DEPARTMENT OF THE NAVY

PROGRAM EXECUTIVE OFFICE PMA260

NAVAL AIR SYSTEMS COMMAND

PATUXENT RIVER, MARYLAND 20670-1161

SYSTEM PERFORMANCE SPECIFICATION FOR THE HANDHELD AIRCRAFT WIRE TESTER (HAWT)

DISTRIBUTION STATEMENT: Approved for public release; distribution unlimited.

APPROVED: _____
TITLE: Logistics Integration Management (AIR-6.6)
DATE: 2/9/11

APPROVED: _____
TITLE: SE and ALRE Systems Engineering Division (AIR-4.8.1)
DATE: 2/7/11

APPROVED: David Sutherland
TITLE: Program Manager
DATE: 2/9/11

Table of Contents

1 Scope

1.1 Identification

The Handheld Aircraft Wire Tester (HAWT) is being acquired by NAVAIR PMA-260 as common support equipment.

1.2 System Overview

The HAWT is a handheld Time Domain Reflectometer (TDR) whose primary functions are 1) detecting faults in aircraft metallic wires and wire harnesses and 2) determining the distance to the faults. The HAWT Assembly comprises a transit case and its contents: the HAWT, test leads and adapters, and any special tools and accessories. The HAWT will be used to maintain Navy and Marine Corps aircraft at the Organizational Level (O-Level) of maintenance on aircraft carriers, L-Class and air-capable ships, and at shore-based facilities.

1.3 Document Overview

This System Performance Specification (SPS) defines the minimum performance requirements, physical requirements, and environmental and electromagnetic requirements for the HAWT and HAWT Assembly.

2 Applicable Documents, Terms, and Definitions

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the listed documents and the contents of this specification, the contents of this specification shall be considered the superseding requirement.

2.1 Government Documents

MIL-PRF-28800F	General Specification for Test Equipment for use with Electrical and Electronic Equipment
MIL-STD-461F	Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems and Equipment
MIL-STD-464C	Electromagnetic Environmental Effects Requirements for Systems
MIL-STD-810G	DoD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests
MIL-HDBK-217F	Reliability Prediction of Electronic Equipment
MIL-STD-1472F	Department of Defense Design Criteria Standard for Human Engineering

2.2 Terms and Definitions

HAWT	Handheld Aircraft Wire Tester: The handheld tester, itself.
HAWT Assembly	The HAWT transit case and its contents, comprising the tester, test leads and adapters, any special tools and equipment, and other accessories.
TDR	Time-Domain Reflectometer (TDR): An electronic instrument used to characterize

	and locate faults in metallic cables (e.g., twisted wire pairs, coaxial cables, and power leads). A TDR transmits a short-rise-time pulse down the cable and provides information from the signal reflected by any faults.
FOD	Foreign Object Damage: Damage to aircraft caused by objects such as tools, fasteners, dust caps, connectors, writing utensils, paper, and other debris left on runways, taxiways, and flight lines.
VoP	Velocity of Propagation: The speed at which a signal travels along a transmission line, expressed as a fraction of the speed of light in free space. It is alternatively referred to as Propagation Velocity, V_p.

3 System Requirements

3.1 Definition

3.1.1 General Description

The HAWT is a Time Domain Reflectometer (TDR) that will be used for locating faults, such as opens and shorts, in metallic wires and wire harnesses. The HAWT Assembly comprises a transit case and its contents: the HAWT, test leads and adapters, and special tools and accessories.

3.1.2 Operational Requirements

3.1.2.1 Need

Navy aircraft maintenance procedures call for an environmentally and electromagnetically suitable TDR to detect and locate faults, such as opens and shorts, in aircraft wires and wire harnesses at the Organizational Level (O-Level) of maintenance.

3.1.2.2 Mission utilization profile

The HAWT will be employed on the hangar decks of aircraft carriers, L-Class ships, and air-capable ships as well as at Navy and Marine Corps ground facilities to troubleshoot wiring systems on aircraft.

3.2 Characteristics

3.2.1 Performance Characteristics

3.2.1.1 Fault detection

3.2.1.1.1 Detect hard opens

The HAWT shall detect hard opens in aircraft metallic wire conductive paths. A hard open is a complete break in electrical continuity of a conductor.

3.2.1.1.2 Detect dead shorts

The HAWT shall detect dead shorts in aircraft metallic wire conductive paths. A dead short is an anomalous, unintended short-circuit path with extremely low (i.e., near-zero) impedance.

3.2.1.2 Distance To Fault (DTF)

3.2.1.2.1 Determine DTF

The HAWT shall determine the DTF for hard opens and dead shorts in aircraft wire harnesses of five to 100 feet in length and shall display the results to the operator. The operator shall not be required to transfer data to an external computer for analysis to determine the DTF.

3.2.1.2.2 Display the diagnostic waveform trace

The HAWT shall display a diagnostic waveform trace so the operator can determine visually if a fault exists and can ascertain the distance to that fault. The display of the trace on the screen shall be optimized for wire harness lengths of five to 100 feet. The diagnostic waveform trace shall provide enough useful information on the screen of the HAWT to allow the operator to determine the DTF.

3.2.1.2.3 Display the discrete DTF value

In addition to displaying a diagnostic waveform trace, the HAWT shall calculate the DTF and display a discrete value, defined as a numeric output requiring no interpretation by the operator. This feature may be fully automatic or semi-automatic.

3.2.1.2.4 DTF accuracy

For single-wire conductors of uncontrolled impedance, the HAWT shall determine the DTF to within plus or minus 20 percent of the wire length for detected opens and shorts.

For wires of controlled impedance, the HAWT shall determine the DTF to within plus or minus 10 percent of the wire length for detected opens and shorts.

3.2.1.3 Single-ended diagnostic mode

The HAWT shall detect faults and determine the DTF from one end of the harness under test. That is, the user shall not be required to access both ends of the conductive path, either simultaneously or sequentially, to obtain a useful result with the HAWT.

3.2.1.4 Self-test

The HAWT shall have a self-test feature that runs on boot-up or when activated by the user.

3.2.2 Physical Characteristics

3.2.2.1 Size and weight

The HAWT Assembly shall conform to the one-person “Male and Female” size and weight restrictions specified in section 5.9.11.3.3 of MIL-STD-1472F. The weight of the HAWT (tester) shall not exceed 12 pounds.

3.2.2.2 Display

The HAWT shall have a display to present numeric and graphical data to the operator in low light, characterized by an illumination of 0.01 lux or less. The display shall be readable in full daylight, characterized by an illumination of 10,000 lux or greater.

3.2.2.3 Batteries

The HAWT shall be energized by rechargeable or disposable batteries (or a single battery) that are replaceable by the user. Rechargeable batteries shall be charged outside the HAWT in a separate charging unit.

The minimum battery life of a new set of disposable batteries or a freshly charged set of rechargeable batteries shall be three hours. The HAWT shall have a battery level indicator.

A battery warning label compliant with section 3.11.1.3 of MIL-PRF-28800F shall be affixed to the HAWT.

The HAWT shall not be energized by elemental Lithium batteries. Li-ion batteries are acceptable.

3.2.2.4 Test lead adapter tips

Test lead adapter tips that mate securely with pin and socket contacts size 12 through 22 shall be provided. In addition, "alligator" type clips shall be provided.

3.2.2.5 Transit case

The HAWT shall be packaged in a rugged, reusable transit case that meets the design requirements of section 3.7 of MIL-PRF-28800F and protects the gear from damage during transit and exposure to severe environmental conditions.

To reduce the potential for FOD and to easily identify missing items, all parts and accessories, including adapter tips, contained in the case shall be held captive. The case shall contain a content chart with a diagram showing the layout of the parts and accessories in the case.

3.2.3 Environmental Characteristics

The HAWT shall be compatible with the hangar decks of aircraft carriers, L-Class ships, and air-capable ships as well as U.S. Navy and Marine Corps ground facilities. The HAWT Assembly and HAWT shall conform to the operational environmental requirements of MIL-PRF-28800F as specified and de-rated in the following sub-sections.

3.2.3.1 High temperature

The HAWT shall not be damaged and shall perform without degradation when exposed to a high operating temperature of 55 degrees Celsius (131 degrees Fahrenheit) and a high storage temperature of 71 degrees Celsius (160 degrees Fahrenheit).

3.2.3.2 Low temperature

The HAWT shall not be damaged and shall perform without degradation when exposed to a low operating temperature of -10 degrees Celsius (14 degrees Fahrenheit) and a low storage temperature of -40 degrees Celsius (-40 degrees Fahrenheit).

3.2.3.3 Relative humidity

The HAWT shall operate without degradation when the relative humidity is 5 to 95 percent in the temperature range of 10 to 30 degrees Celsius (inclusive), 5 to 75 percent in the temperature range of 30 to 40 degrees Celsius (inclusive), and 5 to 45 percent for temperatures above 40 degrees Celsius.

3.2.3.4 Low pressure (altitude)

The HAWT shall perform without degradation after being subjected to a low pressure equivalent to an altitude of 4000 meters.

3.2.3.5 Bounce (loose-cargo)

The HAWT shall not be damaged and shall perform without degradation after the HAWT Assembly is exposed to a loose-cargo transportation environment.

3.2.3.6 Transit drop

The transit case shall suffer no significant damage and the HAWT shall perform without degradation after the HAWT Assembly has been dropped 26 times from a height of 48 inches.

3.2.3.7 Shock (high-impact)

The HAWT (tester) shall perform without degradation after being dropped from a height of 48 inches onto a hard surface made of asphalt or concrete.

3.2.3.8 Explosive atmosphere

The HAWT shall not cause ignition of an ambient-explosive-gaseous mixture with air.

3.2.4 System Quality Factors

3.2.4.1 Reliability

The MTBF of the HAWT shall be at least 1000 operating hours for a *Sheltered Naval (N_s)* environment as defined in section 3.4.3 of MIL-HDBK-217F.

3.3 Design and Construction

3.3.1 Hazardous Materials

In general, hazardous materials shall not be used unless no feasible alternatives exist.

Hazardous materials are any items or biological, chemical, or physical agents that have the potential to cause harm to humans, to animals, or to the environment, either by themselves or through interaction with other items or agents. This includes but is not limited to materials that:

- are regulated as a hazardous material per 49 CFR 173.2
- require a Material Safety Data Sheet (MSDS) per 29 CFR 1910.1200
- are regulated as an Extremely Hazardous Substance (EHS) per 40 CFR 355, Appendices A and B
- are regulated as a Toxic Chemical per 40 CFR 372.65
- meet or have the potential to meet the definition of hazardous waste as defined by 40 CFR 261 Subparts A, B, C, or D during end use, treatment, handling, packaging, storage, transportation or disposal
- are referred to in section 101(14) or Section 102 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) per 40 CFR 302.4, or
- are identified as a Volatile Organic Chemical (VOC) per 40 CFR Part 51.100(s).

- are regulated as an Ozone Depleting Substance (ODS) per 40 CFR 82 Subpart A, Appendices A and B
- are identified in the Clean Air Act, Chapter 85, Subchapter I – 7412 as a Hazardous Air Pollutant (HAP)

3.3.1.1 Restricted materials

The following restricted materials shall not be used under any circumstances for the HAWT (or HAWT Assembly) throughout its life cycle, including its manufacture, operation, maintenance, and disposal:

- Asbestos
- Class-I Ozone-Depleting Substances (ODS)
- Class-II ODS
- Polychlorinated Biphenyls (PCBs)

3.3.1.2 Hexavalent chromium

The HAWT and its components shall not contain hexavalent chromium in concentrations greater than 0.1 percent by weight in any homogeneous material.

3.3.1.3 Exemptions

Chromium and nickel as constituents of metal alloys are exempted. Lead as a constituent of solder is exempted.

3.3.2 Electromagnetic Radiation

3.3.2.1 Electromagnetic compatibility (EMC)

The HAWT shall comply with the EMC requirements of MIL-STD-464C for metallic surface ships (below deck) and U.S. Navy and Marine Corps ground facilities.

3.3.2.2 Warning label

If the HAWT is not electromagnetically compatible with the flight deck, a warning label shall be affixed to the unit.

3.3.3 Safety

See section 3.2.3.8 herein.

4 Quality Assurance Provisions

4.1 Responsibility for Testing

The contractor is responsible for the performance of all testing requirements as specified herein. The contractor may utilize his own facilities or any qualified commercial facility acceptable to the government, who reserves the right to perform any of the verification methods herein to ensure the HAWT conforms to the requirements. The government reserves the right to witness or participate in any testing conducted by the contractor or his agent.

4.2 Characteristics Verification

4.2.1 Performance Tests

4.2.1.1 Fault Detection

4.2.1.1.1 Detect hard opens

The detection of hard opens shall be verified using three different wire/cable types of two different lengths each. The wire/cable types shall be coaxial, such as RG-302, 75-ohm; twisted pair, such as M22759/11-26-7; and single-conductor wire, such as MIL-DTL-22759/91-20. Wire/cable lengths shall be six and 25 feet.

4.2.1.1.2 Detect dead shorts

The detection of dead shorts shall be verified using three different wire/cable types of two different lengths each. The wire/cable types shall be coaxial, such as RG-302, 75-ohm; twisted pair, such as M22759/11-26-7; and single-conductor wire, such as MIL-DTL-22759/91-20. Wire/cable lengths shall be six and 25 feet.

4.2.1.2 Distance to Fault (DTF)

4.2.1.2.1 Determine DTF

The DTF feature of the HAWT shall be verified for the faults found in each of the wire/cable types and lengths used in the fault-detection tests of 4.2.1 herein. The DTF tests shall be conducted by placing the wire/cables on conducting and non-conducting surfaces.

4.2.1.2.2 Display the diagnostic waveform trace

The display of the diagnostic waveform trace shall be verified via demonstration.

4.2.1.2.3 Display the discrete DTF value

The display of the discrete DTF value diagnostic waveform trace shall be verified via demonstration.

4.2.1.2.4 DTF accuracy

The HAWT DTF accuracy as specified in 3.2.1.2.4 herein shall be verified by comparing the DTF value returned by the HAWT with the actual distance to the fault as measured with a tape measure. The difference between the two values shall be divided by the wire length and converted to a percentage. It is acceptable to "shoot" the wire from both ends and use the midpoint between the two DTF values for the calculation of accuracy.

4.2.1.3 Single-ended diagnostic mode

The single-ended diagnostic mode shall be verified via demonstration. This shall be accomplished by "shooting" the wire from only one end of the harness (i.e., one connector) and obtaining a DTF reading for any detected faults.

4.2.1.4 Self-test

The self-test feature shall be verified via demonstration.

4.2.2 Physical Characteristics Verification

4.2.2.1 Size and weight

The HAWT Assembly size and weight requirements of 3.2.2.1 herein shall be verified by measuring it in all three dimensions and weighing it using an appropriate scale.

4.2.2.2 Display

The HAWT display requirements of 3.2.2.2 herein shall be verified via demonstration. For all tests, a light meter shall be used to measure the ambient illumination. While powered on, the HAWT's display shall be observed in low light (less than 0.01 lux) and full daylight (greater than 10,000 lux) to ensure it is readable.

4.2.2.3 Batteries

Except for battery life, the HAWT battery requirements of 3.2.2.3 herein shall be verified via inspection. Battery life shall be verified via test. The test shall be conducted with backlighting on and with backlighting off to determine the nominal battery duration in both modes.

4.2.2.4 Test lead adapter tips

The number and type of test leads and adapter tips of the HAWT shall be verified via inspection.

4.2.2.5 Transit case

The HAWT transit case requirements of 3.2.2.5 herein shall be verified via inspection.

4.2.3 Environmental Tests

4.2.3.1 High temperature

The HAWT shall be tested in accordance with Method 501.5 Procedure I (storage) and Procedure II (operating) of MIL-STD-810G for the high temperatures specified in 3.2.3.1 herein.

4.2.3.2 Low temperature

The HAWT shall be tested in accordance with Method 502.5 Procedure I (storage) and Procedure II (operating) of MIL-STD-810G for the low temperatures specified in 3.2.3.2 herein.

4.2.3.3 Relative humidity

The HAWT relative humidity ranges specified in 3.2.3.3 herein shall be tested in accordance with Method 507.5 Procedure II of MIL-STD-810G.

4.2.3.4 Low pressure (altitude)

The HAWT low pressure requirement specified in 3.2.3.4 shall be tested in accordance with Method 500.5 Procedure I of MIL-STD-810G.

4.2.3.5 Bounce (loose-cargo)

The HAWT loose-cargo bounce requirement specified in 3.2.3.5 herein shall be tested in accordance with Method 514.6 Procedure II of MIL-STD-810G.

4.2.3.6 Transit drop

The HAWT Assembly (with the HAWT contained therein) shall be dropped once on each face, edge, and corner (a total of 26 drops) from a height of 48 inches in accordance with Method 516.6 Procedure IV of MIL-STD-810G.

4.2.3.7 Shock (high-impact)

While energized, the HAWT shall be dropped (in its protective boot or case if so equipped) onto a surface of concrete or asphalt from a height of 48 inches. The HAWT shall be dropped ten times: once on its face and back, left and right sides, bottom and top, top-left and top-right corners, and bottom-left and bottom-right corners. After the first drop on its face, the HAWT shall be turned on and a "self-alignment," "self-test," or equivalent procedure shall be performed to determine whether the unit is functional. The self-alignment or self-test procedure shall also be performed after the fifth and tenth drops.

4.2.3.8 Explosive atmosphere

The HAWT explosive atmosphere requirement specified in 3.2.3.8 herein shall be tested in accordance with Method 511.5 Procedure I of MIL-STD-810G.

4.2.4 System Quality Factors Verification

4.2.4.1 Reliability

The MTBF shall be verified via analysis. If available, actual field failure data from commercial units shall be provided. If the data are not available, a parts breakdown structure showing the failure rates of all (lowest assembly) piece parts shall be provided and a "roll-up" of all failure rates shall be calculated. The reciprocal of the rolled-up failure rate will determine the estimated MTBF and shall be used as the basis from which the government will assess the risk associated with meeting the MTBF specified in section 3.2.4.1 herein.

4.3 Design and Construction Verification

4.3.1 Hazardous Materials

The proscriptive requirements of 3.3.1 herein shall be verified via analysis.

4.3.2 Electromagnetic compatibility

The following conducted and radiated susceptibility and emissions tests listed in Table V of MIL-STD-461F for *Surface Ships* (below deck) and *Navy Ground* environments shall be conducted: CE101, CE102, CS101, CS106, CS114, CS115, CS116, RE101, RE102, RS101 and RS103. When different radiation levels or limits are specified for ground and below-deck environments, the more stringent level or limit shall be used. The HAWT test leads shall be considered part of the equipment under test for all EMC tests.

Appendix A – Requirements Verification Matrix

Requirement	Characteristics Section	Quality Assurance Section	Method
Performance Characteristics			
Detect hard opens	3.2.1.1.1	4.2.1.1.1	Test
Detect dead shorts	3.2.1.1.2	4.2.1.1.2	Test
Determine DTF	3.2.1.2.1	4.2.1.2.1	Test
Display the diagnostic waveform trace	3.2.1.2.2	4.2.1.2.2	Demonstration
Display the discrete DTF value	3.2.1.2.3	4.2.1.2.3	Demonstration
DTF accuracy	3.2.1.2.4	4.2.1.2.4	Test
Single-ended diagnostic mode	3.2.1.3	4.2.1.3	Test
Self-test	3.2.1.4	4.2.1.4	Demonstration
Physical Characteristics			
Size and weight	3.2.2.1	4.2.2.1	Inspection
Display	3.2.2.2	4.2.2.2	Demonstration
Batteries	3.2.2.3	4.2.2.3	Inspection/test
Test leads and adapter tips	3.2.2.4	4.2.2.4	Inspection
Transit case	3.2.2.5	4.2.2.5	Inspection
Environmental Characteristics			
High temperature	3.2.3.1	4.2.3.1	Test
Low temperature	3.2.3.2	4.2.3.2	Test
Relative humidity	3.2.3.3	4.2.3.3	Test
Low pressure (altitude)	3.2.3.4	4.2.3.4	Test
Bounce (loose-cargo)	3.2.3.5	4.2.3.5	Test
Transit drop	3.2.3.6	4.2.3.6	Test
Shock (high-impact)	3.2.3.7	4.2.3.7	Test
Explosive atmosphere	3.2.3.8	4.2.3.8	Test
Electromagnetic compatibility	3.3.2.1	4.3.2	Test
Design and Construction			
Hazardous Materials	3.3.1	4.3.1	Analysis
Electromagnetic Radiation	3.3.2	4.3.2	Test
System Quality Factors			
Reliability (MTBF)	3.2.4.1	4.2.4.1	Analysis