

MIL-T-18404 (NOrd)

25 January 1955

MILITARY SPECIFICATION
TORPEDOES, ENVIRONMENTAL REQUIREMENTS ;
GENERAL SPECIFICATION FOR

1. SCOPE

1.1 Scope. - This specification covers the general environmental requirements for the design, development, evaluation and laboratory testing of torpedoes. This specification sets forth the environmental limits within which torpedoes, related component, and associated equipment must operate satisfactorily and reliably. The detailed performance and test requirements for a particular torpedo, particular components, or associated equipment shall be as defined in the detailed specifications.

2. APPLICABLE DOCUMENTS

MIL-S-901 - Shockproof Equipment, Class HI (High Impact),
Shipboard Application Tests. for

MIL-A-8591 - Airborne Stores and Associated Suspension Equipment;
General Design Criteria for.

3. REQUIREMENTS

3.1 Definitions. - For the purpose of this specification the following definitions will apply.

3.1.1 Torpedo. - Torpedo shall mean the weapon in an assembled state, related component, or associated equipment.

3.1.2 Related components. Related components are the assemblies, sub-assemblies and parts which comprise the torpedo.

3.1.3 Associated equipment. - Associated equipment is that equipment appended to the torpedo for carrying, launching, or decelerating purposes. This specifically excludes torpedo workshop equipment and torpedo launching equipment not appended to the torpedo such as tubes and racks.

3.1.4 Torpedo condition.

3.1.4.1 Non-operating. - The condition of the torpedo, assembled or not, when stored, transported or handled.

3.1.4.2 Ready, non-operating. - The condition of the torpedo when assembled, prepared (fueled and checked out for example), issued, transported. and handled.

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3.1.4.3 Ready. - The condition of the torpedo when fully assembled with the propulsion system non-operating and with some or all of the components in operation as defined by the individual specification. This condition occurs when the torpedo is installed on the launching vehicle and prior to firing.

3.1.4.4 Operating. - The condition of the torpedo when running in the water.

3.1.5 Vibration. - Vibration is a sinusoidal motion defined by amplitude and frequency. The amplitude may refer to displacement or acceleration. The displacement is given in inches peak to peak or the corresponding maximum acceleration in gravity units (g). The frequency is given in cycles per second (cps).

3.1.6 Shock. - Shock is an abrupt change in the motion of a body resulting from the sudden application of a large external force of short duration. Shock, in general, can be described as a build-up of 90 percent of peak force in less than 0.010 sec. Shock is described (a) as a pulse in units of gravitational acceleration (g's), duration in milliseconds (ins) and some description of the shock wave form, or (b) in terms of test conditions outlined in MIL-S-901.

3.1.7 Acceleration (steady state). - Acceleration (steady state) is the time rate of change of velocity of a body resulting from the application of a sustained external force with a uniform build-up to peak in more than 0.010 sec. Acceleration is given in gravitational units (g's).

3.1.8 Temperature. - The temperature of the environment to which the torpedo is exposed is expressed in degrees Fahrenheit (°F.).

3.1.9 Pressure. - The pressure of the environment to which the torpedo is exposed is expressed in pounds per square inch absolute (psia).

3.1.10 Humidity. - Humidity is the relative humidity of the environment to which the torpedo is exposed expressed in percent (%).

3.1.11 Marine environment. - The marine environment to which the torpedo is exposed is the salt-laden atmosphere of the sea and the sea itself.

3.1.12 Sand and dust. - Sand and dust is the environment of surface or airborne particles of soil, sand, coral, ash or other similar natural or man-made substances to which the torpedo is exposed.

3.1.13 Tropical environment. - Tropical environment is conditions of high humidity, high temperature and spore exposure which present an opportunity for fungi growth.

3.1.14 Torpedo axes. - The axes of the torpedo are:

- (a) longitudinal (axial)
- (b) Perpendicular and transverse to (a)
- (c) mutually perpendicular to (a) and (b)

3.2 Environmental conditions. - The torpedo is required to operate during exposure to some of the environments described here. The torpedo is also required to perform in its operating state after exposure to additional environments described here. Selection of the torpedo condition for each environmental requirement is dependent upon the particular torpedo design and shall be indicated in the individual specification.

3.2.1 Vibration

3.2.1.1 Torpedo non-operating. ready non-operating or ready. - The torpedo shall be capable of performing according to the individual specification after being subjected to vibrations of 3g over the frequency range 10 to 100 cps for time periods and at temperatures as specified in 4.4.1.3.1. in the non-operating ready non-operating, and ready conditions. These vibrations may occur in any direction.

3.2.1.2 Torpedo operating - The torpedo shall be capable of performing according to the individual specification when subjected to vibrations, as defined in 4.4.1.3.2 of 1g over the frequency range of 20 to 150 cps, These vibrations may occur in any direction.

3.2.2 Shock

3.2.2.1 Torpedo non-operating. ready non-operating or ready (transportation. - The torpedo shall be capable of performing according to the individual specification after being subjected to repeated shock pulses, as specified in 4.4.2.3. of (a) 60g peak magnitude, not less than 8 ms duration, and with a pulse shape approximating a one-half sine wave, or (b) test procedures as outlined in MIL-S-901 for medium-weight equipment; this equipment generates shocks which, in general, produce conditions enabling the torpedo to withstand natural service environments, but are not faithful reproduction of service shock a torpedo will encounter.

3.2.2.2 Torpedo ready, or operating - The torpedo shall be capable of performing according to the individual specification during or after experiencing the applicable water-entry shock as listed below and as specified in 4.4.2.3.

- (a) Submerged tube launching - no additional shock requirement.
- (b) Deck launching - 60g peak magnitude. not less than 8 ms pulse duration and approximating a one-half sine wave pulse.
- (c) Air-borne launching with external attachment such as parachutes, nose coverings, etc. - 150g peak magnitude, not less than 8 ms pulse duration, and approximating a one-half sine wave pulse.
- (d) Air-borne launching without external attachments - 250g peak magnitude, not less than 8 ms pulse duration, and approximating a one-half sine wave pulse.

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3.2.3 Acceleration (steady state).

3.2.3.1 Torpedo ready non-operating, ready or operating. - Torpedoes designed for tube or rack launching, or for use on catapult launched or arrested landed aircraft, or with missiles using booster take-off, or torpedoes arrested by a parachute opening in flight, shall be capable of performing according to the individual specification after experiencing acceleration of 15g applied for not less than 0.2 sec. as specified in 4.4.3.

3.2.4 Temperature and humidity.

3.2.4.1 Torpedo non-operating. - The torpedo shall be capable of performing according to the individual specification after experiencing transportation and storage temperatures and humidities between -65°F. and /160°F. for 28 days as specified in 4.4.4.1.

3.2.4.2 Torpedo ready non-operating.

3.2.4.2.1 Surface and underwater launched. - Torpedoes launched from surface craft. or surface launched missiles or torpedoes launched underwater shall be capable of performing according to the individual specification over the temperature range of -20°F. to /130°F. as specified in 4.4.4.2.1.1 and 4.4.4.3.1.

3.2.4.2.2 Air launched. - Torpedoes launched from aircraft or air-launched missiles shall be capable of performing according to the individual specification over the temperature range of -40°F. to /130°F. as specified in 4.4.4.2.1.2 and 4.4.4.3.1.~

3.2.4.3 Torpedo ready or operating.

3.2.4.3.1 Above water launched.

3.2.4.3.1.1 Surface launched. - Torpedoes launched from surface craft or surface launched missiles shall be capable of performing according to the individual specification over the temperature range of -20°F to /130°F. as specified in 4.4.4.2.2.2 and 4.4.4.3.1.

3.2.4.3.1.2 Air launched. - Torpedoes launched from aircraft or air launched missiles shall be capable of performing according to the individual specification over the temperature range of -40°F. to /130°F. as specified in 4.4.4.2.2.1 and 4.4.4.3.1.

3.2.4.3.2 Underwater launched. - Torpedoes launched underwater shall be capable of performing according to the individual specification over the temperature range or /28°F. to /130°F. as specified in 4.4.4.2.2.3 and 4.4.4.3.1.

3.2.5 Pressure.

3.2.5.1 Altitude. - Torpedoes subject to air transportation shall be capable of performing according to the individual specification after exposure to pressure, as specified in 4.4.6.1, of 1.7 psia (approximately equivalent to 50,000 ft. altitude).

3.2.5.2 Snorkeling. - Torpedoes subject to snorkeling submarine transportation shall be capable of performing according to the Individual specification after exposure to pressure cycles, as specified in 4.4.5.2, between atmospheric pressure and 10 psia.

3.2.5.3 Launching - Surface and Submarine.

3.2.5.3.1 Surface launched.

3.2.5.3.1.1 Against surface ships. - Torpedoes launched above water against surface ships shall be capable of performing according to the individual specification after or during exposure to pressure Of 150 psia as specified in 4.4.5.3.

3.2.5.3.1.2 Against submarines. - Torpedoes launched above water against submarines shall be capable of performing according to the individual specification after or during exposure to pressure of 500 psia as specified in 4.4.5.3.

3.2.5.3.2 Submarine launched. - Torpedoes launched from submarines shall be capable of performing according to the individual specification after or during exposure to pressure of 600 psia as specified in 4.4.5.3.

3.2.6 Humidity. - The torpedo shall perform according to the individual specification after exposure to humidity of 95% as specified In 4.4.4.1.

3.2.7 Sunlight (radiation). - The torpedo shall be capable of performing according to the individual specification after being subjected to sunlight (radiation) in the non-operating or ready non-operating condition m specified in 4.4.6.

3.2.8 Sand and dust. - The torpedo shall function in accordance with the individual specification after exposure to sand and dust in the non-operating or ready non-operating condition as specified in 4.4.7.

3.2.9 Tropical environment. - The torpedo shall function in accordance with the individual specification after exposure to tropical environment as specified in 4.4.8.

3.2.10 Marine environment. - This torpedo shall perform in accordance with the individual specification after exposure to natural marine environment under the following conditions:

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- (a) Torpedo, assembled and sealed, exposed at dockside for sixty (60) days in the non-operating and ready non-operating condition.
- (b) Torpedo, assembled and sealed in the ready non-operating condition, immersed in the sea daily for eighteen (18) hours, and removed daily for six (6) hours, for thirty (30) days. No fresh-water rinse shall be permitted.
- (c) Torpedo, assembled but open to the salt-laden atmosphere, exposed at dockside for ten (10) days in the ready non-operating condition.

3.3 Combinations and sequences. - Tests shall be performed in the combinations and sequences specified in 4.2 for each test group. Test groups may be interchanged when specified in the individual specification.

3.4 Test performance. - Tests conducted to the conditions of this specification shall be accomplished by activities designated by the Bureau of Ordnance.

3.4.1 Review and approval. - The test plan, the instruments and facilities, the test methods, the data and test results and its handling and interpretation, and the report schedule shall be subject to review by the Bureau of Ordnance or an activity designated by the Bureau of Ordnance.

3.5 Life. - The individual specification shall require the following:

- (a) Storage life
- (b) Operational readiness life
- (c) Operating life
- d) Conditions affecting a, b, c
- e) Overhaul or replacements permitted

4. QUALITY ASSURANCE PROVISIONS

4.1 Performance criteria. - Prior and subsequent, or during, as appropriate, to any of the tests specified here the torpedo shall be checked to determine if its performance is satisfactory. Satisfactory performance shall be determined by specific measurements with tolerances as defined in the individual specification.

4.2 Test sequence. - Tests shall be performed according to the sequence listed within the test groups described in table I. Test groups may be interchanged in the order of testing. Test groups listed in table I are designed to cover the environments in general within which the torpedo must operate in its various conditions. However, the individual specification shall detail the sequence dictated by its design objectives.

TABLE I

Test Group 1		Test Group 2		Test Group 3	
Sequence	Test para-graph	Sequence	Test para-graph	Sequence	Test para-graph
1	Accel. - 4.4.3	1	Temp. - 4.4.4.1	1	Press. - 4.4.5
2	Shock - 4.4.2.3 (b) 4.4.2.3 (c)	2	Vibr. - 4.4.1.3.1		
3	Vibr. - 4.4.1.3.2	3	Shock 4.4.2.3 (a)		
4	Temp. - 4.4.4.2 4.4.4.3	4	Sunlight 4.4.6		
		5	Sand and dust - 4.4.7		
		6	Tropical envir. - 4.4.8		
		7	Marine envir. - 4.4.9		

4.3 Test specimen. - The tests prescribed here shall be made using the same test specimen except for necessary repairs or replacements. The number of units to be tested shall be as required in the individual specification but shall not be less than three (3) units.

4.4. Environmental test procedures

4.4.1 Vibration test.

4.4.1.1 Mounting. - The torpedo shall be mounted on the vibration table to simulate as realistically as possible the service installation including vibration isolators or mounting devices, if any, as specified in the individual specification.

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4.4.1.2 Direction of test. - Vibration tests shall be conducted in the three (3) mutually perpendicular directions of the torpedo axes as defined in 3.1.14.

4.4.1.3 Vibration test procedure.

4.4.1.3.1 Torpedo non-operating, ready non-operating or ready. - ~~The torpedo shall be vibrated according to schedule I in each of the test axes.~~

SCHEDULE I

<u>Frequency</u> . Range	Amplitude	<u>Minimum Test Duration</u>		
		<u>Room Temperature</u>	<u>-20°F.</u>	<u>+ 130%.</u>
10 - 30 cps	0.060 ± 0.006 inches	60 min.	15 min.	15 min.
31 - 60 cps	3g ± 0.3g	60 min.	15 min.	15 min.
61 - 100 cps	3g ± 0.3g	60 min.	15 min.	15 min.

The frequency shall be continuously varied between each of the limits given, at a uniform rate over a 3 to 5 minute period for the duration of the test.

As an alternate method the torpedo shall be vibrated at specific frequencies differing by not more than 5 cps in each of the test axes and covering the entire frequency range and amplitudes of schedule I. The total test time shall not be less than that of schedule I and the test times at the specific frequencies shall be equally divided.

4.4.1.3.2 Torpedo operating. - ~~The torpedo shall be vibrated according to schedule II in each of the test axes.~~

SCHEDULE II

<u>Frequency Range</u>	Amplitude	<u>Minimum Test Duration</u>
		<u>Room Temperature</u>
20 -60 cps	1g ± 0.1g	15 min.
61 - 150 cps	1g ± 0.1g	15 min.

The frequency shall be continuously varied between each of the limits given at a uniform rate over a 3 to 5 minute period for the duration of the test.

An alternate method the torpedo shall be vibrated at specific frequencies differing by not more than 5 cps in each of the test axes and covering the entire frequency range and amplitude of schedule II. The total test time shall not be less than that of schedule II and the test times at the specific frequencies shall be equally divided.

4.4.2 Shock test procedures.

4.4.2.1 Mountin - The torpedo shall be mounted on the shock testing table to simulate as realistically as possible the service installation including vibration isolators or mounting devices, if any, as specified in the individual specification.

4.4.2.2 Direction of tests. - The shock tests shall be conducted along the axes defined in 3.1.14 and in the following directions:

- (a) axis a, inertia load forward: transportation water entry after deck launching, and water entry after air launching.
- (b) Axis a, inertia load aft: transportation, and water entry after deck launching.
- (c) Axes b and c, both directions: transportation, water entry after deck launching, and water entry after air launching.

4.4.2.3 Torpedo non-operating, ready non-operating, ready or operating. The torpedo shall be subject to 3 shock pulses in each of the applicable direction specified in 4.4.2.2 (total of 18 shock pulses). The shock pulse will be as follows:

- (a) Transposition and water entry after deck launching: 60g \pm 6g peak magnitude not less than 8 ms pulse duration, and approximating a one-half sine wave, or the test procedures defined in MIL-S-901 for medium-weight equipment.
- (b) Water entry after air launching with external attachments; 150g \pm 15g peak magnitude, not less than 8 ms pulse duration, and approximating a one-half sine wave.
- (c) Water entry after air launching without external attachments; 250g \pm 25g peak magnitude, not less than 8 ms pulse duration, and approximating a one-half sine wave.

4.4.3 Acceleration (steady state) test procedure.

4.4.3.1 Mounting. - The torpedo shall be mounted on the testing device to simulate as realistically as possible the service installation including shock isolators or mounting devices, if any, as specified in the individual specification.

4.4.3.2 Direction of test. - Acceleration (steady state) tests shall be conducted along the axes specified in 3.1.14 and in the following directions:

- (a) Axis a, inertia load forward: arrested landing and parachute opening.
- (b) Axis a, inertia load aft: catapult launched, tube launched, and booster launched.
- (c) Axes b and c, inertia load both directions: rack launched, catapult launched, arrested landing, and parachute opening.

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4.4.3.3 Torpedo ready non-operating, ready, or operating. . The torpedo shall be subject to 15g / 2g acceleration in the directions specified in 4.4.3.2 as appropriate for a time period of not less than 0.2 sec.

4.4.3.3.1 Load. - Load applications for aircraft carried torpedoes may require special consideration. In such cases load applications shall conform to MIL-A-8591.

4.4.4 Temperature test procedures. - Except for the torpedo operating, all the temperature tests shall be made with all access covers removed, and such that condensation from the test chamber cannot drip into these openings. Prior to torpedo checkout, wiping or air-hose drying may be performed but no drying by heating or baking shall be done. (For the torpedo operating, access covers shall be replaced)

4.4.4.1 Torpedo non-operating.

4.4.4.1.1 Temperature and humidity cycling. . The total test is made up of two 14-day temperature and humidity cycles. The term "chamber temperature" used in this test is the temperature of the air immediately surrounding the torpedo. Chamber temperature may be changed (1) by varying the temperature of a single chamber, or (2) by moving the torpedo from one constant-temperature chamber to another. The fluctuation from all specified temperatures shall not exceed ~~10°F.~~ The following test sequence is based on a start at 0800 Monday. Regardless of the day and time the test is initiated, there shall be no deviation from the test sequence as prescribed.

4.4.4.1.1.1 At 0800 Monday place the torpedo in a chamber maintained at -65°F. for at least two hours (humidity not controlled).

4.4.4.1.1.2 At 1600 Monday the chamber temperature shall be changed to ~~160°F.~~ and 95 percent humidity. The chamber temperature must reach ~~160°F.~~ and 95 percent humidity not later than 1800.

4.4.4.1.1.3 The torpedo shall be held under these conditions until 0800 Tuesday, at which time the temperature decrease shall begin. The rate of decrease of chamber temperature shall be equal to or greater than 36% per hour for at least 2 1/2 hours. Thus, at 1030, the temperature of the air surrounding the torpedo must be ~~170°F.~~ or lower. The chamber temperature must reach -65°F. no later than 1400, and this temperature shall be held until 1600.

4.4.4.1.1.4 At 1600 Tuesday the chamber temperature shall be changed to ~~160°F.~~ and 95 percent humidity as rapidly as practicable (not later than 1800) and held until 0800 Wednesday.

4.4.4.1. 1.5 On Wednesday, Thursday, and Friday the operations performed on Tuesday shall be repeated.

4.4.4.1.1.6 The chamber temperature shall be raised to + 160°F. and 95 percent humidity on Friday evening and shall be so maintained until 0800 Monday.

4.4.4.1.1.7 At 0800 Monday, the sequence Of operations described above for Tuesday of the first week shall be followed and shall be repeated dally until Friday of the second week.

4.4.4.1.1.8 On Friday the chamber temperature shall be reduced to -65°F., and this temperature shall be maintained unitl 0800 Monday of the third week. The cycle is complete at 0800 Monday.

4.4.4.1.1.9 This sequence of temperature and humidity conditions shall constitute one cycle. Two such cycles shall be applied.

4.4.4.1.1.1C The second cycle is completed on Monday of the fifth week at 0800 at which time the torpedo 18 allowed to return to room temperature.

4.4.4 2 Low temperature tests.

4.4.4.2.1 Torpedo ready non-operating.

4.4.4.2.1.1 Surface and underwater launched. - The torpedo shall be placed in a test chamber whose temperature shall be levered to -20°F. \pm 5°F. and maintained at this temperature for a period of 48 hours \pm 5 hours. At the end of this test period the torpedo, while still at the test temperature of -20°F., shall be performance checked.

4.4.4.2.1.2 Air launched. - The torpedo shall be placed in a test chamber whose temperature shall be lowered to -40°F, \pm 5°F. and maintained at this temperature for a period of 48 hours \pm 5 hours. At the end of this test period the torpedo, while still at the test temperature of 40°F., shun be Performance checked.

4.4.4.2.2 Torpedo ready or operating.

4.4.4.2.2.1 Air launched. - The torpedo shall be placed in a test chamber whose temperature shall be levered to -40°F. \pm 5°F. and maintained at this temperature for a period of 48 hours \pm 5 hours. At the end of this test period the torpedo, while still at the test temperature of -40°F., shall be performance checked.

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4.4.4 .2.2.2 surface launched. - The torpedo shall be placed In a test chamber whose temperature shall be lowered to $-20^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ and maintained at this temperature for a period of 48 hours ± 5 hours. At the end of this test period the torpedo, while still at the test temperature of -20°F. , shall be performance checked.

4.4.4.2.2.3 Submarine launched. - The torpedo shall be placed In a test chamber whose temperature shall be lowered to $+28^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ and maintained at this temperature for a period of 48 hours ± 5 hours. At the end of this test period the torpedo, while still at the test temperature of $+28^{\circ}\text{F.}$, shall be performance checked.

4.4.4.3 High temperature tests.

4.4.4.3.1 Ready non-operating, ready, or operating. - The torpedo shall be placed within a test chamber whose temperature shall be raised to $+130^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ and maintained at this temperature-for a period of 48 hours ± 5 hours. At the end of this test period the torpedo, while still at the test temperature of $+130^{\circ}\text{F.}$, shall be placed in the appropriate torpedo condition and performance checked.

4.4.5 Pressure test procedures.

4.4.5.1 Altitude. - The torpedo shall be placed In a test chamber and the pressure reduced to 1.7 psia ± 0.2 psia for a minimum period of 15 minutes.

4.4.5.2 Submarine launched. - The torpedo shall be subject to a pressure Cycle between 10 psia ± 1 psia and 15 psia ± 1 psia at a rate of 6 cycles per minute for a minimum period of 30 minutes.

4.4.5.3 Pressure. - The torpedo shall be subjected to external pressure as required in 3.2.5.3 for a minimum time period of 30 minutes. The tolerance on the pressure values shall be ± 5 percent.

4.4.6 Sunlight (radiation), torpedo non-operating or ready non-operating. The torpedo shall be placed within a test chamber and subjected to radiant energy at the rate of 100 to 140 watts per square foot. Forty-five (45) to fifty-five (55) percent of the total energy shall be in wave lengths above 8,000 angstrom units and 8 to 12 percent in wave lengths below 4,000 angstrom units. The test chamber temperature shall be maintained at $113^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ during the course of the test, 48 ± 5 hours. At the end of this test period the torpedo shall be allowed to cool to room temperature and then performance checked.

4.4.7 Sand and dust test, non-operating, or ready non-operating. - The torpedo shall be placed within a test chamber, with all external cover plates, dust covers, etc. in place and the sand and dust density raised and maintained

at 0.1 to 0.5 grams per cubic foot within the test space. The relative humidity shall not exceed 30 percent at any time during the test. Sand and dust used in the test shall be of angular structure and shall have characteristics as follows :

- (a) 100 percent of the sand and dust shall pass through a 100-mesh screen, U. S. Standard Sieve Series.
- (b) 98 \pm 2 percent of the sand and dust shall pass through a 140-mesh screen, U. S. Standard Sieve Series.
- (c) 90 \pm 2 percent of the sand and dust shall pass through a 200-mesh screen, U. S. Standard Sieve Series.
- (d) 75 \pm 2 percent of the sand and dust shall pass through a 325-mesh screen, U. S. Standard Sieve Series.
- (e) Chemical analysis of the dust shall be as follow:

<u>Substance</u>	<u>Percent by Weight</u>
SiO_2	97 to 99
Fe_2O_3	0 to 2
Al_2O_3	0 to 1
TiO_2	0 to 2
MgO	0 to 1
Other materials	0 to 2

The Internal temperature of the test chamber shall be maintained at $77^\circ\text{F.} \pm 5^\circ\text{F.}$ for a period of 6 hours \pm 1/2 hour with wind velocity through the test chamber in the vicinity of the torpedo of not less than 200 feet per minute. After 6 hours at the above conditions, the temperature shall be raised to and maintained at $130^\circ\text{F.} \pm 5^\circ\text{F.}$ These conditions shall be maintained for 6 hours \pm 1/2 hour. At the end of this test period, the torpedo shall be removed and allowed to cool to room temperature and performance checked.

4.4.8 Tropical environment. - The tropical environmental tests on the torpedo shall be made with all access covers removed. Drying or wiping prior to performance checking shall not be done.

4.4.8.1 Torpedo non-operating or ready non-operating. - The torpedo, including applicable external connections, shall be placed in a mold chamber maintaining an internal temperature of $86^\circ\text{F.} \pm 5^\circ\text{F.}$ and a relative humidity of 90 percent \pm 5 percent and sprayed with the suspension of mixed spores. **These conditions shall be maintained for twenty-eight (28) days. At the conclusion of the test the torpedo shall be allowed to return to room temperature before performance checking. At least five groups of fungi shall be used in torpedo inoculation. Five groups of fungi are listed**

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below, and one type of fungus from each group shall be used. In preparing the spore suspension, distilled water (having a pH value between 5.8 and 7.2 at 77°F.) shall be preparedly sterilization in convenient containers (approximately 100 milliliters each). Approximately 10 milliliters of the solution shall then be introduced directly into a stock culture of one fungus and shaken vigorously in order that a well sporulated suspension will result without disturbing the agar. This process shall be repeated for each type fungus. The separate spore suspension from the types of fungi shall then be mixed together in an atomizer to provide a composite suspension. Actively growing cultures in ripe fruiting condition shall be used for each Inoculation and under no condition will the inoculum be kept for more than an 8 hour period.

- Group I. Cbaetomium globosum USDA 1042.4, ATCC 6205, or Myrothecium verrucaria USDA 1334.2, ATCC 9095.
- Group II Rhizopus nigricana S.N. 32, ATCC 10404, or Aspergillus niger USDA TC215-4247, ATCC 6275.
- Group III Aspergillus flavus AMC No. 26, ATCC 10836, or Aspergillus terreus PQMD 82J, ATCC 10690.
- Group IV Penicillium luteum USDA 1336.1, ATCC 9776
Penicillium sp. USDA 1336.2, ATCC 9112, or Penicillium citrinum ATCC 9849,
- Group V Menmonielliella echinata AMC No. 37, ATCC 9597, or Fusarium moniliforme USM 1004.1, ATCC 10052.

4.4.9 Marine environment tests. - Drying, wiping, or baking prior to performance checking shall not be done.

4.4.9.1 Torpedo ready non-operating - natural environment

4.4.9.1.1 Sea atmosphere.

- (a) The torpedo, resembled, sealed, and ready for service use, shall be exposed at dockside or on the weather deck of a ship for a period of 60 days ± 5 days.
- (b) The torpedo with access covers removed shall be exposed at dockside or on the weather deck of a ship for a period of 10 days ± 1 day. The torpedo shall be protected from rain or snow by an appropriate shelter such that free circulation of air is permitted around the torpedo .

4.4.9.1.2 Immersion. - The torpedo, assembled and sealed as in service use, shall be immersed in natural sea water for 18 hours ± 2 hours and removed for a period of 6 hours ± 1 hour. The sequence is repeated 30 times. No fresh-water rinse shall be permitted during this period.

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4.4.9.2 Torpedo ready non-operating.

4.4.9.2.1 Simulated sea atmosphere. - A laboratory salt-spray test may be performed to supplement the above tests.

4.4.9.2.1.1 Apparatus. - Apparatus used in the salt spray test shall include the following:

- (a) Exposure chamber with racks for supporting the torpedo.
- (b) Salt-solution reservoir.
- (c) Means for atomizing salt solution. including suitable nozzles and compressed air supply.
- (d) Chamber heating means and control.
- (e) Means for humidifying the air at a temperature above the chamber temperature.

4.4.9.2.1.2 Chamber. - The chamber and all accessories shall be made of material which will not affect the corrosiveness of the fog, such as glass, hard rubber, plastic or wood other than plywood. In addition, all parts which come in contact with the torpedo shall be of materials that will not cause electrolytic corrosion. The chamber and accessories shall be so constructed and arranged that there is no direct impinging of the spray or dripping of the condensate on the torpedo, that the spray circulates freely about all parts, and that no liquid which has come in contact with the torpedo returns to the salt-solution reservoir.

4.4.9.2.1.3 Atomizers. - The atomizers used shall be of such design and construction as to produce a finely divided, wet, dense fog.

4.4.9.2.1.4 Air supply - The compressed air entering the atomizers shall be free from all impurities such as oil and dirt. Means shall be provided to humidity and warm the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided, dense fog with the atomizer or atomizers used. To insure against clogging the atomizers by salt deposition, the air should have a relative humidity of at least 85 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water. The temperature of the water should be 95°F. or higher. The permissible temperature increases with increasing volume of air and decreasing heat insulation of the chamber and temperature of its surroundings.

4.4.9.2.1.5 Salt solution. - The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent of sodium iodide, and not more than 0.2 percent of total impurities. The solution shall be prepared by dissolving 20 / 2 parts by weight of salt in 80 parts by weight of distilled or other water containing not more than 200 parts per million of total solids. The solution shall be kept free from solids by filtration

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or decantation. The solution shall be adjusted to and maintained at a specific gravity of from 1.126 to 1.157 and at a pH of between 6.5 to 7.2, when measured at a temperature between 92°F. and 97%. Only C.P. hydrochloric acid or C.P. sodium hydroxide shall be used to adjust the pH.

4 4.9.2.1.6 Temperature - The test shall be conducted with the temperature in the chamber maintained at 85°F.

4.4.9.2.1.7 Atomization. - The conditions maintained in all parts of the exposure zone shall be such that a receptacle placed at any point in the exposure zone will collect from 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 centimeter diameter). When using nozzles made of material nonreactive to the salt solution, suitable atomization usually can be obtained in boxes having a volume of less than 12 cubic feet with the following conditions:

- (a) Nozzle pressure between 12 and 18 pounds per square inch.
- (b) Orifices between 0.02 and 0.03 inch in diameter.
- (c) Atomization of approximately 3 quarts of the salt solution per 10 cubic feet of box volume per 24 hours.

4 4.9.2.1.8 Duration - The length of the salt spray test shall be not less than 50 hours. Salt deposits resulting from the test conditions may be removed by washing and drying prior to operation.

5 PREPARATION FOR DELIVERY

5.1 General - Requirement for packaging, packing, testing and marking for shipment shall be as required by the individual specification.

6. NOTES

6.1 Limitations. - Environmental conditions more extreme than the requirements of this specification occur; however, because the frequency of their occurrence has not been adequately established, their use here in a general specification cannot be justified. Where appropriate, more severe requirements shall be specified in the individual specification.

6.2 Additional tests. - Testing beyond that defined in this specification will be required to meet the objective of the various torpedo programs. For example, field testing will be required in Bureau of Ordnance Torpedo Evaluation Programs.

6.3 Artificial environments. - Individual components of a torpedo may be subjected to environmental conditions beyond the requirements of this specification. An example might be additional temperature effects on components adjacent to propulsion machinery which radiates heat during the operating state of the torpedo. Such artificial environments are not included here.

6.4 usage - The following charts are constructed as guides for the use of this specification. As such the charts are not mandatory nor are they necessarily complete. See 1.1.

CHART A
TORPEDO - AIRCRAFT

ENVIRONMENT	APPLICABLE SECTIONS	PAGE NO.
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	4.4.3.2 (a)	9
	4.4.3.2 (b)	9
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	4.4.6	12
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Test Specimen	4.3	7
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TORPEDO - SURFACE SHIP

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	4.4.1	7
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	4.4.4.2.2.2	12
	4.4.4.3.1	12
Pressure	3.2.5.1	5
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	4.4.5.3	12
Humidity	3.2.6	5
Sunlight	3.2.7	5
	4.4.6	12
Sand and Dust	3.2.8	5
	4.4.7	12
Tropical Environment	3.2.9	5
	4.4.8	13
Marine Environment	3.2.10	5
	4.4.9.1	14
Combinations and Sequences	3.3	6
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TORPEDO - SUBMARINE

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	3.2.5.2	5
	3.2.5.3.2	5
	4.4.5.2	12
	4.4.5.3	12
Tropical Environment	3.2.9	5
	4.4.8	13
Marine Environment	3.2.10	5
	4.4.9.1	14
Combinations and Sequences	3.3	6
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CHART D
TORPEDOES - ALL .

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Humidity	3.2.6	5
Sunlight	3.2.7 4.4.6	5 12
Tropical Environment	3.2.9 4.4.8	5 13
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