NATO STANDARD

AAS3P-12

SAFETY AND SUITABILITY FOR SERVICE ASSESSMENT TESTING FOR AIRCRAFT LAUNCHED MUNITIONS

EDITION A VERSION 1
FEBRUARY 2017

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED AMMUNITION SAFETY AND SUITABILITY FOR SERVICE PUBLICATION

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NORTH ATLANTIC TREATY ORGANISATION

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NATO LETTER OF PROMULGATION

24 February 2017

1. The enclosed Allied Ammunition Safety and Suitability for Service Publication AAS3P-12, Edition A, Version 1, SAFETY AND SUITABILITY FOR SERVICE ASSESSMENT TESTING FOR AIRCRAFT LAUNCHED MUNITIONS, has been approved by the nations in the CNAD AMMUNITION SAFETY GROUP (CASG - AC/326), is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4759.

2. AAS3P-12, Edition A, Version 1 is effective upon receipt.

4. This publication shall be handled in accordance with C-M(2002)60.

Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS

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RECORD OF SPECIFIC RESERVATIONS

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SAFETY AND SUITABILITY FOR SERVICE ASSESSMENT TESTING FOR AIRCRAFT LAUNCHED MUNITIONS

CHAPTER 1 INTRODUCTION

This Allied Publication (AP) is aimed at the Safety and Suitability for Service (S3) Assessment Testing for Aircraft Launched Munitions as agreed under Standardization Agreement (STANAG 4759). STANAG 4629 and Allied Ammunition Safety and Suitability for Service Assessment Testing Publication – Guidance (AAS3P-1) provide general discussion of Safety and Suitability for Service Assessment Testing. AAS3P-12 is intended to act as a munition type specific document dealing specifically with the necessary safety testing and assessments for aircraft launched munitions to enter service within the North Atlantic Treaty Organization (NATO) community. Two Safety and Suitability for Service (S3) test approaches, analytical and empirical, are presented in this AP with the intent that the manager of the test program shall select the more appropriate approach for the munition under test. This document was developed within the international community and is written with primarily references to NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards. Whilst each test standard often has unique requirements, the table does not imply the standards are the same or interchangeable.

If tailoring is determined to be necessary, the tailoring may be carried out in accordance with the following general principles:

1. The tailored environment shall be at least as severe as the expected lifecycle environment.
2. Any alternative test standards / methods that are utilised shall be technically equivalent or superior to the referenced standards / methods.
3. The tailored test procedures and severities, along with full justification / rationale shall be documented as part of the S3 assessment report.
4. Tailoring shall be approved by the relevant National Authority prior to test.

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CHAPTER 2 SCOPE

2.1. PURPOSE

The purpose of this AP is to guide personnel involved in the planning and implementation of S3 assessment testing of munitions to enable appropriate evidence to be collected covering the entire life cycle. The objective of the safety test program defined by this AP is to provide data to determine whether the munition will be “safe for use”, as defined in AAS3P-1, throughout the potential deployment possibilities in NATO service.

2.2. APPLICATION

The guidance provided in this AP is applicable to NATO, multi-National collaborative, and National acquisition of guided and unguided munitions deployed on fixed and rotary wing aircraft (manned or unmanned). The munitions covered by this AP include aircraft launched missiles, rockets, and bombs as defined in Section 3 of this document. For the purpose of this AP, aircraft launched torpedoes follow the S3 requirements defined for aircraft launched bombs.

2.3. LIMITATIONS

This AP is not intended to be used in the assessment of effectiveness, reliability, or performance of a munition unless failure to be reliable or to perform effectively is deemed to represent a direct and immediate safety hazard to the user or other personnel. However, the data may be used in support of effectiveness, reliability, or performance assessments. This document does not define the In-Service Surveillance or Stockpile Reliability test requirements; however, the data may be used in the support of planning for these requirements. Refer to STANAG 4675 for further guidance. This document is not intended to address nuclear munitions.

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CHAPTER 3 DEFINITIONS

Definitions in this AP take precedence over those in AAS3P-1, until such time as they can be incorporated into Allied Ordnance Procedure (AOP)-38. Refer to AAS3P-1 for definitions related to Safety and Suitability for Service test procedures.

3.1. AIRCRAFT BOMB

An air dropped, unpowered munition. May be guided or unguided.

3.2. ROCKET

An unguided projectile, which is launched from a reloadable or non-reloadable launcher, and employs self-contained propulsive energy during flight.

3.3. MISSILE

A guided projectile, which is launched from a reloadable or non-reloadable launcher, and employs self-contained propulsive energy during flight.

3.4. TORPEDO

A self-propelled munition that follows an underwater path and is designed to detonate either on contact with or within close proximity to its target. It may be launched from above or below the water surface.

3.5. COMPLETE ROUND

A complete fully assembled munition consisting of all components as required for intended use. This will include, for example, live energetics, tactical electronics, safe-and-arm devices, etc. The munition may come factory assembled or may require assembly by service personnel prior to use. In some countries, this is also known as an All Up Round.

3.6. TEMPERATURE CONDITIONING

Exposure of a munition to a thermal environment in preparation for a test event at a specified test temperature.

3.7. PRE-STRESS

Exposure of a munition to a sequence of one or more environmental stresses (i.e., temperature, humidity, shock, vibration, etc.) prior to conducting a particular test event.

3.8. SOLAR RADIATION EQUIVALENT (SRE) TEMPERATURE

The maximum temperature value experienced by the energetic material (e.g. motor propellant, warhead, fuze) during the solar test. Determination of this value will require exposure of an inert, internally instrumented munition, with similar thermal characteristics to the complete round, to the full solar test requirement defined in Allied Environmental Conditions and Test Publication (AECTP) 200, Category A1. The SRE temperature should be determined for the packaged and unpackaged state. In the absence of this data, a value of 71 °Celsius (C) should be used for the SRE temperature.

3.9. TEMPERATURE STABILIZATION

Temperature stabilization is achieved when the part of the item considered to have the longest thermal lag is changing no more than 2 °C per hour. Since it may not be practical to monitor the part of a live munition with the longest thermal lag during test without damaging seals, the stabilization time may be determined prior to live munition testing using an inert, internally instrumented munition, with similar thermal characteristics to the complete round. The stabilization time will typically be required for the munition in both the unpackaged and the transport configurations, and at the hot and cold temperature extremes. For the purpose of this document and in the absence of measured data, a stabilization time of 24 hours may be applied as a default value for an individually unpackaged munition or 36 hours for a packaged or palletized munition.

3.10.CAPTIVE CARRIAGE

Captive Carriage is the configuration of a munition attached to an aircraft (e.g., missile attached to a launcher on an aircraft wing).

CHAPTER 4 FACILITIES AND INSTRUMENTATION

4.1. FACILITIES

All test facilities utilized must suit specific test requirements and provide adequate protection for personnel and equipment in accordance with local and national regulations for testing of hazardous materiel. Note that although it is not necessary for all the facilities to be co-located, consideration should be given to the safe transport of potentially degraded test articles between test facilities. In addition to the requirements provided in Annex F (Table F-1), test facilities shall be prepared for the handling and possible disposal of explosive items.

4.2. INSTRUMENTATION ACCURACY AND CALIBRATION

The instruments and test equipment used to control or monitor the test parameters shall have an accuracy at least equal to 1/3 the tolerance of the variable to be measured. Recommended tolerances are provided in Annex F, Table F-2. In the event of conflict between this accuracy and guidelines for accuracy in any one of the test procedure or methods referenced in this document, the more stringent accuracy requirement takes precedence. The instrumentation and test equipment shall be calibrated periodically to laboratory standards whose calibration is traceable to national laboratory standards. The test facility shall maintain the calibration records.

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CHAPTER 5 LIFE CYCLE ENVIRONMENTAL PROFILE (LCEP)

5.1. LCEP

An aircraft launched munition is expected to encounter the environments shown in Figure 1 during its life cycle. General test flows associated with these environments are presented in Figures 2 and 3. Test flow details are provided in Annex B as sequential test flow charts and munition allocation tables. Test guidelines are provided in Annex C and rationale are provided in Annex A. An attempt has been made to define test flows such that environmental tests are conducted at representative points in the life cycle. These test flows are based upon the applicable environmental factors for storage, transportation, and deployment selected from Annex A of AECTP 100, along with the generic usage profiles from Annex E of AECTP 100, for aircraft launched missiles and aircraft bombs. Testing in accordance with this life cycle sequence and combining environments (i.e., vibration with temperature) is required to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard. If the munition specific LCEP identifies environments or usage profiles significantly in excess of those provided in this document, the test specifications should be adjusted accordingly.

5.2. Deviations

Deviations from the S3 test flows contained in this document shall be approved by National S3 Authority(ies) or other appropriate authorities prior to the start of testing. The rationale used in tailoring shall be documented and retained as part of the Munition Safety Data Package as noted in Annex C of AOP-15.

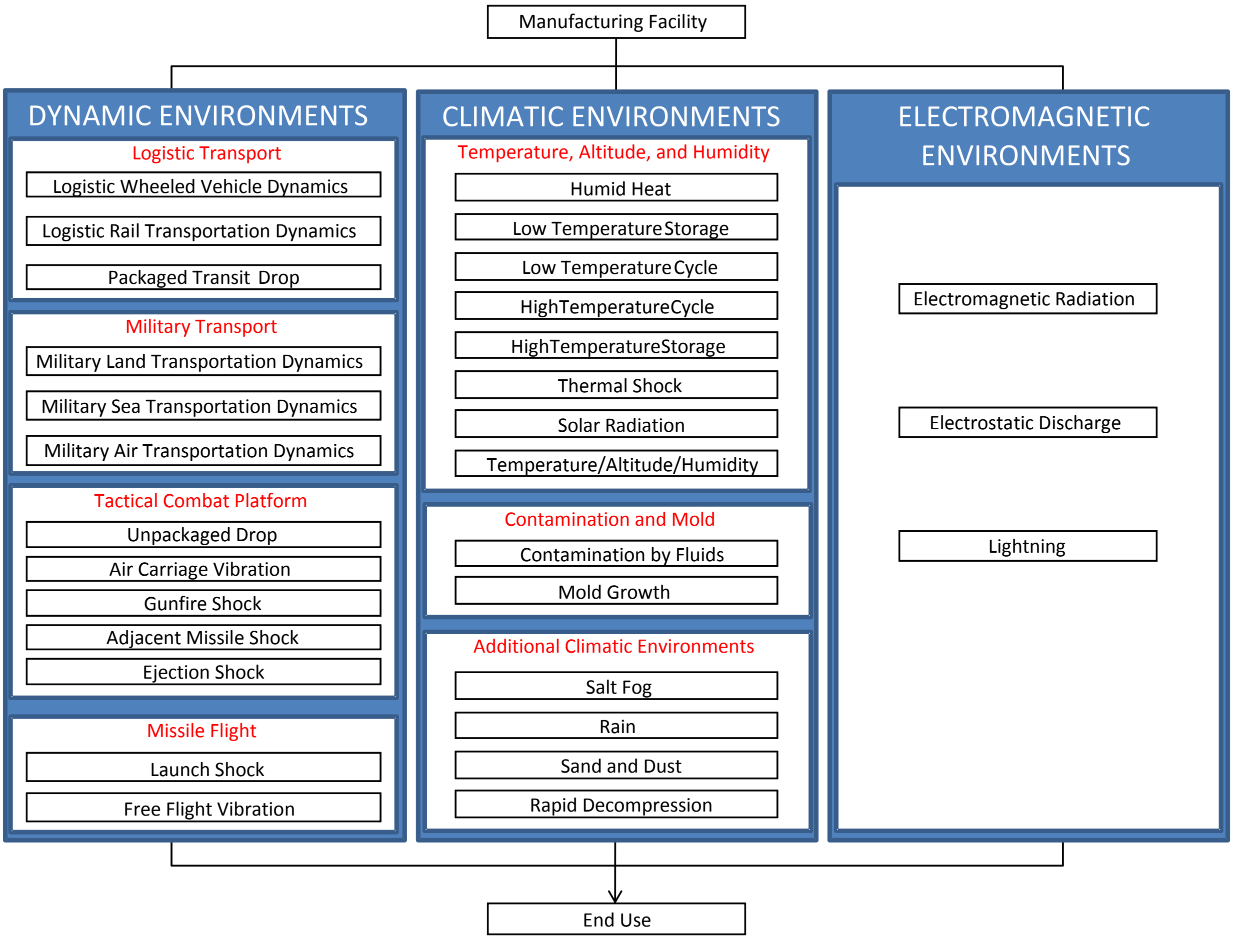

Figure 1: Expected Environments for Aircraft Launched Munitions Life Cycle

CHAPTER 6 SAFETY TEST PLANNING

6.1. Overall Test Objectives

The objective of the safety tests is to provide data to demonstrate that the munition is “safe for use” as defined in AAS3P-1. Safety tests must provide data to determine the following:

a. Existence and nature of actual and potential munition hazards to personnel and equipment.

b. Safety of the munition throughout the planned LCEP including storage, transport, maintenance, training, operations, firing, and disposal.

6.2. Data Sources

Safety assessment of munitions is an evolutionary process, which begins in the early design phase of the munition and continues after deployment. The data gathered during the S3 tests described in this document should not be considered the exclusive source of data to support the safety assessment. Other sources of safety data such as the ones described below shall also be considered.

6.2.1. Design and Test Data Review

Review of existing safety, design, and test data is recommended prior to development of the test plan in order to identify any potential hazards and their causes. Specifically this should include review of documentation relating to munition requirements, design, safety, and any prior testing, including data from component and munition level performance and safety testing (engineering design or component-development tests). The degree to which this AP is followed and the degree to which other data are accepted in place of these AP tests depend on the characteristics of the munition and on the credibility and completeness of existing safety data. These reviews and this AP must be used to develop the detailed test plan and shall be in accordance with the National health and safety standards and regulations. If the data review indicates a high probability of passing a test, then the test procedures described in this document may be conducted. If the review indicates probable shortcomings in the munition, or if component and munition level performance test data are insufficient, then the procedures of this document should be expanded accordingly to validate the safety of the munition.

6.2.2. Safety Assessment Report (SAR)

The SAR is a formal document that identifies potential hazards and mitigations which, in accordance with standardized procedures, shall be submitted by the munition developer prior to testing. The SAR shall delineate the safety related characteristics of the munition, identify potential hazards, assess the severity and probability for each identified hazard, and recommend procedures and precautions to mitigate hazards to an acceptable risk.

6.3. TEST TAILORING

The safety tests recommended in this document are intentionally conservative to account for a wide range of deployment possibilities in NATO service. Test tailoring may be necessary for a variety of reasons including test conduct safety considerations, variation of deployment requirements and/or life cycle environmental profile, and the need to address nation specific requirements. When nation specific requirements conflict with requirements in this document, the reference tables in Annex I may be used to assist in the process of cross-referencing the national and international documents. The rationale used in tailoring shall be documented and retained as part of the S3 assessment file. Particularly, document the elimination of tests, reduction of sample quantities, or reduction of severities, any of which may result in reduced evidence to fully support the required safety assessment of the munition. Deviations from the S3 assessment testing program shall be approved by National S3 Authority(ies) or other appropriate Authorities prior to the start of testing. A tailoring example is provided in Annex B, Appendix 5 to show how test tailoring may be applied to an S3 Test Program based on a specific set of circumstances.

6.4. ENVIRONMENTAL TEST LEVELS

The environmental test levels specified in this document are based on the anticipated extreme conditions for storage, transportation, handling, maintenance and firing or release of the munition. For deployment and aircraft related vibration and shock, the environments should be tailored based on measured data. Natural and induced environmental factors for storage and transportation were selected from AECTP 100, Annex A. Climatic test levels are based upon climatic categories defined in AECTP 230 and 300. Transportation dynamic test levels are based on AECTP 240 and 400. Operational dynamic test levels should be based upon tailoring guidance in AECTP 240. Electromagnetic environmental effects (E3) test levels are based on AECTP 250 and 500. National test method specifications may be employed to meet the environmental test requirements if it can be demonstrated that the national specification is technically equivalent or superior to the referenced methods. In addition, the national documents listed in the cross reference table in Annex I may also contain unique test requirements and severities only applicable to the specific nation. Rationale for the specific test levels in this document is provided in Annex A. Test levels or specification deviations for munitions designated to be deployed to specific areas of the world or on specific transport or tactical vehicles may result in limitations on service use or require use of special procedures. Test time compression in accordance with AECTP 240 may be acceptable, however, the risk of introducing false failure modes should be considered.

6.5. TEST OUTLINE

S3 assessment testing of aircraft launched munitions requires a series of sequential environmental tests, operating / firing tests and non-sequential (stand-alone) environmental tests. The test flow charts and munition allocation tables are shown in Annex B of this document. These include sequential and combined environmental tests (i.e., vibration with temperature) to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard.

6.6. TEST SAFETY CONSIDERATIONS

Explosive materials often become less stable with age. This ageing is exacerbated by increased temperature, humidity, and vibration/mechanical stressing. It is therefore necessary to review the projected test sequence and determine whether the sequence, including any temperature conditioning and storage, result in an unacceptable hazard. As a minimum this will require an assessment of explosive material stability with respect to extreme temperature exposure durations. It might be necessary to divide the overall test time (shock & vibration in particular) into smaller portions to prevent heat build-up within the weapon and subsequent unintended energetic reaction. It is essential and mandatory to have a log for each weapon indicating the amount of time that has been spent at extreme temperature for the entire test sequence, including all periods of temperature conditioning.

6.7. TEST SAMPLE QUANTITIES

The test sample quantities are largely dictated by the minimum number of destructive tests (i.e., static firing, dynamic firings, breakdown test and critical analysis (BTCA), pressure vessel structural integrity tests, hazard classification, and insensitive munitions) to provide sufficient evidence of munition safety. Specific rationale for the quantities in each of the destructive test categories is provided in Annex A. The following general notes should be considered when assessing the test sample quantities required for an S3 test program:

a. Materiel having more than one configuration, operating state, and/or operational platform may require increased test sample quantities.

b. Existing safety data may also be reviewed for acceptability with the goal of reducing sample sizes and the number of tests. The degree to which this data can be used depends upon munition characteristics, reliability and completeness of the existing safety data, and the adequacy with which it treats hardware configuration, input stress, potential synergistic effects, types and severity of hazards, and the probability of hazard occurrences. However, tests that may interact with each other synergistically (e.g., vibration/shock or vibration/climate) must not be removed from the sequence.

c. Additional munitions beyond those recommended in this document may be needed for baseline purposes and/or to replace items damaged during testing. Also, fully inert munitions may be required for pre-cursor testing (thermal and mechanical) to evaluate and certify test procedures, setups, and fixtures. Completely functional inert munitions may also be required to perform powered HERO tests.

d. Completely functional live munitions are required for test assets designated for the dynamic firing tests. For all other test assets, non safety-critical components (e.g., tactical, guidance, and control sections) may be removed to reduce test cost. Any hardware that is removed should be replaced by mass simulants (thermal, structural, and dynamic characteristics similar to the tactical hardware).

e. Tailoring of Test Sample Quantities. The test sample quantities or configuration may be modified, provided the rationale is approved by the appropriate National S3 Authority(ies) or other appropriate Authorities. For example, the number of dynamically fired test items may be reduced if:

(1) Previous firing tests of worst case pre-stressed and temperature conditioned munitions provide the required test data. Data from the previous firing tests are required to be provided with the new S3 assessment file.

(2) The fuze arming tests are not applicable. For example, specific munition classes may lack a warhead, such as kinetic energy munitions.

CHAPTER 7 PRE- AND POST-TEST INSPECTIONS

Perform inspections of the munitions as indicated in the sequential test flowcharts in Annex B. Inspections are to be conducted in accordance with the inspection levels defined below. Perform the appropriate inspections, checks, or disassembly before and after any non-destructive munition S3 test, and when test exposure is considered to have affected the test item. Conduct radiographic and/or other non-destructive inspection of the test item to ascertain and document any external or internal conditions existing prior to, or resulting from testing. Safety mechanisms and devices shall remain in their safe condition. Non-destructive techniques utilized shall have the capability to accurately assess condition of the safety critical characteristics.

7.1. INITIAL (BASELINE) INSPECTION

An initial inspection should be conducted to verify conformance of the munition to the build standard (see AAS3P-1) and to establish a baseline condition for subsequent test inspections. In addition to the Level 1 and Level 2 inspections described in Paragraphs 7.2 and 7.3, initial inspections should include baseline photographs and dimensions of the munition and packaging. Deviations from the build standard should be assessed by the appropriate authorities to determine that the asset(s) is satisfactory for the S3 test program.

7.2. LEVEL 1 (BASIC) INSPECTION

Level 1 (Basic) consists of visual inspection and built in test (BIT). Visually inspect all test items to determine the following:

a. Condition of shipping container.

(1) Physical damage.

(2) State of pressurization, fluids, and seals.

(3) State of desiccant and humidity indicators.

(4) State of munition retention hardware.

(5) State of shock and temperature indicators.

(6) Container markings.

(7) Electrical Earthing / Grounding device.

b. Condition of the munition or subsystem.

(1) Physical damage.

(2) Indication of seepage, leaks, or exudation.

(3) State of indicators.

(4) State of seals.

(5) State of safe and arm (S&A) devices and fuzes.

(6) Munition markings.

(7) Check connectors.

(8) Condition of exposed cables.

(9) BIT checks if appropriate.

(10) Inspection of health monitoring unit (HMU) and data if applicable.

7.3. LEVEL 2 (INTERMEDIATE) INSPECTION

Level 2 (Intermediate) encompasses Level 1, but also consists of radiography and/or non-destructive inspections (e.g., ultrasonic, tomography, magna-flux, eddy-current, etc.) of all munitions and pyrotechnic devices. The inspection facility should have the capability to conduct radiographic inspection at low temperature extremes, or as soon as possible, but no longer than 15 minutes for man-portable items or 30 minutes for non-man portable items, after removal from a cold conditioning chamber. Deviation from this should be recorded and accepted by the appropriate authority. Level 2 inspections should determine the following:

a. State of S&A devices and fuzes to include testing all accessible squibs with a certified low current circuit tester or squib meter and performing umbilical electrical tests to ensure the munition is safe for handling and continued testing.

b. Indications of structural damage.

c. Condition of the propulsion unit assembly to check for cracks, voids, slump, liner cracking/detachment, or any other failure modes identified during the preliminary design assessment. If cold Level 2 inspection is required, this inspection should be conducted at the low operating temperature.

d. Condition of the warhead assembly to check for damage, cracks, voids, defective adhesion, exudation, or any other failure modes identified during the preliminary design assessment. If cold Level 2 inspection is required, this inspection should be conducted at the low operating temperature.

e. Movement of internal components.

7.4. LEVEL 3 (BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA))

a. Level 3 (BTCA) encompasses Levels 1 and 2, but also includes disassembly for internal inspection. This is typified by destructive inspection assessing the chemical (composition, hazard properties, etc.) and physical (tensile, hardness, etc.) properties of not just the explosive materials, but also of other critical engineering materials contained within the test item. The requirements in Annex E encompass safety critical and energetic aging matters.

b. For all munitions other than aircraft launched bombs, a reduced BTCA option is allowed if the chemical analysis procedures described in paragraphs E.2.7.2 through E.2.7.6 of Annex E are either not available or cost prohibitive. In the absence of this chemical analysis data, additional test assets are required for dynamic firing and/or component level tests.

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CHAPTER 8 S3 TEST PROGRAM

8.1. S3 TEST PROGRAM OVERVIEW

Two approaches to S3 Testing, Analytical and Empirical, are presented in Annex B, each of which may be conducted with full or reduced BTCA options. While both of these approaches provide satisfactory confidence in the S3 assessment of any munition type, there are inherent benefits in terms of cost and test efficiency that tend to associate the Analytical S3 Test Approach with complex missile systems and the Empirical S3 Test Approach with the smaller, less complex rockets. The Analytical Approach with the full BTCA option is required for aircraft launch bombs for which chemical analysis of the main charge energetic material following sequential environmental testing is essential to provide a full S3 assessment.

8.1.1. Analytical S3 Test Approach (Annex B, Appendixes 1 and 2)

a. The Analytical S3 Test Approach, as shown in Figure 2, relies heavily on component level testing and BTCA for evaluation of the munition condition following sequential environmental testing. This approach requires the minimum number of assets since it provides the highest level of component level test data for all safety critical components. Details of the Analytical Test Flow with full and reduced BTCA options are provided in Annex B, Appendixes 1 and 2. Note that additional assets are required in the reduced BTCA option since the chemical analysis portions of the BTCA requirements in paragraphs E.2.7.2 through E.2.7.6 of Annex E are not conducted.

b. No dynamic firing tests are required under the Analytical S3 Test Approach. Thus, all test assets are allowed to have mass simulants in place of non-safety related components. For this reason, the Analytical S3 Test Approach is typically associated with complex missile systems containing expensive, non-safety related components.

c. When using the Analytical S3 Test Approach for aircraft launched bombs, full BTCA is required in order to provide chemical analysis of the main charge energetic material which is essential to provide a full S3 assessment of aircraft launched bombs. For bombs that are not rocket assisted, the assets identified for rocket motor firings may be eliminated.

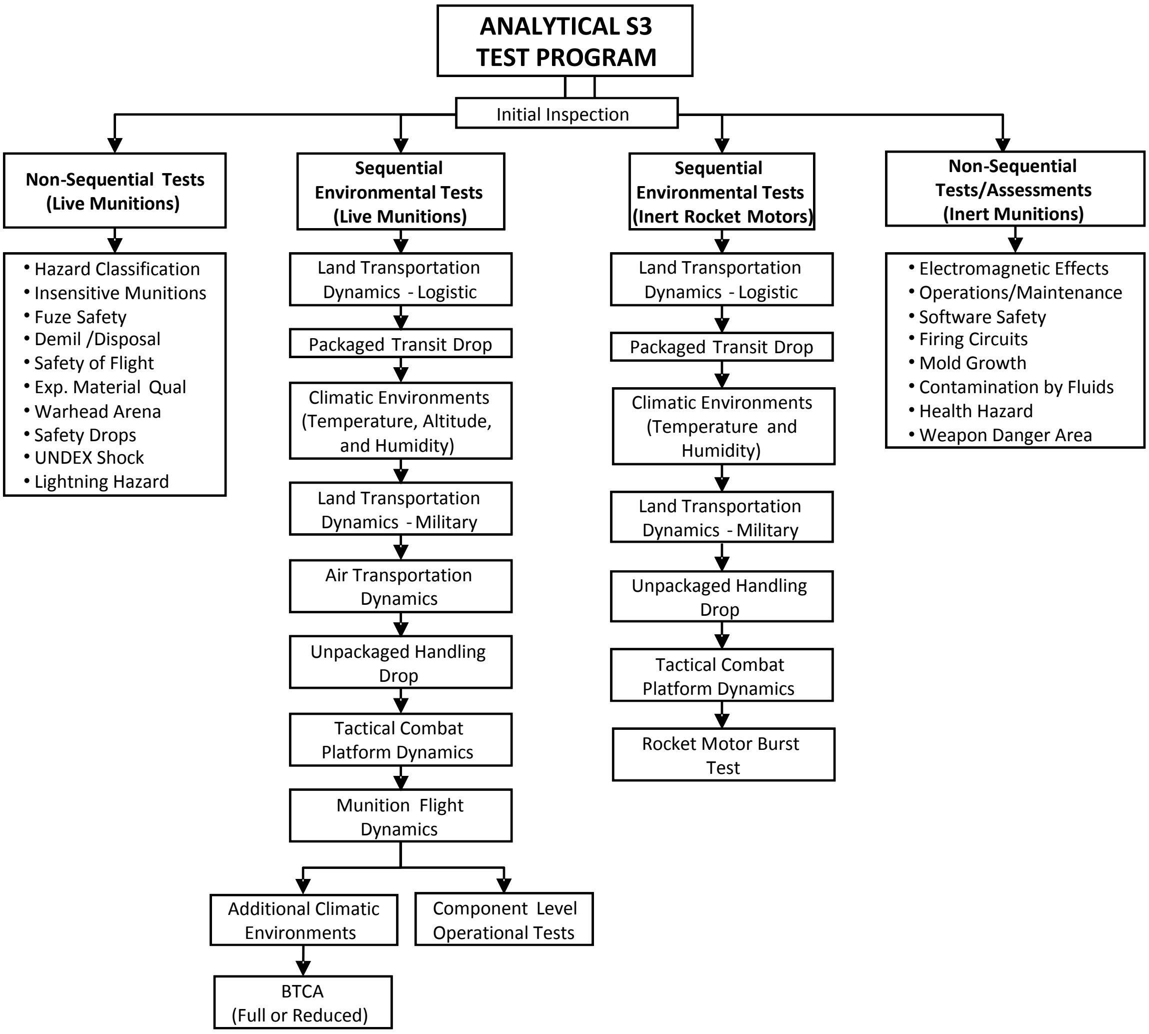

Figure 2. General S3 Test Flow for Aircraft Launched Munitions (Analytical Approach)

8.1.2. Empirical S3 Test Approach (Annex B, Appendixes 3 and 4)

a. The Empirical S3 Test Approach, as shown in Figure 3, relies heavily on dynamic firings, rocket motor firings, and BTCA for evaluation of the munition condition following sequential environmental testing. This approach requires more test assets than the Analytical S3 Test Approach since, in the absence of component level test data for all safety critical components during dynamic firings, more assets are required to establish safety margin of the system. Details of the Empirical Test Flow with full and reduced BTCA options are provided in Annex B, Appendixes 3 and 4. Note that additional assets are required in the reduced BTCA option since the chemical analysis portions of the BTCA requirements in paragraphs E.2.7.2 through E.2.7.6 of Annex E are not conducted.

b. The test assets required for dynamic firing tests are required to be fully functional munitions while all other tests may be conducted with mass simulants in place of non-safety related components. For this reason, the Empirical S3 Test Approach is typically associated with basic rocket systems and not complex missile systems containing expensive, non-safety related components. Assets identified for rocket motor firings are required, as a minimum, to contain live rocket motors and initiators but may have mass simulants in place of other safety critical components since there is no requirement for component level testing of these assets. The Empirical S3 Test Approach is not recommended for aircraft launched bombs due to the lack of safety related data obtainable from dynamic firings.

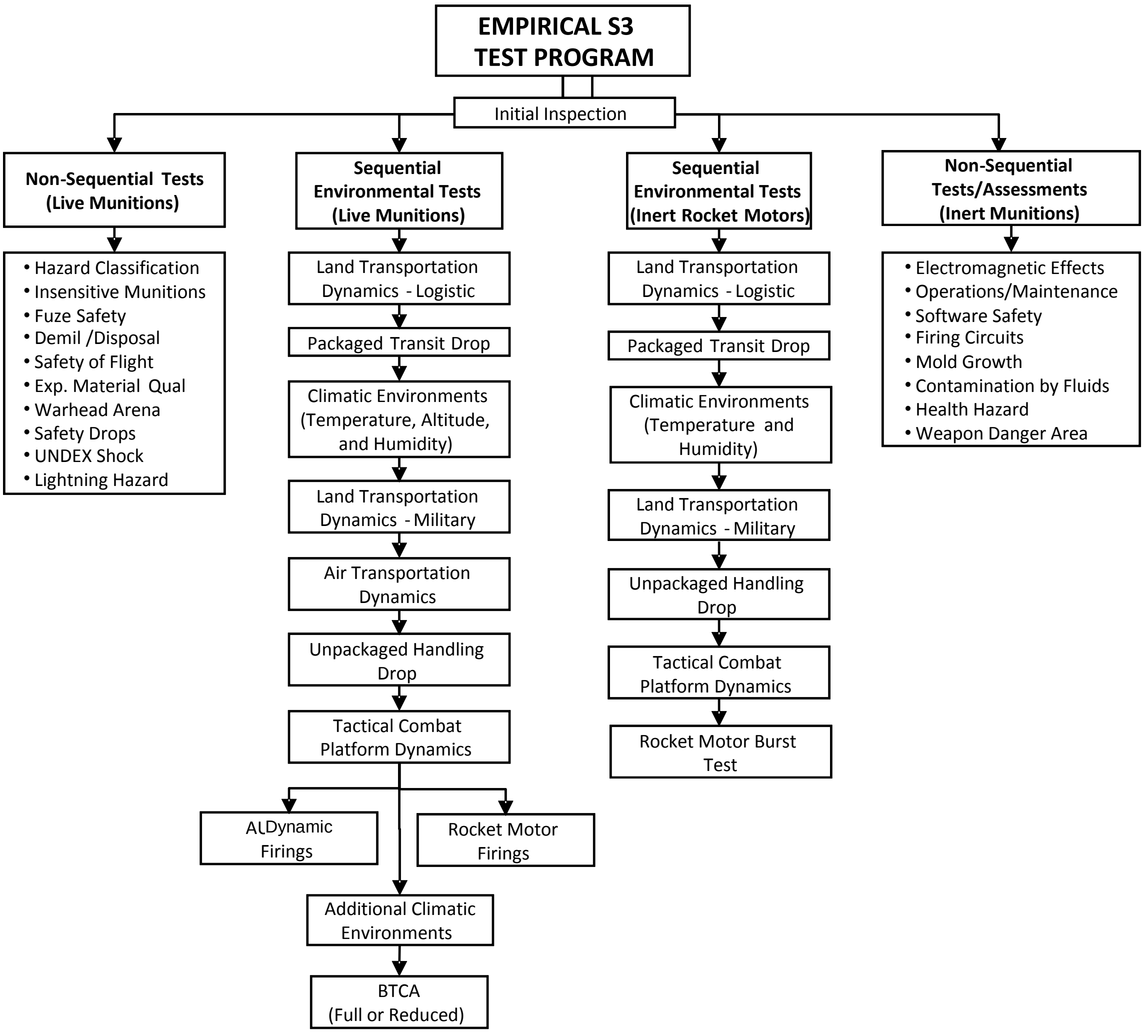

Figure 3. General S3 Test Flow for Aircraft Launched Munitions (Empirical Approach)

8.2. TEST SAMPLE QUANTITIES

8.2.1. Analytical S3 Test Approach with Full BTCA (Annex B, Appendix 1)

The recommended sample quantities for munitions following the Analytical S3 Test Approach with Full BTCA are shown in Annex B, Appendix 1, Tables B1-1 and B1-2; and illustrated in the test flow chart in Annex B, Appendix 1, Figures B1-1 and B1-2.

8.2.2. Analytical S3 Test Approach with Reduced BTCA (Annex B, Appendix 2)

The recommended sample quantities for munitions following the Analytical S3 Test Approach with Reduced BTCA are shown in Annex B, Appendix 2, Tables B2-1 and B2-2; and illustrated in the test flow chart in Annex B, Appendix 2, Figures B2-1 and B2-2.

8.2.3. Empirical S3 Test Approach with Full BTCA (Annex B, Appendix 3)

The recommended sample quantities for munitions following the Empirical S3 Test Approach with Full BTCA are shown in Annex B, Appendix 3, Tables B3-1 and B3-2; and illustrated in the test flow chart in Annex B, Appendix 3, Figures B3-1 and B3-2.

8.2.4. Empirical S3 Test Approach with Reduced BTCA (Annex B, Appendix 4)

The recommended sample quantities for munitions following the Empirical S3 Test Approach with Reduced BTCA are shown in Annex B, Appendix 4, Tables B4-1 and B4-2; and illustrated in the test flow chart in Annex B, Appendix 4, Figures B4-1 and B4-2.

8.3. ENVIRONMENTAL TESTS

Annex C provides descriptions of the environmental tests required by the S3 test flows presented in Annex B. Background and rationale for these tests are provided in Annex A. An attempt has been made to address all environments described in Annex A of AECTP 100 and as shown in Figure 1. Whenever possible, environmental test details are deferred to the STANAG 4370 AECTPs referenced in the sequential test procedures. For test methods which are not currently covered by STANAGs and/or Allied Publications (APs), reference should be made to the appropriate International Test Operations Procedure (ITOP) or National document.

8.4. OPERATING TESTS

Annex D provides descriptions of the firing safety and component level tests required on munitions that have undergone sequential environmental testing.

8.4.1. Firing Safety Tests (Unmanned Dynamic Firings)

Appendix 1 of Annex D describes the ground launched firing safety tests required in the Empirical S3 Test Approach for munitions that have undergone sequential environmental testing to evaluate firing safety (at motor ignition); munition operation, launch, and flight safety; and warhead minimum arming distance. The unmanned firings are also used to evaluate the need for supplemental testing. Health Hazard and Weapon Danger Area data may be acquired during dynamic firing tests as described in Annex D. Background and rationale for these tests are provided in Annex A, Appendix 2.

8.4.2. Component Level Tests

Appendix 2 of Annex D describes the component level tests required for munitions that have undergone sequential environmental testing. Component level assessment of energetics, pressure vessels, and other safety critical components is required in order to estimate the probability and severity of failure during operational use. Examples are gas generators, pressure vessels, safe and arm devices, or thermal batteries which could present a hazard to personnel as well as gyros and inertial measurement units that may present a hazard to the aircraft by failing to operate properly upon launch. Background and rationale for these tests are provided in Annex A, Appendix 2.

8.5. ADDITIONAL TESTS AND ASSESSMENTS

Tests and assessments in addition to the environmental and operational testing described above are required as part of the S3 Package. In particular, Hazard Classification, Insensitive Munitions Assessment, and Munition Software System Safety Assessment are required but the details regarding the series of tests are not provided in this document since they are governed by other STANAGs. References to the governing STANAGs are provided below.

8.5.1. Munition Hazard Classification

Appropriate munition hazard classification testing shall be conducted in accordance with STANAG 4123 and Allied Ammunition Storage and Transport Publication (AASTP)-3.

8.5.2. Insensitive Munitions (IM) Assessment

The IM assessment testing shall be conducted in accordance with STANAG 4439 and AOP-39. For a system expected to have significant changes to its vulnerability with age/use, using environmentally stressed munitions within IM vulnerability test and assessment should be considered.

8.5.3. Munition Software System Safety Assessment

Munition software shall be designed, assessed, and tested to assure its safety and suitability for service in accordance with AOP-52.

8.5.4. Firing Circuits

Conduct a full hazard assessment using Fault Tree Analysis (FTA), Failure Modes Effects and Criticality Analysis (FMECA), and sneak circuit analysis techniques and examine the firing system for adequacy of design and safety features and for compliance with specifications. Use inspections and simulated firings to determine that firing switches and interlocks are located so as to protect against accidental firings and that firing circuit connections are protected against accidental grounding or shorting. Development testing should include tests to determine whether the firing circuit acts as intended and that it will not fire when faults are introduced into the circuit.

8.5.5. Fuze Safety Testing

The central objective of S3 of Fuzing Systems is to confirm and document that the fuzing system is safe and performs as intended in all expected service environments. The design safety requirements standard is STANAG 4187, and the fuze procedures document is AOP-20. Test requirements for S3 assessment is STANAG 4157, which is based on the principles of AOP-15.

8.5.6. Electromagnetic Environmental Effects (E3)

E3 assessment testing shall be conducted in accordance with STANAG 4370, and AECTPs 250 and 500. This testing must address Hazards of Electromagnetic Radiation to Ordnance (HERO), Electromagnetic Compatibility (EMC), Electrostatic Discharge (ESD), Lightning Tests, and Firing Circuit Analysis that are required to demonstrate electrical safety. Expected test asset quantities are provided in Annex B. General guidance is provided in Annex H, Appendix 1.

8.5.7. Munition Demilitarisation and Disposal Assessment Testing

Appropriate safety testing and analysis to assess the demilitarization and disposal qualities of a munition shall be required in accordance with STANAG 4518.

8.5.8. Render Safe Procedure Testing

Appropriate testing and analysis shall be performed to develop explosive ordnance disposal (EOD) render safe procedures for new munitions entering the inventory.

8.5.9. Range Safety and Sustainability

In accordance with AOP-15, appropriate testing and analysis shall be conducted to assess range safety and sustainability. The potential for individual and cumulative environmental effects of munitions use on operational ranges, (e.g., the expected deposition of hazardous substances, pollutants and contaminants, or emerging contaminants) should be assessed.

8.5.10. Explosive Materials Qualification Testing

All explosive materials in a munition shall undergo appropriate testing and assessment per STANAG 4170 and AOP-7 to determine whether each possesses properties which make it safe for consideration for use in its intended role.

8.5.11. Health Hazards Testing

Appendix 2 of Annex H describes the testing and analysis to assess potential health hazards posed by the chemical elements or combinations present in munitions and by munitions use.

8.5.12. Aircraft Integration/Safety of Flight

Appropriate testing and analysis shall be performed to assess aircraft integration, air worthiness, and safety of flight hazards for new munitions entering the inventory. Sufficient evidence should be provided to determine whether the aircraft interface and the munition have adequate structural integrity to withstand the anticipated dynamic loading. In addition, live fire testing from ground launch stations and aircraft platforms will be required to provide sufficient evidence of safe separation, launch/blast effects, and human factors associated with weapon system operation. At a minimum, these tests should encompass the dynamic firing objectives as described in Annex A, Appendix 2 (paragraph A2.1.1), and the operations and maintenance (O&M) objectives as described in Annex H, Appendix 3.

8.5.13. Operational and Maintenance Review

Appendix 3 of Annex H describes the operational tests required to assess the safety of operational and maintenance procedures and equipment during field handling exercises.

8.5.14. Other Safety Tests to be Considered

Appendix 4 of Annex H includes additional tests to be considered for inclusion in the S3 assessment. Consideration of these tests should be based on the anticipated LCEP, measured environments, or other environmental factors.

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CHAPTER 9 MUNITION SAFETY DATA PACKAGE

As stated in AAS3P-1 and Annex C of AOP-15, the results of the testing and assessments required in this document will be compiled into a Munition Safety Data Package for use by the appropriate S3 approving authority in determining the overall S3 for air launched munitions.

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ANNEX A. BACKGROUND/RATIONALE

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

A.1. INTRODUCTION

This Annex provides background information and rationale for the sample quantities and test environments recommended by this document. Formal safety testing is required to establish test data, in support of the safety certification. The tests may indicate that the safety certification must be issued with restrictions. These restrictions may limit exposure to certain environments (climatic, dynamic, electromagnetic, etc.), restrict methods of transportation, or define special handling and operating procedures. Generally, because of increased severity associated with safety testing, satisfactory performance of the test item is not required. Poor performance after exposure to test environments may indicate a need for further investigation.

A.2. SAMPLE QUANTITIES AND STATISTICAL CONSIDERATIONS

The sample size recommendations of this document are based on prior tests of similar weapons and munitions, rather than strictly statistical considerations. Serious hazards such as warhead detonation or rocket motor burst at launch are observed as binomial (pass or fail) events, but the parameters that cause these events are unlikely to be so. For a simple binomial assessment, the predicted low failure rate coupled with a requirement for high statistical confidence, the sample sizes become very large, sometimes in excess of the eventual service population. This is not practical. Therefore, other approaches are required in combination with statistical methods to estimate the residual safety margin based on measured parameters. For sequential environmental testing, confidence is built by ensuring the test environment provides the maximum feasible cumulative stress to the test items. Statistical methods are used to derive test severities that best envelope the predicted environment. However, as stated above, the final test quantities presented in this document are a compromise based upon the experience of a large international community of subject matter experts.

A.2.1. Performance Test Data

Successful performance tests (component and munition level) with and without environmental exposure add confidence to the safety of the munition. Utilization of these data effectively increases the total number of samples.

A.2.2. Increased-Severity Testing

In order to yield acceptable confidence in safety test results with a relatively small sample size, increased-severity testing is prescribed in this document. The probability of munition failure resulting in a hazardous condition is increased by testing under conditions that represent credible extremes or slight margins above the environments to be encountered in actual munition use. These extreme environments occur with low probability. Rationale for the specific environments is presented in Appendix 1 of this Annex.

A.2.3. Sequential and Combined Environments

Munitions are subjected to sequential environmental testing which is representative of the probable LCEP scenario. Testing in accordance with this life cycle sequence and with combined environments (i.e., vibration with temperature) is recommended to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard.

A.2.4. Inspection For Incipient Failure

For each sample that fails during test, many may nearly fail. Detailed inspection of the test items before, during, and after test adds significantly to the confidence of the test, enhances the value, and helps compensate for the limited sample size. Radiographic inspections provide particularly useful insight into the condition of the munition. For example, they can detect at an early stage either displacement of components or cracking or debonding of energetic materials. Conditioning the munition to a cold temperature for the radiographic inspection enhances cracks in the energetic materials and provides for easier detection of defects. If the inspections indicate likely failure, further investigation or testing may be required. If the inspections indicate that a margin of safety exists (that no safety hazard is likely), the test can be declared complete. In either case, the data generated by conventional testing have been supplemented.

A.2.5. Variable Test Data

The use of measured variable data (pressure, force, strain, etc.) is recommended whenever practical. If margins of safety can be demonstrated between measured test data and measured or analytical failure modes, confidence in the test results is enhanced. If measured variable data indicate only small margins of safety exist, further investigation or testing may be required.

ANNEX A BACKGROUND/RATIONALE
APPENDIX 1 - ENVIRONMENTAL TESTS

A1.1. GENERAL

A1.1.1. LCEP

During its expected life cycle, a munition will experience: 1) transportation from its place of manufacture to a storage facility, 2) transportation to a place of temporary storage in an operational theatre, 3) tactical transportation within that operational theatre, and finally 4) function or return to storage. At each stage it will experience various environments resulting from the local climate, general rough handling and transportation via numerous platforms. It may also experience abnormal environments such as being accidentally dropped.

A1.1.2. Test Levels

This Appendix gives rationales for the specific test procedures and test severities recommended in this document. The test levels are credible extreme environments, to which the inventory may be exposed as part of the LCEP. Conflicts between the recommended test levels and munition specific LCEP environments should be addressed through test tailoring and/or safety release restrictions.

A1.1.3. Temperatures

Munitions are required to remain safe and suitable for service at extremes of temperature where personnel are expected to be capable of military operations, namely within NATO climate categories C2 to A1. It would be expected for the munitions to remain S3 during and following storage and transportation by various platforms within these climate categories. The extreme temperatures of these climate categories (or the SRE temperature for hot stream weapons) form the basis for the conditioning temperatures for all mechanical environment tests intended to address logistic movements. Munitions are also expected to remain safe and suitable following storage at extreme cold conditions of a C3 climate category, but would not necessarily be expected to be moved during the coldest period within this climate zone due to difficulties with vehicles and the temperatures being outside the human comfort zone (i.e., survival as opposed to capable of military operations). For this reason, the cold temperature extreme for mechanical environmental tests have been based on the C2 climate category. During operational/captive air carriage on high performance fixed wing combat aircraft, high altitude flight may induce temperatures lower than those expected at ground level; whilst low altitude flight at high speeds may induce temperatures higher than those expected at ground level due to aerodynamic heating effects. The estimation of body temperatures produced by aerodynamic heating are addressed in more detail in AECTP-230 Leaflet 239/1 Annex A. This document is not intended to address bomb bay temperatures which may require additional consideration.

A1.1.4. Temperature Stabilization

For environmental tests that require temperature conditioning, temperature stabilization is achieved when the part of the item considered to have the longest thermal lag is changing no more than 2 °C per hour. Since it may not be possible to monitor the interior parts of a live munition with the longest thermal lag during test without damaging seals, the stabilization time may be determined prior to live munition testing using an instrumented thermally-equivalent inert munition. The stabilization time will typically be required for the munition in both the unpackaged and the transport configurations and at the hot and cold temperature extremes. As an alternative, a default duration of 24 hours for unpackaged, 36 hours for packaged, or 48 hours for palletized may be applied after the chamber air around the test article has stabilized to the test temperature. Care should be taken that no item exceeds the safe life of the energetic material when subjected to multiple exposures of high temperature conditioning.

A1.1.5. SRE Temperature

As an alternative to installing solar lamps in a vibration test chamber, the SRE temperature is specified in most mechanical environment tests in order to facilitate testing. The SRE temperature is the maximum temperature experienced by the energetic material (e.g., rocket motor propellant, warhead main charge) after exposure to direct or indirect solar radiation. Determination of this temperature will require exposure of an inert, internally-instrumented munition, with thermal characteristics similar to the complete round, to the full solar test requirement defined in Annex C, Appendix 1, Paragraph C1.5. The SRE temperature should be determined for both the packaged and unpackaged state and then applied for all mechanical environment tests such that the packaged SRE temperature is used for packaged tests and the unpackaged SRE temperature for the unpackaged tests. In the absence of this data, a value of 71 °C should be used in lieu of the SRE temperature since this reflects the maximum value of the A1 Storage and Transit diurnal cycle defined in AECTP 230 Leaflet 2310/1.

A1.2. CLIMATIC ENVIRONMENT TESTS (ANNEX C, APPENDIX 1)

Provided below is the rationale for the climatic exposure tests. If only one test configuration (packaged or unpackaged) is to be used, it must represent the most severe configuration for the item under test. In most (but not all) cases, this is likely to be the unpackaged configuration.

A1.2.1. Humid Heat (Annex C, Appendix 1, Paragraph C1.1)

The humid heat test is performed to determine the resistance of materiel to the effects of a warm humid atmosphere. Moisture can alter burning characteristics of propellants and may promote corrosion degradation. Materiel may be exposed to this environment year-round in tropical areas and seasonally in mid-latitude areas. The procedure recommended by this document is an aggravated test. It does not reproduce naturally occurring or service-induced temperature-humidity scenarios. In order to reduce the time and cost of testing, the test item is exposed to higher temperature and humidity levels than those found in nature; however, the exposure duration is shorter. A minimum of ten test cycles has proven to be effective at inducing degradation/failures that are indicative of long-term effects. For test items incorporating seals that protect moisture sensitive materials, longer test durations may be required to satisfactorily determine whether the munition will remain S3 in warm-humid conditions.

A1.2.2. Temperature Storage and Cycling (Annex C, Appendix 1, Paragraphs C1.2 through C1.4)

a. High and low temperature diurnal cycling is carried as part of the sequential trials program in order to induce thermo-mechanical stressing and accelerated aging in the test munition. For most systems, 28 days high temperature A1 cycling and 3 days cold storage is considered sufficient to induce thermo-mechanical stressing representative of that which could occur in service. This duration has historically provided sufficient confidence for initial deployment of at least 3 months tactical storage.

b. For aircraft launched munitions, it is recommended that more thermal aging activity is undertaken. It is considered that a total of 56 days high temperature A1 cycling should be sufficient for the early signs of degradation to become apparent (based on a fall-back model assuming an activation energy of 70 kJ/mol). This allows an initial assessment to be made of potential failure modes and for adjustments to be made to the ageing model if necessary.

c. Based on an Arrhenius kinetic model of 70 kJ/mol activation energy, a 9 day constant temperature storage test at 71 °C may be considered a suitable substitute for 28 days of the 56 days of high temperature cycle. This 9 day constant temperature addresses the deep storage element of the service life provided the 28 days of cycling is conducted to cover the direct exposure to the A1 induced environment. The 28 day minimum is because fixed temperature aging assessments will not take account of the thermo-mechanical stressing. In addition, it should be noted that laboratory based aging tests on small samples of energetic material do not take account of the geometry of the component and so some potential failure modes could be missed. Whatever aging tests are conducted as part of the sequential trials program, the resulting predictions must be compared with the results of surveillance testing to determine how accurate they were and whether any potential failure modes were missed.

A1.2.2.1. Low Temperature Storage (Annex C, Appendix 1, Paragraph C1.2)

The low temperature storage test is intended to determine the effects of low-temperature storage on the munition. There is a 1 percent probability that materiel deployed in arctic areas (Category C3, AECTP 200) will be exposed to a temperature of -51 °C. Category C3 applies to the coldest area of the North American continent and the areas surrounding the coldest parts of Siberia and Greenland. The low temperature can be expected to dwell once reached with no solar heating effects. A minimum of 3 days is recommended since this is considered sufficient duration to thermally stabilize the munition. If the item under test could be susceptible to low temperature fluctuations or if C3 storage is not part of the LCEP, then a 7 day C2 cycle, or that defined in the LCEP, should be used.

A1.2.2.2. Low Temperature Cycling

The low temperature cycling test is intended to determine the effects of low-temperature operational environments on the munition (storage at extreme cold is addressed by the cold temperature storage test). The temperatures associated with the low-temperature cycling test are created by meteorological air temperatures (note that at this temperature extreme, the meteorological and induced diurnal cycles become aligned). The induced air temperature diurnal cycle (C2) for Category C storage and transit conditions given in AECTP 200 Leaflet 2310/1, Annex A, Table 4, is considered to adequately encompass most conceivable situations. For aircraft launched munitions, low temperature cycling is not an S3 requirement although it may be considered as a substitute for low temperature storage.

A1.2.2.3. High Temperature Storage (Annex C, Appendix 1, Paragraph C1.3)

a. The high temperature storage test is intended to accelerate chemical based degradation mechanisms via a period of testing using a constant elevated temperature. A constant temperature of 71 °C is the maximum temperature that should be considered since this reflects the peak temperatures likely to be encountered during field storage or full solar exposure. Alternatively, a constant temperature of 58 °C may be more appropriate where the use of 71 °C is thought to generate unrealistic degradation (e.g., for nitro-cellulose + nitro-glycerine based propellants).

b. Nine days of testing at 71 °C has been calculated (using the Arrhenius relationship) to give a similar degree of chemical degradation to that expected for 28 A1 'Storage and Transit' temperature cycles using an assumed activation energy of 70 kJ/mol for the degradation mechanism. The 58 °C temperature will require a longer test duration of 22 days. Conditioning time for mechanical environmental tests should not be counted since this is effectively a thermal ramp and it can prove difficult to determine the amount of thermal energy input to the munition, and hence difficult to model the equivalent thermal degradation likely to have occurred within the munition.

c. Great care is required when using this test as it may induce unrepresentative failure modes or may not adequately exercise potential failure modes. Consideration must be given to the design of the munition and any design limitations. For example, gas cracking, phase changes, or changes in the chemical reaction mechanism can occur during constant temperature aging which may not occur during diurnal cycling or in service. This test should not be conducted instead of high temperature cycling, but is used to supplement the chemical aging effects of diurnal cycling tests. If the item under test could be susceptible to high temperature fluctuations, then the A1 storage and transit (induced) cycle or that defined in the LCEP should be used.

A1.2.2.4. High Temperature Cycling (Annex C, Appendix 1, Paragraph C1.4)

The high temperature cycling test is intended to determine the effects of high-temperature storage and operational environments on the munition. The temperatures associated with the high-temperature cycling test are created by meteorological air temperatures combined with solar radiation. The induced air temperature diurnal cycle (A1) for Category A storage and transit conditions given in AECTP 200 Leaflet 2310/1, Annex A, Table 1, is considered to adequately encompass most conceivable situations. For other environments, such as Naval controlled environments, other storage categories may be considered.

A1.2.3. Solar Radiation (Annex C, Appendix 1, Paragraph C1.5)

This test is intended to aggravate those thermally induced degradation mechanisms associated with elevated skin temperatures and thermal gradients within the munition, that are induced due to solar radiation. Since most Nations solar test chambers do not incorporate the ultraviolet element of the spectrum they tend not to aggravate the photo-chemical (actinic) degradation modes associated with solar radiation. If this is of concern (as may be the case for some paints, adhesives, and polymers) then a separate ultra-violet exposure test will also be required. A minimum of seven A1 climate category cycles (meteorological temperature and solar radiation) is recommended in order to attain the maximum elevated temperatures throughout the test item. The solar radiation level of 1120 W/m² is derived from AECTP 200.

A1.2.4. Thermal Shock (Annex C, Appendix 1, ParagraphC1. 6)

This test is intended to simulate the rapid temperature transitions that are possible during logistic movements of munitions and those that are possible during deployment on combat aircraft. This latter consideration may not be applicable to helicopter deployed munitions since the rate of ascent/descent may be insufficient to generate the rapid transitions of temperature required to constitute a thermal shock. Two possible approaches are described below. Regardless of whether the munitions are carried internally or externally, or by fixed wing aircraft or helicopter, all testing should be carried out on unpackaged items. This test is intended to simulate the operational configuration of the munitions. Stabilization at the temperature extremes is required.

A1.2.4.1. Fixed Wing Aircraft Munitions

a. For fixed wing combat aircraft carrying munitions externally, the temperatures at high altitude and those induced during high speed low altitude flight need to be considered. The transition between temperature extremes at ground level and flight altitude during take-off and landing may subject deployed munitions, particularly those carried externally, to faster temperature changes than those occurring meteorologically while the aircraft is on the ground. Even faster changes, over a wider range of temperature extremes, are likely when externally carried munitions are subjected to aerodynamic heating during short-burst high-speed maneuvers on high performance aircraft. In the absence of measured data, severities can be derived from maximum rates of climb and descent for the host aircraft. Rates of change associated with dynamic heating should be determined from data measured during representative flight trials. In this scenario, a single set of temperature shocks will be required. The temperature shock test consists of ten cycles from a temperature of -51 °C to the temperature assessed (or measured) as being generated due to low altitude high speed flight (this should be no less than 71 °C).

The rate of change should simulate the most rapid ascent/decent of the aircraft.

b. For fixed wing aircraft carrying munitions internally (e.g., in a bomb-bay), temperatures induced within the enclosure need to be considered in conjunction with the temperatures likely to be encountered at the flight altitudes at which the enclosure will be opened.

A1.2.4.2. Rotary Wing Aircraft Munitions

a. Helicopter flight altitudes may be insufficient to generate the extreme cold conditions associated with the high altitude flight of fixed wing combat aircraft. Therefore, for helicopter deployment, the conditions likely to be encountered for logistic movements may be sufficient. However, the following scenarios should be considered and the worst case thermal shock applied:

(1) movement of warm munitions from storage (e.g., magazine or process area) to an extreme cold environment, or vice versa;

(2) movement of cool munitions from storage (e.g., magazine or process area) to an extreme hot environment (e.g., hardened aircraft shelter) or vice versa;

(3) rapid ascent from a desert airfield to flight altitude (or vice versa) for helicopter deployment.

b. Two sets of temperature shocks will be required to address both ‘low’ and ‘high’ temperature scenarios. The ‘low-temperature shock’ test consists of five temperature shock cycles between the temperatures of 21 °C (standard ambient) and -51 °C. The ‘high temperature shock’ test consists of five temperature shock cycles from the temperature associated with the flight altitude for air delivery (typically -5 °C) and the unpackaged SRE temperature.

A1.2.5. Temperature Altitude Humidity (Annex C, Appendix 1, Paragraph C1.7)

This test is intended to simulate the synergistic effects of temperature transitions, altitude change, and humidity variations that are possible during logistic movements of munitions and those that are possible during deployment on combat aircraft. AECTP 300, Method 317 provides general guidance for this test and the test parameters should be tailored for the intended aircraft platform(s). The defaults provided in this document are based on historical examples and Military Standard (MIL-

STD)-810G, Method 520. The default altitude and altitude change rate for fixed wing aircraft is based on the F-16C (16,000 meters with a change rate of 15,240 meters/minute). Other high performance aircraft, such as the Typhoon, Rafale, and F-22 may operate at altitudes up to 20,000 meters with altitude change rates up to 19,000 meters/minute. The default altitude and altitude change rate for rotary wing aircraft is based on the AH-64 Apache with altitude of 6,400 meters and altitude change rate of 762 meters/minute. If applicable, unmanned aircraft performance envelopes should also be considered.

A1.2.6. Salt Fog (Annex C, Appendix 1, Paragraph C1.8)

a. The salt fog test (AECTP 300, Method 309) provides a set of repeatable conditions to determine the relative resistance of the munition to the effects of an aqueous salt atmosphere. This test helps to identify potential degradation mechanisms within a relatively short period of time, and is required for munitions/components that will experience exposure to high levels of salt in the atmosphere. It should be noted that testing at the component level will not address galvanic corrosion.

b. As a minimum, this AP requires alternating wet-dry-wet-dry conditions of 24 hours each to be imposed. Alternating periods of salt fog exposure and drying conditions provides a higher damage potential than does continuous exposure to a salt atmosphere. The munition should be tested in the most severe configuration; that is, outside its shipping/storage container. The number of cycles may be increased if a higher degree of confidence is required to assess the ability of the materials involved to withstand a corrosive environment. Note, there is no relationship between this test and any real world exposure duration but it does provide an indication of potential degradation mechanisms associated with the salt (maritime) environment, nearby water sources, and from salted roads during winter operations.

A1.2.7. Sand and Dust (Annex C, Appendix 1, Paragraph C1.9)

a. The sand and dust test (AECTP 300, Method 313, Procedures I and II) determines the effects on munitions after exposure to dust and sand laden atmospheres. Dust consists of particles less than 150 microns in size. Sand has particles sizes greater than or equal to 150 microns.

b. Munitions may be exposed to sand and dust environments on a worldwide basis. The greatest exposure would be expected during operations in desert regions due to nearby and host aircraft/helicopter movements, during which munitions may be subjected to artificially blown sand and dust. Sand concentrations of 2.2 g/m^3 are likely for munitions installed on helicopters; the default value of 1.1 g/m^3 is considered adequate for munitions only installed on fixed wing aircraft. Furthermore, consideration should be made to the likelihood of high speed impact with sand and dust particles during take-off, landing and low altitude operations. Material deposited inside the munition may cause short-circuiting, build-up of static electricity, interference between moving parts, and contamination of any lubrication systems. Sand and dust may also cause abrasion of transparencies rendering optical devices inoperable. It may also abrade and remove surface finishes and/or identification markings. This AP requires the munition to be tested in the most severe configuration; that is, outside of its shipping/storage container, using the most severe exposure parameters defined in Procedures I and II of Method 313 to simulate sand and dust exposure when mounted to external launchers on the host aircraft.

A1.2.8. Rain/Watertightness (Annex C, Appendix 1, Paragraph C1.10)

The rain test (AECTP 300, Method 310, Procedure I, Part 3) recommends a severity of 100±20 mm/hr for two hours. This severity is considered adequate to address exposure throughout most of the world apart from tropical zones, where rainfall rates can be much higher. If deployment to tropical zones is anticipated, then the munition should probably be subjected to the higher severity of 200±50 mm/hr. However, it should also be considered whether the munition will actually be fielded during a tropical rainstorm. If not, then the ‘typical’ worldwide severity would be adequate. This AP requires the munition to be tested in the most severe configuration; that is, outside of its shipping/storage container. The wind speed of 18 m/s is consistent with AECTP 300, Method 310, Procedure 1.

A1.2.9. Mold Growth (Fungus and Biological Hazards) (Annex C, Appendix 1, Paragraph C1.11)

Microbial deterioration is a function of temperature and humidity and is an inseparable condition of hot-humid tropics and the mid-latitudes. AECTP 300, Method 308, is used to determine if mold growth will occur and, if so, how it may degrade/impact the use of the munition. Twenty-eight days is the minimum test period to allow for mold germination, breakdown of carbon containing molecules, and degradation of material. This is a non-sequential test and may be conducted on leftover components or material samples.

A1.2.10. Contamination by Fluids (Annex C, Appendix 1, Paragraph C1.12)

Contamination of the munition may arise from exposure to fuels, hydraulic fluids, lubricating oils, solvents and cleaning fluids, de-icing and anti-freeze fluids, insecticides, sunblock, disinfectants, coolant dielectric fluid, and fire extinguishants. Select the fluids most commonly encountered throughout the munitions life cycle and apply to the unpackaged item per AECTP 300, Method 314 using the intermittent exposure method. Contamination must be analyzed for its immediate or potential (long term) effects on the safety of the munition.

A1.2.11. Cargo Aircraft Decompression (Annex C, Appendix 1, Paragraph C1.13)

Rapid decompression can result when cabin pressurization is lost during an accident scenario in a transport aircraft. Rapid decompression may result in damage to munition seals during cargo aircraft transportation. This test should be conducted using packaged munitions to verify that the packaging does not present a secondary hazard to the munition or aircraft crew. An initial cargo compartment pressurization of 60 kPa is sufficient to address most common military transport aircraft worldwide.

A1.3. MECHANICAL ENVIRONMENT TESTS (ANNEX C, APPENDIX 2)

Provided below are the rationales for the dynamic environments likely to result from normal usage in severe environmental conditions, or from plausible mishandling during logistic and field operations. The weapons should be tested following temperature conditioning at either the SRE temperature (packaged or unpackaged as appropriate for the test configuration) for the hot weapons and -46 °C for the cold weapons (rationale given at Appendix 1, paragraphs A1.1.3 and A1.1.5) with the exception of -55 °C for fixed wing air carriage environments.

A1.3.1. Logistic Transport Dynamics

Aircraft launched munitions may be subjected to logistic land transportation by either commercial or military vehicles. Distances for each mode of transport are specified in AECTP 100. Each of these environments must be addressed as applicable. Table A-1 summarizes the military land transportation dynamics requirements as an example based on the current versions of AECTP 100 and AECTP 400.

A1.3.1.1. Logistic Transportation Dynamics (Commercial)

A1.3.1.1.1. Logistic Wheeled Vehicle Transportation Dynamics (Annex C, Appendix 2, Paragraph C2.1.1)

The movement of packaged materiel from the point of manufacture to the storage location is usually accomplished by commercial logistic vehicles over improved or paved highways. This can be addressed by the ‘Ground Wheeled Common Carrier’ vibration profiles in AECTP 400, Method 401. No factors of safety need to be applied to the amplitude since AECTP 400 vibration schedules are specified. These vibration schedules have been developed from field data and have conservatism factors built into them. Common Carrier vibration should be applied for a duration equivalent to the distances specified in AECTP 100 for Commercial Land Vehicles in the Transportation Mode. This is the first test to be performed in the munition life cycle test sequences of Annex B.

A1.3.1.1.2. Logistic Rail Transportation Dynamics

a. Rail Transport vibration testing is not normally considered necessary as this environment has been assessed to be relatively benign compared to other vibration environments. If required, Rail Vibration testing should be conducted in accordance with AECTP 400, Method 401, Annex E.

b. Rail impact testing (AECTP 400, Method 416) is a requirement for military transportation certification in the US.

Table A-1: Land Transportation Test Duration Examples Based on AECTPs 100-4 and 400-3

TRANSPORT MODE	COMBAT AIRCRAFT PLATFORM	PERCENTAGE OF AECTP 100 DISTANCE	AECTP 100-4[1] DISTANCE FOR AIR LAUNCHED MISSILE OR AIRCRAFT BOMB (km)	AAS3P-12 DEFAULT DISTANCES (km)	AECTP 400-3[2] TEST RELATION TO FIELD EXPOSURE	AAS3P-12 TEST DURATIONS (MIN/AXIS)
Secured Cargo – Common Carrier	Fixed and Rotary Wing	100%	10,000[3] Commercial Vehicle Land Transportation	10,000	Vertical Axis: 1hr/axis= 4000 km Longitudinal and Transverse Axes: 1hr/axis= 1609 km	Vert: 150 min/axis Long/Trans: 372 min/axis
Secured Cargo – Tactical Wheeled Vehicle	Rotary Wing	8%	10,000[4] Military Vehicle Land Transportation	800	All Axes: 40 min/axis= 805 km	40 min/axis
	Fixed Wing	2%		200	All Axes: 40 min/axis= 805 km	10 min/axis
Restrained Cargo Transport Shock – Off-Road	Fixed and Rotary Wing	10%		1000	Number of Shocks in Table C-1 = 1000 km	See Table C-1

NOTE 1: AECTP 100-4 Distances provided as examples only. The most current AECTP 100 values should be applied.

NOTE 2: AECTP 400-3 Time/Distance Relations provided as examples only. The most current AECTP 400 values should be applied.

NOTE 3: AECTP 100-4 distance for aircraft launched torpedoes is 5,000 km. Test duration for this example will be reduced accordingly.

NOTE 4: Not required for aircraft launched torpedoes.

A1.3.1.1.3. Packaged Transit Drop (Annex C, Appendix 3, Paragraph C3.1)

The transit drop test (AECTP 400, Method 414) simulates accidental drops encountered in logistical (packaged) handling of the munitions such as a hovering helicopter dropping the munitions from a sling or the unloading of munitions stacked on a truck.

a. Safe for Use: The default drop heights in AECTP Method 414 are based on the size and weight of a packaged munition. Munitions dropped from these heights are typically expected to be safe for use. Drop heights may be tailored due to known fragility of the munition if tailoring rationale is documented in the S3 Package and the reduced drop height limitation is documented in the Field Maintenance/Technical Manuals to require removal of the munition from service if dropped higher than the test heights.

b. Safe for Disposal: The 2.1 m packaged transit drop height is considered a credible drop scenario for aircraft launched munitions although the probability of occurrence is considered low and there is no expectation for the munition to remain safe for use. Tailoring may be carried out in accordance with the LCEP requirements if it can be demonstrated that the handling procedures for the munition reduces the potential drop height in the packaged configuration.

A1.3.1.2. Logistic Transport Dynamics (Military)

Military transportation for aircraft launched munitions can be subdivided to address military logistic and tactical movements. Logistic movement includes transportation from a point of entry into the theater of operations to an airfield storage site, forward operating base, or naval vessel. These movements may include land, sea, and air transportation on military vehicles. Tactical movement addresses transportation from the storage site to the firing platform. For aircraft launched munitions, tactical movement is limited to airfield movement and the associated dynamic environments are encompassed by the logistic transport environments.

A1.3.1.2.1. Military Land Transportation Dynamics

Military land vehicle transportation from a point of arrival into the theatre of operations (e.g., friendly port or airfield) up to a storage area may be as secured cargo on wheeled vehicles, trailers, and/or tracked vehicles. Although most of this transportation would be expected to be over improved or paved highways, a portion may be by degraded road. Munitions used on rotary wing aircraft are more likely to be deployed to forward operating bases that require land transportation on potentially degraded roads. Vehicle vibration and restrained cargo shock environments must be addressed.

A1.3.1.2.1.1. Wheeled Vehicle and Four Wheeled Trailer Dynamics (Annex C, Appendix 2, Paragraphs C2.2.1 and C2.2.2)

a. Military land transportation of munitions secured on wheeled vehicles, including airfield movement on four wheeled trolleys, consists of both vibration and shock elements that require individual tests to fully address the environment. The vibration element of this environment can be addressed by the vibration profiles in AECTP 400, Method 401, Annex A for 'Tactical Wheeled Vehicle' using a duration equivalent to the distances shown in Table A-2. Although munitions deployed on fixed wing aircraft are not expected to be transported for long distances on degraded roads, some exposure to the tactical wheeled vehicle environment is required since some airfield movement may include shock and vibration environments consistent with tactical wheeled vehicle vibration. Munitions deployed on rotary wing aircraft are more likely to be transported on degraded roads to forward operating bases and thus more exposure to this environment is required.

Table A-2: Military Vehicle Land Transportation Distances

TRANSPORT MODE	MUNITION TYPE	PERCENTAGE OF AECTP 100 DISTANCE FOR MILITARY VEHICLE LAND TRANSPORTATION
Tactical Wheeled Vehicle Vibration (packaged)	Rotary Wing Aircraft Munitions	8% (800 km minimum)
	Fixed Wing Aircraft Munitions	2% (200 km minimum)
Restrained Cargo Transport Shock (packaged)	Fixed and Rotary Aircraft Munitions	10% (1000 km minimum)

b. Restrained cargo shock testing is required to address minor obstacle negotiation for wheeled and tracked vehicles, particularly those travelling in an off-road role. Both aspects of the environment must be conducted in order to meet the dynamic test requirements and individual elements cannot be tailored out. The Restrained Cargo Transport Shock levels in Edition 3 of AECTP 400, Method 403, are not currently considered sufficient to satisfy the intent of this test. The levels specified in Table C2-1(Annex C) are based on Defence Standard (Def-Stan) 00-35, Part 3, Issue 4 and are considered to be more representative of the actual field levels. The number of shocks specified in Table C2-1 (Annex C) represents those typical for 1000 km of transportation.

c. These tests should be conducted in the configuration identified in the LCEP for this mode of transportation. Note that air launched munitions (particularly fixed wing aircraft munitions) may be transported across airfields on four wheeled trolleys either in their containers or unpackaged strapped to racking.

A1.3.1.2.1.2. Two Wheeled Trailer Vibration

Transportation of Air Launched Munitions on a two-wheeled trailer is unlikely and need not be considered unless identified as part of the LCEP. If two wheeled trailer transport is identified as part of the LCEP, this environment can be addressed by the vibration profiles in AECTP 400, Method 401, Annex A for 'Two Wheeled Trailer'.

A1.3.1.2.1.3. Tracked Vehicle Vibration

Transportation of Air Launched Munitions on tracked vehicles is unlikely and need not be considered unless identified as part of the LCEP. If tracked vehicle transport is identified as part of the LCEP, this environment can be addressed by the vibration profiles in AECTP 400, Method 401, Annex B for 'Materiel Transported As Secure Cargo' using a duration equivalent to the distance specified in the LCEP. Typically, the shock aspects associated with this environment are addressed by other tests in the sequence so there is no requirement to address these specifically.

A1.3.1.2.1.4. Loose Cargo Repetitive Shock

Transportation of Air Launched Munitions as loose, or unsecured, cargo is unlikely and need not be considered unless identified as part of the LCEP. If loose cargo is identified as part of the LCEP this requires specific testing within the environmental sequence in accordance with AECTP 400, Method 406 Procedure I or II, depending upon whether the munition in its tactical packaging is likely to slide or roll. Since no overall distance is specified in AECTP 100, the default of 20 minutes testing as per AECTP 400, Method 406 is sufficient for most applications.

A1.3.1.2.2. Military Sea Transportation Dynamics

A1.3.1.2.2.1. Shipboard Vibration

For transportation of materiel by military ships, vibration testing is not normally required since this environment tends to be relatively benign compared to other vibration environments within the LCEP. If specific Ship Vibration testing is considered necessary, this should be conducted in accordance with AECTP 400, Method 401, Annex E using the distances specified in AECTP 100 for Cargo Ships in the Transportation Mode.

A1.3.1.2.2.2. Underwater Explosion (UNDEX) (Annex C, Appendix 2, Paragraph C2.4.1)

The shocks encountered during non-contact underwater explosion (UNDEX) cause significant shock amplitudes that exceed those from normal handling. UNDEX shock testing in accordance with AECTP 400, Method 419 or appropriate National Standards is a mandatory requirement prior to ship embarkation for some NATO Nations and cannot be tailored out. The overall basis for UNDEX shock is addressed in Allied Navy Engineering Publication (ANEP) 43. Additional guidance may be found in STANAGs 4549 and 4150. The temperature in the ship's hold would be expected to be relatively benign, so testing may be performed under standard ambient conditions (21 °C). The typical requirement would be for the munitions to remain 'Safe for Disposal' so testing may be conducted non-sequentially. If, however, the requirement is for the munitions to remain 'Safe for Use' (as may be necessary for Naval application) UNDEX shock testing must be conducted within the sequence.

A1.3.1.2.3. Military Air Transportation Dynamics

Aircraft launched munitions may be subjected to Military Air transportation by either fixed wing transport aircraft (jet and propeller) or helicopters. Distances for each mode of transport are specified in AECTP 100. Each of these environments must be addressed as applicable. Table A-3 summarizes the military air transportation dynamics requirements as an example based on the current versions of AECTP 100 and AECTP 400.

Table A-3: Aircraft Cargo Transportation Test Duration Examples Based on AECTPs 100-4 and 400-3

TRANSPORT MODE	AECTP 100-4[1] FLIGHT DURATIONS FOR AIR LAUNCHED MISSILE OR AIRCRAFT BOMB	AECTP 400-3[2] TEST RELATION TO FIELD EXPOSURE	AAS3P-12 TEST DURATIONS
Fixed Wing Cargo Jet	200 hours	1 min/takeoff (10 hr flight/takeoff)	20 min/axis
Fixed Wing Cargo Turboprop	100 hours	1 hr/axis (no equivalence)	1 hr/axis
Helicopter Internal Cargo	20 hours	1 hr/axis = 6 hrs flight	3.33 hrs/axis

NOTE 1: AECTP 100-4 Distances provided as examples only. The most current AECTP 100 values should be applied.

NOTE 2: AECTP 400-3 Time/Distance Relations provided as examples only. The most current AECTP 400 values should be applied.

A1.3.1.2.3.1. Fixed Wing Turboprop Aircraft Vibration (Annex C, Appendix 2, Paragraph C2.3.1.1)

The most common propeller cargo aircraft used throughout NATO is the C130, of which the four and six bladed propeller variants are most typical (4-blade, f0=68 Hz and 6-blade, f0=102 Hz). The vibration severities for these aircraft are defined in AECTP 400, Method 401, Annex C, for 'Propeller Aircraft'. If other cargo aircraft are identified as part of the LCEP, then the blade frequencies (f0) for these shall also require consideration. Since it is not always possible to predetermine the specific aircraft types that will be used during transportation, the total test duration based on the total flight duration defined in AECTP 100, Annex E, Appendix 1 for each commodity type transported by 'Propeller Aircraft' should be split between the different blade frequencies (f0) identified. For C130, this will require the test to be divided equally between the two blade frequencies (f0=68 Hz & 102 Hz) as a minimum.

A1.3.1.2.3.2. Fixed Wing Jet Aircraft Vibration (Annex C, Appendix 2, Paragraph C2.3.1.2)

The vibration environment associated with cruise is largely addressed by other vibration environments within the LCEP and need not necessarily be tested. The takeoff vibration environment is significantly more severe than that for cruise, and can be addressed by the vibration profiles in AECTP 400, Method 401, Annex C for 'Jet Aircraft Cargo – Takeoff'. The duration of this test is determined based on the number of takeoff events. The number of takeoff events in the life of a munition may be estimated from the total flight duration defined in AECTP 100, Annex E, Appendix 1, for each commodity type transported by 'Jet Aircraft' divided by an assumed average flight duration of 10 hours per flight.

A1.3.1.2.3.3. Helicopter Vibration (Annex C, Appendix 2, Paragraph C2.3.2)

Aircraft launched munitions may be transported by a variety of helicopters as part of its LCEP. Some of the more common helicopter types used throughout NATO with a cargo capacity can be grouped according to their fundamental blade frequencies as per Table A-4. The vibration environment for these cargo helicopters can be addressed by the vibration profiles in AECTP 400, Method 401, Annex D for 'Helicopter Cargo'. If other cargo helicopters are identified as part of the LCEP, then the blade frequencies (f_1) for these shall also require consideration but only if they are sufficiently different to the 11 Hz, 17 Hz, and 21 Hz already identified. Since it is not always possible to predetermine the specific aircraft types that will be used during transportation, the total test duration based on the total flight duration defined in AECTP 100, Annex E, Appendix 1 for each commodity type transported by 'Helicopter' should be split between the different helicopter types identified. For those identified in Table A-4, this will require the test to be divided equally between the three blade frequencies (f_1=11 Hz, 17 Hz, and 21 Hz) as a minimum. In the current release of AECTP 100, air launched munitions are expected to be transported up to 20 hours as internal cargo by helicopter. Based on this guidance and the test equivalence of 1 hr vibration for 6 hrs of flight, helicopter cargo transportation would be conducted for 1.11 hrs per axis at each of the three blade frequencies for a total of 3.33 hrs per axis. If the munition is not suitable for internal helicopter cargo transportation, this test may be eliminated.

Table A-4: Helicopter Main Rotor Parameters

HELICOPTER	MAIN ROTOR			
	ROTATION SPEED, Hz	NUMBER OF BLADES	f1, Hz	S3 TEST FREQUENCY (f1)
UH-1(Huey)	5.40	2	10.80	11 Hz
CH-47D (Chinook)	3.75	3	11.25	
CH-46 (Sea Knight)	4.40	3	13.20	
UH-60 (Black Hawk)	4.30	4	17.20	17 Hz
Sea King / Commando	3.48	5	17.40	
Puma	4.42	4	17.68	
EH101 (Merlin)	3.57	5	17.85	
NH-90	TBD	4	TBD	
CH-53E (Super Stallion)	3.00	7	21.00	21 Hz

A1.3.2. Tactical Combat Platform Dynamics (Air Carriage)

Air carriage dynamics includes air carriage vibration, gunfire shock and adjacent launch shock for the type of platform on which the munition is intended to be used. For munitions deployed on both rotary wing and fixed wing aircraft, all assets must be tested in both modes with test durations adjusted proportional to the expected life cycle. Alternatively, additional assets may be added to the test program to allow full duration testing on each platform type independently. Table A-5 outlines an example of air carriage dynamics for aircraft launched munitions based on AECTP 100-4.

Table A-5: Air Carriage Dynamics Test Duration Examples Based on AECTPs 100-4

MUNITION TYPE	AECTP 100-4 COMBAT PLATFORM FLIGHT DURATION[1] (hrs)	AAS3P-12 DEFAULT FLIGHT DURATIONS [2] (hrs)	AIR CARRIAGE DYNAMIC ENVIRONMENTS	TEST DURATION
Rotary Wing Aircraft Launched Munition	50	200	• Air Carriage Vibration • Gunfire Shock • Ejection Shock • Adj. Missile Launch	Based on Derived Vibration/Shock Specifications
Fixed Wing Aircraft Launched Missile/Rocket	5-500	500		
Fixed Wing Aircraft Launched Bomb	50	100		

NOTE 1. AECTP 100-4 Flight Durations provided as examples only.

NOTE 2. The most current AECTP 100 values should be applied if greater than these default AAS3P-12 values.

A1.3.2.1. Rotary Wing Captive Carriage Vibration (Annex C, Appendix 2, Paragraph C2.5.2)

Rotary wing aircraft vibration testing covers the operational mechanical environments for air launched munitions deployed on helicopters. Testing should be conducted in accordance with AECTP 400, Methods 401 and 421 as appropriate; however, tailored test levels based on measured data will normally be used.

a. Test Temperature. Temperatures are based on the extreme storage temperatures associated with Climatic Category A1 and C2.

b. Test Configuration. The munitions shall be tested in a captive carriage configuration. Different test setups may be used including: reproducing the operational configuration, attachment by yokes, free-free, multi-shaker etc., but whichever method is used it must be sufficiently dynamically representative to ensure that the operational dynamic behavior of the munition is adequately reproduced.

c. Test Level. Tailored tests based on measured data from the intended rotary wing platform(s) will be required to reproduce the dynamic environment. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 247. These tests must take account of the different aircraft that the munition will be deployed on, the different locations on the aircraft, the various attachments / interfaces with the aircraft, the effects of neighboring stores and equipment, and the different aircraft load configurations.

d. Test Duration. Apply the Rotary Wing Aircraft Vibration for a duration equivalent to at least 200 hours of air carriage. Although the data provided in AECTP-100 describes the generic usage profile for munitions on attack helicopters as 50 hours of total flight time, more recent data suggests that up to 200 hours of rotary wing captive carriage can be expected.

A1.3.2.2. Fixed Wing Captive Carriage Vibration (Annex C, Appendix 2, Paragraph C2.5.1)

Fixed wing aircraft vibration testing should be conducted in accordance with AECTP 400 Methods 401, 420 and 421 as appropriate; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 246.

a. Test Temperature. Test temperatures of 71 °C and -55 °C are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. The munitions shall be tested in the captive carriage configuration. Different test setups may be used including: reproducing the operational configuration, attachment by yokes, free-free, multi-shaker etc., but whichever method is used it must be sufficiently dynamically representative to ensure that the operational dynamic behavior of the munition is adequately reproduced.

c. Test Level. Tailored tests based on measured data will be required to reproduce the dynamic environment. These tests must take account of the different aircraft that the munition will be deployed on, the different locations on the aircraft, the various attachments / interfaces with the aircraft, the effects of neighboring stores and equipment, and the different aircraft load configurations.

d. Test Duration. The test duration for aircraft launched missiles and rockets is based on the maximum flight duration of 500 hrs specified in the current draft of AECTP 100, Annex E, Appendix 1, for 'Air Launched Missile' on 'Combat Platform'. Aircraft bombs are to be tested for a duration equivalent to at least 100 hours of air carriage. Although the data provided in AECTP-100 describes the generic usage profile for 'Aircraft Bombs' on 'Combat Platform' as 50 hours of total flight time, more recent data suggests that up to 100 hours can be expected.

A1.3.2.3. Gunfire Shock (Annex C, Appendix 2, Paragraph C2.5.3)

Gunfire shock testing should be conducted in accordance with AECTP 400 Methods 405, 417, and 421 as appropriate; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 246.

a. Test Temperature. Test temperatures of 71 °C and -55 °C (fixed wing) or -46 °C (rotary wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. The munitions shall be tested in the captive carriage configuration. Different test setups may be used including: reproducing the operational configuration, attachment by yokes, free-free, multi-shaker etc., but whichever method is used it must be sufficiently dynamically representative to ensure that the operational dynamic behavior of the munition is adequately reproduced.

c. Test Level. Gunfire shocks are conducted as tailored time waveform replication (TWR) traces in accordance with Method 405, Procedure 1. Tailored tests based on measured data will be required to reproduce the dynamic environment. These tests must take account of the different aircraft that the munition will be deployed on, the different locations on the aircraft, the various attachments / interfaces with the aircraft, the effects of neighboring stores and equipment, and the different aircraft load configurations.

d. Test Duration. The test duration for aircraft launched missiles and rockets is based on the maximum flight duration of 500 hrs specified in the current edition of AECTP 100, Annex E, Appendix 1, for 'Air Launched Missile' on 'Combat Platform'. Aircraft bombs are to be tested for a duration equivalent to at least 100 hours of air carriage. Although the data provided in AECTP-100 describes the generic usage profile for 'Aircraft Bombs' on 'Combat Platform' as 50 hours of total flight time, more recent data suggests that up to 100 hours can be expected.

A1.3.2.4. Ejection Shock (Annex C, Appendix 2, Paragraph C2.5.4)

Ejection shock should be conducted in accordance with AECTP 400, Methods 403 and 417 as appropriate; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 246.

a. Test Temperature. Test temperatures of 71 °C and -55 °C (fixed wing) and -46 °C (rotary wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. Ejection shock tests may be conducted using an appropriate impact mechanism or actual launcher ejection device.

c. Test Level. The tailored test levels are typically specified as shock response spectra in accordance with Method 417 (SRS).

d. Number of shocks. One shock in vertical and lateral axes.

A1.3.2.5. Adjacent Munition Launch Shock (Annex C, Appendix 2, Paragraph C2.5.5)

a. Test Temperature. Test temperatures of 71 °C and -55 °C (fixed wing) or -46 °C (rotary wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. Adjacent munition launch shock tests may be conducted with the munition in captive carriage configuration or restrained in a shock test fixture.

c. Test Level. Derive shock levels from data measured during ground or air launch of munitions likely to be operated in aircraft positions adjacent to the munition under test. Apply the worst case shock levels of all potentially adjacent munitions. The tailored test levels are specified as shock response spectra in accordance with Method 417 (SRS) or as time waveform replication traces. The adjacent munition launch shock levels are typically benign and may be considered for elimination as an S3 test requirement.

d. Number of shocks. The number of shocks is based on the launch frequency of the munition generating the shock environment.

A1.3.2.6. Aircraft Carrier Takeoff/Landing

Materiel deployed on fixed-wing aircraft that takeoff/land on aircraft carriers or short land-based airfields equipped with arrestor gear will be exposed to long duration, low amplitude shocks and transient vibration associated with the catapult launch and/or arrested landing. This environment is normally addressed through system level Aircraft Integration and Safety of Flight tests and assessments (see paragraph 8.5.12). However, the results of the system level tests and assessments may indicate a need to conduct additional munition level safety tests. If required, the test conditions for the munition level test should be derived from measured data on applicable carrying aircraft since shock responses can be affected by local influences such as wing and fuselage bending modes, pylon interfaces, and structural damping. The number of takeoffs/landings for a particular munition will vary according to the LCEP and the required number of munition level shock tests should be based on the munition LCEP. A typical aircraft may fly as many as 200 sorties per year, of which more than two-thirds involve catapult launches and arrested landings. However, for laboratory test purposes, 30 simulated catapult launch/arrested landing events in each of two axes (longitudinal and vertical) should provide confidence that the majority of significant defects will be identified for remedial action.

A1.3.3. Unpackaged Handling Drop

The unpackaged handling drop test simulates accidental drops of unpackaged munitions during handling, operations, and maintenance. For those munitions that may survive a drop with no obvious visual damage and may be subsequently loaded onto an aircraft for use, the drop test should be conducted as part of the sequential environmental test flow with a criterion of safe for use. In addition, non-sequential unpackaged handling drops from a credible drop height should be conducted on 5 munitions with a criterion of safe for disposal.

A1.3.3.1. 0.5 Meter Unpackaged Handling Drop (Annex C, Appendix 3, Paragraph C3.2 - Sequential/Safe for Use)

This test is required for munitions that are likely to withstand an unpackaged handling drop without significant external visual damage. The 0.5 meter default drop height is less than the MIL-STD-810G default of 1.5 meter due to the low probability that an Air Launched Munition would be considered safe for use following a drop from more than 0.5 meter. Due to the severity and accidental nature of this test environment, it is recommended that only half the total number of munitions in the sequential environmental test flow be exposed to the Unpackaged Handling Drop. The drop height may be tailored if the maintenance handling procedures prevent the energetic and safety critical components of a dropped missile or bomb from being loaded onto an aircraft.

A1.3.3.2. 2.1 Meter/3 Meter Unpackaged Safety Drop (Annex C, Appendix 3, Paragraph C3.4 - Non-Sequential/Safe for Disposal)

The recommended drop height of 2.1 meters for rotary wing aircraft munitions and 3.0 meters for fixed wing aircraft munitions is based on the likelihood of an aircraft launched munition being dropped, out of the shipping container, from the firing position (aircraft level) and expected to be safe for disposal. Tailoring may be carried out in accordance with the LCEP requirements if it can be demonstrated that the handling procedures for the munition reduces the potential drop height in the packaged configuration. Note that although the probability of occurrence is considered low, the unpackaged safety drop height is considered a credible drop scenario for aircraft launched munitions. This test may not be required if the 12 meter logistic drop is conducted in the unpackaged configuration.

A1.3.4. 12-Meter Logistic Safety Drop Test (Annex C, Appendix 3, Paragraph C3.5)

This mandatory logistic safety drop test, as described in STANAG 4375, assesses the safety of the munition when exposed to a free-fall drop, which may be encountered during aircraft loading operations while on a naval vessel. This test is conducted as a non-sequential test since it is representing an accident scenario with no expectation for the munition to remain safe for use. The 12-meter logistic safety drop test is required in the unpackaged configuration for any munition handled out of the shipping container on a naval vessel. For this reason, unpackaged should be the default configuration for all air launched munitions. If the LCEP does not include bare munition handling on a naval vessel, the 12-meter logistic safety drop test may be conducted in the packaged configuration. For either configuration, the drop height of 12-meters should not be tailored.

A1.3.5. Munition Flight Dynamics

Aircraft launched missiles and rockets may experience high shock levels during rocket motor ignition and significant vibration levels during free flight. Appropriate functional tests may be conducted during these environments to ensure all safety critical components are functional at the system level. These tests are not required for the Empirical S3 test flow for which these environments will be evaluated through dynamic firings.

A1.3.5.1. Launch Shock (Annex C, Appendix 2, Paragraph C2.6.1)

Launch shock should be conducted in accordance with AECTP 400, Methods 403 and 417 as appropriate; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 246.

a. Test Temperature. Test temperatures of 71 °C and -55 °C (fixed wing) and -46 °C (rotary wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. Attach the munition to the shock exciter as appropriate.

c. Test Level. The tailored test levels are typically specified as either a half-sine shock pulse or a shock response spectra in accordance with Method 417 (SRS).

d. Number of shocks. One shock each in the positive and negative longitudinal axes.

A1.3.5.2. Free Flight Vibration (Annex C, Appendix 2, Paragraph C2.6.2)

Free flight vibration testing should be conducted in accordance with AECTP 400, Methods 401 and 421 as appropriate; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflet 2410, 246.

a. Test Temperature. Test temperatures of 71 °C and -55 °C (fixed wing) and -46 °C (rotary wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

b. Test Configuration. Attach the munition to the shock exciter as appropriate.

c. Test Level. The tailored test levels are typically specified as a random vibration profile in accordance with the test severity derived in accordance with AECTP 240/Leaflet 2.

d. Test Duration. The test duration in each axis should be consistent with the maximum missile flight duration with a minimum of one minute per axis.

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ANNEX A BACKGROUND/RATIONALE
APPENDIX 2- OPERATING TESTS

A2.1. FIRING SAFETY TESTS (ANNEX D, APPENDIX 1)

a. Firing safety tests are conducted under various conditions to determine firing safety related to munition operation, launch, and flight.

b. The firing safety tests are conducted under both high and low temperature conditions. The high temperature tests should be conducted at the higher of 71 °C or the unpackaged SRE temperature. The cold temperature tests should be conducted at -55 °C (fixed wing)/-46 °C (rotary wing). Although these values may be more severe than the manufacturer's recommended upper and lower firing temperatures for munition performance, the extreme values should be used to assess safety aspects of the motor firing under worst case service conditions. Appropriate precautions should be taken if the firing temperature exceeds the manufacturer recommendations.

A2.1.1. Dynamic Firing (Annex D, Appendix 1, Paragraph D1.1)

Dynamic firing tests are conducted from unmanned ground launch stations on an instrumented firing range to demonstrate that the munition: is safe to launch (does not eject hazardous debris or detonate upon ignition); safely separates from the launch platform; and travels at and explosively functions, at trajectories which cause no additional hazards to the platform.

a. The data acquired during firing should be sufficient to support weapon danger area analysis and to capture any performance data that may be related to safety.

b. Blast overpressure, launch blast debris, thermal effects, radiance, and launcher reaction data are potential health hazards that may cause harm to the launch platform or personnel. Other system specific health hazards should be considered. See Annex H, Appendix 2.

c. Evidence toward rocket motor safety and initiation system functioning.

d. Verification of safe separation distance may be obtained from dynamic firings; if needed, additional evidence may be obtained from component level sled tests (with fuze and warhead) or from additional fuze arming distance firings in accordance with Annex H, Appendix 4, paragraph H4.6. For munitions that are expected to penetrate light brush or other obstructions in close proximity to the aircraft (i.e., helicopter munitions), additional fuze sensitivity tests in accordance with Annex H, Appendix 4, paragraph H4.7 should be considered.

e. Collect launch shock data, if required.

A2.2. COMPONENT LEVEL TESTS (ANNEX D, APPENDIX 2)

A2.2.1. Rocket Motor Tests

Static firing and case burst tests are performed to determine the probability of catastrophic motor case rupture during firing operations. All munitions must have been subjected to extreme environmental stresses, such that the characteristic variation of the rocket motor pressure data can be obtained during the static firing and burst tests.

A2.2.1.1. Static Firing (Annex D, Appendix 2, Paragraph D2.1)

Static firing tests are performed to measure maximum internal operating pressures and provide data to determine any changes of motor burn performance that may result from environmental exposure. To induce the maximum operating pressure, and to assess thermal liner/bond line integrity, the rocket motors are static fired under both high and low temperature conditions. The high temperature tests should be conducted at the higher of 71 °C or the unpackaged SRE temperature. The cold temperature tests should be conducted at -55 °C (fixed wing)/-46 °C (rotary wing). Although these values may be more severe than the manufacturers recommended upper and lower firing temperatures for munition performance, the extreme values should be used to assess safety aspects of the motor firing under worst case service conditions. Appropriate precautions should be taken if the firing temperature exceeds the manufacturer recommendations.

A2.2.1.2. Burst (Annex D, Appendix 2, Paragraph D2.2)

Burst tests are performed to measure the internal pressure required to burst the rocket motor. Characterization of the effects of the bursting motor is a secondary objective. Hydrostatic burst testing is the most commonly used test method and may be conducted with or without propellant. Evidence of motor case structural integrity should be obtained from factory fresh motor case burst testing and from environmentally stressed motor case burst testing to determined the susceptibility of the case material and seals to degradation as a result of sequential environmental testing.

A2.2.2. Other Pressure Vessels (Annex D, Appendix 2, Paragraph D2.3)

Appropriate burst tests should be conducted on any other pressure vessel in the munition.

A2.2.3. Warhead Arena Trials (Annex D, Appendix 2, Paragraph D2.4)

The safe separation distance is determined by the warhead fragment characteristics (size, mass, velocity, and spatial dispersion). A sample size of at least four is required because only a portion of the total number of fragments produced is collected in the recovery medium. The sample size must be large enough to reliably evaluate fragmentation characteristics in order to determine the average fragmentation spatial dispersion. Note that data from this test are also used to determine range safety parameters (i.e., Weapon Danger Area or "Safety Fan"). This test is conducted on factory fresh assets in order to obtain the maximum fragmentation distance.

A2.2.4. Other Energetics (Annex D, Appendix 2, Paragraph D2.5)

Appropriate functional testing should be conducted on any other energetic in the munition.

A2.2.5. Other Safety Critical Components (Annex D, Appendix 2, Paragraph D2.6)

Although energetic and pressure vessel components account for most direct safety risks during the transportation, handling, and operation of an aircraft launched munition, other components may contribute to unsafe conditions upon launch. Safety of Flight testing is intended to evaluate potentially unsafe operation of these components. However, Safety of Flight test assets are typically factory fresh and may not account for environmental degradation of the component. If it is determined that a safety critical component is susceptible to environmental degradation, operation of the component should be evaluated following sequential environmental testing either through component level operational tests in the Analytical Flow or dynamic firings in the Empirical Flow. Note that the operational tests are only required to identify potentially unsafe operation and not intended to evaluate the full performance characteristics of the components.

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ANNEX A BACKGROUND/RATIONALE
APPENDIX 3 - NON-SEQUENTIAL TESTS

A3.1. ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3) ASSESSMENT AND TESTING (ANNEX H, APPENDIX 1)

The following E3 affects should be considered to assesse the safety of the weapon when exposed to the environment which may be encountered during the weapon system stockpile to safe separation sequence (transportation/storage, assembly/disassembly, staged, loading/unloading, platform-loaded, and immediate post-launch). Levels should encompass sea, land, and aviation storage, usage, maintenance, and shipment requirements as identified in the LCEP.

A3.1.1. HERO (Annex H, Appendix 1, Paragraph H1.1)

This test assesses the safety of the weapon at a system level by exposing the weapon and its associated platform(s) to its operational electromagnetic environments and monitors the response of the weapons Electrically Initiated Devices (EIDs also known as Electro-explosive Devices (EEDs)) or Electronic Safe and Arming Devices (ESADs) and associated firing circuits when exposed.

A3.1.2. ESD (Annex H, Appendix 1, Paragraph H1.2)

These tests assess the safety of the weapon when exposed to ESD phenomenon such as those encountered during handling and helicopter transport. Test asset quantities should be based on AOP 20.

A3.1.3. Lightning Hazard (Annex H, Appendix 1, Paragraph H1.3)

These tests assess the safety of the weapon when exposed to near and direct strike lightning, which may occur during logistic and field operations.

A3.1.4. Electromagnetic Compatibility

Electromagnetic Compatibility (EMC) tests assess the suitability of the weapon to operate within the electromagnetic environment for which they are designed to be used. These tests are performed on a powered weapon during simulated normal operation and are designed to assess to what extent the weapon not only is affected by the electromagnetic environment in which it is expected to operate but also its electromagnetic affect on other electrical systems it interacts with or is in close proximity to (e.g., on the same platform). Much of this testing is for reliability purposes however some EMC tests provide safety assurance, for example those designed to monitor for interference carried into the weapon via physical electrical interfaces which may affect the performance of EID and/or ESAD firing circuits.

A3.2. HEALTH HAZARDS (ANNEX H, APPENDIX 2)

Health hazard data are to be collected during the component and dynamic firing tests or determined through analysis (see Annex D, Appendix 1). The hazards to be assessed for aircraft launched munitions are described below.

A3.2.1. Toxic Chemical Substances

Rocket exhaust gases contain toxic chemical substances such as CO, CO_2, SO_2, NO, NO_2, and HCl. Other harmful chemicals should be considered if determined to be potentially harmful to the operator or aircraft. These hazards shall be evaluated with respect to the envisaged operational environment and on the basis of pertinent national laws and regulations. This data may be especially significant for rotary wing and hovering aircraft.

A3.2.2. Acoustic Energy (Impulse Noise and Blast Overpressure) (Annex H, Appendix 2, Paragraph H2.1)

The weapon firing precipitates the sudden release of gases into the surrounding air, causing a shock wave or front to be propagated outward from the source. Firing tests are performed to measure blast overpressure and acoustic noise to determine if the shock wave has the potential to damage aircraft and/or injure personnel. Further information may be found in International Standard ISO 10843: 1997 Acoustics - Methods for the Description and Physical Measurement of Single Impulses or Series of Impulses. These data may be especially significant for rotary wing aircraft.

ANNEX B TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

This Annex provides the overall S3 test programs for aircraft launched munitions. Each test program is presented in the form of test flowcharts, munition allocation tables, and test asset quantity tables. It should be noted that several non-sequential test requirements (i.e., hazard classification and insensitive munitions tests) are considered part of the overall S3 program, but are not governed by this document. For these tests, references are provided for determination of test requirements and quantities. See Paragraph 8 of this document for the general description and intended application of the test flow options presented in this Annex.

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ANNEX B TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS
APPENDIX 1 - ANALYTICAL S3 TEST PROGRAM WITH FULL BTCA

S3 assessment testing of aircraft launched munitions requires a series of sequential environmental tests, operating/firing tests, non-sequential (stand alone) environmental tests, and the full set of BTCA requirements in Annex E. The overall munition quantities for the sequential environmental and operational tests are provided in Tables B1-1 and B1-2, respectively. The Analytical S3 Test Program for Aircraft Launched Munitions with Full BTCA is illustrated in the form of test flow charts in Figures B1-1 and B1-2 coupled with the munition allocation table in Table B1-3, which provides the test flow for each individual munition. See paragraph 8.1 for additional discussion and applicability for the Analytical S3 Test Program with Full BTCA. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.7.e.

Table B1-1: Environmental Test Asset Quantities for Analytical S3 Test Program with Full BTCA

TESTS	LIVE MUNITIONS[1]	INERT MUNITIONS[2]	OTHER UNITS OR COMPONENTS
Sequential Environmental Tests:			
Component Level Test Sequence[5]	10	---	---
BTCA Test Sequence	4	---	---
Inert Rocket Motor Case Sequence	---	10	---
Non-Sequential Environmental Tests:			
12m Logistic Drop Test	3	---	---
Shipboard UNDEX Safety Shock	1	---	---
2.1m Packaged Safety Drop (if required)[3]	5	---	---
Unpackaged Safety Drop (if required)[4]	5	---	---
HERO	---	1	1 ea EID/ESAD[6]
ESD	---	1	30 ea EID/ESAD
Lightning Hazard[7]	1	1	20 ea EID/ESAD
Totals	29	13	51

NOTE 1: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 2: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 3: May not be required if the 12 m drop is conducted in the packaged configuration.

NOTE 4: May not be required if the 12 m drop is conducted in the unpackaged configuration.

NOTE 5: No component test assets are required for bombs if they contain no propulsive, rocket assist, sub-munition, or any energetic components other than the main charge.

NOTE 6: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 7: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

Table B1-2: Operating Test and BTCA Asset Quantities (from Sequential Environmental Test Assets) for Analytical S3 Test Program with Full BTCA

OPERATING TESTS/BTCA (USING SEQUENTIAL ENV. TEST ASSETS)	LIVE MUNITIONS	LIVE PROPULSION UNITS	INERT PRESSURE VESSELS	WARHEADS	OTHER ENERGETIC COMPONENTS	OTHER SAFETY CRITICAL COMPONENTS
<u>Component Level Operating Tests</u>						
Static Fire/Operate	---	10	---	---	10 each	10 each
Burst (Hydrostatic)	---	---	10 each	---	---	---
<u>Inspection</u>						
Level 2 (Component Level)	---	---	---	10[1]	---	---
Level 3 (Full BTCA)	4	---	---	---	---	---
Totals	4	10	10 each	10	10 each	10 each
NOTE 1: Live warheads are subjected to Level 2 inspection at the component level.						

B1.1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS FOR ANALYTICAL S3 TEST PROGRAM WITH FULL BTCA

A minimum of 4 munitions are required for the full set of BTCA test requirements outlined in Annex E. These assets are subjected to the environmental test sequence and special climatic tests shown in Figure B1-1. Additional assets (10) are required for system level sequential environmental testing to be followed by component level testing. These assets are complete rounds, with or without functioning guidance and control hardware, depending upon the operational method employed for the final firing test (i.e., static, dynamic, or sled). The quantities required for each type of munition component are listed below. The munition may contain mass simulants (thermal, structural, and dynamic characteristics similar to the tactical hardware) to replace those components not required for component level testing.

a. Live Rocket Motors: Ten live rocket motors are required for static firing following sequential environmental testing. Up to five of these assets may be evaluated through alternative operational tests such as dynamic firings or sled tests if motor pressure is measured during the tests.

b. Rocket Motor Cases: Ten inert rocket motor cases are required for case burst testing following the abbreviated sequential environmental test flow in Figure B1-2.

c. Warheads: Level 2 inspection at the component level is required for ten warheads following sequential environmental testing. Although no additional component level testing of the warhead is required following sequential environmental testing, the warheads may be function tested to provide supplemental performance data or the warhead energetic material may be subjected to the detailed chemistry requirements in paragraphs E.2.7.2 through E.2.7.6 of Annex E to provide supplemental safety data.

d. Other Pressure Vessels: Ten of each type of pressure vessel (excluding rocket motor cases) are required for burst testing following sequential environmental testing.

e. Other Energetic Devices: Energetic devices other than warheads (e.g., igniters, initiators, squibs, pyrotechnics, thermal batteries) which may cause serious hazards at the system level must be static fired following sequential environmental testing. A minimum of ten of each type are required to determine the safety design margin.

f. Other Safety Critical Components: Safety critical components other than energetic and pressure vessels that may contribute to unsafe conditions upon launch (e.g., gyros, control sections, sensors) must be operationally tested. A minimum of ten of each type are required to determine the safety design margin.

B1.2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL SAFETY TESTS FOR ANALYTICAL S3 TEST PROGRAM WITH FULL BTCA

A total of 73 test assets including 15 live munitions, three inert munitions, four warheads, up to 51 sets of EID/ESADs, and additional munitions and/or munition components for Operational and Maintenance, Hazard Classification, and Insensitive Munitions testing will be required for the following non-sequential safety tests:

a. Three (3) live munitions for 12 meter Logistic Drop.

b. One (1) live munition for Shipboard UNDEX Safety Shock.

c. Five (5) live munitions for 2.1 meter Unpackaged Safety Drop (if required).

d. Five (5) live munitions for 2.1 meter Packaged Safety Drop (if required).

e. One (1) live and 3 inert munitions for use with 51 each EID/ESADs required for E3 assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESADs must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

(1) One (1) live munition and 1 inert munition with 20 live sets of EID/ESADs for Lightning Hazard.

(2) One (1) inert munition (no fill/energetics) capable of disassembly/reassembly without damage with instrumented EID/ESAD empty-inert with bridge intact and exposed for HERO tests.

(3) One (1) inert munition with 30 live sets of EID/ESADs for ESD Tests (20 for personnel and 10 for helicopter-borne ESD).

f. Additional inert munitions may be required for Operational and Maintenance Review as described in Annex H, Appendix 3.

g. Additional live munitions will be required for Hazard Classification Testing per STANAG 4123 and AASTP-3.

h. Additional live munitions will be required for Insensitive Munitions Tests per STANAG 4439 and AOP-39.

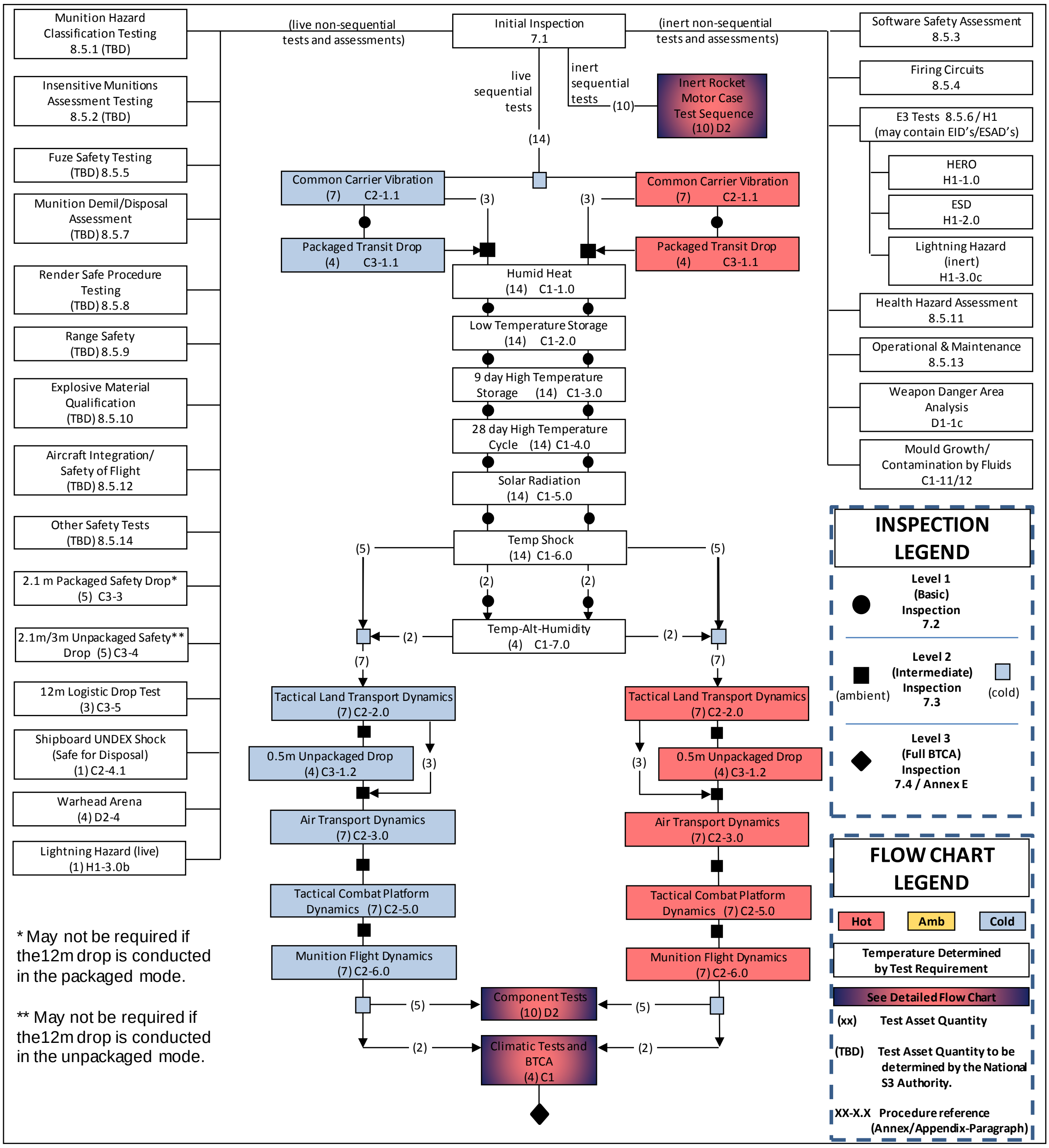
i. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

j. Four modified munitions are subjected to warhead arena trials.

k. Additional test assets may be required for fuze S3 testing per STANAGs 4187 and 4157, and AOP-20.

l. Additional test assets may be required for Aircraft Integration and Safety of Flight testing.

m. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.



* May not be required if the12m drop is conducted in the packaged mode.

** May not be required if the12m drop is conducted in the unpackaged mode.

Figure B1-1: Overall test flow chart for Analytical S3 Test Program with full BTCA (see paragraph 8.1).

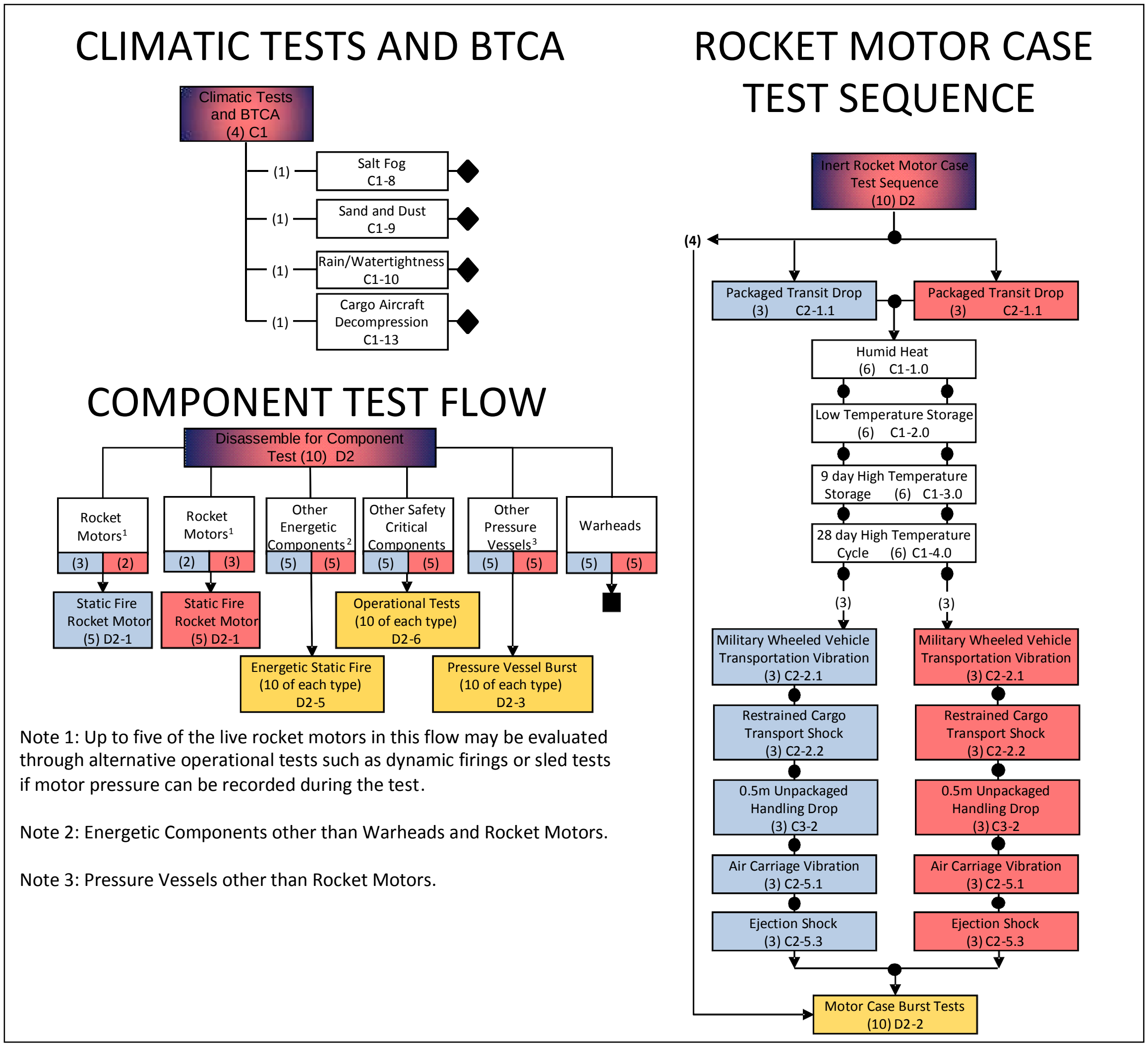


Figure B1-2: Detailed test flow charts for Analytical S3 Test Program with full BTCA.

Table B1-3: Sequential Test Round Allocation Table for the Analytical S3 Test Program with Full BTCA

		Munition number (Live Munitions)														Motor Case Sequence (Inert)									
Test serial	Annex/App/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	h	c	c	c	c	c	c	c										
Packaged transit drop	C/3/1	h		h	h			h	c		c	c			c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Thermal shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Temperature-altitude-humidity	C/1/7	x	x						x	x															
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Tactical land transport dynamics	C/2/2	h	h	h	h	h	h	h	c	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
0.5m unpackaged drop	C/3/2		h	h	h		h			c	c	c		c		h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a	a	a		a			a	a	a		a		a	a	a	a	a	a				
Air transport dynamics	C/2/3	h	h	h	h	h	h	h	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Fixed Wing Captive Carriage Vibration	C/2/5.1	h	h	h	h	h	h	h	c	c	c	c	c	c	c	h	h	h	c	c	c				
Rotary Wing Captive Carriage Vibration	C/2/5.2	h	h	h	h	h	h	h	c	c	c	c	c	c	c	h	h	h	c	c	c				
Gunfire Shock	C/2/5.3	h	h	h	h	h	h	h	c	c	c	c	c	c	c										
Ejection Shock	C/2/5.4	h	h	h	h	h	h	h	c	c	c	c	c	c	c	h	h	h	c	c	c				
Adjacent Weapon Launch Shock	C/2/5.5	h	h	h	h	h	h	h	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Munition flight dynamics	C/2/6	h	h	h	h	h	h	h	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Salt fog	C/1/8									x															
Sand & dust	C/1/9		x																						
Rain/watertightness	C/1/10	x																							
Cargo aircraft decompression	C/1/13								a																
Level 3 Inspection (Full BTCA)	7.4	a	a						a	a															
Rocket motor static firing	D/2/1			h	h	h	c	c			c	c	c	h	h										
Rocket motor burst	D/2/2															a	a	a	a	a	a	a	a	a	a
Other pressure vessel burst integrity	D/2/3			a	a	a	a	a			a	a	a	a	a										
Warhead Level 2 Inspection (component level)	7.3			a	a	a	a	a			a	a	a	a	a										
Other energetic static fire	D/2/5			a	a	a	a	a			a	a	a	a	a										
Other safety critical components operational	D/2/6			a	a	a	a	a			a	a	a	a	a										

KEY: a = ambient test/firing/assessment; h = hot conditioned test/firing/assessment
c = cold conditioned test/firing/assessment; x = test temperature defined in test

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ANNEX B TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS
APPENDIX 2 - ANALYTICAL S3 TEST PROGRAM WITH REDUCED BTCA

S3 assessment testing of aircraft launched munitions following the Analytical S3 Test Approach with Reduced BTCA requires a series of sequential environmental tests followed by BTCA and component level operating/firing tests, and non-sequential (stand alone) operational and environmental tests. The overall munition quantities for the environmental (sequential and non-sequential) are provided in Table B2-1. The munition quantities for the BTCA and component level operating/firing test that follow the sequential environmental testing are included in Table B2-2. The Analytical S3 Test Program for Aircraft Launched Munitions with Reduced BTCA is illustrated in the form of test flow charts in Figures B2-1 and B2-2, coupled with the munition allocation table in Table B2-3, which provides the test flow for each individual munition. This test flow is not recommended for Aircraft Launched Bombs. See paragraph 8.1 for additional discussion and applicability for the Analytical S3 Test Program with Reduced BTCA. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.7.e.

Table B2-1: Environmental Test Asset Quantities for the Analytical S3 Test Program with Reduced BTCA

TESTS	LIVE MUNITIONS[1]	INERT MUNITIONS[3]	OTHER UNITS OR COMPONENTS
Sequential Environmental Tests:			
Component Level Test Sequence	20[2]	---	---
BTCA Sequence	4	---	---
Inert Rocket Motor Case Sequence	---	10	---
Non-Sequential Environmental Tests:			
12m Logistic Drop Test	3	---	---
Shipboard UNDEX Safety Shock	1	---	---
2.1m Packaged Safety Drop (if required)[4]	5	---	---
Unpackaged Safety Drop (if required)[5]	5	---	---
HERO	---	1	1 ea EID/ESAD[6]
ESD	---	1	30 ea EID/ESAD
Lightning Hazard[7]	1	1	20 ea EID/ESAD
Totals	39	13	51

NOTE 1: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 2: Up to ten of these assets may contain mass simulants to replace components that are unrelated to the rocket motor firing (e.g., guidance, control, other energetics, other pressure vessels). Configurations may vary according to particular test objectives.

NOTE 3: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 4: May not be required if the 12 m drop is conducted in the packaged configuration.

NOTE 5: May not be required if the 12 m drop is conducted in the unpackaged configuration.

NOTE 6: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 7: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

Table B2-2: Operating Test and BTCA Asset Quantities (from Sequential Environmental Test Assets) for the Analytical S3 Test Program with Reduced BTCA

OPERATING TESTS/BTCA (USING SEQUENTIAL ENV. TEST ASSETS)	LIVE MUNITIONS	LIVE PROPULSION UNITS	INERT PRESSURE VESSELS	WARHEADS	OTHER ENERGETIC COMPONENTS	OTHER SAFETY CRITICAL COMPONENTS
Component Level Operating Tests						
Static Fire/Operate	---	20	---	---	10 each	10 each
Burst (Hydrostatic)	---	---	10 each	---	---	---
Inspections						
Level 2 (Component Level)	---	---	---	10[2]	---	---
Level 3 (Reduced BTCA)	4[1]	---	---	---	---	---
Totals	4	20	10 each	10	10 each	10 each

NOTE 1: Live munitions with full set of safety critical components are subjected to the reduced set of BTCA requirements in Annex E.

NOTE 2: Live warheads are subjected to Level 2 inspection at the component level.

B2.1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS FOR ANALYTICAL S3 TEST PROGRAM WITH REDUCED BTCA

A minimum of 4 munitions are required for the reduced set of BTCA test requirements. The reduced set of BTCA includes all requirements in Annex E, except for the detailed chemistry requirements in paragraphs E.2.7.2 through E.2.7.6 of Annex E. These assets are subjected to the environmental test sequence and special climatic tests shown in Figures B2-1 and B2-2. Additional assets (20) are required for system level sequential environmental testing to be followed by component level testing. These assets are complete rounds, with or without functioning guidance and control hardware, depending upon the operational method employed for the final firing test (i.e., static, dynamic, or sled). The quantities required for each type of munition component are listed below. The munitions may contain mass simulants (thermal, structural, and dynamic characteristics similar to the tactical hardware) to replace those components not required for component level testing.

a. Live Rocket Motors: Twenty live rocket motors are required for static firing following sequential environmental testing. Up to five of these assets may be evaluated through alternative operational tests such as dynamic firings or sled tests if motor pressure is measured during the tests.

b. Rocket Motor Cases: Ten inert rocket motor cases are required for case burst testing following the abbreviated sequential environmental test flow in Figure B2-2.

c. Warheads: Level 2 Inspection at the component level is required for ten warheads following sequential environmental testing. Although no additional component level testing of the warhead is required following sequential environmental testing, the warheads may be function tested to provide supplemental performance data or the warhead energetic material may be subjected to the detailed chemistry requirements in paragraphs E.2.7.2 through E.2.7.6 of Annex E to provide supplemental safety data.

d. Other Pressure Vessels: Ten of each type of pressure vessel (excluding rocket motor cases) are required for burst testing following sequential environmental testing.

e. Other Energetic Devices: Energetic devices other than warheads (e.g., igniters, initiators, squibs, pyrotechnics, thermal batteries), which may cause serious hazards at the system level, must be static fired following sequential environmental testing. A minimum of ten of each type are required to determine the safety design margin.

f. Other Safety Critical Components: Safety critical components other than energetic and pressure vessels that may contribute to unsafe conditions upon launch (e.g., gyros, control sections, sensors) must be operationally tested. A minimum of ten of each type are required to determine the safety design margin.

B2.2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL SAFETY TESTS FOR ANALYTICAL S3 TEST PROGRAM WITH REDUCED BTCA

A total of 65 test assets including 15 live munitions, three inert munitions, four warheads, up to 51 sets of EID/ESADs, and additional munitions and/or munition components for Operational and Maintenance, Hazard Classification, and Insensitive Munitions testing will be required for the following non-sequential safety tests:

a. Three (3) live munitions for 12 meter Logistic Drop.

b. One (1) live munition for Shipboard UNDEX Safety Shock.

c. Five (5) live munitions for 2.1 meter Unpackaged Safety Drop (if required).

d. Five (5) live munitions for 2.1 meter Packaged Safety Drop (if required).

e. One (1) live and 3 inert munitions for use with 51 ea EID/ESADs required for E3 assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESADs must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

(1) One (1) live munition and 1 inert munition with 20 live sets of EID/ESADs for Lightning Hazard.

(2) One (1) inert munition (no fill/energetics) capable of disassembly/reassembly without damage with instrumented EID/ESAD empty-inert with bridge intact and exposed for HERO Tests.

(3) One (1) inert munition with 30 live sets of EID/ESADs for ESD Tests (20 for personnel and 10 for helicopter-borne ESD).

f. Additional inert munitions may be required for Operational and Maintenance Review as described in Annex H, Appendix 3.

g. Additional live munitions will be required for Hazard Classification Testing per STANAG 4123 and AASTP-3.

h. Additional live munitions will be required for Insensitive Munitions Tests per STANAG 4439 and AOP-39.

i. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

j. Four modified munitions are subjected to warhead arena trials.

k. Additional test assets may be required for fuze S3 testing per STANAGs 4187 and 4157, and AOP-20.

l. Additional test assets may be required for Aircraft Integration and Safety of Flight testing.

m. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.

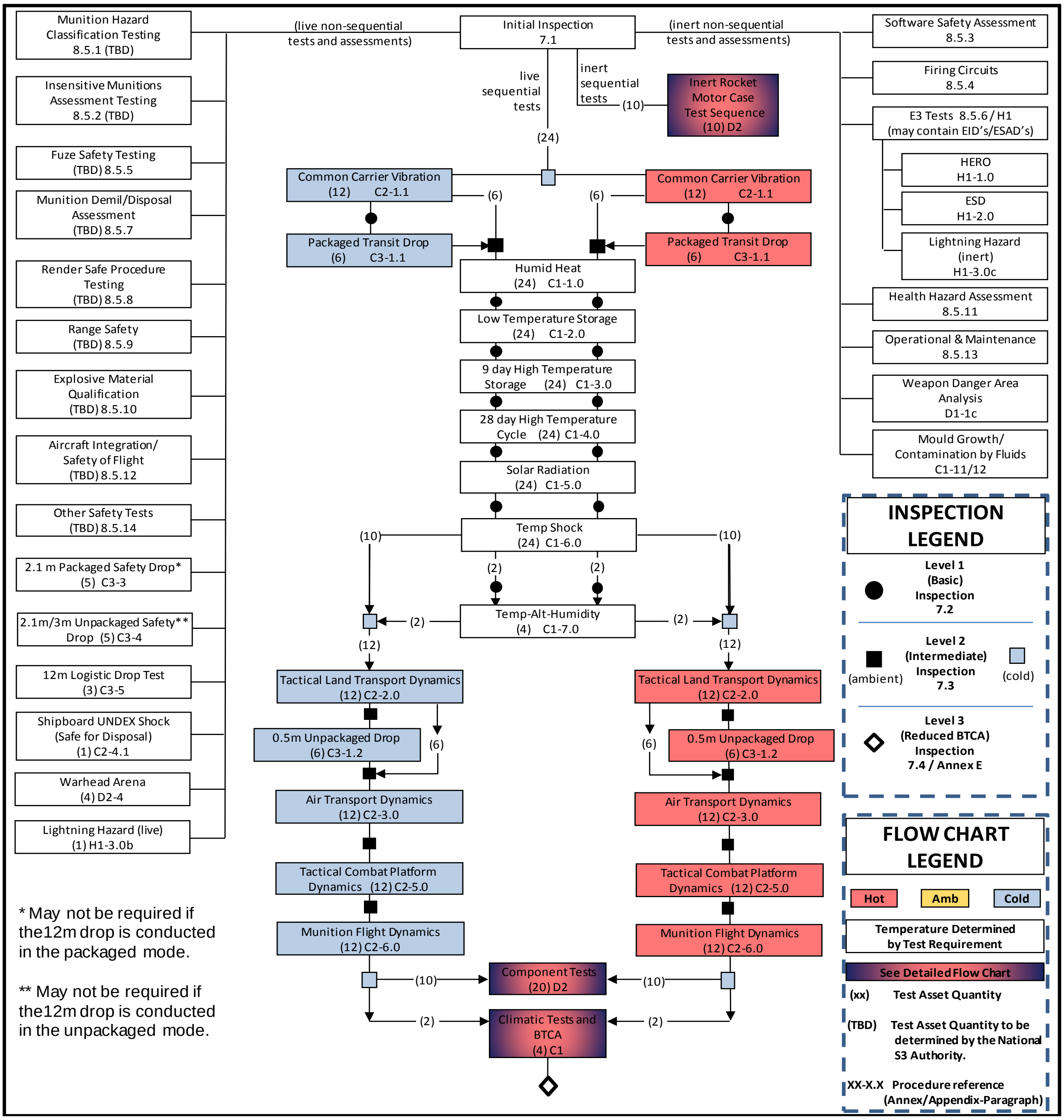
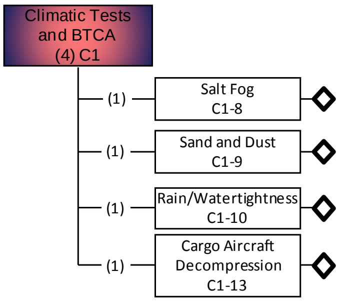


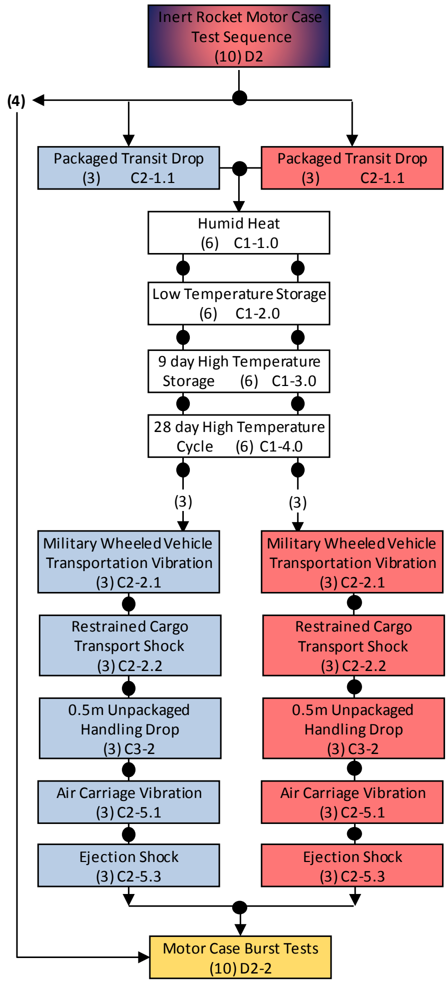
Figure B2-1: Test Flow Charts for Analytical S3 Test Program With Reduced BTCA (see paragraph 8.1)

CLIMATIC TESTS AND BTCA

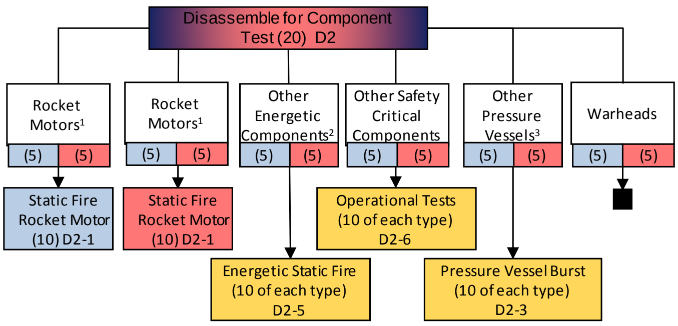


◇For this reduced BTCA test flow, a modified BTCA may be conducted by eliminating the detailed chemistry requirements in Paragraphs 2.7.2-2.7.6 of Annex E. Based on the results of the modified BTCA, more extensive chemical analysis may be required.

ROCKET MOTOR CASE TEST SEQUENCE



COMPONENT TEST FLOW



Note 1: Up to five of the live rocket motors in this flow may be evaluated through alternative operational tests such as dynamic firings or sled tests if motor pressure can be recorded during the test.

Note 2: Energetic Components other than Warheads and Rocket Motors.

Note 3: Pressure Vessels other than Rocket Motors.

Figure B2-2: Detailed Test Flow Charts for Analytical S3 Test Program With Reduced BTCA.

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Table B2-3: Sequential Test Round Allocation Table for the Analytical S3 Test Program with Reduced BTCA)

		Munition number (Live Munitions)																								Motor Case Sequence (Inert)									
Test serial	Annex/App/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Packaged transit drop	C/3/1	h		h	h	h					h	h		c		c	c	c					c	c		h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Thermal shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Temperature-altitude-humidity	C/1/7	x	x											x	x																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Tactical land transport dynamics	C/2/2	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
0.5m unpackaged drop	C/3/2		h		h	h		h	h	h	h				c		c	c		c	c	c	c			h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a		a	a		a	a	a	a				a		a	a		a	a	a	a			a	a	a	a	a	a				
Air transport dynamics	C/2/3	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Fixed Wing Captive Carriage Vibration	C/2/5.1	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Rotary Wing Captive Carriage Vibration	C/2/5.2	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Gunfire Shock	C/2/5.3	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Ejection Shock	C/2/5.4	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Adjacent Weapon Launch Shock	C/2/5.5	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Munition flight dynamics	C/2/6	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Salt fog	C/1/8														x																				
Sand & dust	C/1/9		x																																
Rain/watertightness	C/1/10	x																																	
Cargo aircraft decompression	C/1/13													a																					
Level 3 Inspection (Reduced BTCA)	7.4	a	a											a	a																				
Rocket motor static firing	D/2/1			h	h	h	h	h	c	c	c	c	c			c	c	c	c	c	h	h	h	h	h										
Rocket motor burst	D/2/2																									a	a	a	a	a	a	a	a	a	a
Other pressure vessel burst integrity	D/2/3			a	a	a	a	a								a	a	a	a	a															
Warhead Level 2 Inspection (component level)	7.3			a	a	a	a	a								a	a	a	a	a															
Other energetic static fire	D/2/5			a	a	a	a	a								a	a	a	a	a															
Other safety critical components operational	D/2/6			a	a	a	a	a								a	a	a	a	a															

Key:

a = ambient test/firing/assessment
h = hot conditioned test/firing/assessment
c = cold conditioned test/firing/assessment
x = test temperature defined in test

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ANNEX B - TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS APPENDIX 3. EMPIRICAL S3 TEST PROGRAM WITH FULL BTCA.

S3 assessment testing of aircraft launched munitions requires a series of sequential environmental tests, operating/firing tests, and non-sequential (stand alone) environmental tests. The overall munition quantities for the sequential environmental and subsequent operational tests are provided in Tables B3-1 and B3-2, respectively. The Empirical S3 Test Program for Aircraft Launched Munitions with Full BTCA is illustrated in the form of test flow charts in Figures B3-1 and B3-2, coupled with the munition allocation table in Table B3-3, which provides the test flow for each individual munition. This test flow is not recommended for Aircraft Launched Bombs. See paragraph 8.2 for additional discussion and applicability for the Empirical S3 Test Program with Full BTCA. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.7.e.

Table B3-1: Environmental Test Asset Quantities for Empirical S3 Test Program with Full BTCA

TESTS	LIVE MUNITIONS[3]	INERT MUNITIONS[4]	OTHER UNITS OR COMPONENTS
Sequential Environmental Tests:			
Dynamic Firing Sequence	10[1]	---	---
Rocket Motor Static Firing Sequence	10[2]	---	---
BTCA Sequence	4[3]	---	---
Inert Rocket Motor Case Sequence	---	10	---
Non-Sequential Environmental Tests:			
12m Logistic Drop Test	3	---	---
Shipboard UNDEX Safety Shock	1	---	---
2.1m Packaged Safety Drop (if required)[5]	5	---	---
Unpackaged Safety Drop (if required)[6]	5	---	---
HERO	---	1	1 ea EID/ESAD[7]
ESD	---	1	30 ea EID/ESAD
Lightning Hazard[8]	1	1	20 ea EID/ESAD
Totals	39	13	51

NOTE 1: Fully functional munitions suitable for dynamic firing.

NOTE 2: May contain mass simulants to replace components that are unrelated to the rocket motor firing (e.g., guidance, control, other energetics, other pressure vessels). Configurations may vary according to particular test objectives.

NOTE 3: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 4: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 5: May not be required if the 12 m drop is conducted in the packaged configuration.

NOTE 6: May not be required if the 12 m drop is conducted in the unpackaged configuration.

NOTE 7: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 8: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

Table B3-2: Operating Test and BTCA Asset Quantities (from Sequential Environmental Test Assets) for Empirical S3 Test Program with Full BTCA

OPERATING TESTS/BTCA (USING SEQUENTIAL ENVIRONMENTAL TEST ASSETS)	LIVE MUNITIONS	INERT ROCKET MOTORS
Dynamic Operating Tests		
Dynamic Firings	10[1]	---
Component Level Operating Tests		
Static Rocket Motor Firings	10[2]	---
Burst (Hydrostatic)	---	10
BTCA (Full)	4[3]	---
Totals	24	10

NOTE 1: Fully functional munitions suitable for dynamic firing.

NOTE 2: Munitions containing live rocket motor. May contain mass simulants to replace components that are unrelated to the rocket motor firing (e.g., guidance, control, other energetics, other pressure vessels). Configurations may vary according to particular test objectives.

NOTE 3: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

B3.1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS FOR EMPIRICAL S3 TEST PROGRAM WITH FULL BTCA.

A total of 24 live munitions and 10 inert motor cases are to be subjected to sequential environmental tests. The live munitions may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives. Upon completion of the environmental tests, the test assets are divided into three groups and tested further as follows:

a. Four live munitions are subjected to the full set of BTCA requirements in Annex E.

b. Rocket motors from ten munitions are static fired.

c. Ten munitions are dynamic fired as complete rounds.

d. Ten inert motor cases are burst tested.

B3.2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL SAFETY TESTS FOR EMPIRICAL S3 TEST PROGRAM WITH FULL BTCA.

A total of 73 test assets including 15 live munitions, three inert munitions, four warheads, up to 51 sets of EID/ESADs, and additional munitions and/or munition components for Operational and Maintenance, Hazard Classification, and Insensitive Munitions testing will be required for the following non-sequential safety tests:

a. Three (3) live munitions for 12 meter Logistic Drop.

b. One (1) live munition for Shipboard UNDEX Safety Shock.

c. Five (5) live munitions for 2.1 meter Unpackaged Safety Drop (if required).

d. Five (5) live munitions for 2.1 meter Packaged Safety Drop (if required).

e. One (1) live and 3 inert munitions for use with 51 ea EID/ESADs required for E3 assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESADs must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

(1) One (1) live munition and 1 inert munition with 20 live sets of EID/ESADs for Lightning Hazard.

(2) One (1) inert munition (no fill/energetics) capable of disassembly/reassembly without damage with instrumented EID/ESAD empty-inert with bridge intact and exposed for HERO Tests.

(3) One (1) inert munition with 30 live sets of EID/ESADs for ESD Tests (20 for personnel and 10 for helicopter-borne ESD).

f. Additional inert munitions may be required for Operational and Maintenance Review as described in Annex H, Appendix 3.

g. Additional live munitions will be required for Hazard Classification Testing per STANAG 4123 and AASTP-3.

h. Additional live munitions will be required for Insensitive Munitions Tests per STANAG 4439 and AOP-39.

i. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

j. Four modified munitions are subjected to warhead arena trials.

k. Additional test assets may be required for fuze S3 testing per STANAGs 4187 and 4157, and AOP-20.

l. Additional test assets may be required for Aircraft Integration and Safety of Flight testing.

m. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.

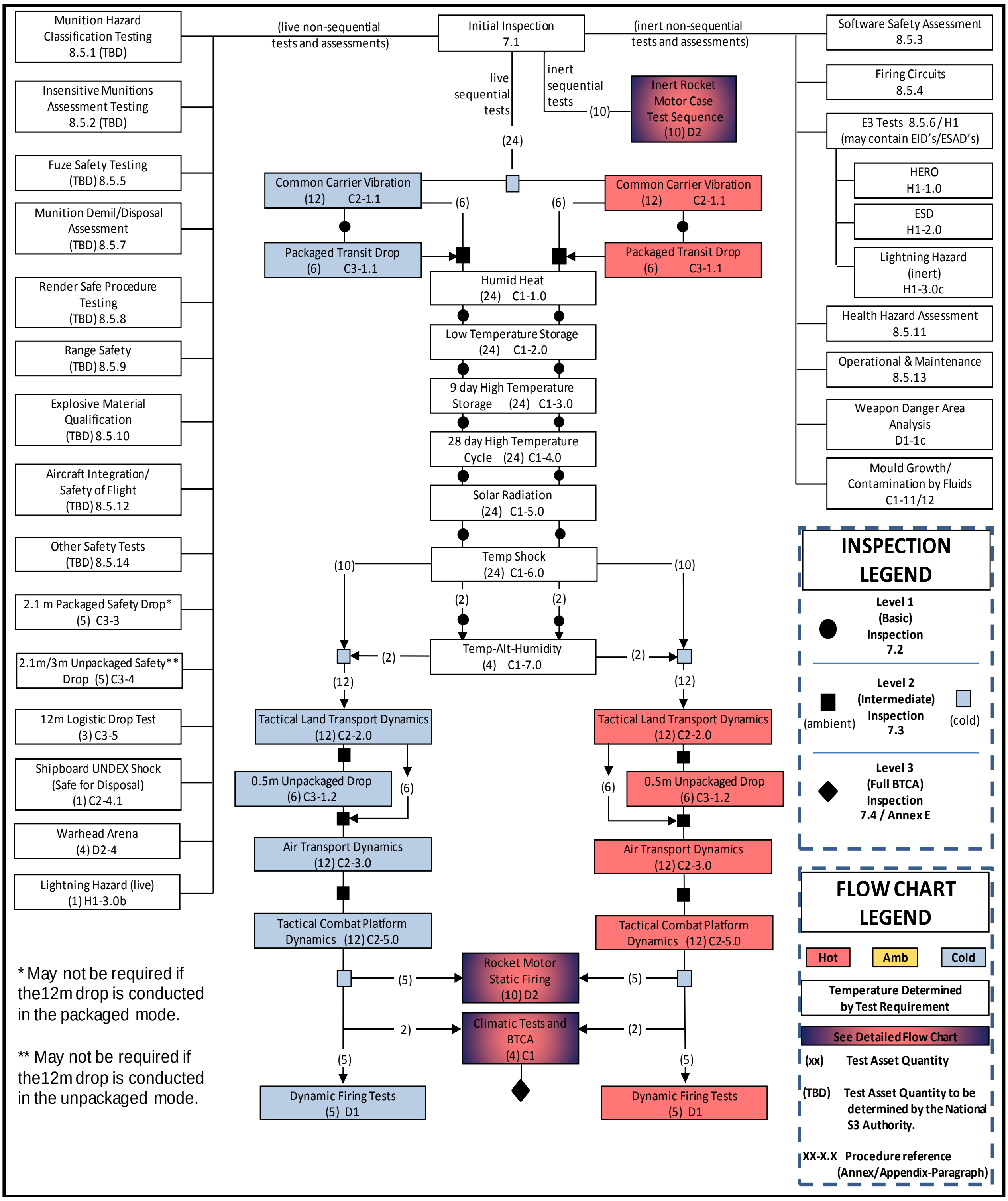

Figure B3-1: Overal Test Flow Chart for Empirical S3 Test Program With Full BTCA (see Paragraph 8.2)

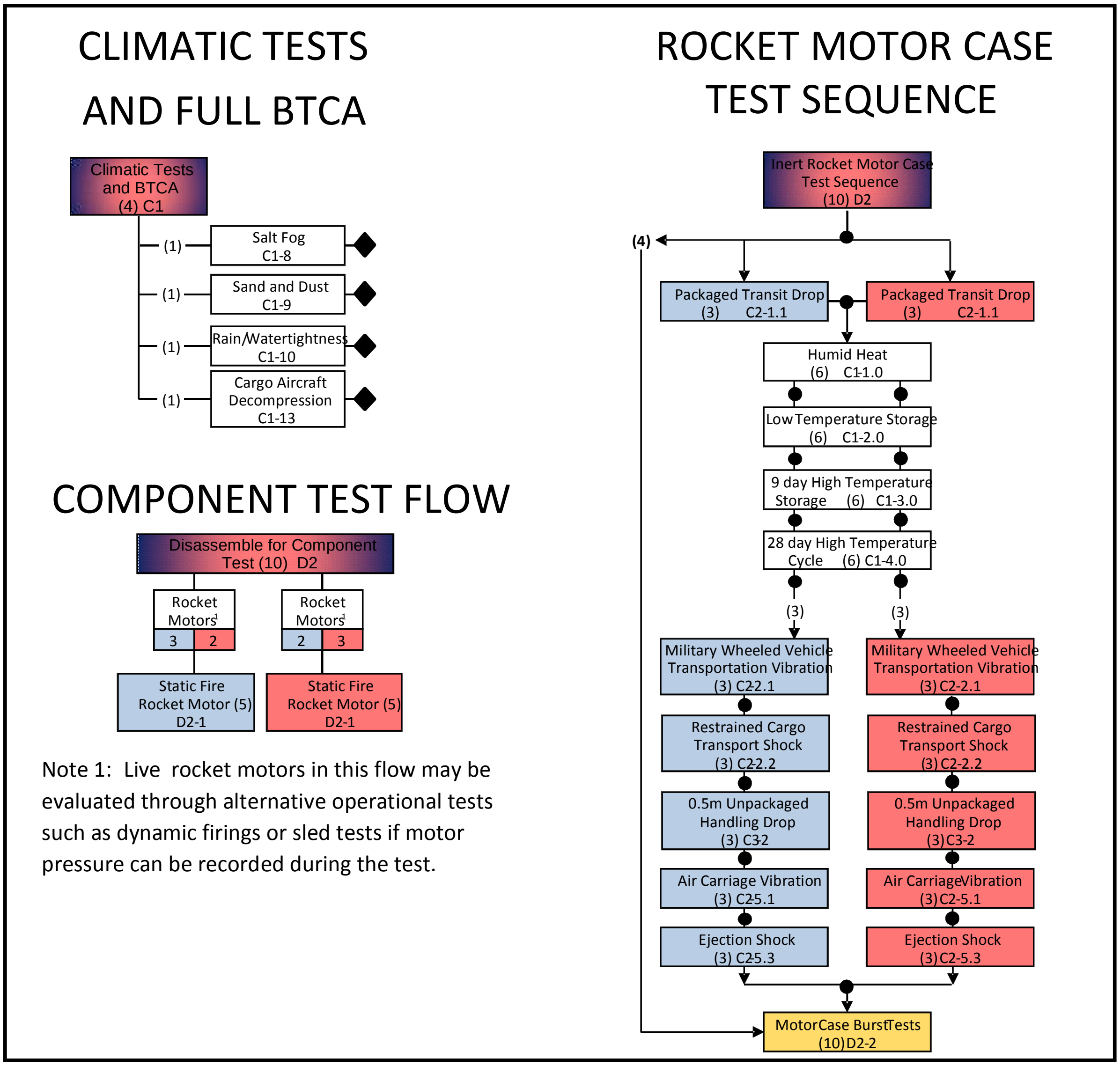

Figure B3-2: Detailed Test Flow Charts for Empirical S3 Test Program with Full BTCA

Table B3-3: Sequential Test Round Allocation Table for Empirical S3 Test Program with Full BTCA

		Munition number (Live Munitions)																								Motor Case Sequence (Inert)									
Test serial	Annex/App/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Packaged transit drop	C/3/1	h		h	h	h					h	h		c		c	c	c					c	c		h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Thermal Shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Temperature-Altitude-Humidity	C/1/7	x	x											x	x																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Tactical Land Transport Dynamics	C/2/2	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
0.5m Unpackaged drop	C/3/2		h		h	h		h	h	h	h				c		c	c		c	c	c	c												
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a		a	a		a	a	a	a				a		a	a		a	a	a	a			a	a	a	a	a	a				
Air Transport Dynamics	C/2/3	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Fixed Wing Captive Carriage Vibration	C/2/5.1	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Rotary Wing Captive Carriage Vibration	C/2/5.2	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Gunfire Shock	C/2/5.3	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Ejection Shock	C/2/5.4	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Adjacent Weapon Launch Shock	C/2/5.5	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Salt fog	C/1/8														x																				
Sand & dust	C/1/9		x																																
Rain/Watertightness	C/1/10	x																																	
Cargo Aircraft Decompression	C/1/13													a																					
Level 3 Inspection (Full BTCA)	7.4	a	a											a	a																				
Dynamic firing	D/1/1				h		h		h		h		h				c		c		c		c		c										
Rocket Motor Static Firing	D/2/1			h		h		h		c		c				c		c		c		h		h											
Rocket Motor Burst	D/2/2																									a	a	a	a	a	a	a	a	a	a

Key:

a = ambient test/firing/assessment
c = cold conditioned test/firing/assessment
h = hot conditioned test/firing/assessment
x = test temperature defined in test

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ANNEX B TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS
APPENDIX 4. EMPIRICAL S3 TEST PROGRAM WITH REDUCED BTCA

S3 assessment testing of aircraft launched munitions requires a series of sequential environmental tests, operating/firing tests, and non-sequential (stand alone) environmental tests. The overall munition quantities for the sequential environmental and operational tests are provided in Tables B4-1 and B4-2, respectively. The Empirical S3 Test Program for Aircraft Launched Munitions with Reduced BTCA is illustrated in the form of test flow charts in Figures B4-1 and B4-2, coupled with the munition allocation table in Table B4-3, which provides the test flow for each individual munition. This test flow is not recommended for Aircraft Launched Bombs. See paragraph 8.2 for additional discussion and applicability for the Empirical S3 Test Program with Reduced BTCA. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.7.e.

Table B4-1. Environmental Test Asset Quantities for Empirical S3 Test Program with Reduced BTCA

TESTS	LIVE MUNITIONS[3]	INERT MUNITIONS[4]	OTHER UNITS OR COMPONENTS
Sequential Environmental Tests:			
Dynamic Firing Sequence	20[1]	---	---
Rocket Motor Static Firing Sequence	20[2]	---	---
BTCA (Reduced) Sequence	4[3]	---	---
Inert Rocket Motor Case Sequence	---	10	---
Non-Sequential Environmental Tests:			
12m Logistic Drop Test	3	---	---
Shipboard UNDEX Safety Shock	1	---	---
2.1m Packaged Safety Drop (if	5	---	---
required)[5]	5	---	---
Unpackaged Safety Drop (if	---	1	1 ea EID/ESAD[7]
required)[6]	---	1	30 ea EID/ESAD
HERO	1	1	20 ea EID/ESAD
ESD			
Lightning Hazard[8]			
Totals	59	13	51

NOTE 1: Fully functional munitions suitable for dynamic firing.

NOTE 2: Munitions containing live rocket motor. May contain mass simulants to replace components that are unrelated to the rocket motor firing (e.g., guidance, control, other energetics, other pressure vessels). Configurations may vary according to particular test objectives.

NOTE 3: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 4: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 5: May not be required if the 12 m drop is conducted in the packaged configuration.

NOTE 6: May not be required if the 12 m drop is conducted in the unpackaged configuration.

NOTE 7: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 8: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

Table B4-2: Operating Test and BTCA Asset Quantities (from Sequential Environmental Test Assets) for Empirical S3 Test Program With Reduced BTCA

OPERATING TESTS/BTCA (USING SEQUENTIAL ENVIRONMENTAL TEST ASSETS)	LIVE MUNITIONS[2]	INERT ROCKET MOTORS
Dynamic Operating Tests		
Dynamic Firings	20[1]	---
Component Level Operating Tests		
Static Rocket Motor Firings	20[3]	---
Burst (Hydrostatic)	---	10
BTCA (Reduced)	4	---
Totals	44	10

NOTE 1: Fully functional munitions suitable for dynamic firing.

NOTE 2: Live munitions contain all safety critical components. The may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 3: Munitions containing live rocket motor. May contain mass simulants to replace components that are unrelated to the rocket motor firing (e.g., guidance, control, other energetics, other pressure vessels). Configurations may vary according to particular test objectives.

B4.1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS FOR EMPIRICAL S3 TEST PROGRAM WITH REDUCED BTCA

A total of 44 live munitions and 10 inert motor cases are to be subjected to sequential environmental tests. The live munitions may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives. Upon completion of the environmental tests, the test assets are divided into three groups and tested further as follows:

a. Four live munitions are subjected to the reduced set of BTCA requirements which includes all BTCA requirements in Annex E except for the detailed chemistry requirements in Paragraphs E2.7.2 through E2.7.6 of Annex E. Based on the results of the modified BTCA, more extensive chemical analysis may be required.

b. Rocket motors from twenty munitions are static fired.

c. Twenty munitions are dynamic fired as complete rounds.

d. Ten inert motor cases are burst tested.

B4.2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL SAFETY TESTS FOR EMPIRICAL S3 TEST PROGRAM WITH REDUCED BTCA

A total of 73 test assets including 15 live munitions, three inert munitions, four warheads, up to 51 sets of EID/ESADs, and additional munitions and/or munition components for Operational and Maintenance, Hazard Classification, and Insensitive Munitions testing will be required for the following non-sequential safety tests:

a. Three (3) live munitions for 12 meter Logistic Drop.

b. One (1) live munition for Shipboard UNDEX Safety Shock.

c. Five (5) live munitions for 2.1 meter Unpackaged Safety Drop (if required).

d. Five (5) live munitions for 2.1 meter Packaged Safety Drop (if required).

e. One (1) live and 3 inert munitions for use with 51 ea EID/ESADs required for E3 assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESADs must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

(1) One (1) live munition and 1 inert munition with 20 live sets of EID/ESADs for Lightning Hazard.

(2) One (1) inert munition (no fill/energetics) capable of disassembly/reassembly without damage with instrumented EID/ESAD empty-inert with bridge intact and exposed for HERO Tests.

(3) One (1) inert munition with 30 live sets of EID/ESADs for ESD Tests (20 for personnel and 10 for helicopter-borne ESD).

f. Additional inert munitions may be required for Operational and Maintenance Review as described in Annex H, Appendix 3.

g. Additional live munitions will be required for Hazard Classification Testing per STANAG 4123 and AASTP-3.

h. Additional live munitions will be required for Insensitive Munitions Tests per STANAG 4439 and AOP-39.

i. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

j. Four modified munitions are subjected to warhead arena trials.

k. Additional test assets may be required for fuze S3 testing per STANAGs 4187 and 4157, and AOP-20.

l. Additional test assets may be required for Aircraft Integration and Safety of Flight testing.

m. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.

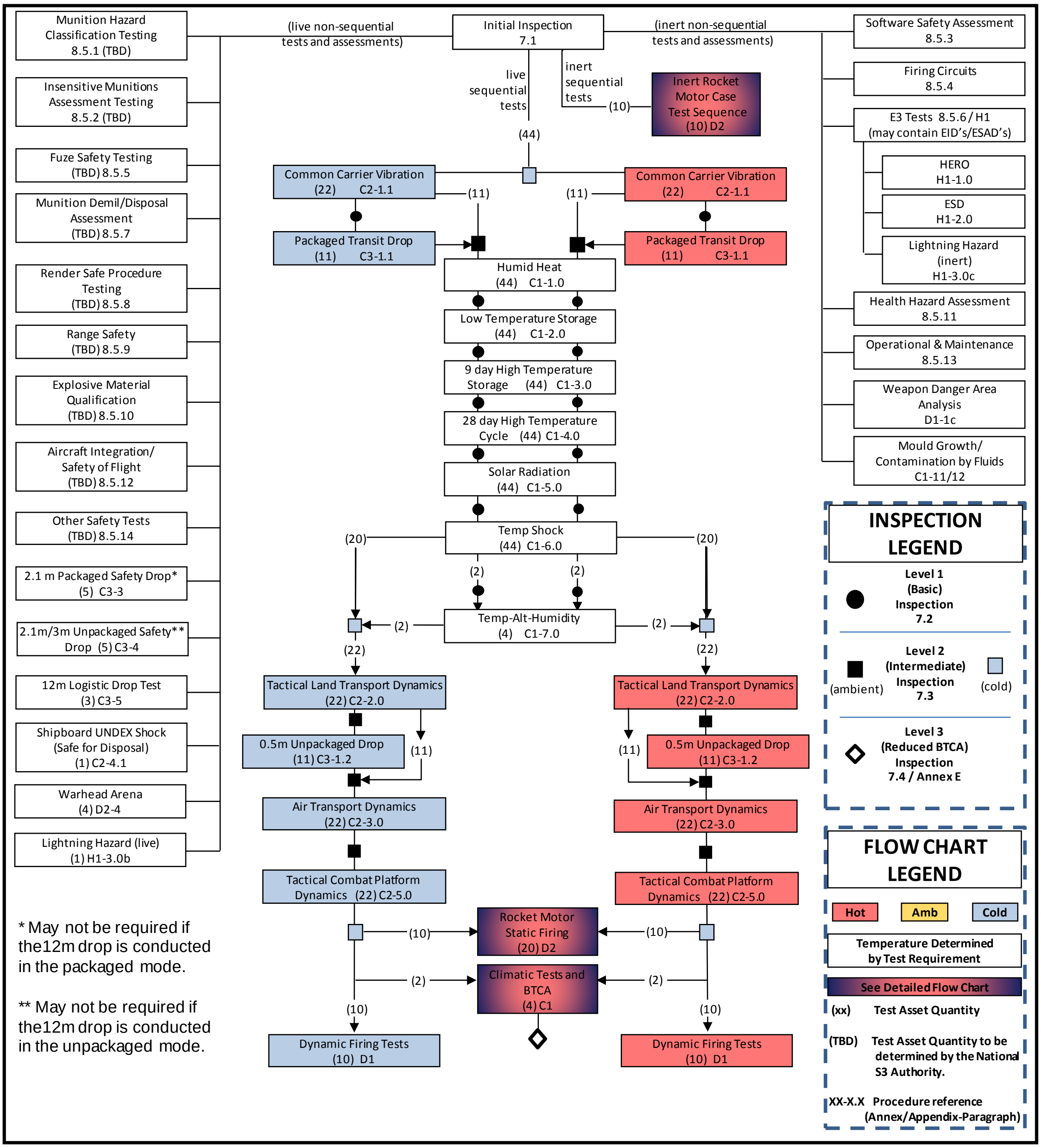
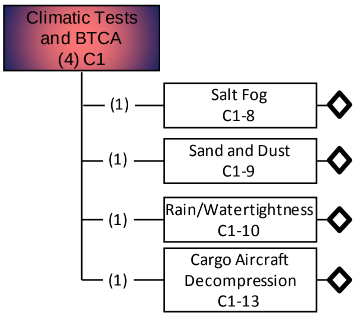


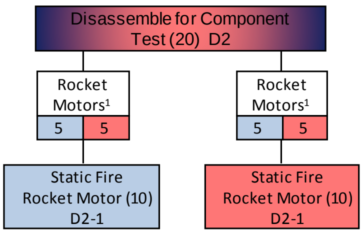
Figure B4-1: Overal Test Flow Chart for Empirical S3 Test Program With Reduced BTCA (see paragraph 8.2)

CLIMATIC TESTS AND FULL BTCA



◇For this reduced BTCA test flow, a modified BTCA may be conducted by eliminating the detailed chemistry requirements in Paragraphs 2.7.2-2.7.6 of Annex E. Based on the results of the modified BTCA, more extensive chemical analysis should be conducted.

COMPONENT TEST FLOW



Note 1: Live rocket motors in this flow may be evaluated through alternative operational tests such as dynamic firings or sled tests if motor pressure can be recorded during the test.

ROCKET MOTOR CASE TEST SEQUENCE

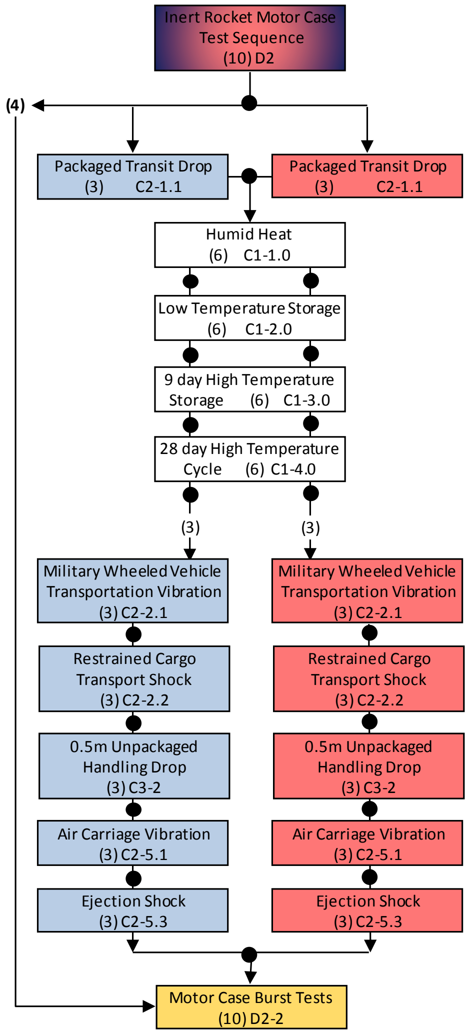


Figure B4-2: Detailed Test Flow Charts for Empirical S3 Test Program With Reduced BTCA

Table B4-3: Sequential Test Round Allocation Table for Empirical S3 Test Program with Reduced BTCA

		Munition number (Live Munitions)												Motor Case Sequence (Inert)									
Test serial	Annex/App/Para	1	2	3-7	8-12	13-17	18-22	23	24	25-29	30-34	35-39	40-44	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	c	c	c	c	c	c										
Packaged transit drop	C/3/1	h		h		h		c		c		c		h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x										
Thermal Shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x										
Temperature-Altitude-Humidity	C/1/7	x	x					x	x														
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Tactical Land Transport Dynamics	C/2/2	h	h	h	h	h	h	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
0.5m Unpackaged drop	C/3/2		h	h	h				c	c	c			h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a	a	a				a	a	a			a	a	a	a	a	a				
Air Transport Dynamics	C/2/3	h	h	h	h	h	h	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a										
Fixed Wing Captive Carriage Vibration	C/2/5.1	h	h	h	h	h	h	c	c	c	c	c	c	h	h	h	c	c	c				
Rotary Wing Captive Carriage Vibration	C/2/5.2	h	h	h	h	h	h	c	c	c	c	c	c	h	h	h	c	c	c				
Gunfire Shock	C/2/5.3	h	h	h	h	h	h	c	c	c	c	c	c										
Ejection Shock	C/2/5.4	h	h	h	h	h	h	c	c	c	c	c	c	h	h	h	c	c	c				
Adjacent Weapon Launch Shock	C/2/5.5	h	h	h	h	h	h	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Salt fog	C/1/8								x														
Sand & dust	C/1/9		x																				
Rain/Watertightness	C/1/10	x																					
Cargo Aircraft Decompression	C/1/13							a															
Level 3 Inspection (Reduced BTCA)	7.4	a	a					a	a														
Dynamic firing	D/1/1			h			h			c			c										
Rocket Motor Static Firing	D/2/1				h	c					c	h											
Rocket Motor Burst	D/2/2													a	a	a	a	a	a	a	a	a	a

Key:

a = ambient test/firing/assessment
c = cold conditioned test/firing/assessment
h = hot conditioned test/firing/assessment
x = test temperature defined in test

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ANNEX B TEST PROGRAM FOR AIRCRAFT LAUNCHED MUNITIONS
APPENDIX 5. WORKED EXAMPLE OF TEST TAILORING FOR AN AIRCRAFT LAUNCHED ROCKET.

B5.1. INTRODUCTION

The text below gives a worked example showing how the test quantities can be tailored given a specific set of circumstances. It is not to be used as the definitive test quantities set or as a substitute for those quantities provided in Annex B. As stated in paragraph 6.3, deviations from the S3 assessment testing program shall be approved by National S3 Authority(ies) or other appropriate Authorities prior to the start of testing. For the purpose of this worked example, it is assumed that the appropriate S3 Authority(ies) would have reviewed and approved the design assessment as it relates to test requirements below.

B5.2. TEST QUANTITIES TAILORING - WORKED EXAMPLE

B5.2.1. Example System Description

For the purposes of this example an S3 test program is to be conducted for a previously fielded 2.75 inch rocket with a new warhead. The modifications include changes to the main charge fill and the warhead case, but the fuze and booster components remain unchanged, as do the rocket motor, the overall mass, center of gravity, structural design, and the seals and interfaces between the sections of the rocket. The anticipated user environment is also unchanged. In addition, the main charge fill energetic material has been qualified in accordance with AOP-7.

B5.2.2. Defining the S3 Test Program

B5.2.2.1. S3 Test Approach

Dynamic firings for low cost rockets are an efficient means of demonstrating that the munition is safe for use following sequential environmental testing. In addition, dynamic firings provide exposure to the launch shock and free flight vibration environment without the cost of laboratory shock and vibration testing. For these reasons, the empirical test approach (Annex B, Appendix 3) is selected for this 2.75 inch rocket.

B5.2.2.2. BTCA Option

In order to provide detailed inspection of the warhead case and chemical analysis of the warhead energetic material following the sequential environmental tests, the full BTCA option is selected.

B5.2.3. Tailoring of Test Asset Configuration

Non-Tactical Components: The test assets may include inert rocket motor and other non-tactical components if those components have previously completed S3 testing with the exception that fully functional components will be required for the dynamic firing test assets. Any non-tactical mass simulants are required to have thermal, structural, and dynamic characteristics similar to the tactical hardware.

B5.2.4. Sequential Environmental Trial and Operation Test Tailoring Considerations

B5.2.4.1. Reduction in Climatic Test Requirements

Immersion, Salt Fog, Sand and Dust, Rain/Watertightness, and Altitude tests may be eliminated since no changes to the weapon seals have been made.

B5.2.4.2. Reduction in BTCA Test Requirements

BTCA is an underpinning principle of S3 testing and analysis since this provides significant information in respect to residual safety margins. Furthermore, BTCA data obtained as part of a S3 program can also form the body of evidence to be used during subsequent In-Service Surveillance activities. Additionally, some Nations place greater emphasis on the results of BTCA than other tests. For these reasons BTCA cannot be eliminated from any S3 program, but there is rationale for reducing the quantity based on confidence from prior field experience, a good understanding of the energetic material used in the main charge fill, and a design assessment of the new warhead. However, four assets (two hot / two cold) are considered to be the minimum number required to provide adequate material for the AOP-7 testing, and so in this example, the number of assets cannot be reduced. Nevertheless, BTCA is only required for the new component (i.e., warhead).

B5.2.4.3. Elimination of Static Firing Test for the Rocket Motor and Other Energetic Components

These firings may be eliminated since the rocket motor and other energetic are unchanged and the changes to the warhead are assessed not to affect the results of these tests. However, tests of the warhead will still be required.

B5.2.4.4. Reduction in Dynamic Firing Test Requirements

Dynamic firings should not be eliminated, but the quantities may be reduced based on confidence from prior field experience, developmental tests, and static firing data. Minimum quantities for this example are five hot/five cold for dynamic firing. As the fuze, booster, and rocket motor are not being evaluated in this test, it is acceptable to assemble the environmentally stressed warheads into otherwise unstressed rockets.

B5.2.4.5. Elimination of Rocket Motor Case and Other Pressure Vessel Burst Integrity Test Requirements

These tests may be eliminated since the rocket motor is unchanged.

B5.2.5. Non-Sequential Test Tailoring Considerations

B5.2.5.1. Reduction in 12 m Logistic Safety Drop Test Asset Quantity

Since the full system has been previously qualified, only one missile with a live warhead (non-tactical rocket motor, guidance, and seeker) is required. This drop needs to be in the worst case orientation for the warhead.

B5.2.5.2. Reduction in 2.1 m Unpackaged Drop Test Asset Quantity

Since the full system has been previously qualified, only one missile with a live warhead (non-tactical rocket motor, guidance, and seeker) is required. This drop needs to be in the worst case orientation for the warhead.

B5.2.5.3. Consideration of UNDEX Test Requirements

UNDEX testing at the 'safe for disposal' level will be required on one rocket with a live warhead, but inert components may be used in place of the rocket motor, fuze, and booster.

B5.2.5.4. Consideration of HERO, ESD, and Lightning Hazard Test Requirements

Tailoring of these tests may occur since no changes have been made to electrical or electronic components. A HERO analysis can be performed in place of a HERO test since no changes to the firing circuit, cable bonding/grounding, weapons external envelope, or carrying platform has occurred. ESD testing for personnel-borne can be eliminated based on the changes, however, helicopter-borne testing will still be required. Lightning Hazard will be similar to ESD in that near strike testing could be eliminated but direct strike would need to occur.

B5.2.5.5. Elimination of Operational and Maintenance Review Requirements

Since no changes have been made to the overall characteristics, the environmental requirements or operational usage of the rocket, there is no requirement to repeat the operational and maintenance review.

B5.2.5.6. Consideration of Hazard Classification Test Requirements

Appropriate munition hazard classification testing shall be conducted in accordance with STANAG 4123 and AASTP-3. The detailed requirements for testing including the need for live warhead only or all live energetic components will be based on advice from the appropriate National Authorities.

B5.2.5.7. Consideration of Insensitive Munitions Test Requirements

Appropriate IM assessment testing shall be conducted in accordance with STANAG 4439 and AOP-39. The detailed requirements for testing including the need for live warhead only or all live energetic components will be based on advice from the appropriate National Authorities.

B5.2.5.8. Consideration of Warhead Arena Trial Requirements

There is no basis on which to reduce the number of assets required for the warhead arena trial and so the full quantity of four assets will be used. However, if suitable evidence is available from Design Authority development trials it may be possible to read across and so eliminate additional warhead arena trials.

B5.2.5.9. Elimination of Fuze Test Requirements

Since no changes have been made to the fuze and no changes have been made to the rocket that would affect fuze arming, the results from the original S3 trials may be read across.

B5.2.5.10. Elimination of Fluid Contamination and Mold Growth Test Requirements

These tests may be eliminated since no changes to the structural components or weapon seals have been made.

B5.3. TAILORED TEST PROGRAM

a. Based on the preceding discussion, the following test assets may be reduced from the sequential tests from the S3 Test Flow:

(1) Ten (10) live assets assigned to static firings.

(2) Ten (10) inert assets assigned to motor burst tests.

b. This effectively removes 10 live munitions and 10 inert munitions from the 34 munition sequential test program shown in Table B5-1, leaving just 14 weapons as shown in Table B5-2.

c. Additionally, the following assets may be reduced from the non-sequential tests:

(1) Two (2) live logistic drop assets.

(2) One (1) live unpackaged safety drop asset.

(3) Fifty-one (51) each EID/ESADs required for E3 assessment tests.

(4) One (1) live and 3 inert munitions for use with the 51 ea EID/ESADs required for E3 assessment tests.

(5) Inert munitions for the operational and maintenance review.

(6) Live fuze testing assets.

(7) Fluid contamination and mold growth test assets.

Table B5-1: Aircraft Launched Rocket Example – Tailored from Empirical Approach With Full BTCA

		Munition number (Live Munitions)																								Motor Case Sequence (Inert)									
Test serial	Annex/App/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Packaged transit drop	C/3/1	h		h	h	h					h	h		c		c	c	c					c	c		h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Thermal Shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Temperature-Altitude-Humidity	C/1/7	x	x											x	x																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Tactical Land Transport Dynamics	C/2/2	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a				
0.5m Unpackaged drop	C/3/2		h		h	h		h	h	h	h				c		c	c		c	c	c	c												
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a		a	a		a	a	a	a				a		a	a		a	a	a	a			a	a	a	a	a	a				
Air Transport Dynamics	C/2/3	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a										
Tactical Combat Platform Dynamics	C/2/5	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	a	a	a	a	a	a				
Salt fog	C/1/8														x																				
Sand & dust	C/1/9		x																																
Rain/Watertightness	C/1/10	x																																	
Cargo Aircraft Decompression	C/1/13													a																					
Level 3 Inspection (Full BTCA)	7.4	a	a											a	a																				
Dynamic firing	D/1/1				h		h		h		h		h				c		c		c		c		c										
Rocket Motor Static Firing	D/2/1			h		h		h		c		c				c		c		c		h		h											
Rocket Motor Burst	D/2/2																									a	a	a	a	a	a	a	a	a	a

Key:

a = ambient test/firing/assessment
c = cold conditioned test/firing/assessment
h = hot conditioned test/firing/assessment
x = test temperature defined in test
[hatched box] = eliminated through tailoring

Table B5-2. Final Tailored Sequential Tests – Aircraft Launched Rocket Example

		Munition number (Live Munitions)													
Test serial	Annex/App/Para	1	2	4	6	8	10	12	13	14	16	18	20	22	24
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C/2/1.1	h	h	h	h	h	h	h	c	c	c	c	c	c	c
Packaged transit drop	C/3/1	h		h			h		c		c			c	
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Humid heat	C/1/1	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Low temperature storage	C/1/2	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature cycling	C/1/3	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature storage	C/1/4	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Solar radiation	C/1/5	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thermal Shock	C/1/6	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Temperature-Altitude-Humidity	C/1/7	x	x						x	x					
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Tactical Land Transport Dynamics	C/2/2	h	h	h	h	h	h	h	c	c	c	c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a
0.5m Unpackaged drop	C/3/2		h	h		h	h			c	c		c	c	
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3		a	a		a	a			a	a		a	a	
Air Transport Dynamics	C/2/3	h	h	h	h	h	h	h	c	c	c	c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Tactical Combat Platform Dynamics	C/2/5	h	h	h	h	h	h	h	c	c	c	c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Level 3 Inspection (Full BTCA)	7.4	a	a						a	a					
Dynamic firing	D/1/1			h	h	h	h	h			c	c	c	c	c

<u>**Key:**</u> a = ambient test/firing/assessment h = hot conditioned test/firing/assessment
c = cold conditioned test/firing/assessment x = test temperature defined in test

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ANNEX C. ENVIRONMENTAL TEST DESCRIPTIONS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

This annex provides descriptions of all of the environmental (climatic and dynamic) tests required in the S3 Test Programs included in Annex B. Appendix 1 contains the climatic test descriptions; Appendix 2 contains the dynamic test descriptions except for drop test, which are included in Appendix 3. Rationales for all environmental tests are provided in Annex A.

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ANNEX C. ENVIRONMENTAL TEST DESCRIPTIONS
APPENDIX 1. CLIMATIC TESTS

C1.1. HUMID HEAT (HOT HUMID CYCLE)

Perform Aggravated Humidity testing in accordance with AECTP 300, Method 306, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level: AECTP 300, Method 306, Figure 1 ‘Aggravated Cycle (cycle 3)’.

c. Test Duration: Ten 24-hour cycles to be applied.

C1.2. LOW TEMPERATURE STORAGE

Perform Low Temperature testing in accordance with AECTP 300, Method 303, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level: Constant temperature of -51 °C.

c. Test Duration: 72 hours (3 days) continuous.

C1.3. HIGH TEMPERATURE STORAGE

Perform High Temperature testing in accordance with AECTP 300, Method 302, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Levels:

(1) Munitions that do not contain temperature sensitive energetic materials: Constant temperature of 71 °C for 216 hours (9 days).

(2) Munitions that contain energetic materials that are temperature sensitive (e.g., explosives based on TNT, or double/triple base propellants): Constant temperature of 58 °C for 456 hours (19 days).

C1.4. HIGH TEMPERATURE CYCLE

Perform High Temperature testing in accordance with AECTP 300, Method 302, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level: AECTP 300, Method 302, Table 1 ‘High Temperature Diurnal Cycles’ Category A1 Induced Conditions (Temperatures: +33 °C to +71 °C).

c. Test Duration: 28 diurnal (24-hour) cycles to be applied.

C1.5. SOLAR RADIATION

Perform Solar Radiation testing in accordance with AECTP 300, Method 305, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level: AECTP 300, Method 305, Figure 1 ‘Cycling Test’ Category A1 (Temperatures: 32 °C to 49 °C. Irradiance: 0W/m^2 to 1120W/m^2).

c. Test Duration: Seven 24-hour solar cycles to be applied.

C1.6. THERMAL SHOCK

Expose all munitions to the high- and low-temperature phases of the temperature shock tests in accordance with AECTP 300, Method 304, Procedure 1 and as described below. Munitions are tested in their unpackaged configuration.

C1.6.1. Rotary Wing Aircraft Munitions

Perform Thermal Shock testing in accordance with AECTP 300, Method 304, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level:

(1) Low Temperature Shock Test: 21 °C to -46 °C.

(2) High Temperature Shock Test: Unpackaged SRE temperature to -5 °C.

c. Test Duration: Five cycles of both the low and high temperature shock tests (10 shocks in total). The munitions are to remain in each test chamber until temperature stabilization is achieved (24 hours maximum for unpackaged munitions). Transition time between temperature extremes shall be less than 5 minutes.

C1.6.2. FIXED WING AIRCRAFT MUNITIONS

Perform Thermal Shock testing in accordance with AECTP 300, Method 304, Procedure II using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Level: Temperature Shock Test: Unpackaged SRE temperature to -55 °C.

c. Test Duration: Ten cycles of temperature shock tests between high and low extremes. The munitions are to remain in each test chamber until temperature stabilization is achieved (24 hours maximum for unpackaged munitions). Transition time between temperature extremes shall be less than 5 minutes.

C1.7. TEMPERATURE-ALTITUDE-HUMIDITY

Expose all designated munitions to ten cycles of combined temperature-altitude-humidity tests in accordance with AECTP 300, Method 317, Procedure II using the parameters provided below. Figure C1-1 illustrates one cycle of the Temperature Altitude Humidity Test to be conducted on unpackaged munitions. Test parameters are highly dependent on the tactical mission profile, which include air speed, rate of climb or descent, atmospheric temperature, and air humidity at low altitude. These parameters should be tailored for the intended aircraft platform(s). In the absence of data, the default values provided in Table C1-1 may be applied for munitions deployed on rotary wing and the default values provided in Table C1-2 may be applied for munitions deployed on fixed wing aircraft:

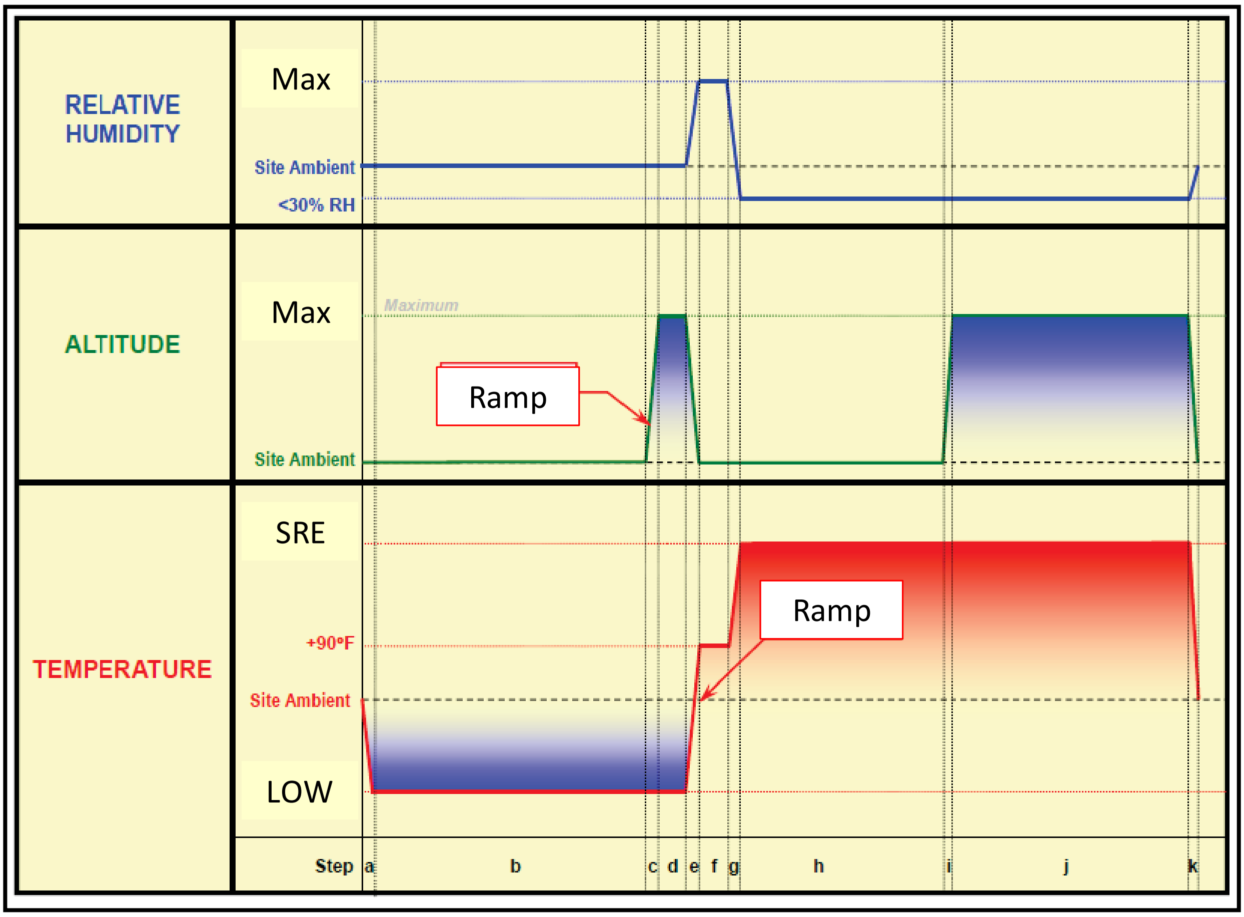

Figure C1-1: Temperature Altitude Humidity Cycle (General)

C1.7.1. Rotary Wing Aircraft Munitions

The default test levels provided in Table C1-1 describe the conditions for each step of the Temperature-Altitude-Humidity Cycle in Figure C1-1. These default conditions are based on the following test parameters for munitions deployed on rotary wing aircraft:

a. Low Temperature extreme: -32 °C.

b. High Temperature extreme: Unpackaged SRE temperature.

c. Temperature ramp rate: 5 °C/min.

d. Humidity: 30-95%.

e. Humidity change rate: Facility maximum.

f. Altitude: 6,400 m.

g. Altitude ramp rate: 762 m/min.

Table C1-1: Temperature/Altitude/Humidity Test Matrix for Rotary Wing Aircraft Munitions

STEP	TIME (minutes)	TEMPERATURE[2]	ALTITUDE[2]	RELATIVE HUMIDITY (%)[2]
a	Maximum Temp Rate	Ramp ≥5 °C/min	Site	Ambient
b	240[1]	Minimum Operating Temp -32 °C	Site	Ambient
c	Maximum Climb Rate	Minimum Operating Temp -32 °C	Ramp	Ambient
d	30	Minimum Operating Temp -32 °C	6,400 m	Ambient
e	Maximum Descent Rate	Ramp ≥ 5 °C/min	Ramp	Ramp
f	30	32 °C	Site	95
g	Maximum Temp Rate	Ramp ≥ 5 °C/min	Site	Ramp
h	120[1]	Maximum Operating Temp, (Unpackaged SRE Temp)	Site	<30
i	Maximum Climb Rate	Maximum Operating Temp, (Unpackaged SRE Temp)	Ramp	<30
j	240[1]	Maximum Operating Temp, (Unpackaged SRE Temp)	6,400 m	<30
k	Maximum Descent Rate	Ramp ≥ 5 °C/min	Ramp	Ramp

NOTE 1: Allow sufficient time for stabilization of munition temperature. Actual test times may vary.

NOTE 2: Ramp rates are subject to facility limitations.

Table C1-2: Temperature/Altitude/Humidity Test Matrix for Fixed Wing Aircraft Munitions

STEP	TIME (minutes)	TEMPERATURE[2]	ALTITUDE[2]	RELATIVE HUMIDITY (%)[2]
a	Maximum Temp Rate	Ramp $\geq$10 °C/min	Site	Ambient
b	240[1]	Minimum Operating Temp -54 °C	Site	Ambient
c	Maximum Climb Rate	Minimum Operating Temp -54 °C	Ramp	Ambient
d	30	Minimum Operating Temp -54 °C	16,000 m	Ambient
e	Maximum Descent Rate	Ramp $\geq$10 °C/min	Ramp	Ramp
f	30	+32 °C	Site	95
g	Maximum Temp Rate	Ramp $\geq$10 °C/min	Site	Ramp
h	120[1]	Maximum Operating Temp, (Unpackaged SRE Temp)	Site	<30
i	Maximum Climb Rate	Maximum Operating Temp, (Unpackaged SRE Temp)	Ramp	<30
j	240[1]	Maximum Operating Temp, (Unpackaged SRE Temp)	15,860 m	<30
k	Maximum Descent Rate	Ramp $\geq$10 °C/min	Ramp	Ramp

NOTE 1: Allow sufficient time for stabilization of munition temperature. Actual test times may vary.

NOTE 2: Ramp rates are subject to facility limitations.

C1.7.2. Fixed Wing Aircraft Munitions

The default test levels provided in Table C1-2 describe the conditions for each step of the Temperature-Altitude-Humidity Cycle in Figure C1-1. These default conditions are based on the following test parameters for munitions deployed on fixed wing aircraft:

a. Low Temperature extreme: -54 °C.

b. High Temperature extreme: Unpackaged SRE Temperature.

c. Temperature ramp rate: Facility maximum, $\geq$10 °C/min.

d. Humidity: 30-95%.

e. Humidity change rate: Facility maximum.

f. Altitude: 16,000 m.

g. Altitude ramp rate: 15,250 m/min.

C1.8. SALT FOG

Perform Salt Fog testing in accordance with AECTP 300, Method 309 using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Test Levels: Use default parameters as specified in AECTP 300, Method 309.

c. Test Duration: Two alternating 48 hour wet-dry cycles (48 hrs/cycle).

C1.9. SAND AND DUST

Perform Sand and Dust testing in accordance with AECTP 300, Method 313, Procedures I (Blowing Dust) and II (Blowing Sand) using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Conditioning Temperature: Munitions are to be preconditioned to a temperature of 49 °C prior to exposure.

c. Test Levels:

(1) Wind Blown Dust: Use default parameters as specified in AECTP 300, Method 313, Procedure I.

(2) Wind Blown Sand:

(a) For munitions installed on helicopters, use default parameters as specified in AECTP 300, Method 313, Procedure I for material that may be used near helicopters (sand concentration = 2.2±0.5 g/m^3; wind velocity = 18 to 30 m/s).

(b) For munitions installed only on fixed wing aircraft, use default parameters as specified in AECTP 300, Method 313, Procedure II for material that may be used near operating surface vehicles (sand concentration = 1.1±0.3 g/m^3; wind velocity = 18 to 30 m/s).

d. Test Duration: Apply default parameters as specified in AECTP 300, Method 313. Note that it is recommended to conduct the sand and dust tests individually.

C1.10. RAIN/WATERTIGHTNESS

Perform Rain/Watertightness testing in accordance with AECTP 300, Method 310, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions.

b. Conditioning Temperature: Munitions are to be preconditioned to a temperature of 10 °C above the water temperature.

c. Test Levels: Rainfall rate = 100 mm/hour. Wind velocity = 18 m/s.

d. Test Duration: 2 hours.

C1.11. MOLD GROWTH

Perform per AECTP 300, Method 308 on the munition in the unpackaged configuration for a minimum of 28 days. This test should be conducted as a non-sequential test.

C1.12. CONTAMINATION BY FLUIDS

Perform per AECTP 300, Method 314 on the munition in the unpackaged configuration. Test requirements are to be tailored according to the materials on the test article. This test should be conducted as a non-sequential test.

C1.13. CARGO AIRCRAFT DECOMPRESSION

Perform Rapid Decompression testing in accordance with AECTP 300, Method 312, Procedure III using the following test parameters:

a. Munition Configuration: Packaged munitions.

b. Conditioning Temperature: Munitions are to be preconditioned to laboratory ambient temperature.

c. Pressures: Initial pressure = 60 kPa. Final pressure = 18.8 kPa.

d. Decompression Time: No longer than 15 seconds.

ANNEX C. ENVIRONMENTAL TEST DESCRIPTIONS
APPENDIX 2. DYNAMIC TESTS

This annex contains all dynamic test descriptions except for drop tests, which are described in Annex C, Appendix 3.

C2.1. LOGISTIC LAND TRANSPORTATION DYNAMICS - COMMERCIAL

Commercial (Common Carrier) Transportation Vibration. Perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: Packaged or palletized unit of issue. Note that unit of issue may include separately packaged components.

b. Test Level: AECTP 400, Method 401, Figure A-1 ‘Ground Wheeled Common Carrier’.

c. Test Duration: Test duration is equivalent to the distance specified in AECTP 100, Annex E, Appendix 1 for transportation by ‘Land Commercial Vehicle’ for Air Launched Missiles and Aircraft Bombs.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

Note: Although the Common Carrier vibration environment is relatively benign compared to other wheeled vehicle vibration environments, the test should not be tailored out due to the intent of loosening up the test munitions prior to conduct of temperature and humidity tests.

C2.2. LOGISTIC LAND TRANSPORTATION DYNAMICS - MILITARY

For aircraft launched munitions, military land transportation dynamics addresses the mechanical environments that may be encountered during military transportation by wheeled vehicles (as restrained and loose cargo). When testing for wheeled vehicle, there is effectively a vibration and a shock element. Both the wheeled vehicle transportation vibration and retrained cargo shock tests must be completed in order to satisfy the S3 objectives for Logistic Land Transportation Dynamics for Military Vehicles.

C2.2.1. Military Wheeled Vehicle (Tactical/Composite Wheeled Vehicle) Transportation Vibration

Perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: This test should be conducted on individual munitions in military transport and tie-down configuration. For systems that may be transported in or out of the transport container, the test duration should be split with half of the test duration packaged in the transport container and half of the test duration unpackaged.

b. Test Level: AECTP 400, Method 401, Figure A-2 'Tactical Wheeled Vehicle - All Terrain'.

c. Test Duration.

(1) Fixed Wing Aircraft Munitions: Test duration is equivalent to 2% of the distance specified in AECTP 100, Annex E, Appendix 1 for transportation by 'Land Military Vehicle' for either Air Launched Missile or Aircraft Bomb, but no less than 200 km. Based on the current versions of AECTP 100 and 400, the test duration is 10 minutes/axis as calculated in Table A-2.

(2) Rotary Wing Aircraft Munitions: Test duration is equivalent to 8% of the distance specified in AECTP 100, Annex E, Appendix 1 for transportation by 'Land Military Vehicle' for Air Launched Missile, but no less than 800 km. Based on the current versions of AECTP 100 and 400, the test duration is 40 minutes/axis as calculated in Table A-2.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C2.2.2. Restrained Cargo Transport Shock

Perform shock testing in accordance with AECTP 400, Method 403 using the following test parameters:

a. Munition Configuration: This test should be conducted on individual munitions in military transport and tie-down configuration. For systems that may be transported in or out of the transport container, the test duration should be split with half of the test duration packaged in the transport container and half of the test duration unpackaged.

b. Test Level: All shocks stated in Table C2-1 shall be applied in each sense of each orthogonal axis. The shocks may be applied as either half-sine pulses or a single decaying sinusoidal pulse encompassing both senses in each axis. Terminal peak sawtooth pulses or Shock Response Spectrum (SRS) methods may be substituted for the levels specified in Table C2-1 if it can be shown to produce equivalent velocities. AECTP 400, Method 417 provides guidance for SRS methods.

c. Number of Shocks: The required number of shock repetitions are stated in Table C2-1.

Table C2-1. Restrained Cargo Transport Shock Levels

HALF SINE PULSE		OR	DECAYING SINUSOID	
Duration 5 ms			Frequency (F): 100 Hz Duration (T): 0.37 s (Number of Complete Cycles (N): 37) Damping Factor: 3% of critical	
Amplitude (g pk)	Number of Shocks[1,2]		Amplitude of First Peak (g pk)	Number of Repetitions[1,2]
8.0	42		8.0	42
10.0	21		10.0	21
12.0	3		12.0	3

NOTE 1: Transport Distance Equivalence: 1000 km.

NOTE 2: All shocks to be applied in each sense of each orthogonal axis.

d. Test Temperature: Temperature condition the test munitions prior to, and during shock testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C2.3. LOGISTIC AIR TRANSPORTATION DYNAMICS - MILITARY

Military Air Transportation Dynamics addresses the mechanical environments that may be encountered during military transportation by fixed wing aircraft (propeller and jet), and helicopter. *All tests under these sections must be completed in order to satisfy the S3 objectives for Military Air Transportation unless the mode of transportation is not applicable to the munition under test.*

C2.3.1. Fixed Wing Aircraft Cargo Transportation Vibration

Fixed Wing Aircraft Transportation includes both Turboprop and Jet Aircraft Vibration as described in the following paragraphs.

C2.3.1.1. Cargo Aircraft Transportation Vibration - Turboprop Aircraft

Perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: AECTP 400, Method 401, Figure C-1 'Propeller Aircraft' for C130K (4-blade, f0=68 Hz) and C130J (6 blade, f0=102 Hz), with L0 = 1.2g2/Hz for f0. Other aircraft types may be added if their fundamental blade passing frequencies (f0 component) are known.

c. Test Duration: The test should be conducted for a total test duration equivalent to the flight duration specified in AECTP 100, Annex E, Appendix 1 for transportation by 'Turboprop Aircraft' for either Air Launched Missiles or Aircraft Bombs. Based on the current versions of AECTP 100 and 400, the test duration is 1 hour/axis as calculated in Table A-3. The test duration for a stated axis should be split such that each set of blade passing frequencies are addressed equally. (For C130 only, this would require the total test duration to be divided equally between the two blade passing frequencies of 68 Hz and 102 Hz).

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C2.3.1.2. Cargo Aircraft Transportation Vibration - Jet Aircraft

Perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: AECTP 400, Method 401, Figure C-2 'Jet Aircraft Cargo - Takeoff'.

c. Test Duration: The test should be conducted for a total test duration equivalent to the flight duration specified in AECTP 100, Annex E, Appendix 1 for transportation by 'Jet Aircraft' for either Air Launched

Missiles or Aircraft Bombs. Since the test level is for the take-off environment only, the test duration is based on the number of flights. To derive appropriate test durations, apply an average flight time of 10 hours per transport to determine the appropriate number of take-off events. Based on the current versions of AECTP 100 and 400, the test duration is 20 min/axis as calculated in Table A-3.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C2.3.2. Helicopter Cargo Transportation Vibration

For munitions transported as cargo on Rotary Wing Aircraft, perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: AECTP 400, Method 401, Figure D-1 'Helicopter Cargo'. Fundamental blade passing frequencies (f1 component) of 11 Hz, 17 Hz, and 21 Hz should be used to address most transport helicopter types. Other aircraft types may be added if their fundamental blade passing frequencies (f1 component) are known.

c. Test Duration: The test should be conducted for a total test duration equivalent to the flight duration specified in AECTP 100, Annex E, Appendix 1 for transportation by 'Helicopter' for either Air Launched Missiles or Aircraft Bombs. Based on the current versions of AECTP 100 and 400, the test duration is 3.33 hours/axis as calculated in Table A-3. The total test duration for a stated axis should be split such that each set of blade passing frequencies are addressed equally.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C2.4. NAVAL TRANSPORTATION DYNAMICS

a. Military Sea Transportation Dynamics addresses the mechanical environments that may be encountered during transportation by military ships.

b. Shipboard Shock (UNDEX). Perform UNDEX testing in accordance with AECTP 400, Method 419 using the following test parameters:

(1) Munition Configuration: Packaged.

(2) Test Level: Test parameters are to be determined by National Authority to ensure Safe for Disposal requirements are met. Guidance can be found in NATO publications ANEP-43, STANAG 4549, and STANAG 4150.

(3) Test Temperature: Temperature condition the test munitions prior to, and during shock testing. Stabilize at 21 °C.

(4) This test should be conducted as a non-sequential test on a single tactical transportation package if the criteria is 'safe for disposal', or during the LCEP life cycle test sequence on selected munitions if the criteria is 'safe for use'.

C2.5. TACTICAL COMBAT PLATFORM DYNAMICS

Tactical Combat Platform Dynamics addresses the mechanical environments that may be encountered during deployment on the tactical combat platform. It is recommended that actual environments be measured and used to develop vibration and shock test criteria in accordance with AECTP 240-1 Leaflets 2410 and 249-1.

C2.5.1. Fixed Wing Captive Carriage Vibration

For munitions deployed on fixed wing aircraft, perform vibration testing in accordance with AECTP 400, Method 401, Procedure IV using the following test parameters:

a. Test Configuration: Attach the unpackaged munition to the shock exciter as appropriate to simulate captive carriage.

b. Test Level: Vibration test each munition in accordance with the vibration test schedule representative of the launcher location on the aircraft platform(s). Vibration specification development guidance is provided in AECTP 240-1 Leaflet 2410.

c. Test Duration: The required test duration is equivalent to 500 hrs of flight on fixed wing aircraft for air launched missiles, and 100 hrs of flight for aircraft bombs.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -55 °C, and all hot munitions to the unpackaged SRE temperature.

C2.5.2. Rotary Wing Captive Carriage Vibration

For munitions deployed on rotary wing aircraft, perform vibration testing in accordance with AECTP 400, Method 401, Procedure IV using the following test parameters:

a. Test Configuration: Attach the unpackaged munition to the shock exciter as appropriate to simulate captive carriage.

b. Test Level: Vibration test each munition in accordance with the vibration test schedule representative of the launcher location on the aircraft platform(s). Vibration specification development guidance is provided in AECTP 240-1 Leaflet 2410.

c. Test Duration: The required test duration is equivalent to 200 hrs of flight on rotary wing aircraft.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the unpackaged SRE temperature.

C2.5.3. Gunfire Shock

Perform shock testing in accordance with AECTP 400, Method 405, Procedure I using the following test parameters:

a. Test Configuration: Attach the unpackaged munition to the shock exciter as appropriate to simulate captive carriage.

b. Test Level: Test each munition to tailored time waveform replication traces representative of the launcher location on the aircraft platform(s).

c. Test Duration: The required test duration is equivalent to 500 hrs of flight for munitions on fixed wing aircraft, 200 hrs of flight for munitions on rotary wing aircraft, and 100 hrs of flight for aircraft bombs.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C (rotary wing)/-55 °C (fixed wing), and all hot munitions to the unpackaged SRE temperature.

C2.5.4 Ejection Shock

For munitions deployed on fixed wing aircraft, perform ejection shock testing in accordance with AECTP 400, Method 417, using the following test parameters:

a. Test Configuration: Attach the unpackaged munition to the shock exciter as appropriate to allow unrestrained dynamic response of the munition following the shock event.

b. Test Level: Shock test each munition to a tailored shock response spectrum (SRS) representative of the launcher location on the aircraft platform(s). SRS specification development guidance is provided in AECTP 240-1 Leaflet 249-1.

c. Number of Shocks: If this test is conducted using tactical launcher ejection hardware, one shock will be required. If the test is conducted using laboratory shock exciters, one ejection shock test should be conducted in both the vertical and lateral axes.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C (rotary wing)/ -55 °C (fixed wing), and all hot munitions to the unpackaged SRE temperature.

C2.5.5 Adjacent Weapon Launch Shock

Perform shock testing in accordance with AECTP 400, Method 417, using the following test parameters:

a. Test Configuration: Attach the unpackaged munition to the shock exciter as appropriate to simulate captive carriage.

b. Test Level: Shock test each munition to a tailored SRS representative of the launcher location on the aircraft platform(s). SRS specification development guidance is provided in AECTP 240-1 Leaflet 249-1. This test may be eliminated if determined to be sufficiently benign compared to other dynamic environments.

c. Number of Shocks: The required number of shocks is equivalent to 500 flight hours for missiles and 100 flight hours for bombs on fixed wing aircraft; 200 flight hours on rotary wing aircraft munitions.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C (rotary wing)/-55 °C (fixed wing), and all hot munitions to the unpackaged SRE temperature.

C2.6. MUNITION FLIGHT DYNAMICS

Munition Flight Dynamics addresses the mechanical environments that may be encountered during missile and rocket launch and flight. Test levels are to be tailored from measured data.

C2.6.1 Launch Shock

Launch shock should be conducted in accordance with AECTP 400, Methods 403 and 417 as appropriate; however, tailored test levels based on measured data will normally be used. Derive test severities in accordance with AECTP 240/Leaflets 2410 and 246.

a. Test Configuration. Attach the munition to the shock exciter as appropriate.

b. Test Level. The tailored test levels are typically specified as either a half-sine shock pulse or a shock response spectra in accordance with Method 417 (SRS).

c. Number of shocks. One shock each in the positive and negative longitudinal axes.

d. Test Temperature. Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C (rotary wing)/-55 °C (fixed wing), and all hot munitions to the unpackaged SRE temperature.

C2.6.2 Free Flight Vibration

Conduct free flight vibration testing in accordance with AECTP 400, Methods 401 and 421 as appropriate. Tailor test levels based on measured data. Test severities should be derived in accordance with AECTP 240/Leaflets 2410 and 246.

a. Test Configuration. Attach the munition to the vibration exciter as appropriate.

b. Test Level. The tailored test levels are typically specified as a random vibration profile in accordance with the test severity derived in accordance with AECTP 240/Leaflets 2410 and 246.

c. Test Duration. The test duration in each axis should be adequate to address the safe separation distance of the munitions from the aircraft.

d. Test Temperature. Test temperatures of 71 °C and -46 °C (rotary wing)/ -55 °C (fixed wing) are based on anticipated air carriage temperatures accounting for kinetic heating (hot) and carriage at high altitudes (cold). Half of the test quantity should be conducted hot and half cold.

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ANNEX C. ENVIRONMENTAL TEST DESCRIPTIONS
APPENDIX 3. DROP TESTS

This annex contains an overview of the S3 drop test requirements in Table C3-1 along with descriptions of each drop test.

Table C3-1. Drop Test Overview

<table>
<tr><th>Title</th><th>AAS3P-12 Reference</th><th>Test Standard Reference</th><th>Transport Mode</th><th>Config</th><th>Criteria</th><th>Default Drop Heights for Air Launched Munitions</th><th>Number of Assets</th><th>Drop Orientation Notes</th><th>Temperature</th></tr>
<tr><td>Packaged Transit Drop</td><td>Annex C, Appendix 3, Paragraph 1.1</td><td>AECTP 400 Method 414 and MIL-STD-810G Method 516 Table 516.7-VII</td><td>Logistic Transport</td><td>Packaged</td><td>Safe for Use</td><td>0.5-1.2m (Size/Weight Dependent)</td><td>Half of all Sequential Environmental Test Assets</td><td>5-26 orientations to be addressed (based on size/weight); orientations may be distributed over multiple assets</td><td>Packaged SRE or -46 °C</td></tr>
<tr><td>0.5m Unpackaged Handling Drop***</td><td>Annex C, Appendix 3, Paragraph 1.2</td><td rowspan="2">STANAG 4375, Procedure II and MIL-STD-810G Method 516 Table 516.7-VIII</td><td rowspan="2">Tactical Transport</td><td>Unpackaged</td><td>Safe for Use</td><td>0.5m</td><td>Half of all Sequential Environmental Test Assets</td><td rowspan="2">5 orientations to be addressed (1 per item)</td><td rowspan="2">Packaged SRE or -46 °C</td></tr>
<tr><td>2.1m Packaged Tactical Transport Drop</td><td>Annex C, Appendix 3, Paragraph 1.3</td><td>Packaged</td><td rowspan="4">Safe for Disposal</td><td>2.1m</td><td>5*</td></tr>
<tr><td rowspan="2">2.1m/3m Unpackaged Safety Drop</td><td rowspan="2">Annex C, Appendix 3, Paragraph 1.4</td><td rowspan="2">STANAG 4375, Procedure II and MIL-STD-810G Method 516 Table 516.7-IX</td><td>Rotary Wing Aircraft</td><td rowspan="2">Unpackaged</td><td>2.1m</td><td rowspan="2">5**</td><td rowspan="2">5 orientations to be addressed (1 per item)</td><td rowspan="2">Packaged SRE or -46 °C</td></tr>
<tr><td>Fixed Wing Aircraft</td><td>3m</td></tr>
<tr><td>12m Logistic Drop</td><td>Annex C, Appendix 3, Paragraph 1.5</td><td>STANAG 4375, Procedure I and MIL-STD-810G Method 516 Table 516.7-IX and MIL-STD-2105</td><td>Ship Transport</td><td>Unpackaged or Packaged per LCEP</td><td>12m</td><td>3</td><td>3 orientations (1 per item)</td><td>Ambient</td></tr>
<tr><td colspan="10">* May not be required if 12m drop is conducted in the packaged mode.
** May not be required if 12m drop is conducted in the unpackaged mode.
*** For missiles, this height and quantity may be expected to be tailored with sufficient rationale.</td></tr>
</table>

C3.1. PACKAGED TRANSIT DROP - SAFE FOR USE

Subject half of all sequential test munitions to the Packaged Logistic Transit Drop Test with criteria of Safe for Use. Table C3-2, from Edition 3 of AECTP 400, Method 414, Procedure 1, describes the logistic transit drop test requirements based on the weight and dimensions of the packaged munition. Perform the packaged transit drop test in accordance with the current edition of AECTP 400, Method 414, Procedure I using the following test parameters:

a. Munition Configuration: Packaged (primary packaging).

b. Test Level/Drop Orientation: The test levels and drop orientations in AECTP 400, Method 414, Procedure 1 are based on the weight and dimensions of the packaged munition. Table C3-2 (from AECTP 400, Edition 3) is provided for reference.

Table C3-2. Packaged Transit Drop Test

WEIGHT OF TEST ITEM AND CASE, kg (lb)	LARGEST DIMENSION, cm (inches)	SEE NOTES	DROP HEIGHT, cm, (inches)	NUMBER OF DROPS
Under 45 (100) Manpacked or transportable	< 91 (36)	1, 4	122 (48)	Drop on each face, edge, and corner. Total of 26 Drops
	≥ 91 (36)	1, 4	76 (30)	
45 to 90 (100 to 200) Inclusive	< 91 (36)	1	76 (30)	Drop on each corner. Total of 8 Drops
	≥ 91 (36)	1	61 (24)	
90 to 450 (200 to 1000) Inclusive	< 91 (36)	1	61 (24)	
	91 to 152 (36 to 60)	2	61 (24)	
	> 152 (60)	2	61 (24)	
Greater than 450 (1000)	No limit	3	46 (18)	Drop on each bottom edge and bottom face or skids. Total of 5 Drops.

Note 1: The test item shall be oriented so that upon impact a line from the centre of gravity of the test item to the point of impact is perpendicular to the impact surface.

Note 2: The longest dimension of the test item shall be parallel to the floor. The test item shall be supported at the corner of one end by a block 0.125 meter in height, and at the other corner along the same edge by a block 0.30 meter in height. The lowest opposite end of the test item shall be raised to the specific height at the lowest unsupported corner and allowed to fall freely.

Note 3: While in the normal position, the test item shall be subjected to the edgewise drop test as follows: If the normal transit position is unknown, the test item shall be so oriented that the two longest dimensions are parallel to the floor. One edge of the base of the test item shall be supported on a block 0.15 meter in height. The opposite edge shall be raised to the specific height and allowed to fall freely.

Note 4: The 26 drops may be divided among no more than five test items.

c. Test Temperature: Temperature condition the test munitions prior to testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature. The drop tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 30 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

C3.2. 0.5 METER UNPACKAGED HANDLING DROP - SAFE FOR USE

Subject half of all sequential test munitions to the Unpackaged Handling Drop Test with criteria of Safe for Use. Perform drop testing in accordance with STANAG 4375 Procedure 2 (Deployment Drop) using the following test parameters:

a. Munition Configuration: Unpackaged.

b. Test Level: The default drop height is 0.5 m onto a concrete supported steel surface. However, this height and quantity may be expected to be tailored for aircraft launched missiles since the 0.5 meter bare drop is likely to damage the test items to such a degree that it is determined that the round should not be loaded onto the aircraft. If there is a reasonable expectation of such damage, a separate subtest using inert assets should be used to determine a set of reduced-severity conditions of drop orientations and heights which will reduce the damage to the munition to a level where all or nearly all of the test items will be capable of being loaded and fired. After the subtest has determined an acceptable height, the remainder of the LCEP rounds will be tested at this height.

c. Drop Orientation: Each test munition is to be dropped once to impact in one of the following orientations (sample size should be sufficient to ensure that all orientations are addressed):

(1) Major axis horizontal.

(2) Major axis vertical, nose up / base down.

(3) Major axis vertical, nose down / base up.

(4) Major axis 45°, nose up / base down.

(5) Major axis 45°, nose down / base up.

d. Test Temperature: Temperature condition the test munitions prior to testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature. The drop tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 15 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

C3.3. 2.1 METER PACKAGED SAFETY DROP - SAFE FOR DISPOSAL

Subject 5 test munitions to the 2.1 meter Packaged Drop with criteria of Safe for Disposal. This test may not be required if the 12 meter Logistic Drop is successfully conducted in the packaged mode. Perform drop testing in accordance with STANAG 4375, Procedure 2 (Deployment Drop) using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: One drop of 2.1 meter onto a concrete supported steel surface.

c. Drop Orientations: Each package is to be dropped once to impact in the following orientations (sample size should be sufficient to ensure that all orientations are addressed):

(1) Major axis horizontal.

(2) Major axis vertical, nose up / base down.

(3) Major axis vertical, nose down / base up.

(4) Major axis 45°, nose up / base down.

(5) Major axis 45°, nose down / base up.

d. Test Temperature: Temperature condition the test munitions prior to testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature. The drop tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 30 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

e. Test munitions may be factory fresh (non-sequential) or may be selected from sequential environmental assets as the final test prior to component level testing as long as the condition of the asset following drop allows for sufficient data to be collected.

C3.4. 2.1 METER/3 METER UNPACKAGED SAFETY DROP - SAFE FOR DISPOSAL

Subject five test munitions to the Unpackaged Safety Drop Test with criteria of Safe for Disposal. This test may not be required if the 12 meter Logistic Drop is successfully conducted in the unpackaged mode. Perform drop testing in accordance with STANAG 4375, Procedure 2 (Deployment Drop) using the following test parameters:

a. Munition Configuration: Unpackaged.

b. Test Level: Single drop onto a concrete supported steel surface. Drop heights are combat platform specific or selected from the following default values:

(1) Rotary Wing Aircraft Munitions = 2.1 meters.

(2) Fixed Wing Aircraft Munitions = 3 meters.

c. Drop Orientation: Each test munition is to be dropped once to impact in the orientation considered most vulnerable by the National Authority. If multiple vulnerabilities are identified, then testing should be conducted to address each of these.

d. Test Temperature: Temperature condition the test munitions prior to testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature. The drop tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 15 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

e. Test munitions may be factory fresh (non-sequential) or may be selected from sequential environmental assets as the final test prior to component level testing as long as the condition of the asset following drop allows for sufficient data to be collected.

C3.5. LOGISTIC DROP (12 METER) - SAFE FOR DISPOSAL

Subject 3 test munitions to the Logistic Drop Test with a criteria of Safe for Disposal. Perform drop testing in accordance with STANAG 4375, Procedure 1 (Logistic Drop) using the following test parameters:

a. Munition Configuration: Aircraft launched munitions that are handled out of the shipping container while on naval vessels are required to be tested in the unpackaged mode. Other munitions may be tested in the packaged mode.

b. Test Level: One drop of 12 meter onto a concrete supported steel surface.

c. Drop Orientations: Each test munition to impact in one of the following orientations (sample size should be sufficient to ensure that all orientations are addressed):

(1) Major axis horizontal.

(2) Major axis vertical, nose up / base down.

(3) Major axis vertical, nose down / base up.

d. Test Temperature: Ambient.

ANNEX D. OPERATING TEST DESCRIPTIONS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

This annex provides descriptions of all of the firing and operating tests required in the S3 Test Programs included in Annex B. Rationale for these tests are provided in Annex A, Appendix 2.

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ANNEX D. OPERATING TEST DESCRIPTIONS
APPENDIX 1. FIRING SAFETY TESTS

Firing safety tests are performed upon completion of the sequential environmental tests. These tests are conducted remotely using a ground launcher with the munition temperature conditioned to the appropriate temperature. The low-temperature test items are to be temperature stabilized to -55 °C (fixed wing) or -46 °C (rotary wing) prior to performing the firing tests. The high-temperature test items are to be temperature stabilized to 63 °C or the unpackaged SRE temperature, whichever is higher, prior to performing the firing tests. Firing tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be 15 minutes.

D1.1. DYNAMIC FIRING

Dynamic firings are conducted from a ground launch station on an instrumented firing range to demonstrate that the munition is safe to launch (does not eject hazardous debris or detonate upon ignition), safely separates from the launch point, and travels at and explosively functions at trajectories which cause no additional hazards to the firing crew. Performance data shall be recorded but not used as acceptance criteria except as related to safety. Additional data is collected to support the Weapon Danger Area and Health Hazard Analyses.

a. Record launch, early flight, and air burst or target impact portions of the flight with high-speed cameras, radars, or infrared sensors. Record fire control and ground signals. Obtain air burst data, munition position and velocity data, and as applicable, miss distance data for these firings.

b. Health Hazard Analysis. Collect applicable health hazard data as required for the intended aircraft platform(s). Consider launch blast debris, acoustic energy, thermal effects, radiance, and launch shock (recoil) data in accordance with Annex H, Appendix 2. These data are collected at positions to be occupied by the launch crew. Also collect these data outside of the firing position to define the launch space that is unsafe for occupancy during firings.

c. Weapon Danger Area Analysis. Plot all munition impact coordinates (measured during successful and unsuccessful dynamic firings) on weapon danger area profiles. Develop statistical density distributions of the impacts for assessment of the specified weapon danger area profiles and the firing range safety profiles. Use warhead arming and functioning data from the unmanned firings and the warhead arena trials (Annex D,

Appendix 2, paragraph D2.1.4), combined with munition impact data and weapon danger area profiles, to assess launch area safety and downrange safety, including overflight safety, as applicable. Further guidance may be found in STANAGs 2240 and 2401, Allied Range Safety Publication 1 (ARSP-1 VOL II) Weapon Danger Areas / Zones For Unguided Weapons For Use by NATO Forces in a Ground Role.

d. Verify safe separation distance with data from dynamic firings and warhead arena trials; if needed, obtain additional evidence from component level sled test (with fuze and warhead), or from additional fuze arming distance firings in accordance with Annex H, Appendix 4, paragraph H4.6. For munitions that are expected to penetrate light brush or other obstructions in close proximity to the aircraft (i.e, helicopter munitions), conduct additional fuze sensitivity tests in accordance with Annex H, Appendix 4, paragraph H4.7.

ANNEX D. OPERATING TEST DESCRIPTIONS
APPENDIX 2. COMPONENT LEVEL OPERATING TESTS

Munitions that have undergone sequential environmental testing require component level assessment of energetic, pressure vessel, and other safety critical components in order to estimate the probability and effect of catastrophic failure during operational use. In addition to warheads and rocket motors, other items may require these tests. Examples are gas generators, pressure vessels, or thermal beacons which could burst during operation and present a hazard to personnel. See Annex A, Appendix 2 for additional background and rationale.

D2.1. ROCKET MOTOR STATIC FIRING

Static firings are conducted to measure the internal operating pressure of rocket motors during operational use. Guidance for this test may be found in International Test Operations Procedure (ITOP) 05-2-500.

a. The items should be temperature conditioned to -55 °C (fixed wing) or -46 °C (rotary wing) and the higher of 63 °C or the unpackaged SRE temperature.

b. Mount the item in an appropriate static firing stand.

c. Instrument item with pressure, force, strain, temperature, and vibration transducers as required.

d. Static fire item and record internal operating pressure, thrust, strain, temperature, and acceleration parameters as required.

e. Perform a post test inspection of the motor to check for 'burn-through' of rocket motor case, heat damage to nozzle/venturi and damage to thermal barrier (if present).

f. The probability of motor case rupture is estimated using the static firing and burst test pressure data in the statistical method presented in Annex G.

D2.2. ROCKET MOTOR BURST TESTS

Burst tests are conducted to measure the pressure required to burst the rocket motor case under conditions similar to actual firing. These tests are conducted at ambient temperature using the hydrostatic burst test method described below.

a. Position the item in an appropriate restraining fixture and instrument with pressure transducers to record the internal operating pressure.

b. Fill the rocket motor completely with an inert test fluid such as water.

c. Using a high-pressure pump or a bursting diaphragm arrangement, rapidly pressurize the vessel until it bursts. Note that the fluid line should have provisions for an additional volume of test fluid to be pumped into the vessel to account for motor case expansion. The rate of pressurization shall approximate the pressurization rate of a normally fired motor.

d. Perform a post test inspection of the motor case to check for indications of structural failure.

e. The probability of motor case rupture is estimated using the static firing and burst test pressure data in the statistical method presented in Annex G. Further guidance on burst test methods may be found in ITOP 05-2-621.

D2.3. OTHER PRESSURE VESSELS

Other types of pressure vessels (gas generators, high pressure pneumatic vessels, etc.) in the munition are hydrostatically burst tested to assess personnel hazards and determine safety design margins. Ten pressure vessels of each type in the munition shall be burst tested. Compare burst pressures to determine the safety margin and the likelihood of burst. Determine the fragment size, the velocity, and the fragment distribution to assess the hazard in the event of burst during service use of the vessel.

D2.4. WARHEAD ARENA TRIALS

a. Warhead arena trials are performed to determine safe separation distances and range safety parameters. These trials should be conducted with non-sequential, factory fresh warheads unless it can be shown that exposure to thermal and dynamic stresses in the environmental test sequence results in an increase in fragmentation distance. Guidance for this test can be found in ITOP 04-2-813.

(1) Perform this test on four individual warheads at ambient temperature.

(2) Warhead arena trials require the use of the warhead only. However, the tester should evaluate whether components directly attached to the warhead or in the immediate area of the warhead,

either by design or by inadvertent action, could significantly affect the warhead's fragment dispersion pattern.

(3) Place the item in the instrumented arena and detonate the warhead.

b. Determine warhead fragment size, velocity, mass, spatial distribution, and levels of noise and blast pressure.

D2.5. OTHER ENERGETICS

Other types of energetic materials in the munition (e.g., thermal batteries, safe and arm devices, squibs) are static fired to assess functionality with respect to safe operation. Ten of each type of energetic device in the munition shall be static fired.

D2.6. OTHER SAFETY CRITICAL COMPONENTS

Conduct operational tests on safety critical components to the extent required to identify potentially unsafe operation. Ten of each safety critical component shall be operationally tested.

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ANNEX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA)

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

The following BTCA procedures must only be conducted by suitably qualified and experienced personnel.

E.1. GENERAL INSPECTION

Prior to disassembly for BTCA, conduct a thorough review of Level 1 (basic visual) and Level 2 (radiography) inspection results and non-functioning test results obtained throughout the sequential environmental trial. Any anomaly should be carefully considered with regard to the safety of the munition disassembly and BTCA processes.

E.2. BREAKDOWN AND ANALYSIS REQUIREMENTS

E.2.1. APPLICABILITY

The following tests are broadly applicable to warheads (main charge and firing train), rocket motors (main charge, igniter, intermediaries) and pyrotechnic devices (actuators, tracers, etc.).

E.2.2. REQUIREMENT CONSIDERATIONS

The exact requirements for BTCA need to be determined on a case by-case basis taking into consideration the degree of novelty and/or complexity of the munition. They will be determined by known failure modes and life limiting factors for comparable munitions.

E.2.3. BASELINE TEST CONSIDERATIONS

Prior to commencement of all trials, at least one munition from the same batch/lot as those undergoing the sequential environmental trial should be disassembled and analyzed to identify potential failure modes that may occur. This sets the baseline for comparison against the environmentally stressed munitions. There should also be baseline munitions for the functioning (dynamic and static firing) tests. It may also be possible to use the results from material Qualification tests (to STANAG 4170) for baseline purposes, or data from material manufacturers batch/lot acceptance tests provided these give data equivalent to that from the Qualification tests. Furthermore, firing data from development trials may be used for baseline purposes provided the munition is of the same build standard as the test munitions and provides the required data. However, it should be noted that none of these latter options will permit comparison against the physical condition of the munitions following the sequential environmental trial.

E.2.4 TEST CONSISTENCY CONSIDERATIONS

It is essential to ensure that the same test procedures used to determine the baseline properties of materials are used during BTCA.

E.2.5 CONTAMINATION CONSIDERATIONS

During disassembly and material extraction, care must be taken to ensure that the extracted samples do not become contaminated (by structural materials or other matter) and/or physically damaged/changed (e.g., compressed, cracked, abraded).

E.2.6 FUNCTIONAL TEST CONSIDERATIONS

Small items such as igniters, initiators, squibs etc. pose particular difficulties during disassembly, and it may not be possible to extract sufficient material without damaging the material contained within. In such cases it is acceptable to perform just visual and radiographic inspection followed by functioning tests (at extremes of service temperature). This should include electrical resistance checks and tests performed during lot acceptance such as performance tests during functioning. In some cases it may be possible to extract sufficient material to perform small scale tests such as volatile content determination or differential scanning calorimetry (DSC).

E.2.7. BTCA TEST REQUIREMENTS

The aspects below are provided as an indication of the types of testing required. Tests marked with (P) are considered primary tests that are essential to BTCA objectives; tests marked with (S) are considered secondary tests that provide supplemental aging data that may be used to support S3 evaluation.

E.2.7.1. Inspection and Disassembly (P)

a. Physical integrity and dimensional checks of the munition, sub-systems, energetic materials, and structural materials. This can be achieved through visual inspection (including photography as required), radiography, CT Scan, Dye Penetrant, Bore-scope (for rocket motor conduits), Ultrasonic inspection, and/or Fluoroscopy both prior to, and following disassembly. Some techniques may be more applicable to structural materials which must also be assessed. Dimensional checks should assess physical dimensions and mass of the complete munition, sub-systems and energetic materials to demonstrate compliance with specifications/drawings.

b. During disassembly, pay particular attention to signs of cracking, surface crystallization/dusting (e.g., Ammonium Perchlorate in rocket motors and Nitramines in warheads), debonding/delamination (e.g., thermal liners and inhibitors for rocket motors), exudation (e.g., energetic and inert plasticizers in rocket motors), corrosion, discoloration, wear, missing components and other damage.

c. Plastics, rubbers, foams, seals etc. should be examined for signs of degradation or uptake of plasticizer. ‘O’ rings should be examined for compression set and that they still meet their specification requirements.

E.2.7.2. Chemical Tests (P)

a. Chemical composition, including total volatile matter and moisture content, must be assessed to demonstrate compliance with specifications/drawings.

b. Chemical stability must be assessed for all energetic materials, although the tests used will be material dependant. The vacuum stability test is particularly applicable for main charge explosives. Chemical stabilizer depletion testing (to AOP-48) is applicable for nitrate-ester propellants, with a preference for multi-temperature aging since this gives both stabilizer content and chemical kinetics.

E.2.7.3. Compatibility Tests (S)

a. Chemical/explosive compatibility between all components of construction with the explosives they will be in communication with (both in physical contact and by gas/vapor path) should have been assessed during material qualification and/or design of the munition. This compatibility data shall be presented as a matrix that lists the materials, and for each explosive declares whether there is communication or not with evidence to support the claim of compatibility where communication is expected.

b. During BTCA, any material incompatibilities and/or migration of explosive species are likely to become evident during inspection. Any such anomalies observed shall be noted and assessed further to address whether the munition remains safe as defined AAS3P-1. An example is the migration of energetic plasticizers into thermal liners in rocket motors which may render the thermal liner incapable of fulfilling its intended design role and give rise to an unsafe situation.

E.2.7.4. Physical Properties - Explosives (S)

a. Assessment of flow properties and particle size distribution for granular materials (such as granular propellants and some pyrotechnic compositions), checking for coagulation of granular materials, ‘slump’ (particularly in propellants), bulk cracking, and surface cracking/crazing.

b. Thermal analysis methods, especially Differential Scanning Calorimetry, are useful tools that may indicate changes in the material over time and are particularly suited to subsequent comparison during In-Service Surveillance. They are applicable to most explosive materials, especially pyrotechnics, since they can be performed on small samples of material.

E.2.7.5. Mechanical Properties (S)

Mechanical properties (such as tensile/compressive/ shear strength and hardness) of explosive materials must be assessed at the full range of working temperatures for the munition. It will also be necessary to test structural materials at temperature extremes for safety critical items, such as rocket motor cases, in order to verify design safety margins. Typical methods will include uniaxial tensile test to STANAG 4506, Dynamic Mechanical Thermal Analysis (DMTA) to STANAG 4540 and burst overpressure tests on rocket motor cases (although it may prove difficult to conduct these as part of BTCA). It may also be necessary to assess fatigue crack growth for some structural materials. The types of testing will ultimately be determined by the type of material being tested.

E.2.7.6. Hazard Properties (P)

a. Repetition of the small scale tests to assess hazard properties must be undertaken. These may include, but are not limited to, methods to determine ease of initiation by impact, friction and electrical spark, along with temperature of ignition. Explosive material testing and assessment should be conducted in accordance with STANAG 4170 and AOP-7.

b. Normally the small scale tests will be sufficient but larger scale tests may also be required if an issue is identified. The exact methods used would depend upon the type and quantity of material available for the tests but may include ‘gap tests’ and tests to assess Velocity of Detonation. However, they may ultimately require full scale (i.e., complete round) tests to assess the IM properties of the munition following environmental exposure.

E.2.7.7. Electrical Components (P)

a. Where the munition contains electrical sub-assemblies (e.g., electronic safe/arm device, weapon controller, seeker) these should be removed during BTCA for inspection and functional checks. Functional checks should be performed initially on the initial sub-assembly, using the factory test specification. Where this is not possible or does not allow full testing, then the sub-assembly may require further disassembly to permit such testing.

b. Following this, full disassembly should be conducted for detailed component level inspection. Specific points to observe are broken/loose joints (connectors and solder), damaged/broken components, damaged/broken circuit board tracks, abraded/broken cables/wiring, corrosion, dendritic growth (e.g., ‘tin whiskers’), condition of ‘potting’ compound (if present), and burst batteries.

c. Electrical resistance of igniters/EIDs (EEDs) should be checked, and EIDs (EEDs) functioned using a normal firing pulse.

E.2.7.8. Fuze (Mechanical) Components (P)

a. Where the munition contains a mechanical fuze this should be removed during BTCA for inspection where possible.

b. If there is any doubt regarding the safe and reliable function of the fuze, or it cannot be demonstrated by alternative means, it may be necessary to carry out tests that simulate the various external stimuli required to arm the fuze (e.g., acceleration, spin).

c. The fuze (either armed or safe) should be disassembled to determine its internal physical condition and verify its safe condition.

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ANNEX F. FACILITIES AND INSTRUMENTATION REQUIREMENTS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

Table F-1. Facility Requirements

ITEM	REQUIREMENT
Inspection and Non-Destructive Test (NDT) Facility	Material inspection equipment such as video borescope, ultrasonic, and radiographic must be available to determine the condition of the munition and its components before and after exposure to environmental tests. Facility should have the capability to conduct radiographic inspection of munitions at low temperature extremes or within 15 minutes of removal from a conditioning chamber.
Climatic Test Facility	• Climatic chamber equipment capable of temperature conditioning live munitions to the extremes of -55 to 75 °C and relative humidities from 5 to 95%. • High temperature chamber equipped with solar lamps capable of at least 1120 W/m^2 output. • Combined environments chamber capable of conducting combined temperature, altitude, and humidity of live munitions. • Equipment capable of conducting Sand and Dust, Salt Fog, and Rain tests on live munitions.
Rapid Decompression Test Facility	Chamber capable of pressure change from 60 kPa to 18.8 kPa within 15 seconds. Must be suitable for packaged, live munitions.
Dynamic Test Facility	Equipment suitable for simulating the full range of dynamic environments (e.g., transportation shock and vibration, tactical shock and vibration, drop test) expected during the munition’s lifetime. Facility should have the capability to conduct shock and vibration tests at temperature extremes and drop tests within 15 minutes of removal from a conditioning chamber.
Static Firing Test Facility	Remotely located site capable of measuring motor thrust, pressure, strain, acceleration, and temperature data as a function of time. Facility should have the capability to conduct static firing tests at temperature extremes or within 30 minutes of removal from a conditioning chamber.
Burst Test Facility	Isolated location having remotely controlled pressure generating equipment and capable of measuring pressure and strain data on inert motor cases.
Firing Range (if required)	Selected to suit missile and rocket test requirements and to provide adequate protection for personnel and equipment. Facility should have the capability to conduct firing tests at temperature extremes or within 30 minutes of removal from a conditioning chamber.

Table F-1: Facility Requirements (continued)

ITEM	REQUIREMENT
Warhead Test Area	Test area must have an adequate surface safety danger zone, including overhead air space for open field testing.
Munition Disassembly	Facility suitable for disassembly of live munitions for detailed inspection and component level testing.
Energetic Material Extraction (if required)	Equipment suitable for the extraction of energetic material samples for chemical analysis.
Chemistry Laboratory (if required)	Equipment suitable for the conduct of the chemical analysis tests set out in STANAG 4170, AOP-7, and paragraphs E.2.7.2 through E.2.7.6 of Annex E (BTCA).
Electromagnetic Radiation Test Facility	Facility suitable for the generation of the specified field intensities with an adequate test volume for the test of the munition and launcher as required by the stockpile to launch configuration.
Electrostatic Discharge Test Facility	Facility suitable for the generation of the required ESD environments and large enough for the munition and launcher as required by the stockpile to launch configuration.
Lightning Test Facility	Facility capable of conducting the required lightning strike test on live munitions.
Data Collection/Processing Facility	Test data shall be recorded on Digital Recorders for post-test processing. The data processing system shall edit, display, and print out the desired data plot for analysis and reporting purposes.
Video/Photographic	Closed circuit video is required for personnel safety to permit observation of munition tests. Video Camera/Recording Systems having a sufficient frame rate to record and playback desired events. High speed digital cameras and/or UV/IR cameras may also be required.

Table F-2: Measurement Tolerances

DEVICES FOR MEASURING	MEASUREMENT TOLERANCE
Pressure	±5 percent of the value or ±200 Pa, whichever is greater.
Strain	± 1 percent of highest expected value
Thrust (Load Cells)	± 1 percent of highest expected value
Heat Flux	± 1 percent of highest expected value
Resistance (Low Current Circuit Tester/ Squib Tester)	± 0.05 ohms
Firing Pulse (Automatic Fire Control System)	As required for the initiation of static fire or burst tests and the automatic sequencing of the data collection systems.
Motor Ignition Events (Video)	Frame rate sufficient to record desired event.
Time	± 1 percent
Temperature Climatic Temperature Measurements Static Fire/Burst Temperature Measurements	 ± 2 °C ± 5 °C
Relative Humidity	± 5 percent
Solar Radiation	± 20 W/m^2
Vibration Acceleration	See AECTP 400 Method 401
Acoustic Sound Pressure Level	See AECTP 400 Method 402
Mechanical Shock	See AECTP 400 Method 403
Toxic Gas (NO, NO_2, NO_x, CO, CO_2, SO_2)	2 percent of full scale
Particulates (0.5-15 microns)	2 percent of full scale
Pyrolysis products (fluoride, chloride, bromide, cyanide, aldehydes)	2 percent of full scale
Length	± 1 percent
Weight	± 1 percent
Meteorological Conditions Temperature Relative Humidity Barometric Pressure UV Radiation Potential Lightning/Severe Weather Wind	 ± 2 °C ± 3 percent ± 0.25 mm of Hg ± 20 W/m^2 > 2 km ± 3 km/hr

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ANNEX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

G.1. GENERAL

This annex provides a statistical procedure to determine, at a suitable level of confidence, that the probability of the motor case rupturing is less than some predetermined small value. The probability of case rupture is determined from two measured parameters, the maximum operating pressure of the motor, and the pressure required to rupture the motor case. The reliability of the motor case is estimated by determining the probability that the strength of the motor case exceeds the stresses exerted on the motor case.

G.2. CONFIDENCE COEFFICIENT

An estimate of the probability of motor case rupture is determined from a relatively small sample size, which is assumed to be randomly selected from the total population. A confidence interval with an associated confidence coefficient must be defined. The probability of motor case rupture for this document has been set at a "one sided" confidence interval of 10^{-5} with a confidence coefficient of 90 percent (US requirement). That is, we are 90% confident that 99.999% of the motor population does not exceed the maximum pressure.

G.3. TOLERANCE LIMIT PROCEDURE

The Tolerance Limit Procedure discussed in Annex I, Reference 31 (US) is used to determine that at a 90 percent level of confidence, the probability of motor case rupture is better than one in 100,000 (the "one-sided" confidence interval of 10^{-5}). This means that the motor case rupture pressure must be much better than the motor operating pressure. The following procedure is based upon the assumptions of independence and normality of the data. The normality of the rupture and operating pressure data can be checked by calculating the skewness and kurtosis values.

G.4. DEFINITIONS

X	- burst pressure
Y	- maximum operating pressure
μ_x	- mean of the population for X
μ_y	- mean of the population for Y

σ_x - standard deviation of the population for X
σ_y - standard deviation of the population for Y
$\overline{X}$ - average dynamic burst pressure (estimate of μx)
S_x - standard deviation of burst pressure (estimate of σx)
n_x - burst pressure sample size
f_x - degrees of freedom of estimate Sx
$\overline{Y}$ - average static fire maximum operating pressure (estimate of μy)
S_y - standard deviation of the maximum operating pressure (estimate of σy)
n_y - maximum operating pressure sample size
f_y - degrees of freedom of estimate Sy
f_{x-y} - degrees of freedom for X and Y
S_{x-y} - standard deviation of the difference X - Y

and

$$\overline{X-Y} = \overline{X} - \overline{Y} \qquad \text{(G1)}$$

$$S_{x-y}^2 = S_x^2 + S_y^2 \qquad \text{(G2)}$$

When applying tolerance limits to determine the probability that X-Y>0, it is necessary to determine a sample size, n_{x-y}, to be used in the computation. If $n_x = n_y$, then set $n_{x-y} = n_x = n_y$. If n_x does not equal n_y, then the following shall be used to determine n_{x-y}.

$$n_{x-y} = \frac{s_x^2 + s_y^2}{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}} \qquad \text{(G3)}$$

The procedure used to determine equation G3 is as follows:

a. The t-test for the equality of two means with unequal variances is:

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\left[\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}\right]^{1/2}} \qquad \text{(G3a)}$$

b. If $n_x = n_y = n$, the formula becomes:

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\left[\frac{S_x^2 + S_y^2}{n}\right]^{1/2}} \qquad \text{(G3b)}$$

c. Equating the two formulas G3a and G3b and solving for n results in equation G3.

d. The above procedure cannot be considered more than a plausible reason for equation G3, however, equation G3 does have the following desirable attributes:

(1) If $n_x = n_y$, then $n_{x-y} = n_x = n_y$.

(2) If $S_x = S_y$, then n_{x-y} is the harmonic mean of n_x and n_y.

(3) n_{x-y} is bound by n_x and n_y.

(4) If $S_x > S_y$, then n_{x-y} will be closer to n_x, and this is desirable since the larger S has the greater influence on S_{x-y} in equation G2. The degrees of freedom for X and Y are:

$$f_{x-y} = \frac{(s_x^2 + s_y^2)^2}{\frac{S_x^4}{f_x + 2} + \frac{S_y^4}{f_y + 2}} - 2 \qquad \text{(G4)}$$

The differences in pressure in multiples of standard deviations are:

$$K = \frac{(\bar{x} - \bar{y})}{[s_x^2 + s_y^2]^{1/2}} \qquad \text{(G5)}$$

From the computed values of equations G3, G4, and G5 and by using the One-Sided Tolerance Limit tables of values of k for various values of n, the probability of (X-Y)>0 can be determined.

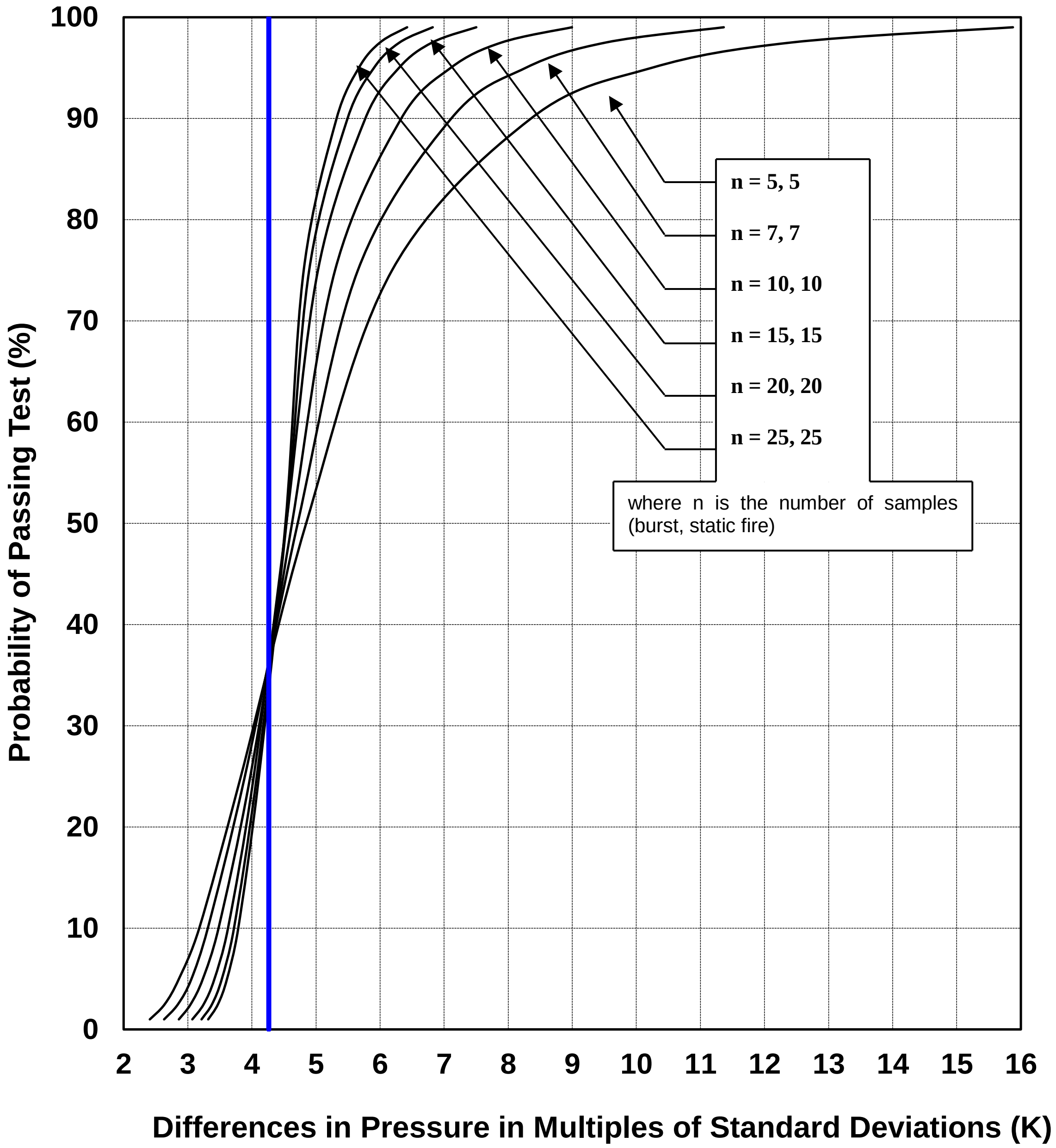
G.5. OPERATING CHARACTERISTICS CURVES

a. The operating characteristics curves in Figure G-1 show how the power of the test using the Tolerance Limit Procedure varies with sample size. The numbers associated with each curve denote the sample sizes to be used to measure case burst pressure and maximum generated operating pressure. The abscissa of the figure is the ratio:

$$K = \frac{(\bar{x} - \bar{y})}{[s_x^2 + s_y^2]^{1/2}}$$

b. This ratio has been used because, for a given sample size, the probability of passing the test depends on the ratio rather than on the absolute difference between the mean pressures. The vertical line in the figure is drawn at the criterion level of 4.26489, where the true probability of case rupture is 1/100,000.

c. The test depicted in Figure G-1 is designed with a consumer or Type I risk of 35 percent and criterion level of 4.26489. As one can see from the figure, the motor must be better than the criterion to have much chance of passing the test. Also, the criterion shows how the power of the test to discriminate between good and bad units increases as the sample size is increased. The curves in Figure G-1 may also be used to estimate the level of extra safety that will have to be built into the units to ensure a high probability of passing the test. For example, if 10 units are to be used for testing (5 for burst pressure, 5 for maximum pressure) then to ensure an 80 percent chance of passing the test, it would be necessary to build units with a pressure difference of approximately 6.75 times as large as the standard deviation of the estimate of the difference. On the other hand, the pressure difference would only have to be approximately 5.50 times as large if 20 units were to be used for testing.



$$K = \frac{\bar{X} - \bar{Y}}{\sqrt{S_x^2 + S_y^2}}$$

Figure G1: Operating Characteristic Curves (One-Sided Tolerance Limits).

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ANNEX H. NON-SEQUENTIAL TESTS/ASSESSMENTS

This document was developed within the international community and is written with primarily references to NATO test procedures. Table I2-1 (Annex I, Appendix 2) provides cross reference of similar national and international test standards.

This annex provides descriptions of all of the non-sequential tests required in the S3 Test Programs included in Annex B. Rationales for these tests are provided in Annex A.

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ANNEX H. NON-SEQUENTIAL TESTS/ASSESSMENTS
APPENDIX 1. ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3)

H1.1. HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO)

Conduct the HERO test using guidance in AECTP 500, Category 508, Leaflet 3, and the parameters found in for all LCEP configurations. HERO tests are performed using one complete inert munition with instrumented inert or live Electrically Initiated Devices (EIDs) and/or ESADs. The HERO tests generally use an electric measuring chain (instrumented EIDs) that will collect measured induced current data. The explosively loaded EIDs are replaced with either instrumented versions of the inert EID or substituted with vacuum thermocouple/simulated EIDs. In cases where instrumentation of the device is not feasible, reasonable results can be obtained with go/no-go techniques but a considerably higher number of units and a theoretical analysis will be required. Therefore, for non-instrumented devices, six EIDs or ESADs are required for this test per Annex B and the analysis or higher test environment is required.

H1.2. ELECTROSTATIC DISCHARGE (ESD) TESTS

H1.2.1. PERSONNEL HANDLING.

a. Personnel handling ESD tests are performed using an inert munition which contains inert or live EIDs/ESADs. A minimum of 20 complete sets of EIDs/ESADs are required (see Annex B).

b. Conduct personnel handling ESD tests using guidance in AECTP 508, Leaflet 2. The discharge is applied to all connectors (protective covers removed) and electronics accessible during system checks and/or field assembly. ESADs shall be tested while in the functional mode.

c. Inspect and test all EIDs/ESADs for activation.

H1.2.2. HELICOPTER-BORNE TRANSPORTATION.

a. Helicopter-borne transportation ESD tests are performed using an inert munition, which contains inert or live EIDs/ESADs. A minimum of 10 complete sets of EIDs/ESADs are required (see Annex B).

b. Conduct helicopter-borne transportation ESD tests using STANAG 4235.

c. Inspect and test all EIDs/ESADs for activation.

H1.3. LIGHTNING HAZARD

a. The tests are performed with the weapon in the worst case configuration based on analysis of the LCEP scenario.

b. Direct or Indirect (or both where appropriate) lightning tests shall be performed using inert weapons with instrumented inert or live EIDs/ESADs. A minimum of 20 complete sets of EIDs/ESADs (10 for indirect lightning strike and 10 for direct lightning strike) are required to provide adequate data when instrumented components are not available (see Annex B). In addition, Nation specific requirements may necessitate direct and/or direct lightning tests on one complete live munition..

c. Perform the lightning strike tests using the parameters found in AECTP 508, Leaflet 4.

H1.4. ELECTROMAGNETIC COMPATIBILITY (EMC)

Where appropriate EMC susceptibility tests are carried out on one complete inert weapon and should be completed in accordance with the AECTP 500 series of tests. In some cases, National Standards and Regulations may also apply.

ANNEX H. NON-SEQUENTIAL TESTS/ASSESSMENTS
APPENDIX 2. HEALTH HAZARDS

The hazards to be assessed for aircraft launched munitions are described below.

H2.1. TOXIC CHEMICAL SUBSTANCES (ROCKET EXHAUST GASES)

If toxic chemical substances are identified as a potential hazard to personnel (air crew or support personnel), collect and analyze toxic chemical data during firings. The test design should encompass configurations most likely to produce the greatest toxic fume hazards. Gas concentrations for CO, CO2, SO2, NO, NO2, and HCl shall be measured at strategic locations. The resulting values should be presented in the form of concentration versus time curves and integrated over time to produce the equivalent exposure. The toxic substances under review must be examined by toxicologists, human factors engineers, physicians and/or ecologists for potential human (exposure time and dose) health hazards. These hazards shall be evaluated with respect to the envisaged operational environment and on the basis of pertinent national laws and regulations.

H2.2. RADIATING ENERGY

During dynamic firing or static rocket motor firing tests, install radiometric sensors in the operator's eye positions (including one at the operator's eyepiece and any observer location, as applicable) and aim them along the flight path of the munition. Deploy photometrically calibrated detectors for several firings as above. Radiometric data that contain visible spectrum levels may be reduced to provide photometric data. Obtain heat flux measurements at the operator’s face position.

H2.3. LAUNCH SHOCK (RECOIL)

Mount accelerometer and displacement sensors on the munition and the firing fixture to determine shock levels due to weapon firing and recoil.

H2.4. BLAST DEBRIS

Determine launch debris patterns, velocities, sizes, and masses using soft media fragment collection packs and high speed cameras during the dynamic firings. Collect these data outside of the operator’s position to define the launch space that is unsafe for occupancy during firings.

H2.5. ACOUSTIC ENERGY (IMPULSE NOISE AND BLAST OVERPRESSURE)

If acoustic energy is identified as a potential hazard to the aircraft platform, measure blast overpressure and acoustic noise during dynamic firing and/or rocket motor firing tests to determine if the shock wave has the potential to damage structures and/or injure personnel (especially hearing). The firing position shall be free of any extraneous structures. Position blast overpressure and microphone sensors at the locations corresponding to vulnerable aircraft positions. Fire the munition. Record and analyze impulse noise measurement data.

ANNEX H. NON-SEQUENTIAL TESTS/ASSESSMENTS
APPENDIX 3. OPERATIONS AND MAINTENANCE (O&M)

Operational tests assess the safety of operational and maintenance procedures and equipment during field handling exercises. Human factors engineers (HFEs) shall be involved in the planning, conduct, and evaluation of the following tests.

H3.1. OPERATIONAL AND MAINTENANCE SIMULATION

Ground/air crews using inert munitions and non-maintenance support items perform tactical transportation, system handling, and firing operations tests under simulated battlefield conditions. Human factors engineering tests during simulated firing missions include setup, built-in test equipment (BITE) checks, munition loading, and simulated firings. The operators perform target acquisition and tracking tests to determine any operational limits. Training exercises are performed with the complete training package. The operator manuals are reviewed and followed during the above. Evaluate the ability of operators/maintainers to install the munition on the aircraft while wearing extreme cold weather gear and personnel protective equipment including nuclear, biological, chemical (NBC) masks and clothing. Live munitions may be used once enough testing has been completed to satisfy the safety authorities that the system is safe for use. Review and exercise the system support package (SSP). Assess the safety of preventive and corrective maintenance operations up to depot level. Simulated system faults may be used to exercise test sets and other test, measurement, and diagnostic equipment. Use maintenance manuals for these exercises and evaluate them in terms of safety.

H3.2. HUMAN ERROR CHECKLIST

Develop a checklist of "Common Sources of Human Error" to categorize human errors that occur during operational tests and to suggest potentially hazardous human errors that apply to the system. Develop additional safety checklists to address electrical, mechanical, and miscellaneous safety items. Information for developing this checklist is specified in Test Operations Procedure (TOP) 01-2-610.

H3.3. OPERATIONAL AND MAINTENANCE REPORT

Record, describe, and score actual and potential unsafe operations and maintenance practices by using observations, video records, checklists, measurements, and operator and maintainer debriefings. Note, the experience and impressions gained by the test persons during handling of the equipment should be recorded during and/or immediately after the tests. This could be done best in the form of standardized interviews made by persons who are experienced in social sciences (e.g., HFEs) using a catalog of previously determined questions. The interview results shall be evaluated based on social science criteria (statistical evaluation, etc.).

H3.4. EMITTED RADIATION (IF APPLICABLE)

H3.4.1. CONTROL METHODS

Review existing data on system high-power emitters, including radio or radar band transmitters, non-coherent or coherent (laser) infrared, visible, and ultraviolet band transmitters, etc. against appropriate safety standards. Also review radioactive sources such as optical lenses, indicators, references, etc. Review the methods used to control these emitters, including safety devices and operational and maintenance safety procedures.

H3.4.2. RADIATION PROTECTION PROCEDURES

Non-ionizing radiation measurements are performed to provide a health hazard assessment. Special precautions may be required for items that produce ionizing radiation. For example, it may be necessary to control the exposure of personnel to the radiation. Consult with the installation Radiation Protection Officer during the test planning phase to develop radiation protection procedures for these emitters. Verify the emission characteristics of these devices, to include mapping of levels at operator or maintainer positions, if applicable.

H3.4.3. INADVERTENT ACTIVATION

Test and analyze operations which inadvertently trigger the emitter or change its output characteristics such as operator error, EMR, climatic and dynamic environments, improper installation, interlock bypass, etc. Test and assess shields as necessary.

ANNEX H. NON-SEQUENTIAL TESTS/ASSESSMENTS
APPENDIX 4. OTHER SAFETY TESTS/ASSESSMENTS TO BE CONSIDERED

Additional safety tests should be performed if data from previous testing indicate that further investigation is required. Selection is based on analysis and previous test results, including evidence of incipient failure modes. Hardware sample sizes depend on the nature of the tests.

H4.1. INDUCED FAILURE FIRING TESTS

When required, additional confidence in the safety of the munition may be obtained by conducting tests, wherein failures are induced in munitions, sections of munitions, munition components, and launch stations before or during the firings to investigate personnel hazards and hazard area boundaries. The induced failure conditions listed below investigate the hazards created by possible design weaknesses and evaluate potential hazards identified during previous tests. Hazards caused by operator error may be used to select the types of induced failures based on the operational and maintenance tests of Annex H, Appendix 3. Evaluate all possible conditions that may cause premature launch, misfire, hang-fire, and catastrophic failure of propellant devices and warhead. Examples of induced failures to consider are:

a. Cracked or unbonded propellant grains.

b. Plugged propellant device nozzles.

c. Damaged or incorrectly installed propellant grain supports or insulation.

d. Loose propellant case components.

e. Damaged igniter.

f. Misaligned components.

g. Damaged umbilical.

h. Damaged munition restraint devices.

i. Short or open in fire control circuit.

j. Damaged or incorrectly installed fuze or S&A device.

k. Damaged or incorrectly installed safety shields or launch tubes.

l. Corrosion in critical electrical connections or interfaces.

m. Incompatibility of missile components to chemicals.

n. Defective electrical grounding systems.

H4.2. EXTENDED TEMPERATURE CYCLE

Some energetic materials may crack during low-temperature cycling causing potentially unsafe conditions (e.g., dangerous internal operating pressures in rocket motors).

a. When required, perform the extended temperature cycling test on two separate units (either component or assembled munition). Seal these units against moisture if they or the munition are sealed in the shipping, storage, or tactical configuration.

b. Subject the units to 20 diurnal cycles between 10 °C and -51 °C. Dwell at high and low temperatures for 4 hours, with 8-hour ramps between temperature extremes.

c. The two units are radiographed to determine if cracking or separation has occurred. Static fire the units at operational temperature extremes to assess potential safety hazards.

H4.3. LONG-TERM STORAGE

As a minimum, all explosive materials in a munition shall undergo appropriate testing and assessment per STANAG 4170 and AOP-7 to determine whether each possesses properties which make it safe for consideration for use in its intended role. In addition, energetic components may be subjected to extended diurnal cycling storage tests using guidance in STANAG 4370, AECTP 300. This test will thermo-mechanically stress the item yielding information that might identify potential failure modes and future safety problems. A full BTCA inspection in accordance with Annex E should be conducted following the long-term storage test.

H4.4. THERMAL STABILITY

This test is designed to evaluate the thermal stability of the munition to elevated thermal conditions to determine whether it is too hazardous for transport. The munition may be tested bare or in its logistic container. Gradually raise the temperature of the test munition to 75 ± 2 °C and hold for 48 hours in a chamber equipped with ventilation and explosion proof electrical features. Place a thermocouple either on the outside casing of the unpackaged munition or on the outside casing of the munition that is located near the center of the package. Record the temperature at a minimum of one minute intervals in order to assess any temperature increase that could represent an exothermic reaction. If no reaction occurs, allow the munition to cool to ambient before inspecting for exudation or damage. Additional information is located in United Nations (UN) ST/SC/AC.10/1. The test item is considered too hazardous for transport if any of the following occur:

a. It explodes.

b. It ignites.

c. It generates colored fumes or odor.

d. It experiences a temperature rise exceeding 3 °C.

e. The outside casing of the munition or its container is damaged.

f. For hypergolic munitions, either fuel or oxidizer leaks from its primary storage tank.

H4.5. BALLISTIC SHOCK

a. Test Temperature: Stabilize all cold munitions to -46 °C and all hot munitions to the unpackaged SRE temperature prior to vibration testing. Test temperature is to be maintained throughout testing.

b. Munition Configuration: This test should be conducted with the munitions in the combat transport and tie-down configuration.

c. Test Level: Test items in the tactical transport and tie-down configuration in accordance with AECTP 400, Method 422, Procedure III or V.

H4.6. FUZE ARMING DISTANCE FIRING

Fuze arming distance firings are used in combination with warhead arena trials to verify that the no-arm or “minimum arm distance” exceeds the safe separation distance for the item. Detailed guidance may be found in the AOP-20, Manual of Tests for the Safety Qualification of Fuzing Systems. Consider anticipated launch scenarios (e.g., aircraft velocity, launch attitude, maneuvers) in planning fuze arming tests and analysis.

a. Fuzes function in two primary modes: point detonating and air burst, others may include a delay feature. The Projectile Fuze Arming Distance procedure of AOP-20 Test D2 is used to determine the minimum arm distance for point detonating and delay type fuzing systems. For an air burst type fuzing system, the minimum arm distance is determined using the Time to Air Burst test approach in AOP-20 Test D3.

b. Fire items at an instrumented range and record launch, early flight, and air burst or target impact portions of the flight with high-speed cameras, radars, or infrared sensors. Record fire control and ground signals, as well as target configuration and distance from launch point. Obtain time to burst data, munition position, and velocity data and, as applicable, miss distance data for these firings.

c. Health Hazard Analysis. Collect applicable health hazard data as required for the intended aircraft platform(s). Consider launch blast debris, acoustic energy, thermal effects, radiance, and launch shock (recoil) data in accordance with Annex H, Appendix 2. These data are collected at positions to be occupied by the launch crew. Also collect these data outside of the firing position to define the launch space that is unsafe for occupancy during firings.

H4.7. WARHEAD FUZE SENSITIVITY

Fuze sensitivity tests determine whether or not the fuze functions on impact with light brush or other obstructions in close proximity to the firing crew. A fly-through panel is placed at predetermined distances to simulate obstructions. AOP-20 provides details on this and other fuze sensitivity tests. Some of the munitions may be fired at extreme temperatures.

H4.8. ICING

Munitions are likely to be exposed to severe icing in cold climates. The icing test (AECTP 300, Method 311) determines the potential damaging effects of icing on the munition where stresses are imposed at joints and interfaces of adjacent parts. Damage may also be incurred as a result of the methods used to remove the ice and the subsequent accumulation of moisture after melting of the ice. The principal sources of ice are frosting, freezing rain, refreezing of thawing snow, and freezing of condensation. The thickness of the ice deposited on the item depends upon the duration of the exposure and the contours of the munition. Medium ice loading conditions are required by this AP with the munition being in the most severe configuration; that is, outside of its shipping/storage container. Perform per AECTP 300, Method 311 on the munition in the unpackaged configuration with medium loading ice thickness representing general conditions.

H4.9. FIXED WING AIRCRAFT ACOUSTICS

Fixed wing aircraft acoustic environment should be considered as potentially damaging to aircraft launched munitions, especially for those carried in bomb bays. If determined to be sufficiently severe to test the munition, the test should be conducted in accordance with AECTP 400 Method 402, with tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with AECTP 240/Leaflets 2410 and 246.

H4.10. VERTICAL REPLENISHMENT

Aircraft launched munitions may be moved as an under-slung load by helicopter over land and at sea (often referred to as Vertical Replenishment at Sea or VERTREP). In the case of over land movement, the shock associated with set-down will typically be addressed by other tests in the environmental sequence. For VERTREP, the ship's motion affects the impact velocity and is directly related to sea-state. The AECTPs currently do not provide guidance for suitable test levels for VERTREP, but the values provided in Table H4-1 are based on those from Def-Stan 00-35, Part 3, Issue 4. The impacts at lower sea-states may be addressed by other tests in the environmental sequence so there will be no requirement to specifically test for these, but at sea-states 5 and 6 consideration should be given to addressing these impacts. VERTREP is commonly replicated by a freefall impact in accordance with AECTP 400, Method 414 and should be conducted as a sequential test if required and not covered by other testing. An aircraft launched munition is expected to be safe for use following under-slung helicopter movement.

Table H4-1: Impact Test Severities for VERTREP

SEA-STATE	TOTAL IMPACT VELOCITY (m/s)	EQUIVALENT DROP HEIGHT (m)
3	3.3	0.6
4	4.0	0.8
5	5.6	1.6
6	6.9	2.4

H4.11. PARACHUTE RESUPPLY DYNAMICS

Parachute Resupply Dynamics. Parachute resupply is unlikely for aircraft launched munitions and need not be considered unless identified as part of the LCEP. If parachute resupply is identified as part of the LCEP, AOP-20, the NATO Fuze Qualification manual, gives guidance for the following scenarios:

a. For low velocity parachute delivery per AOP-20, Test E5, states an impact velocity of 8.7 m/s (28.5 ft/s). However, due to variations in parachute delivery systems throughout NATO service and potential variation of drop conditions (cross winds, etc., an elevated velocity of 12.5 m/s (41 ft/s) should be applied. This environment may be replicated by an 8 m freefall drop in accordance with AECTP 400, Method 414 unless specific and validated evidence is presented to the contrary. This test should be conducted as a sequential test with a criterion of Safe for Use since it is representing a deliberate method of delivery.

b. For high speed parachute delivery per AOP-20, Test E5, states an impact velocity of 27.4 m/s (90 ft/s). In the unlikely event that this mode of delivery is identified in the LCEP, this environment may be replicated by a 41 m (135 ft) freefall drop in accordance with AECTP 400, Method 414 unless specific and validated evidence is presented to the contrary. This test should be conducted as a non-sequential test due to its high severity with a criterion of Safe for Use since it is representing a deliberate method of delivery.

c. For malfunctioning parachute per AOP-20, Test E5, states an impact velocity of 45.7 m/s (150 ft/sec). This environment may be replicated by a 116 m (380 ft) freefall drop unless specific and validated evidence is presented to the contrary. This test should be conducted as a non-sequential test with a criterion of Safe for Disposal since it is representing an accident scenario.

H4.12. CATAPULT LAUNCH AND ARRESTED LANDING

A typical aircraft may fly as many as 200 sorties per year, of which more than two-thirds involve catapult launches and arrested landings. However, for laboratory test purposes, 30 simulated catapult/arrested landing events in each of two axes (longitudinal and vertical) should provide confidence that the majority of significant defects will be identified for remedial action.

Derive the test conditions from measured data on applicable carrying aircraft since shock responses can be affected by local influences such as wing and fuselage bending modes, pylon interfaces, and structural damping.

H4.12.1. CATAPULT LAUNCH

Conduct 30 simulated catapult launch events in each of two axes (longitudinal and vertical). Apply the measured response data under exciter time waveform replication, or process the catapult as two shocks separated by a transient vibration. The environment will typically consist of a combination of initial shock followed by a low level transient vibration of some duration having frequency components in the neighborhood of the mounting platform's lowest frequencies, and concluded by a final shock according to the catapult event sequence. AECTP 400, Method 405 (Gunfire) contain additional guidance and options for the replication of this type of transient environment. Aspects of AECTP 400 Methods 403 (classical shock), Method 417 (SRS), and Method 421 (Multi-Exciter Vibration and Shock Testing) may also be applied.

H4.12.2. ARRESTED LANDING

Conduct 30 simulated arrested landing events in each of two axes (longitudinal and vertical). Apply the measured response data under exciter time waveform replication, or process the arrested landing as a shock followed by a transient vibration. For arrested landing, the environment will typically consist of a an initial shock followed by a low level transient vibration of some duration having frequency components in the neighborhood of the mounting platform's lowest frequencies. AECTP 400, Method 405 (Gunfire) contains additional guidance and options for the replication of this type of transient environment. Aspects of AECTP 400 Methods 403 (classical shock), Method 417 (SRS), and Method 421 (Multi-Exciter Vibration and Shock Testing) may also be applied.

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ANNEX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS

This annex provides descriptions of all of the non-sequential tests required in the S3 Test Programs included in Annex B. Rationales for these tests are provided in Annex A.

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ANNEX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS
APPENDIX 1. ABBREVIATIONS

This document was developed within the international community and is written with primarily references to NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Annex I, Appendix 2) provides detailed comparison of similar national and international test standards. Whilst each test standard often has unique requirements, the table does not imply the standards are the same or interchangeable. However, national test standards, or test methods, may be substituted for the international test standard referenced in the AP.

AAS3P	Allied Ammunition Safety and Suitability for Service Assessment Testing Publication
AASTP	Allied Ammunition Storage and Transport Publication
AECTP	Allied Environmental Conditions and Test Publication
ANEP	Allied Navy Engineering Publication
ANSI	American National Standards Institute
AOP	Allied Ordnance Publication
AP	Allied Publication
ARSP	Allied Range Safety Publication
BIT	built in test
BITE	built in test equipment
BTCA	breakdown test and critical analysis
C	Celsius
cm	centimeter
Def-Stan	Defence Standard
DMTA	dynamic mechanical thermal analysis
DSC	differential scanning calorimetry
E3	electromagnetic environmental effects
EED	electro-explosive device
EFI	exploding foil initiator
EID	electrically initiated device
EMC	electromagnetic compatibility
EMR	electromagnetic radiation
EMRH	electromagnetic radiation hazards
EOD	explosive ordnance disposal
ESAD	electronic safe and arm device
ESD	electrostatic discharge

FM	Field Manual
FMECA	failure modes effects and criticality analysis
FR	France
ft	feet
FTA	fault tree analysis
GE	Germany
GHz	gigahertz
HERO	Hazards of Electromagnetic Radiation to Ordnance
HFE	Human Factors Engineer
HMU	health monitoring unit
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IM	insensitive munitions
IR	infrared
ISO	International Organization for Standardization
ITOP	International Test Operations Procedure
JOTP	Joint Ordnance Test Procedure
kg	kilogram
kHz	kilohertz
km	kilometer
lb	pound
LCEP	life cycle environmental profile
m	meter
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
mm	millimeter
NATO	North Atlantic Treaty Organization
NBC	Nuclear, biological, chemical
NDT	non-destructive test
O&M	operations and maintenance
S3	safety and suitability for service
S&A	safe and arming (device)

SAR	safety assessment report
sec	second
SRE	solar radiation equivalent
SRS	shock response spectrum
SSP	system support package
STANAG	Standardization Agreement
TOP	Test Operations Procedure
TWR	time waveform replication
UK	United Kingdom
UN	United Nations
UNDEX	underwater explosion
US	United States
UV	ultraviolet
VERTREP	Vertical Replenishment at Sea

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ANNEX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS
APPENDIX 2. REFERENCES AND RELATED DOCUMENTS

Note: It should not be assumed that the various methods are exactly equivalent or that methods other than the NATO documents can be necessarily deemed acceptable by the relevant national authorities. Further advice should be sought from these national authorities before alternates to the NATO methods are used. National test method specifications may be employed to meet the environmental test requirements if it can be demonstrated that the national specification is technically equivalent or superior to the referenced methods. Revision identifiers have been intentionally removed, the latest version of the above referenced documents should be utilized.

Table I2-1. Cross-Reference Table

	SHORT TITLE	NATO	US	UK	FR	GE
1	Munitions Safety Testing	STANAG 4629	ITOP 05-2-619 MIL-STD-2105 MIL-STD-882		ITOP 05-2-619	ITOP 05-2-619
2	System Safety	AOP-15	MIL-STD-882 MIL-HDBK-764 ITOP 05-1-060	Def Stan 00-56	AOP-15	VG 95373, DIN EN 61508 ITOP 05-1-060
3	Safety Assessment	AOP-15	MIL-STD-882	AOP-15 Joint Services Publication-520		
4	Hazardous Material Classification	STANAG 4123, AASTP-3	TB 700-2 UN ST/SG/AC.10/11	Joint Services Publication 482 Chapter 4 UN ST/SG/AC.10/11	UN ST/SG/AC.10/11	STANAG 4123, AASTP-3
5	Hazardous Material Classification (Thermal Stability)	UN ST/SC/AC.10/11	TB 700-2 UN ST/SG/AC.10/11	Joint Services Publication 482 UN ST/SG/AC.10/11	UN ST/SG/AC.10/11	
6	Insensitive Munitions Tests	STANAG's 4240, 4241, 4382, 4396, 4496	MIL-STD-2105	STANAG's 4240, 4241, 4382, 4396, 4496; UN ST/SG/AC.10/11	STANAG's 4240, 4241, 4382, 4396, 4496	STANAG's 4240, 4241, 4382, 4396, 4496
7	Insensitive Munitions Assessment	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39 STANAG 4439
8	Software Safety	AOP-52	ITOP 01-1-057 QAP-268 Joint Software Systems Safety Engineering Handbook	Def Stan 00-56,	AOP-52	VG 95373, DIN EN 61508 ITOP 01-1-057

Table I2-1. Cross-Reference Table (continued)

	SHORT TITLE	NATO	US	UK	FR	GE
9	Fuze Safety Tests	STANAG 4157, AOP-20; STANAG 4363, AOP-21; STANAG 4187	MIL-STD-331 MIL-STD 1316	STANAG 4157, AOP-20; STANAG 4363, AOP-21;	Tailored Test Methods + AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21; STANAG 4187
10	Explosive Material Qualification	STANAG 4170, AOP-7	STANAG 4170, AOP-7 NAVSEAINST 8020.5C	STANAG 4170, AOP-7	STANAG 4170 AOP-7 S-CAT 17500	STANAG 4170 AOP-7
11	Human Factors	STANAG 7201	MIL-STD-1472 TOP 01-1-015 TOP 01-2-610 MIL-HDBK-46855A	Def Stan 00-250; HSE Regulations	DGA/NO/FHG/913	VG 95115 ZDv 90/20 HdE, MIL-STD-1472
12	Environmental Testing	STANAG 4370, AECTPs 100, 200, 230, 240, 300, 400	MIL-STD-810 MIL-STD-2105	Def Stan 00-35	STANAG 4370 AECTPs 100, 200, 230, 240, 300, 400; GAM EG-13	STANAG 4370, AECTPs 100, 200, 230, 240, 300, 400; MIL-STD-810
12a	Global Climatic Data	STANAG 4370, AECTP 230, Leaflet 2311	MIL-HDBK-310 AR 70-38	Def Stan 00-35 Part 4	STANAG 4370 AECTP 230	STANAG 4370 AECTP 230
12b	Humid Heat	AECTP 300, Method 306	MIL-STD-810, Method 507	Def Stan 00-35, Part 3, Test CL6 Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 306	AECTP 300, Method 306
12c	Low Temperature Storage	AECTP 300, Method 303	MIL-STD-810, Method 502	Def Stan 00-35, Part 3, Test CL5 Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 303	AECTP 300, Method 303
12d	High Temperature Storage	AECTP 300, Method 302	MIL-STD-810, Method 501	Def Stan 00-35, Part 3, Test CL6 (for high humidity) & CL2 (for low humidity) Severity from Def Stan 00-35 Part 4 Ch2-01 if cyclic.	AECTP 300, Method 302	AECTP 300, Method 302
12e	High Temperature Cycle	AECTP 300, Method 302	MIL-STD-810, Method 501	Def Stan 00-35, Part 3, Test CL6 (for high humidity) & CL2 (for low humidity) Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 302	AECTP 300, Method 302
12f	Solar Radiation	AECTP 300, Method 305	MIL-STD-810, Method 505	Def Stan 00-35, Part 3, Test CL3	AECTP 300, Method 305	AECTP 300, Method 305
12g	Thermal Shock	AECTP 300, Method 304	MIL-STD-810, Method 503	Def Stan 00-35, Part 3, Test CL14	AECTP 300, Method 304	AECTP 300, Method 304
12h	Temperature-Altitude-Humidity	AECTP 300, Method 317	MIL-STD-810, Method 520	Def Stan 00-35, Part 3, Test CL13	AECTP 300, Method 317	AECTP 300, Method 317

Table I2-1. Cross-Reference Table (continued)

	SHORT TITLE	NATO	US	UK	FR	GE
12i	Salt Fog	AECTP 300, Method 309	MIL-STD-810, Method 509	Def Stan 00-35, Part 3, Test CN2	AECTP 300, Method 309	AECTP 300, Method 309
12j	Sand and Dust	AECTP 300, Method 313	MIL-STD-810, Method 510	Def Stan 00-35, Part 3, Test CL25	AECTP 300, Method 313	AECTP 300, Method 313
12k	Rain/ Watertightness	AECTP 300, Method 310	MIL-STD-810, Method 506	Def Stan 00-35, Part 3, Test CL27	AECTP 300, Method 310	AECTP 300, Method 310
12l	Immersion	AECTP 300, Method 307	MIL-STD-810, Method 512	Def Stan 00-35, Part 3,Test CL29	AECTP 300, Method 307	AECTP 300, Method 307
12m	Mould Growth	AECTP 300, Method 308	MIL-STD-810, Method 508	Def Stan 00-35, Part 3, Test CN1	AECTP 300, Method 308	AECTP 300, Method 308
12n	Contamination by Fluids	AECTP 300, Method 314	MIL-STD-810, Method 504	Def Stan 00-35, Part 3, Test CN4	AECTP 300, Method 314	AECTP 300, Method 314
12o	Aircraft Cargo Decompression	AECTP 300, Method 312	MIL-STD-810, Method 500	Def Stan 00-35, Part 3, Test CL9	AECTP 300, Method 312	AECTP 300, Method 312
12p	Vibration Test	STANAG 4370, AECTP 400	MIL-STD-810, Method 514	Def Stan 00-35, Part 3, Test M1	STANAG 4370, AECTP 400	STANAG 4370, AECTP 400
12q	Vibration Test Schedule Development	STANAG 4370, AECTP 240, Leaflet 2410	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 5	STANAG 4370, AECTP 240, Leaflet 2410	STANAG 4370, AECTP 240; ITOP 01-01-050
12r	Commercial (Common Carrier) Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
12s	Military Wheeled Vehicle Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
12t	Restrained Cargo Transport Shock	AECTP 400, Method 403	MIL-STD-810, Method 516, 527	Def Stan 00-35, Part 3, Test M3	AECTP 400, Method 417	AECTP 400, Method 417
12u	Fixed Wing Aircraft Cargo Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
12v	Helicopter Cargo Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
12w	Under Water Explosion (UNDEX)	STANAG 4549 STANAG 4150 ANEP 43	MIL-S-901 ANEP 43	Def Stan 00-35, Part 3, Test M7 (or Test M3).		STANAG 4150
12x	Shipboard Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 528, 527; MIL-STD-167	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
12y	Fixed and Rotary Wing Captive Carriage Vibration	AECTP 400, Method 401,420, 421 and AECTP 240 Leaflet 2410	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 5 (test spec development) Def Stan 00-35, Part 3, Test M1and M2 (tailored severities)	AECTP 400, Method 401 and AECTP 240 Leaflet 2410	AECTP 400, Method 401 and AECTP 240 Leaflet 2410
12z	Gunfire Shock (Time Waveform Replication)	AECTP 400, Methods 405, 417, 421	MIL-STD-810, Method 519, 525, and 527	Def Stan 00-35, Part 3, Test M19 (tailored severities)	AECTP 400, Methods 405, 417, and 421	AECTP 400, Methods 405, 417, and 421

Table I2-1. Cross-Reference Table (continued)

	SHORT TITLE	NATO	US	UK	FR	GE
12aa	Tactical and Launch Shocks (Shock Response Spectrum)	AECTP 400, Methods 417, 421 and AECTP 240, Leaflet 249-1	MIL-STD-810, Method 516, 527	Def Stan 00-35, Part 3, Test M19 (tailored severities)	AECTP 400, Methods 417, and AECTP 240, Leaflet 249-1	AECTP 400, Methods 417, and AECTP 240, Leaflet 2491
12ab	Missile Free Flight Vibration	AECTP 400, Method 401, 421 and AECTP 240 Leaflet 2410	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 5	AECTP 400, Method 401 and AECTP 240 Leaflet 2410	AECTP 400, Method 401 and AECTP 240 Leaflet 2410
12ac	Packaged Transit Drop	AECTP 400, Method 414	MIL-STD-810, Method 516	Def Stan 00-35, Part 3, Test M5	AECTP 400, Method 414	AECTP 400, Method 414
12ad	Catapult Launch and Arrested Landing	AECTP 400, Methods 403, 405, 417, and 421	MIL-STD-810 Method 513, 516, and 525	AECTP 400, Methods 403, 405, 417, and 421	AECTP 400, Methods 403, 405, 417, and 421	AECTP 400, Methods 403, 405, 417, and 421
13	Unpackaged Handling Drop	STANAG 4375	MIL-STD-810, Method 516	Def Stan 00-35, Part 3, Test M5	STANAG 4375	STANAG 4375
14	Packaged and Unpackaged Safety Drops	STANAG 4375	MIL-STD-810, Method 516	Def Stan 00-35, Part 3, Test M5	STANAG 4375	STANAG 4375
15	Logistic Drop Test (12m drop)	STANAG 4375	MIL-STD-2105 ITOP 04-2-601	STANAG 4375	STANAG 4375	STANAG 4375
16	Parachute Drop	AOP-20	MIL-STD-331 ITOP 07-2-509 TOP 04-2-509	Def Stan 00-35, Part 3, Test M5 AP101A 1102-1		AOP-20, MIL-STD-331
17	Dynamic Firing	STANAG 4157, AOP-20; STANAG 4363, AOP-21	ITOP 04-2-806	STANAG 4157, AOP-20; STANAG 4363, AOP-21	STANAG 4157, AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21
18	Warhead Minimum Arming Distance	STANAG 4157, AOP-20; STANAG 4363, AOP-21	ITOP 04-2-806	STANAG 4157, AOP-20; STANAG 4363, AOP-21	STANAG 4157, AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21
19	Warhead Arena Test		ITOP 04-2-813; MEM NA 00-130ASR-2-1 (Army FM 101-51-3-CD (EM 0260))	ITOP 04-2-813		ITOP 04-2-813; TL 1300-0011 Part 2, BWB WM VI 2 Hdb. Munitionsbewertun g A 1981
20	Weapon Danger Area	STANAG 2240, 2401, ARSP-1 Vol I and II, STANAG 2470, ARSP-2, Vol. 1	ITOP 05-2-505	STANAG 2240, 2401, ARSP-1 Vol I and II, STANAG 2470, ARSP-2, Vol. 1	TTA206 STANAG 2921	STANAG 2240, 2401, ARSP-1 Vol I and II, STANAG 2470, ARSP-2, Vol. 1; ZDv 44/10; ITOP 05-2-505
21	Rocket Motor Static Firing		ITOP 05-2-500	ITOP 05-2-500 Def Stan 07-85		TL1376-0701, ITOP 05-2-500, AA WTD 91 07-520-004-002

Table I2-1. Cross-Reference Table (continued)

	SHORT TITLE	NATO	US	UK	FR	GE
22	Rocket Motor Case Burst		ITOP 05-2-621	ITOP 05-2-621		ITOP 05-2-621, VA WTD 91 07-330-16
23	Motor Case Burst Probability		ARO Report 75-2 SMC-S-001	Def Stan 07-85		
24	Health Hazards		TOP 06-2-507 TOP 10-2-508 OPNAVINST 5100.19E and OPNAVINST 5100.23G	HSE Regulations		
25	Toxic Gas / Materials		ITOP 05-2-502	HSE Regulations		Erl. BMVg InSan I4-42-19-01 ITOP 05-2-502
26	Laser Hazards	STANAG 3606, ARSP-4	TB MED 524 MIL-HDBK-828	Joint Services Publication 390. HSE Regulations. Control of Artificial Optical Radiation at Work Regulations.	STANAG 3606, ARSP-4	STANAG 3606, ARSP-4
27	Ionizing Radiation Hazards		TOP 03-2-711	HSE Regulations		
28	Electronic Equipment Hazards		MIL-HDBK-45	Def Stan 00-10 HSE Regulations		
29	Radiofrequency Health Hazards	STANAG 2345	TOP 03-2-616 OP3565 Vol. 1 DOD 6055.11	Joint Services Publication 392 Leaflet 35	ENV 501661 ENV 50061	DIN VDE-0848. T.1-4, DIN VDE-0848. T.2
30	Acoustic Noise		MIL-STD-1474 ISO 10843: 1997	Def Stan 00-27 HSE Regulations	AT-83/27/28	ZDv 90/20 VM Blatt 1993
31	Blast Overpressure	STANAG 4569 with references. Final Report RTO-HFM-089, -090, -148 TR-HFM-090-ANN-H	ITOP 04-2-822 DOD 6055.9-STD		Consignes et instructions relatives à l'enregistrement et à l'exploitation des bruits d'armes et des bruits de détonation	Vorschriften und Richtlinien zur Registrierung und Auswertung von Waffen und Detonationsknallen and STANAG 4569 with references. Final Report RTO-HFM-089, -090, -148
32	Electromagnetic Environmental Effects (tests)	STANAG 4370, AECTP 500	MIL-STD-464 TOP 01-2-511 MIL-STD-461	Def Stan 59-411	GAM DRAM 02	STANAG 4370, AECTP 500

Table I2-1. Cross-Reference Table (continued)

	SHORT TITLE	NATO	US	UK	FR	GE
33	Electromagnetic Environmental Effects (environment description)	STANAG 4370, AECTP 250, Leaflet 258	MIL-STD-464 MIL-HDBK-235	Def Stan 59-411	GAM DRAM 01	STANAG 4370, AECTP 250, Leaflet 258
34	Electromagnetic Environmental Effects (HERO)	STANAG 4370, AECTP 508 Leaflet 3	MIL-STD-464 MIL-HDBK-240 JOTP-061 OP3565 Vol. 2	Def Stan 59-114 Def Stan 59-411	GAM DRAM 02	STANAG 4370, AECTP 508, Leaflet 3
35	Electrostatic Discharge (ESD) Environmental Test	STANAG 4370, AECTP 250, Leaflet 253; AECTP 508, Leaflet 2	MIL-STD-464 JOTP-062	Def Stan 59-411	GAM DRAM 01 GAM DRAM 02	STANAG 4370, AECTP 250, Leaflet 253
36	Lightning Environmental Test	STANAG 4370, AECTP 508, Leaflet 4; AECTP 250, Leaflet 254	MIL-STD-464	Def Stan 59-411	GAM DRAM 01 GAM DRAM 02	STANAG 4370, AECTP 508, Leaflet 4; AECTP 250, Leaflet 254
37	Electromagnetic Interference	STANAG 4370, AECTP 501	MIL-STD-461 MIL-STD-464	Def Stan 59-411	STANAG 4370, AECTP 501	STANAG 4370, AECTP 501
38	Electromagnetic Compatibility	STANAG 4370, AECTP-250 and 500; IEC 61000 4-2	MIL-STD-461 MIL-STD-464 MIL-HDBK-237	Def Stan 59-411 IEC 61000 4-2		IEC 61000 4-2
39	Rough Handling Drop Test	STANAG 4370, AECTP 400	ITOP 04-2-602	Def Stan 00-35		STANAG 4370, AECTP 400
40	Fire From Enclosure		ITOP 05-2-517			ITOP 05-2-517

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