Performance Specification (PS)

For the
Airborne Low Frequency Sonar (ALFS)
Improved Cable

On the

MH-60R Aircraft

ECP H60-299-1425

Date
17 November 2014

Prepared by:
H-60 Program Office
PMA-299
Naval Air Systems Command

Document Approval

SUBMITTED BY

Signature
Greg Brannon
PMA-299 Acoustics IPT Lead Systems Engineer

11/17/2014
Date

CONCURRENCE

Signature
Eve Ford
MH-60R Class Desk

11/20/2014
Date

Signature
Erica Gowen
Assistant Program Manager Systems Engineering, PMA-299

11/20/14
Date

Signature
Woody Payton
Director of Logistics, PMA-299

11/20/14
Date

Signature
Mark Lysaght
MH-60R IPT Co-Lead

11/20/14
Date

1.0 SCOPE

1.1 This document establishes the requirements for the procurement and acceptance test procedures for the AN/AQS-22 Airborne Low Frequency Sonar (ALFS) Improved Cable.

2.0 APPLICABLE DOCUMENTS

2.1 Unless otherwise specified, the following documents of the issue shown below shall form a part of this specification to the extent specified. Should a later revision of any document specified become available, that revision may be used provided no requirements of the earlier revisions are degraded. In the event of a conflict between the documents referenced and the contents of this specification, this specification shall take precedence.

2.1.1 **Government Specifications/Standards:**

2.1.2 **MILITARY**

MIL-HDBK-2036	ELECTRONIC EQUIPMENT SPECIFICATION, PREPARATION OF
MIL-DTL-83420M	WIRE ROPE, FLEXIBLE, FOR AIRCRAFT CONTROL, GENERAL SPECIFICATION FOR
MIL-PRF-85285E	COATING: POLYURETHANE, AIRCRAFT AND SUPPORT EQUIPMENT
MIL-STD-202	TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS
ANSI/NCSL Z540.3	REQUIREMENTS FOR CALIBRATION OF MEASURING AND TEST EQUIPMENT

2.1.3 **Commercial Specifications/Standards:**

EIA-364-39B	HYDROSTATIC TEST PROCEDURE FOR ELECTRICAL CONNECTORS, CONTACTS AND SOCKETS
ASTM D4565-99 (2004) e1	STANDARD TEST METHODS FOR PHYSICAL AND ENVIRONMENTAL PERFORMANCE PROPERTIES OF INSULATIONS AND JACKETS FOR

	TELECOMMUNICATIONS WIRE AND CABLE
ASTM D4566-08	STANDARD TEST METHODS FOR ELECTRICAL PERFORMANCE PROPERTIES OF INSULATIONS AND JACKETS FOR TELECOMMUNICATIONS WIRE AND CABLE
ASTM E8/E 8M	STANDARD TEST METHODS FOR TENSION TESTING OF METALLIC MATERIALS
UL 2556	STANDARD FOR WIRE AND CABLE TEST METHODS
ISO 10012-1	QUALITY ASSURANCE REQUIREMENTS FOR MEASURING EQUIPMENT

2.1.4 **Government Test Procedure**

XXX-XXX	NAVAIR OPERATIONAL TEST PLAN FOR THE ALFS IMPROVED CABLE

2.2 INSPECTION RESPONSIBILITY

Unless otherwise specified in the contract or purchase order, the Government is responsible for conducting the Test Article Tests and the supplier is responsible for the performance of the Quality Conformance Tests as specified below and in Table 1. Table 1 is included as a summary of required testing on the last page of this specification after all requirements and tests have been described.

2.3 CLASSIFICATION OF INSPECTION

The inspections performed under this specification shall be of the following classifications:

a. Test Article Tests
b. Quality Conformance Tests

2.3.1 TEST ARTICLE TESTS. Test article tests are indicated in Test-Article Column of Table 1 and will be conducted by the Government using a quantity of (3) Cables per vendor.

2.3.2 QUALITY CONFORMANCE TESTS. Quality Conformance Tests are those tests indicated in Quality Conformance Group column in Table 1. Quality Conformance Tests shall be performed on a 100% basis.

3.0 REQUIREMENTS

3.1 GENERAL

The current ALFS cable consists of a copper coaxial center conductor with shielding, a cable strength member, and cable outer jacket of pressure extruded Hytrel® 5556 with Hytrel® 40CB concentrate for UV protection. Figure 1 depicts current configuration.

The ALFS Improved Cable shall be capable of supporting an attached load of 177 pounds above the ocean surface and 220 pounds below the ocean surface, without damage or change in performance while pulled over a sheave with a minimum diameter of 7 inches at a maximum speed of 10 meters per second (m/s).

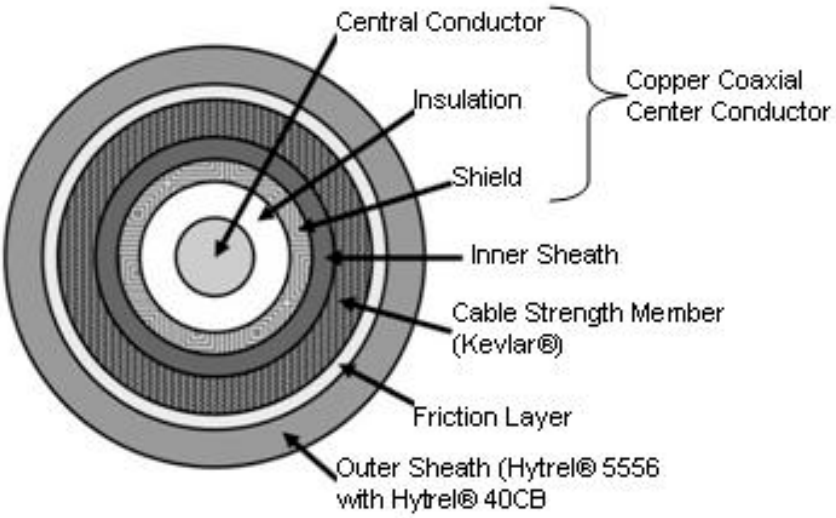

Figure 1: Cable Construction

3.2 CONSTRUCTION

3.2.1 The cable shall incorporate a copper coaxial center conductor with shielding. The cable characteristic impedance shall be 50 ± 3 ohms.

3.2.2 The cable outer jacket shall provide UV protection.

3.2.3 The cable outer surface shall be black in color.

3.2.4 The cable's outer jacket must allow for application of paint (M85285-1-H-17925) for optical sensor synchronizations purposes.

3.2.5 The cable shall be resistant to damage caused by abrasion and friction heating due to surface contact during high-speed (<= 10 m/s) reeling operations.

3.2.6 The jacket shall have a coefficient of friction that allows level winding when guided by a level wind guide.

3.2.7 The cable shall have a dielectric withstanding voltage of at least 2,500V RMS.

3.2.8 The cable capacitance shall be 38 pF per foot maximum.

3.2.9 The cable shall be capable of carrying a pulsed AC current of 4.6 A RMS at 10% duty cycle for an indefinite duration without degradation.

3.2.10 The cable shall be capable of withstanding a continuous DC current of 1.5 A without degradation.

3.2.11 The cable shall have a minimum bend radius not to exceed 3.5 inches.

3.2.12 The cable breaking strength shall be 3,000lb minimum.

3.2.13 The service life of the cable under any combination of operation and storage conditions shall be a minimum of 60 months, with a goal of 120 months.

3.2.14 The cable shall be:

a. Production cables = 2,550 (+7/-0) feet long
b. Test Article cables = 2,550 (+7/-0) feet long.

3.2.15 The cable diameter shall be 6.70mm +/- 0.05mm (0.2618 to 0.2657 inches).

3.2.16 The cable linear mass shall be equal to or less than 3.70 pounds per 100 feet.

3.2.17 The cable shall meet or exceed the requirements as listed in Table 1 3.3, 3.4, and 3.5.

3.3 ENVIRONMENTAL CONDITIONS

3.3.1 OPERATING TEMPERATURE

The cable shall be capable of meeting all electrical requirements as specified in section 3.4 when operating in seawater over the temperature range of -40ºC to +65ºC limited to the temperatures at which seawater remains a liquid.

3.3.2 **NON-OPERATING TEMPERATURE**

When subjected to non-operational conditions, the cable shall be capable of exposure to temperatures over the range of -54 ºC to +85ºC throughout the service life of the cable and shall meet the electrical requirements as specified in section 3.4 after exposure.

3.3.3 **HYDROSTATIC PRESSURE**

3.3.3.1 REQUIREMENT. The cable shall be capable of withstanding a hydrostatic pressure of up to and including 1,305 psi while meeting all electrical requirements as specified in section 3.4, without physical or electrical damage.

3.3.3.2 PROCEDURE. The cable shall be hydrostatically tested to 1,305 +10/-0 psi for 3 cycles as follows:

a. Increase the pressure to 1,305 psi over a period of one minute.
b. Maintain the pressure at 1,305 psi for 15 minutes.
c. Return to atmospheric pressure instantaneously.
d. Maintain atmospheric pressure for 15 minutes. Conduct electrical testing per section 3.4.1 and 3.4.3.

3.3.4 **HUMIDITY**

3.3.4.1 REQUIREMENT. The cable shall withstand the effects of humidity up to 95% during operating and non-operating conditions and shall meet the electrical requirements of section 3.4.1, 3.4.3, and 3.4.5 while exposed to this level.

3.3.4.2 PROCEDURE. The cable shall be tested In Accordance With (IAW) Condition B of MIL-STD-202, Method 103B. The cable shall be terminated with appropriate system plug connectors. Electrical measurements described in Sections 3.4.1, 3.4.3, and 3.4.5 shall be performed at all required test points defined in MIL-STD-202, Method 103B.

3.4 **ELECTRICAL REQUIREMENTS**

3.4.1 **INSULATION RESISTANCE**

3.4.1.1 REQUIREMENT. The insulation resistance value at 500 VDC shall be as follows:

Center to Shield: > 250 megohms

3.4.1.2 PROCEDURE. The insulation resistance shall be tested IAW Condition B of MIL-STD-202, Method 302, measured using a calibrated Megohmmeter capable of providing 500 VDC and reading leakage current equal to or greater than 0.1 milliamps, DC.

3.4.2 **ATTENUATION**

3.4.2.1 REQUIREMENTS. The attenuation of the coaxial cable shall not exceed 107 dB per 1,000 feet at 200 MHz and 17 dB per 1,000 feet at 10 MHz.

3.4.2.2 PROCEDURE. The cable's attenuation shall be measured IAW the test standard ASTM D4566-08

3.4.3 **CONTINUITY TEST**

3.4.3.1 REQUIREMENT. Conductors shall show continuity and shall show no evidence of open circuits. Continuity is defined as a resistance reading when measured with a DC ohmmeter. Readings shall be as follows:

Shield to Shield: < 24.0 ohm
Inner Conductor to Inner Conductor: < 46.0 ohm

3.4.3.2 PROCEDURE. Using an ohmmeter, perform continuity tests from one end to the opposite end of the cable's shield and inner conductor.

3.4.4 **CAPACITANCE**

3.4.4.1 REQUIREMENT. The cable capacitance shall not exceed 125 pF per foot.

3.4.4.2 PROCEDURE. The cable's capacitance shall be measured IAW MIL-STD-202, Method 305A at a frequency of 1 kHz.

3.4.5 **DIELECTRIC WITHSTAND VOLTAGE**

3.4.5.1 REQUIREMENT. The cable shall withstand 2,500 V RMS applied between the center conductor and shield.

3.4.5.2 PROCEDURE. The cable shall be Dielectric Withstand Voltage tested IAW MIL-STD-202, Method 301 with DC potential applied for 60 seconds.

3.4.6 **CURRENT**

3.4.6.1 REQUIREMENT. The cable shall be capable of withstanding an AC current of 4.6 amperes RMS minimum with a 10 percent duty cycle at 1 kHz. They shall also be capable of withstanding a continuous DC current of 1.5 amperes minimum.

3.4.6.2 PROCEDURE. The cable's ability to withstand AC and DC current shall be measured directly per the requirement as specified in paragraph 3.4.6.2. A 1,000 Hz sinusoidal AC source will be used for the AC portion of the test.

3.5 MECHANICAL REQUIREMENTS

3.5.1 VISUAL AND DIMENSIONAL EXAMINATION

3.5.1.1 REQUIREMENT. The cable diameter shall be 6.70mm +/- 0.05mm (0.2618 to 0.2657 inches). The entire cable jacket shall be free of kinks, gouges, or other damage.

3.5.1.2 PROCEDURE. Each of the finished samples selected shall be visually and dimensionally examined to determine that the completed cable conforms to this specification. The cable diameter shall be measured at every 100 foot increment from one end to the other over the entire length of the cable starting approximately 3 feet from an end. At each location, the cable shall be measured in two orthogonal directions. The examination will include the materials used and the manufacturing process.

3.5.2 TENSILE STRENGTH

3.5.2.1 REQUIREMENT. The cable tensile strength shall be sufficient to meet the requirements of this specification.

3.5.2.2 PROCEDURE. The cable samples shall be 18 inches in length and prepared with terminations capable of providing the full cable breaking strength. The tensile strength of the cable samples will be measured using a calibrated instrument capable of exceeding the breaking strength of the cable while controlling the tension ramp speed. An example of a test apparatus is shown in Figure 2. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

a. Apply a load of 1,125 pounds to the test specimen for 10 cycles with a speed of raising and lowering of 2 in/min. At each cycle, increase load continuously from 45 pounds to the maximum value, and then decrease back to 45 pounds, with a cycle frequency of 1 to 1.25 cycles per minute.
b. Increase the load to 1,350 pounds and then repeat cycles as in step a.
c. Increase the load to 1,575 pounds and then repeat cycles as in step a.
d. The cables shall meet the electrical requirements as specified in section 3.4 after tensile testing.

Pass criteria is as follows:

1. No breaking during the 10 cycles at 1,125 pounds.
2. No breaking during the 10 cycles at 1,350 pounds.

3. No breaking during the first 3 cycles at 1,575 pounds.
4. Satisfactory Insulation Resistance, Continuity, and Attenuation.

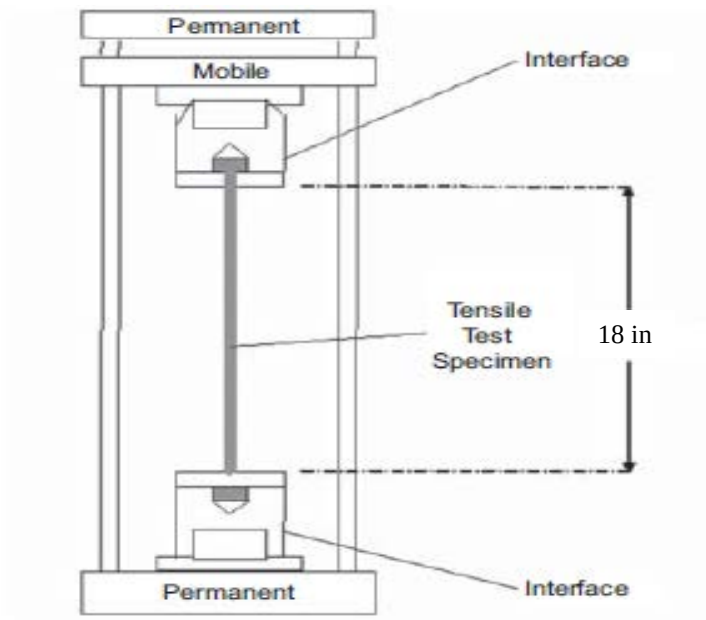

Figure 2: Example of Tensile Strength Test Apparatus

3.5.3 **ELONGATION**

3.5.3.1 REQUIREMENTS. The cable shall not exceed 1.5 % elongation. Percent elongation shall be calculated using the formula below. The cables shall meet the electrical requirements as specified in sections 3.4 after elongation testing.

$$\% \text{ elongation} = \frac{\text{Elongation of gauge length under load}}{\text{Original gauge length}} \times 100 \leq 1.5\%$$

3.5.3.2 PROCEDURE. Two samples, at least 12 feet long and prepared with terminations capable of providing the full cable breaking strength, shall be subjected to a test where the cable is load cycled between 0 and 500 pounds 10 times. The cable's stretch shall be measured continuously from 0 to 500 pounds during cycles 1 thru 10. An example of a test apparatus is shown in Figure 3. The amount of elongation shall be determined on a tension testing machine IAW ASTM E 8/E 8M and from this data. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

3.5.4 ROTATION

3.5.4.1 REQUIREMENTS. The cable rotation shall be sufficient to meet the requirements of this specification. The cable shall not exceed 0.40 degree rotation per foot at 220 pounds and 1.0 degree of rotation at 500 pounds. The cables shall meet the electrical requirements as specified in sections 3.4 after torsional deflection testing.

3.5.4.2 PROCEDURE. The same two samples used in section 3.5.3, prepared with terminations capable of providing the full cable breaking strength, shall be subjected to a test where the cable is load cycled between 0 and 500 pounds 10 additional times. Rotation shall be measured continuously from 0 to 500 pounds during the cycles. An example of a test apparatus is shown in Figure 3. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

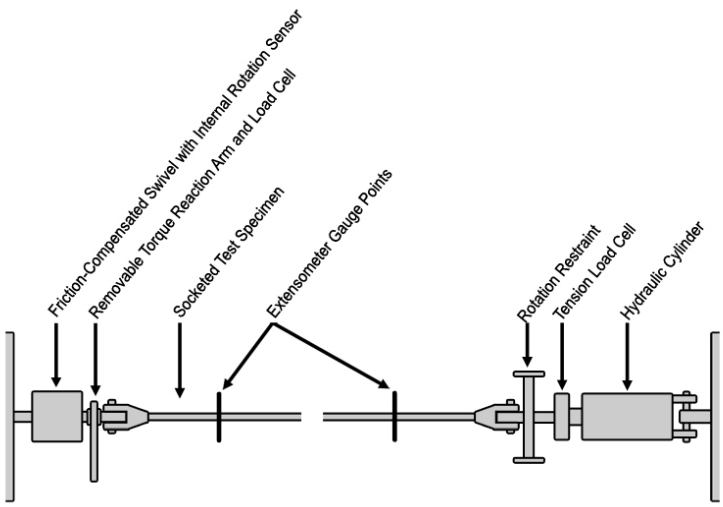

Figure 3: Example of Rotation and Elongation Test Apparatus

3.5.5 CYCLE TENSION FATIGUE

3.5.5.1 REQUIREMENT. The cable shall be capable of withstanding 2,000 cycles from 0 to 300 pounds, the peak recovery tension during normal operation, while maintaining a residual breaking strength of 3,000 pounds minimum.

3.5.5.2 PROCEDURE. The samples, at least 18 inches long and prepared with terminations capable of providing the full cable breaking strength, shall be subjected to a test where the cable is load cycled between 0 and 300 pounds 2,000 times. An example of a test apparatus is shown in Figure 3. Prior to the beginning of the test, and at the conclusion of the test should the specimen survive the desired cycle limit, measurements shall be made of conductor and

insulation resistance. During the test, continuity of the test samples (as defined in 3.4.3 adjusted for the shorter length) shall be monitored continuously. At the conclusion of the test, one sample shall be dissected and visually examined for damaged components, and the other sample shall be pulled to failure to determine its residual breaking strength. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

3.5.6 BENDING FATIGUE LIFE

3.5.6.1 REQUIREMENT. The cable shall be capable of withstanding 6,000 bending cycles. The cables shall meet the electrical requirements as specified in sections 3.4 after bending fatigue testing. The residual breaking strength shall be 3,000 pounds minimum.

3.5.6.2 PROCEDURE. Two samples, at least 15 ft long and prepared with terminations capable of providing the full cable breaking strength, shall be subjected to a hybrid test where two tensions are used while stroking back and forth over a residual breaking strength sheave. A tension of 300 pounds, the peak recovery tension during normal operation shall be used during one stroke, and a tension of 225 pounds, the nominal tension during a normal deployment, shall be used during the return stroke of each machine cycle. An example of a test apparatus is shown in Figure 4. During a test, continuity (as defined in 3.4.3) shall be monitored continuously. In the event of an electrical short or an open, the failed component(s) shall be identified, and the test shall be continued. At the conclusion of the test, one sample shall be dissected and visually examined for damaged components, and the other sample shall be pulled to failure to determine its residual breaking strength. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

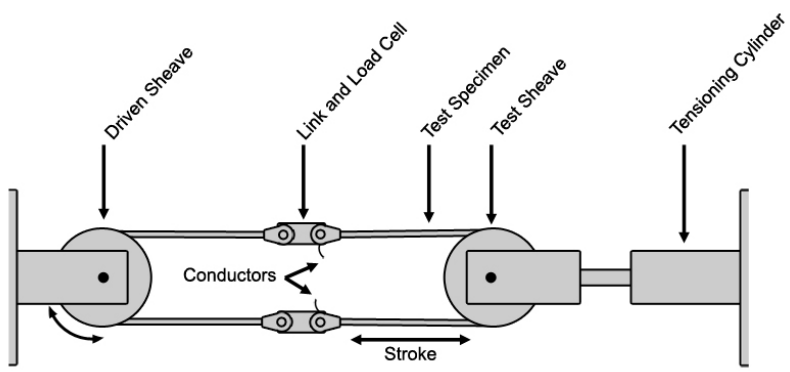

Figure 2: Example of Bending Fatigue Life Test Apparatus

3.5.7 FUNNEL WEAR LIFE

3.5.7.1 REQUIREMENT. The cable funnel wear life strength shall be sufficient to meet the requirements of this specification. The residual breaking strength shall be 3,000 pounds minimum.

3.5.7.2 PROCEDURE. Two samples, at least 15 ft long and prepared with terminations capable of providing the full cable breaking strength, shall be subjected to a test where the cable is cycled back and forth with a stroke of 3 ft while the cable is being bent 12.5 degrees over a section of aluminum rod that conforms to the helicopter funnel configuration. The cable shall be subjected to 2,000 bending cycles while at a tension of 300 lb. An example of a test apparatus is shown in Figure 3. During the test, continuity of the test samples (as defined in 3.4.3 adjusted for the shorter length) shall be monitored continuously. At the conclusion of the test, one sample shall be dissected and visually examined for damaged components, and the other sample shall be pulled to failure to determine its residual breaking strength. In the case of a failure due to an unsatisfactory end termination, the test will be disregarded and a new test conducted.

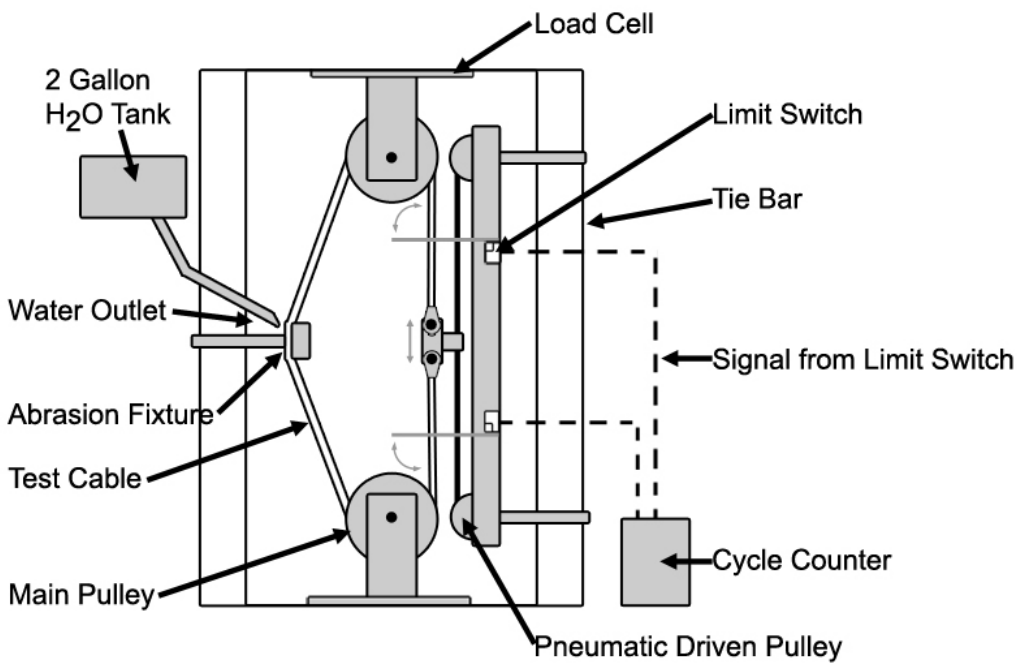

Figure 3: Example of Funnel Wear Life Test Apparatus

3.6 OPERATIONAL CONDITIONS

3.6.1 OPERATIONAL TEST

3.6.1.1 REQUIREMENT. The cable shall be capable of performing all operational tests when terminated with electrical connectors and wrapped on a system specific

reel. The cable shall meet all requirements described in the NAVAIR OPERATIONAL TEST PLAN FOR THE ALFS IMPROVED CABLE.

3.6.1.2 PROCEDURE. The cable shall be subjected to the operational test procedures as defined by the NAVAIR OPERATIONAL TEST PLAN FOR THE ALFS IMPROVED CABLE which will be conducted in an operationally representative environment.

3.7 LOGISTICS/MAINTENANCE INTERFACE

3.7.1 LOGISTICS/MAINTENANCE INTERFACE

3.7.1.1 REQUIREMENT. Threshold: The cable shall meet all requirements described in the NAVAIR OPERATIONAL TEST PLAN FOR THE ALFS IMPROVED CABLE with minimal changes required to integrate the cable into the existing logistics and maintenance processes and procedures. Objective: The cable shall meet all requirements described in the NAVAIR OPERATIONAL TEST PLAN FOR THE ALFS IMPROVED CABLE with no changes required to the existing processes and procedures.

3.7.1.2 PROCEDURE. The cable will be subjected to the same storage, shipping, repair, and maintenance procedures as currently in effect and documented for the existing cable.

3.7.1.3 Note: The supplier is not responsible for delivering a cable that is compatible with existing logistics and maintenance processes and procedures, and the Government assumes responsibility for any changes to existing logistics and maintenance processes and procedures.

Table 1: Categories of Inspection

TEST OR EXAMINATION	PARA. NO.	TEST ARTICLE	QUALITY CONFORMANCE GROUP
ENVIRONMENTAL			
OPERATING TEMPERATURE	3.3.1	X	Not Performed
NON-OPERATING TEMPERATURE	3.3.2	X	Not Performed
HYDROSTATIC PRESSURE	3.3.3	X	X
HUMIDITY	3.3.4	X	Not Performed
ELECTRICAL			
INSULATION RESISTANCE	3.4.1	X	X
ATTENUATION	3.4.2	X	X
CONTINUITY TEST	3.4.3	X	X
CAPACITANCE	3.4.4	X	X
DIELECTRIC WITHSTAND VOLTAGE	3.4.5	X	X
CURRENT	3.4.6	X	X
MECHANICAL			
VISUAL AND DIMENSIONAL EXAMINATION	3.5.1	X	X
TENSILE STRENGTH	3.5.2	X	X
ELONGATION	3.5.3	X	Not Performed
ROTATION	3.5.4	X	Not Performed
CYCLE TENSION FATIGUE	3.5.5	X	Not Performed
BENDING FATIGUE LIFE	3.5.6	X	Not Performed
FUNNEL WEAR LIFE	3.5.7	X	Not Performed
OPERATIONAL CONDITIONS			
OPERATIONAL TEST	3.6.1	X	Not Performed
LOGISTICS/MAINTENANCE INTERFACE			
LOGISTICS/MAINTENANCE INTERFACE	3.7.1	X	Not Performed