NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

NATO STANDARDIZATION AGENCY (NSA)
AGENCE OTAN DE NORMALISATION (AON)

1110 BRUSSELS

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8 October 2001

See CNAD AC/310 STANAG distribution

STANAG 4516 PPS (EDITION 1) - CANNON (GREATER THAN 12.7mm), DESIGN SAFETY REQUIREMENTS AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION OF THE WEAPON/MUNITION COMBINATION

Reference: AC/310-D/174, dated 14 December 1999

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page (iii) is promulgated herewith.

2. The reference listed above is to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

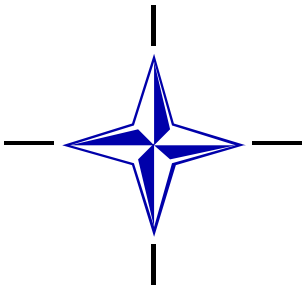
4. National staffs are requested to examine page (iii) of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

Enclosure:
STANAG 4516 (Edition 1)

STANAG 4516
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)



NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: CANNON (GREATER THAN 12.7 mm), DESIGN SAFETY REQUIREMENTS AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION OF THE WEAPON/MUNITION COMBINATION

Promulgated on 8 October 2001

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

STANAG 4516
(Edition 1)

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

STANAG 4516
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT
(STANAG)

CANNON (GREATER THAN 12.7 mm), DESIGN SAFETY REQUIREMENTS AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION OF THE WEAPON/MUNITION COMBINATION

Annexes:

A. Design Safety Requirements.
B. Assessments In Support Of Cannon Safety And Suitability For Service Evaluation.
C. Tests in Support of Cannon Safety and Suitability for Service Evaluation.

Related Documents:

The following documents of the date and issue of this document form the basis for or have relationship to this document. AC/310 Cadre Group STANAGs related to environments and test procedures must also be consulted in connection with this STANAG.

AECP-1	Mechanical Environmental Conditions to which Materiel Intended for Use by NATO Forces Could be Exposed.
AECTP-100	Environmental Guidelines for Defence Materiel.
AECTP-200	Environmental Conditions.
AECTP-300	Climatic Environmental Tests.
AECTP-400	Mechanical Environmental Tests.
AECTP-500	Electrical Environmental Tests.
AEP-4	Nuclear Hardening Criteria for Armed Forces Material and Installations.
AOP-11	Interoperability of NATO Aircraft and Stores.
AOP-15	Guidance on the Assessment of the Safety and Suitability For Service of Munitions for NATO Armed Forces.
AOP-20	Tests for the Safety Qualification of Fuzing Systems
AOP-24	Electrostatic Discharge, Munition Assessment and Test Procedure.
AOP-25	Lightning, Munition Assessment and Test Procedures.
AOP-38	Glossary of Terms and Definitions Concerning the Safety and Suitability for Service of Munitions, Explosives and Related Products.
STANAG 1307	Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar.
STANAG 1402	Guidelines for the National Technical Authority (NTA) Assessment of Naval Gun Ammunition Interchangeability.
STANAG 2401	Heavy Weapons Range Safety Criteria.

STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design/Test Criteria for NATO Forces' Materiel.
STANAG 2914	Mechanical Environmental Conditions to Which Materiel Intended for Use by NATO Forces Could be Exposed – AECP-1.
STANAG 3791	Interoperability of NATO Aircraft and Stores - AOP-11(F).
STANAG 4110	Definition of Pressure Terms and their Inter-Relationship for Use in the Design and Proof of Cannons and Ammunition.
STANAG 4234	Electromagnetic Radiation (Radio Frequency) - 200 kHz to 40 GHz Environment - Affecting The Design of Materiel for Use by NATO Forces.
STANAG 4235	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4236	Lightning Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4239	Electrostatic Discharge, Munition Test Procedures.
STANAG 4242	Vibration Test Method and Severities for Munitions Carried in Tracked Vehicles.
STANAG 4324	Electromagnetic Radiation (Radio Frequency) Test Information to Determine The Safety and Suitability for Service of Electro-Explosive Devices and Associated Electronic Systems in Munitions and Weapon Systems.
STANAG 4327	Lightning, Munition Assessment and Test Procedures.
STANAG 4404	Safety Design Requirements and Guidelines for Munition Related Safety Critical Computing Systems.
STANAG 4416	Nuclear Electromagnetic Pulse, Testing of Munitions containing Electro-Explosive Devices.
STANAG 4423	Cannon Ammunition (12.7 to 40 mm), Safety and Suitability for Service Evaluation.
STANAG 4452	Safety Assessment Requirements for Munitions Related Computing Systems.
STANAG 4517	Large Calibre Ordnance Greater than 40 mm, Design Safety Requirements and Safety and Suitability for Service Evaluation.

AIM

1. The aim of this agreement is to standardize design safety requirements and to define standard tests required to support the evaluation of the safety and suitability for service of the weapon/munition combination for cannons of greater than 12.7 mm.

AGREEMENT

2. Participating nations agree to comply with the design safety requirements and safety and suitability for service evaluation procedures outlined in this STANAG. The participating nations further agree that the results of the design safety assessment and the safety and suitability for service evaluation performed for the weapon/munition combination in accordance with this document will be provided by the developing nation to participating nations on a valid request.

DEFINITIONS

3. Cannon. A cannon, for the purpose of this STANAG, is defined as an automatic gun, capable of a sustained rate of fire in excess of about 100 rounds per minute, with a calibre greater than 12.7 mm, together with any associated ammunition feed mechanism essential to enable the gun to execute automatic fire, loading and/or (re)firing operations.

4. This definition does not include those items which are peculiar to the installation in the vehicle/ship/aircraft, such as ammunition storage containers, systems for transfer of the ammunition from storage tank to gun, remote firing circuitry from the operator to the gun or components necessary for the correct aiming of the gun.

5. This STANAG does not address weapon systems designed for the use of caseless ammunition.

6. Credible. A credible event is one believed to have a probability of occurrence that can be expressed in meaningful numerical terms.

7. Safe Fatigue Life. The Safe Fatigue life is a limit, which should not be exceeded in service, on the working life of an item where the probability of catastrophic fatigue failure is no longer considered to be acceptably low. The fatigue life is normally derived from a test to destruction of a number of barrels, or other components, and the application of a statistical analysis to set a 90% confidence bound on the lower 0.1 percentile of the failure distribution, although national procedures may vary.

8. Wear Life. The wear life is defined as the limit that could, if exceeded, result in unstable, inaccurate, inconsistent or unsafe, performance of the projectile.

GENERAL

9. The purpose of the design safety assessment and safety and suitability for service evaluation of the weapon/munition combination is to establish that:

a. The cannon will remain safe and suitable for service and will function within acceptable performance limits after being exposed to environmental conditions equivalent to those which are likely to be found on installation and operation during the entire stated service life of the cannon.

b. The risk of a safety failure occurring at any point throughout the service life of the cannon is acceptably low. Hazards that may arise during functioning of the cannon, or a credible accident, or an otherwise survivable enemy action, or the process of repair following such an accident, or disposal at the end of life, are to be either designed out or adequately controlled.

10. Safety of installation The safety and suitability of the cannon weapon system, including ammunition storage and transfer arrangements, remote firing facilities, mounting control, etc., needs to be assessed in specific installation configurations. Where the developing nation(s) has conducted tests on a cannon weapon system, the configuration of the cannon and system should be included in the trial report. In addition the local environment experienced by the cannon should be measured, recorded and included with the cannon test results. These assessments should be conducted in accordance with national procedures and are not included within the scope of this STANAG.

DETAILS OF THE AGREEMENT

11. Procedures. To enable a nation to conduct an evaluation of design safety, and safety and suitability for service of cannon or cannon weapon systems to be used by its own Services, the evaluator will require copies of the design characteristics, safety analyses and trial reports from the nation responsible for the development of the cannon and weapon system. Where trials and assessments have been conducted on the cannon as part of a weapon system, the developing nation shall record in a report the environmental levels experienced on the cannon along with the configuration. The nations carrying out the evaluation of design safety, and safety and suitability for service of a particular cannon installation agree to make their test parameters, safety analyses and trials reports available, on a valid request, to other NATO nations intending to purchase or to take over the weapon.

12. Variations on the Procedures.

a. Notwithstanding the intention to avoid duplication of testing, each nation reserves the right to carry out additional testing if considered appropriate and, when necessary, to bear the financial costs of so doing.

b. Any significant changes proposed to the agreed evaluation procedures will be provided to the user nation for comment and concurrence.

c. The service environment and usage profile to which the cannon may be subjected will be specified by the user nation. The specific test programme need not be limited to tests described in this document. To ensure that any predicted failure modes are adequately investigated the selection of tests, test parameters and test sequences shall be based on the following:

(1) A design safety assessment, including hazard analysis, of the cannon weapon system;

(2) The measured, or analytically forecast, environmental life cycle profile, including firing shocks, of the cannon in accordance with AOP-15;

d. The final safety evaluation shall take account of development trials, as well as individual national safety appraisal procedures, in order to make a valid evaluation of the cannon in the specified service environment.

13. Cannon and ammunition interaction Cannons may be developed to fire a wholly new nature or type of ammunition of the same standard, or to fire a range of existing ammunition. The initial feasibility studies for the use of a new type of ammunition in the cannon as a munition system will need to take account of the cannon design criteria (e.g. chamber characteristics and design pressure). The likely combinations of cannon and ammunition natures need to be established to ensure that all relevant dimensional, pressure, wear rate and fatigue criteria are taken into account. Naval requirements are given in STANAG 1402, and Air requirements in STANAG 3791 and AOP-11. There is no equivalent document for Land Service cannon and ammunition.

14. Interaction between the cannon and the mounting Cannon weapon systems may be developed using an existing cannon in a new or modified mounting. The forces exerted by the cannon on the mounting at the extremes of operational temperature, and with the range of ammunition identified through the assessment in Paragraph 13, should be measured and recorded by the developing nation during the initial Strength of Design testing of the cannon.

15. Lubricants The operation of a cannon is dependent on satisfactory lubrication under all operational conditions. The effectiveness of many lubricants varies significantly with temperature. The

lubricants used during any environmental testing are to be appropriate for that environment. Trial conditions and the lubricants used are to be recorded.

16. Pressure relationships and terminology The pressure relationships and terminology detailed in STANAG 4110 are relevant and are to be applied to cannon in this STANAG.

17. Life cycle During its life cycle, a cannon weapon system may encounter great variations in ground, sea or air environmental conditions. Furthermore, within these environments the cannon may be subjected to maintenance; repair; testing; loading and firing. The tests required to establish the safety and suitability for service characteristics of the cannon shall take account of the need to demonstrate the effects of the expected environment on the cannon during its expected life cycle in accordance with the operational requirement. The tests will need to establish that the durability of components is satisfactory.

18. Environmental specification To ensure that the environments used during tests are representative, the test environments shall be consistent with the operational requirement and the design specification for the cannon. The appropriate operational requirements department of the developing nation's Service, or Services, shall certify that the anticipated environments have been correctly defined. For the ammunition, this process is defined in AOP-15. When the system is required to withstand a nuclear environment, the appropriate levels from AEP-4 shall be applied.

19. Environments selected for testing should represent those extremes anticipated for the planned life cycle of the cannon and should include the climatic conditions specified in STANAG 2895. Environments which shall be considered for the assessment and testing of cannon weapon systems include the following:

a. Natural environments created regardless of human intervention, e.g. temperature, pressure, humidity, sand and dust, lightning or salt spray;

b. Induced environments associated with the mechanical stresses of the transportation or installation of the cannon in a ship, vessel, aircraft, fighting vehicle, or other military installation;

c. Induced electromagnetic, electrostatic and nuclear environments resulting from human intervention;

d. Hazardous environments associated with enemy action and/or accidents, e.g. fire, strike by other ordnance or fragments, aircraft crash, loading accidents, handling, etc.

These environments should be documented in accordance with the guidance provided in STANAG 4370 (AECTP-100).

20. Design safety assessment The cannon shall be assessed against the design safety requirements specified in Annex A of this STANAG and as further amplified by the developing nation(s) if required. Complex elements of the weapon may need to be analysed by formal hazard analysis methods, as described in AOP-15. This safety assessment should identify the safety tests required and may highlight the need to examine in more detail some particular features or perceived weaknesses of the design. Annex B of this STANAG summarises the assessments to be conducted.

21. Safety and suitability for service test programme The safety and suitability for service test programme shall be developed for the cannon from the design safety assessment, hazard analysis and the environmental profile as indicated in Paragraphs 12c, 17, 18, 19 and 20. Such a programme shall include non-sequential functioning and safety tests, and sequential environmental tests representing in-service use, as described in Paragraph 22. The selection of tests, test methods,

parameters, duration, sequence and the logic of these choices related to the specified environment shall be documented.

22. Safety and suitability for service tests and assessments The safety and suitability for service tests and assessments are those which shall be conducted to establish adequate safety during operation of the cannon and also in credible accident situations, and to determine suitability for service. These assessments are outlined in Annex B, and the tests in Annex C. The applicability of some of these tests is conditional upon the design of the particular cannon, although all of the tests and assessments shall be considered when developing a safety and suitability test programme for the cannon. The tests are grouped in the following categories:

a. **Safety Tests and Analyses**. Safety tests and analyses are to demonstrate that:

(1) Operation of the cannon will not result in a hazard to the crew, vehicle or platform;

(2) The cannon will withstand the firing forces under extreme service conditions;

(3) When exposed to credible hazardous events the response of the cannon will not endanger life;

(4) The design will not permit the unintentional firing of the weapon when subjected to any stimulus other than the designed firing sequence.

b. **Environmental Functioning and Durability Tests**. These tests are to ensure that:

(1) The cannon functions satisfactorily in, and/or after exposure to, the extreme limits of the specified environment, as required by the operational requirement;

(2) The durability of components is satisfactory.

23. Additional tests Further tests, not included in Annex C, may be conducted if considered necessary by the developing authority. In particular, novel designs may require additional tests to be conducted. They may be configured to examine any specific areas of concern highlighted during the design safety assessment. Any test intended to assess the response of the cannon to a particular environment or hazard is to be conducted to simulate satisfactorily the effects of that environment or hazard. For cannon that are routinely installed in other vehicles or aircraft, additional tests for specific applications may be required.

24. Test parameters Standard test procedures and test parameters are given in Annex C. Test severities shall be no less than the minimum requirements presented, or referred to, in Annex C. If the results of analyses lead to more severe testing, or tests not covered in the Annex, the appropriate severities or tests shall be included in the test programme. Nothing in this STANAG should prevent a nation deciding on a higher or more severe criterion if it so wishes. However, the developing nation should be consulted in the event that a more severe test is specified in case the test is outside the specified design parameters of the cannon or installation.

25. Test procedures The tests described in Annex C shall be conducted in accordance with ratified test STANAGs. In those instances where appropriate STANAGs have not yet been approved, national procedures will apply until superseded by ratified STANAGs. Components of the cannon, (e.g. a barrel) may be tested in isolation from the complete weapon provided this does not detract from the purpose of the test or the test sequence. Such configurations must be specified in the test plan and documented in the test report.

26. Choice of test and test sequence Some or all of the safety and suitability for service tests within the programme are conducted sequentially to verify that the cannon will be safe and suitable for service in the expected environment. Such sequences may end with firing tests or detailed disassembly and examination. Components may be withdrawn at various points in the testing sequence for detailed examination to ascertain the effects of specific tests or environments. The detailed design of the cannon should be critically examined so that the sequence or sequences represent the best compromise between a realistic life cycle and those sequences which may cumulatively produce the most severe degradation of the cannon under test. The scope of the testing, content of test sequences and the extent of the assessment will also be influenced by any similarities with previous designs or by technical innovation in the design. Where a cannon, or cannon weapon system, being assessed is a modification of a known and previously assessed design, some reduction of testing may be possible.

27. Results and reports of tests and assessments Results and reports of tests and assessments shall be made available by the developing nation on a valid request. Where there is evidence of unacceptable or unsatisfactory results, the significance of these shall be explained by the developing nation. The environmental conditions against which the cannon has been assessed and tested shall be identified in order to enable the need for further testing in subsequent installation environments to be established.

28. Relationship with development testing Tests on cannon shall be classified as “development” or “safety and suitability for service” tests. It is expected that contractor developmental trials will also cover the spectrum of tests in Annex C. The essential difference between the 2 programmes is that the developmental tests may involve a non-representative build standard of cannon, whilst that selected for the safety and suitability test programme must be fully representative of the production procedures and build standard. Additionally the cannon should successfully pass the environmental and safety test criteria. The results of development trials carried out with a cannon or components which can be proven to be representative of the production build standard, may be taken into consideration in the evaluation of safety and suitability for service, providing test data are made available.

29. Reports on safety and suitability for service tests and assessments It is essential that adequate data are available to national/service safety evaluation organisations for the evaluation of cannon safety and suitability for service. Therefore, nations developing the weapon system shall compile a data package that documents the test methods and rationale for the test programme selection. Reports should be from accredited test houses/ranges/ authorities and carry a satisfactory assurance of quality. The package will also give the detailed results obtained during safety and suitability for service tests. Where results from the developmental trial of components have been used to allow reductions in the scope or the duration of tests, then the results of these development trials should also be included, providing the characteristics of the development munition under test has not been changed in the production version. This data package shall be supplemented by a technical design data package.

IMPLEMENTATION OF THE AGREEMENT

30. This STANAG is implemented by a nation when that nation has issued instructions to its services that all new cannon weapon system designs procured for Service use will be designed, assessed and tested in accordance with the requirements and procedures detailed in this agreement.

ANNEX A to
STANAG 4516
(Edition 1)

DESIGN SAFETY REQUIREMENTS – CANNON WHOLE SYSTEM

1. Strength of Design

   a. The strength of the design of the cannon shall be sufficient to sustain all firing loads during the service life. The probability of the system pressure reaching or exceeding cannon design pressure shall be less than 1 x 10-6, under extreme conditions as defined in STANAG 4110;

   b. The cannon and ammunition should be matched to meet the criteria set out in STANAG 4110 for the System Permissible Maximum Pressure (System PMP).

2. Safe Operation The cannon shall remain safe to operate under all specified climatic, mechanical and electrical environmental conditions for all natures of ammunition to be fired. The specified conditions should include all those likely to be met during the defined life cycle of the cannon.

3. Material Compatibility Materials used in the construction of the cannon shall perform as required by the design throughout the defined life cycle. Materials used in the construction of the cannon shall be compatible with the combustion products produced during firing.

4. Single Point Failure No single fault or failure shall result in the unintentional firing of the weapon, or in it becoming unsafe.

5. Safe Service Life The barrel and breech of a cannon are to be safe to fire throughout its intended service life for all natures of ammunition to be used in the gun. The safe service life of these items must be established as dictated by the lesser of 2 principal factors; the wear life and the safe fatigue life.

6. Projectile Stability The barrel internal configuration shall ensure that projectiles remain safe and stable over the operational range of the system.

7. Barrel Locking

   a. The barrel shall be capable of being locked positively and secured in position when fitted to the cannon such that it will not become loose or detached as a result of the operating environment;

   b. Weapons shall not be capable of being fired without the barrel correctly fitted;

   c. Where appropriate, barrels shall be capable of being changed without risk of injury to the weapon handler or crew, using any tools or special equipment identified by the manufacturer.

8. Noise and Blast The blast overpressure in the vicinity of crew members, or locations likely to be occupied by other adjacent personnel, is to be within declared national limits.

9. Barrel Attachments Barrel attachments (blast suppresser, flash-hider, restraints, etc.) shall withstand the forces of firing, recoil and interaction with a projectile and sabots/pushers, etc. on muzzle exit, and continue to function safely. The safe life of these components should be at least as great as that of a barrel.

CHAMBER AND OBTURATION SYSTEM ASSEMBLY

10. Obturation

a. The breech mechanism shall be designed in conjunction with the ammunition to ensure effective obturation;

b. Firing shall not take place until the round is fully chambered and, where appropriate, the breech block, cylinder or bolt, is correctly positioned and locked;

c. The cylinder or breech block/bolt shall not unseal the chamber until the projectile has left the barrel and, preferably, the residual gases have vented, unless appropriate shielding or a ventilation system is incorporated to ensure no hazard to the crew, or damage to the weapon;

d. Sealing of the chamber and residual gases (after chamber opening) shall be such that levels of toxic concentration in manned areas from firing the cannon shall not exceed levels specified by the national safety authority. Levels of toxic concentration are to be measured, where appropriate, in installed weapon systems;

e. For revolver cannon, a breech cylinder should not commence rotation until the projectile has left the barrel. If rotation commences before projectile exit, then a thorough assessment shall be conducted to satisfy the developing nation that the level of risk is as low as possible and acceptable;

f. Satisfactory obturation shall be achieved under all environmental conditions including adverse conditions (e.g. wet or oily ammunition, icing conditions).

11. Bore Status Indicator An indicator is to be provided to give a readily accessible mechanical, visual or tactile indication of the presence of a round in the chamber. If feasible a similar indication should be given of the presence of any other hazardous object in the chamber.

12. Hot Gun Cook-off

a. Based on maximum practical operational and training firing regimes, the numbers of rounds to be fired and, for aircraft, the effects of the flight profile and other heating influences that could create cook-off temperatures in the breech, are to be established;

b. The temperature and associated dwell times at which cook-off of a chambered round may occur shall be established for each nature of ammunition;

c. A chambered round shall not cook-off under any specified firing regime or environment.

13. Dwell Time

a. The dwell time for a locked chamber of an externally powered weapon shall be sufficient to ensure that the round is fired and the chamber pressure has dropped to a safe level before the breech is opened;

b. In the case of a hangfire, no hazard to the crew or damage to the aircraft/carrier platform shall occur. The effects of a hangfire functioning after unlocking shall be assessed as a safety test (annex C, paragraph 7).

FEED/EXTRACTION MECHANISMS

14. Feed Operation The internal cannon feed/extraction mechanism shall not cause damage to the ammunition being cycled in the weapon that will result in a hazard or unsatisfactory functioning of either the weapon or ammunition.

15. Double Loading The cannon feed/extraction mechanism shall not allow the ramming of a round into an already occupied chamber.

16. Unloading The cannon feed/extraction mechanism shall enable unloading of ammunition from the feed mechanism without hazard to the firer, crew or vehicle.

FIRING MECHANISM/FIRING CIRCUITS

17. Vibration and Shocks The firing mechanism, whether cocked or uncocked, shall not inadvertently function as the result of shock (including survivable underwater shock for naval mountings and shock from firing), vibration, or any single mode of failure.

18. Electrical/Electronic Safety The design of firing circuits shall ensure that no single fault or failure of any kind can result in the inadvertent firing of a round.

19. Electro Explosive Device (EED) Safety

a. When a cannon which fires ammunition with an electrically initiated propelling charge is exposed to the specified electromagnetic (EM) environment, there shall be no induction of electromagnetic energy into the firing circuit the level of which would exceed the established No-Fire Threshold (NFT) energy level of the electro-explosive device (EED) lowered by a defined safety margin;

b. Where EED are used in the natures of ammunition in a cannon, the NFT for each nature shall be established by the developing nation to be the level of energy corresponding to a 0.001 probability of functioning with a single sided 95% level of confidence. The safety margin below the established NFT to which the firing circuit is designed shall be determined in accordance with the guidance provided by national authorities. If it is assessed that a significant probability exists of operation, the circuit shall be subjected to a safety test (Annex C Paragraph 11).

SAFETY MECHANISM/DEVICE

20. Safety Interlocks

a. Safety mechanisms/devices shall be provided to prevent the unintentional firing of a cannon:

(1) In a mechanically fired weapon, such a device should normally provide a mechanical interlock that would prevent the cartridge primer being struck;

(2) For electrically operated firing mechanisms, the requirement is for at least 2 independent safety switches, connected in series between the EED and its source of firing power. All switches controlling the initiation of an EED should be designed so that it is possible to return them to their open circuit condition, in the event of a misfire or cancellation of the firing, so that the required level of safety can be restored.

ANNEX B to
STANAG 4516
(Edition 1)

ASSESSMENTS IN SUPPORT OF CANNON SAFETY AND SUITABILITY FOR SERVICE EVALUATION

GENERAL

1. Paragraph 20 of this STANAG calls for analysis of the weapon system by formal hazard analysis methods. Conduct of this analysis is necessary to:

a. Determine the need for the conduct of the tests outlined in Annex C and to identify additional national tests.

b. Determine the appropriate test conditions as follows:

(1) Control (Annex C, Paragraph 2);

(2) Hot Gun Cook-Off (Annex C, Paragraph 5);

(3) Premature Functioning/Hangfire (Annex C, Paragraph 7);

(4) Double Loading (Annex C, Paragraph 8);

(5) Toxic Concentration/Gas Leakage (Annex C, Paragraph 9);

(6) Electrical Environments (Annex C, Paragraph 11);

(7) Contamination by Fluids (Annex C, Paragraph 12);

(8) Bump and Impact (Annex C, Paragraph 24);

(9) Underwater Shock (Annex C, Paragraph 25);

(10) Vibration (Annex C, Paragraph 26).

c. Assess compliance with particular design requirements where tests do not fully cover the design requirement(s) and/or are deemed to be inadequate:

(1) Single Point Failure (Annex A, Paragraph 4);

(2) Fatigue (Annex A, Paragraph 5);

(3) Barrel Locking (Annex A, Paragraph 7);

(4) Barrel Attachments (Annex A, Paragraph 9);

(5) Bore Status Indicator - detection of hazardous object other than a round (Annex A, Paragraph 11);

(6) Unloading (Annex A, Paragraph 16);

(7) Safety Interlocks (Annex A, Paragraph 20);

2. In general the results of tests conducted under Annex C should be assessed against the appropriate design requirement(s). Specific assessments in addition to the tests detailed in Annex C are outlined below.

SPECIFIC ASSESSMENTS

3. CRITICAL EXAMINATION

a. Reason For Assessment. Critical examinations are conducted to assess the effects of the environmental stressing and endurance firings on the cannon components;

b. Information. The cannon components are examined to determine if any physical or chemical changes have occurred in the components during the simulated life cycle. The need to examine other features may be identified during the environmental and firing tests;

c. Assessment Procedures. The examinations shall be conducted in accordance with national procedures.

4. RANGE SAFETY

a. Reason For Assessment. A range safety assessment is conducted to identify the area susceptible to the hazards produced by firing the cannon. The measurements will be applied to establish the Weapon Danger Area (WDA) and Noise/Toxic hazard areas;

b. Information. The assessment is required to identify the dimensions of the WDA specified in STANAG 2401 [when promulgated] and hazard areas for land ranges, training areas and sea firings. Information on ballistic performance from range tables will be required. The following additional information will also be required:

(1) Burst safety distance (explosively filled projectiles);

(2) Ricochet danger area (inert and explosive projectiles);

(3) Levels of toxic contaminants (for range installation) (Annex C, Paragraph 9);

(4) Noise (for range installation configuration) (Annex C, Paragraph 10);

(5) Minimum arming distance, in accordance with AOP-20, (for all types of fuze-fitted ammunition in use).

c. Assessment Procedure. The assessment shall be conducted in accordance with STANAG 2401, or national procedures.

TESTS IN SUPPORT OF CANNON SAFETY AND SUITABILITY FOR SERVICE EVALUATION
STRENGTH OF DESIGN

1. STRENGTH OF DESIGN

a. Reason For Test. The Strength of Design test is conducted to demonstrate that the cannon will remain safe and serviceable at the maximum extreme of gun pressure;

b. Information. The cannon is fired under precautions with ammunition prepared (or conditioned) to produce cannon Design Pressure (DP):

(1) Cannon DP may be achieved either by firing rounds filled with a special charge, or by firing standard rounds temperature conditioned to give the required pressure;

(2) The test should include firing all relevant types of ammunition (natures) at the maximum achievable rates of fire at the Upper Firing Temperature (UFT) and Lower Firing Temperature (LFT). The rate of fire may be dependent on both propellant temperature and the gun feed system; hence allowance is to be made for any likely increases in the rate of fire resulting from these influences.

c. Test Procedure. The test shall be conducted in accordance with national procedures. Trunnion forces should be monitored and recorded during these tests.

2. CONTROL OF FIRING MECHANISM

a. Reason For Test. The Control of Firing Mechanism test sequence is conducted to show whether the cannon will fire only when intended, and at the bearing and elevation intended.

b. Information. This test shall be used to determine the probability of a hazardous event where a Design Safety Assessment indicates that inadvertent firing may occur. The following aspects may be subjected to test:

(1) Vibration (Annex A Paragraph 17). The effect of vibration and shock likely to be experienced by the cannon in a weapon system (including underwater shock for naval mountings and shock from firing) shall be assessed to determine the probability of inadvertent operation of the firing mechanism. If it is assessed that a significant probability of inadvertent functioning exists, the firing mechanism shall be subjected to a safety test;

(2) Electrical Safety (Annex A Paragraph 18). The electrical design shall be assessed using FTA, FMECA or other structured analysis technique for component or sub-system failure and its consequences. Environmental effects shall also be examined, including the effect of conducted and radiated electromagnetic interference on the firing circuits. Tests, if appropriate, shall be made to ensure that a satisfactory degree of immunity to inadvertent operation or firing is demonstrated. Appropriate levels and tests identified in STANAGs 1307, 4234, 4235, 4236, 4239, 4324 4327 and 4370 (AECTP-500 series), or national documents shall be used.

(3) Interlocks (see Annex A Paragraph 20). The ability of the safety mechanisms/devices to prevent the unintentional firing of the cannon shall be assessed or tested in all appropriate modes of the cannon:

(a) In a mechanically fired weapon, such a device should normally provide a mechanical interlock that would prevent the cartridge primer being struck;

(b) For electrically operated firing mechanisms, the requirement is for at least 2 independent safety switches, connected in series between the electro-explosive device (EED) and its source of firing power. All switches controlling the initiation of an EED should be designed so that it is possible to return them to their open circuit condition, in the event of a misfire or cancellation of the firing, so that the required level of safety can be restored. The detailed assessment of the safety of firing circuits and safety switches shall be conducted in accordance with national safety documentation.

c. Test Procedure. Tests shall be conducted in accordance with procedures identified in Paragraphs 11, 24, 25 and 26 of Annex C or with national procedures.

3. ACCURACY

a. Reason For Test. The Accuracy test is conducted to demonstrate that the trajectory of projectiles fired from the cannon throughout its life will remain predictable and within the accuracy stated by the developing nation. For the trajectory to be predictable implies that the projectile will have adequate stability on muzzle exit to remain stable throughout its flight;

b. Information. The cannon is fired with new and worn barrels and with all natures of ammunition to be used on the gun;

c. Test Procedure. Tests shall be conducted in accordance with national procedures. The accuracy assessment may be incorporated into other trials requiring similar firing prerequisites.

4. FULL FIRE OUT

a. Reason For Test. The Fire Pull Out test is conducted to demonstrate safety in the event of the fire control system failing to de-activate;

b. Information. This test is normally applied to aircraft installations where there is the possibility of a full ammunition load being fired in one burst which may result in aircraft self-damage from unstable rounds. The cannon is fired with a part worn barrel and with ammunition representative of the worst stress load on the gun;

c. Test Procedure. Tests shall be conducted in accordance with national procedures.

5. HOT GUN COOK-OFF

a. Reason For Test. The Hot Gun Cook Off test is conducted to establish the conditions under which cook-off may occur;

b. Information. The cook-off temperatures and the associated dwell time for all natures of ammunition used in the cannon shall be established before this test. For aircraft, the effects of kinetic heating need to be established. The temperature gradient between the outside and inside of the chamber, obtained by experiment if necessary, must be known. The cannon is fired at the maximum rate and duration of sustained fire specified. The external chamber temperature is to be observed continuously during firing. If the external reading indicates that the chamber may have reached the cook-off temperature threshold, firing is to cease immediately, leaving the gun empty. Immediately after firing ceases, the temperature of the chamber is to be measured to confirm that the cook-off threshold was reached. If the cook-off temperature is reached before the specified duration of fire is achieved, consideration may have to be given to altering the cycle to ensure safety. When making this decision, i.e. altering the cycle to ensure an acceptable level of safety, any change to the dwell time and the possibility of it being extended further by a fault condition, must be considered;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

6. OBSTRUCTED BARREL

a. Reason For Test. This test is conducted to identify credible hazards created if a cannon is fired with an obstructed barrel;

b. Information. The test shall be conducted with each nature of live ammunition. The result of firing through any intended muzzle cover shall be established in this or other firing tests;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

7. PREMATURE FUNCTIONING/HANGFIRE

a. Reason For Test. The Premature Function/Hangfire test is conducted to identify hazards in the event of a round functioning during feeding, howsoever caused, or, in the case of externally powered cannon, after bolt unlocking in the event of a hangfire;

b. Information. This test is only required if the hazard analysis or design safety assessment identifies such an event to be a credible hazard. The positions in which a round may function are to be established from the design safety assessment;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

8. DOUBLE LOADING

a. Reason For Test. The Double Loading test is conducted to identify hazards in the event of a round being rammed into an already occupied chamber;

b. Information. This test is only required if the hazard analysis or design safety assessment identifies double loading as a hazard. Consideration shall be given to

conducting this test with each nature of live ammunition; some read-across may be possible.

c. Test Procedure. The test shall be conducted in accordance with national procedures.

9. TOXIC CONCENTRATION/GAS LEAKAGE

a. Reason For Test. The Toxic Concentration/Gas Leakage test is conducted to assess the hazards from the leakage of combustion products from the cannon;

b. Information. Samples of combustion products are to be collected in selected crew and adjacent personnel locations and analysed. Levels of toxic concentration in the area of crew stations in manned weapons are to be within the limits set by national safety authorities. For aircraft, the composition and quantities of propellant gases are to be established and any explosive hazard from these gases is to be identified to assist the design of the ventilation system for the aircraft installation. The ammunition nature which produces the "worst" toxic concentration shall be used. Firing from vehicle or aircraft installations shall be conducted with all likely variations of hatches/doors open/shut;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

10. NOISE/BLAST OVERPRESSURE

a. Reason For Test. The Noise/Blast Overpressure test is conducted to establish the potential area for damage to personnel and equipment from blast overpressure;

b. Information. Blast overpressure/noise levels in the vicinity of the cannon shall be established. The test may be carried out without any adjacent structure to identify the basic noise danger area. The ammunition nature which produces the "worst" blast overpressure shall be used. It will be necessary for national authorities to repeat the tests for each specific installation in each particular type of ship or vehicle because the noise experienced by the crews of weapon systems will be significantly affected by the reflection and adsorption from adjacent surfaces. This is not normally applicable to fixed aircraft cannon. The levels of noise in the area of crew stations in manned weapons are to be within the limits set by national safety authorities;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

11. ELECTRICAL ENVIRONMENTS

a. Reason For Test. The electrical environment tests are conducted to assess the vulnerability of the firing and/or fuze setting circuits or cannon weapon system circuits to electrical environments;

b. Information. These tests are applicable to cannon containing electrical circuits which influence safety and suitability for service. Tests which may be required are:

(1) Transient Test. The Transient Test identifies the effect of electrical switching sequences within the weapon on the ignition EED;

(2) Internal RADHAZ. This test identifies the effect of the operation of internal rf sources on the ignition EED or fuze setting, if applicable. For an electrically controlled weapon system then the test should also be applied to the control circuits;

(3) External RADHAZ. This test identifies the effect of likely external rf sources on the ignition EED or fuze setting, if applicable. For an electrically controlled weapon system then the test should also be applied to the control circuits;

(4) Electrostatic Test. This identifies the vulnerability of the ignition system EED to electrostatic discharges. The test will normally only be undertaken if the hazard assessment indicates potential vulnerability of the EED to electrostatic discharge;

(5) Lightning. This test identifies the vulnerability of the ignition system EED to lightning. The test procedure will normally be conducted only after a Lightning Hazard Design Assessment in accordance with STANAG 4327 and AOP-25;

(6) Electromagnetic Compatibility (EMC). These tests are to demonstrate the conducted and radiated EMC of all components of the cannon system.

c. Test Procedures. Environments appropriate for use in tests are described in national procedures or other documents (sub-paragraphs (1) and (2)) and STANAGs 1307, 4234, 4235 and 4236 (sub-paragraphs (3), (4) and (5)). The following procedures are applicable:

(1) Transient Test. All electrical switching sequences within the weapon system are to be operated and the effect recorded following national procedures. Such measurements are best made using test equipment that simulates an EED in its electrical properties but has no explosive content;

(2) Internal RADHAZ. The operational EED in the ignition system is replaced with an inert, instrumented device which measures the level of induced power. All internal rf sources are then operated in turn or together to a set plan representative of the worst operational combination and all likely frequency variations. Where practicable, power is enhanced by 6dB to allow for equipment variations. Tests on fuze setting and control functions shall also be conducted, as applicable, using national procedures;

(3) External RADHAZ. Using the instrumented device, likely combinations of external radio and radar transmitters are operated to a set plan and the results recorded. Levels may be extrapolated to give the worst case, except for electronic circuits which may be non-linear. In such cases, a higher level can be simulated by use of current monitoring and injection techniques. The tests shall be conducted in accordance with STANAG 4324 Ed. 2 (when ratified) or national procedures. Tests on fuze setting and control functions shall also be conducted, as applicable, using national procedures;

(4) Electrostatic Test. If required, the test shall be conducted in accordance with STANAG 4239 and AOP-24;

(5) Lightning. If required, the test(s) shall be conducted in accordance with STANAG 4327 and AOP-25;

(6) Electromagnetic Compatibility. Tests shall be conducted in accordance with the AECTP-500 series procedures (when published) or in accordance with national procedures.

12. CONTAMINATION BY FLUIDS

a. Reason For Test. The Contamination by Fluids test is conducted to demonstrate that the cannon will remain safe and serviceable following exposure to fluids typical of those which may cause contamination in service;

b. Information. The range of fluids to be considered includes fuels, oils, hydraulic fluids, solvents, cleaning fluids, battery electrolytes and nuclear fall-out decontamination fluids. The fluids to be used and the severity parameters should be determined from a consideration of the life cycle and hazard analyses. Consideration shall be given to the need to pre-heat some fluids to appropriate temperatures. The cannon is to be mounted in a representative service installation and account shall be taken of any environmental protection provided for the weapon. These tests do not attempt to assess the compatibility of materials continuously exposed to operating fluids. Compatibility testing should be conducted separately where materials are in continuous contact with a new material;

c. Test Procedures. The test shall be conducted in accordance with AECTP-300 - Method 314.

13. NUCLEAR HARDENING

a. Reason For Test. The Nuclear Hardening test or assessment is conducted to demonstrate that the cannon will remain safe, or safe and serviceable, following exposure to the effects of a nuclear explosion;

b. Information. The potentially damaging effects of a nuclear explosion are electromagnetic pulse (EMP), initial nuclear radiation (INR), air-blast and thermal radiation. Consideration should be given to severity levels of these effects at which the cannon should remain safe, and severity levels at which the cannon should remain safe and serviceable;

c. Test Procedure. The EMP test or assessment for firing circuits shall be conducted in accordance with STANAG 4416 (Draft). National procedures shall be used for INR, air-blast and thermal assessments.

FUNCTIONING AND DURABILITY TESTS

14. INITIAL FUNCTIONING

a. Reason For Test. The Initial Functioning test is conducted to demonstrate that all cannon supplied for testing function safely as designed;

b. Information. In order to provide assurance that cannon delivered for testing function safely as designed, a firing test is conducted with all natures of ammunition to be used in the gun as a precursor to any sequential tests. A similar test would normally be conducted on all cannon delivered for operational use;

c. Test Procedure. Firing tests using all natures of ammunition to be used in the gun shall be conducted in accordance with national procedures.

15. FUNCTIONING - HOT

a. Reason For Test. This test is conducted to demonstrate that the cannon will remain safe and serviceable during, and after, functioning in hot humid or hot dry conditions;

b. Information. The test is conducted with the cannon and ammunition conditioned to the Upper Firing Temperature (UFT). The UFT will depend on the environment to which the cannon is to be subjected in-service. For internally mounted cannon, the maximum shade temperature may be selected. For externally mounted cannon, other than on aircraft, the UFT shall be the upper temperature of the storage and transit diurnal cycle for the appropriate Climatic Category as specified in STANAG 2895. For aircraft cannon, the maximum likely effect of kinetic heating shall be simulated. The test may be conducted with low humidity conditions, or with controlled high humidity conditions superimposed. The selection of the constant temperature to be used, and the degree of humidity to be applied, will depend upon assessment of the worst case in-service installation of the weapon. Account shall be taken of any environmental protection provided for the weapon which may be removed, where appropriate, after conditioning and before firing;

c. Test Procedure. The test shall be conducted in accordance with AECTP-300 - Method 302 using a sample of rounds representative of the duty cycle.

16. FUNCTIONING - COLD

a. Reason For Test. This test is conducted to demonstrate that the cannon will remain safe and serviceable during, and after, functioning in dry, cold conditions;

b. Information. This test is conducted with the cannon and ammunition conditioned to the Lower Firing Temperature (LFT). The LFT test constant temperature is the lowest temperature of the storage and transport diurnal cycle specified in STANAG 2895 for the anticipated life cycle profile. Account shall be taken of any environmental protection provided for the weapon which may be removed, where appropriate, after conditioning and before firing;

c. Test Procedure. The test shall be conducted in accordance with AECTP-300 - Method 303 using a sample of rounds representative of the duty cycle.

17. FUNCTIONING - CHANGING TEMPERATURE/HUMIDITY CONDITIONS

a. Reason For Test. This test is conducted to demonstrate that the cannon will remain safe and serviceable during and after functioning during the transition between thawing and freezing conditions;

b. Information. This test is applicable to externally mounted and aircraft mounted cannon;

c. Test Procedure. The test shall be conducted in accordance with AECTP-300 - Method 315 (when promulgated).

18. BARREL WEAR TRIAL

a. Reason For Test. The Barrel Wear Trial is conducted to determine the amount of wear beyond which safety and/or performance requirements are not met, and hence to assess the wear limit of the barrel in service;

b. Information. Two barrels are required in order to provide 2 sets of data. The barrels must be of the same type and build standard. Ideally both barrels should be new, but they may be partially worn provided that wear is similar and their firing histories have been properly documented and representative of service use. Rounds are fired in repeated cycles of control rounds, where the performance is monitored, and expenditure rounds to wear the barrel. The control rounds should be conditioned to the UFT and expenditure rounds conditioned to 21±3°C. After each cycle an ordnance inspection should be conducted to assess the wear. The cycle is repeated until wear degrades the performance of the control rounds to the point where requirements (accuracy, velocity, safety, etc.) are not met;

c. Test Procedure. The test shall be conducted in accordance with STANAG 4517, or national procedures.

19. FATIGUE TEST

a. Reason For Test. The Fatigue Test is conducted to determine the amount of barrel and breech assembly fatigue beyond which safety requirements are not met, and hence to determine the safe fatigue life of the ordnance;

b. Information. A number of cannon are tested to the point of fatigue failure to determine the safe fatigue life of the barrel and breech assembly. It would be prohibitive to conduct the test purely by the expenditure of rounds, hence after an initial firing period it is normal to pressure cycle the ordnance to failure using the Cannon Fatigue Design Pressure as defined in STANAG 4110;

c. Test Procedure. The test shall be conducted in accordance with STANAG 4517, or national procedures.

20. INTERCHANGEABILITY OF PARTS

a. Reason For Test. The Interchangeability of Parts test is conducted to demonstrate that the cannon will remain safe and serviceable when new and worn components or groups of components are interchanged;

b. Information. The component exchange shall be related to anticipated in-service maintenance and repair policies. The test may be conducted during the Endurance Firing Test (Annex C, Paragraph 30);

c. Test Procedure. The test shall be conducted in accordance with national procedures.

21. CANTED CANNON FIRING

a. Reason For Test. The Canted Cannon Firing test is conducted to demonstrate that the cannon will remain safe and serviceable when operated in the automatic mode at all anticipated angles of roll, pitch, azimuth and elevation;

b. Information. The cannon is functioned at the extremes of permissible movement and at sample points in between, as appropriate;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

22. RECOCKING

a. Reason For Test. The Recocking test is conducted to demonstrate that the cannon will remain safe and serviceable after the operation of any automatic recocking system;

b. Information. This test is usually only required for aircraft cannon. The test may be undertaken during the Endurance Firing (Annex C Paragraph 30) or other suitable test;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

23. FEED CHANGE

a. Reason For Test. The Feed Change test is conducted to demonstrate that the cannon remains safe and serviceable when alternative ammunition feed mechanisms are selected;

b. Information. This test is only required for cannon with 2 or more selectable feed systems. It may be undertaken during other firing tests;

c. Test Procedure. The test shall be conducted in accordance with national procedures.

24. BUMP AND IMPACT

a. Reason For Test. The Bump and Impact test is conducted to demonstrate that the cannon will not function unintentionally during shock loading and will function satisfactorily afterwards;

b. Information. Shock, transient vibration or accidental impacts may occur during the life of the weapon system. They may arise by design during use (e.g. catapult launch/arrested landing in aircraft mounted systems). The severity should be chosen to be representative of the worst case likely to be encountered during the life cycle. Tests shall be conducted with the cannon cocked and uncocked;

c. Test Procedure. The test shall be conducted in accordance with AECTP-400 - Method 403.

25. UNDERWATER SHOCK

a. Reason For Test. The Underwater Shock tests are conducted to demonstrate that the cannon, when installed in a naval or merchant vessel and subjected to the shock of

underwater explosion, will not function unintentionally and, where appropriate, will remain safe and suitable for service after the shock;

b. Information. There are 2 levels of severity of test:

(1) The cannon is required not to function unintentionally at the level appropriate to vessel survival (ammunition is required to remain safe for handling and disposal);

(2) For Weapon Survival for Service Use, the cannon must not function unintentionally and the weapon (and ammunition) must remain safe and serviceable. The Survival for Service Use Test is to be conducted as part of the sequential trial.

c. Test Procedure. The tests shall be conducted in accordance with national procedures. The shock levels will vary according to the class of ship and the location of the mounting. The levels used by the developing nation(s) for this test shall be measured on the cannon and be recorded.

26. VIBRATION

a. Reason For Test. The Vibration test is conducted to demonstrate that the cannon will not function unintentionally while being subjected to anticipated service vibration regimes, and will remain safe and serviceable afterwards;

b. Information:

(1) The action of the cannon will be exposed to significant and repetitive gun shocks prior to and during firing;

(2) The type of vibration testing selected must be chosen from the worst cases identified from the life cycle specified. When the cannon is installed in a mounting for the purpose of vibration testing, the configuration should be defined and vibration levels, experienced on the gun, should be measured and recorded. It may be necessary to carry out the selected vibration tests at appropriate high and/or low temperatures associated with specified areas for operational deployment. It may be necessary to consider the effect of low air pressures associated with carriage and operation at high altitude.

c. Test Procedure. Tests shall be conducted in accordance with AECTP-400 - Method 401, using data gathered from the appropriate platforms and gun systems for gun shock levels. If the firing platform is to be a tracked vehicle, test levels shall be in accordance with STANAG 4242. The vibration levels experienced on the gun shall be measured and recorded by the developing nation(s).

27. RAIN

a. Reason For Test. The Rain test is conducted to demonstrate that the cannon will remain safe and serviceable during and after exposure to driving rain;

b. Information. The parameters of the test are defined by rainfall intensity and duration. The cannon is to be mounted in a representative service installation and account shall be taken of any environmental protection provided for the weapon;

c. Test Procedures. The test shall be conducted in accordance with AECTP-300 - Method 310 and the weapon functioned during the test and on completion of the test procedure.

28. SALT SPRAY

a. Reason For Test. This test is conducted to demonstrate that the cannon will remain safe and serviceable following prolonged exposure to a salt atmosphere;

b. Information. This test is normally only conducted for Naval mountings or aircraft cannon systems if metallic parts are exposed to this environment. The severity of the test is determined by the spraying time and the subsequent storage conditions (temperature, humidity and duration). The cannon is to be mounted in a representative service installation and account shall be taken of any environmental protection provided for the weapon;

c. Test Procedures. The test shall be conducted in accordance with AECTP-300 - Method 309 and the weapon functioned on completion of the test procedure.

29. DUST AND SAND

a. Reason For Test. The Dust and Sand test is conducted to demonstrate that the cannon will remain safe and serviceable following exposure to blowing dust and sand;

b. Information. The test is applicable to cannon systems mounted in vehicles or rotorcraft. It may also be appropriate for fixed wing aircraft systems. The test severity is determined by the particle size and concentration, the air velocity and the test duration. The cannon is to be mounted in a representative service installation and account shall be taken of any environmental protection provided for the weapon;

c. Test Procedures. The test shall be conducted in accordance with AECTP-300 - Method 313 and the weapon functioned during the test, if appropriate, and on completion of the test procedure.

30. ENDURANCE FIRING

a. Reason For Test. The Endurance Firing tests are conducted to demonstrate that the cannon will function satisfactorily throughout the anticipated service life of the cannon and the durability of components;

b. Information. The tests shall be conducted with service weapons including representative feed systems, spent case and link (or clip) ejection systems, as applicable, together with gun control units. The cannon is fired to establish the functional reliability after a full programme of environmental stressing. The effect of temperature and wear is established. The firing regimes shall represent specified in-service usage. Other tests may be incorporated into the firing sequence. The programme may include:

(1) Firing at ambient temperature (if required);

(2) Firing hot conditioned ammunition;

(3) Firing cold conditioned ammunition;

(4) Barrel wear and erosion rates for the specified firing cycle;

(5) Firing with a worn barrel;

(6) Firing at extremes of elevation.

c. Test Procedures. The tests shall be conducted in accordance with national procedures. On completion a critical examination should be conducted in accordance with Annex B, Paragraph 3.