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MILITARY STANDARD

CRITERIA AND TEST PROCEDURES

FOR ORDNANCE EXPOSED TO

AN AIRCRAFT FUEL FIRE



MIL-STD-1648A(AS)

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND

Washington, D.C. 20361

Criteria and Test Procedures for Ordnance Exposed to an Aircraft Fuel
Fire

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1. This Military Standard is approved by the Naval Air Systems Command and is mandatory for use in the qualification of all air-launched weapons developed for shipboard use.
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ENGINEERING SPECIFICATIONS AND STANDARDS DEPARTMENT (CODE 93) NAVAL AIR ENGINEERING CENTER, LAKEHURST, N.J. 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter. Revisions to this Standard will be approved by Commander, Naval Air Systems Command (AIR-09E), Washington, D.C. 20361.

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FOREWARD

This Military Standard establishes the criteria and test procedures to evaluate the capability of air launched ordnance to resist detonation when engulfed in an aircraft fuel fire. Because of testing and hardware constraints a limited confidence level is assigned to the test results. Following passing of the tests, any opportunity to increase this confidence level by incorporating known/accepted cook-off improvement features shall be acted on.

Several catastrophic accidents aboard carriers have resulted from ordnance detonating in fires while attempts were being made to extinguish the fire. The Russell Panel Report to Review Safety in Carrier Operations after the Forrestal accident, and the Report to the Navy Laboratory Research Planning Panel for Enhanced Carrier Survivability, recommended that all weapons used aboard carriers be afforded fire survivability. The Naval Weapons Cook-off Program Plan, as approved by the Chief of Naval Material, established the cook-off program to correct in-service air-launched ordnance cook-off times. The original cook-off plan did not provide detailed criteria and test procedures for judging ordnance survivability nor did it provide fire survivability standards for development of future ordnance.

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1. SCOPE

1.1 Purpose. This document establishes the minimum fast cook-off test requirements for air launched weapons used aboard aircraft carriers and other air capable ships. This document specifies the criteria and procedures to be used in demonstrating an acceptable level of cook-off safety of weapons when engulfed in an aircraft fuel fire.

1.2 Application. This standard applies to all air launched weapons, targets, and pyrotechnics containing energetic material, which are used aboard aircraft carriers and other air capable ships. The tests specified herein shall be conducted as an integral part of a weapon or weapon component development program. The tests specified herein shall also be conducted to assess the impact of engineer changes to weapon hardware or energetic materials if those changes have a possibility of impacting cook-off characteristics.

2. REFERENCED DOCUMENTS

This section is not applicable to this standard.

3. DEFINITIONS

3.1 Burning reaction. The process wherein the ordnance energetic material undergoes combustion. During this reaction, the energetic material enclosure may open up and vent. The item remains in position although it may fall due to structural failure. The burning reaction presents a minimal hazard to fire fighting personnel.

3.2 Cook-off. A reaction, of varying intensity, which occurs when an energetic material (propellant/explosive) is exposed to intense heat for a significant period of time.

3.3 Deflagration reaction. The process wherein the ordnance energetic material undergoes rapid combustion and ruptures its enclosure. The item or major parts thereof may be thrown up to 50 feet by the reaction. No damage due to blast effects or fragmentation. Fire fighting personnel may be endangered or inhibited by expansion of fire and burning material and parts being thrown about.

3.4 Detonation. Munition performs in design mode. Maximum possible air shock is formed. Essentially all of case is broken into small fragments. Blast and fragment damage is at maximum. Severity of blast causes maximum ground crater or flight-deck hole capable by the munition involved.

3.5 Explosion. Violent pressure rupture and fragmentation of munition case with resulting air shock. Most of metal case breaks into large pieces which are thrown about with unreacted or burning

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explosive. Some blast and fragmentation damage to environment. Fire and smoke damage as in deflagration. Severity of blast could cause minor ground crater, or small depression on flight deck or carrier if munition is large bomb.

3.6 Partial detonation. Only part of total explosive load in munition detonates. Strong air shock and small as well as large case fragments produced. Small fragments are similar to those in normal munition detonation. Extensive blast and fragmentation damage to environment. Amount of damage and extent of breakup of case into small fragments increases with increasing amount of explosive detonated. Severity of blast could cause large ground crater, or large flight-deck hole on carrier if munition is large bomb; hole size depends on amount of explosive that detonates.

3.7 Propulsion. The reaction whereby adequate force is produced to impart flight to the test item.

4. REQUIREMENTS AND CRITERIA

4.1 Test safety requirements. This standard requires the performance of ordnance cook-off tests wherein field test personnel and equipment will be exposed to potentially extreme hazards. Consequently, the test activity is responsible for formalizing and issuing general and specific guidance, safety criteria, procedures, instructions, precautions, and other related safety information essential to the safe performance of the tests.

4.2 Reaction severity. In the establishment of the criteria for this standard, the order of severity of the explosive reaction increases from a. to f. as shown below:

- a. Burning reaction.
- b. Deflagration reaction.
- c. Explosion.
- d. Propulsion.
- e. Partial detonation.
- f. Detonation.

4.3 Ordnance requirements. Two ordnance items shall be individually tested in two separate fires as prescribed by this Standard. These items shall be production units or pre-production units built to the same drawings and specifications as the production unit and configured as a complete round as normally found on the aircraft on the flight deck. Prior to the cook-off tests the ordnance items shall be subjected to realistic life cycle environmental tests, such as temperature, temperature/

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humidity, vibration and shock tests, selected from the environmental qualification series. Electronic or other sections not containing energetic material may be mechanically, geometrically, and thermally simulated. Pressurized vessels which are a part of the tactical round shall be a part of the test unit. If alternate components containing energetic material could be selected, the two ordnance test items shall be comprised of those components demonstrated, or judged, to yield the most violent reaction in a fuel fire. Component level tests during the design phase shall be conducted with the component as a part of a simulated round.

4.4 Ordnance passing criteria. Ordnance shall be judged to have passed the fuel fire test if the following criteria are achieved:

a. During the first 5 minutes of the test, the severity of the reaction shall be no greater than that for a burning reaction. Burning reactions are acceptable any time during the test. Propulsive burning judged sufficient to launch the test item is not acceptable at any time.

b. After the first 5 minutes, and until the test ordnance returns to ambient temperature, the severity of the reaction shall be no greater than that for a deflagration reaction.

5. TEST PROCEDURES AND DATA RECORDS

5.1 Description of test. The test consists of engulfing the ordnance for at least fifteen minutes in a fuel fire and recording its reaction as a function of time. Liquid fuels are normally contained in a specially prepared film lined earthen test pan. The ordnance is suspended 3 feet above the fuel in an attitude and position similar to those which would be encountered on an aircraft on a flight deck. The test is terminated upon completion of the reaction(s) of the ordnance.

5.2 Test specification.

5.2.1 Test facility. Test facility construction shall be designed to provide a heat source which completely engulfs the test item at the specified flame temperature for the duration of the test.

5.2.2 Fuel. JP-5 aircraft fuel shall be used when available or JP-4 fuel as an alternate. The quantity of fuel used should be sufficient to ensure a fire that engulfs the entire ordnance unit for at least 15 minutes.

5.2.3 Flame temperature rise rate. The flame temperature shall reach 1000°F within 30 seconds after ignition as measured by any two thermocouples defined in paragraph 5.2.6. The time over 30 seconds until flame temperature, as measured by the two thermocouples, reaches 1000°F shall be subtracted from the time of reaction.

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5.2.4 Average flame temperature. An average flame temperature of at least 1600°F as measured by all valid thermocouples at the test item without contribution of the burning ordnance will be considered a valid test. This temperature is determined by averaging the temperature from the time the flame reaches 1000°F until all ordnance reactions are completed or until 15 minutes has elapsed.

5.2.5 Ordnance suspension. The ordnance suspension system shall be designed in such a manner as to represent the configuration of the ordnance service suspension system. Ordnance configured with rocket motors may be restrained to avoid launching due to a propulsive reaction; however, the restraining and/or suspension method shall not interfere with heating of the ordnance. The horizontal center line of the test ordnance shall be located 3 feet above the fuel surface. Methods shall be employed to prevent the test item from falling into and being quenched by more than one inch depth of fuel.

5.2.6 Thermocouples. Four thermocouples shall be located 4 to 8 inches outside the ordnance skin for each item tested. The thermocouples shall be positioned on each end and side of the ordnance skin in a horizontal plan through the ordnance center line. Thermocouple readings shall be made and recorded at least once every second throughout the duration of the 15 minute fire.

5.2.7 Camera coverage. Closed circuit color T.V. with audio shall be used to record each test. Still photos shall be taken to show test set up prior to test and the remains after test. Color motion picture film coverage with audio is optional.

5.3 Air pollution control devices. Air pollution control devices shall be used when practicable. Any air pollution control device or technique used in conjunction with fast cook-off testing must not alter the rate of heat transfer to the test item(s).

5.4 Data records.

5.4.1 Pretest data. Pretest data shall include the following:

- a. Item(s) designation including fuze, pressure vessels, and other components. Detailed description, with photos, of any simulated or dummy components interfacing with the item under test.
- b. Item(s) lot number and/or serial numbers.
- c. Environmental qualification series tests performed.
- d. Location and size of defects if any, in test item(s).
- e. Type of energetic material and weight.

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- f. Date of test.
- g. Type of fuel for fire.
- h. Quantity of fuel.
- i. Fuel surface dimensions.
- j. Meteorological data (wind velocity and direction).
- k. Drawings and photos of test set up prior to test.
- l. Thermocouple identification and locations.

5.4.2 Test data. Test data shall include the following:

- a. Time of ignition of fuel. (Pulse to igniter.)
- b. Time at which thermocouples reach or exceed 1000^oF.
- c. Times to weapon reaction(s).
- d. Type of reaction(s).
- e. Time to subsequent weapon reaction(s).
- f. Type of subsequent reaction(s).
- g. Complete video or motion picture film coverage of test with indicated time.
- h. Still photos of test item(s) or remains after test and photos of test item position after test. An overview picture or drawing shall show location of remains after the test with respect to the original test item position.
- i. Temperature data for each thermocouple.

5.5 Final data report. All data gathered in compliance with paragraph 5.4 shall be made available in a test report for review by the developing agency to judge if the passing criteria is met. A copy of the final data report shall be forwarded to PACMISTESTCEN, Code 2145, for inclusion in the cook-off information file.

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5.6 Disposal of test ordnance. All tested ordnance items shall be disposed of as follows:

a. Material which has ignited shall be permitted to burn out.

b. Ordnance which has provided no reaction shall be disposed of preferably by using Explosive Ordnance Disposal (EOD) procedures and EOD certified personnel.

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Preparing Activity:
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