Extended Testing for Packaged-Products 150 lb (68 kg) or Less

1C 2014

ISTA 1 Series Non-Simulation Integrity Performance Test Procedure

VERSION DATE
Last TECHNICAL Change: MARCH 2014

Last EDITORIAL Change: JULY 2022

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

Preface

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 two sections: Overview and Testing

- **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**.**

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 1C

Test Procedure 1C is an integrity test for individual packaged-products.

- 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.

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

OVERVIEW OF PROCEDURE 1C

Scope

Test Procedure 1C covers testing of individual packaged-products weighing 150 lb (68 kg) or less when prepared for shipment.

EXCEPTION:
Individual packaged-products on a visible skid or pallet and that weigh more than 100 lb (45 kg) may be tested according to Test Procedure 1E or Procedure 3E.

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:

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Sequence #	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning	Temperature and Humidity	Ambient	Required
2	Compression Conditioning	Machine or Static	Calculated Test Load or Force	Required
3	Vibration (Alternative methods allowed – select one test type)	Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required
		Random	Overall G_{rms} level of 1.15	Required
4	Shock (Alternative methods allowed – select one test type)	Drop	Height varies with packaged-product weight	Required
		Incline Impact (Conbur)	Impact Velocity varies with packaged-product weight	
		Horizontal Impact	Impact Velocity varies with packaged-product weight	

EQUIPMENT REQUIRED FOR PROCEDURE 1C

Equipment Required Compression Conditioning

The following alternatives are acceptable for the equipment required for the Compression Conditioning:

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

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.
  Rotary or vertical linear motion of the platform is 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.

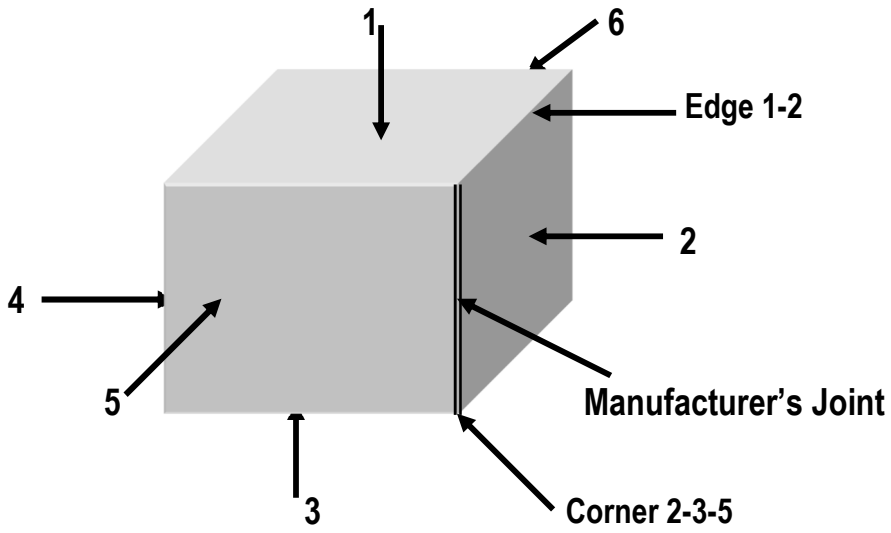
Equipment Required Shock

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

Type of Shock Test	Equipment	In compliance with the apparatus section of …
Drop Test	Free fall drop tester	ASTM D 5276
Vertical Shock Test	Shock test machine	ASTM D 5487
Alternative Incline Test	Incline impact tester (conbur)	ASTM D 880
Alternative Horizontal Test	Horizontal impact test system	ASTM D 4003

BEFORE YOU BEGIN PROCEDURE 1C

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)? • 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? • 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? • 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	**Identify faces** according to the diagram below. 
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.

BEFORE YOU BEGIN PROCEDURE 1C

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)

Required Preconditioning:
The packaged-product shall be preconditioned to laboratory ambient temperature and humidity for twelve (12) hours prior to testing.

CAUTION

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

NOTE:

This is only a conditioning requirement before the vibration and impact tests begin:

- it is not a compression performance test **or**
- a predictor of warehouse or vehicle stacking capability.
- there is a minimum test force or load **and** a maximum test force or load.

Familiarity with the following formulas is required:

Compression Test System	**Test Force**	English Units - Pounds Force (lbf)	Metric Units – Newtons (N)
Apply & Release Test Force	AR	[300 + W_t + [3 x (L + W)]] x 1.4	[1300 + (W_t x 9.8) + [530 x (L + W)]] x 1.4
Apply & Hold Test Force	AH	300 + W_t + [3 x (L + W)]	1300 + (W_t x 9.8) + [530 x (L + W)]
Weight & Load Spreader	**Test Load**	English Units Pounds (lb)	Metric Units Kilograms (kg)
Dead Weight Test Load	DW-AH	300 + W_t + [3 x (L + W)]	135 + W_t + [54 x (L + W)]

Where

W_t	Total weight of the packaged-product	Pounds		Kilograms	
	Type of Test	Min.	Max.	Min.	Max
AR	Apply and Release test force	420 lbf	1050 lbf	1870 N	4670 N
AH	Apply and Hold –Machine test force	300 lbf	750 lbf	1330 N	3340 N
DW-AH	Apply and Hold –Dead Weight test load	300 lb	750 lb	135 kg	340 kg
	Formula values, force	3		530	
	Formula values, load	3		54	
L	Overall container length	Inches		Meters	
W	Overall container width	Inches		Meters	
	Compensating Factor for time of compression	1.4		1.4	
	Metric conversion factor	NA		9.8	

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BEFORE YOU BEGIN PROCEDURE 1C

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Determine the test force or load to be used in the Compression Conditioning Block from the following table

Step	Action	
1	Is the package height over 60 in (1.5 m)? • **If Yes,** then use the appropriate minimum values only from the previous table as the test force or load. • If **No**, then continue with the next step.	
2	Determine the maximum test force or load to be used by performing the appropriate action as indicated below:	
	IF the calculated test force or load from the previous table is …	**Then use...**
	Equal to or less than 420 lbf (1870 N) for AR **or** Equal to or less than 300 lbf (1330 N) for AH **or** Equal to or less than 300 lb (135 kg) for DW-AH	the appropriate minimum values from the previous table as the test force or load.
	More than 420 lbf (1870 N) but less than 1050 lbf (4670 N) for AR **or** More than 300 lbf (1330 N) but less than 750 lbf (3340 N) for AH **or** More than 300 lb (135 kg) but less than 750 lb (340 kg) for DW-AH	the appropriate test force or load calculated from the previous table as the test force or load.
	Equal to or greater than 1050 lbf (4670 N) for AR **or** Equal to or greater than 750 lbf (3340 N) for AH **or** Equal to or greater than 750 lb (340 kg) for DW-AH	the appropriate maximum values from the previous table as the test force or load.

BEFORE YOU BEGIN PROCEDURE 1C

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.

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:

$$\text{Test Duration in Minutes} = \frac{\text{14, 200 Vibratory Impacts}}{\text{Cycles Per Minute (CPM) } \textbf{or} \text{ [Cycles Per Second (Hz) x 60]}}$$

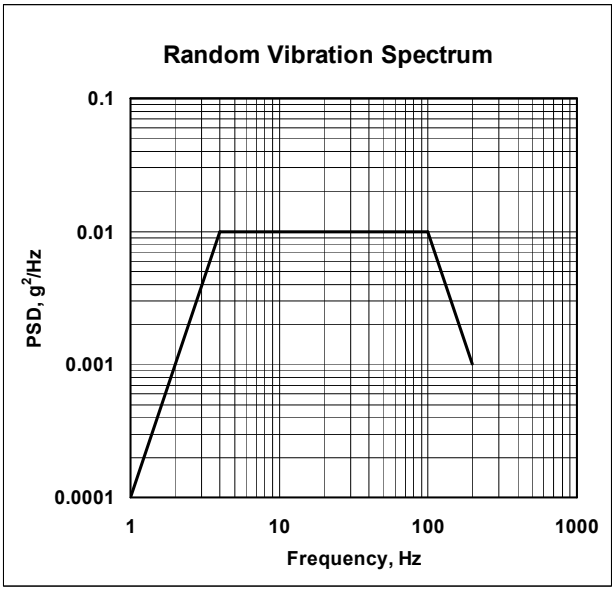
The chart below shows **example** Test Durations calculated for several frequencies.

CPM	Hz	Test Duration in Minutes
150	2.5	95
180	3.0	79
210	3.5	68
240	4.0	60
270	4.5	53
300	5.0	48

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 1C

The test drop height varies with the weight of the packaged-product. Find the weight of the packaged-product in the following chart to determine a drop height or an equivalent impact velocity or velocity change to be used for a substituted drop:

Packaged-Product Weight				Drop Height			Impact Velocity	
Equal to or greater than		But Less than		Free Fall			Incline or Horizontal	
lb	kg	lb	kg	in.	mm		ft/s	m/s
0	0	21	10	30	760		13	3.9
21	10	41	19	24	610		11	3.5
41	19	61	28	18	460		10	3.0
61	28	100	45	12	310		8.0	2.5
100	45	150	68	8	200		6.6	2.0

- The test method requires the packaged-product to be dropped in several different package orientations.
- A drop test must be performed in all required orientations where dropping the packaged-product is practical.
- If dropping in a required orientation is not practical an equivalent incline or horizontal test can be substituted for that orientation.
- 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 1C

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

TEST BLOCK 1
Atmospheric Conditioning
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TEMPERATURE AND HUMIDITY	
Step	**Action**
1	PRE-CONDITIONING: The packaged-product should be stored at laboratory ambient temperature and humidity for twelve (12) hours prior to testing.
2	Record the ambient laboratory temperature and humidity when testing starts.
3	At the end of testing record temperature and humidity.
4	Go to TEST BLOCK 2 (Compression).

TEST BLOCK 2
Compression Conditioning

COMPRESSION		
Step	**Action**	
1	Testing is to be conducted using the test load from Before You Begin Compression Conditioning and by performing the appropriate action as indicated in the table below:	
	IF the testing equipment to be used is a …	**THEN…**
	Compression Test System	Step 2.
	Weight and load spreader	Step 7.
2	Center the packaged-product with face-3 resting on the lower platen of the compression tester.	
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 AR Test Force value determined in Before You Begin Compression Conditioning. Then go to Step 5.
	Apply and Hold Test	Increase the force until it reaches the AH Test Force value determined in Before You Begin Compression Conditioning. Then go to Step 6.
5	Release the force. Compression Conditioning is complete. Go to TEST BLOCK 3 (Vibration).	
6	Maintain the force for one (1) hour, and then release the force. Go to TEST BLOCK 3 (Vibration).	
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 packaged-product.	
9	Apply the necessary weight to bring the total of the load spreader and weights up to the DW-AH Test Load determined in Before You Begin Compression Conditioning and maintain for one (1) hour.	
10	Remove the weight and load spreader.	
11	Compression Conditioning is complete. Go to TEST BLOCK 3 (Vibration).	

TEST SEQUENCE FOR PROCEDURE 1C

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 4 (Vibration – Random)
2	Put the packaged-product on the vibration table so that face-3 rests on the platform.	
3	Start the vibration system to vibrate at 1 in (25 mm) total displacement at the machine's lowest frequency.	
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 the 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	Stop the vibration test after completion of one-half ($^1/_2$) of the total minutes of test duration. Invert the packaged-product so that face-1 rests on the platform.	
9	Re-start the vibration system to vibrate at 1.0 in (25 mm) total displacement at the machine's lowest frequency.	
10	Maintain a fixed displacement at 1 inch (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.	
11	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 12). • If **No**, then slowly increase the frequency until the requirement of this Step (Step 11) is met, and hold that vibration frequency.	
12	Resume timing the test duration.	
13	Stop the vibration test after completion of one-sixth ($^1/_6$) of the total minutes of test duration. Place the packaged-product so that either face-2 or 4 rests on the platform.	

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TEST SEQUENCE FOR PROCEDURE 1C

TEST BLOCK 3 CONTINUED Vibration (Fixed Displacement)

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Step	Action
14	Re-start the vibration system to vibrate at 1.0 in (25 mm) total displacement at the machine's lowest frequency.
15	Maintain a fixed displacement at 1 inch (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.
16	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 17). • If **No**, then slowly increase the frequency until the requirement of this Step (Step 16) is met, and hold that vibration frequency.
17	Resume timing the test duration.
18	Stop the vibration test after completion of one-sixth ($^1/_6$) of the total minutes of test duration. Place the packaged-product so that either face-5 or 6 rests on the platform.
19	Re-start the vibration system to vibrate at 1.0 in (25 mm) total displacement at the machine's lowest frequency.
20	Maintain a fixed displacement at 1 inch (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.
21	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 22). • If **No**, then slowly increase the frequency until the requirement of this Step (Step 21) is met, and hold that vibration frequency.
22	Resume timing the test duration.
23	Stop the vibration testing after completion of one-sixth ($^1/_6$) of the total minutes of test duration.
24	Vibration testing is now complete. Go to TEST BLOCK 5 (Shock)

TEST BLOCK 4 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 system after the completion of 30 minutes. Invert the packaged-product so that face-1 (top) rests on the platform.
4	Begin the vibration duration for this orientation.
5	Stop the vibration system after the completion of 10 minutes. Place the packaged-product so that either face-2 or 4 rests on the platform.
6	Begin the vibration duration for this orientation.
7	Stop the vibration system after the completion of 10 minutes. Place the packaged-product so that either face-5 or 6 rests on the platform.
8	Begin the vibration duration for this orientation.
9	Stop the vibration testing at the end of 10 minutes.
10	Vibration testing is now complete. Go to TEST BLOCK 5 (Shock).

TEST SEQUENCE FOR PROCEDURE 1C

SHOCK - DROP			
Step	**Action**		
1	Determine the method(s) of test and the required drop height or impact velocity in Before You Begin Shock Testing.		
2	Do you have a packaged-product with only 6 faces as identified in Face, Edge and Corner Identification? • If **Yes**, continue with the next Step. • If **No**, then go to Step 6.		
3	Test the packaged-product according to the method(s) and level(s) determined in Step 1. Follow the sequence in the table below.		
4	**Sequence #**	**Orientation**	**Specific face, edge or corner**
	1	Corner	most fragile face-3 corner, if not known, test 2-3-5
	2	Edge	shortest edge radiating from the corner tested
	3	Edge	next longest edge radiating from the corner tested
	4	Edge	longest edge radiating from the corner tested
	5	Face	one of the smallest faces
	6	Face	opposite small face
	7	Face	one of the medium faces
	8	Face	opposite medium face
	9	Face	one of the largest faces
	10	Face	opposite large face
5	All testing is now complete. Go to the Reporting an ISTA Test section at the end of this Procedure.		
6	Select a bottom face corner to replace the corner required in Step 4 Sequence 1 to begin the test.		
7	Identify the edges of the packaged-product that meet the Step 4 Sequence 2 through 4 requirements.		
8	Select any 6 faces to replace the faces required in Step 4 Sequence 5 through 10.		
9	Using the corner, edges and faces from Steps 6 through 8 go to Step 3 and proceed.		
10	All testing is now complete.		

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