

ISTA, Your Alliance in Transport Packaging, is the world leader in Performance Tests for Packaged-Products.

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 3C

Preface

Test Procedure 3C is a general simulation test for individual packaged-products shipped through a parcel delivery system.

- 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 in a parcel delivery system.
- The test levels are based on general data and may not represent any specific 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:

- For small packaged-products 12 x 12 x 3 inches (310 x 310 x 80 mm) and/or 10 lb (4.5 kg) or less, use ISTA Test Procedure 3A or 3D and not 3C.
- For elongated packaged-products use ISTA Partial-Simulation Performance Test Procedure 2E or Procedure 3A and not 3C.

Elongated shall be defined any packaged-product where:

- The packages longest dimension is 36 inches (910 mm) or greater **and**
 - both of the packages other dimensions are each 20 percent or less of that of the longest dimension.
 - For flat packaged-products use ISTA Partial-Simulation Performance Test Procedure 2D or Procedure 3A and not 3C.
- Flat shall be defined any packaged-product where:
- The packages shortest dimension is 8 inches (200 mm) or less **and**
 - The packages next shortest dimension is four (4) or more times larger than the shortest dimensions.
- Refer to *Guidelines for Selecting and Using ISTA Procedures and Projects* for additional information.

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OVERVIEW OF PROCEDURE 3C

Scope

Test Procedure 3C covers testing of individual packaged-products weighing 150 pounds (68 kg) or less when prepared for shipment via a parcel delivery service.

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:

One sample is required for the tests in this procedure however it is strongly recommended to test three or more samples.

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	Temperature and Humidity	Ambient	Required
2	Atmospheric Conditioning	Controlled Temperature and Humidity	Temperature and Humidity Chosen from chart	Optional
3	Shock	Drop	Height varies with packaged-product weight	Required
4	Vibration	Under Dynamic Load Random	Calculated or maximum Top-Load and overall G_{rms} level of .53	Required
5	Shock	Drop	Height varies with packaged-product weight. Includes drop on hazard	Required

EQUIPMENT REQUIRED FOR PROCEDURE 3C

Equipment Required Atmospheric

Atmospheric Conditioning:

- Humidity recording apparatus complying with of the apparatus section of ASTM D 4332-01.
- Temperature recording apparatus complying with the apparatus section of ASTM D 4332-01.

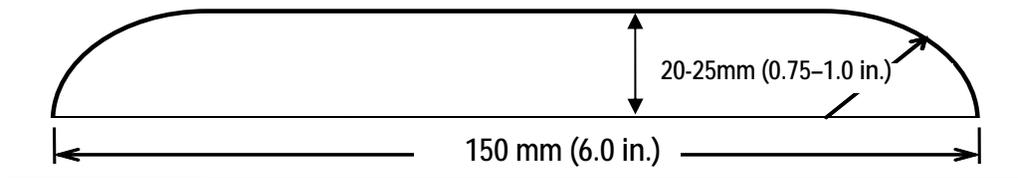
Optional Atmospheric Conditioning

- Chamber and Control apparatus complying with the apparatus section of ASTM D 4332-01.

Equipment Required Shock

Free Fall Drop Test:

- Free Fall Drop Test System complying with of the apparatus section of ASTM D 5276-98.
- **Hazard Block:** The block shall be made of hardwood or metal. The height shall be 20 to 25 mm (0.75 to 1.0 in.) and the width 150 mm (6.0 in.). The length shall be at least 200 mm (8.0in.) longer that the second shortest package dimension of the length, width and height. The long top edges of the block shall be rounded to a radius equal to the height of the block $\pm 0.02\text{mm}$ (0.0625 in).



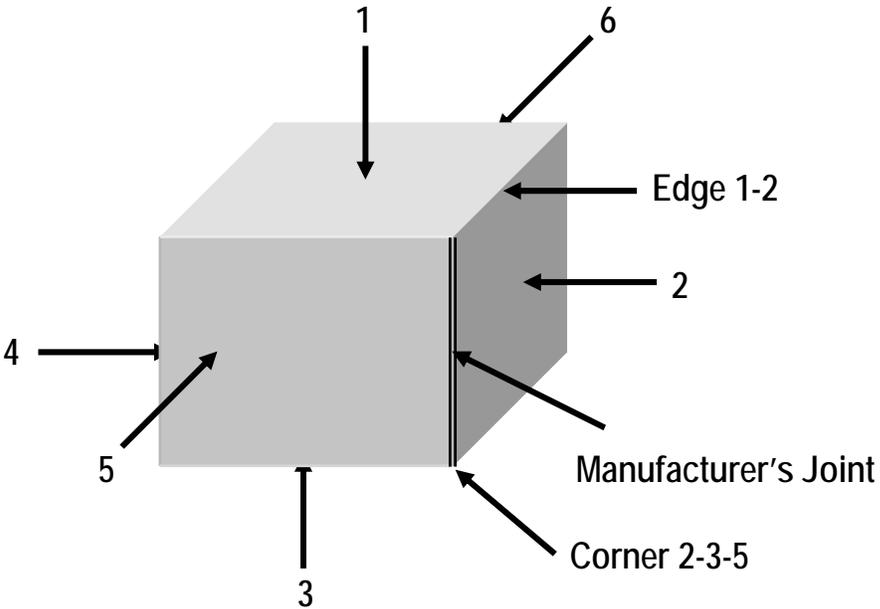
Equipment Required Vibration

Random Vibration Test:

- Random Vibration Test System complying with the apparatus section of ASTM D 4728-01.
- Top-Load apparatus of one, two or three separate loading systems.

BEFORE YOU BEGIN PROCEDURE 3C

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

Step	Action
1	Place the packaged-product so the package is in its most stable orientation (largest face down) with the label facing up or toward you.
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 the next Block.
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>  <p>The diagram shows a 3D perspective of a rectangular prism. The top face is labeled '1'. The front face is labeled '2'. The right face is labeled '3'. The left face is labeled '4'. The bottom face is labeled '5'. The back face is labeled '6'. A vertical line on the right face is labeled 'Manufacturer's Joint'. The edge between the top and front faces is labeled 'Edge 1-2'. The corner where the front, bottom, and left faces meet is labeled 'Corner 2-3-5'.</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 Block.

BEFORE YOU BEGIN PROCEDURE 3C

Packaged-Product Weight and Size Measurement

You shall know the packaged-products:

- 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.

Optional Conditioning Recommended:

After the required precondition 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 shall be used, **but**
- **Recommends** that both the highest and lowest atmospheric conditions be used.

A separate 3C test sequence should be conducted following each atmospheric condition selected from the table below:

Anticipated Conditions	Time in Hours	Temperature in °C ±2°C (°F ±4°F)	Humidity in %
Frozen or winter ambient	72	-29°C (-20°F)	uncontrolled RH
Refrigerated packages	72	5°C (40°F)	85% RH ±5%
Controlled temperature	72	23°C (72°F)	85% RH ±5%
Tropical (Wet) climate	72	38°C (100°F)	85% RH ±5%
Tropical (Wet) then desert (Dry):	72 then 6	38°C (100°F) then 60°C (140°F)	85% RH ±5% then 30% RH ±5%
Desert or summer ambient	72	50°C (120°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 Shock Testing

The test drop height varies for packaged-products that weigh:

- less than (<) 50 lb. (23 kg),
- 50 lb. (23 kg) to 100 lb. (45 kg) and
- greater than (>) 100 lb. (45 kg) up to 150 lb. (68 kg).

The drop height also varies with the drop sequence.

Before You Begin Vibration Under Dynamic Load Testing

CAUTION:

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

- Prevent the Top-Load from moving off the package being tested **and**
- Prevent the test specimen from moving off the platform **and**
- Maintain test orientation of the stack, **but**
- The device or devices shall not restrict the vertical motion of the test specimen during the test.

The packaged-product is tested

- in all three axis
- with a Top-Load calculated for the face 3 down axis

Continued

BEFORE YOU BEGIN PROCEDURE 3C

Top-Load

The Top-Load is to simulate 12-pounds/cubic foot (190 kg/m³) of assorted freight on top of a floor loaded shipping unit in a 108-inch (2.7 m) trailer.

The Top-Load apparatus shall be

- Larger than the test specimen, **and**
- Shall distribute the calculated Top-Load (TL) evenly over the test specimen.

A possible Top-Load apparatus system would be one or more containers with the following specifications:

- RSC – style corrugated container **and**
- 33 lb. (161 g/m²) maximum basis weight corrugated medium **and**
- 0.5 in. (13 mm) minimum thickness plywood pieces covering the entire area of the bottom inside flaps of the container, **and**
- Plastic bags of sand.

Note:

To convert basis weight in gm/m² (Metric) to basis weight in lb/1000ft² (English), divide by 4.885.

Dynamic Top-Load

The Top-Load is to simulate the effect of 12 pounds per cubic foot (lb/ft³) [200 kilograms per cubic meter (kg/m³)] of assorted freight on top of a floor loaded shipping unit in an over-the-road trailer with an inside height of 108 in. (2.7 m).

The Dynamic Top-Load for each axis is determined by

- Starting with the possible height within a tractor trailer of 108 inches (2.7 meters) **and**
- Subtracting the vertical dimension of the package in the axis of the test **and**
- Taking the resultant and multiply it by each dimension of the other two axes, **and**
- Multiplying that resultant by the Loading Factor **and**
- That will be the Top-Load in pounds (kilograms) for the vibration test, **unless**
- That value is greater than 350 pounds (160 kilograms), **then**
- Use a Top-Load of 350 pounds (160 kilograms).

The Loading Factor has been determined by empirical testing that resulted in correlation between damage in the test lab and damage in the field. The Loading Factor is calculated by

- Starting with the estimated average density of a trailer of parcel packages at 12 lb/ft³ (200 kg/m³) **and**
- For English units, divide 12 lb/ ft³ by (1728 in³/ft³) to get .007 lb/in³ **or**
- For Metric units use 200 kg/m³ **and**
- Multiply 0.007 lb/in³ (200 kg/m³) by 0.5 to get the Loading Factor of .0035 lb/in³ (100 kg/m³).

Note:

This is a major change from previous versions of 3C. It reduces the Top-Load by 50%.

Continued

BEFORE YOU BEGIN PROCEDURE 3C

Familiarity with the following formula is required:

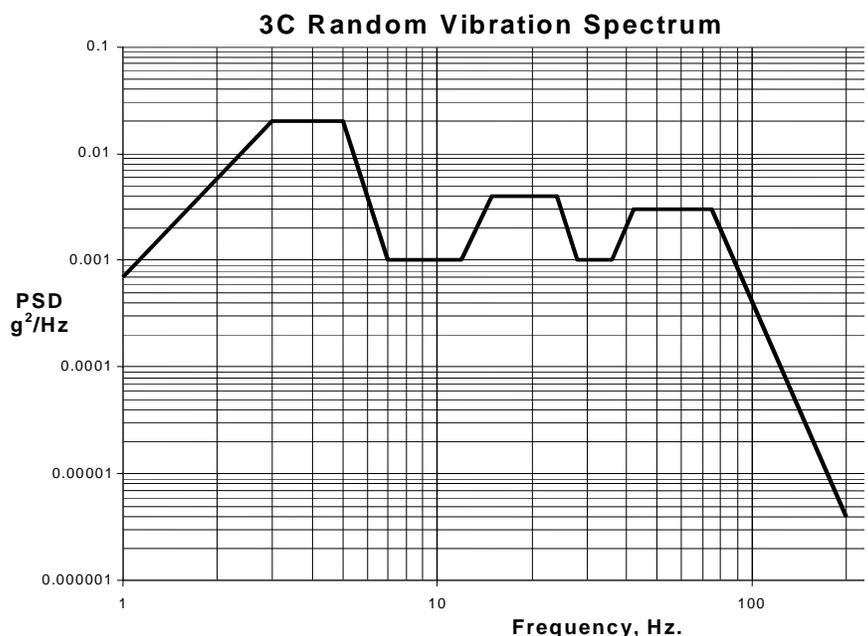
Top-Load Formulas TL		English Units in Inches	Metric Units in Meters
Top-Load (TL-H) with face 3 down	TL1	$(108 - H) \times L \times W \times 0.0035$	$(2.7 - H) \times L \times W \times 100$
Top-Load (TL-W) with face 4 down	TL2	$(108 - L) \times H \times W \times 0.0035$	$(2.7 - L) \times H \times W \times 100$
Top-Load (TL-L) with face 6 down	TL3	$(108 - W) \times H \times L \times 0.0035$	$(2.7 - W) \times H \times L \times 100$
Where			
TL	Total Weight of the Top-Load Package	Pounds	Kilograms
2.7 m (108 in.)	Height of typical trailer	Inches	Meters
H	Height of shipping unit	Inches	Meters
L	Length of shipping unit	Inches	Meters
W	Width of shipping unit	Inches	Meters
Loading Factor	50% of the Average density of freight	0.0035 lb/in ³	100 kg/m ³

Determine the Maximum Top-Load weight with the following Table

Maximum Top-Load weight (TL) for any Axis	English Units	Metric Units
Determine the Top-Load weight to be used for each axis by comparing the calculated TL against the following statements.		
IF the calculated Top-Load for an axis is ...	THEN ...	
350 lb (160 kg) or Less	Use the calculated Top-Load (TL) for that axis.	
Greater than 350 lb (160 kg)	Use 350 lb (160 kg) as the Top-Load (TL)	

The following breakpoints are for an over-the-road trailer typical for parcel delivery movement and shall be programmed into the vibration controller to produce the acceleration versus frequency profile (spectrum) below with an overall G_{rms} level of 0.53. The theoretical stroke required to run this vibration profile is 1.855 inches (47.12 mm):

Frequency (Hz)	PSD Level, g^2/Hz
1	0.0007
3	0.02
5	0.02
7	0.001
12	0.001
15	0.004
24	0.004
28	0.001
36	0.001
42	0.003
75	0.003
200	0.000004



TEST SEQUENCE FOR PROCEDURE 3C

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

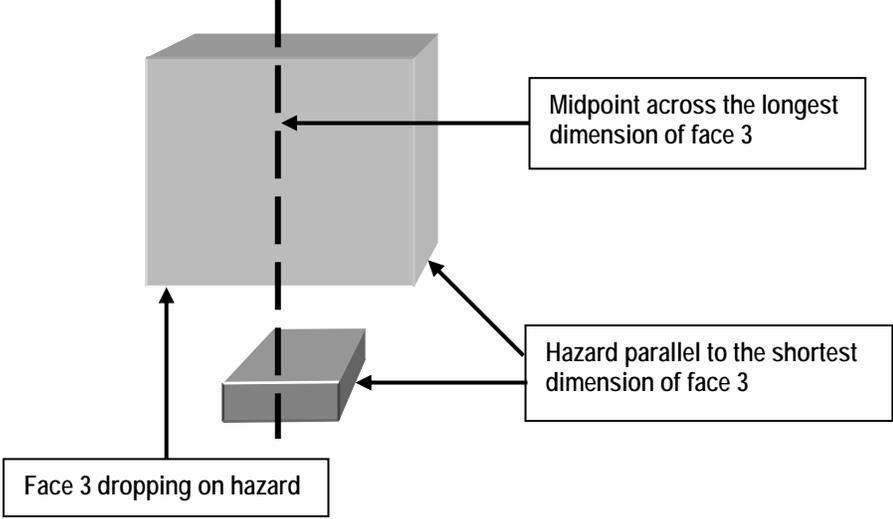
TEMPERATURE AND HUMIDITY	
Step	Action
1	The packaged-product should be stored at laboratory ambient temperature and humidity for twelve (12) hours.
2	Is optional conditioning going to be performed? <ul style="list-style-type: none"> • If Yes, go to Step 6. • If No, go to the next Step.
3	Record the ambient laboratory temperature and humidity when testing starts.
4	At the end of all testing record temperature and humidity.
5	Go to the next First Shock Test Block.
6	Select an anticipated condition from the Before You Begin Block.
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. Go to the First Shock Test Block and perform the remaining test sequence as quickly as possible.

DROP					
Step	Action				
1	Follow the table below to determine the height and orientation for the first 7 drops.				
	Drop Number	< 50 lb (23 kg)	50-100 lb (23-45 kg)	> 100-150 lb (45-68 kg)	Test Specimen
	1	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	edge 3-4
	2	15 in. (380mm)	12 in. (310 mm)	9 in. (230 mm)	edge 3-6
	3	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	edge 4-6
	4	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	corner 3-4-6
	5	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	corner 2-3-5
	6	30 in. (760 mm)	24 in. (610 mm)	18 in. (460 mm)	face 3
7	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	face 3	
2	Shock test is now complete. Go to the Vibration Under Dynamic Load Test Block.				

TEST SEQUENCE FOR PROCEDURE 3C

DYNAMIC LOAD AND RANDOM	
Step	Action
1	Complete the following test sequence for each type of package that has a check in the box:
2	Place the packaged-product on the center of the vibration table so that face-3 rests on the platform.
3	Place the Dynamic Top-Load package as determined in the Before You Begin Vibration Under Dynamic Load Testing Block for TL-H on top of the test specimen.
4	Using some form of column stack fixturing to make sure that the stack maintains its orientation without restricting the vertical motion of the Top-Load package or the test specimen.
5	Start the vibration machine to produce the Over-the-Road random vibration spectrum indicated in the Before You Begin Block.
6	After 60 minutes, stop the vibration testing and remove the Dynamic Top-Load package(s).
7	Inspection of the packaged-product for visible damage is allowed, provided inspection does not alter, in any way, the current condition of the package or the condition or position of the product(s).
8	Rotate the test specimen so that face-4 rests on the center of the vibration table platform.
9	Place the Dynamic Top-Load package as determined in the Before You Begin Vibration Under Dynamic Load Testing Block for TL-L on top of the test specimen.
10	Using some form of column stack fixturing to make sure that the stack maintains its orientation without restricting the vertical motion of the Top-Load package or the test specimen.
11	Start the vibration machine to produce the Over-the-Road random vibration spectrum indicated in the Before You Begin Block.
12	After 30 minutes, stop the vibration testing and remove the Dynamic Top-Load package(s).
13	Inspection of the packaged-product for visible damage is allowed, provided inspection does not alter, in any way, the current condition of the package or the condition or position of the product(s).
14	Rotate the test specimen so that face-6 rests on the center of the vibration table platform.
15	Place the Dynamic Top-Load package as determined in the Before You Begin Vibration Under Dynamic Load Testing Block for TL-W on top of the test specimen.
16	Using some form of column stack fixturing to make sure that the stack maintains its orientation without restricting the vertical motion of the Top-Load package or the test specimen.
17	Start the vibration machine to produce the Over-the-Road random vibration spectrum indicated in the Before You Begin Block.
18	After the completion of 30 minutes, stop the vibration testing and remove the Dynamic Top-Load package(s).
19	Inspection of the packaged-product for visible damage is allowed, provided inspection does not alter, in any way, the current condition of the package or the condition or position of the product(s).
20	Vibration testing is now complete. Go to the appropriate Second Shock Test Block

TEST SEQUENCE FOR PROCEDURE 3C

DROP					
Step	Action				
1	Follow the table below to determine the height and orientation for the final set of 8 drops.				
	Drop Number	< 50 lb (23 kg)	50-100 lb (23-45 kg)	> 100-150 lb (45-68 kg)	Test Specimen
	1	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	edge 3-4
	2	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	edge 3-6
	3	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	edge 3-5
	4	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	corner 3-4-6
	5	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	corner 1-2-6
	6	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	face 1
7	30 in. (760 mm)	24 in. (610 mm)	18 in. (460 mm)	face 4	
 <p style="text-align: center;">Face 3 dropping on hazard</p> <p style="text-align: center;">Midpoint across the longest dimension of face 3</p> <p style="text-align: center;">Hazard parallel to the shortest dimension of face 3</p> <p>For the next drop, the test specimen should strike the hazard midpoint across the longest dimension of the face and parallel to the shortest dimension of the face being impacted. The required drop distance is to the impact surface, not to the hazard. The diagram above shows this concept:</p>					
Drop 8	15 in. (380 mm)	12 in. (310 mm)	9 in. (230 mm)	face 3 on hazard	
2	All testing is now complete. Go to the Test Report Block.				

TEST REPORT FOR PROCEDURE 3C

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

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.

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

ISTA Transit Tested Program

The ISTA Transit Tested Certification Mark as shown is a:

- registered certification mark **and**
- can only be used by license agreement **and**
- by a member of the International Safe Transit Association.

When a member prints this certification mark on a packaged-product with their license number they are showing their customer and the carrier that it has passed the requirements of ISTA preshipment testing.



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.

Changes in the product include changes in:

- Design **or**
- Size **or**
- Materials.

Changes in the process include changes in:

- Manufacturing **or**
- Assembly **or**
- Filling.

Changes in the package include changes in:

- Configuration **or**
- Dimensions **or**
- Weight **or**
- Materials **or**
- Components.

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

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