

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 1D

Test Procedure 1D 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.

Specific suggestions:

- For unitized loads of the same product use ISTA Procedure 1E or ISTA General Simulation Performance Test Procedure 3E.
- For a single packaged-product that is unitized consider ISTA Procedure 1E. 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.

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

OVERVIEW OF PROCEDURE 1D

Test Procedure 1D covers testing of individual packaged-products weighing more than 150 lb (68 kg) when prepared for shipment.

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 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.

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	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	
4	Shock (Alternative methods allowed – select one test type)	Drop	6 in (150 mm)	Required
		Incline Impact (Conbur)	69 in (1.7 m) per second impact velocity	
		Horizontal Impact	69 in (1.7 m) per second velocity change	
5	Shock	Rotational Edge Drop	8 in (200 mm)	Required when not testing face 1

EQUIPMENT REQUIRED FOR PROCEDURE 1D

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

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:

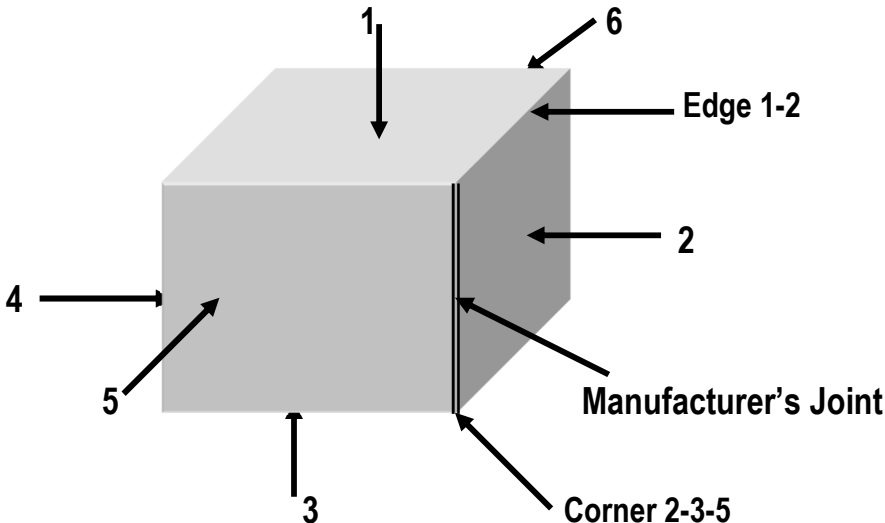
- Random Vibration Test System complying with the apparatus section of ASTM D 4728.

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
Incline Test	Incline impact tester (conbur)	ASTM D 880
Horizontal Test	Horizontal impact test system	ASTM D 4003
Rotational Test	Rotational drop	ASTM D 6179

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.

Weight and Size Measurement

Before You Begin Atmospheric Conditioning

Before You Begin Compression Conditioning

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:

similarity 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	$[300 + W_t + [3 \times (L + W)]] \times 1.4$	$[1300 + (W_t \times 9.8) + [530 \times (L + W)]] \times 1.4$			
Apply & Hold Test Force	AH	$300 + W_t + [3 \times (L + W)]$	$1300 + (W_t \times 9.8) + [530 \times (L + W)]$			
Weight & Load Spreader	Test Load	English Units Pounds (lb)	Metric Units Kilograms (kg)			
Dead Weight Test Load	DW-AH	$300 + W_t + [3 \times (L + W)]$	$135 + W_t + [54 \times (L + W)]$			
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	

Continued on next page

BEFORE YOU BEGIN PROCEDURE 1D

Continued from previous page

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)? <ul style="list-style-type: none"> • 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
Vibration
Testing

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:

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

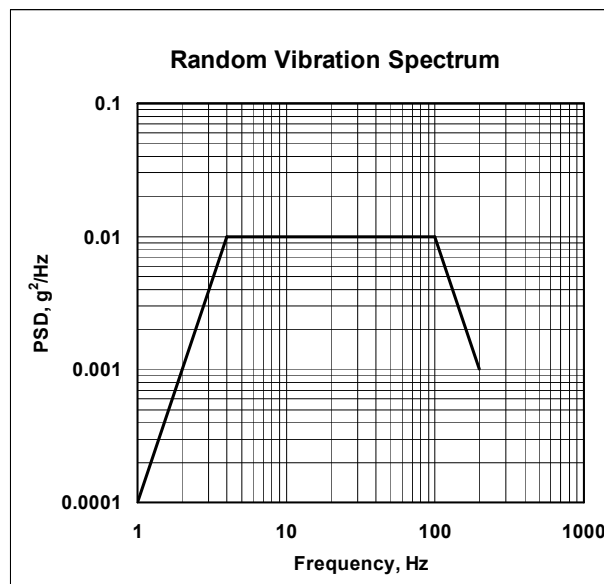
The chart below shows **example** Test Duration's calculated for several frequencies.

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



Select Drop, Incline or Horizontal as a test method.

For Drop Test Method the drop height shall be 6 in (150 mm) for Free Fall Drop, Shock Machine Equivalent Free Fall Drop, or Sling Drops.

For Incline Test Method the minimum impact velocity is 69 in per second (1.7 m per second).

For Horizontal Test Method the minimum velocity change is 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.

EXCEPTION:

You do not have to conduct a shock test on face 1 (top) if:

- the packaged-product has a visible skid or pallet, **or**
- positioning or testing the packaged-product in this orientation would be unsafe.

CAUTION:

If the test item is large and:

- has a length equal to or greater than twice the width **and**
- has a center of gravity above the midpoint of the height.
- there is the possibility that it 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 BLOCK 1
Atmospheric
Conditioning
O

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

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 (Vibration).

TEST BLOCK 2
Compression
Conditioning

COMPRESSION							
Step	Action						
1	Testing is to be conducted using the test load from the Before You Begin Compression Conditioning and by performing the appropriate action as indicated in the table below:						
	<table> <tr> <th>IF the testing equipment to be used is a ...</th><th>THEN...</th></tr> <tr> <td>Compression Test System</td><td>Step 2.</td></tr> <tr> <td>Weight and load spreader</td><td>Step 7.</td></tr> </table>	IF the testing equipment to be used is a ...	THEN...	Compression Test System	Step 2.	Weight and load spreader	Step 7.
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:						
	<table> <tr> <th>IF the compression test is a...</th><th>THEN...</th></tr> <tr> <td>Apply and Release Test</td><td>Increase the force until it reaches the AR Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 5.</td></tr> <tr> <td>Apply and Hold Test</td><td>Increase the force until it reaches the AH Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 6.</td></tr> </table>	IF the compression test is a...	THEN...	Apply and Release Test	Increase the force until it reaches the AR Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 5.	Apply and Hold Test	Increase the force until it reaches the AH Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 6.
IF the compression test is a...	THEN...						
Apply and Release Test	Increase the force until it reaches the AR Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 5.						
Apply and Hold Test	Increase the force until it reaches the AH Test Force value determined in the Before You Begin Compression Testing block. Then go to Step 6.						
5	Release the force. Compression Conditioning is complete. Go to TEST BLOCK 3 (Vibration Testing).						
6	Maintain the force for one (1) hour, and then release the force. Go to TEST BLOCK 3 (Vibration Testing).						
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 Testing).						

TEST BLOCK 3
Vibration
(Fixed
Displacement)

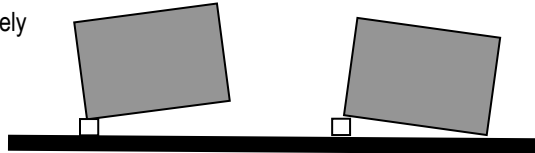
VIBRATION - FIXED DISPLACEMENT		
Step	Action	
1	Determine if testing is going to be Fixed Displacement or Random Vibration.	
	IF Vibration testing is going to be ...	THEN go to ...
	Fixed Displacement	Step 2.
	Random	TEST BLOCK 4 (Vibration - Random).
2	Put the packaged-product on the vibration table 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? <ul style="list-style-type: none"> • 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	Are you using a vertical linear motion on the vibration system? <ul style="list-style-type: none"> • If Yes, then go to Step 13. • If No, then continue with the next step. 	
9	Stop the vibration test after completion of one-half ($\frac{1}{2}$) of the total minutes of test duration and perform the appropriate action as indicated in the table below:	
	IF a single 90° horizontal rotation is...	THEN perform a horizontal rotation of ...
	Possible	90° as the specimen rests on the platform.
	Not practical because of the size of the packaged-product or the stability of the packaged-product.	180° as the specimen rests on the platform.
10	Re-start the vibration system to vibrate at 1.0 in (25 mm) total displacement at the machine's lowest frequency.	
11	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.	
12	Can a metal shim be intermittently moved between the bottom of the longest dimension of the packaged-product and the surface of the platform? <ul style="list-style-type: none"> • If Yes, hold that frequency and then continue to the next step (Step 13). • If No, then slowly increase the frequency until the requirement of this Step (Step 12) is met, and hold that vibration frequency. 	
13	Resume or continue timing the test, and complete the second half of the vibration duration.	
14	Vibration testing is now complete. Go to TEST BLOCK 5 (Shock).	

TEST SEQUENCE FOR PROCEDURE 1D

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 the Before You Begin Block.	
3	Stop the vibration system after the completion of 30 minutes and perform the appropriate action as indicated in the table below:	
	IF the packaged-product can be shipped ...	THEN ...
	<ul style="list-style-type: none"> Only with face 3 down. 	<ul style="list-style-type: none"> Continue the vibration test with face 3 resting on the platform and test for 30 minutes. Go to Step 4.
	<ul style="list-style-type: none"> Face 1 down and in both of the other two possible shipping axes. 	<ul style="list-style-type: none"> Invert the packaged-product so that face 1 (top) rests on the platform. Start the vibration system, test for 10 minutes and then stop the vibration system. Turn the packaged-product so that either face 2 or 4 rests on the platform. Start the vibration system, test for 10 minutes and then stop the vibration system. Turn the packaged-product so that either face 5 or 6 rests on the platform. Start the vibration system, test for 10 minutes and then stop the vibration system. Go to Step 4.
	<ul style="list-style-type: none"> Face 1 down, but Only one of the other two possible shipping axes. 	<ul style="list-style-type: none"> Invert the packaged-product so that face 1 (top) rests on the platform. Start the vibration system, test for 15 minutes and then stop the vibration system. Turn the packaged-product in the axis that it could be shipped with either face on the platform. Start the vibration system, test for 15 minutes and then stop the vibration system. Go to Step 4.
	<ul style="list-style-type: none"> In both of the other two possible shipping axes, but Can't be shipped face 1 down. 	<ul style="list-style-type: none"> Turn the packaged-product so that either face 2 or 4 rests on the platform. Start the vibration system, test for 15 minutes and then stop the vibration system. Turn the packaged-product so that either face 5 or 6 rests on the platform. Start the vibration system, test for 15 minutes and then stop the vibration system. Go to Step 4.
	<ul style="list-style-type: none"> Only one of the other two possible shipping axes, but Can't be shipped face 1 down. 	<ul style="list-style-type: none"> Turn the packaged-product in the axis that it could be shipped with either face on the platform and test for 30 minutes. Go to Step 4.
4	Vibration testing is now complete. Go to TEST BLOCK 5 (Shock – Drop or Impact) or TEST BLOCK 6 (Shock – Impact and Rotational Edge Drop).	

TEST SEQUENCE FOR PROCEDURE 1D

SHOCK - DROP OR IMPACT			
Step	Action		
1	Did you determine in Before You Begin Shock Testing not to shock test face 1 (top)? <ul style="list-style-type: none"> If Yes, then go to TEST BLOCK 6 (Shock – Impact and Rotational Edge Drop). If No, go to the next Step. 		
2	Determine the drop height, impact velocity or velocity change from Before You Begin Shock Testing.		
3	Test the packaged-product according to the level in Step 2. Follow the sequence in the table below.		
	Sequence #	Orientation	Specific face
	1	Face	one of the smallest faces
	2	Face	opposite small face
	3	Face	one of the medium faces
	4	Face	opposite medium face
	5	Face	one of the largest faces
	6	Face	opposite large face
4	All testing is now complete.		

SHOCK - IMPACT AND ROTATIONAL EDGE DROP			
Step	Action		
1	Determine the impact velocity or velocity change from Before You Begin Shock Testing.		
2	Test the packaged-product according to the level in Step 1. Follow the sequence in the table below.		
	Sequence #	Orientation	Specific face
	1	Face	one of the smallest vertical faces
	2	Face	opposite small vertical face
	3	Face	one of the largest vertical faces
	4	Face	opposite large vertical face
3	Perform a rotational edge drop. Follow the sequence in the table below.		
	Sequence #	Action	
	1	Place the unitized load onto a flat, rigid surface such as steel or concrete.	
	2	Support any face 3 edge with a timber or support 3.5 to 4.0 in (90 to 100 mm) in height and width.	
	3	Lift the opposite face 3 edge to 8 in (200 mm) off the surface.	
	4	Release the edge so that it falls freely on to a flat, rigid surface.	
			
4	Repeat Step 3 on one of the bottom edges radiating 90° from the edge tested in Step 3 Sequence 3.		
5	All testing is now complete.		
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