ISTA® PROCEDURES AND PROJECTS:

IMPORTANT: Procedures periodically receive corrections or revisions before the publish date of the next Resource Book. Please visit the ISTA® website at www.ista.org for the most up-to-date procedures and projects. Members receive free and complete online access to all Test Procedures.

1 SERIES: NON-SIMULATION INTEGRITY PERFORMANCE TESTS

Challenge the strength and robustness of the product and package combination. Not designed to simulate environme occurrences. Useful as screening tests, particularly when used as a consistent benchmark over time.

- **1A** Packaged-Products weighing 150 lb (68 kg) or Less
- **1B** Packaged-Products weighing Over 150 lb (68 kg)
- **1C** Extended Testing for Individual Packaged-Products weighing 150 lb (68 kg) or Less
- **1D** Extended Testing for Individual Packaged-Products weighing Over 150 lb (68 kg)
- **1E** Unitized Loads
- **1G** Packaged-Products weighing 150 lb (68 kg) or Less (Random Vibration)
- **1H** Packaged-Products weighing Over 150 lb (68 kg) (Random Vibration)

2 SERIES: PARTIAL SIMULATION PERFORMANCE TESTS

Tests with at least one element of 3 Series type General Simulation performance tests, such as atmospheric conditioni mode-shaped random vibration, in addition to basic elements of a 1 Series type Non-Simulation Integrity test.

- **2A** Packaged-Products weighing 150 lb (68 kg) or Less
- **2B** Packaged-Products weighing Over 150 lb (68 kg)
- **2C** Furniture Packages

Note - The following procedures have been discontinued from this series:
- *ISTA Procedure 2D (use ISTA Procedure 3A-flat)*
- *ISTA Procedure 2E (use ISTA Procedure 3A-elongated)*
- *ISTA Procedure 2F (use NCC LTL Item 180, available from National Motor Freight Traffic Association www.nmfta.org)*

3 SERIES: GENERAL SIMULATION PERFORMANCE TESTS

Designed to provide a laboratory simulation of the general damage-producing motions, forces, conditions, and sequenc of transport environments. Applicable across broad sets of circumstances, such as a variety of vehicle types and routes a varying number of handling exposures. Characteristics will include simple shaped random vibration, different drop heights applied to the sample package, and/or atmospheric conditioning.

- **3A** Packaged-Products for Parcel Delivery System Shipment weighing 70kg (150 lb) or Less
- **3B** Packaged-Products for Less-Than-Truckload (LTL) Shipment
- **3E** Unitized Loads of Same Product
- **3F** Packaged Products for Distribution Center to Retail Outlet Shipment, 100 lb (45 kg) or Less
  (The ISTA Technical Division has determined not to discontinue Procedure 3F as previously announced)
- **3H** Products or Packaged-Products in Mechanically Handled Bulk Transport Containers
- **3K** Fast-Moving Consumer Goods in the European Retail Supply Chain

ISTA, Distributing Confidence, Worldwide™

ISTA 1 Series are the most basic category of performance tests.

- They challenge the capability of the package and product to withstand transport hazards, **but**
- They are not simulations of actual transport hazards, **and**
- Do not necessarily comply with carrier packaging regulations.

When properly applied, ISTA procedures will provide tangible benefits of:

- Shortened packaged development time and confidence in product launch
- Protection of products and profits with reduced damage and product loss
- Economically balanced distribution costs
- Customer satisfaction and continued business.

There are three sections: Overview, Testing and Report

- **Overview** provides the general knowledge required before going into the testing laboratory **and**
- **Testing** presents the specific instructions to do the testing in the laboratory **and**
- **Report** indicates what data shall be recorded to submit a test report to ISTA.

Two systems of weights and measures are presented in ISTA test procedures. They are the English system (Inch-Pound) and the international system SI (Metric). Inch-Pound units are shown first with Metric units in brackets, except in some tables where they are shown separately.

- Either system may be used as the unit of measure (standard units), **but**
- The standard units chosen shall be used consistently throughout the procedure.
- Units are converted to two significant figures **and**
- Not exact equivalents.

VERY IMPORTANT:

The entire document shall be read and understood before proceeding with a test.

OVERVIEW OF PROCEDURE 1E

Test Procedure 1E is an integrity test for unitized loads of the same retail or institutional packaged-products. A unitized load is defined as one or more products or packaged-products usually on a skid or pallet, but always secured together or restrained for distribution as a single load. Examples would be a stretch wrapped pallet load of individual containers, a single non-packaged machine banded to a pallet and a pallet with a corrugated tray, tube and a cap.

- It can be used to evaluate the performance of a packaged-product.
- It can be used to compare relative performance of package and product design alternatives.
- The package and product are considered together and not separately.
- Some conditions of transit, such as moisture, pressure or unusual handling, may not be covered.

Other ISTA Procedures may be appropriate for different conditions or to meet different objectives.

- Consider ISTA General Simulation Performance Test Procedure 3E.

Refer to *Guidelines for Selecting and Using ISTA Procedures and Projects* for additional information.

1E

OVERVIEW OF PROCEDURE 1E

Scope

Test Procedure 1E covers testing of unitized loads, made up of either single or multiple products or packages of the same products.

Product Damage Tolerance and Package Degradation Allowance

The shipper shall determine the following prior to testing:

- what constitutes damage to the product **and**
- what damage tolerance level is allowable, if any, **and**
- the correct methodology to determine product condition at the conclusion of the test **and**
- the acceptable package condition at the conclusion of the test.

For additional information on this determination process refer to *Guidelines for Selecting and Using ISTA Procedures and Projects.*

Samples

Samples should be the untested actual package and product, but if one or both are not available, the substitutes shall be as identical as possible to actual items.

Number of samples required:

- One sample is required for the tests in this procedure.

Replicate Testing Recommended:
To permit an adequate determination of representative performance of the packaged-product, ISTA:

- Requires the procedure to be performed one time, **but**
- Recommends performing the procedure five or more times using new samples with each test.

NOTE:
Packages that have already been subjected to the rigors of transportation cannot be assumed to represent standard conditions. In order to insure testing in perfect condition, products and packages shipped to certified laboratories for testing must be:

- over-packaged for shipment to the laboratory **or**
- repackaged in new packaging at the laboratory.

Test Sequence

The tests shall be performed on each test sample in the sequence indicated in the following table:

Sequence #	Test Category	Test Type	Test Level	For ISTA Certification
1	Vibration (Alternative methods allowed – select one test type)	Vertical Linear Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required
		Random	Overall G_{rms} level of 1.15	
2	Shock (Alternative methods allowed – select one test type)	Incline Impact (Conbur)	69 in (1.7 m) per second impact velocity	Required
		Horizontal Impact	69 in (1.7 m) per second velocity change	
3	Shock	Rotational Edge Drop	8 in (200 mm)	Required

EQUIPMENT REQUIRED FOR PROCEDURE 1E

The following alternatives are acceptable for the equipment required for the Vibration Test:

Fixed Displacement Vibration Test:

- Vibration Test System with a 1 in (25 mm) fixed or controlled displacement complying with Method A1 or A2 of the apparatus section of ASTM D 999.
  Only vertical linear motion of the platform is acceptable; rotary motion is not acceptable.
- Metal shim 0.06 in (1.5 mm), thick approximately 2 in (50 mm) wide and at a convenient length.
- Tachometer or suitable indicator for determining vibration frequency in cycles per second (Hz) or cycles per minute (CPM).
- Automatic timer or stopwatch.

Random Vibration Test:

- Random Vibration Test System complying with the apparatus section of ASTM D 4728.

Rotational Edge Drop Test:

- Rotational Edge Drop Test System complying with the apparatus section of ASTM D 6179.

The following alternatives are acceptable for the equipment required for the **Impact Test**:

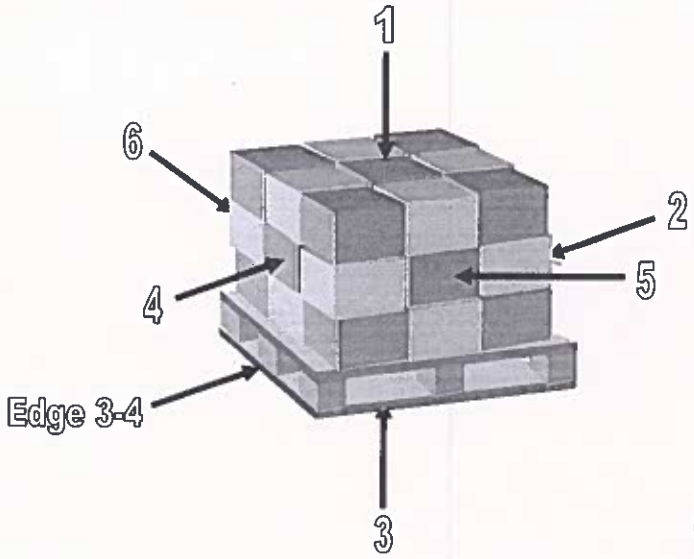
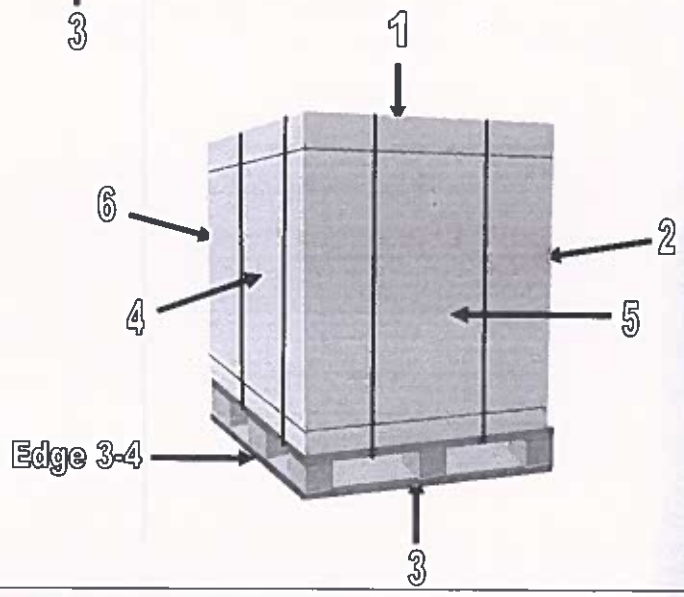
Type of Shock Test	Equipment	In compliance with the apparatus section of:
Incline Test	Incline impact tester (conbur)	ASTM D 880
Horizontal Test	Horizontal impact test system	ASTM D 4003

1E

Identification of Faces, Edges and Corners

BEFORE YOU BEGIN PROCEDURE 1E

Prior to beginning the tests identify the faces, edges and corners according to the procedure below.

Step	Action
1	Place the unit load in its designed transport orientation.
2	Position one of the smallest width faces of the unit load directly in front of you.
3	**Identify faces** according to the diagram below.  
4	**Identify edges** using the numbers of the two faces forming that edge. Example: Edge 3-4 is the edge formed by face 3 and face 4 of the unit load.

You shall know the unit load's:

- gross weight in pounds (kg), **and**
- outside dimensions of Length, Width and Height (L x W x H) in inches (mm or m)

CAUTION:

A restraining device or devices shall be used with the vibration test system to:

- Prevent the test specimen from moving off the platform **and**
- Maintain test orientation of the packaged-product, **but**
- The device or devices shall not restrict the vertical motion of the test specimen during the test.

Select Fixed Displacement Vibration or Random Vibration as a test method.

For Fixed Displacement Vibration:

Familiarity with the following formula is required to calculate the test duration after the frequency required to bounce the packaged-product is determined in the Vibration Test Block:

$$\text{Test Duration in Minutes} = \frac{\text{11,800 Vibratory Impacts}}{\text{Cycles Per Minute (CPM) or [Cycles Per Second (Hz) x 60]}}$$

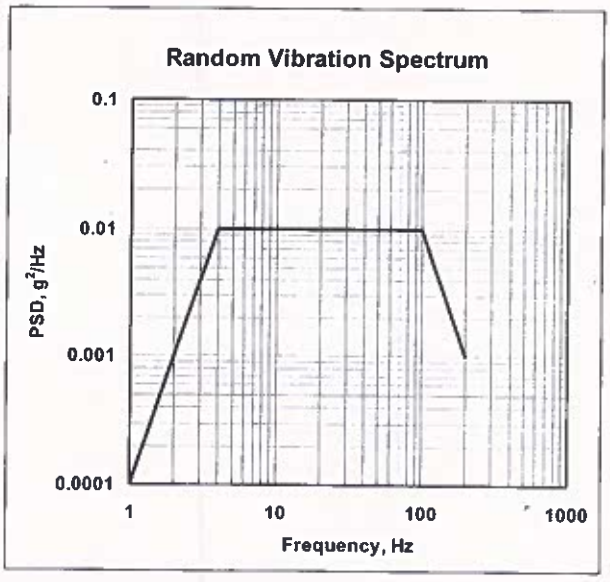
The chart below shows **example** Test Duration's calculated for several frequencies:

CPM	Hz	Test Duration in Minutes
150	2.5	79
180	3.0	66
210	3.5	57
240	4.0	50
270	4.5	44
300	5.0	40

For Random Vibration:

The following breakpoints shall be programmed into the vibration controller to produce the acceleration versus frequency profile (spectrum) below with an overall G_{rms} level of 1.15. The theoretical stroke required to run this vibration profile is 22.45 mm (0.884 in) peak to peak.

Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.0001
4.0	0.01
100.0	0.01
200.0	0.001



BEFORE YOU BEGIN PROCEDURE 1E

CAUTION:

If the Unit Load:

- has a length equal to or greater than twice the width **and**
- a center of gravity above the midpoint of the height.
- there is the possibility that Unit Load could tip over when testing one of the longest edges, **therefore**
- you may conduct the Rotational Edge Drop test on both of the shortest edges.

Test the unitized load at a minimum of 69 in per second (1.7 m per second).

NOTE:

69 in per second is equal to 5.75 ft per second.

When using impact velocity or velocity change, if any velocity in a Test Sequence is below the required minimum level, that sequence event must be repeated until the test velocity meets the minimum.

TEST SEQUENCE FOR PROCEDURE 1E

The test blocks that follow contain tables that indicate the required steps for each test in the procedure.

ST BLOCK 1
Vibration
(Fixed
splacement)

VIBRATION - FIXED DISPLACEMENT		
Step	**Action**	
1	Determine if testing is going to be Fixed Displacement or Random Vibration.	
	IF Vibration testing is going to be ...	**THEN go to ...**
	Fixed Displacement	Step 2.
	Random	TEST BLOCK 2 (Vibration – Random)).
2	Put the unitized load on the vibration table so that face 3 rests on the platform.	
3	Start the test machine to vibrate at 1 in (25 mm) total displacement at the machine's lowest frequency using vertical linear motion only.	
4	Maintain a fixed displacement at 1 in (25 mm) and slowly increase the frequency (speed) of the vibration table until the packaged-product begins to momentarily leave the surface of the platform.	
5	Can a metal shim be intermittently moved between the bottom of the longest dimension of the packaged-product and the surface of the platform? • If **Yes**, hold that frequency and then continue to the next Step (Step 6). • If **No**, then slowly increase the frequency until the requirement of this Step (Step 5) is met, and hold that vibration frequency.	
6	Determine test duration in minutes using the formula indicated in Before You Begin Vibration Testing and the CPM or Hz frequency identified in Step 5.	
7	Begin timing the vibration test duration.	
8	Complete the vibration duration.	
9	Vibration testing is now complete. Go to TEST BLOCK 3 (Shock).	

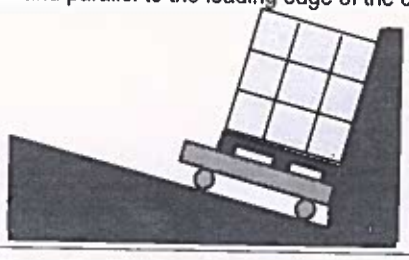
T BLOCK 2
Vibration
(Random)

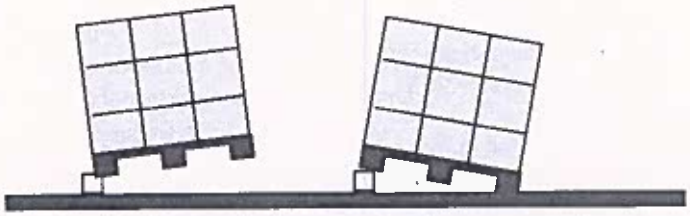
VIBRATION - RANDOM	
Step	**Action**
1	Put the packaged-product on the vibration table so that face 3 rests on the platform.
2	Start the vibration system to produce the random vibration spectrum indicated in Before You Begin Vibration Testing.
3	Stop the vibration testing at the end of 60 minutes.
5	Vibration testing is now complete. Go to TEST BLOCK 3 (Shock).

1E

TEST BLOCK 3
Shock
(Impact)

TEST SEQUENCE FOR PROCEDURE 1E

<table>
<tr><th colspan="2">SHOCK - IMPACT</th></tr>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Do the packaged-products overhang the edge of the pallet?
• If Yes, then go to Step 3.
• If No, then continue with the next Step.</td></tr>
<tr><td>2</td><td>Center the unitized load on the carriage with the pallet edge flat against the backstop or sail and parallel to the leading edge of the carriage and go to Step 4.
  </td></tr>
<tr><td>3</td><td>Center the unitized load on the carriage with the vertical face of the unitized load flat against the backstop or sail and parallel to the leading edge of the carriage.
  </td></tr>
<tr><td>4</td><td>Test the unitized load at a minimum of 69 in per second (1.7 m per second). If any velocity in the sequence is below the required 69 in per second (1.7 m per second) minimum, that sequence event must be repeated until it meets the minimum. Follow the sequence in the table below.
<table>
<tr><th>Sequence #</th><th>Orientation</th><th>Specific face</th></tr>
<tr><td>1</td><td>Face</td><td>one of the smallest vertical faces</td></tr>
<tr><td>2</td><td>Face</td><td>opposite small vertical face</td></tr>
<tr><td>3</td><td>Face</td><td>one of the largest vertical faces</td></tr>
<tr><td>4</td><td>Face</td><td>opposite large vertical face</td></tr>
</table></td></tr>
<tr><td>5</td><td>Impact testing is now complete. Go to TEST BLOCK 4 (Shock - Rotational Edge Drop).</td></tr>
</table>

<table>
<tr><th colspan="3">SHOCK - ROTATIONAL EDGE DROP</th></tr>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>1</td><td colspan="2">Perform rotational edge drops. Follow the sequence in the table below.</td></tr>
<tr><td></td><td>Sequence #</td><td>Action</td></tr>
<tr><td></td><td>1</td><td>Place the unitized load onto a flat, rigid surface such as steel or concrete.</td></tr>
<tr><td></td><td>2</td><td>Support one of the shortest face 3 edges with a timber or support 3.5 to 4.0 in (90 to 100 mm) in height and width.</td></tr>
<tr><td></td><td>3</td><td>Lift the opposite face 3 edge to 8 in (200 mm) off the surface.</td></tr>
<tr><td></td><td>4</td><td>Release the edge so that it falls freely onto the flat, rigid surface.
  </td></tr>
<tr><td>2</td><td colspan="2">Does the Unit Load have a length equal to or greater than twice the width and a center of gravity above the midpoint of the height?
• If Yes, then go to Step 4.
• If No, then continue with the next step.</td></tr>
<tr><td>3</td><td colspan="2">Repeat Step 1 on one of the face 3 edges radiating 90° from the edge just tested in Step 1 Sequence 4. Then go to Step 5.</td></tr>
<tr><td>4</td><td colspan="2">Repeat Step 1 on the face 3 edge opposite the edge just tested in Step 1 Sequence 4. Then go to the next Step.</td></tr>
<tr><td>5</td><td colspan="2">All testing is now complete. Go to the Reporting an ISTA Test section at the end of this Procedure.</td></tr>
</table>

OVERVIEW OF PROCEDURE 3B

The tests shall be performed on each test sample in the sequence indicated in the following tables:

Test Sequence STANDARD, 200 lb (91 kg) or Less

3B – STANDARD, 200 lb (91 kg) or less

Sequence Number	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient	Required
2	Atmospheric Conditioning TEST BLOCK 1	Controlled Temperature and Humidity	Temperature and Humidity chosen from chart	Optional
3	Shock TEST BLOCK 2	Tip/Tip Over	Use a 22 degree tip angle	Required for packages ≥48 in. (1.2 m) tall **and** ≥100 lb. (45 kg) weight **and** any one base dimension < ½ the height; **or** for packages ≥ 30 in. (760 mm) tall **and** with a center of gravity vertical location > ½ the package height
4	Shock TEST BLOCK 3	Free-Fall Drop	6 drops - height varies with packaged-product weight	Required
5	Vertical Vibration TEST BLOCK 7	Random With Top Load	Overall G_{rms} level of 0.54	Required
6	Shock TEST BLOCK 10	Concentrated Impact	Impact mass free-fall drop, guided drop, or pendulum, 15 in (380 mm)	Required only for Non-Rigid Containers
7	Shock TEST BLOCK 11	Free-Fall Drop	6 Drops - height varies with packaged-product weight.	Required
8	Shock TEST BLOCK 16	Full Rotational Drop	1 drop	Required only for Elongated packages
9	Shock TEST BLOCK 17	Bridged Impact	Hazard Box dropped 16 in (410 mm)	Required only for Elongated packages
10	Shock TEST BLOCK 16	Full Rotational Drop	2 drops	Required only for Flat packages
11	Shock TEST BLOCK 18	Concentrated Edge Impact	Hazard box dropped 16 in (410 mm)	Required only for Flat packages

3E

OVERVIEW OF PROCEDURE 3E

Scope

Test Procedure 3E covers testing of unitized loads, made up of either single or multiple products or packages of the same products.

Product Damage Tolerance and Package Degradation Allowance

The shipper shall determine the following prior to testing:

- what constitutes damage to the product **and**
- what damage tolerance level is allowable, if any, **and**
- the correct methodology to determine product condition at the conclusion of the test **and**
- the acceptable package condition at the conclusion of the test.

For additional information on this determination process refer to *Guidelines for Selecting and Using ISTA Procedures and Projects.*

Samples

Samples should be the untested actual package and product, but if one or both are not available, the substitutes shall be as identical as possible to actual items.

Number of samples required:
One sample (unitized load) is required for the tests in this procedure.

Replicate Testing Recommended:
To permit an adequate determination of representative performance of the packaged-product, ISTA:

- Requires the procedure to be performed one time, **but**
- Recommends performing the procedure five or more times using new samples with each test.
- Refer to *Guidelines for Selecting and Using ISTA Procedures and Projects* for additional information on statistical sampling.

NOTE:
Packages that have already been subjected to the rigors of transportation cannot be assumed to represent standard conditions. In order to insure testing in perfect condition, products and packages shipped to certified laboratories for testing must be:

- over-packaged for shipment to the laboratory **or**
- repackaged in new packaging at the laboratory.

It is important to thoroughly document the configuration, materials, and construction of the tested product and package. Significant variations in performance can sometimes be caused by seemingly insignificant differences. Photo documentation is strongly recommended to supplement detailed written descriptions.

Test Sequence

The tests shall be performed on each test sample in the sequence indicated in the following table:

Sequence #	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning	Temperature and Humidity	Ambient	Required
2	Atmospheric Conditioning	Controlled Temperature and Humidity	Temperature and humidity chosen from chart	Optional
3	Shock (Alternative methods allowed – select one test type)	Incline Impact (Conbur)	42 in per second (1.1 m per second)	Required
		Horizontal Impact	42 in per second (1.1 m per second)	
4	Shock	Rotational Edge Drop	8 in (200 mm)	Required
5	Compression (Alternative methods allowed – select one test type)	Machine Apply and Release	Calculated Test Force x 1.4	Required
		Machine Apply and Hold	Calculated Test Force	
		Weight and Load Spreader	Calculated Test Load	
6	Vibration	Random	Overall G_{rms} level of 0.54	Required
7	Shock	Rotational Edge Drop	8 in (200 mm)	Required