

ISTA 3 Series
General
Simulation
Performance
Test
Procedure

VERSION
DATE
Last

TECHNICAL
Change:
MARCH
2017

Last
EDITORIAL
Change:
MARCH
2017

For complete
listing of
Procedure
Changes and
Version Dates
go to
www.ista.org

Preface

ISTA, Distributing Confidence, Worldwide™

ISTA 3 Series tests are advanced tests.

- They challenge the capability of the package and product to withstand transport hazards, **but**
- They use general simulation of actual transport hazards, **and**
- They 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 3F

Test Procedure 3F is a general simulation test for packaged-products that are shipped as an individual package from a distribution center to a retail outlet in a mixed pallet configuration.

- It can be used to evaluate the protective performance of packaged-products related to vibrations, shocks and other stresses normally encountered during handling and transportation.
- The test levels are based on general data and may not represent any specific retail distribution system.
- 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.

Specific suggestions:

- To test unitized loads of this packaged-product being transported to the distribution center, use ISTA Test Procedure 3E.
- To test individual cases where floor load mixed loads are common, use ISTA Test Procedure 3A.

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

Scope

Test Procedure 3F covers testing of individual packaged-products weighing 100 lb (45 kg) or less shipped as part of a mixed pallet load for regional shipment; typically from a distribution center (DC) to a retail facility.

Product Damage
Tolerance and
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:

Six (6) samples are 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	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	Compression (Alternative methods allowed – select one test type) TEST BLOCK 2	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	
4	Shock TEST BLOCK 3	Drop	12 and 30 in (310 and 760 mm)	Required
5	Vibration TEST BLOCK 4	Random	Overall G_{rms} level of 0.54	Required
6	Shock TEST BLOCK 5	Drop	18 and 24 in (460 and 610 mm)	Required

**Equipment
Required
Atmospheric
Conditioning**

Atmospheric Conditioning:

- Humidity recording apparatus complying with of the apparatus section of ASTM D 4332.
- Temperature recording apparatus complying with the apparatus section of ASTM D 4332.

Optional Atmospheric Conditioning

Chamber and Control apparatus complying with the apparatus section of ASTM D 4332.

**Equipment
Required
Shock**

Free Fall Drop Test:

- Free Fall Drop Test System complying with of the apparatus section of ASTM D 5276.

**Equipment
Required
Compression**

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Type of Compression Test	Equipment	In compliance with the apparatus section of:
Apply and Release Test	Compression test system	ASTM D 642 Fixed or Floating platen acceptable
Apply and Hold Test	Compression test system	
Apply and Hold Test	Weight and load spreader	NA

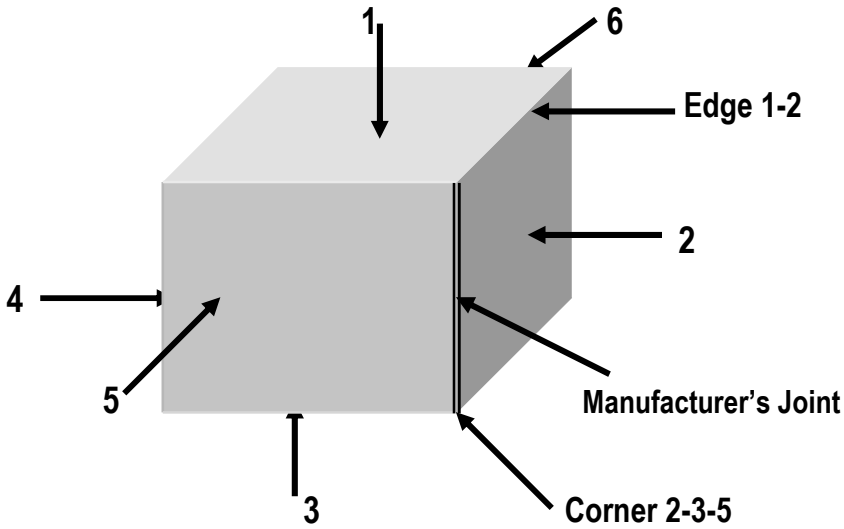
**Equipment
Required
Vibration**

Random Vibration Test:

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

Identification of Faces, Edges and Corners

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

Step	Action
1	Place the packaged-product in its intended shipping position as determined by shipper. If the shipping position can be variable, place the packaged-product so that the primary shipping label location is on the top face.
2	Does the packaged-product have only six faces (2 sides, 2 ends, top and bottom)? <ul style="list-style-type: none"> If Yes, then go to Step 5. If No, continue to next Step.
3	Develop a method to identify each face, edge and corner and document with a diagram.
4	Go to next page for further Before You Begin details.
5	Is the package a corrugated container? <ul style="list-style-type: none"> If Yes, continue to next Step. If No, then go to Step 8.
6	Does the package have a manufacturer's joint connecting a side and an end face? <ul style="list-style-type: none"> If Yes, continue to next Step. If No, then go to Step 8.
7	Turn the packaged-product so that you are looking directly at a face with the manufacturer's joint on the observer's right and go to Step 9.
8	Position one of the smallest width faces of the packaged-product directly in front of you.
9	<p>Identify faces according to the diagram below.</p> 
10	Identify edges using the numbers of the two faces forming that edge. Example: Edge 1-2 is the edge formed by face 1 and face 2 of the packaged-product.
11	Identify corners using the numbers of the three faces that meet to form that corner. Example: Corner 2-3-5 is the corner formed by face 2, face 3, and face 5 of the packaged-product.
12	Go to next page for further Before You Begin details.

**Packaged-
Product
Weight and
Size
Measurement**

You shall know the packaged-product's:

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

**Before You
Begin
Atmospheric
Conditioning**

Required Preconditioning:

The packaged-product should be stored prior to climate conditioning at laboratory ambient temperature and humidity for twelve (12) hours.

**Before You
Begin
Optional
Atmospheric
Conditioning**

Optional Conditioning Recommended (to be performed after the required preconditioning):

To permit an adequate determination of packaged-product performance at anticipated atmospheric limits and where it is known that the atmospheric extremes are detrimental to the product, ISTA:

- **Requires** the highest temperature and humidity limits of the product be used, **but**
- **Recommends** that both the highest and lowest atmospheric conditions be used.

Condition packaged-products according to one or more of the conditions listed in the table below.

- Remaining test requirements should be performed as soon as possible after removing the packaged-product from environmental conditioning apparatus.
- If more than one conditioning sequence is selected, a new and complete test should be performed following each sequence.

Anticipated Conditions	Time in Hours	Temperature in °C ±2°C (°F ±4°F)	Humidity in %
Extreme Cold, Uncontrolled RH	72	-29°C (-20°F)	uncontrolled RH
Cold, Humid	72	5°C (40°F)	85% RH ±5%
Controlled Conditions	72	23°C (73°F)	50% RH ±5%
Hot, Humid	72	38°C (100°F)	85% RH ±5%
Hot, Humid then Extreme Heat, Moderate RH:	72 then 6	38°C (100°F) then 60°C (140°F)	85% RH ±5% then 30% RH ±5%
Elevated Temperature, Uncontrolled RH	72	50°C (120°F)	uncontrolled RH
Extreme Heat, Dry	72	60°C (140°F)	15% RH +/- 5%
Severe Cold, Uncontrolled RH	72	-18°C (0°F)	uncontrolled RH
User Defined High Limit	72	Based upon known conditions	Known conditions
User Defined Low Limit	72	Based upon known conditions	Known conditions
User Defined Cycle	72	Based upon known conditions	Known conditions

BEFORE YOU BEGIN PROCEDURE 3F

Overview:

The Compression test force/weight to be applied is determined from formulas listed below.

Either a compression machine or a system of weights and a load spreader may be used for these tests. If a compression machine is used, both force “apply-and-release” and “apply-and-hold” methodologies are permitted.

CAUTION:

When using weights and a load spreader use extreme care to prevent injury

Formula Term Definitions for Calculations:

The following are definitions of terms used in the Warehouse Compression calculation section that follow:

Wt = Gross weight of the packaged-product (lbs. or kg.)

S = Total number of potential packaged-products in a warehouse stack, including the bottom packaged-product

F = Compensating Factor

1.4 = Factor to account for time of compression *

9.8 = Metric conversion factor

1 = Represents the bottom container in a Stack

The Compensating Factor, F, is used to account for effects which may not be simulated in the laboratory tests, such as temperature/humidity conditions, misalignments, long-duration loading, etc. The Factor values given in the sections that follow are typical, but other F values may be used in certain situations **including reduced factors**.

For example:

- If compression testing is performed in conjunction with atmospheric conditioning which reduces container strength (e.g. corrugated containers under high humidity, plastic containers under high temperature), **Compensating Factors may be reduced**.
- If the materials and structures which support the compression load (whether product, primary package, transport package, or a combination) are not affected by time, temperature, or humidity, then **Compensating Factors may be reduced**.
- If the Compensating Factor values given in the sections that follow are not used, sufficient justification must be included in the Test Report.

Warehouse Compression Calculation:

There are three separate calculations, each with English and Metric units, to accommodate the three different allowable test approaches.

Test System And Methodology	English Units	Metric Units
Compression Test System	Pounds Force (lbf)	Newtons (N)
Apply-and-release test force *	$Wt \times (S - 1) \times F \times 1.4$	$Wt \times (S - 1) \times F \times 9.8 \times 1.4$
Apply-and-hold test force	$Wt \times (S - 1) \times F$	$Wt \times (S - 1) \times F \times 9.8$
Weight and Load Spreader	Pounds (lb)	Kilograms (kg)
Apply-and-hold dead weight test	$Wt \times (S - 1) \times F$	$Wt \times (S - 1) \times F$

NOTES:

Use an F value of 3 for these calculations, or supply sufficient justification in the Test Report to support use of a different value.

If there is never the potential that anything will be stacked on the packaged-product during warehousing, then the S value = 1 (one), the Warehouse Compression Calculation = 0 (zero), and no compression test will be required by **this section**.

If you do not know the number of packaged-products that may be in a stack then divide 196 in (5 m) by the height of one packaged-product in inches (m). Round the value calculated up to a whole number and use the number just determined as “S” in the appropriate formula above.

$$S = 196 \text{ in} \div H \text{ (Metric: } S = 5 \div H \text{)}$$

Note: 196 in (5 m) represents a high warehouse stack, but stacks may be even higher in some situations. The best approach is to determine S from actual field knowledge.

BEFORE YOU BEGIN PROCEDURE 3F

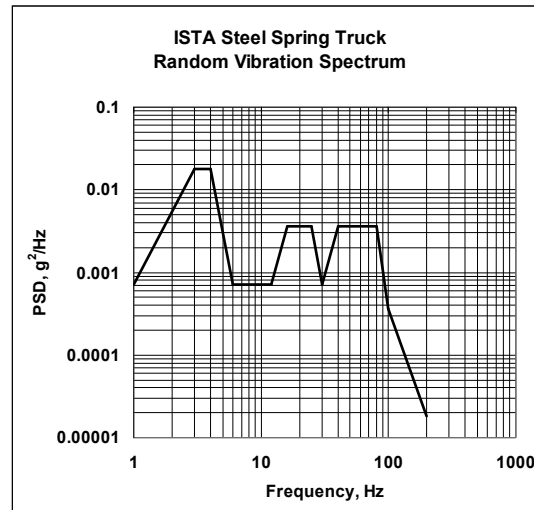
CAUTION:

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 or stack, **but**
- The restraining device or devices shall not restrict the vertical motion of the test specimen during the test.

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 0.54. The theoretical stroke required to run this vibration profile is 45.13 mm (1.777 in) peak to peak.

Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.00072
3.0	0.018
4.0	0.018
6.0	0.00072
12.0	0.00072
16.0	0.0036
25.0	0.0036
30.0	0.00072
40.0	0.0036
80.0	0.0036
100.0	0.00036
200.0	0.000018



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

TEST BLOCK 1
Atmospheric
Conditioning

TEMPERATURE AND HUMIDITY	
Step	Action
1	The packaged-product should be stored at laboratory ambient temperature and humidity for twelve (12) hours.
2	Is optional conditioning going to be performed? <ul style="list-style-type: none"> • If Yes, go to Step 6. • If No, go to the next Step.
3	Record the ambient laboratory temperature and humidity when testing starts.
4	At the end of all testing record temperature and humidity.
5	Go to TEST BLOCK 2 (Shock).
6	Select an anticipated condition from Before You Begin Optional Atmospheric Conditioning.
7	Check the conditioning apparatus to insure that the temperature and humidity are at the required levels.
8	Place the packaged-product in the conditioning.
9	At the completion of the required conditioning time remove the packaged-product from the conditioning apparatus.
10	Record the ambient laboratory temperature and humidity when testing starts.
11	Go to TEST BLOCK 2 (Compression) and perform the remaining test sequence as quickly as possible.

TEST BLOCK 2
Compression

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COMPRESSION	
Step	Action
1	Testing is to be conducted using the test force or dead weight value from the Compression Test Force/Weight Determination section of Before You Begin Compression Testing.
	IF the testing equipment to be used is a ... THEN go to ...
	Compression Test System Step 2.
	Weight and load spreader Step 7.
2	Center the packaged-product with the bottom face of the intended warehouse stacking orientation resting on the lower platen of the compression tester. Note: The intended warehouse stacking orientation might be different than the most stable orientation identified in the <i>Identification of Faces, Edges and Corners</i> section. If the intended warehouse stacking orientation is unknown then place the packaged-product in the most stable orientation, face 3 down.
3	Start the test machine and bring the platens together at the rate of one-half (0.5) in (13 mm) per minute.
4	Perform the appropriate action as indicated in the table below:
	IF the compression test is a... THEN ...
	Apply and Release Test Increase the force until it reaches the test force from the Compression Test Force/Weight Determination section of Before You Begin Compression Testing. Then go to Step 5.
	Apply and Hold Test Increase the force until it reaches the test force from the Compression Test Force/Weight Determination section of Before You Begin Compression Testing. Then go to Step 6.

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TEST BLOCK 2
Compression
(Continued)

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COMPRESSION	
Step	Action
5	Release the force. Go to Step 11.
6	Maintain the force for one (1) hour, and then release the force. Go to Step 11.
7	Place the packaged-product with face 3 resting on a smooth, flat, rigid surface.
8	Place a rigid load spreader that is larger than the top face of the test specimen on the unitized load.
9	Add weight to the load spreader to bring the total dead weight up to the value from the Compression Test Force/Weight Determination section of Before You Begin Compression Testing and maintain for one (1) hour.
10	Remove the weight and load spreader.
11	Is the product damaged or the package degraded according to the Product Damage Tolerance and Package degradation Allowance? <ul style="list-style-type: none"> If Yes, then the packaged-product has failed the test; go to the Reporting an ISTA Test section at the end of this Procedure. If No, then go to TEST BLOCK 3 (Shock: Free Fall Drop).

TEST BLOCK 3
Shock: Free Fall
Drop

SHOCK - DROP	
Step	Action
1	Perform a 12 in (310 mm) face drop on face 3 for all specimens.
2	Perform a 30 in (760 mm) face drop on face 3 for all specimens.
3	Shock testing is now complete. Go to TEST BLOCK 4 (Vibration).

TEST BLOCK 4
Vibration

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VIBRATION - RANDOM VIBRATION		
Step	Action	
1	Using some form of column stack fixturing, stack specimens 1, 2 & 3 on the center of the vibration table with the all of the face 3's in the down orientation in the following order:	
	Specimen Number	Stack Order
	1	Bottom of Stack
	2	Middle of Stack
	3	Top of Stack
2	Is the stacked packaged-products height over 108 inches (2,743 mm)? <ul style="list-style-type: none"> If Yes, then continue with next Step. If No, then go to Step 7. 	
3	Remove Specimen Number 3 off the Stack.	
4	Is the stacked packaged-products height over 108 inches (2,743 mm)? <ul style="list-style-type: none"> If Yes, then continue with next Step. If No, then go to Step 6. 	
5	Remove Specimen Number 2 off the Stack.	
6	Place any removed Specimens from Steps 2 or 5, on the vibration table so that Face 3 (the bottom) rests on the platform.	

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TEST BLOCK 4
Vibration
(Continued)

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7	Place specimens 4, 5 and 6, each in the orientation shown below (not stacked), somewhere on the remaining vibration surface:	
	Specimen Number	Orientation
	4	Face 3 down
	5	Face 4 down
	6	Face 6 down
8	Start the vibration machine to produce the random vibration spectrum indicated in Before You Begin Vibration Testing.	
9	Stop the vibration testing at the end of 30 minutes.	
10	Vibration testing is now complete. Go to TEST BLOCK 5 (Shock - Drop).	

TEST BLOCK 5
Shock: Free Fall
Drop

SHOCK - DROP							
Step	Action						
1	Perform an 18 in (460 mm) face drop on face 3 for all specimens.						
2	Perform a 24 in (610 mm) drop. Follow the table below to determine the orientation of the drop.						
	Specimen #	1	2	3	4	5	6
	Orientation	3 face	3-4-5 corner	3-6 edge	2-3-5 corner	2-3 edge	2-5 edge
3	All testing is now complete. Go to the Reporting an ISTA Test section at the end of this Procedure.						

Reporting an
ISTA Test:
Completing and
Submitting
an ISTA
Test Report

ISTA Test Report Forms may be downloaded by members through the online ISTA Member Center (www.ista.org/members/). Custom forms are also acceptable, but information on an official ISTA Report Form is considered to be the minimum required for any test report submission and consideration. Test report forms should be submitted to ISTA Headquarters by mail, fax or electronically. Test reports should be detailed enough for accurate repeatability of the test.

The packaged-product has satisfactorily passed the test if, upon examination, it meets the Product Damage Tolerance and Package Degradation Allowance determined prior to testing.

ISTA Certified Testing Laboratories:

- Should file a test report on all ISTA Test Procedures or Projects conducted.
- Shall file a test report on all ISTA Test Procedures or Projects conducted to obtain Transit Tested Package Certification or Acknowledgement.

To submit a test report form:

- Email to ista@ista.org
- Mail to address shown below
- Fax to +1 517-333-3813.

ISTA Transit Tested Program: Packaged-Product Certification

The ISTA Transit Tested Certification Mark as shown:

- is a registered certification mark **and**
- can only be printed on certified packages **and**
- can only be used by license agreement **and**
- by a Shipper member of the International Safe Transit Association.



When a Shipper member prints this certification mark on a packaged-product, with their manufacturer's license number, they are showing their customer, vendors and carriers that it has passed the requirements of ISTA preshipment testing.

To obtain initial certification of a packaged-product:

- the product manufacturer must be a Shipper member of ISTA in good-standing and with a valid License Agreement on file
- the testing laboratory must be a member of ISTA in good-standing and have a valid lab certification date
- a test report must be submitted by the laboratory to ISTA Headquarters.

In order to maintain its certified status and eligibility for identification with the Transit Tested Certification Mark, each packaged-product must be re-tested whenever a change is made in the:

- Product or
- Process or
- Package.

If corrugated packaging is used, it is recommended that the basis weights of the constituent papers/paperboards be determined after testing and documented to provide the best indicator of equivalence or change.

As a quality control procedure, packaged-products should be re-tested frequently, for example, yearly.

For additional information, refer to *Guidelines for Selecting and Using ISTA Test Procedures and Projects*.

ISTA Membership information is available at www.ista.org.

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