATION AND PHOTOELECTRIC, ADVANCED FIRE AND SMOKE SENSOR SYSTEM (AFSSS)

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for both ionization and photoelectric smoke sensors (see 6.8.10 and 6.8.12, respectively) and their universal bases and junction boxes, which are components of an overall Advanced Fire and Smoke Sensor System (AFSSS) for use on naval ships. These ionization and photoelectric smoke sensors, universal bases, and junction boxes may be of commercial-off-the-shelf (COTS) design, but must be rugged (see 6.8.15) enough to meet all of the requirements of this performance specification and the rigors of Navy shipboard service. Performance requirements for the other associated AFSSS components (e.g., heat sensors (see 6.8.9), flame detectors (see 6.8.7), Flame Detector Zone Modules (FDZM) (see 6.8.8), Switch Closure Zone Modules (SCZM) (see 6.8.20), isolators (see 6.8.11), and alarm panel (see 6.8.2)) are contained in their respective AFSSS specifications.

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.

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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for
MIL-E-2036	-	Enclosures for Electric and Electronic Equipment, Naval Shipboard
MIL-DTL-24643	-	Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specifications for

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". 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.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

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

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.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 72	-	National Fire Alarm Code

(Copies of this document are available from National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269 or online at http://www.nfpa.org/.)

UNDERWRITERS LABORATORIES INC. (UL)

UL 268	-	Smoke Detectors for Fire Protective Signaling Systems

(Copies of this document are available from Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096 or online at www.ul.com.)

2.4 Order of precedence. 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 4.2.

3.2 Design requirements.

3.2.1 Design, materials, and manufacturing processes. The contractor shall select the materials, but the materials shall meet all interface, operational, and performance requirements specified herein.

3.2.2 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should 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 Configuration. The overall ionization smoke sensor shall consist of an ionization smoke sensor head, a universal sensor base, and a junction box. The overall photoelectric smoke sensor shall consist of a photoelectric smoke sensor head, a universal sensor base, and a junction box. Alternately, the universal sensor base and junction box may be combined into one unit, provided this one unit meets all of the combined requirements of both the universal sensor base and the junction box. The terms, “ionization smoke sensor” and “photoelectric smoke sensor,” as used in this specification, refer to the overall smoke sensors consisting of the appropriate smoke sensor head, the universal sensor base, and the junction box or, alternately, the appropriate smoke sensor head and a combined universal sensor base and junction box.

3.3.1 Sensor head. The sensor head shall contain the actual smoke sensing element of the ionization or photoelectric smoke sensor. The sensor head shall be compatible with the universal sensor base and shall securely attach to it but be easily attached and removed without the need for special tools. Sensor heads shall be easily disassembled for cleaning without the need for special tools. Sensor heads shall operate properly in both overhead (vertical) and bulkhead (horizontal) mounted positions.

3.3.1.1 Interchangeability. The AFSSS ionization smoke sensor head shall have a unique model number and shall be physically identical and interchangeable with all other AFSSS ionization smoke sensor heads from the same manufacturer. The AFSSS photoelectric smoke sensor head shall have a unique model number, different than that of the ionization smoke sensor head, and shall be physically identical and interchangeable with all other AFSSS photoelectric smoke sensor heads from the same manufacturer.

3.3.1.2 Ionization smoke sensor heads. Ionization smoke sensor heads shall consist of a single radioactive Americium 241 source of 1 microcurie (uCi) or less that ionizes two chambers, which causes a small DC current to flow between the electrodes in each chamber. Smoke shall freely enter one chamber while the second chamber shall be virtually sealed to smoke. Smoke entering the first chamber shall cause a reduction in the DC current, and the imbalance between the two chambers shall be proportional to the smoke density. When the sensed input value exceeds a predetermined threshold, an alarm shall be indicated. Ionization smoke sensors shall be restorable (see 6.8.14) after a reset (see 6.8.13) of the alarm at the alarm panel is manually executed and the sensor is free of smoke (i.e., ionization smoke sensor alarms shall latch at the alarm panel).

3.3.1.3 Photoelectric smoke sensor heads. Photoelectric smoke sensor heads shall consist of a light emitting diode (LED) and photodiode arrangement. The chamber shall be designed such that light emitted by the LED cannot normally reach the photodiode. In the event of fire, particles of smoke enter the chamber and scatter the light. As the smoke level increases, the scattering effect increases, causing more light to hit the photo diode until an alarm is indicated at a predetermined threshold. Photoelectric smoke sensors shall be restorable after a reset of the alarm at the alarm panel is manually executed and the sensor is free of smoke (i.e., photoelectric smoke sensor alarms shall latch at the alarm panel).

3.3.2 Universal sensor base. The universal sensor base shall securely accept attachment of ionization smoke sensor heads, photoelectric smoke sensor heads, and AFSSS heat sensor heads. The base shall be universal, permitting direct interchange between and compatibility with the ionization smoke sensor head, the photoelectric smoke sensor head, and the AFSSS heat sensor head from the same manufacturer. Universal sensor bases shall operate properly in both overhead (vertical) and bulkhead (horizontal) mounted positions. The universal sensor base and junction box may be combined into one unit, provided this one unit meets all of the combined requirements of both the universal sensor base and the junction box.

3.3.2.1 Interchangeability. The AFSSS universal sensor base from the same manufacturer shall have a unique model number assigned to it, and shall be physically identical and interchangeable with all other AFSSS universal sensor bases from the same manufacturer.

3.3.3 Individual addressability and LED. Either the sensor head or the universal sensor base shall have an adjustable mechanical device or dipswitch that can be easily set to allow each sensor to be individually identifiable and addressable (see 6.8.1) by the alarm panel once installed in a specific location in a shipboard compartment. Once set, this device or dipswitch shall be easily capable of later being set to a different address, without the use of special tools or equipment, to support sensor head or base interchangeability. Either the sensor head or the universal sensor base shall also contain one or more LEDs. Failure of any LED shall not interfere with the operation of the head or base or the transmission of sensor information or alarm or trouble signals (see 6.8.21) to the alarm panel. The LED(s) shall be capable of visually showing the condition of the sensor head and universal base. The LED(s) shall distinctly identify the three possible sensor states:

State 1: Power is not being supplied to the sensor or the sensor is not properly operating (darkened LED).

State 2: Power is being supplied to the sensor and the sensor is operating but is not in an alarm state.

State 3: Power is being supplied to the sensor and the sensor is in an alarm state.

3.3.4 Junction box. A junction box shall securely accept attachment of the universal sensor base. The junction box and universal sensor base may be combined into one unit, provided this one unit meets all of the combined requirements of both the universal sensor base and the junction box. All junction boxes from the same manufacturer used for ionization and photoelectric smoke sensors shall be identical, and shall also be identical to those used for AFSSS heat sensors. The junction box shall possess two flat areas to allow two separate LS2SWU-1 cables (see MIL-DTL-24643) with appropriate watertight stuffing tubes (see MIL-E-2036) to penetrate the junction box. The conductors of the LS2SWU-1 cables shall provide sensor power and supervision from the alarm panel and shall be wired to the universal sensor base. The junction box shall provide a conductive path for the shields of the LS2SWU-1 cables to connect to ship's hull to provide shield termination. The junction box shall possess mounting tabs or brackets with clearance holes for bolts that will secure the junction box to 1-inch long threaded-female metal standoffs welded to the overhead or bulkhead of the compartment. When installed on the overhead of a compartment, the junction box shall be drip-proof such that water falling from above shall not enter the junction box. Therefore, standard 4-inch electrical boxes with holes or knockout plugs (which are commonly used for mounting commercial grade smoke sensors and bases, but are not drip-proof) are not permitted as junction boxes.

3.4 Drip-proof. When installed on the overhead of a compartment, the overall smoke sensor shall be drip-proof (15 degrees) in accordance with MIL-E-2036 such that water falling from above shall not enter the junction box, universal sensor base, or sensor head.

3.5 Weight. The total weight of the ionization smoke sensor (consisting of the sensor head, the universal sensor base, and the junction box) shall not exceed 3 pounds. The total weight of the photoelectric smoke sensor (consisting of the sensor head, the universal sensor base, and the junction box) shall not exceed 3 pounds.

3.6 Size. Ionization and photoelectric smoke sensors (consisting of the sensor head, the universal sensor base, and the junction box) shall have a low profile. The maximum height of the overall ionization smoke sensor, assembled with sensor head mounted on the universal base and the junction box, shall not exceed 7 inches. The maximum height of the overall photoelectric smoke sensor, assembled with sensor head mounted on the universal base and the junction box, shall not exceed 7 inches. The maximum diameter of the overall ionization or photoelectric smoke sensor shall not exceed 8 inches.

3.7 Interface requirements.

3.7.1 Electrical interface. Ionization and photoelectric smoke sensor heads and their universal sensor bases shall obtain power from and be compatible with the UL listed AFSSS alarm panel. The universal bases of ionization and photoelectric smoke sensors shall be two-conductor devices, whose power supply terminals are the same as their signaling terminals. The cable used to interface the alarm panel with the ionization and photoelectric smoke sensors (via their universal bases and junction boxes) shall be LS2SWU-1. The LS2SWU-1 cabling shall be routed from the alarm panel to the various sensors throughout the ship's compartments and then return to the alarm panel in a looped NFPA 72, Style 6, Class A signaling line circuit (see 6.8.17) arrangement so that single opens on the loop will not result in the loss of any sensors.

3.7.2 Ship interface. The ionization and photoelectric smoke sensors shall attach to their universal bases, which, in turn, shall attach to their junction boxes. These junction boxes shall be mounted with bolts to 1-inch long threaded-female metal standoffs welded onto the overheads and bulkheads of the ship's compartments. Alternately, the universal sensor base and junction box may be combined into one unit, provided this one unit meets all of the combined requirements of both the universal sensor base and the junction box.

3.8 Operating requirements.

3.8.1 Basic operation. When tested in accordance with 4.5.1, ionization and photoelectric smoke sensors shall alarm when subjected to sufficient smoke and shall send appropriate alarm data or an alarm signal (see 6.8.3) to the alarm panel. Ionization and photoelectric smoke sensors shall provide actual smoke measurement information to the alarm panel, commensurate with the amount of smoke at the sensor, which will allow the alarm panel to display individual sensor real-time measurements of smoke in percent obscuration per foot units.

3.8.2 Sensitivity. When tested in accordance with 4.5.2, ionization and photoelectric smoke sensors shall comply with UL 268 requirements for gray smoke sensitivity tests and alarm thresholds (set points). Ionization and photoelectric smoke sensors shall have a minimum of three discrete alarm threshold settings, all within the range allowed by UL 268. For both ionization and photoelectric smoke sensors, the most sensitive (lowest) alarm threshold (sensitivity) setting shall be greater than or equal to 0.5 percent obscuration per foot (gray smoke), but less than 1.0 percent obscuration per foot (gray smoke). For ionization smoke sensors, the least sensitive (highest) alarm threshold (sensitivity) setting shall be greater than 1.5 percent obscuration per foot (gray smoke). For photoelectric smoke sensors, the least sensitive (highest) alarm threshold (sensitivity) setting shall be greater than 2.5 percent obscuration per foot (gray smoke). Initial selection and later changing of these discrete alarm threshold settings shall be easily executable at the AFSSS alarm panel (using at least a middle security access level) for individual smoke sensors, without the need to make changes or adjustments at the individual sensors. Appropriate alarm data or an alarm signal shall be sent to the alarm panel when the amount of smoke at the ionization or photoelectric smoke sensor reaches or exceeds the alarm threshold (sensitivity setting) for the sensor.

3.8.3 Sensitivity shift. When tested in accordance with 4.5.2, ionization and photoelectric smoke sensors shall be uniform in operation with repeatable sensitivities (alarm threshold settings). In accordance with UL 268, the sensitivity of the sensors shall be within 25 percent of the manufacturer's assigned values. Under no circumstances shall the sensitivity of a sensor shift outside the sensitivity limits of 0.5 to 4.0 percent obscuration per foot (gray smoke), as specified in UL 268.

3.8.4 Real-time measurement of smoke. Ionization and photoelectric smoke sensors shall be analog initiating devices (see 6.8.5), which provide measurement values of the amount of smoke present at the sensor, whether that measurement is below (thus, in a normal state) or above (thus, in an alarm state) the alarm threshold of the sensor. When tested in accordance with 4.5.1, ionization and photoelectric smoke sensors shall measure all smoke levels from 0.0 percent obscuration per foot (clean air) up to at least 4.0 percent obscuration per foot (gray smoke), and convey this measurement information to the alarm panel for viewing. The alarm panel shall display individual sensor real-time smoke measurements in percent obscuration per foot units.

3.8.5 Alarm verification. Ionization and photoelectric smoke sensors shall have an alarm verification feature (see 6.8.4) capability, in compliance with UL 268, to help eliminate/minimize nuisance alarms. The alarm verification time shall be 10 to 30 seconds, as specified and verified/tested in UL 268. This alarm verification feature shall reside in the alarm panel, not the smoke sensor. This alarm verification feature shall be easily enabled and disabled for individual/specific (as desired) smoke sensors at the alarm panel (using at least a middle security access level), not at the sensor location.

3.8.6 Self-testing circuitry. The ionization and photoelectric smoke sensors and their universal bases shall perform an automatic functional self-test (see 6.8.16) from the alarm panel, without the need to generate smoke at or attach meters to the sensors, to verify that the sensors are fully operational.

3.8.7 Automatic compensation for sensor contamination. The clean-air condition of ionization and photoelectric smoke sensors shall be supervised for contamination in accordance with UL 268.

3.9 Performance requirements.

3.9.1 Commercial performance requirements. Ionization and photoelectric smoke sensors, universal bases, and junction boxes shall be UL listed and be compatible with a UL listed AFSSS alarm panel. Ionization and photoelectric smoke sensors, universal bases, and junction boxes shall comply with UL 268, with the following exceptions/clarifications:

a. An alarm verification feature is required at the alarm panel for the smoke sensors, and shall not be contained within the smoke sensors.

b. The use of a sealing compound during installation shall not be permitted to meet the UL 268 enclosure requirement or the drip-proof requirement in 3.4 of this specification.

c. Junction boxes (outlet boxes or electrical boxes) with holes that would allow water to penetrate/drip inside are prohibited for mounting of smoke sensors or bases.

d. The use of glass or glass panels (e.g., glass covering an enclosure opening) is not permitted.

e. Isolated (non-grounded) detectors are not permitted.

f. At least one LED shall be provided on a spot-type detector head (see 6.8.19) or base to identify it is the unit from which the alarm was initiated with no exceptions. This LED shall also distinguish between the sensor's three states: not powered, powered without an alarm, and powered with an alarm.

g. Batteries are not allowed as the main source of power for a smoke detector (See 6.8.18). Batteries (including those for back up power) are not allowed within the construction of a smoke sensor. Smoke sensors shall be powered by the alarm panel.

h. An audible alarm signaling appliance shall not be provided integral with a smoke sensor.

i. A motor is not permitted in a smoke sensor.

j. The 90-day stability test requirement in UL 268 is not required. The alternate accelerated aging test (long-term stability test) in UL 268 is required.

k. The ten cycles of temperature variations for the UL 268 stability test shall be between 0 °F and 150 °F, not between 32 °F and 120 °F (which is for household use only).

l. There will be no exceptions for false alarms (see 6.8.6) during any of the air velocities tested in the UL 268 test for effect of air velocity. False alarms are prohibited to occur under all test conditions.

m. Smoke sensors shall withstand vibration as required for UL 268 listing, and shall also comply with the Government performance requirements for vibration in 3.9.2.1 of this specification.

n. Smoke sensors shall withstand jarring as required for UL 268 listing, and shall also comply with the Government performance requirements for shock in 3.9.2.2 of this specification. In addition, a momentary trouble signal or alarm, resulting from jarring, is not acceptable. Sensor operation shall not be affected. Dislodgment of parts is not acceptable, whether dislodged parts affect the operation of the unit or not.

o. Smoke sensors shall withstand transient tests as required for UL 268 listing, and shall also comply with the requirements for electromagnetic interference (EMI) in 3.9.2.3 of this specification.

p. High voltage AC-operated detectors are not permitted.

3.9.1.1 Operating temperature range. Ionization and photoelectric smoke sensors, universal bases, and junction boxes shall operate properly at temperatures ranging from 0 °F to 150 °F.

3.9.1.2 Storage temperature range. Ionization and photoelectric smoke sensors, universal bases, and junction boxes shall be able to withstand storage temperatures ranging from -22 °F to 158 °F.

3.9.2 Government performance requirements. In addition to the UL 268 requirements and listing, the following Government requirements shall be met.

3.9.2.1 Vibration. When tested in accordance with 4.6.2.1, ionization and photoelectric smoke sensors (consisting of sensor heads, universal bases, and junction boxes) shall meet the requirements of MIL-STD-167-1. Ionization and photoelectric smoke sensors shall operate normally without interruption, trouble indications, nor alarm indications (other than those alarms specifically caused by operational tests) throughout the vibration test. Ionization and photoelectric smoke sensors shall not show any evidence of physical damage throughout the vibration test. No excessive resonances of any parts shall be present during the test such that sensor operation is affected or early failure can be expected. Ionization and photoelectric smoke sensors shall comply with the requirements of 3.8.1 and shall not exhibit any of the failures listed in 3.10 during or after the vibration test. All four smoke sensors shall also comply with the requirements of 3.8.2, 3.8.3, and UL 268 after the vibration test when tested in accordance with 4.5.2 at their most sensitive and least sensitive alarm thresholds for gray smoke.

3.9.2.2 Shock. When tested in accordance with 4.6.2.2, ionization and photoelectric smoke sensors (consisting of the sensor heads, universal bases, and junction boxes) shall meet the Grade A, Class I, Type A requirements of the lightweight MIL-S-901 shock test. Ionization and photoelectric smoke sensors shall operate normally without interruption, trouble indications, nor alarm indications (other than those alarms specifically caused by operational tests) throughout the shock test. Ionization and photoelectric smoke sensors shall not show any evidence of physical damage throughout the shock test. No excessive resonances of any parts shall be present during the test such that sensor operation is affected or early failure can be expected. Ionization and photoelectric smoke sensors shall comply with the requirements of 3.8.1 and shall not exhibit any of the failures listed in 3.10 during or after the shock test. All four smoke sensors shall also comply with the requirements of 3.8.2, 3.8.3, and UL 268 after the shock test when tested in accordance with 4.5.2 at their most sensitive and least sensitive alarm thresholds for gray smoke.

3.9.2.3 Electromagnetic interference (EMI). When tested in accordance with 4.6.2.3 (including 4.6.2.3.1 through 4.6.2.3.8), ionization and photoelectric smoke sensors (consisting of sensor heads, universal bases, and junction boxes) shall meet the requirements of MIL-STD-461. Ionization and photoelectric smoke sensors shall operate normally without interruption, trouble indications, nor alarm indications (other than those alarms specifically caused by operational tests) throughout the EMI test. Ionization and photoelectric smoke sensors shall not show any evidence of physical damage throughout the EMI test. Ionization and photoelectric smoke sensors shall comply with the requirements of 3.8.1 and shall not exhibit any of the failures listed in 3.10 during or after the EMI test. All four smoke sensors shall also comply with the requirements of 3.8.2, 3.8.3, and UL 268 after the EMI test when tested in accordance with 4.5.2 at their most sensitive and least sensitive alarm thresholds for gray smoke.

3.10 Failure criteria. Ionization and photoelectric smoke sensors (consisting of smoke sensor heads, universal bases, and junction boxes) shall be reliable and not exhibit any failures such as:

a. Failure to meet all applicable UL 268 requirements.

b. Failure to be UL listed.

c. Failure to meet any Government requirements in this specification.

d. Inability to transmit appropriate alarm data or an alarm signal to the alarm panel when an actual alarm condition is present at the sensor.

e. Inability to transmit appropriate trouble data or a trouble indication to the alarm panel when an actual trouble condition is present at the sensor.

f. Transmission of alarm data or an alarm indication, whether temporary, intermittent or latched, when no such condition exists at the sensor.

g. Transmission of trouble data or a trouble indication, whether temporary, intermittent or latched, when no such condition exists at the sensor.

h. Failure of the sensor LED(s) or any incorrect LED indication for any of the three sensor states.

i. Erroneous measurements of smoke (once displayed in per cent obscuration per foot units at the AFSSS alarm panel in the range of 0.0 to 4.0 percent obscuration per foot (gray smoke)) whether measured in clean air, smoke at levels below the sensor's alarm threshold, or smoke at levels above the sensor's alarm threshold.

j. The shifting of alarm threshold settings beyond the limits of 3.8.3 or outside the sensitivity limits of 0.5 to 4.0 percent obscuration per foot (gray smoke), as specified in UL 268.

k. The loss of alarm verification or a change in alarm verification time.

l. Any physical damage, warping, or cracking of the sensor head, universal base, or junction box. Any physical damage, warping, cracking, or dislodging of any components from the sensor head, universal base, or junction box. Any dislodging of the entire sensor head from its universal base, the entire base from its junction box, or the entire junction box from its installation mounts (standoffs). Any physical damage that would render the sensor head, universal base, or junction box no longer drip-proof.

m. Any mechanical failure or alteration of the sensor's mechanical device or dipswitch (which sets the sensor's individual address) that results in a trouble signal, renders the sensor inaddressable from the alarm panel, or changes the address of the sensor.

3.11 Maintainability. To the maximum extent possible, ionization and photoelectric smoke sensors, universal bases, and junction boxes shall require minimum planned maintenance, cleaning, and replacement while maintaining performance.

3.12 Reliability. To the maximum extent possible, ionization and photoelectric smoke sensors, universal bases, and junction boxes shall be highly reliable devices that eliminate or significantly minimize the occurrence of false alarms while maintaining an acceptable level of early warning fire detection capability. Numerous false alarms for an installed shipboard system can erode crew confidence in the system. As specified in 3.10, any transmission of alarm data or an alarm indication, whether temporary, intermittent or latched, when no such condition exists at the sensor is considered a failure during the conductance of all first article and conformance inspection tests.

4. VERIFICATION

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

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on ionization and photoelectric smoke sensors when a first article sample is required (see 3.1). This inspection shall include the examination and tests listed in Table I.

4.2.1 Disposition of first article units. Final disposition of first article samples shall be as specified (see 6.2).

4.3 Conformance inspection. Conformance inspection shall include the examination and tests listed in Table I.

TABLE I. First article and conformance inspections.

Name	Requirement paragraph	Verification paragraph	First article inspection	Conformance inspection
Configuration	3.3	4.4	X	X
Drip-proof	3.4	4.4	X	X
Weight	3.5	4.4	X	X
Size	3.6	4.4	X	X
Interface requirements	3.7	4.4	X	X
Basic operation	3.8.1	4.5.1	X	X
Sensitivity	3.8.2	4.5.2	X	X
Sensitivity shift	3.8.3	4.5.2	X	X
Real-time measurement of smoke	3.8.4	4.5.1	X	X
Alarm verification	3.8.5	4.4	X	X
Self-testing circuitry	3.8.6	4.4	X	X
Automatic compensation for sensor contamination	3.8.7	4.4	X	X
Commercial performance requirements	3.9.1	4.6.1	X	
Operating temperature range	3.9.1.1	4.6.1	X	
Storage temperature range	3.9.1.2	4.6.1	X	
Vibration	3.9.2.1	4.6.2.1	X	
Shock	3.9.2.2	4.6.2.2	X	
Electromagnetic interference	3.9.2.3	4.6.2.3	X	

4.4 General examination. Ionization and photoelectric smoke sensors (consisting of smoke sensor heads, universal sensor bases and junction boxes) shall be thoroughly examined for compliance with the requirements specified in 3.3 through 3.7 and 3.8.5 through 3.8.7. A visual examination shall be made to ensure the proper overall sensor configuration (sensor head, universal sensor base, and junction box or sensor head and combination sensor base and junction box), the inclusion of an adjustable mechanical device or dipswitch for individually identifiable addressability, the proper assembly/disassembly/interchangeability of the sensor components, and the drip-proof integrity of the overall sensor as required in 3.4. The sensors shall also be weighed and measured for compliance with 3.5 and 3.6, respectively. The inspection shall also include operational checks of proper LED operation, as specified in 3.3.3, when the sensors, powered and monitored by the alarm panel in accordance with 3.7, are in their non-powered, powered/normal, and powered/alarm states. The inclusion of an alarm verification feature capability, self-testing circuitry, and automatic compensation for sensor contamination, as specified in 3.8.5, 3.8.6, and 3.8.7, respectively, shall be verified as described in UL 268.

4.5 Operational tests.

4.5.1 Basic operational tests. Six ionization smoke sensors shall be powered and monitored by the AFSSS alarm panel. These six ionization smoke sensors shall be designated I1, I2, I3, I4, I5, and I6. LS2SWU-1 cables and appropriate stuffing tubes shall be used to connect the six sensors to the alarm panel. The LS2SWU-1 cabling shall be routed from the alarm panel to the six sensors and then returned to the alarm panel in a looped NFPA 72, Style 6, Class A signaling line circuit arrangement. All six ionization smoke sensors shall have their alarm thresholds set to their most sensitive alarm thresholds (i.e., their percent obscuration per foot alarm settings closest to zero). The alarm verification feature (see 3.8.5) shall not be used for any of the sensors during these tests. Operational tests shall be conducted on all six sensors. The operational tests shall consist of:

a. Subjecting the smoke sensors to sufficient smoke to cause an alarm.

b. Reading real-time (analog) values (measurements) of the amount (or lack) of smoke for the smoke sensors.

c. Visually inspecting the sensors, bases, and junction boxes for physical damage, cracks, loosening, warping, or thermal deterioration.

The six ionization smoke sensors shall comply with the requirements of 3.8.1 and 3.8.4 and shall not exhibit any of the failures listed in 3.10. These same operational tests will be repeated for six photoelectric smoke sensors. These six photoelectric smoke sensors shall be designated P1, P2, P3, P4, P5, and P6. These six photoelectric smoke sensors shall also comply with the requirements of 3.8.1 and 3.8.4 and shall not exhibit any of the failures listed in 3.10.

4.5.2 Sensitivity test. The twelve smoke sensors previously tested in 4.5.1 (ionization smoke sensors I1, I2, I3, I4, I5, and I6 and photoelectric smoke sensors P1, P2, P3, P4, P5, and P6) shall be powered and monitored by the AFSSS alarm panel and subjected to smoke chamber sensitivity testing, one at a time, in accordance with UL 268. Ionization and photoelectric smoke sensors shall have their alarm thresholds set to their most sensitive alarm threshold (i.e., their percent obscuration per foot alarm settings closest to zero). The alarm verification feature (see 3.8.5) shall not be used for any of the sensors during these tests. Each sensor shall be subjected to three gray smoke trials. These same six ionization and six photoelectric smoke sensors shall then have their alarm thresholds set to their least sensitive (highest) alarm threshold and shall be subjected, one at a time, to three gray smoke trials. For each sensor tested, the final values used for the most sensitive and least sensitive sensitivity are to be the average of the three gray smoke readings at each sensitivity setting. Sensors shall comply with the requirements of 3.8.2 and 3.8.3 and UL 268 requirements and shall not exhibit any of the failures listed in 3.10. The primary purpose of this test is to establish a baseline for each sensor's most sensitive and least sensitive alarm threshold setting. This test will then be repeated after each of the vibration, shock and EMI tests to ensure that the sensors' alarm thresholds do not change/vary. (Thus, the primary purpose of this test is not to ensure basic compliance with UL 268, which is covered separately by the UL testing and listing requirement in 3.9.1.)

4.6 Performance tests.

4.6.1 Commercial performance tests. Ionization and photoelectric smoke sensors, universal bases, and junction boxes shall be inspected for UL listing, compliance with UL 268, and compatibility with the AFSSS alarm panel. Sensors shall also be inspected to ensure that the UL 268 exceptions and clarifications of 3.9.1 are met as specified (see 6.2). An accelerated aging test shall be performed in accordance with UL 268. The UL 268 alternate accelerated aging test (long-term stability test) shall be conducted. The UL 268 stability test shall be conducted with the ten cycles of temperature variations being between 0 °F and 150 °F, not between 32 °F and 120 °F (which is for household use only). The UL 268 test for effect of air velocity shall be conducted, but with no exceptions for false alarms during any of the air velocities (i.e., false alarms are prohibited from occurring under all test conditions). Sensor operating and storage temperature ranges shall be verified to comply with the requirements of 3.9.1.1 and 3.9.1.2, respectively.

4.6.2 Government performance tests.

4.6.2.1 Vibration. Two ionization smoke sensors (I1 and I2) (each consisting of an ionization smoke sensor head, universal base, and junction box) and two photoelectric smoke sensors (P1 and P2) (each consisting of a photoelectric smoke sensor head, universal base, and junction box) shall be subjected to MIL-STD-167-1 vibration testing. Sensors I1, I2, P1, and P2 shall be subjected to the operational tests of 4.5.1 and the sensitivity tests of 4.5.2 prior to this vibration test. Both ionization smoke sensors and both photoelectric smoke sensors shall be mounted on the vertical bracket of the vibration platform. The junction boxes of all four sensors will be bolted to the vibration platform using 1-inch long threaded-female standoffs to duplicate actual shipboard mounting conditions. (The bottoms of the junction boxes shall not rest flush against the vibration platform. The bottoms of the junction boxes shall rest flush against the faces of the 1-inch standoffs.) All four sensors shall be powered and monitored by the AFSSS alarm panel. The AFSSS alarm panel shall not be mounted on the vibration platform. LS2SWU-1 cables and appropriate stuffing tubes shall be used to connect the four smoke sensors to the alarm panel. The LS2SWU-1 cabling shall be routed from the alarm panel to the four sensors and then returned to the alarm panel in a looped NFPA 72, Style 6, Class A signaling line circuit arrangement. Additional AFSSS sensors, detectors, and devices (e.g., other smoke sensors not being subjected to this vibration testing or other heat sensors, flame detectors, FDZMs, SCZMs, and isolators also being subjected to this vibration testing) may be included on this sensor loop. Ionization and photoelectric smoke sensors shall have their alarm thresholds set to their most sensitive alarm thresholds (i.e., their percent obscuration per foot alarm settings closest to zero). The alarm verification feature (see 3.8.5) shall not be used for any of the sensors during these tests. The exploratory, variable frequency, and endurance tests shall be conducted for each of the three rectilinear orientation axes. The full frequency range (4 through 50 Hz) shall be tested with vibration amplitudes as specified in MIL-STD-167-1. For each of the three orientations, the operational tests of 4.5.1 shall be conducted on each of the four smoke sensors (while mounted on the vibration platform) once after the exploratory test, once after the variable frequency test, and once midway during the endurance test (or midway at each resonant frequency, if tested at more than one frequency during the endurance test). After the vibration test, the sensors shall also be subjected to the (gray smoke) sensitivity tests of 4.5.2 at both their most sensitive and least sensitive alarm thresholds. All four smoke sensors shall meet the requirements of 3.9.2.1.

4.6.2.2 Shock. Two ionization smoke sensors (I3 and I4) (each consisting of an ionization smoke sensor head, universal base, and junction box) and two photoelectric smoke sensors (P3 and P4) (each consisting of a photoelectric smoke sensor head, universal base, and junction box) shall be subjected to lightweight, Grade A, Class I, Type A, MIL-S-901 shock testing. Sensors I3, I4, P3, and P4 shall have been subjected to the operational tests of 4.5.1 and the sensitivity tests of 4.5.2 prior to this shock test. Both ionization smoke sensors and both photoelectric smoke sensors shall be mounted on the (vertical) Fixture 4A of the shock machine. The junction boxes of all four sensors will be bolted to the shock machine fixture using 1-inch long threaded-female standoffs to duplicate actual shipboard mounting conditions. (The bottoms of the junction boxes shall not rest flush against the shock machine fixture. The bottoms of the junction boxes shall rest flush against the faces of the 1-inch standoffs.) All four sensors shall be powered and monitored by the AFSSS alarm panel. The AFSSS alarm panel shall not be mounted on the shock machine. LS2SWU-1 cables and appropriate stuffing tubes shall be used to connect the four smoke sensors to the alarm panel. The LS2SWU-1 cabling shall be routed from the alarm panel to the four sensors and then returned to the alarm panel in a looped NFPA 72, Style 6, Class A signaling line circuit arrangement. Additional AFSSS sensors, detectors, and devices (e.g., other smoke sensors not being subjected to this shock testing or other heat sensors, flame detectors, FDZMs, SCZMs, and isolators also being subjected to this shock testing) may be included on this sensor loop. Ionization and photoelectric smoke sensors shall have their alarm thresholds set to their most sensitive alarm thresholds (i.e., their percent obscuration per foot alarm settings closest to zero). The alarm verification feature (see 3.8.5) shall not be used for any of the sensors during these tests. After each of the nine shock blows, the operational tests of 4.5.1 shall be conducted on each of the four smoke sensors (while mounted on the shock machine). After the shock test, the sensors shall also be subjected to the (gray smoke) sensitivity tests of 4.5.2 at both their most sensitive and least sensitive alarm thresholds. All four smoke sensors shall meet the requirements of 3.9.2.2.

4.6.2.3 Electromagnetic interference (EMI). Two ionization smoke sensors (I5 and I6) (each consisting of an ionization smoke sensor head, universal base, and junction box) and two photoelectric smoke sensors (P5 and P6)(each consisting of a photoelectric smoke sensor head, universal base, and junction box) shall be subjected to EMI testing in accordance with MIL-STD-461. Sensors I5, I6, P5, and P6 shall have been subjected to the operational tests of 4.5.1 and the sensitivity tests of 4.5.2 prior to this EMI test. The junction boxes of all four sensors will be bolted to the EMI ground plane using 1-inch long threaded-female standoffs to duplicate actual shipboard mounting conditions. (The bottoms of the junction boxes shall not rest flush against the ground plane. The bottoms of the junction boxes shall rest flush against the faces of the 1-inch standoffs.) All four sensors shall be powered and monitored by the AFSSS alarm panel. The AFSSS will be EMI tested as a system; thus, the AFSSS alarm panel shall be included in the EMI test. LS2SWU-1 cables and appropriate stuffing tubes shall be used to connect the four smoke sensors to the alarm panel. The LS2SWU-1 cabling shall be routed from the alarm panel to the four sensors and then returned to the alarm panel in a looped NFPA 72, Style 6, Class A signaling line circuit arrangement. Additional AFSSS sensors, detectors, and devices (e.g., other heat sensors, flame detectors, FDZMs, SCZMs, and isolators also being subjected to this EMI testing) may be included on this sensor loop. The shields of the LS2SWU-1 cables shall connect to the EMI ground plane to provide shield termination (electrical conductivity) at each sensor. The shields of the LS2SWU-1 sensor cables at the alarm panel shall connect to the chassis of the alarm panel, which shall be attached and grounded to the EMI ground plane. Ionization and photoelectric smoke sensors shall have their alarm thresholds set to their most sensitive alarm thresholds (i.e., their percent obscuration per foot alarm settings closest to zero). The alarm verification feature (see 3.8.5) shall not be used for any of the sensors during these tests. The EMI tests of 4.6.2.3.1 through 4.6.2.3.8 shall be conducted in accordance with MIL-STD-461 on all four smoke sensors and the alarm panel (and any additional heat sensors, flame detectors, FDZMs, SCZMs, and isolators included in the sensor loop for this EMI test). The operational tests of 4.5.1 shall be conducted on each of the four smoke sensors during the EMI tests as specified in 4.6.2.3.1 through 4.6.2.3.8. After all of the EMI tests specified in 4.6.2.3.1 through 4.6.2.3.8 are conducted, the sensors shall be subjected to the (gray smoke) sensitivity tests of 4.5.2 at both their most sensitive and least sensitive alarm thresholds. All four smoke sensors shall meet the requirements of 3.9.2.3. EMI requirements for the alarm panel and other AFSSS sensors, detectors and devices are contained in separate AFSSS component specifications.

4.6.2.3.1 Conducted emissions (CE 102)(10 kHz to 10 MHz). Conducted emissions on all power leads shall be measured over the range of 10 kHz to 10 MHz. The operational tests of 4.5.1 shall not be conducted during or after this portion of the EMI test.

4.6.2.3.2 Radiated emissions (RE 101)(30 Hz to 100 kHz). Radiated magnetic field emissions from all power and interconnecting leads, sensors and the alarm panel shall be measured over the range of 30 Hz to 100 kHz. The operational tests of 4.5.1 shall not be conducted during or after this portion of the EMI test.

4.6.2.3.3 Radiated emissions (RE 102)(10 kHz to 18 GHz). Radiated electric field emissions from all power and interconnecting leads, sensors, and the alarm panel shall be measured over the range of 10 kHz to 18GHz. The operational tests of 4.5.1 shall not be conducted during or after this portion of the EMI test.

4.6.2.3.4 Conducted susceptibility (CS 101)(30 Hz to 150 kHz). All power leads shall be subjected to CS 101 test signals as specified in MIL-STD-461 over the range of 30 Hz to 150 kHz. The operational tests of 4.5.1 shall be conducted after this portion of the EMI test.

4.6.2.3.5 Conducted susceptibility (CS 114)(10 kHz to 200 MHz). All interconnecting cables shall be subjected to CS 114 test signals as specified in MIL-STD-461 over the range of 10 kHz to 200 MHz. The operational tests of 4.5.1 shall be conducted after this portion of the EMI test.

4.6.2.3.6 Conducted susceptibility (CS 116)(10 kHz to 100 MHz). All interconnecting cables shall be subjected to CS 116 test signals as specified in MIL-STD-461 over the range of 10 kHz to 100 MHz. The operational tests of 4.5.1 shall be conducted after this portion of the EMI test.

4.6.2.3.7 Radiated susceptibility (RS 101)(30 Hz to 100 kHz). All power and interconnecting leads, sensors, and the alarm panel shall be subjected to radiated magnetic fields over the range of 30 Hz to 100 kHz as specified in RS 101 of MIL-STD-461. The operational tests of 4.5.1 shall be conducted after this portion of the EMI test.

4.6.2.3.8 Radiated susceptibility (RS 103)(2 MHz to 40 GHz). All power and interconnecting leads and sensors shall be subjected to radiated electric fields over the range of 2 MHz to 40 GHz at 25 volts per meter as specified in RS 103 of MIL-STD-461. The alarm panel shall be shielded from the effects of the 25 volts per meter field. The alarm panel shall be subjected to radiated electric fields over the range of 2 MHz to 40 GHz at 10 volts per meter as specified in RS 103 of MIL-STD-461. The operational tests of 4.5.1 shall be conducted after this portion of the EMI test.

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 material 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 that may be helpful, but is not mandatory.)

6.1 Intended use. The ionization smoke sensor is a sensing device that is effective at detecting submicron sized smoke particles from a small flaming fire but can also detect visible smoke from smoldering or flaming fires. The photoelectric smoke sensor is a sensing device that is effective at detecting larger, visible sized smoke particles from a smoldering fire but can also detect visible smoke from a flaming fire. Both ionization and photoelectric smoke sensors are considered early warning fire detectors and are used for life safety purposes. These sensors are two of several types of sensors used in the AFSSS and intended for use on Navy ships.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. When first article is required. (see 3.1 and 6.3)

c. Quantity of first article ionization and photoelectric smoke sensors (and an alarm panel, if applicable) required.

d. Final disposition of first article test samples, which are considered consumed and undeliverable. (see 4.2.1 and 6.3)

e. Proof of UL compliance including a full copy of the UL listing report for the ionization and photoelectric smoke sensors, universal bases, and junction boxes (with UL 268 testing data and results). This UL listing report will verify that the requirements of the alternate accelerated aging test (long term stability test), the wider temperature variations (0 °F to 150 °F) for the stability test, and the lack of any false alarms for the test for effect of air velocity have been met. (see 4.6.1)

f. Packaging requirements. (see 5.1)

g. Technical manual requirements. (see 6.4)

h. Provisioning requirements. (see 6.5)

i. Warranty requirements. (see 6.7)

6.3 First article. When requiring a first article inspection, contracting documents should provide specific guidance to offerors. This guidance should cover the number of test items. These documents should also include specific instructions regarding arrangements for examination, approval of first article test results, and disposition of first articles. (see 3.1 and 6.2)

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, a technical manual contract requirement (TMCR) should be obtained and cited in the contract. (see 6.2)

6.5 Provisioning. Provisioning technical documentation (PTD), spare parts, and repair parts should be furnished as specified (see 6.2). When ordering spare parts or repair parts for the equipment covered by this specification, the spare parts and repair parts should meet the same requirements as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.6 Compatibility. If ionization and photoelectric smoke sensors are being procured for use with a previously procured or existing system, ensure that the sensors are compatible and UL listed with the specific alarm panel in that system. Individually addressable ionization and photoelectric smoke sensors from one manufacturer are generally not compatible nor UL listed with an alarm panel from another manufacturer.

6.7 Warranty. Warranty requirements should be as specified (see 6.2).

6.8 Definitions.

6.8.1 Addressable sensor. A sensor with discrete identification that can have its status individually identified by the alarm panel.

6.8.2 Alarm panel. A system component that provides power to various fire sensors and monitors and visually and audibly displays their status. The alarm panel might also provide transfer of this information to a graphic display system.

6.8.3 Alarm signal. A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

6.8.4 Alarm verification feature. A feature of automatic fire detection and alarm systems to reduce unwanted alarms wherein smoke sensors report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period after being reset, in order to be accepted as a valid alarm initiation signal.

6.8.5 Analog initiating device (sensor). An initiating device (sensor) that transmits a signal indicating varying degrees of condition as contrasted with a conventional initiating device, which can only indicate an alarm/normal condition.

6.8.6 False alarm. Any alarm caused by mechanical or electrical failure, malfunction, or environmental effects other than the actual signature (e.g., smoke, high temperature, high rate of temperature rise, actual flame radiation) appropriate for that type of sensor.

6.8.7 Flame detector. A fire detector that detects radiant energy (such as ultraviolet, visible, or infrared) that is emitted as a product of combustion reaction and obeys the laws of optics.

6.8.8 Flame detector zone module (FDZM). An individually addressable device that is used to interface flame detectors with the alarm panel for monitoring purposes. FDZMs generally connect appropriate power from the alarm panel to the flame detector for operation as well as provide the individually addressable flame detector alarm signal to the alarm panel.

6.8.9 Heat sensor. A fire sensor that senses heat. Heat sensors could be of the fixed temperature type (where the sensor responds when its operating element becomes heated to a predetermined level), the rate of temperature rise type (where the sensor responds when the temperature rises at a rate exceeding a predetermined value), or both.

6.8.10 Ionization smoke sensor. A sensor that uses a small amount of radioactive material to ionize the air between two differentially charged electrodes to sense the presence of smoke particles. Smoke particles entering the ionization volume decrease the conductance of the air by reducing ion mobility. The reduced conductance signal is processed and used to convey an alarm condition when it meets preset criteria.

6.8.11 Isolators. Devices that protect sections of sensor loops from short circuits. Isolators are placed in series on the sensor loops, where they monitor for short circuits. Isolators are installed after groups of heat or smoke sensors or flame detectors, depending on the degree of overall sensor loop survivability desired. In the event of a short circuit, two isolators open, removing the shorted section of line from the sensor loop. The sensors and detectors remaining on both non-isolated sections of the sensor loop will continue to operate and communicate with the AFSSS alarm panel. The sensors and detectors located between the isolators (within the shorted section of cabling) will not be powered nor operational, and the alarm panel will report those sensors/detectors as troubles (missing), thus assisting in isolating the location of the short circuit.

6.8.12 Photoelectric (light-scattering) smoke sensor. A sensor that uses a light source and a photosensitive sensor arranged in a manner so that the rays from the light source do not normally fall onto the photosensitive sensor. When smoke particles enter the light path, some of the light is scattered by reflection onto the sensor. The light signal is processed and used to convey an alarm condition when it meets preset criteria.

6.8.13 Reset. A control function performed by a system operator, that attempts to return a system or device to its normal, non-alarm state.

6.8.14 Restorable initiating device. A device (sensor) whose sensing element is not ordinarily destroyed in the process of operation.

6.8.15 Ruggedized. Physical and operational characteristics that allow equipment to withstand rough handling and extreme or hostile environments.

6.8.16 Self-test. A test or series of tests, performed by a device upon itself, that shows whether or not the device is operating within designed limits.

6.8.17 Signaling line circuit. A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both, are carried.

6.8.18 Smoke detector (sensor). A device that detects visible or invisible particles of combustion.

6.8.19 Smoke detector (sensor) – spot type. A sensor whose detecting element is concentrated at a particular location.

6.8.20 Switch closure zone module (SCZM). An individually addressable device that is used to interface switch closure devices (such as water flow switches, manual pull stations, water switches, and flooding switches) with the alarm panel for monitoring purposes.

6.8.21 Trouble signal. A signal initiated by the fire alarm system or sensor indicative of a fault in a monitored circuit or component.

6.9 Subject term (key word) listing.

Alarm signal

Flame detector

Flame Detector Zone Module

Smoke detector

Switch Closure Zone Module

Custodians:
Army – CR4
Navy – SH
Air Force – 99

Preparing Activity:
Navy – SH
(Project 6320-2005-003)

Review Activities:
DLA – GS, GS2

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 http://assist.daps.dla.mil.