COMMONWEALTH OF AUSTRALIA

AUSTRALIAN DEFENCE STANDARD

DEF(AUST)1000C

ADF PACKAGING;

STANDARD

PART 4: STANDARD PACKAGING TEST PROCEDURES

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AUSTRALIAN DEFENCE STANDARD

DEF(AUST)1000C

ADF PACKAGING

PART 4 : STANDARD PACKAGING TEST PROCEDURES

JULY, 2000

Prepared by the ADF Packaging Committee under the Authority of the Defence Standardisation Coordination Group.

Specific inquiries regarding the application of this Standard to Requests for Tender or contracts should be addressed to the Procurement Authority named in the Request for Tender, or to the Quality Assurance Authority named in the contract, as appropriate.

This Standard is mandatory for use by the RAN, Australian Army and RAAF, and Contractors to the ADF

This Standard supersedes DEF(AUST)1000B PART 4 : Standard Packaging Test Procedures.

This PART of the Standard implements the requirements of QSTAG 1155 : Standard Packaging Test Procedures.

WARNING

This Standard may call for use of substances and test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or user from statutory obligations relating to health and safety at any stage of manufacture or use.

DEF(AUST)1000C is issued in 20 parts, with each part sub-divided into Sections. The 20 parts are:

PART 1: General Information
PART 2: Packaging Requirements
PART 3: Packaging Practices and Materials
PART 4: Standard Packaging Test Procedures
PART 5: Marking of Packages
PART 6: Packing of Dangerous Goods (Except Dangerous Goods Class 1); Packaging Requirements and Packaging Mediums
PART 7: Packaging for Materiel Susceptible to Damage by Electrostatic Discharge
PART 8: Defective Packaging Reporting System
PART 9: Requirements for Reusable Containers
PART 10: Australian Quarantine Inspection Service (AQIS) Requirements
PART 11: Unitisation
PART 12: Bar Code Symbology
PART 13: Packaging Material Catalogue
PART 14: Minimum Packaging Specifications of Commercial Items
PART 15: Packaging Specifications and Classification Systems
PART 16: Creative Brief Template
PART 17: Packaging ILS Checklist
PART 18: Life Cycle Analysis
PART 19: Caching

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PART 20: Techniques for Deployment, Packaging and Storage for Tropical Conditions.

Two or more parts may apply to any one packaging requirement and it is essential that all parts be considered and used where appropriate.

This PART of the Defence standard concerns packaging test procedures.

This Standard does not apply to the packaging of ammunition and explosives (for packaging information refer to Joint Ammunition Logistic Organisation [JALO]).

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SECTION A - INTRODUCTION

1. SCOPE

1.1 This PART of the Defence Standard relates to the Department of Defence requirements for the testing of packages. These procedures shall, when applicable, be designed to provide protection to the Military Packaging Levels requirements of DEF(AUST)1000, PART 2, SECTION C.

1.2 It contains details of the tests including test procedures and the applicability of the tests. These procedures can be used to verify conformance to those national levels and their deemed American, British, Canadian, Australian (ABCA) equivalent, as listed in the comparison of ABCA packaging levels or nearest national level for packaging contained in, DEF(AUST)1000, PART 2, TABLE 1, SECTION C.

2. WARNING

This PART of the Defence Standard calls for the use of substances and/or test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or the user from statutory obligations relating to health and safety at any stage of manufacture or use.

3. RELATED DOCUMENTS

3.1 Reference may be necessary to the latest issue of the following documents:

Department of Defence

DEF(AUST)1000 PART 1 - ADF Packaging
General Requirements (Glossary of Packaging Terms)

DEF(AUST)1000 PART 2 - ADF Packaging
Packaging Requirements (Levels of Packaging)

American, British, Canadian, Australian (ABCA) Document

QSTAG 1155 - Standard Packaging Test Procedures

Standards Australia

AS 2582 - Complete, Filled Transport Packages - Methods of Tests

US ASTM Standard

ASTM-D642-76 - Containers Shipping, Compression Test for

ISO Standard

ISO 2233 - Packaging - Complete, filled transport packages - Conditioning for Testing

3.2 Reference in this Defence Standard to any related document means, in any tender or contract, the edition current at the date of such tender or contract unless a specific edition is indicated.

3.3 Copies of AS and ISO documents referred to in 3.1 are obtainable from Standards Australia, in all state capitals

4. PURPOSE OF TESTING

4.1 Package testing is primarily intended to assess the overall performance of the package design in terms of its ability to meet the required level of protection for the enclosed materiel. This usually involves subjecting a test package to a variety of tests in a sequence planned to provide evidence for assessment of its performance in a cumulative manner.

4.2 Testing is also used as an aid to development of the package design. This usually entails subjecting a test package or constituent parts of the package to one or a number of specific tests to ascertain the performance of a particular design facet.

5. APPLICATION OF TESTS

5.1 The scope and degree of package testing is dependent upon the environments and hazards which are encountered or expected to be encountered, during the life cycle of the package.

5.2 To check the total performance of a package design and achieve 100% level of confidence in the ability of the designed package to meet all the hazards of distribution up to the point of use of the item, an ideal series of tests would accurately simulate the life of the package. In practice the ideal is unattainable and is moderated either by a belief that the package would survive the hazard/test or by a knowledge that a particular hazard/test is not applicable.

5.3 A package is not necessarily expected to be 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. Rationalization of the hazards and environments into practical tests results in a compromise, which concedes an element of chance failure of the package with damage or loss of the materiel.

5.4 Evidence for assessment of the performance may be gained by subjecting the test package to alternate climatic and physical tests where one acts as a conditioning test for the next. Evidence may be more usefully gained by simultaneously subjecting two or more test packages to the sequence and withdrawing one at a particular stage for examination.

5.5 During development of the design, tests may be applied to analyse particular aspects of performance. Often this entails putting a package through a short sequence of tests or subjecting it to discrete tests in which event it is usual to refurbish or renew the package or one or more of its constituents before proceeding to another test. It may be necessary to carry out a test repeatedly. Sometimes it may be necessary to carry out performance tests on constituents of a package or to carry out tests on the item as a preliminary to development to gain quantitative and qualitative information on its vulnerability to damage and deterioration.

5.6 The tests detailed in SECTION C are set out in terms of:

a. the basis of the test, i.e. the hazard;

b. the purpose of the test;

c. test equipment;

d. method of test. and

e. interpretation of results.

5.7 Each of the tests is a simulation either wholly or in part of an environment or hazard which varies according to the Military Packaging Level and the package mass, size and shape. The tests may be used as appropriate during the development phase of package design or may form part of a test sequence to provide for the acceptance of package designs. However, for very simple package designs, or where recent test experience gained in the design of a package for a technically similar item confirms the adequacy of the protection measures employed, it may not be necessary to carry out any forms of development test.

6. DEVELOPMENT TESTS

6.1 Tests appropriate to the development phase of package design fall broadly into four groups:

a. Tests on the item for which the package is to be designed, i.e. Packaging Information tests.

b. Tests on constituent materials, which are to form part of the package, i.e. Materials tests.

c. Tests on constituent parts of the package, i.e. Detail tests.

d. Tests on the complete package, i.e. Package tests.

6.2 **Packaging Information Tests**. These tests are primarily applied for assessment of the susceptibility of the item to physical damage during distribution e.g. for assessment of the durability of the item under conditions of impact and vibration. Such tests will need to be carried out when the information is not available from the manufacturer or designer of the item.

6.3 **Material Tests**. The performance of many packaging materials is assured by specification. Other materials may require to be subjected to tests to enable design information to be obtained e.g. strength of timbers in compression or shear.

6.3.1 Where the specification does not control the dynamic performance of a material, particularly a cushioning material, this may be required to be assessed. The results of such an assessment could be retained for use in further design applications.

6.3.2 Whatever materials test is considered necessary, the results of the test should be interpreted in terms of the performance expected of the package constituent of which the material forms part, or that expected of the complete package.

6.4 **Detail Tests**. These are tests primarily applied to constituent parts of a package e.g. containers, container bases, item mounting frames, slinging and lifting attachments, closure devices.

6.4.1 The tests may be wholly physical or wholly climatic or may be applied in sequence where one acts as a conditioning test for the other. Where practicable, some physical tests such as the Static Load Test (SECTION C), may be more advantageously carried out whilst the container is exposed to the climate environment of the Damp Heat Test (SECTION C).

6.4.2 A test may be applied at one particular level or may be applied in increasing levels of severity until failure occurs. The performance of suitably ballasted containers or structures under impact may be assessed in the latter manner and thereby provide evidence which may guard against the production of an over-protective design. Tests in this group will also include proof load testing of package structures, e.g. item mounting frames, or tests to verify structure performance where generally accepted factors of safety have been adopted. These tests may be particularly appropriate where arbitrary factors of safety have been adopted or where an assessment of an applied theory of failure is desirable. As with materials tests, both destructive and non-destructive testing techniques will be appropriate to this group.

6.4.3 Where a detail is to be subjected to more than one type of test, it may be of value to refurbish or replace the detail completely before commencing the next test where the results of cumulative sequential testing are of importance in terms of complete package performance.

6.5 **Package Tests**. Package tests will normally be confined to those described in Section C, each test being applied for assessment of the ability of the package to protect the contents against a discrete hazard or climatic environment.

6.5.1 For purposes of development the package may be refurbished or renewed before proceeding from one test to the next. This course may be particularly appropriate when the package needs to be subjected to a test in varying attitudes, e.g. to assess its most vulnerable face, edge, etc. for purposes of final performance impact testing or confirmation of the performance of a cushioning system.

6.5.2 Reimbursement may also be appropriate after a short sequence of tests has been carried out and particularly after each sequence where a number of short sequences are considered necessary. For example, typical short sequences may be:

a. Dry Heat Test followed by the Vibration Test

b. Vibration Test followed by the Damp Heat Test, or

c. Vibration Test followed by the Impact (Vertical) Test.

Many other such sequences will be found valid dependent on particular facets of the design.

6.5.3 Dummy loads or dummy representative items may as a matter of expediency be utilized in development testing. Their use is particularly appropriate where measurements of displacement, stress, acceleration, loading, etc. are necessary. Where the effects of some tests are not directly measurable, for example, where visual deterioration or evidence of future failure by deterioration is the criteria, the package will generally need to contain the item for which it is designed.

6.5.4 Guidance on the choice of sequence for acceptance testing of a complete package design is given in SECTION B. Reimbursement is only appropriate where design changes necessitate re-test. The term unserviceable used in this group is defined as "the condition of materiel that is not fit for its intended use".

SECTION B - TESTING REQUIREMENTS

1. INTRODUCTION

1.1 The prime objective of packaging is to extend the useful life-span of an item. The protected item must remain in that state of protection until it is placed into service. To ensure this protection thorough and efficient inspection and test procedures for packages are necessary.

1.2 Damage Hazards

1.2.1 **Force**. Damage may result from hazardous forces encountered in transportation, handling and storage.

1.2.2 **Exposure**. Exposure to the different climatic conditions and weather hazards - such as high humidity, rain, salt spray, extreme cold, dry intense heat - and the cycling of these weather conditions tend to accelerate deterioration of unprotected items. Moisture in its different forms is the main damaging factor. Exposure hazards are controlled by preservation and packaging.

1.3 Types of Tests

1.3.1 An item packaged in accordance with a method of preservation as outlined in DEF(AUST)1000, PART 3 SECTION E, must be tested to determine the effectiveness of that method. To be acceptable, the packaging materials and the item must show no signs of damage or operational malfunction as a result of a test.

1.4 The Value of Testing

1.4.1 Containers may be exposed to laboratory simulated environmental extremes. Before any of these tests are specified, the logistic pattern of the packaged item should be studied to be sure that an actual requirement exists. The value of some of the tests described may be questionable, but are considered necessary to ensure that the container has been properly sealed.

1.5 Conditioning

1.5.1 Exposure of the package to predetermined atmospheric conditions for a predetermined period of time;

a. one of the preferred conditions given in TABLE 1 should be selected based on the anticipated exposure conditions, however different conditions may be chosen by agreement of the interested parties.

TABLE I

CONDITION	TEMPERATURE		RELATIVE HUMIDITY (RH)
	° C	TOLERANCE	% ± 5%
A	- 55	±3°C	-
B	- 35	±3°C	-
C	- 18	±2°C	-
D	5	±1°C	85
E	20	±2°C	65
F	20	±2°C	90
G	23	±2°C	50
H	27	±2°C	65
J	40	±2°C	Uncontrolled RH
L	40	±2°C	90
M	55	±3°C	30

Note 1: When using condition D, care should be taken to ensure that the dew point is not reached.

Note 2: a. Temperature tolerances quoted are not necessarily those required to maintain the required tolerances on relative humidity; closer temperature tolerances may therefore be necessary in order to comply with the tolerances required for relative humidity.

b. Place the package within the working space of the conditioning chamber and expose it to the specified conditions for the specified period.

c. On withdrawal from the conditioning chamber proceed immediately with the test.

Note 3: This table is taken from ISO 2233.

SECTION C - TEST PROCEDURES

1. STACKING TEST (AS 2582.3)

1.1 Scope

1.1.1 This test is applicable to packages, which may be subjected to the compressive loads applied to lower containers in a stack of identical containers. It is also applicable to packages that may be subjected to side compressive loads that are applied whilst being lifted by a net. The test is intended to assess the effectiveness of the protective qualities of the container against compression, where buckling, crushing or partial collapse of the container may permit unacceptable transference of the load to the packaged item, as well as to check the stability of the package when stacked.

1.2 Purpose of Test

1.2.1 The test is primarily intended to assess the effectiveness of the physical protection, i.e. the container and method of location of the item. For example:

a. **Container construction** - strength/flexural characteristics, particularly with skid or sill type base; frame structure and effectiveness of sheathing.

b. **Method of location** - effectiveness of blocking/bracing or other furniture, excursion of resiliently mounted items, particularly those with low G Factor/long impulse duration systems.

1.2.2 The test may also reveal weaknesses in measures employed for climatic protection through damage to waterproof, water-vapour-resistant, or water-vapour-proof barriers, e.g. rupture of waterproof container linings through excessive flexure.

1.3 Apparatus

1.3.1 The testing apparatus shall be capable of imposing a constant downward vertical force on the test specimen and may be a:

a. **Horizontal surface**, which is flat (the difference in height between the highest and lowest points not exceeding 2 mm) and rigid. A concrete floor at least 150 mm thick is suitable.

b. **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. The load and loading platform may be integral.

c. **Means of loading**, such that the loading platform can be placed centrally over the test package and the load can be applied by means of;

(i) weights making up the load,

(ii) hydraulically, pneumatically or mechanically activated compression testing machine with suitable force and deflection recording devices and one fixed and one floating rigid platen.

d. **Means of measuring deflection** (if necessary), accurate to ±1 mm and capable of indicating either an increase or a decrease in dimensions.

1.4 **Conditioning**

1.4.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

1.5 **Procedure**

1.5.1 The test shall be carried out if possible in the same atmospheric conditions as used for conditioning, or if not the test must commence within 5 minutes of removing the package from those atmospheric conditions.

1.5.2 Place the package in the predetermined attitude on the flat horizontal surface (1.3.1a).

1.5.3 Place the loading platform (1.3.1b) centrally over the test package, so that it extends at least 100 mm over all sides of the top surface.

1.5.4 Apply the specified load as given in paragraph 1.7.1a or 1.7.1b below, to the loading platform by either;

a. Placing the weights making up the load on the loading platform without impact, ensuring that they are in full contact with the loading platform before being released. The weights shall be distributed uniformity 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.

b. Hydraulically, pneumatically or mechanically activated compression testing machine.

1.5.5 After testing remove the load and examine.

1.6 **Severity**

1.6.1 The test force shall stimulate the actual force on the bottom package of a stack of identical packages, including contents, to a total height not exceeding;

a. 2 m for packages up to and including 15 kg mass,

b. 4 m for packages over 15 kg mass.

When simulating net loads the package shall stand on its side or end, relative to the base, and the load shall be half of the load calculated in a. or b. above.

1.7 **Duration**

1.7.1 Apply the load for the specified time or until premature collapse of the package. This test typically takes 24 hours.

1.8 **Evaluation**

1.8.1 Any permanent plastic deformation of the package, malfunction of the fittings and hardware (seals, closures, hinges, handles, etc.), or any damage 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.

1.8.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

2. BENDING TEST

2.1 Scope

2.1.1 Application of this test is normally confined to packages of a length exceeding four times the smallest cross - sectional dimension of the package and with contents vulnerable to damage through bending, or to packages failure of which, through bending, could be a cause of later unserviceability of the item. The test is to assess the resistance of the package to bending, (i.e., rigidity along its length), as well as its ability to withstand compressive loads across its section.

2.2 Apparatus

2.2.1 No specific requirement.

2.3 Conditioning

2.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

2.4 Procedure

2.4.1 The package shall be supported at each end, and a static load of three times the gross package mass shall be applied over a centre span area for a period of not less than five minutes. The centre span area shall extend the full width of the package and be equal to the cross - sectional area of the package. the ends of the package shall each be supported over an area equal to half the centre span area. The package shall rest on the supports in the attitude normally expected in transit.

2.5 Evaluation

2.5.1 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 in which would potentially cause the item to unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

2.5.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and minor visible deterioration of the test package.

3. DROP TEST (FREE FALL) (AS 2582.4)

3.1 Scope

3.1.1 This test specifies a method of making a vertical impact test on a package by tripping. It may be performed either as a single test to investigate the effects of vertical impact or as part of a sequence of tests designed to measure the ability of a package to withstand a distribution system that includes a vertical impact hazard.

3.2 Apparatus

3.2.1 The drop test shall consist of:

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;

(i) integral with a mass at least 20 times that of the heaviest package to be tested.

(ii) flat, such that no two points on its surface differ in level by more than 2 mm.

(iii) 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.

(iv) sufficiently large to ensure that the test package falls entirely upon the surface.

3.3 Conditioning

3.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached and dropped within 5 minutes of removal from the conditioning chamber.

3.4 Procedure

3.4.1 The package is raised above a rigid plane surface and released to strike this surface after a free fall. The atmospheric conditions, the height of drop and the attitude of the package are predetermined.

3.4.2 In some circumstances a completely free fall may not be possible and in such circumstances the impact velocity shall be within 1% of that which is achieved by a free fall.

3.4.3 Lift the package and hold it in the predetermined attitude at a height within ±2% of the predetermined drop height as defined by the distance between the lowest point on the package at the time of release and the nearest point on the impact surface.

3.4.4 Release the package from its predetermined attitude within the following tolerances;

a. For face or edge drops: 2° maximum between the impacting face or edge, and the horizontal surface.

b. For edge or corner drops: the angle between a prescribed surface of the package and the horizontal surface ±1°.

3.5 **Severity**

3.5.1 **NATO Levels 1 and 2 (Australian Level A, DEF(AUST)1000, PART 2 refers)**

a. Packages having a mass greater than 450 kg shall be dropped on each end of it's designated base from a height of 0.3 m. Lift each end in turn and drop.

b. Package 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 1.0 m.

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 3.5.1a. to 3.5.1d.

3.5.2 **NATO Level 3 (Australian Level B, DEF(AUST)1000, PART 2 refers)**

a. Packages having a mass greater than 450 kg shall be dropped on each end of it's 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 0.75 m.

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 indicated in 3.5.2a and 3.5.2b.

3.5.3 **NATO Level 4 (Australian Level C, DEF(AUST)1000, PART 2 refers)**

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

3.6 **Evaluation**

3.6.1 Any 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

3.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

4 CORNERWISE DROP (ROTATIONAL) TEST

4.1 Scope

4.1.1 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.

4.1.2 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 a combination of these for which the free - fall drop test is not considered practical or adequate. Large containers shall be considered as 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.

4.1.3 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 and 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.

4.2 Apparatus

4.2.1 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 corner - wise drop test.

4.3 Conditioning

4.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

4.4 Procedure

4.4.1 All tests shall be conducted at ambient temperature (21°C ±6°C) except as noted in paragraph 4.4.4.

4.4.2 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 with out 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.

4.4.3 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).

4.4.4 Unless otherwise specified, the drop height shall conform to TABLE I.

4.4.4.1 Unless otherwise specified, there shall be one drop on each corner of the container base (four drops). If the test specimen contains materials, which are significantly affected by temperature, the test shall be conducted while the container is stabilised at the extremes of the

temperature. In this case, one drop shall be made on each of two diagonally opposite corners at –28°C ±2°C. The test specimen shall be allowed to normalise to ambient temperature prior to conditioning at the other extreme. One drop shall be made on each of the other two diagonally opposite corners at 60°C ±2°C. Thus a total of four drops constitutes a complete test.

4.5 **Severity**

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 corners (mm)**	
		ABCA Packaging levels (QSTAG 1151) refer DEF(AUST)1000 Part 2 SECTION C TABLE 1	
		1 & 2 (Australia A)	**3 (Australia B)**
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.

4.6 **Evaluation**

4.6.1 The package shall be considered to have failed the test if the packaged item is unserviceable or is affected in any way, which would potentially cause the item to be come unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

4.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

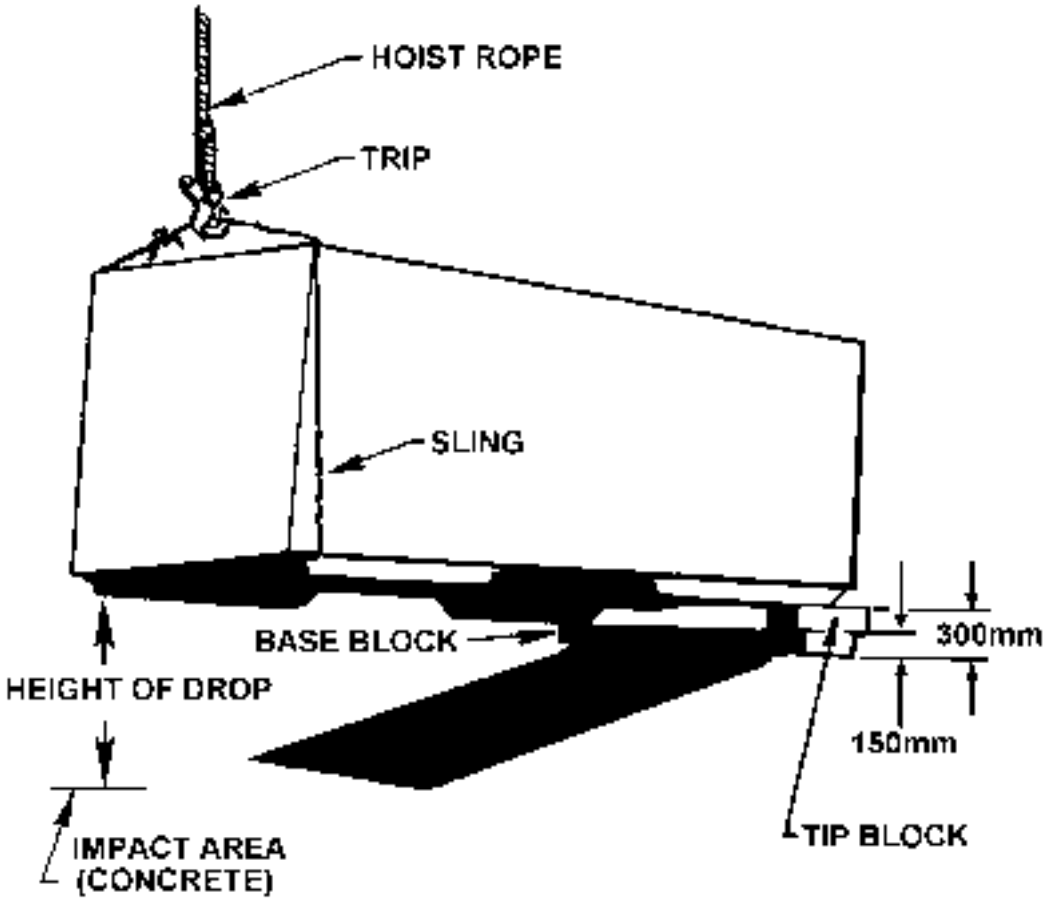

FIGURE 1. CORNERWISE DROP (ROTATIONAL)

5. EDGEWISE DROP (ROTATIONAL) TEST

5.1 Scope

5.1.1 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.

5.1.2 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.

5.1.3 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 actual contents is not practicable, 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.

5.2 Apparatus

5.2.1 The container may be handled by 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.

5.3 Conditioning

5.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

5.4 Procedures

5.4.1 All tests shall be conducted at ambient temperature (21°C ±6°C) except as noted in 5.4.8.

5.4.2 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.

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

5.4.4 Unless otherwise specified, the drop height shall conform to TABLE II.

5.4.5 Unless otherwise specified, 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.

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

5.4.7 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 the total of more than four rim drops is specified, the additional drops shall be on sections not previously dropped on.

5.4.8 If the test specimen contains materials, which are significantly affected by temperature, the test shall be conducted while the container is stabilised at the extremes of temperature. Unless otherwise specified, half the number of drops shall be made at −28°C ±2°C. The test specimen shall be allowed to normalise to ambient temperature prior to conditioning at the other extreme. Half the total number of drops shall be made at 60°C ±2°C.

5.5 **Severity**

TABLE II

ROTATIONAL DROP HEIGHTS FOR CONTAINERS OF VARIOUS SIZES AND MASSES

Gross Mass (kg)	**Dimensions of any edge, height or width (mm)**	**Height of drop corners (mm)**	
		ABCA Packaging levels (QSTAG 1151) refer DEF(AUST)1000 Part 2 SECTION C TABLE 1	
		1 & 2 (Australia A)	**3 (Australia B)**
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.

5.6 **Evaluation**

5.6.1 The package shall be considered to have failed the test if the packaged item is unserviceable or is affected in any way, which would potentially cause the item to be come unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

5.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

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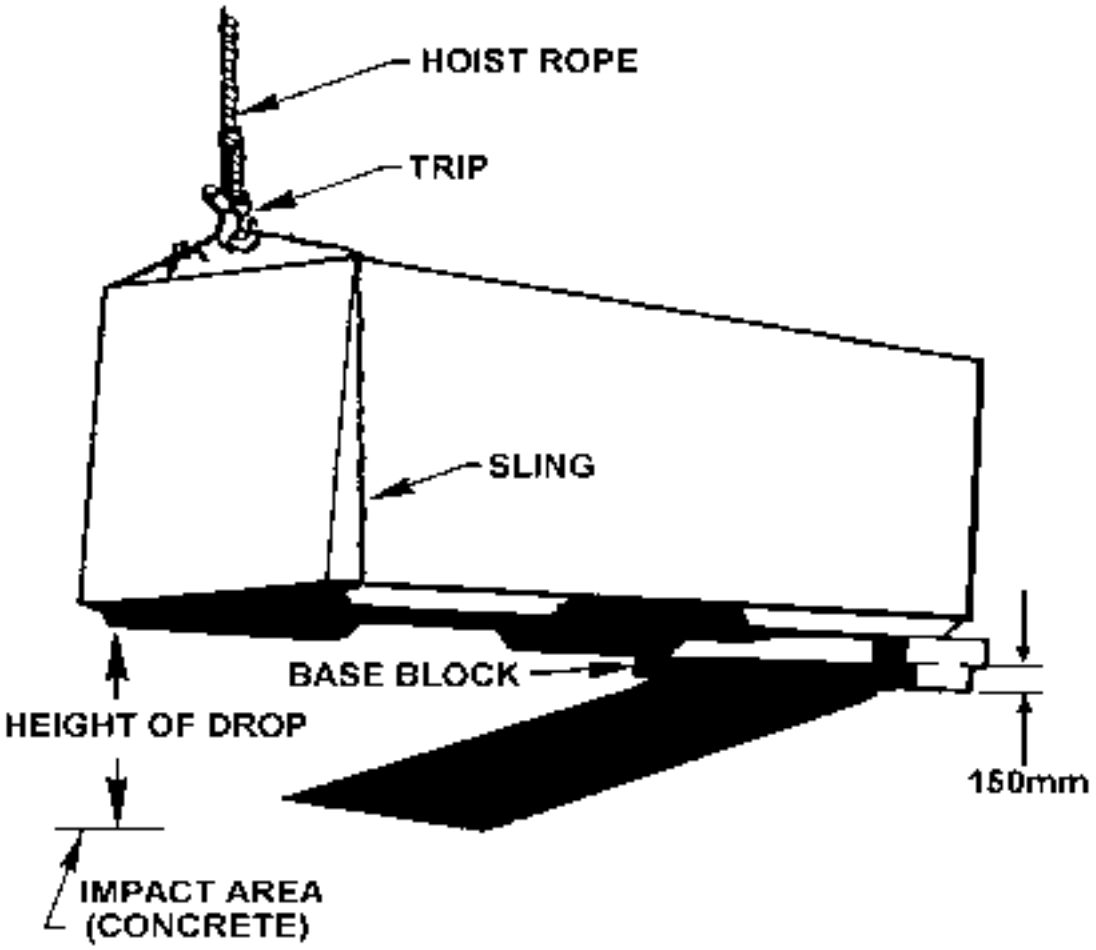


FIGURE 2. EDGEWISE DROP (ROTATIONAL)

6. FLEXING (RACKING) TEST

6.1 Scope

6.1.1 This test is largely for assessment of the rigidity of packages exceeding 225 kg mass; whose design is such that the packaging and contents are liable to become unserviceable when stored or lifted under conditions which would produce twisting. Containers having skids or a sill base construction will vary in response to this test. The validity of its application is a matter of permitted distortion of the container and its contents.

6.2 Apparatus

6.2.1 No specific equipment.

6.3 Conditioning

6.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

6.4 Procedures

6.4.1 With the package standing on its base on a hard level surface, a base corner shall be lifted and supported at a height of 300 mm for a period of not less than five minutes. The package shall then be lowered and the operation repeated on the diagonally opposite corner. The two remaining corners shall then be similarly treated.

6.5 Evaluation

6.5.1 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

6.5.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

7. TOPPLE TEST

7.1 Scope

7.1.1 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.

7.2 Apparatus

7.2.1 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.

7.2.2 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.

7.2.3 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 with of the package from the pivot edge.

7.3 Conditioning

7.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached and dropped within 5 minutes of removal from the conditioning chamber.

7.4 Procedure

7.4.1 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 the 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.

7.5 Evaluation

7.5.1 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

7.5.2 A Test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

8. ROLLING TEST

8.1 Scope

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

8.2 Apparatus

8.2.1 The rolling test apparatus should be:

a. **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:

(i) Integral with a mass at least 20 times that of the heaviest package to be tested.

(ii) Flat, such that no two points on its surface differ in level by more than 2 mm.

(iii) 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.

(iv) Sufficiently large to ensure that the test package falls entirely upon the surface.

8.3 Conditioning

8.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

8.4 Procedures

8.4.1 Rectangular packages.

8.4.1.1 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.

8.4.2 Cylindrical packages

8.4.2.1 Shall be similarly toppled on to top, base and side.

8.5 Evaluation

8.5.1 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

8.5.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

9. HORIZONTAL IMPACT (INCLINE) TEST (AS 2582.5)

9.1 Scope

9.1.1 This test is performed to demonstrate the ability of a package to withstand horizontal impacts at a velocity of 2.5 m/s.

9.2 Apparatus

9.2.1 The horizontal impact test apparatus should be;

a. **Impact surface,** which should be either,

(i) a plane inclined to the vertical at $10 \pm 1^{\circ}$ (for the inclined plane test), or

(ii) a plane vertical to within 1°(for the pendulum test).

The dimensions of the impact surface shall be greater than those of the impacting face, or selected part, of the package under test.

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.

b. **Impact testing apparatus,** which should be either;

(i) Inclined plane tester (see Figure 3), comprising of the following items:

Two-rail steel track, inclined at $10^{\circ}$to the horizontal. The distance along the incline shall be marked at intervals of 50 mm.

Rolling carriage or dolly. The friction between the package and carriage 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.

Impact surface. 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. 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

(i) 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.

(ii) The apparatus should be 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.

(iii) The track wheels shall be kept clean.

(iv) The wheel bearings shall be regularly lubricated, roller bearings are recommended.

(v) Pendulum apparatus (see Figure 4) comprising of a regular 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.

9.3 **Conditioning**

9.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

9.4 **Procedure**

9.4.1 The test shall be carried out, if possible, at the same atmospheric conditions as used in conditioning, or if not the test must commence within 5 minutes of removing the package from those atmospheric conditions.

9.4.2 The impact velocity shall be 2.5 m/s ±5% of the predetermined horizontal velocity.

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°.

When the impact is on an edge of a parellelepipedal 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.

9.4.3 **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 the height up the incline, which corresponds with the desired impact velocity, then release it.

9.4.4 **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.

9.5 **Severity**

9.5.1 **NATO Levels 1, 2, 3 and 4 (Australian Levels A, B, and C, DEF(AUST)1000, PART 2 refers)**

9.6 **Evaluation**

9.6.1 Any malfunction of the fittings and hardware (seals, closure, 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.

9.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

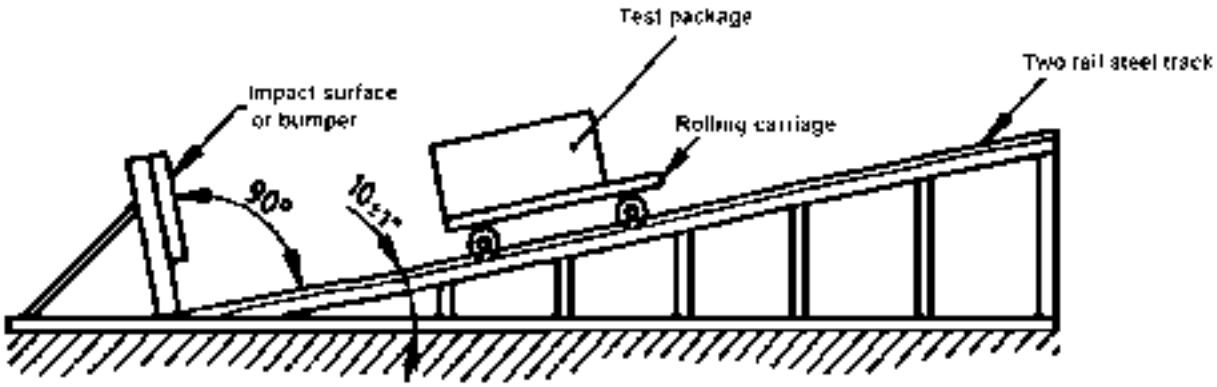


FIGURE 3. INCLINE PLANE TESTER

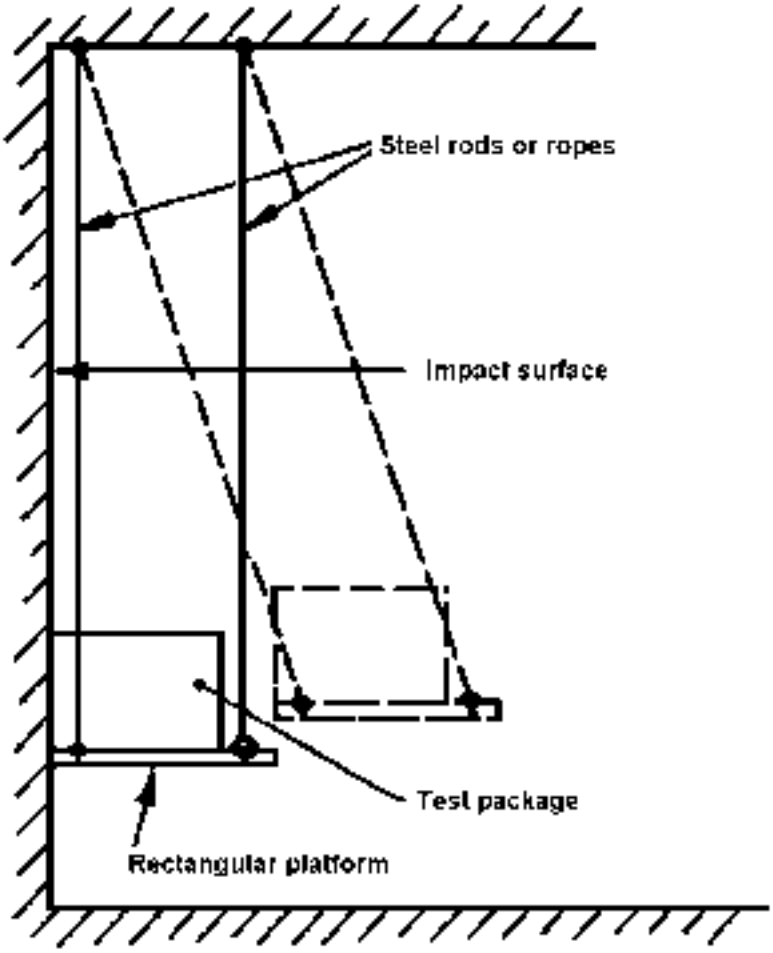


FIGURE 4. PENDULUM APPARATUS

10. HANDLING TEST

10.1 Scope

10.1.1 This test is performed to demonstrate that a package can be handled either manually or with various mechanical methods.

10.2 Apparatus

10.2.1 The apparatus shall consist of an adequate pallet truck, forklift truck, dump truck, slip-sheet truck, overhead crane, lifting cables, slings and chains, and personnel as applicable.

10.3 Conditioning

10.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

10.4 Procedure

10.4.1 ` Packages fitted with handles shall be subjected to a static test load of three times the design gross packaging mass distributed to maintain the normal centre of gravity. Lift the test item and freely suspend it from each handle in turn.

10.4.2 Packages fitted with lifting attachments shall be subjected to a static load of twice the design gross packaging mass distributed to maintain the normal centre of gravity. Lift the test item using slings attached to the lifting points; the angles between the legs of a two legged sling and the diagonally opposite legs of a four legged sling should not be greater than 90^{o} and not less than 60^{o}.

10.4.3 Packages fitted with forklift facilities shall be subjected to a static load of one and one quarter times the design gross mass. The container shall be lifted clear of the ground by forklift truck. The forks shall extend to two-thirds of the underside dimensions of the base of the specimen across which the forks are carrying out the lift.

10.4.4 Packages providing for the use of grabs shall be loaded to twice the gross package mass and lifted clear of the ground by grabs applied at the designed grab points.

10.4.5 Large packages with no lifting devices shall be loaded to three times the gross package mass and lifted clear of the ground by two slings positioned at approximately one sixth of the length of the container from each end. The angle between the diagonally opposite legs of the slings should not be greater than 90^{o} and not less than 60^{o}.

10.5 Severity

10.5.1 **NATO Levels 1, 2, 3 and 4 (Australian Levels A, B, and C, DEF(AUST)1000, PART 2 refers)**. Lift the package and hold it in mid air for five minutes.

10.6 Evaluation

10.6.1 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.

10.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

11. MECHANICAL HANDLING TEST

11.1 Scope

11.1.1 This test determines the ability of a package or container to withstand handling by mechanical handling equipment.

11.1.2 This test provides independent procedure for each of the following tests:

(i) Lifting and transporting by forklift truck,
(ii) Hoisting with slings,
(iii) Hoisting with grabs,
(iv) Pushing,
(v) Towing, and
(vi) Conveying.

11.1.3 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 must be used. Conversely, any of these tests not appropriate for a specific package should not be applied.

11.2 Specimen

11.2.1 One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing of 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, and cushioned in place for shipment.

11.3 Apparatus

11.3.1 The apparatus for each test shall be as follows;

a. **Lifting and transporting by forklift truck**

(ii) A rubber tyred forklift truck of sufficient capacity for the mass to be handled. Forks shall be adjusted to a spacing appropriate for the specimen under test, but not greater than 762 mm centre to centre.

(ii) Six nominal 25 mm by 100 mm boards longer than the width of the forklift truck.

b. **Hoisting with slings**

(i) A crane, hoist, or other arrangement of sufficient capacity for the mass to be lifted.

(ii) Slings of the lengths required to test the specimen.

c. **Hoisting with grabs**

(i) A crane, hoist, or other arrangement of sufficient capacity for the mass to be lifted.

(ii) 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.

d. **Pushing**

a. A vehicle of sufficient capacity to push the specimen.

e. **Towing**

(i) A vehicle of sufficient capacity to tow the specimen.

(ii) A tow-line of sufficient strength.

f. **Conveying**

(i) 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.

(ii) If necessary, equipment to move the specimen.

11.4 **Conditioning**

11.4.1 Unless otherwise specified, no special conditioning of the test specimen shall be necessary.

11.5 **Procedure**

11.5.1 **Lifting and transporting by forklift truck.**

11.5.1.1 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.

11.5.1.2 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 60° to the trucks path so that the left wheel strikes first; and the third pair shall be laid 27 m from the starting point at about 75° to the truck's path so the right wheel strikes first.

11.5.1.3 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 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**,** so the mass of three (408 kg) would be superimposed on the test specimen). If the specimen is more that 915 mm wide and is stable on 915 mm long forks, the forks shall extend only 915 mm under the specimen.

11.5.1.4 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 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 lifted, report the length of the forks used and state that the specimen could not be carried on the forklift truck at either end.

11.5.2 **Hoisting with slings**

11.5.2.1 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 11.5.1.3 for examples). Such superimposed loads shall not contact the slings or lend reinforcement to the top structure of the package.

11.5.2.2 **Underslung handling (Figure 5).** 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 the 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 two minutes. Observe carefully for any indications of inadequacies and let the specimen down.

11.5.2.3 **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^{o} and 25^{o} with a horizontal plane (Figure 6A)**.** Lift the specimen clear of the floor and hold it suspended for less than two 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 two minutes.

11.5.3 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 (Figure 6B). Record observations and lower the specimen to the ground. Repeat with each lifting point provided on the specimen.

11.5.4 **Hoisting with grabs (Figure 7).**

11.5.4.1 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 specimens 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^{o} angles ($\pm 5^{o}$) to the horizontal. For an operating line extending from one grab up to the hoist attachment and 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^{o} ($\pm 2.5^{o}$) 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 two minutes, and return it to 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.

11.5.5 **Pushing**

11.5.5.1 Position the vehicle to abut the end of the specimen near the floor. If the 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.

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

11.5.6 **Towing**

11.5.6.1 Attach a sling to the tow-line attachment fitting 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 tow-line, 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 tow-line. Then reattach the tow-line and tow the specimen sideways over the same distance. Record observations.

11.5.6.2 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 strength of the container structure, as well as the skids, shall survive the test without failure or permanent deformation.

11.5.7 **Conveying**

11.5.7.1 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.

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

11.5.7.3 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.

11.5.8 **Severity**

11.5.8.1 **NATO levels 1, 2, 3 and 4 (Australian Levels A, B, and C, DEF(AUST)1000, PART 2 refers).**

11.5.9 **Evaluation**

11.5.9.1 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

11.5.9.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

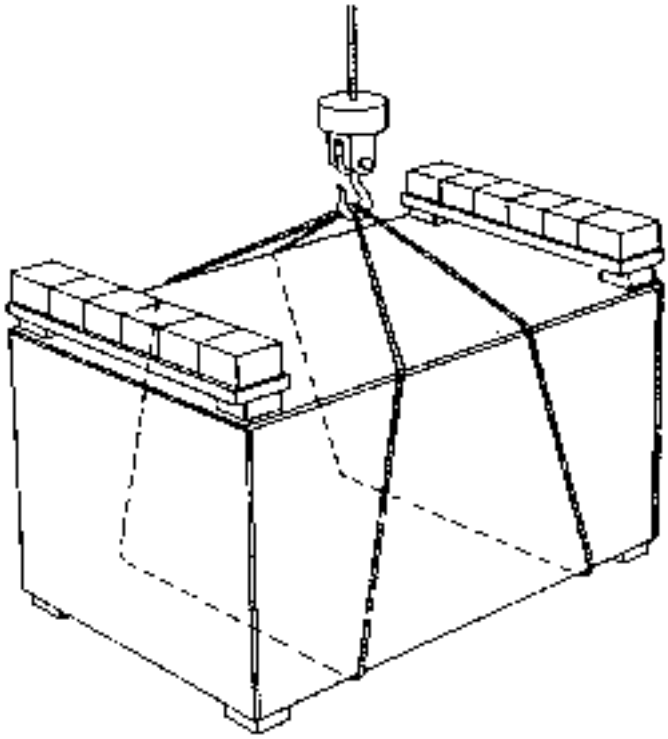


FIGURE 5. SLINGS PLACED AROUND SPECIMEN WITH SUPERIMPOSED LOAD

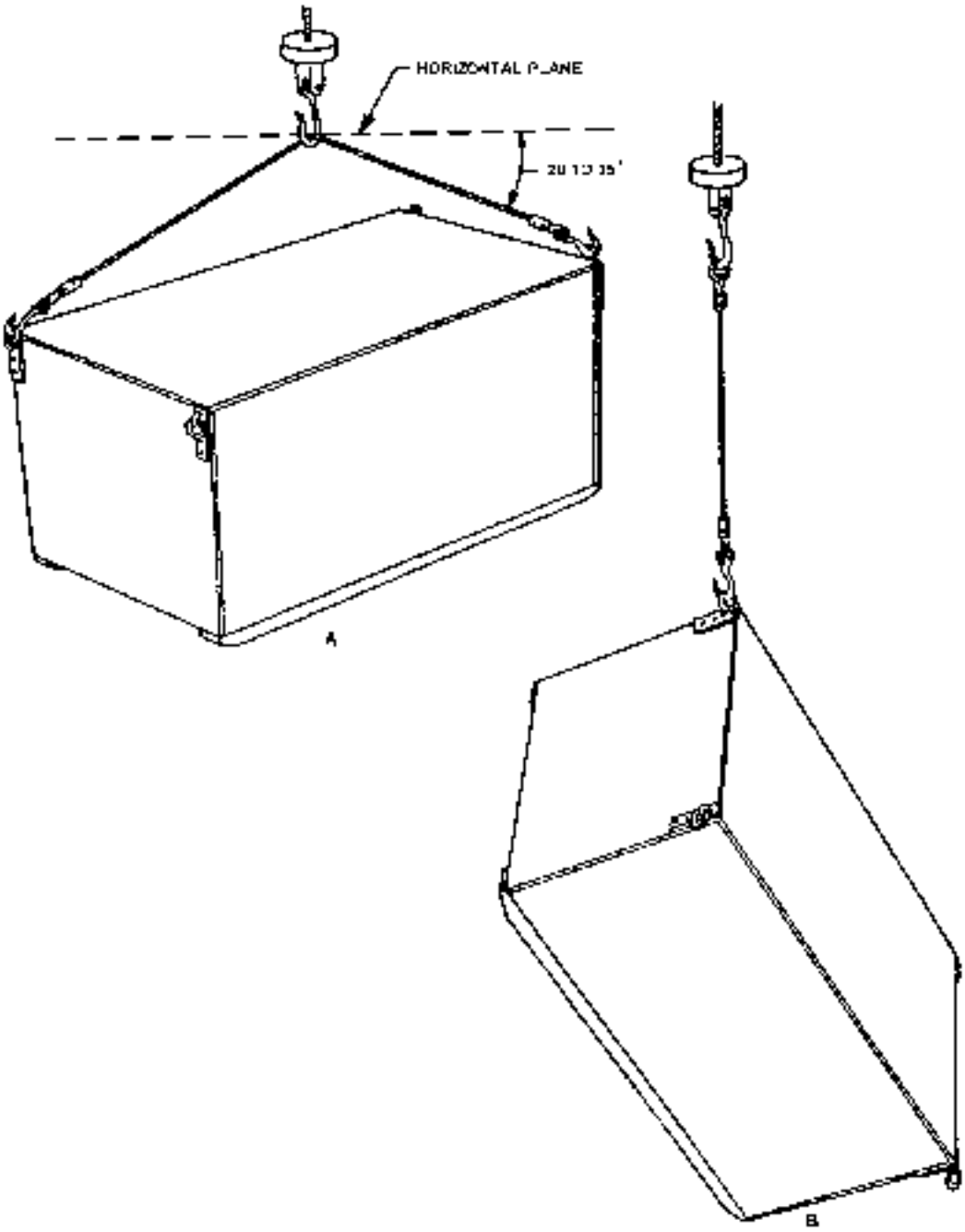


FIGURE 6. HOISTING WITH SLING ATTACHMENT PROVISIONS

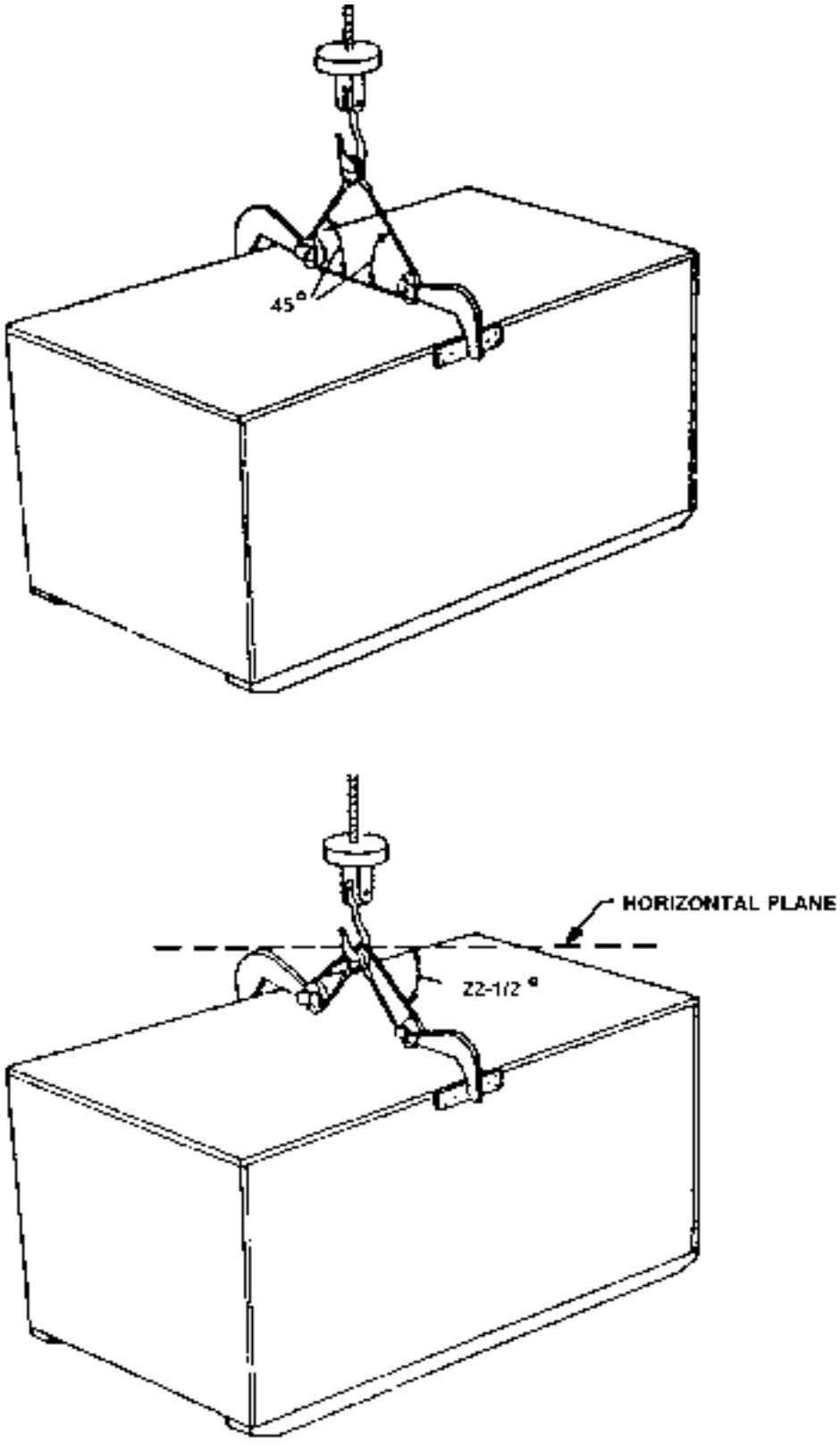


FIGURE 7. HOISTING WITH GRABS

12. BOUNCE (WHEELED VEHICLE TRANSPORTATION) TEST

12.1 Scope

12.1.1 This test is intended to assess the capability of the package to withstand the hazards associated with transit by road, without degradation of the package, internal packaging components or damage to the packaged item.

12.2 Apparatus

12.2.1 The test apparatus shall consist of a flat assembly coupled to two shaft driven eccentric assemblies, which are mounted, on a base framework.

12.2.2 The table assembly shall be of 25 ±1 mm plywood firmly secured by recessed fasteners to a steel frame.

12.2.3 Barriers shall consist of 75 mm steel channel section faced with 25 ±1 mm plywood firmly secured. Alternatively, they may be constructed of 75 ±5 mm square section softwood.

12.2.4 The eccentrics shall produce a maximum peak to peak vertical displacement of the upper surface of the plywood table, in the region between the drive shafts, of $25\ ^{+1.0mm}_{-0.5mm}$

12.2.5 The motion of the table surface in the direction normal to the drive shafts shall be as produced by the basic mechanism shown in Figure 8. In the direction parallel to the drive shafts the motion shall be nominally zero, being only that attributable to the engineering tolerances of the mechanism.

12.2.6 The relative speed of the two drive shafts shall be not less than 0.87 **:** 1, and not greater than 0.92 **:** 1.

12.2.7 The high-speed shaft of the machine shall rotate at 285 ±5 rpm.

12.2.8 The machine shall be fixed so that with the eccentric assemblies at their lowest positions the table surface slopes downwards towards the high speed shaft at an angle of 20° ±10 minutes.

12.2.9 Other test apparatus may be used provided it can be shown to give equivalent results.

12.3 Conditioning

12.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

12.4 Procedure

12.4.1 The package shall be placed on the test table centrally between the centre lines on the drive shafts (see dimension A of Figure 8).

12.4.2 The presence of vehicle sidewalls shall be simulated by a rectangular arrangement of retaining barriers securely attached to the table frame (see example at Figure 9). The retaining barriers shall be of such a number and be so arranged as to restrict movement of the test package to within the confines of the test area of the plywood table.

12.4.3 The barriers shall be erected with all round clearance between them and the vertical surfaces of the package of between 50 mm and 75 mm. The top edge of the uppermost barrier shall be positioned between 50 ±25 mm below the top of the package and 75 ±25 mm above the centre of gravity of the package, and shall not be more than 600 mm from the top surface of the plywood table, (600 mm is the normal vehicle wall height of those vehicles most commonly used by the Services).

12.4.4 Where the aspect ratio of the package (the ratio of its longest side to its shortest) does not exceed 3 **:** 1 and its mass does not exceed 50 kg, it shall be bounced on each of its faces (normally three for a cylinder and six for a rectangular package) orientated with respect to the table.

12.4.5 Where there is a requirement for transit stacking simulation the stack shall be built on the test table centrally between the centre lines of the drive shafts (see dimensions A of Figure 8). The procedure shall then be followed using the apparatus outlined in Paragraph 12. 2. 1.

12.4.6 The presence of vehicle sidewalls shall be simulated by a rectangular arrangement of retaining barriers securely attached to the table frame. The retaining barriers shall be of such a number and be so arranged as to restrict movement of the test packages to within the confines of the test area of the plywood table.

12.5 **Severity**

12.5.1 **For NATO levels 1, 2 & 3 (Australian levels A & B**, **DEF(AUST)1000, PART 2 refers),** the package stack shall be subjected to the test for 15 minutes. If the number of test attitudes are required the test period shall be divided equally between them.

12.5.2 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 dissipated, the rest periods shall be in addition to the 15 minute test period.

12.5.3 **For NATO level 4 (Australian level C, DEF(AUST)1000 PART 2 refers)**, the package or stack shall be subjected to the test for 5 minutes.

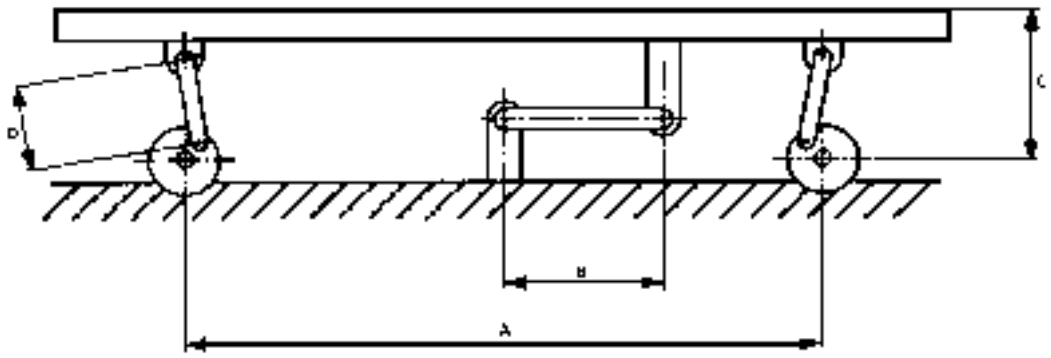
12.5.4 A single package shall be tested while standing on its base or the face which it normally is expected to be transported.

12.5.5 Packages within a stack shall be tested in the same attitude as in Paragraph 12.5.4 unless otherwise specified.

12.6 **Evaluation**

12.6.1 The package shall be considered to have failed the test if the packed item is unserviceable or if the package is affected in any way, which would potentially, cause the item to become unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

12.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.



Dimension

A Shall be not less than 600 mm and not greater than1700 mm
B Shall be greater than 250 mm
C Shall be 25% ± 5% of dimension A
D Shall be 8% ± 7% of dimension A

FIGURE 8. BOUNCE MACHINE, BASIC DRIVE MECHANISM

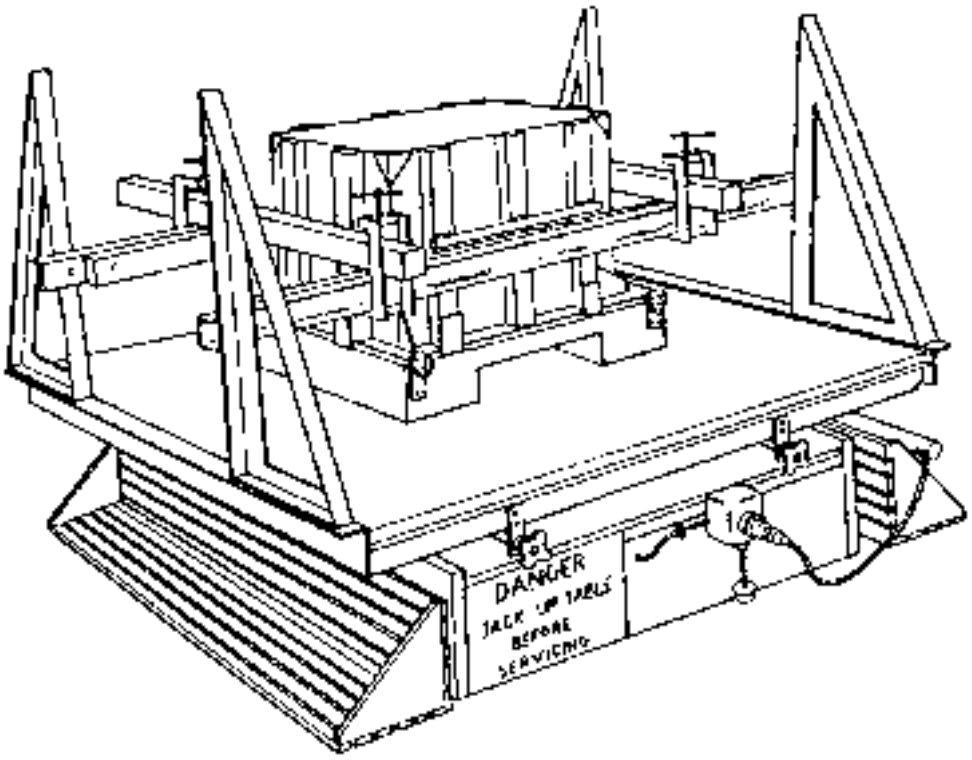


FIGURE 9. TYPICAL BARRIER ARRANGEMENT

13. BUMP TEST

13.1 Scope

13.1.1 The test is primarily intended to assess the effectiveness of the physical protection, i.e. the container and the method of location. For example:

a. container construction - loosening of nails, screws and fastenings:

b. method of location - security of furniture and fittings; strength of locating load - spreading parts; fatigue/bedding down of cushioning, load - spreading and space - filling materials.

13.1.2 The test may also cause deterioration of the climatic protection through scuffing, abrasion or weakening of barriers, or the displacement of or damage to protective coatings applied to the item.

13.2 Apparatus

13.2.1 The bump machine shall be capable of accommodating the mass of the test package. The impact parameters shall be monitored at the table by an accelerometer system capable of recording the requirements of paragraph 13.2.2.

13.2.2 At the monitoring, point the height of drop of the table and the retarding medium of the machine shall produce a pulse approximating to one half cycle of a sine wave of 5 g acceleration, amplitude A and 30 ±5 ms duration (D) represented by dotted lines in Figure 10. The true value of acceleration of the actual pulse shall be within the tolerance boundary shown in Figure 8 unless otherwise agreed.

13.3 Conditioning

13.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

13.4 Procedure

13.4.1 The package shall be firmly secured to the table of the bump machine and bumped in accordance with the requirements of paragraph 13.2.2.

Note: When the test is to 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.

(i) Packages up to and including 70 kg shall be capable of withstanding the test when standing on any one face.

(ii) 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.

(iii) 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.

13.5 Severity

13.5.1 The package may be subjected to a total of up to 10000 ±5% bumps when firmly secured to the table of the bump machine.

13.6 **Evaluation**

13.6.1 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. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

13.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

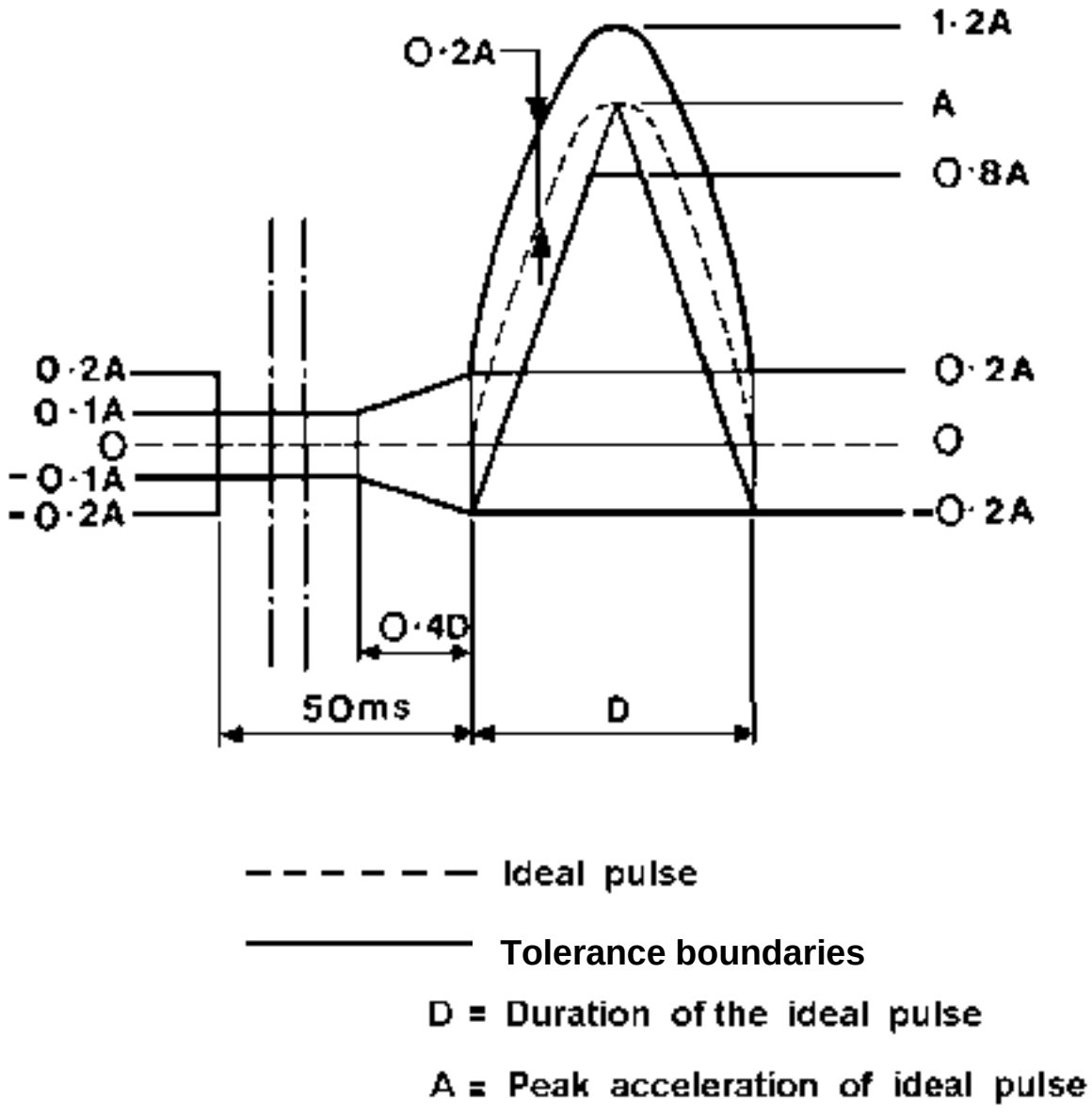


FIGURE 10. PULSE SHAPE (Half Sine)

14. VIBRATION TEST

14.1 Scope

14.1.1 This test is performed to demonstrate the ability of a package to withstand vibration within a range 5 - 350 Hz.

14.2 Apparatus

14.2.1 The test apparatus shall be flat horizontal test bed capable of supporting the test package that vibrates in vertical sinusoidal motion within a range of 5 - 350 Hz.

14.3 Conditioning

14.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

14.4 Procedure

14.4.1 Immediate upon removal from the conditioning chamber, firmly secure the test package to the vibrating surface in its normal orientation for transport and vibrate it.

14.5 Severity

14.5.1 Sweep the frequency between 5 and 350 Hz in both increasing and decreasing frequency at a continuous logarithmic rate of 0.5 to 1.0 octave/min while maintaining the acceleration at the level(s) agreed to by the criterion.

14.5.2 Packages of up to and including 70 kg mass shall be vibrated for two hours in each of three mutually perpendicular planes at a vibration amplitude of ±6 mm peak from 5 to 9 Hz and ±2 g peak from 9 to 350 Hz.

Note: If, because of the geometry of the package, it is considered impracticable or unnecessary to vibrate the package in a particular plane, the package shall be vibrated in two remaining test planes for three hours each.

14.5.3 Packages over 70 kg mass shall be vibrated for six hours whilst standing on their designated base at a vibration amplitude of ±mm peak from 5 to 9 Hz and ±2g peak from 9 to 150 Hz. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

14.6 Evaluation

14.6.1 If the packaged item is found to be unserviceable or any malfunction of the fittings and hardware (seals, closures, hinges, handles, etc), and any damage 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.

14.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

15. WATER SPRAY TEST

15.1 Scope

15.1.1 This test is conducted to demonstrate the ability of a package to withstand exposure to continuous water spray that stimulates natural rainfall.

15.2 Apparatus

15.2.1 The test area shall include a draining and spraying system consisting of 4 portable spray nozzles. The test surface shall be flat, horizontal, porous surface elevated above the draining surface to prevent contact of the bottom of the test package with ground water.

15.3 Conditioning

15.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

15.3 Procedure

15.3.1 Place the test package on the test surface in its normal transport/storage position. Direct a spray nozzle at an angle of 45 degrees to each of the four top corners of the test package adjusted such that the nozzles are facing the corners (Figure 11a). Angle the aperture of the spray nozzles downward to an angle of 45 degrees to the horizontal and the distance to the plane of the package top surface and nozzle is 2.5 m (Figure 11b).

15.3.2 For cylindrical packages (Figure 12a) the spray shall be applied in a similar manner as to the rectangular packages, but from four positions spaced at four positions spaced at intervals of 90 degrees.

15.3.3 The water discharge pressure shall not be less than 2.5 bars.

15.4 Severity

15.4.1 The temperature of the spray water shall be between 5°C and 35°C. The packages shall be sprayed uniformly with water at a rate of not less than $360\ ^{+40}_{-0}$ 1/m^2/h per nozzle.

15.5 Duration

15.5.1 The duration of the spray test shall be 6 hours.

15.6 Evaluation

15.6.1 Any penetration of water into the test package causing deterioration of its contents, malfunction of 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.

15.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, any minor visible deterioration of the test package.

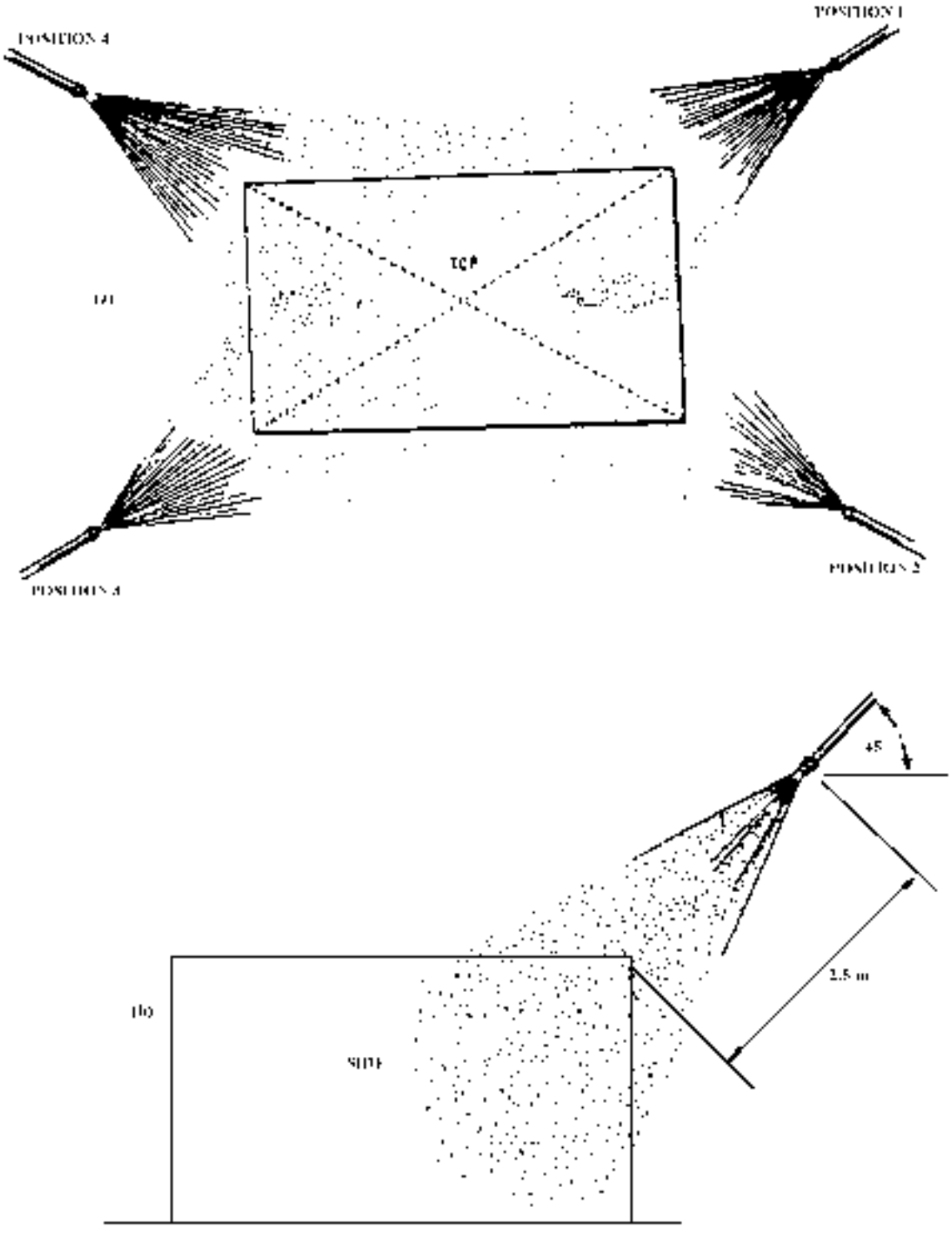


FIGURE 11. WATER SPRAY - RECTANGULAR PACKAGE

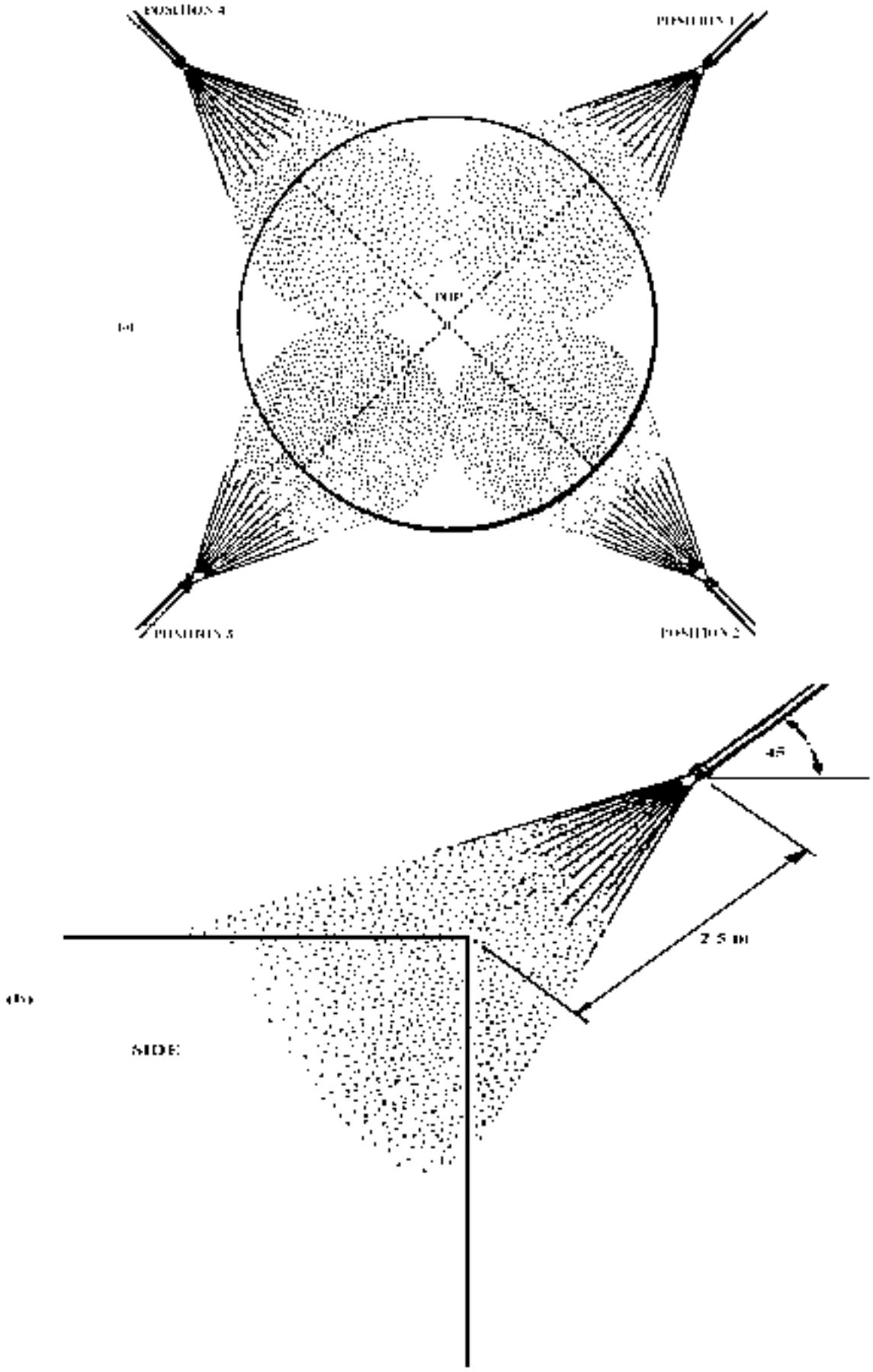


FIGURE 12. WATER SPRAY - CYLINDRICAL PACKAGE

16. LEAKS IN CONTAINERS

16.1 Scope

16.1.1 This test procedure provides eight common techniques for detecting leaks in containers.

16.1.2 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.

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

a. **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 inspected while immersed to the required depth.

b. **Simulated rainfall method.** The container closed for shipment is subjected to water spray and subsequently opened and inspected for leakage.

c. **Hydraulic pressure method.** Internal pressure is utilized to force water or other liquids through any leaks.

d. **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.

16.2 Apparatus

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

a. **Vacuum retention.** A vacuum pump and pressure gauge 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.

16.2.2 Tests for water leaks, or other contents, require the following apparatus with different methods:

a. **Submersion (or immersion).** A vessel of water in which the specimen may be submerged or immersed.

b. **Simulated rainfall.** The method described in paragraph 16 shall be used.

c. **Hydraulic pressure.** A source of hydraulic pressure with gauge and a pressure regulator.

d. **Static leakage.** Blocking as necessary to support the specimen in the various positions required.

16.2.3 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.

16.3 **Conditioning**

16.3.1 Unless otherwise specified, no special conditioning of the specimen is required and all tests shall be conducted at ambient temperature ($21^{\circ}C \pm 6^{\circ}C$) as contained in the following procedures:

a. **Vacuum retention method.**

(i) During the preparation of the specimen, make provisions for the connection of a tube to evacuate 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 valve stem incorporated in a rigid container or other acceptable devices that can be either sealed or removed from the container without adverse effect.

(ii) Connect the vacuum pump to the specimen and evacuate the air until the specimen 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.

CAUTION

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

(iii) When the specimen is evacuated to a specified pressure, stop evacuating air and record the vacuum pressure gauge reading.

(iv) After ten minutes, unless otherwise specified, read and record the loss in vacuum pressure.

b. **Pneumatic pressure method.**

(i) 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 leak 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, " 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.

(ii) Pressurise 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.

CAUTION

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

(iii) When the specimen is pressurised to a constant specified pressure, read and record this initial pressure.

(iv) After 30 minutes, read and record the final pressure. If no change is noted between the initial and final gauge pressures, the item is considered sealed, if however, any loss of pressure is detected, the leaks can be located by means of an ultrasonic detector, submersion or bubble supporting film methods and repaired as required to seal the container.

(v) An ultrasonic translator detector finds areas where leakage occurs. This method can be used on all types and sizes of pressurised containers as a rapid means of pin pointing the source of leak.

(vi) 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 a 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.

c. **Squeeze method.**

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

a. Submerge the specimen 25 to 50 mm under water and, while squeezing the specimen, observe all seams and surface for leakage,

b. 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”.

d. **Hot water method.**

(i). Any wax dipped specimens shall be cooled to equilibrium at an initial temperature between 10°C and 15°C.

(ii) 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 specimen). 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”.

e. **Submersion (or immersion) method.**

(i) Unless otherwise specified, the specimen 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 one 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.

(ii) When immersion of an open 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.

(iii) Inspect the inside for leakage. Record whether or not the specimen leaked and if possible, the location of leaks.

f. **Hydraulic pressure method.**

(i) Before filling and sealing the specimen, a suitable leak-proof connection for a pressure line shall be installed in the specimen.

(ii) Unless otherwise specified, fill the specimen with coloured water and connect either an air or water pressure line to the specimen.

(iii) Increase the pressure uniformly over a 10 second period to the test pressure and maintain it for a period of time specified. Unless otherwise specified, the pressure shall be one bar and the period shall be five minutes. Inspect the exterior of the specimen for leakage, particularly around joints and fastenings.

(iv) Record whether or not leakage was observed, and describe the locations of the leaks.

g. **Static method.**

(i). 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.

(ii). 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

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

16.4 **Evaluation**

16.4.1 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.

16.4.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

17. WATER IMMERSION TEST

17.1 Scope

17.1.1 This test is performed to demonstrate the ability of a package to resist penetration of water from a static head of standing water. The immersion test is replaced by the water spray test when the exterior dimensions of the test package, as calculated below, exceed 3 m;

a. for a rectangular prism exterior dimensions = length + width + height,

b. for a cylinder exterior dimensions = length plus twice the diameter.

17.2 Apparatus

17.2.1 The test apparatus shall consists of a water storage tank equipped with porous false floor permitting exposure of the package bottom face to standing water. The tank shall be of adequate size and shall contain sufficient water to immerse the test package and hold a static head of water of 1.3 m. Tie downs shall be incorporated in the tank to hold down packages that float or tend to float.

17.3 Conditioning

17.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

17.4 Procedure

17.4.1 The Temperature of the water in the holding tank shall not exceed 27°C.

17.4.2 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.

17.4.3 Packages over 40 kg shall be immersed standing on their base for the total time.

17.4.4 Cylindrical packages shall be immersed standing on their ends and sides.

17.5 Severity

17.5.1 **NATO Levels 1 and 2 (Australian Level A, DEF(AUST)1000, PART 2 refers)**. All test packages shall be immersed in water for a total of 2 hours.

17.6 Evaluation

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

17.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

18. DAMP HEAT TEST

18.1 Scope

18.1.1 Packages in transit overseas, and particularly in storage overseas, may be exposed to diurnal cycling of tropical temperature and humidity. Under such extreme climatic conditions, deterioration of inadequately protected items is most rapid. Unless adequately preserved or protected the protective quality of some packaging materials may also deteriorate. The test is primarily intended to assess the effectiveness of the climatic protection. The test may also be used to condition the package for assessment of the effects of tropical climate on the performance of its physical protective elements, e.g. the performance of the container, its furniture, load-bearing and cushioning materials may be reduced. When the test is sequentially applied to physical tests such as bounce or impact, it may reveal weaknesses in the climatic protection such as abrasion or rupture of barriers, which have occurred during these tests.

18.2 Apparatus

18.2.1 The temperature and humidity within the chamber shall be capable of control to meet the required conditions and shall be monitored by sensing devices suitably located in the working space. Provision shall be made for a continuous record of chamber conditions throughout the test.

18.2.2 The conditions prevailing throughout the working space shall be uniform and shall be within the required limits. Air in the chamber shall be continuously agitated or circulated throughout to reduce temperature and humidity variation. Air circulation shall be the minimum consistent with satisfactory control.

18.3 Conditioning

18.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

18.4 Procedure

18.4.1 The package shall be placed in a suitable test chamber at standard laboratory conditions. It shall stand on its base or the face upon which it is normally expected to be transported or stored.

18.4.2 The chamber temperature shall be adjusted to and maintained at 25° ±2°C for a sufficient period to enable the package to stabilize at the chamber temperature. The humidity shall be maintained between 45 and 75% relative humidity. Then during a period not exceeding one hour, the humidity shall be raised to not less than 95% relative humidity.

18.4.3 The package shall then be exposed to the 24 hour test cycle conditions detailed below (see also Figure 13):

a. The chamber temperature shall be raised, at an approximately uniform rate over a period of three hours to 40° ±2°C. During this period the humidity shall be maintained at not less than 95% relative humidity and shall be such that condensation occurs on the surface of package (this implies that the package temperature is below dew point and to achieve this will necessitate a chamber of size and construction adequately related to the size and thermal capacity of this package).

b. The chamber temperature shall be maintained at 40° ±2°C until 12 ±30 minutes after the start of the cycle. During this period the humidity shall be between 90 and 96% relative humidity.

c. The chamber temperature shall be allowed to fall to 25° ±2°C over a period of three to six hours with an initial fall for the first 1.5 hours of approximately 5°C per hour. The humidity shall be not less than 90% relative humidity during this period.

d. The chamber temperature shall be maintained at 25° ±5C° with a humidity not less than 95% relative humidity for a period to complete a 24 hour cycle.

18.5 **Severity**

18.5.1 **For NATO levels 1 and 2 (Australian Level A, DEF(AUST)1000, PART 2 refers)** only when approved materials and/or techniques only are incorporated in the package design, the package shall be subjected to four complete cycles.

18.6 **Evaluation**

18.6.1 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 be unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

18.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

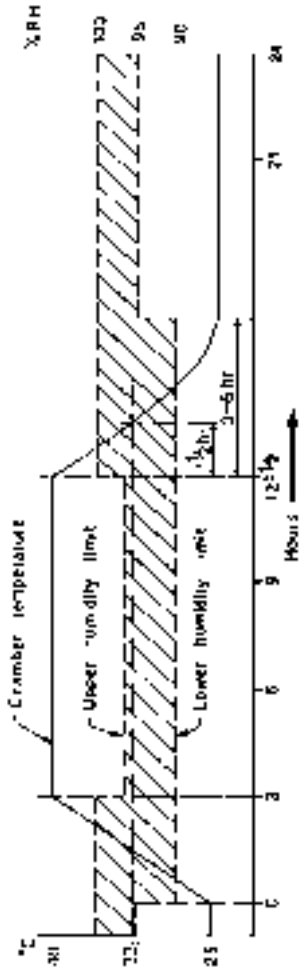


FIGURE 13. CONDITIONS FOR DAMP HEAT TEST

19. DRY HEAT TEST

19.1 Scope

19.1.1 Under dry hot conditions of storage or during transit, the materials used in construction of packages will dry out and thus tend to alter the level of protection applied to the packaged item. The test is primarily intended to assess the effects of drying out on the protective properties of the package, e.g. through shrinkage of timber and loosening of fastenings such that the item is permitted free movement; the dehydration of paper-based materials and degradation of some rubbers and plastics.

19.1.2 Subsequent physical tests, e.g. bounce, impact, should be carried out with minimum delay.

19.2 Apparatus

19.2.1 The temperature and humidity within the chamber shall be capable of control to meet the test conditions and shall be monitored by sensing devices suitability located in the working space. Provision shall be made for a continuous record of chamber conditions throughout the period of the test.

19.2.2 The conditions prevailing throughout in the working space shall be uniform and shall be within the required limits. Air in the chamber shall be continuously agitated or circulated throughout to reduce temperature and humidity variation. Air circulation shall be the minimum consistent with satisfactory control.

19.3 Conditioning

19.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

19.4 Procedure

19.4.1 The package shall be placed in a suitable test chamber at standard laboratory conditions. It shall stand on its base or the face on which it is normally expected to be transported or stored. The chamber temperature shall be raised to $55^{\circ} \pm 2^{\circ}C$ at a rate not exceeding $3^{\circ}C$ per minute.

19.4.2 The chamber temperature shall be maintained at $55^{\circ} \pm 2^{\circ}C$ for 48 hours.

19.4.3 At the completion of the high temperature phase, the chamber temperature shall be allowed to return to standard laboratory conditions at a rate not exceeding $3^{\circ}C$ per minute.

19.4.4 Throughout the test the relative humidity shall not exceed 75 per cent relative humidity or a water vapour pressure of 30 millibars, whichever is the lesser. (See Figure 14).

19.5 Severity

19.5.1 **The test is applicable to NATO levels 1 and 2 (Australian Level A, DEF(AUST)1000, PART 2 refers)**.

19.6 Evaluation

19.6.1 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 be unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

19.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

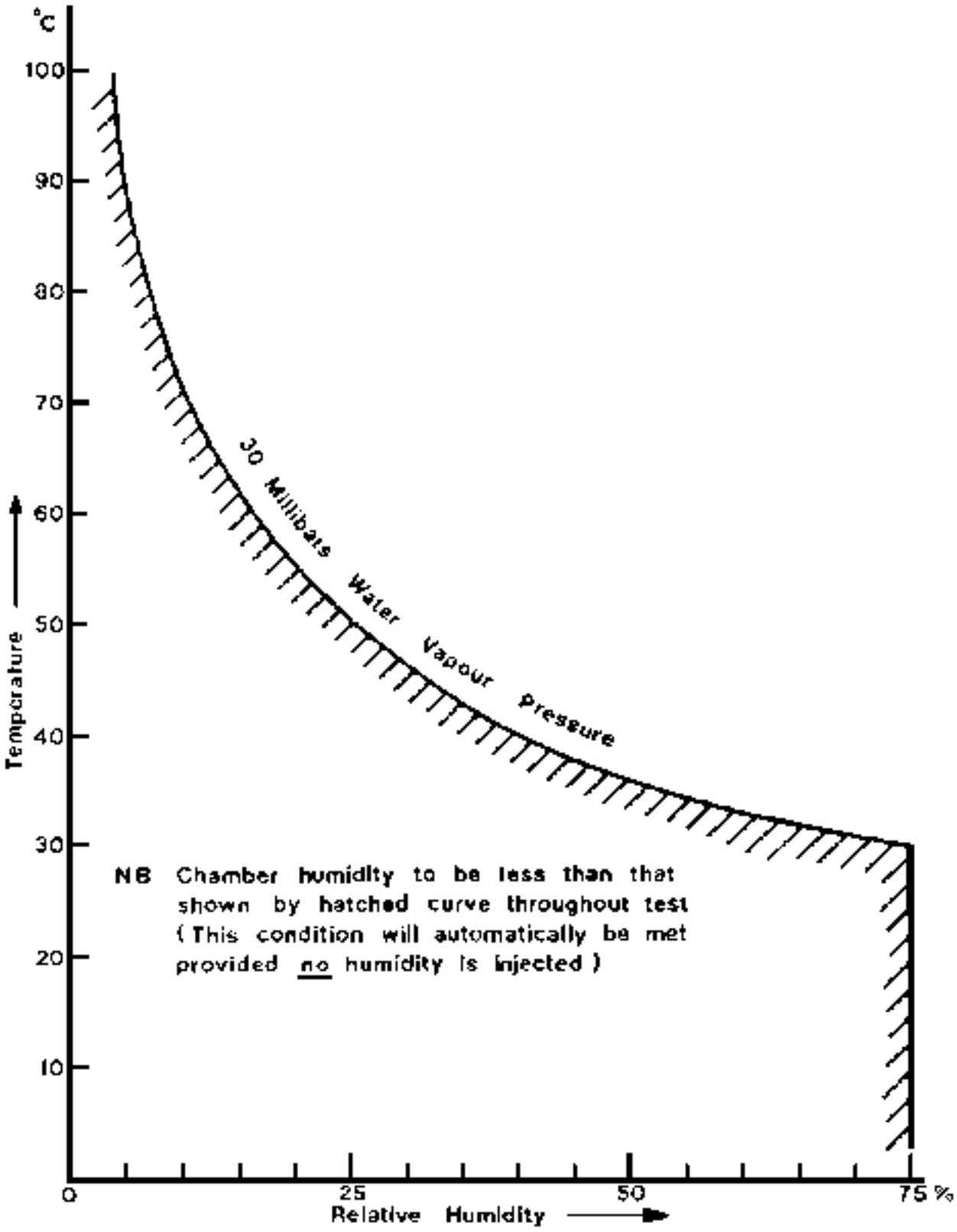


FIGURE 14. HUMIDITY LIMIT FOR DRY HEAT TEST

20. DRY HEAT EXPOSURE TEST (SOLAR RADIATION)

20.1 Scope

20.1.1 This test is more of a simulation of exposure to hot dry climatic conditions than the Dry Heat Test, but will also enable assessment to be made of the effect of drying out the protective properties of the package, i.e. shrinking, dehydration and the deterioration of constituent organic materials. It will also condition the package for assessment of organic materials. It will also condition the package for assessment of its physical protective quality if subjected to subsequent movement and handling in the dry condition. The test may also have purpose if there is a requirement for thermal insulation.

20.2 Apparatus

20.2.1 The temperature and humidity within the chamber shall be capable of control and shall be monitored by sensing devices suitably located in the working space. Provision shall be made for continuous record of chamber conditions throughout the period of test.

20.2.2 The conditions prevailing throughout the working space shall be uniform and shall be within the required limits prevailing in the immediate vicinity of the sensing devices. Air in the chamber shall be agitated continuously or circulated throughout to reduce temperature and humidity variation. Air circulation shall be the minimum consistent with satisfactory control.

20.2.3 To obtain a reasonably close simulation of the spectral energy distribution of natural solar radiation it is necessary to use xenon or carbon arc lamps in combination with suitable filters. However, if only the heating effects of sunlight exposure are of interest, then the use of tungsten filament lamps to provide the desired radiant heating may be appropriate. But it must be clearly appreciated that the spectral energy distribution of tungsten filament lamps differs markedly from that of natural solar radiation. The radiation intensity must therefore be adjusted so that the radiation absorbed by the surface of the package under test is the same as it would be if the surface were irradiated by natural sunlight.

20.2.4 Test house staff must be made aware of the hazards associated with solar radiation testing.

20.3 Conditioning

20.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

20.4 Procedure

20.4.1 The package shall be placed in a suitable test chamber. It shall stand on its base or the face upon which it is normally expected to be transported or stored. It shall be exposed to the 24 hour test cycle detailed below (see also Figure 15). Throughout the test the humidity shall not exceed 75% Relative Humidity or a water vapour pressure of 30 millibar, whichever is less (see Figure 16).

NOTE: Where facilities for providing the desired solar radiation test envelope are not available, the simplified envelope is permissible as an alternative. The same net heating effect is obtained without the complication of gradual rise and fall of intensity

a. A heating period of approximately six hours during which the temperature shall rise at a uniform rate to 55 ±2°C. During this period, simulated solar radiation shall be applied to the top surface of the package and its intensity shall rise at a uniform rate from zero to 1120 Wm^3 (±10%) which it shall attain for four hours. The level shall be maintained for the remaining two hours.

b. A period of four hours at a temperature of 55 ±2°C. Simulated solar radiation at 1120 W/m^2 (±10%) intensity shall continue to be applied for the first two hours of this period and the level shall then fall at a uniform rate to 560 W/m^2 over the remaining two hours of the period.

c. A cooling period of approximately 10 hours during which the temperature shall fall to 30 ± 2°C. The intensity of the simulated solar radiation shall continue to fall at a uniform rate from 560 W/m^2 to zero over the first two hours of the period.

d. A period of not less than four hours during which the temperature shall be maintained at 30 ± 2°C.

e. When approved materials and/or techniques only are incorporated in the package design, the package shall be subjected to four complete cycles.

20.5 **Severity**

20.5.1 **The test is applicable to NATO levels 1 and 2 (Australian Level A, DEF(AUST)1000, PART 2 refers).**

20.6 **Evaluation**

20.6.1 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 be unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

20.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

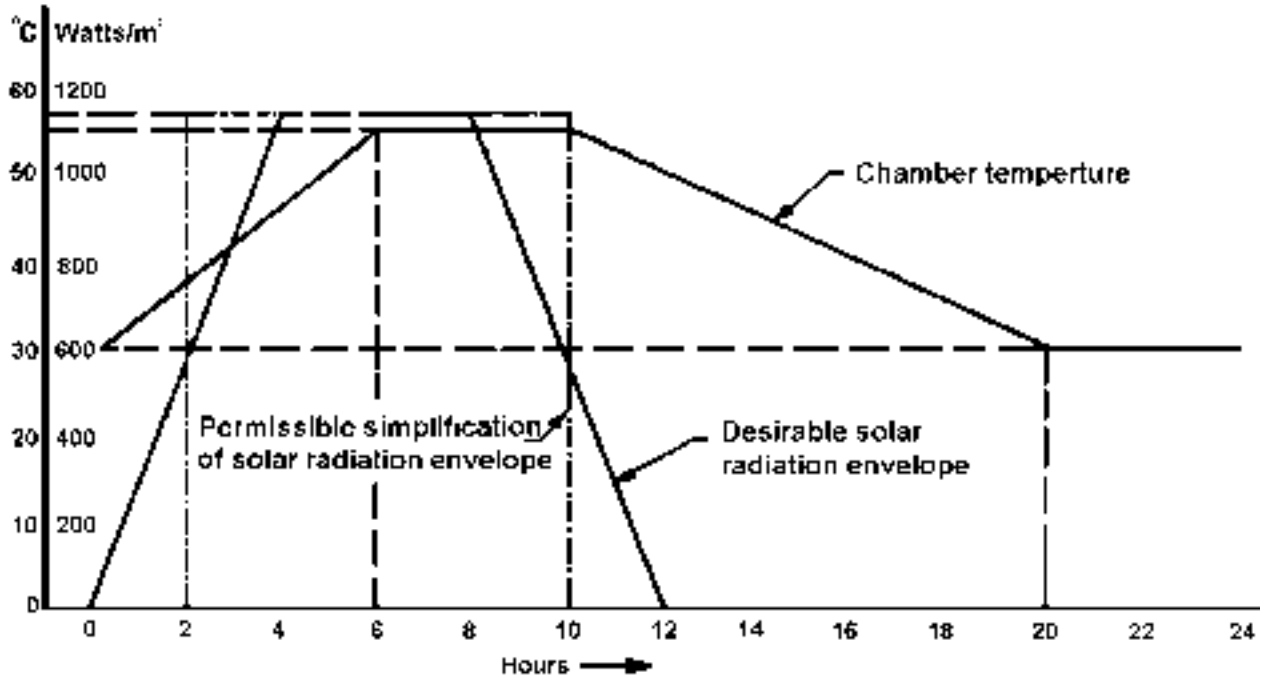


FIGURE 15. RADIATION/TEMPERATURE CYCLE FOR DRY HEAT EXPOSURE TEST

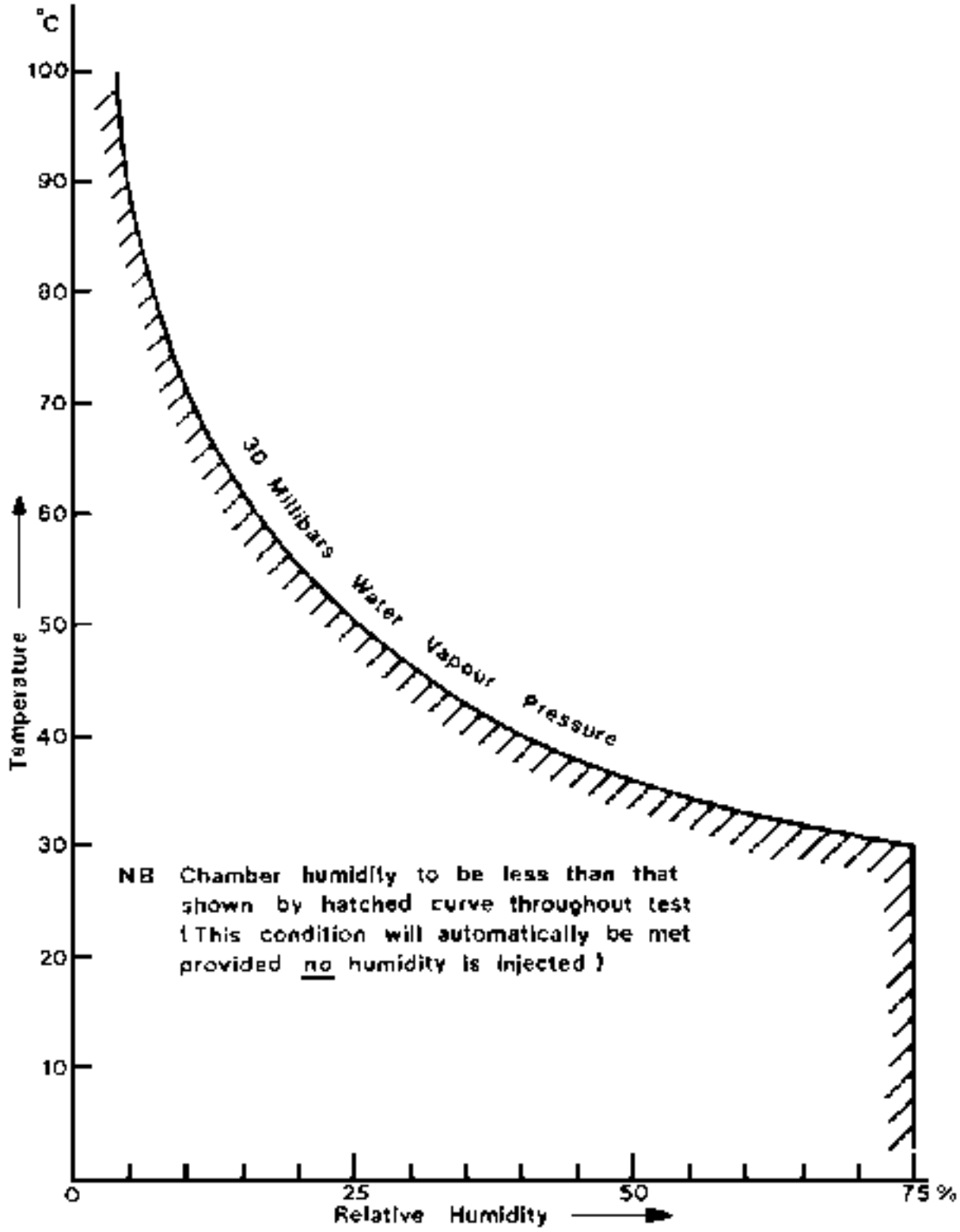


FIGURE 16. HUMIDITY LIMIT FOR DRY HEAT EXPOSURE TEST

21. LOW TEMPERATURE TEST

21.1 Scope

21.1.1 The test is primarily intended to condition the package and its contents to enable assessment to be made of the effect of low temperature on the protective properties of the package, e.g. the stiffening of cushioning materials, the contraction and stiffening of barriers, etc.

21.2 Apparatus

21.2.1 A suitable environmental chamber, which shall be capable of control to meet the test conditions and shall be monitored by sensing devices suitably, located in the working space. Provisions shall be made for a continuous record of chamber conditions throughout the period of test.

21.2.2 The conditions prevailing throughout the working space shall be uniform and shall be within the required limits. Air in the chamber shall be continuously agitated or circulated throughout to reduce temperature and humidity variation. Air circulation shall be the minimum consistent with satisfactory control.

21.3 Conditioning

21.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

21.4 Procedure

21.4.1 The package shall be placed in a suitable test chamber at a standard laboratory conditions. It shall stand on its base or the face upon which it is normally expected to be transported or stored.

21.4.2 The chamber temperature shall be lowered to the test temperature at a rate not exceeding $3^{\circ}C$ per minute.

21.4.3 The chamber temperature shall be maintained at this temperature for:

a. 16 hours after the package has reached the test temperature, or

b. 7 days if the time required for the complete package to attain the temperature cannot be assessed.

21.4.4 Subsequent physical testing of the package, e.g. impact, should be carried out in the test chamber following the period of exposure to low temperature but, where this is impractical, the tests should be carried out immediately on removal of the package from the chamber.

21.5 Severity

21.5.1 **For NATO levels 1 and 2 (Australian level A, DEF(AUST)1000 PART 2 refers)** the test temperature shall be $-20 \pm 2^{\circ}C$.

21.5.2 **For NATO levels 3 and 4 (Australian levels B and C, DEF(AUST)1000 PART 2 refers),** the test temperature shall be $-10 \pm 2^{\circ}C$.

21.6 Evaluation

21.6.1 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 be unserviceable. Failure may not become apparent until the test package is subjected to other tests carried out in sequence with this test.

21.6.2 A test report shall be prepared certifying compliance to or deviation from this method, the acceptability of the test package, all causes of any package failure, and any minor visible deterioration of the test package.

22. HEAT-SEALED SEAM TEST

22.1 Scope

22.1.1 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 joint.

22.2 Apparatus

22.2.1 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 the seams shall be reproducible.

22.2.2 A test frame 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.

22.2.3 A weighted clamp 25 mm wide to suspend the lower portion of the specimen. Unless otherwise specified, the total mass shall be 1.6 kg.

22.3 Conditioning

22.3.1 Test packages shall be conditioned in accordance with one of the conditions described in SECTION B, Paragraph 1.5, Conditioning, for the lesser of 16 hours or until equilibrium is reached.

22.4 Procedure

22.4.1 All tests shall be conducted at ambient temperature (21°C ±6°C).

22.4.2 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 heat-sealed 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.

22.4.3 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 weighted clamp to the lower end of the specimen so the weight is suspended by the specimen.

22.4.4 Unless otherwise specified, the weight shall remain freely suspended for five 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.

22.5 **Evaluation**

22.5.1 Report the extent to which the seam opened and any other evidence of failure of the specimen.

SECTION D - TEST PACKAGE MARKING

1. MARKING REQUIREMENTS

1.1 Test packages shall be marked as prescribed below. The markings shall be used for identification of the package parts to which any test is applied and for identification of the attitude of the package when subjected to any test and for the recording of results, and as a quality record to meet quality system requirements.

2. RECTANGULAR PACKAGES (See FIGURE 1)

2.1 **Faces.** Facing one end of the container with the manufacturer's joint, if any, on the observer's RIGHT, faces are identified:

Top face (1)
Right side (2)
Base (3)
Left side (4)
Near end (5)
Far end (6)

2.2 **Edges.** An edge is identified by the numbers of the two faces forming it, e.g. 1/2 is edge between top and right side.

2.3 **Corners.** A corner is identified by the numbers of the three faces forming it, e.g. 1/2/5 is top right hand near corner.

3. CYLINDRICAL PACKAGES (See FIGURE 2)

3.1 The quarter points (90^{o} angular spacing) around the top edge of the package, i.e. the head, shall be designated as point 1, 3, 5 and 7. The quarter points around the bottom edge of the package, i.e. the base, shall be designated as points 2, 4, 6 and 8. Where a movable locking collar is present the lever housing must be situated at a point on the circumference of the head midway between point 1 and 3. Imaginary lines joining point 1 and 2, 3 and 4, 5 and 6, and 7 and 8 shall be parallel to each other.

3.2 Imaginary lines joining the top and bottom edges quarter points shall be designated as 1 2, 3 4, 5, 6 7, and 8 respectively. If the package has one or more manufacturer's joints one of the joints shall occupy the position 5, 6.

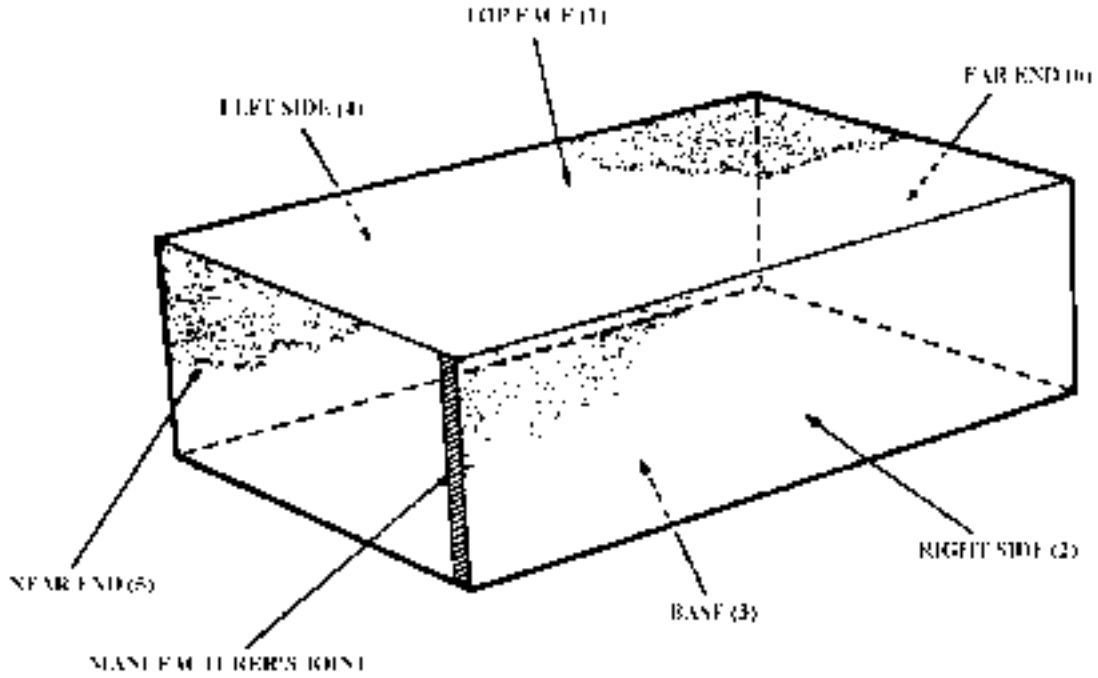


FIGURE 1

MARKING REQUIREMENTS RECTANGULAR PACKAGES

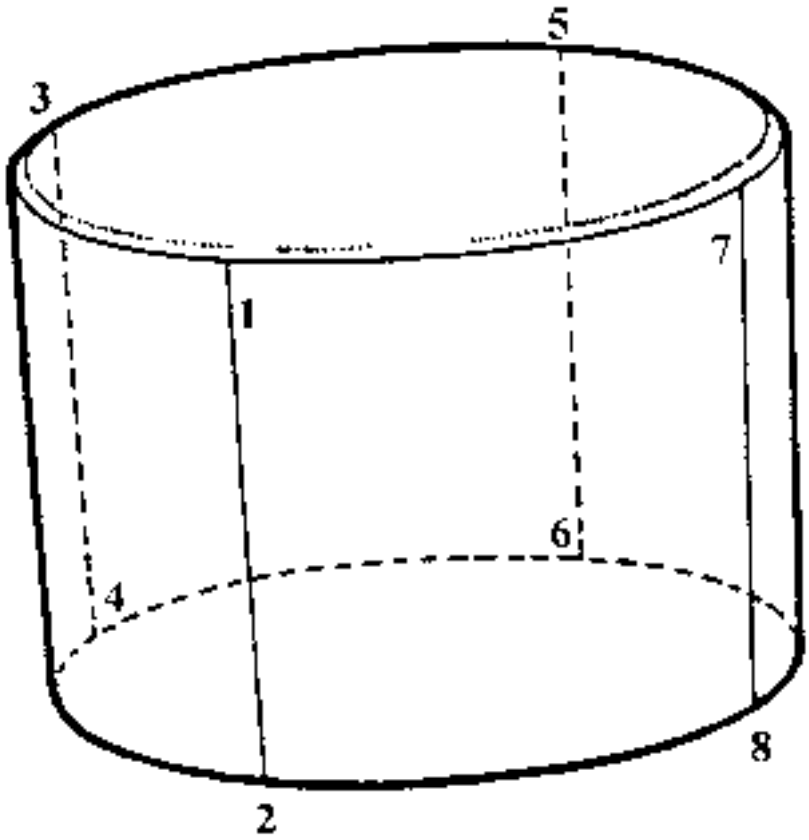


FIGURE 2

MARKING REQUIREMENTS CYLINDRICAL PACKAGES

SECTION E - TEST CONSTRUCTION AND RECORDING

1. CONSTRUCTION OF DUMMY LOAD

1.1 When a test is to be instrumented during development, e.g. for responses of a cushioning system, with few exceptions only dummy loads should be used.

1.2 The output signal obtained from a transducer attached to an actual item will be affected and sometimes obscured by superimposed signals arising from the transient excitation of the item or its component parts. To avoid this and provide for a meaningful output signal, by which the performance of the cushioning system may be judged, an inert dummy load must be substituted.

1.3 Dummy loads should as far as practicable be representative in terms of shape, dimensions, mass, centre of gravity and moment of inertia.

1.4 Care should be taken in the construction of all dummy loads and the transducer should be mounted with maximum rigidity to a solid structural member and normally as near as possible to the centre of gravity of the load.

1.5 Small items, i.e. in terms of mass and/or size; may be represented by forming (machining or moulding) the dummy load from a suitable internally damped material such as wood or a synthetic resin. Alternatively it may be more convenient to produce the required shape by laminating and gluing these materials. When it is necessary to represent heavy and/or bulky items the dummy load may best be provided by a loaded sheathed framework. The frame should be made of substantial timber members accurately jointed with the joints glued and screwed. The sheathing should be relatively substantial to reduce flexure of the frame and thence the load, e.g. 12 mm plywood glued and screwed to the frame. Sheet metal should be avoided. Care should be taken in providing for the mass of the dummy load; i.e. in loading the structure, to avoid unwanted responses. The form of loading chosen should be rigidly restrained within the frame. Suitable materials for dense loads are lead, concrete or mild steel sections.

2. RECORDING OF TESTS

2.1 Development and Acceptance Tests should be recorded as per quality system recording requirements. The record, which should include the following minimum information, shall be retained with the record for the package design:

a. Service identification particulars (Item name, NSN, Drawing Nos., Modification particulars, etc.) of the item of materiel.

b. Military Packaging Level.

c. Primary Package Quantity.

d. Gross package mass.

e. Packaging dimensions.

2.2 **Tests**

a. Details of equipment tests before and after package tests.

b. Tests and/or sequence of tests applied (including attitude of impact/vibration etc.) and date carried out.

c. Results of tests and record of climatic chamber conditions where applicable.

d. Details of tests equipment and procedure if different from the requirement stated in SECTION C.

e. Details of dummy loads or dummy representative items.

f. Instrumentation specification and calibration.

Where fragility has been assessed, the method and result of assessment should be included in the record. Any other package design information tests should also be recorded.

DOCUMENT IMPROVEMENT PROPOSAL

DEF(AUST) 1000C - ADF PACKAGING
PART 4: STANDARD PACKAGING TEST PROCEDURES

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2. Has any new technology rendered any process obsolete? Suggestions supported by examples are welcome where the new process/hardware has proved satisfactory.

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