NATO STANDARD

AEPP-3

NATO STANDARD PACKAGING TEST PROCEDURES

Edition B Version 1
January 2015

NORTH ATLANTIC TREATY ORGANIZATION

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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NATO LETTER OF PROMULGATION

12 January 2015

1. The enclosed Allied Engineering Practices Publications AEPP-3, NATO STANDARD PACKAGING TEST PROCEDURES, Edition B, Version 1, which has been approved by the nations in the Life Cycle Management Group (AC/327), is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4340.

2. AEPP-3 Edition B Version 1 is effective upon receipt.

3.

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
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]

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CHAPTER 1 - INTRODUCTION

1.1 Purpose

The purpose of this Allied Publication is to establish NATO Standard Packaging Test Procedures. These procedures shall, when applicable, be used to validate that packaging meets the storage and distribution requirements of STANAG 4280 "NATO Packaging and Preservation".

1.2 Application

Participating nations agreed that the test procedures in chapter 4 shall, as applicable, be used to determine conformance to any of the NATO Levels of packaging as described at STANAG 4280. It is also agreed that the test requirements and procedures can be used to verify conformance to those national levels and their deemed NATO equivalent as listed in the comparison maxtrix given in STANAG 4280.
Test methods and severities are either defined in STANAG 4370 with associated Allied Environmental Conditions and Test Publications (AECTPs) or chapter 4 of this document.

1.3 Limitations

These test procedures are limited to the package itself including any isolation materiel (etc.) and not applicable to the assessment of the content of packages.

The test procedures in this document are a convergence of the previous packaging test procedures in AEPP-3 edition 1 with the appropriate AECTPs. In this interim document the severities and procedures have not been fully harmonized. Currently, the severities and procedures that are not fully harmonized are discussed in the limitations section of each test procedure.
Any additional requirements (beyond those given in the AECTP) are indicated in the additional guidelines sections of each procedure within this document. At a later date severities and procedures will be revised as necessary.

1.4 Definitions

Related terms used in AEPP-3 are defined in AAP-23.

1.5 Related Documents

AAP-23	NATO Glossary of Packaging Terms and Definitions (English and French).
ISO 2233	Packaging - Complete, filled transport packages - Conditioning for testing.
ISO 2234	Packaging - Complete, filled transport packages - Stacking tests using static load.
STANAG 2828	Military pallets, packages and containers
STANAG 2830	Material handling aids
STANAG 4280	NATO Packaging and Preservation
STANAG 4340	NATO Standard Packaging Test Procedures
STANAG 4370	Environmental Testing
STANAG 4398	NATO Requirements for Reusable Containers (AEPP-1)
STANAG 4434	NATO Standard Packaging for Materiel Susceptible to Damage by Electrostatic Discharge (AEPP-2)

1.6 Outline of Test Requirement

Standard test procedures as detailed in chapter 4 shall be performed, as deemed appropriate between participating Nations, to ensure packagings will be resistant to damage and deterioration when exposed to the standard storage and distribution requirements defined in STANAG 4280 " NATO Packaging and Preservation".

Appropriate levels of severity, as defined by these tests, shall be selected as required by the NATO level in which the package is to be exposed, as defined in STANAG 4280 and chapter 2 of this AEPP.

If variations occur in conditioning, storage, and distribution requirements of chapter 2 and national procedures, the requirements of chapter 2 shall take precedence.

These standard tests define criteria, methods and severity of tests performed to simulate the hazards and environments described in chapter 2.

a. Package testing is primarily intended to assess the overall ability of the package design to resist the external influences. This usually involves subjecting a package to tests in a sequencial program to provide evidence for assessment of its performance in a cumulative manner.
b. The scope and degree of package testing is dependent upon the environments and hazards expected to be encountered during the life cycle of the package.
c. To check the total performance of a package design and achieve a high level of confidence in the ability of the designed package to meet the hazards of distribution, an ideal series of tests would accurately simulate the life of the package. In practice, the ideal is moderated either by a belief that the package would survive the hazard/test or by knowledge that a particular hazard/test is not applicable. A package is not necessarily subjected to all the tests since the nature of the packaged item and the detail of the package design may indicate that only certain tests are appropriate.
d. Evidence for assessment of the performance may be gained by subjecting the test package to climatic and physical tests alternately where one acts as a conditioning test for the next. Evidence may be more usefully gained by simultaneously subjecting two or more packages to the test sequence and withdrawing one at a particular stage for examination.

CHAPTER 2 – NATO LEVELS OF PACKAGING

2.1 Packaging to NATO Level 1

Packaging to this level shall provide adequate protection against the following environmental conditions and mechanical constraints.

Table 1 – NATO Level 1

Aspects	Specifics	Test procedure(s) to be considered
	Storage	
Storage manner	*Outdoor (watertightness and damp heat required)*	
Climatic zones (AECTP 230 / Leaflet 2311)	*A1, A2, A3, B1, B2, B3, C0, C1, C2, C3, M1, M2 and M3*	*A , B , C , D*
Expected temperatures and humidity	*Storage and transit conditions of mentioned zones above*	
Stacking heights	*4m max.*	*M , N , O*
Duration	*1 year*	
	Distribution	
Transit by	*Road, rail, sea and air in open or enclosed conditions*	
Climatic conditions	*Diurnal temperatures, humidities and rainfall as defined above*	*F*
Handling	*By any method*	*J , P , Q , R , S , T , U , V*
Transportation means	*Wheeled : all types of terrain* *Tracked : all types of terrain* *Air : propeller, jet, helicopter* *Sea : hull, deck and cargo hold* *Rail*	*H , I*
Shocks	*Vertical drop up to max. 1m height* *Horizontal impact velocity of 2.5 m/s*	*K , L*
Vibration	*Vibration levels should envelope all transportation means as mentioned above*	*G*
Immersion	*Partial for 6 days*	*E*

2.2 Packaging to NATO Level 2

Packaging to this level shall provide adequate protection against the following environmental conditions and mechanical constraints.

Table 2 – NATO Level 2

Aspects	Specifics	Test procedure(s) to be considered
	Storage	
Storage manner	*Outdoor (watertightness and damp heat required)*	
Climatic zones (AECTP 230 / Leaflet 2311)	*A2, A3, B1, B2, C0, C1 and C2*	*A , B , C , D*
Expected temperatures and humidity	*Storage and transit conditions of mentioned zones above*	
Stacking heights	*4m max.*	*M , N , O*
Duration	*3 years*	
	Distribution	
Transit by	*Road, rail, sea and air in open or enclosed conditions*	
Climatic conditions	*Diurnal temperatures, humidities and rainfall as defined above*	*F*
Handling	*By any method*	*J , P , Q , R , S , T , U , V*
Transportation means	*Wheeled : all types of terrain* *Tracked : all types of terrain* *Air : propeller, jet, helicopter* *Sea : hull, deck and cargo hold* *Rail*	*H , I*
Shocks	*Vertical drop up to max. 1m height* *Horizontal impact velocity of 2.5 m/s*	*K , L*
Vibration	*Vibration levels should envelope all transportation means as mentioned above*	*G*
Immersion	*Partial for 6 days*	*E*

2.3 Packaging to NATO Level 3

Packaging to this level shall provide adequate protection against the following environmental conditions and mechanical constraints.

Table 3 – NATO Level 3

Aspects	Specifics	Test procedure(s) to be considered
	Storage	
Storage manner	*Ventilated permanent buildings (watertightness not required)*	
Climatic zones (AECTP 230 / Leaflet 2311)	*A2, A3, C0 and C1, C2*	*A , B*
Expected temperatures and humidity	*Meteorological conditions of mentioned zones above*	
Stacking heights	*4m max.*	*M , N , O*
Duration	*5 years*	
	Distribution	
Transit by	*Road, rail, sea and air in enclosed conditions*	
Climatic conditions	*Diurnal temperatures and humidities as defined above*	*C*
Handling	*By any method, but use of mechanical handling equipment preferred*	*J , P , Q , R , S , T , U , V*
Transportation means	*Wheeled : paved roads, cross country* *Tracked : all types of terrain* *Air : propeller, jet, helicopter* *Sea : hull, deck and cargo hold* *Rail*	*H , I*
Shocks	*Vertical drop up to max. 0.75m height* *Horizontal impact velocity of 2.5 m/s*	*K , L*
Vibration	*Vibration levels should envelope all transportation means as mentioned above*	*G*
Immersion	*Not required*	

2.4 Packaging to NATO Level 4

Packaging to this level shall provide adequate protection against the following environmental conditions and mechanical constraints.

Table 4 – NATO Level 4

Aspects	Specifics	Test procedure(s) to be considered
	Storage	
Storage manner	*Ventilated buildings (watertightness not required)*	
Climatic zones (AECTP 230 / Leaflet 2311)	*A2, A3, C0 and C1, C2*	*A , B*
Expected temperatures and humidity	*Meteorological conditions of mentioned zones above*	
Stacking heights	*4m max.*	*M , N , O*
Duration	*1 year*	
	Distribution	
Transit by	*Road, rail and sea in enclosed freight container conditions, air without transhipment*	
Climatic conditions	*Diurnal temperatures and humidities as defined above*	*C*
Handling	*Minimal handling by mechanical handling equipment only*	*J , R , S , T , U , V*
Transportation means	*Wheeled : paved roads* *Tracked : not required* *Air : propeller, jet, helicopter* *Sea : hull, deck and cargo hold* *Rail*	*H , I*
Shocks	*Vertical drop up to max. 0.3m height* *Horizontal impact velocity of 2.5 m/s*	*K , L*
Vibration	*Vibration levels should envelope all transportation means as mentioned above*	*G*
Immersion	*Not required*	

CHAPTER 3 - STANDARD TEST REQUIREMENTS AND PROCEDURES

3.1 General

The procedures detailed in this document are either related to environmental testing or are packaging specific tests.

The environmental testing procedures are set out in terms of:

a. reference to an applicable AECTP test method,
b. limitations to the referenced AECTP method when applied as packaging test,
c. additional guidelines when applying the referenced AECTP method as packaging test.

The packaging specific tests are set out in terms of:

a. the basis and / or purpose of the test,
b. test equipment / apparatus,
c. test procedure.

Table 5 - Comparison table AEPP procedures with AECTP methods

Criteria	AEPP-3 Prodecure	Comparable AECTP Method (STANAG 4370)
Climatic	A - Dry Heat	302 ‘High Temperature’
	B - Low Temperature	303 ‘Low Temperature’
	C -Dry Heat (solar exposure)	305 ‘Solar Radiation’
	D - Damp Heat	306 ‘Humid Heat’
	E - Water immersion	307 ‘Immersion’
	F - Water spray	310 ‘Rain and Watertightness’
Mechanical	G - Vibration	401 ‘Vibration’
	H - Bump	403 ‘Classical Waveform Shock’
	I - Bounce	406 ‘Loose Cargo’
	J - Handling	409 ‘Materiel Lifting’
	K - Drop test (Free fall)	414 ‘Handling’ Procedure I
	L - Horizontal Impact	414 ‘Handling’ Procedure II
Storage	M - Stacking	410 ‘Materiel Stacking’
	N - Bending	411 ‘Materiel Bending’
	O - Flexing	412 ‘Materiel Racking’
Packaging specific	P - Cornerwise drop	No comparable test method
	Q - Edgewise drop	
	R - Topple	
	S - Rolling	
	T - Mechanical Handling	
	U - Leaks in containers	
	V - Heat-sealed Seam	

Each of the tests is a simulation either wholly or in part of an environment or hazard which varies according to the NATO Packaging Level (STANAG 4280) and the package mass, size and shape.

This AEPP does not address all of the safety and health aspects associated with its use. It is the responsibility of whoever uses this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

The appropriate tests and their sequence for acceptance of a package design should be decided after consideration of the following factors:

a. the required NATO packaging level;
b. the nature of the item of materiel; and
c. the design features of the package.

It may not be necessary to invoke any form of acceptance test for very simple package designs, or where the results of development tests are deemed to provide adequate evidence for acceptance of the design, or where test experience in the design of the package for a technically similar item has confirmed the adequacy of the protection measures employed.

Additional tests, or tests not normally applicable to the NATO level of packaging under review, may be included if considered necessary for purposes of acceptance, particularly if a special operational requirement exists.

It is possible that during testing damage may occur which is not apparent until the performance of subsequent tests performed in the programme. It is important therefore that due care is taken when evaluating the results of any individual test or sequence of tests.

3.2 Climatic Conditioning

Where it is expected that the resistance of a package against the acting environmental influences will be affected by by its temperature, it is advised to perform those tests with a temperature conditioned test packaging.
Test packages shall be conditioned in accordance with one or several of the maximum temperatures as mentioned in STANAG 4280 for the lesser of 16 hours or until equilibrium is reached.

The tests should, wherever practical, be conducted in a chamber with the test item stabilised at the required conditions. If size limitations or safety hazards prevent this, the stabilised test item should be removed from the chamber and the test must commence within 5 minutes or as quickly as possible.
Subsequent pre-conditioning of the test item may again be required if the climatic conditions of the test item exceed the tolerances in the Test Instructions during the test. Refer to individual procedures for possible additional conditioning guidelines.

3.3 Evaluation

The test item performance should meet all appropriate Test Instruction requirements during and following the application of the test loading and environmental conditions. The package shall be considered to have failed the test if the packaged item is unserviceable or if the package is affected in any way which would potentially cause the item to become unserviceable or unsafe to handle. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test. A test report shall be prepared certifying compliance to or deviation from the test procedure, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package. Refer to individual procedures for possible additional evaluation guidelines.

CHAPTER 4 - TEST PROCEDURES

PROCEDURE A – DRY HEAT TEST

General

The dry heat environment and how to test for it is described in Method 302 “High Temperature” of AECTP 300 under STANAG 4370. Packages which are required to withstand dry heat have historically employed the same method as Method 302 but including limitations and additional requirements that are now considered to be unrepresentative. Method 302 should be used without limitations and additional requirements.

Limitations

There are no limitations on the Method 302 “High Temperature”.

Additionial guidelines

The prescribed procedure and severity in Method 302 “High Temperature”, Procedure I shall be used.

PROCEDURE B – LOW TEMPERATURE TEST

General

The low temperature environment and how to test for it is described in Method 303 “Low Temperature” of AECTP 300 under STANAG 4370. Packages which are required to withstand low temperature have historically employed the same method as Method 303 but including limitations and additional requirements that are now considered to be unrepresentative. Method 303 procedure I should be used without limitations and additional requirements.

Limitations

There are no limitations on the Method 303 “Low Temperature”.

Additionial guidelines

The prescribed procedure and severity in Method 303 “Low temperature”, Procedure I shall be used.

PROCEDURE C – DRY HEAT (SOLAR) EXPOSURE TEST

General

The solar radiation environment and how to test for it is described in Method 305 “Solar Radiation” of AECTP 300 under STANAG 4370. Packages which are required to withstand solar radiation have historically employed the same method as Method 305 but including limitations and additional requirements that are now considered to be unrepresentative. Method 305 should be used without limitations and additional requirements.

Limitations

There are no limitations on the Method 305 “Solar Radiation”.

Additionial guidelines

The prescribed procedure and severity in Method 305 ‘Solar radiation’, Procedure I and II shall be used.

PROCEDURE D – DAMP HEAT TEST

General

The low temperature environment and how to test for it is described in Method 306 “Humid Heat” of AECTP 300 under STANAG 4370. Packages which are required to withstand damp heat have historically employed the same method as Method 306 but including limitations and additional requirements that are now considered to be unrepresentative. Method 306 procedure I should be used without limitations and additional requirements.

Limitations

There are no limitations on the Method 306 “Humid Heat”.

Additionial guidelines

The prescribed procedure and severity in Method 306 “Humid Heat”, Procedure I shall be used.

PROCEDURE E – WATER IMMERSION TEST

General

The immersion environment and how to test for it is described in Method 307 “Immersion” of AECTP 300 under STANAG 4370. Packages which are required to withstand immersion have historically employed the same method as Method 307 but including the limitations and additional requirements given below. This does not cover any specific environment as described in Method 307 but can be used for comparision with other packages. If a specific environment is required then Method 307 should be used without limitations and additional requirements given below.

Limitations

Contrary to the prescribed procedure and severity as mentioned in Method 307 “Immersion” Procedure I ‘Complete Immersion’, the following shall apply:

a. Immerse the test package and hold a static head of water of 1.3 m
b. The test package shall be immersed for a total of 2 hours

Additional guidelines

In addition to the prescribed procedure and severity as mentioned in Method 307 “Immersion” Procedure I ‘Complete Immersion’, the following shall also apply:

a. The immersion test is replaced by the water spray test when the exterior dimensions of the test package, as calculated below, exceed 3 m.
    - For a rectangular prism exterior dimensions = length + width + height
    - For a cylinder exterior dimensions = length plus twice the diameter
b. The temperature of the water in the holding tank shall not exceed 27°C.
c. Packages up to and including 40 kg shall be immersed, standing on each face in turn, for a period of 20 minutes in each position.
d. Packages over 40 kg shall be immersed standing on their base for the total time.
e. Cylindrical packages shall be immersed standing on their ends and sides.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any penetration of moisture into the test package shall constitute failure of the test.

PROCEDURE F – WATER SPRAY TEST

General

The general purpose and application of this test can be found in Method 310 ‘Rain and Watertightness’ of AECTP 300 under STANAG 4370. The procedure I ‘Rain and Blowing/Driving rain’ of that method also describes the procedure and severity of this test.

Limitations

There are no limitations on the Method 310 “Rain and Watertightness”.

Additional guidelines

Historicially the recommended rate was as follows.

a. Place the nozzles such that the distance to the plane of the package top surface is 2.5 m (at a downward angle of 45°).
b. The water discharge pressure shall not be less than 2.5 bars.
c. The temperature of the spray water shall be between 5°C and 35°C.
d. The packages shall be sprayed uniformly with water at a rate of minimal 360 l/m²/h (-0 / +40) per nozzle.
   (360 l/m²/h = 6 mm/min) * 4 nozzles = 24 mm/min total)
e. The duration of the spray test shall be 6 hours.

The current recommendations are as per Method 310 Procedure II which is 40 mm/min for a duration of 15 minutes/face, as this is considered adequate to assess watertightness.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any penetration of water into the test package causing deterioration of its contents, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc) shall constitute failure of the package. Minor visible deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE G - VIBRATION TEST

General

The general purpose and application of this test can be found in Method 401 “Vibration” of AECTP 400 under STANAG 4370.

Limitations

There are no limitations on the Method 401 “Vibration”.

Additional guidelines

Follow the guidelines below:

a) Refer to Table 1 of Method 401 of AECTP 400 to select the appropriate severities.

b) Historically sine sweep testing was used as the only test to characterize the vibration environment for packaging. Since the more representative random and combined sine-on-random or narrow-band random-on-random test methodologies are employed per Method 401 of AECTP 400, swept sinusoidal testing may not be required (with the exception of ship-board).

c) Swept sinusoidal testing is a laboratory test that can be used to determine the isolation system’s balance of natural frequency, and damping characteristics.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any permanent plastic deformation, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), and any damage to or spillage of the package contents shall constitute failure of the package. Minor visible deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE H - BUMP TEST

General

The general purpose and application of this test can be found in Method 403 ‘Classical Waveform Shock’ of AECTP 400 under STANAG 4370. The ‘half-sine shock’ of that method also describes the procedure and evaluation of the test.

Limitations

There are no limitations on the Method 403 ‘Classical Waveform Shock’.

Additional guidelines

In addition to the prescribed procedure and severity for ‘half-sine shock’ as mentioned in Method 403 ‘Classical Waveform Shock’, the following shall also apply:

a. The machine shall produce a half sine pulse approximating to an amplitude (A) of 5 g acceleration and 30 ± 5 ms duration (D). The true value of acceleration of the actual pulse shall be within the tolerance boundaries.
b. Packages up to and including 70 kg shall be capable of withstanding the test when standing on any one face.
c. Packages over 70 kg and up to and including 225 kg shall be capable of withstanding the test when standing on any one long face or, if cubic, on any face.
d. Packages over 225 kg shall be capable of withstanding the test when standing on the base or face upon which the package is normally expected to be transported.
e. The package may be subjected to a total of up to 10,000 ± 5% bumps when firmly secured to the table of the bump machine. When the test is to be applied to a package containing a "live" load and/or a package incorporating resilient protection, the response of the system may affect the rate at which the specified bump can be applied. The bump repetition rate should be adjusted so that the response to one bump has died away before the next bump is applied. A rate of between 30 and 240 bumps per minute may be found suitable.

PROCEDURE I – BOUNCE TEST

General

The general purpose and application of this test is similar as described in Method 406 “Loose Cargo” of AECTP 400 under STANAG 4370.

Limitations

For levels NATO levels 1, 2 & 3, the package or stack shall be subjected to the test for 15 minutes. If a number of test attitudes are required the 15 minute test period shall be divided equally between them. During this test heat may be generated in the packaged item and/or in the package constituents, particularly any cushioning system. Where it is advisable to impose rest periods during the test to allow heat generated to be dissipated, the rest periods shall be in addition to the 15 minute test period.

For NATO level 4, the package or stack shall be subjected to the test for 5 minutes.

A single package or packages within a stack shall be tested while standing on its base or the face which it normally is expected to be transported.

Additional guidelines

There are no additions to the Method 406 “Loose Cargo”.

PROCEDURE J - HANDLING TEST

General

The general purpose and application of this test can be found in Method 409 “Materiel Lifting” of AECTP 400 under STANAG 4370. The five procedures of that method describe the procedures and severities of this test.

Limitations

There are no limitations on the Method 409 “Materiel Lifting”.

Additional guidelines

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- The package shall be considered to have failed the test if the packaged item is rendered unserviceable or a safe lift is not achieved. The package shall also have failed the test if the condition of the lift attachments constitutes a potential hazard.

PROCEDURE K - DROP TEST (FREE FALL)

General

The general purpose and application of this test can be found in Method 414 ‘Handling’ of AECTP 400 under STANAG 4370. Procedure I ‘Transit Drop’ of that method describes the procedure and severity of this test.

Limitations

Contrary to the prescribed procedure and severity as mentioned in Method 414 ‘Handling’, the following severities shall apply:

NATO Levels 1, 2 and 3

a. Packages having a mass greater than 450 kg shall be dropped on each end of its designated base from a height of 0.3 m. Lift each end in turn and drop.
b. Packages having a mass greater than 225 kg up to and including 450 kg shall be dropped once onto its designated base from a height of 0.3 m.
c. Packages having a mass greater than 30 kg up to and including 225 kg shall be dropped once onto its designated base from a height of 0.5 m.
d. Packages having a mass up to and including 30 kg shall be dropped once onto its designated base and all perpendicular and parallel faces from a height of either 1.0 m for levels 1&2, or 0.75 m for level 3.
e. Packages not rectangular prisms in shape nor having a designated base shall be dropped on each face, corner or seam as deemed necessary by the requesting and approving authority. Depending on the mass of the package, the drop height will be as indicated in a to d.

NATO Level 4

All packages shall be dropped once onto its designated base from a height of 0.3 m.

Additional guidelines

In addition to the prescribed procedure and severity as mentioned in Method 414 ‘Handling’, the following shall also apply.

Small packages up to 10 kg mass which qualify for postal distribution may require impact testing from heights in excess of those quoted in the drop test. Impact velocities of up to 8 m/s, equivalent to drop heights up to approximately 3 m, should be considered.

The drop test apparatus shall consist of a:

a. Lifting arrangement, which will not damage the package during either lifting or release;
b. Means of holding the package prior to release in its predetermined attitude. The difference in behaviour of a sack, for example, suspended from the top or supported below in an end drop, could be significant. In such instances the method of holding the package before dropping shall be described in the test report.
c. Release mechanism, to release the package in such a way that its fall is not obstructed by any part of the apparatus before striking the impact surface.
d. Impact surface, horizontal and flat, massive enough to be immovable and rigid enough to be non-deformable under test conditions. In normal circumstances the impact surface provided shall be:
    - Integral with a mass at least 20 times that of the heaviest package to be tested.
    - Flat, such that no two points on its surface differ in level by more than 2 mm.
    - Rigid, such that it will not be deformed by more than 0.1 mm when a pressure of 1 MPa is loaded statically anywhere on the surface.
    - Sufficiently large to ensure that the test package falls entirely upon the surface

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any permanent plastic deformation, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), and any damage to or spillage of the package contents shall constitute failure of the package. Minor visible deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE L – HORIZONTAL IMPACT TEST

General

The general purpose and application of this test can be found in Method 414 ‘Handling’ of AECTP 400 under STANAG 4370. Procedure II ‘Horizontal Impact’ of that method also describes the severity of the test, but gives only little guidance on the apparatus and procedure.

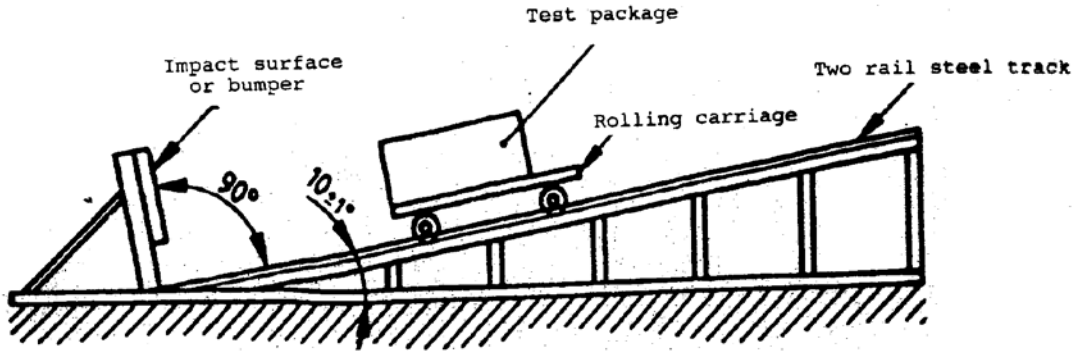
Limitations

There are no contradicitons to the prescribed procedure and severity as mentioned in Method 414 ‘Handling’, Procedure II.

Additional guidelines

In addition to the prescribed purpose and severity as mentioned in Method 414 ‘Handling’, Procedure II, the following shall also apply regarding the apparatus, impact and procedures.

The horizontal impact apparatus should be an inclined plane tester or pendulum.

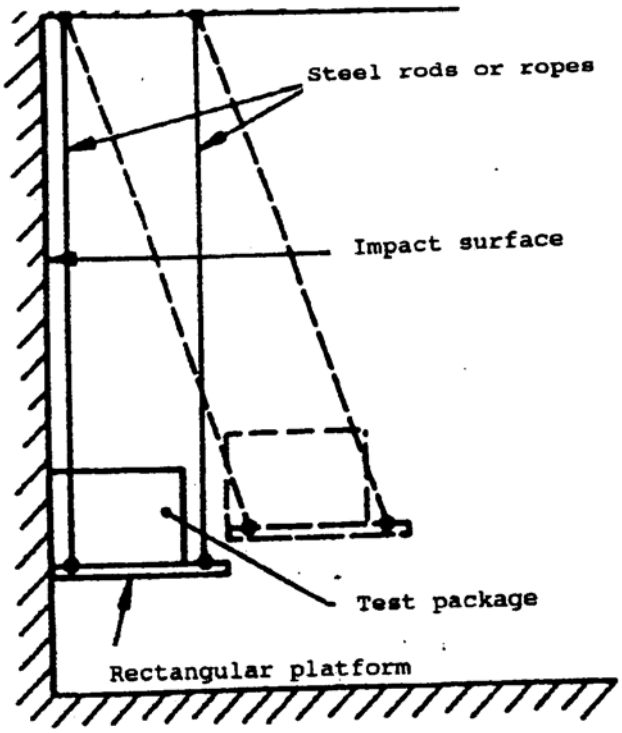


Inclined plane tester, comprising of the following items:

a. Two-rail steel track, inclined at 10° to the horizontal. The distance along the incline shall be marked at intervals of 50 mm.
b. The friction between package and rolling carriage or dolly shall be such that during movement from rest to impact the package will not move in relation to the carriage, but such that upon impact the package will move freely.
c. The impact surface (or bumper) shall be placed at the bottom of the track with its face perpendicular to the direction of movement of the carriage (thus at 10° ±1° to the vertical). It shall consist of a concrete block which may be faced with steel or a number of heavy timbers, of sufficient thickness and density so as to resist the impacts without excessive deformation or breakage, mounted horizontally across the impact face.

Notes:

- It is recommended that the bumper be made in such a way that the carriage can travel underneath it for about 100 mm so that the package impacts the bumper before the carriage stops.
- The apparatus should preferably be equipped with a device to prevent the carriage springing back after the impact. Either a spring damper or an oil damper may be incorporated into such a device.
- The track and wheels shall be kept clean.
- The wheel bearings shall be regularly lubricated. Roller bearings are recommended.



Pendulum apparatus, comprising of a rectangular platform suspended at each corner by steel rods or ropes so that in its rest position the front edge just touches an impact surface vertical to within 1°. The suspension system shall be such that it moves freely and its path is not obstructed when the package is mounted on the platform. For certain types of package, such as carboys, it may be sufficient to suspend the test package from a single rod or rope. In both instances the suspension system shall not impart a rotary movement to the test package.

Impact

a. The dimensions of the impact surface shall be greater than those of the impacting face, or selected part, of the package under test.
b. The impact surface shall be sufficiently rigid not to deflect more than 0.25 mm when an area of 1 cm^2 anywhere on the surface is loaded to 160 kg.
c. The impact velocity shall be 2.5 m/s + 5% of the predetermined horizontal velocity.
d. When the impact is on a face or edge, the package shall strike the impact surface so that the angle between the face or edge and the plane of the impact surface is less than 2°.
e. When the impact is on an edge of a parallelepipedal package, the attitude of the package at impact shall be such that the angle between a prescribed surface of the package and the impact surface is within ±5° or ±10% of the permitted angle, whichever is the greater.

Procedure

a. Procedure with inclined plane tester.
   Place the test package on the carriage in an attitude that will ensure that it strikes the impact surface in the desired position. The package shall not project beyond the edges of the carriage. Raise the carriage to that height up the incline, which corresponds with the desired impact velocity, then release it.
b. Procedure with pendulum apparatus.
   Place the test package on the rectangular platform so that the impacting face or edge just touches the impact surface. Raise the pendulum by pulling out the platform to the distance from the impact surface appropriate for the velocity required, then release it.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any permanent plastic deformation, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), and any damage to or spillage of the package contents shall constitute failure of the package. Minor visible deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE M - STACKING TEST

General

The general purpose and application of this test can be found in Method 410 “Materiel Stacking” of AECTP 400 under STANAG 4370. The procedure I ‘Vertical Loading’ and procedure II ‘Side or End Loading’ of that method describe the procedure and severity of this test.

Limitations

Contrary to the prescribed procedure and severity as mentioned in Method 410 “Materiel Stacking”, the following shall apply:

a. The maximum loading force for packages over 15 kg mass shall be identical to a stacking height up to 4 m.
b. Apply the load for the specified time or until premature collapse of the package. The test typically takes 24 hours.

Additional guidelines

In addition to the prescribed procedure and severity as mentioned in Method 410 “Materiel Stacking”, the following may also apply:

a. Use of a horizontal and rigid surface (the difference in height between the highest and lowest points not exceeding 2 mm). A concrete floor at least 150 mm thick is suitable.
b. Use of a loading platform, which is free to tilt when placed centrally on top of the package, shall be large enough to extend to at least 100 mm over all sides of the top surface of the package and rigid enough to support the load completely without deformation.
c. Means of measuring deflection, accurate to ± 1mm and capable of indicating either an increase or a decrease in dimensions.
d. When using weights for applying the load, place them without impact. The weights shall be distributed uniformly over that portion of the surface of the loading platform in direct contact with the package to ensure that the centre of gravity of the load is immediately above the centre of the package. The total mass of the weights and loading platform shall be within 2% of the predetermined value. The distance of the centre of gravity of the load above the loading platform shall not exceed 50% of the height of the package.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any permanent plastic deformation, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), and any damage to or spillage of the package contents shall constitute failure of the package. Minor visible

deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE N - BENDING TEST

General

The general purpose and application of this test can be found in Method 411 “Materiel Bending” of AECTP 400 under STANAG 4370. That method also describes the procedure and severity of this test.

Limitations

There are no limitations on the Method 411 “Materiel Bending”.

Additional guidelines

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any permanent plastic deformation, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), and any damage to or spillage of the package contents shall constitute failure of the package. Minor visible deterioration of the test package shall be noted but does not necessarily constitute failure of the package.

PROCEDURE O - FLEXING TEST

General

The general purpose and application of this test can be found in Method 412 “Materiel Racking” of AECTP 400 under STANAG 4370. That method also describes the procedure and severity of this test.

Limitations

There are no limitations on the Method 412 “Materiel Racking”.

Additional guidelines

There are no additions to the Method 412 “Materiel Racking”.

PROCEDURE P - CORNERWISE DROP

General

This test is applicable for determining the ability of large shipping containers to resist the impacts of being dropped on their corners and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is dropped on its corners.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

For the purpose of this test, a large shipping container may be a box, case, crate, or any other container constructed of wood, metal, or other material, or any combination of these for which the free-fall drop test is not considered practical or adequate. Large containers shall be considered as those having:

a. gross mass over 70 kg, or gross mass under 70 kg with the container equipped with skids.
b. length of any edge over 1500 mm.

One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, rigidity, shape, centre of gravity, position in the container, and be appropriately instrumented to record shock forces or deflections during the test. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

Apparatus

The container may be handled with any convenient equipment, such as a forklift truck, a hoist, or a block and tackle. A smooth, level, concrete surface (or similarly unyielding surface) shall be used in performing the cornerwise-drop test.

Procedure

The specimen shall be placed on its base. One corner of the base shall be supported on a block nominally 150 mm in height, and a block nominally 300 mm in height shall be placed under the other corner of the same end. If the dimensions of the container are such that the 300 mm height cannot be attained without instability, a block of the greatest attainable height shall be substituted. These heights shall be increased, if necessary, to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the drop end is raised for the drop.

The unsupported end of the container shall be raised so that the lower corner of that end reaches the prescribed height (see Table I) and then allowed to fall freely to the concrete surface or similarly unyielding surface (see figure 1).

Unless otherwise specified, the drop height shall conform to Table I. There shall be one drop on each corner of the container base (four drops).

Table I. Rotational drop heights for containers of various sizes and masses

Gross mass (kg)	Dimensions of any edge height or width (mm)	Height of drop on corners (mm)	
		NATO Levels (STANAG 4280	
		1 & 2	3
70 - 115	1500 - 1675	915	685
115 - 180	1675 - 1830	810	610
180 - 270	1830 - 2030	710	535
270 - 455	2030 - 2400	610	460
455 - 680	2400 - 2895	510	410
680 - 910	2895 - 3660	430	355
910 - 1360	Above - 3660	380	305
Above - 1360	No limit	305	230

Note: Use the lowest drop height indicated by either gross mass or dimension. For example, a container having a gross mass of 225 kg and maximum edge dimension of 2750 mm shall be dropped 510 mm for levels 1 & 2 tests, or 410 mm for NATO level 3 tests.

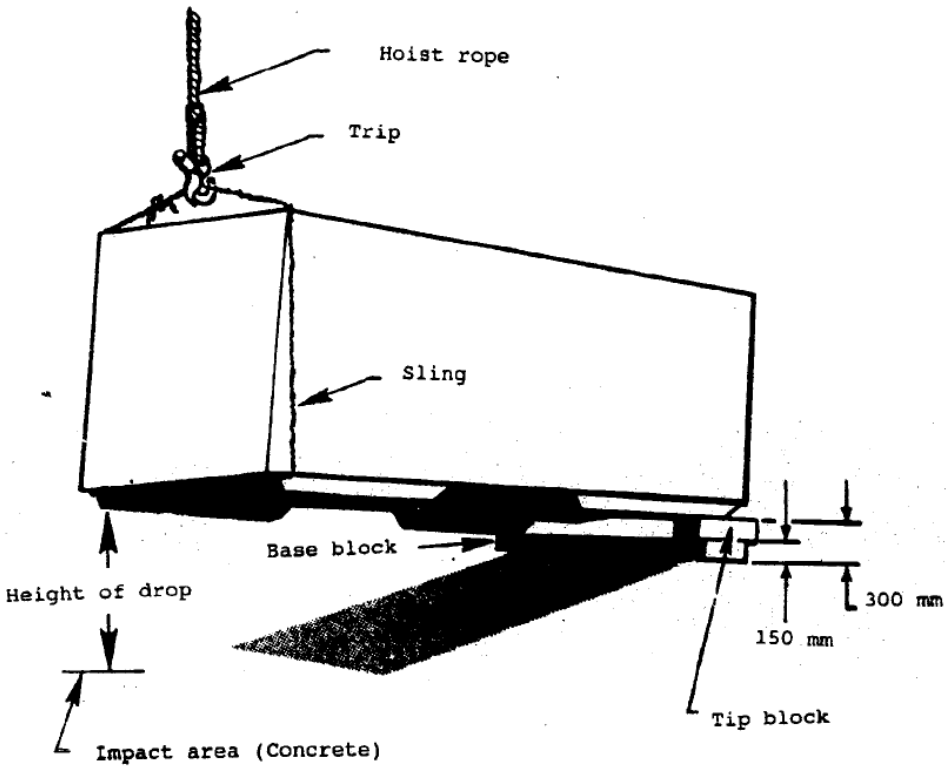


Figure 1. Cornerwise drop (Rotational)

PROCEDURE Q - EDGEWISE DROP

General

This test is applicable for determining the ability of large shipping containers to resist the impacts of being dropped on their edges and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is dropped on its edges.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

For the purpose of this test, a large shipping container may be a box, case, crate, or any other container constructed of wood, metal, or other material, or any combination of these for which the free-fall drop test is not considered practical or adequate. Large containers shall be considered as those having:

a. gross mass over 70 kg, or gross mass under 70 kg with the container equipped with skids.
b. length of any edge over 1500 mm.

One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, rigidity, shape, centre of gravity, position in the container, and be appropriately instrumented to record shock forces or deflections during the test. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

Apparatus

The container may be handled with any convenient equipment, such as a forklift truck, a hoist, or a block and tackle. A smooth, level, concrete surface (or similarly unyielding surface) shall be used in performing the edgewise drop test.

Procedure

The specimen shall be placed on its base. One end of the base of the container shall be supported on a block nominally 150 mm high. These heights shall be increased, if necessary, to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the drop end is raised for the drop.

The unsupported end of the container shall be raised so that the end reaches the prescribed height (see Table I) and then allowed to fall freely to the concrete surface or similarly unyielding surface (see figure 2).

Unless otherwise specified, the drop height shall conform to Table I. A total of four drops constitute a complete test. If the size of the container and the location of the centre of gravity are such that the drop cannot be made from the prescribed height, the height of the sill base block shall be raised.

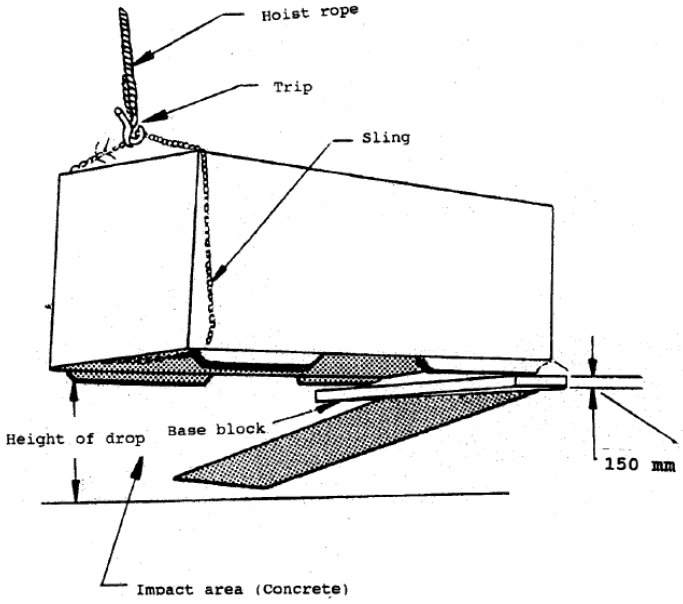
Rectangular containers shall be dropped once on each edge of the container base (four drops).

Cylindrical containers shall be dropped on the top and bottom rims at diagonally opposite quadrants. The quadrant pairs shall be separated by approximately 90°. If a total of more than four rim drops is specified, the additional drops shall be on sections not previously dropped on.

Table I. Rotational drop heights for containers of various sizes and masses.

Gross mass (kg)	Dimensions of any edge height or width (mm)	Height of drop on corners (mm)	
		NATO Levels (STANAG 4280)	
		1 & 2	3
70 - 115	1500 - 1675	915	685
115 - 180	1675 - 1830	810	610
180 - 270	1830 - 2030	710	535
270 - 455	2030 - 2400	610	460
455 - 680	2400 - 2895	510	410
680 - 910	2895 - 3660	430	355
910 - 1360	Above - 3660	380	305
Above - 1360	No limit	305	230

Note: Use the lowest drop height indicated by either gross mass or dimension. For example, a container having a gross mass of 225 kg and maximum edge dimension of 2750 mm shall be dropped 510 mm for levels 1 & 2 tests, or 410 mm for NATO level 3 tests.



PROCEDURE R - TOPPLE TEST

General

Application of this test is normally confined to packages containing items particularly vulnerable to damage through bending or to shock. The test may also be of greater significance than the impact (vertical) test when the position of the centre of gravity of the package is markedly different from the geometric centre of the package.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

Apparatus

A hard flat-surfaced mass of concrete, faced if necessary with a steel plate. The effective mass of the foundation shall be at least 20 times the mass of the package under test.

Attached to the test surface there shall be a girder of cold rolled steel having a channel approximately 100 mm x 50 mm and a length exceeding the width or length of the package surface. The girder should preferably be fixed with the web uppermost to the surface onto which the topple is to be made.

The girder shall be positioned so that the test package impact occurs along a line parallel to the pivot edge at a distance of half the length or width of the package from the pivot edge.

Procedure

The package, when standing on its side or end on a hard flat-surfaced mass shall be toppled freely by rotation about the pivot edge onto:

a. The hard, flat-surfaced mass, or
b. A steel girder affixed to the mass so that impact occurs on the large surface area of the package.

Note 1: Packages containing items more susceptible to damage by bending than by shock should be tested using the impact surface and steel girder.

Note 2: All other packages shall be tested using the hard flat-surfaced mass.

PROCEDURE S - ROLLING TEST

General

This test is intended to assess the capability of the container to withstand manual handling and toppling on a face or edge.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

Apparatus

The rolling test apparatus should be a horizontal and flat surface, massive enough to be immovable and rigid enough to be non-deformable under test conditions.
In normal circumstances the impact surface provided shall be:

a. Integral with a mass at least 20 times that of the heaviest package to be tested.
b. Flat, such that no two points on its surface differ in level by more than 2 mm.
c. Rigid, such that it will not be deformed by more than 0.1 mm when a stress of 1 Mpa is loaded statically anywhere on the surface.
d. Sufficiently large to ensure that the test package falls entirely upon the surface.

Procedure

Rectangular packages: With the specified edge resting on a hard flat-surfaced mass, the package shall be tilted by hand until the point of balance is reached and allowed to overbalance and topple without thrust so as to impact on the specified face. This sequence shall be repeated to include impact on all faces, including top face and base.

Cylindrical packages: Shall be similarly toppled on to top, base and side.

PROCEDURE T – MECHANICAL HANDLING TEST

General

This test determines the ability of a package or container to withstand handling by mechanical handling equipment. This test provides independent procedures for each of the following tests:

a. Lifting and transporting by forklift truck,
b. Hoisting with slings,
c. Hoisting with grabs,
d. Pushing,
e. Towing,
f. Conveying.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

Limitations

These tests do not include every conceivable mechanical handling hazard to a package. If the package must withstand other known hazards not represented by these tests, other tests should be used. Conversely, any of these tests not appropriate for a specific package should not be applied.

One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight distribution, shape, centre of gravity, position in the container, and be appropriately instrumented to record shock forces or deflections during the test. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

Apparatus

The apparatus for each test shall be as follows:

a. Lifting and transporting by forklift truck.
    - Forks shall be adjusted to a spacing appropriate for the specimen under test, but not greater than 762 mm centre to centre.
    - Six nominal 25 mm by 100 mm boards longer than the width of the forklift truck.

b. Hoisting with grabs.
    - A pair of chain or cable operated gravity type grabs. The length of the chain or cable shall be adjustable if necessary. The gripping surface of each grab shall be appropriate for the specimen being tested. For example, the surface for use on wood boxes or crates might be a flat plate with several conical teeth, that with pressure will become embedded into the wood of the container and prevent slipping.

c. Conveying.
    - A level length of skate-wheel conveyor not less than 3050 mm long and wide enough to handle the specimen. Width may be made up of more than one section of conveyor.

Procedures

Procedure I – Lifting and transporting by forklift truck

The specimen shall be lifted clear of the ground by a forklift truck at one side of the specimen and transported on the forks in the level or the back-tilt position across a hard pavement for a distance of not less than 30 m.

Parallel pairs of 25 mm boards spaced 1400 mm apart shall be laid flat-wise on the pavement across the path of the forklift truck. The first pair shall be placed squarely across the truck's path and centred 9 m from the starting point; the second pair shall be laid 18 m from the starting point at an angle of 600 to the truck's path so that the left wheel strikes first; and the third pair shall be laid 27 m from the starting point at about 75º to the truck's path so the right wheel strikes first.

If the specimen is less than 1000 mm high and weighs less than 230 kg, a load shall be superimposed on the specimen throughout the test to simulate stacking of the minimum number of specimens that will attain either a height not less than 2030 mm or a weight not less than 460 kg. (For example, if a specimen were 760 mm high and mass of 91 kg, a superimposed load would be required. A stack of three would measure 2280 mm high, which is over 2030 mm, so the mass of two (182 kg) would be superimposed on the test specimen. Similarly, if a test specimen were 380 mm high and weighed 136 kg a stack of four would weigh 544 kg, which is greater than 460 kg, so the mass of three (408 kg) would be superimposed on the test specimen.) If the specimen is more than 915 mm wide and is stable on 915 mm long forks, the forks shall extend only 915 mm under the specimen.

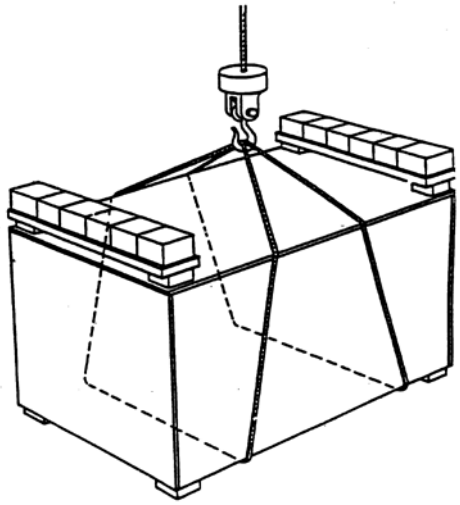
The forklift truck carrying the specimen and superimposed load, if required, shall travel the 30 m in about 20 seconds at a uniform speed (normal walking speed), and then shall be brought to a stop. The specimen shall be carefully observed during the traverse and while the forklift truck is at a stop for any damage, evidence of inadequacy, or deflection of the specimen that might cause damage or displacement of the contents. A record shall be made of the observations. The specimen with its superimposed load, if any, shall then be lowered to the ground. The forklift truck shall be moved from the side to the end of the specimen. The forks shall be run under the specimen as far as possible and then operated to lift the end

150 mm. Observe the specimen, particularly in the vicinity of the ends of the forks, and record observations. If the specimen can thus be lifted clear of the floor, transport it on the forks over the same 30 m course, and record observations. If it cannot be thus lifted, report the length of forks used and state that the specimen could not be carried on the forklift truck at either end.

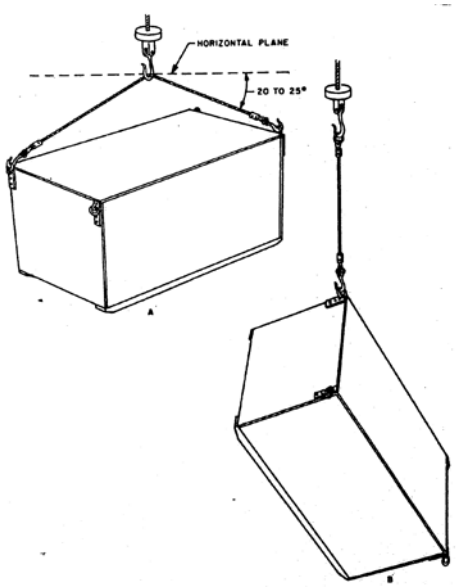
Procedure II – Hoisting with slings.

If the specimen is less than 1000 mm high and weighs less than 230 kg, a load shall be superimposed on the specimen throughout the test to simulate stacking to not less than either a height 2030 mm or a mass of 460 kg (see 7 c. for examples). Such superimposed loads shall not contact the slings or lend reinforcement to the top structure of the package.

Underslung handling. Two slings without spreaders shall be placed around the specimen, each passing beneath the specimen, one near each end where indicated on the package and brought to a common point above the centre of balance for attachment to the hoist. When no indication is provided, locate slings at outside end of rubbing strips if possible. If not possible, locate slings about midway between the centre of balance and the ends. Lift the specimen and any superimposed load, and hold suspended for not less than 2 minutes. Observe carefully for any indications of inadequacies and let the specimen down again. Record all observations.



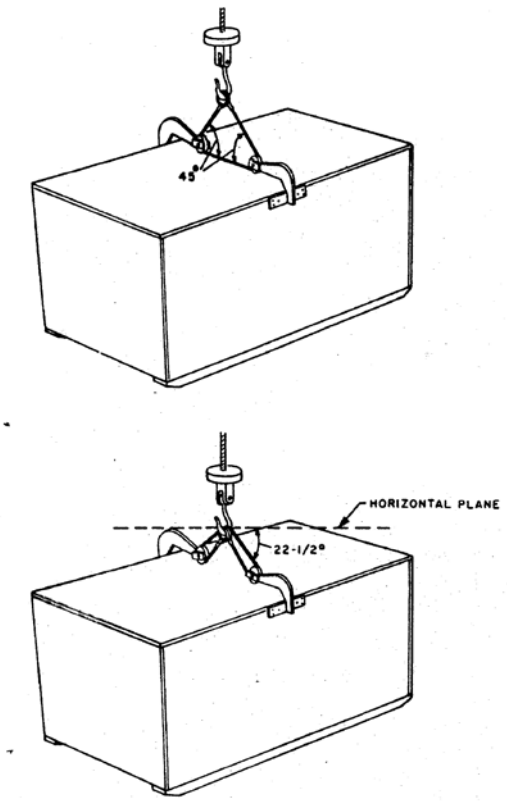
Sling handling with attachments. Attach slings to two hoisting attachment provisions (lift rings, eyes, lugs, or other devices), one on each or each end of the container, so that the specimen will remain upright when hoisted. The length of the slings shall be such that when lifting they form angles between 20° and 25° with a horizontal plane. Lift the specimen clear of the floor and hold it suspended for not less than 2 minutes. Observe for any indications of inadequacies of the specimen. Record observations and let the specimen down again. Repeat with other hoisting attachment provisions until each has been tested. If the specimen has only one attachment provision, attach only one sling to hold the specimen suspended for 2 minutes.



If more than one attachment point is provided, remove the superimposed load, if any, from the specimen. Attach one sling to one lifting point, and lift the specimen clear of the ground. Record observations and lower the specimen to the ground. Repeat with each lifting point provided on the specimen.

Procedure III – Hoisting with grabs

Align the grabs on opposite sides or ends of the specimen above its centre of balance. Adjust the grab operating chain or cable so that while the specimen is suspended, the grab pressure normal to the surface of the container will be about 1.2 times the specimen's mass. (For an operating line extending continuously from the hoist attachment downward to a pulley on one grab, then horizontally to a pulley on the other grab then upward to the hoist attachment, the required pressure will result when the inclined portion of the line forms 45° angles (±5°) to the horizontal. For an operating line extending from one grab up to the hoist attachment and then down to the other grab (not horizontally between the grabs), the required pressure will result when the inclined portions of the line form angles of 22.5° (±2.5°) with a horizontal plane.). Connect the hoist to the lifting point of the grab operating line and slowly lift. If the specimen tilts excessively upon lifting, lower it and relocate the grabs and the lifting point if necessary to align with the centre of gravity of the specimen. Hoist the specimen clear of the floor, hold it suspended for 2 minutes, and return it the floor. Observe for any evidence of inadequacy or damage to the container, or deflection of the container that might cause damage or displacement of contents. A record shall be made of observations.



Procedure IV – Pushing

Position the vehicle to about the end of the specimen near the floor. If a forklift truck is used, the mast shall be vertical or at a slight back-tilt, and the forks shall extend beneath the specimen but shall not support it. Operate the truck to push the specimen along a hard, dry pavement a distance of 11 m in about 90 seconds at a uniform speed, observing the specimen for any inadequacies or damage. Record observations. Move the vehicle to abut the side of the specimen near the floor and move the specimen over the same distance. Record observations.

When specified, the pushing test shall be repeated with one end of the container lifted off the ground about 150 mm by the tips of the forks inserted between the skids. The container structure as well as the skids, shall survive the test without failure or permanent deformation.

Procedure V – Towing

Attach a sling to the towline attachment fittings at one end, and connect with a towing vehicle at a height not greater than the fittings. If no fittings are provided, use a sling or gravity type grabs at the base of the specimen for attaching the towline, or some other feasible arrangement may be devised. Operate the vehicle to tow the specimens along a hard, dry pavement a distance of 30 m in about 20 seconds at a uniform speed (normal walking speed), observing the specimen for any inadequacies or damage. Record observations and the method of attaching the towline. Then reattach the towline and tow the specimen sideways over the same distance. Record observations.

When specified, the towing test shall be repeated with one end of the container lifted off the ground about 150 mm by the tips of the forks inserted between the skids. The container structure, as well as the skids, shall survive the test without failure or permanent deformation.

Procedure VI – Conveying

Place the specimen lengthwise on the conveyor, and convey the specimen back and forth until the specified distance lengthwise is accumulated. Each movement shall be not less than the length of the container. Place the specimen crosswise on the conveyor and convey the specimen back and forth until the specified distance is accumulated. Observe and record any damage to the package or conveyor and record any difficulties in conveying the specimen.

Unless otherwise specified, the total conveyed distance shall be 300 m lengthwise and another 300 m crosswise.

Inspection after handling. Open the specimen and examine the inner surfaces of the container and inspect the contents for evidence of inadequacies or damage. Record observations.

PROCEDURE U – LEAKS IN CONTAINER

General

This test procedure provides eight common techniques for detecting leaks in containers.
This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

For the leakage of air the following methods are included:

a. Vacuum retention method. In which air is evacuated from the container and it is vacuum-sealed. Leakage is indicated by loss of vacuum.
b. Pneumatic pressure method. The air in the container is pressurized.
c. Squeeze method. (Applicable only to flexible specimens such as bags, envelopes, etc.) A flexible container is sealed containing air at ambient conditions as for shipment, and then is squeezed to increase the internal air pressure.
d. Hot water method. A container is sealed containing air at ambient conditions as for shipment, and then immersed in hot water so that the rise in internal air temperature will produce a rise in internal air pressure.

For the leakage of water, or other contents indicated, the following methods are included:

e. Submersion method. The sealed container is submerged in various positions under water and following removal from the water is subsequently opened and inspected for leakage. A variation is the "immersion method" in which an open top container is
f. inspected while immersed to the required depth.
g. Simulated rainfall method. The container closed as for shipment is subjected to water spray and subsequently opened and inspected for leakage.
h. Hydraulic pressure method. Internal pressure is utilized to force water or other liquids through any leaks.
i. Static leak test. The container is filled with water, or other contents, and observed at rest in various positions to detect leakage of such contents.

Apparatus

Tests for air and water leaks require the following apparatus with the different methods:

a. Vacuum retention. A vacuum pump and pressure gauge such as a manometer.
b. Pneumatic pressure. A supply of compressed air, pressure gauge and either a vessel in which the specimen can be submerged in water or a quantity of bubble supporting liquid.
c. Squeeze. Either a vessel in which the specimen can be submerged in water or a bubble supporting liquid.
d. Hot water. A vessel of hot water in which the specimen can be submerged and a means of maintaining the water temperature.

e. Submersion (or immersion). A vessel of water in which the specimen may be submerged or immersed.
f. Simulated rainfall. The method described in Procedure Q shall be used.
g. Hydraulic pressure. A source of hydraulic or pneumatic pressure with gauge and a pressure regulator.
h. Static leakage. Blocking as necessary to support the specimen in the various positions required. Tests in which the specimen is submerged in water of test, other than simulated rainfall, in which the water is specified may be coloured to assist the detection of leaks.

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall also apply:

- Any penetration of moisture into the test package shall constitute failure of the test.
- Any loss in pressure greater than 2.6 mm of mercury constitutes failure.

Procedures

Procedure I - Vacuum retention method

During the preparation of the specimen, make provisions for the connection of a tube to evacuate the air, a gauge to indicate any loss in vacuum pressure and an effective closing method of the container after removal of the tube and gauge. Such provisions may be a tube and gauge sealed into openings at the corners of a seam of a flexible container or a drilled and tapped hole for a plug or a valve stem incorporated in a rigid container or other acceptable devices that can be either sealed or removed from the container without adverse effect. Connect the vacuum pump to the specimen and evacuate the air until the specified vacuum is attained. Unless otherwise specified, the vacuum pressure shall be 9 ± 1 mm of mercury or 105 ± 12 mm of water. The required vacuum may be drawn more than once to ensure that equilibrium within the specimen is reached.
When the specimen is evacuated to the specified pressure, stop evacuating air and record the vacuum pressure gauge reading. After 10 minutes, unless otherwise specified, read and record the final pressure reading. Compute and record the loss in vacuum pressure.

Vacuum pressure may cause damage to a flexible specimen or its contents; use of that method may be inappropriate for some designs.

Procedure II - Pneumatic pressure method

During preparation of the specimen, provisions shall be made for connecting a tube or clamp in valve to the specimen. Either attach a pressure gauge to the specimen or use a low-pressure hand type gauge to sense any change in pressure. A tube or valve may be sealed into an opening at one end of a seam in a flexible container,

a hole drilled and tapped with a plug, a "clamp in valve" stem incorporated in a rigid container, or other methods which will permit removal and seal without adverse effects of the serviceability of the container. Pressurize the specimen with air from the compressed air supply. Gradually introduce air until either the prescribed pressure in the specimen is attained or leakage becomes apparent.

Pneumatic pressure may cause explosive failure of weak specimens. The applied pressure should be no greater than necessary to reveal leaks.

When the specimen is pressurized to a constant specified pressure, read and record this initial pressure. After 30 minutes, read and record the final gauge pressure. If no change is noted between the initial and final gauge pressures, the item is considered sealed, if however, any loss in pressure is detected, the leaks can be located by means of ultrasonic detector, submersion or bubble supporting film methods and repaired as required to seal the container. An ultrasonic translator detector finds areas where leakage occurs. That method can be used on all types and sizes of pressurized containers as a rapid means of pin pointing the source of leak. If a water tank is available and the containers are relatively small, the specimens may be submerged 25 to 50 mm under water and observed for leakage with the specimen upright and with the specimen inverted. If the tank is not available or the container is too large, leakage can be detected by coating joints, castings, connections, and other likely points with a bubble supporting film, and observed for leaks.

Procedure III - Squeeze method.

During sealing of the specimen entrap as much air as possible within the specimen and either:

- Submerge the specimen 25 to 50 mm under water and, while squeezing the specimen, observe all seams and surface for leakage,
- Coat all seams, joints, or other areas likely to leak with a bubble supporting film and observe each for leaks while squeezing the specimen. Record locations of leaks or state, "no leaks."

Procedure IV - Hot water method

Any wax dipped specimens shall be cooled to equilibrium at an initial temperature between 10°C and 15°C. Unless otherwise specified, submerge the specimen in water heated to a temperature at least 10°C above the initial temperature of the specimen (not over 38°C for wax dipped specimens). While holding the specimen submerged with the uppermost surface covered by not more than 25 mm of water, observe for at least 15 seconds to detect leakage. The specimen shall be rotated and observed repeatedly until all of the specimen has been examined. Total time in hot water shall not exceed 8 minutes. Record the locations of any leaks or state, "no leaks".

Procedure V - Submersion (or immersion) method.

Note: This is for detecting leaks and not for testing the immersion environment and is not a substitute for AECTP 300 Method 307.

Unless otherwise specified, the specimen shall be submerged so that the uppermost surface is beneath the water surface not less than 25 mm or more than 50 mm for 1 hour or longer in water maintained at temperature of not less than 15°C below the temperature at which the specimen is sealed. After submersion and before opening the specimen, carefully dry the outside of the specimen where the opening will be made. Then open the specimen. When immersion of an open top container is required, the container shall be positioned in the water at the depth specified and held in such position for a period of time specified. Inspect the inside for leakage. Record whether or not the specimen leaked and if possible, the location of leaks.

Procedure VI - Hydraulic pressure method.

Before filling and sealing the specimen, a suitable leak-proof connection for a pressure line shall be installed in the specimen. Unless otherwise specified, fill the specimen with coloured water and connect either an air or water pressure line to the specimen. Increase the pressure uniformly over a 10 second period to the test pressure and maintain it for the period of time specified. Unless otherwise specified, the pressure shall be one bar and the period shall be 5 minutes. Inspect the exterior of the specimen for leakage, particularly around joints and fastenings. Record whether or not leakage was observed, and describe the locations of the leaks.

Procedure VII - Static method.

If the intended contents of the specimen are not fluid, unless otherwise specified, use the coloured water instead of the intended contents to fill the specimen, and close it as for shipment.
Unless otherwise specified, place the specimen in each of the following positions and leave it in each of the following positions for a period of 15 minutes:

- Upright
- Upside down
- On one side
- On one end
- On other side
- On other end

Examine the specimen after each period and record location of any leakage or "no leakage."

PROCEDURE V – HEAT-SEALED SEAM TEST

General

This test is applicable for determining whether or not the strength of a heat-sealed seam is adequate to resist a dead weight load applied in a manner tending to open the seam. The test does not measure the tensile strength of the seam or indicate its efficiency in developing the strength of the material joined.

This test is specifically for the testing of packagings and no comparable method can be found in the AECTP's under STANAG 4370.

Apparatus

Appropriate heat-sealing equipment with accurate controls of temperature, pressure, and time adjusted to fuse the material joined in the heat-sealed seam. The quality of seams shall be reproducible. A test frame is needed with means to hold not more than 50 mm of the upper end of the specimen so that the rest of the specimen hangs free. A 25 mm wide weighted clamp is needed to suspend from the lower portion of the specimen. Unless otherwise specified, the total mass shall be 1.6 kg.

Procedure

Specimens shall be formed as follows:

a. Sheet Material. Unless otherwise specified, a representative 300 x 600 mm of the material shall be used to form the test specimens. Fold the piece in the centre and seal the 300 mm ends together on the heat-sealing equipment adjusted appropriately for the material. The edge of the heat-sealed area shall be accurately marked while in the sealer. The heat-sealed seams shall be permitted to cool at ambient temperature for one hour before cutting the test specimens. From the flattened tube, cut perpendicular to the seam to form three bands 25 mm ± 0.5 mm wide, discarding the end strips. Cut each band on the fold line to form a 25 mm ± 0.5 mm wide specimen with the heatsealed seam extending across the centre of the specimen.
b. Fabricated bags, pouches ,etc. Unless otherwise specified, a representative fabricated item or items shall be used to form the test specimens for each heat-sealed seam. The heat-sealed seams shall be permitted to cool at ambient temperature for one hour before cutting the test specimens. Flatten the item with the test seam at one edge, and cut 25 mm ± 0.5 mm wide strips perpendicular to the seam to form double thickness strips 25 mm ± 0.5 mm wide by a convenient length so that when the strip is extended, the heat-sealed seam extends across the centre of the specimen. Not less than three specimens from each typical heat-sealed seam shall be tested.

Fasten one end of the test specimen to the test frame and allow the rest of the specimen to hang free. Carefully and without impact loading, attach the weighed clamp to the lower end of the specimen so the weight is suspended by the specimen.

Unless otherwise specified, the weight shall remain freely suspended for 5 minutes. Then remove the weight and measure to 1 mm the extent to which the heat-sealed seam opened within the marked edges of the heat-sealed area. Record this and any other evidence of failure of the seam or the adjacent material affected by the seam.

In contradiction to the general guidance on the climatic conditioning prior to and during the tests (as mentioned in par. 3.2) the following shall apply:

- Unless otherwise specified, no special conditioning of the test specimen is required for the tests 'heat-sealed seam'. This test shall be conducted at ambient temperature (21ºC ± 6ºC).

In addition to the general guidance on the evaluation of the test results (as mentioned in par. 3.3) the following shall apply:

- For the 'Heat-sealed seam' test a report with the extent to which the seam opened and any other evidence of failure of the specimen is sufficient.

AEPP-3 (A)(1)