ISTA 3 Series General Simulation Performance Test Procedure

VERSION DATE Last TECHNICAL Change: JANUARY 2009

Last EDITORIAL Change: JANUARY 2009

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 3H

Test Procedure 3H is a general simulation test for mechanically handled bulk loads.

- It is intended for bulk loads of the same product but it can also be considered for mixed loads.
- It can be used to evaluate the protective performance of bulk transport systems related to vibrations, shocks and other stresses normally encountered during handling and transportation.
- It can be used to evaluate interior dunnage.
- 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.

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

3H

OVERVIEW OF PROCEDURE 3H

Scope

Test Procedure 3H covers testing of bulk loads made up of one transport container or system consisting of the same product that because of their size and/or weight must be handled by mechanical means, for example, automotive parts in reusable racks.

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.

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.

OVERVIEW OF PROCEDURE 3H

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	Horizontal Impact	2 mph (0.9 m/s) 15 ms half sine	Required
4	Shock	Rotational Flat Drop	4 in (100 mm)	Required
5	Shock	Rotational Edge Drop	4 in (100 mm)	Required
6	Shock	Rotational Flat Drop	4 in (100 mm)	Required
7	Shock	Rotational Edge Drop	4 in (100 mm)	Required
8	Vibration	Random	Overall G_{rms} level varies with Mode of Transport	Required
9	Shock	Horizontal Impact	4 and 6 mph (1.8 and 2.7 m/s) 300 ms Trapezoidal	Required for Rail Shipments Only
10	Shock	Horizontal Impact	2 mph (0.9 m/s) 15 ms Half Sine	Required
11	Shock	Rotational Flat Drop	4 in (100 mm)	Required
12	Shock	Rotational Edge Drop	4 in (100 mm)	Required
13	Shock	Rotational Flat Drop	4 in (100 mm)	Required
14	Shock	Rotational Edge Drop	4 in (100 mm)	Required
15	Compression (Alternative methods allowed – select one test type)	Machine Apply and Release	Calculated Test Force x 1.4	Optional
		Machine Apply and Hold	Calculated Test Force	
		Weight and load Spreader	Calculated Test Load	

EQUIPMENT REQUIRED FOR PROCEDURE 3H

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

Horizontal Impact Test:

- Horizontal Impact Test System complying with the apparatus section of ASTM D 4003.

Rotational Edge Drop Test:

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

Equipment Required Vibration

Random Vibration Test:

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

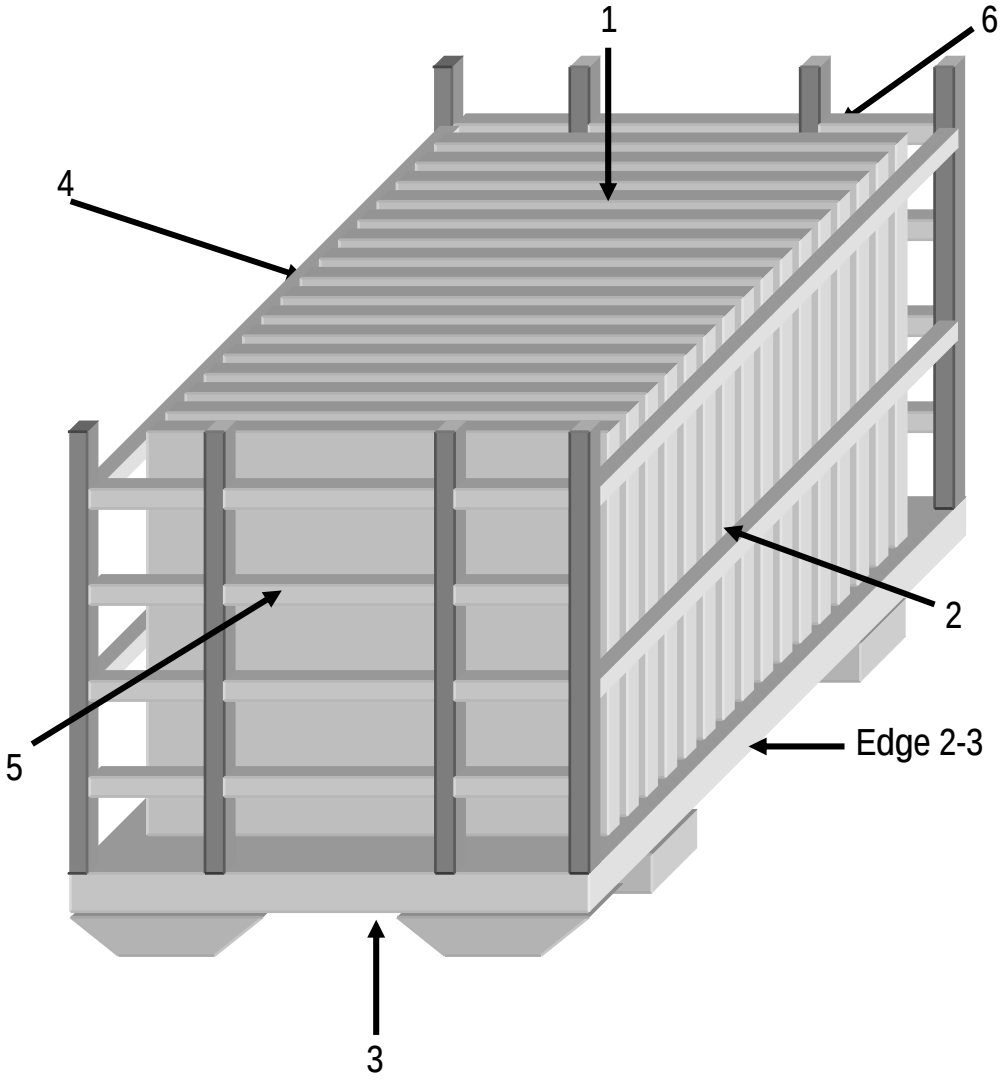
Equipment Required Compression

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

Type of Compression Test	Equipment	In compliance with the apparatus section of:
Apply and Release Test	Compression test system	ASTM D 642 "Fixed-Platen Testing Machine" requirements
Apply and Hold Test	Compression test system	
Apply and Hold Test	Weight and load spreader	NA

BEFORE YOU BEGIN PROCEDURE 3H

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

Step	Action
1	Place the bulk container in its normal shipping position.
2	Position one of the smallest width faces of the container directly in front of you.
3	**Identify faces** according to the diagram below. 
4	**Identify edges** using the numbers of the two faces forming that edge. Example: Edge 2-3 is the edge formed by face 2 and face 3 of the packaged-product.
5	Go to next page for further Before You Begin details.

BEFORE YOU BEGIN PROCEDURE 3H

Bulk Container Weight and Size Measurement

You shall know the bulk containers:

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

Optional Conditioning Recommended (to be performed after the required preconditioning):
To permit an adequate determination of the bulk container's 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 bulk container 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 bulk container 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	60ºC (140ºF)	15% RH +/- 5%
Severe Cold, Uncontrolled RH	72	-18ºC (0ºF)	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 following determinations must be made:

- Determine if the mechanically handled bulk container and products will be shipped by rail.

For rail shipments there are two possible loading orientations (axes) for a bulk container. Possible loading orientations are based upon variables such as size of the bulk container and size of the transport trailer, container, or railcar that will be used. It also depends are on whether or not the shipper can insure that only one orientation is ever used.

- Determine if the bulk container could and would be loaded with the:
  - Longest faces parallel to the end walls of the vehicle only or
  - Shortest faces parallel to the end walls of the vehicle only or
  - Either the longest or shortest face parallel to the end walls of the vehicle

BEFORE YOU BEGIN PROCEDURE 3H

CAUTION:

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

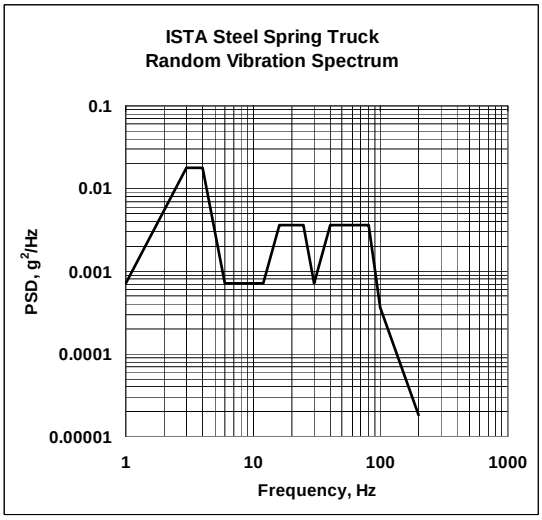
- Prevent the test specimen from moving off the platform and
- Maintain test orientation of the bulk container or stack, but
- The restraining device or devices shall not restrict the vertical motion of the test specimen during the test.

The following determination must be made:
Determine if the mechanically handled bulk container and products will be shipped via railcar, steel spring truck trailers or air-ride truck trailers. If only one type of transport is possible, then use the random spectrum associated with that mode from the following spectra. If more than one mode is possible use the spectrum with the highest G_{rms} value from the potential modes.

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

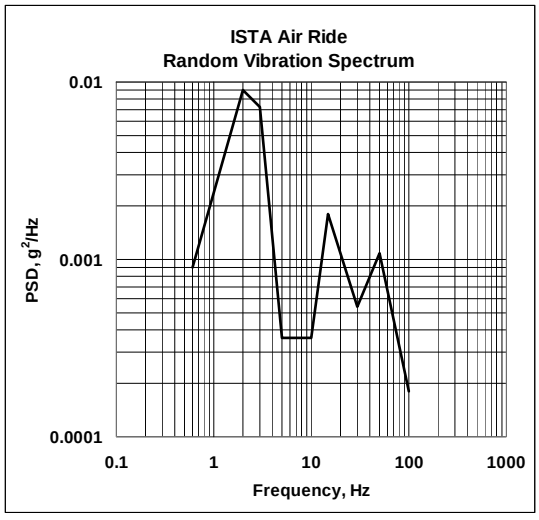
Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.00072
3.0	0.018
4.0	0.018
6.0	0.00072
12.0	0.00072
16.0	0.0036
25.0	0.0036
30.0	0.00072
40.0	0.0036
80.0	0.0036
100.0	0.00036
200.0	0.000018



For Air-Ride Truck 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 0.28. The theoretical stroke required to run this vibration profile is 82.58 mm (3.251 in) peak to peak.

Frequency (Hz)	PSD Level, g^2/Hz
0.6	0.0009
2.0	0.009
3.0	0.0072
5.0	0.00036
10.0	0.00036
15.0	0.0018
30.0	0.00054
50.0	0.00108
100.0	0.00018



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BEFORE YOU BEGIN PROCEDURE 3H

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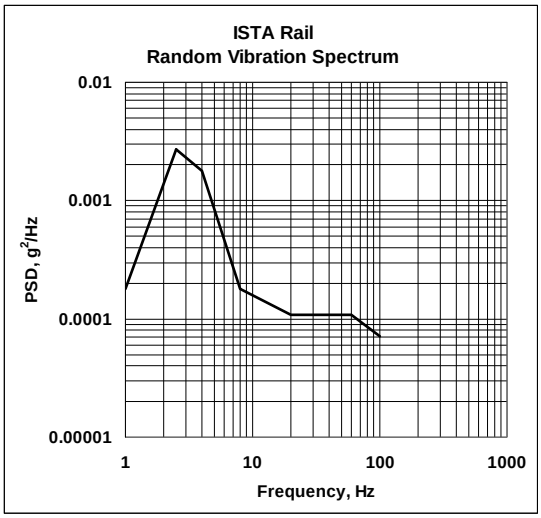
For Railcar Random Vibration:

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 0.13. The theoretical stroke required to run this vibration profile is 21.26 mm (0.837 in) peak to peak.

Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.00018
2.5	0.0027
4.0	0.0018
8.0	0.00018
20.0	0.000108
60.0	0.000108
100.0	0.000072



Calculating Test Time

Estimate the anticipated total distance of the ground shipment the packaged-product may encounter during distribution to determine a test time from the following formulas:

Test Time duration in minutes = (Transport Miles) ÷ 5. Maximum test time 240 minutes

OR

Test Time duration in minutes = (Transport Kilometers) ÷ 8. Maximum test time 240 minutes

Examples:
If the estimated distance is 750 miles, the Test Time would be 150 minutes.
If the estimated distance is 1000 km., the Test Time would be 125 minutes.

BEFORE YOU BEGIN PROCEDURE 3H

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

NOTE:
Each of the formula has a numerical factor that compensates for other hazards that are not simulated in the test protocol.

Familiarity with the following formulas is required for bulk containers that will be warehoused for more than 48 hours prior to shipment:

WAREHOUSING COMPRESSION (W)			
		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	W-AR-C	W_t x (S –1) x F x 1.4	W_t x (S –1) x F x 9.8 x 1.4
Apply and Hold (AH) Test Force	W-AH-C	W_t x (S –1) x F	W_t x (S –1) x F x 9.8
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	W- AH - DW	W_t x (S –1) x F	W_t x (S –1) x F

Where	
W	Warehouse Compression
C	Compression Test System
DW	Dead Weight and Load Spreader
AR	Test Load for Apply and Release
AH	Test Load Apply and Hold
W_t	Gross weight of the bulk container
S	Total number of bulk containers in a stack *NOTE:* If nothing is stacked on the packaged-product, then the S value = 1 (one), the test load or force = 0 (zero) and no compression test is required.
1	Represents the bottom bulk container
1.4	Compensating factor for time of compression
F	Compensating factor. Use a value of 3 for bulk containers warehoused for more than 48 hours prior to shipment.*
9.8	Metric conversion factor

* Compensating factors account for effects not tested, such as temperature/humidity, stacking patterns, long-duration loading, etc. Other factors may be used in certain situations. 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 ISTA recommendations above are not followed, sufficient justification must be included in the Test Report.

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BEFORE YOU BEGIN PROCEDURE 3H

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Familiarity with the following formulas is required:

VEHICLE COMPRESSION (V)			
Bulk Container height = 55 inches (1.4 m) or over		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	V-AR-C	W_t x F x 1.4	W_t x F x 9.8 x 1.4
Apply and Hold (AH) Test Force	V-AH-C	W_t x F	W_t x F x 9.8
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	V- AH - DW	W_t x F	W_t x F
Bulk Container height = less than 55 inches (1.4 m)		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	V-AR-C	W_t x F x 1.4	W_t x F x 9.8 x 1.4
Apply and Hold (AH) Test Force	V-AH-C	W_t x F	W_t x F x 9.8
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	V- AH - DW	W_t x F	W_t x F

Where	
V	Vehicle Compression
C	Compression Test System
DW	Dead Weight and Load Spreader
AR	Test Load for Apply and Release
AH	Test Load Apply and Hold
W_t	Gross weight of the bulk container
1.4	Compensating factor for time of compression
F	Compensating factor. Use a value of 1.5 for bulk containers with a height of 55 in (1.4 m) or over. Use a value of 3 for bulk containers less than 55 in (1.4 m) in height.
9.8	Metric conversion factor

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BEFORE YOU BEGIN PROCEDURE 3H

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Use the following table to determine which Load Force and what calculated test load to use in the Compression Test Block.

Step	Action	
1	Calculate a test force/load using the appropriate formula and test conditions (Apply and Release, Apply and Hold, Apply and Hold-Dead Weight) from the tables above as indicated in the table below:	
	IF the bulk container has a height...	THEN use the Formula for ...
	55 in (1.4 m) or over.	Vehicle Compression (V) - load height 55 in (1.4 m) or over.
	Less than 55 in (1.4 m).	Vehicle Compression (V) - load height less than 55 in (1.4 m).
2	Determine if the Bulk Container will be subjected to stacking in a warehouse for more than 48 hours before being shipped. • If Yes, then continue with the next Step. • If No, go to Compression Test Block. The Vehicle Compression (V) determined in Step 1 will be used in the Compression Test Block.	
3	Calculate a test force/load using the Warehousing Compression (W) formula and test conditions (Apply and Release, Apply and Hold, Apply and Hold-Dead Weight) in Before You Begin Compression.	
4	Use the larger of the Vehicle Compression (V) calculated in Step 1 or the Warehousing Compression (W) calculated in Step 3 as the load/force to be applied in the Compression Test Block.	
	IF the calculated Warehousing Compression (W) from Step 3 is ...	THEN use the...
	Less than the calculated Vehicle Compression (V) from Step 1	Vehicle Compression (V) calculated test load from Step 1 as the test load in the Compression Test Block.
	Equal to or greater than the calculated Vehicle Compression (V) from Step 1	Warehousing Compression (V) calculated test load from Step 3 as the test load in the Compression Test Block.

TEST SEQUENCE FOR PROCEDURE 3H

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

TEST BLOCK 1
Atmospheric Conditioning

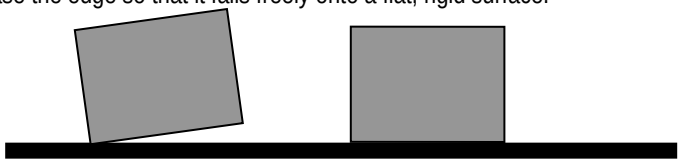
TEMPERATURE AND HUMIDITY	
Step	Action
1	The bulk container should be stored at laboratory ambient temperature and humidity for twelve (12) hours.
2	Is optional conditioning going to be performed? • If Yes, go to Step 6. • If No, go to the next Step.
3	Record the ambient laboratory temperature and humidity when testing starts.
4	At the end of all testing record temperature and humidity.
5	Go to TEST BLOCK 2 (Shock – Horizontal Impact).
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 bulk container in the conditioning.
9	At the completion of the required conditioning time remove the bulk container from the conditioning apparatus.
10	Record the ambient laboratory temperature and humidity when testing starts.
11	Go to TEST BLOCK 2 (Shock – Horizontal Impact) and perform the remaining test sequence as quickly as possible.

TEST BLOCK 2
Shock (Horizontal Impact)

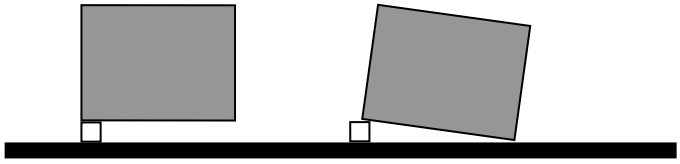
SHOCK - HORIZONTAL IMPACT						
Step	Action					
1	Conduct a horizontal Impact test on the bulk container according to the levels and sequence in the table below.					
	Sequence #	Pulse Shape	Duration in milliseconds	Velocity Change in mph (m/s)	Surface to be Shocked	Gap in inches (mm)
	1	Half Sine	15	2 (0.9)	2	0
	2	Half Sine	15	2 (0.9)	5	0
	3	Half Sine	15	2 (0.9)	4	0
	4	Half Sine	15	2 (0.9)	6	0
2	This Shock Test is now complete. Go to TEST BLOCK 3 (Shock – Rotational Flat Drop).					

TEST SEQUENCE FOR PROCEDURE 3H

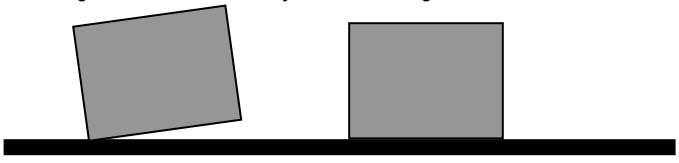
TEST BLOCK 3
Shock
(Rotational
Flat Drop)

SHOCK - ROTATIONAL FLAT DROP		
Step	Action	
1	Perform a rotational flat drop.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Lift edge 3-4 four (4) in (100 mm) off the surface.
	3	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 4 (Shock – Rotational Edge Drop).	

TEST BLOCK 4
Shock
(Rotational
Edge Drop)

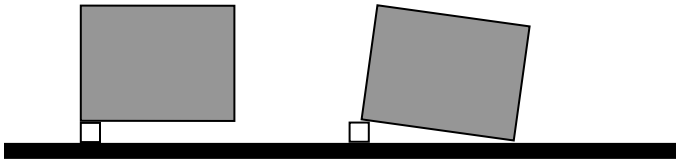
SHOCK - ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Support edge 2-3 with a timber or support 3.5 to 4.0 in (90 to 100 mm) in height and width.
	3	Lift the edge 3-4 four (4) in (100 mm) off the surface.
	4	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 5 (Shock – Rotational Flat Drop).	

TEST BLOCK 5
Shock
(Rotational
Flat Drop)

SHOCK - ROTATIONAL FLAT DROP		
Step	Action	
1	Perform a rotational flat drop.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Lift edge 3-6 four (4) in (100 mm) off the surface.
	3	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 6 (Shock - Rotational Edge Drop).	

TEST SEQUENCE FOR PROCEDURE 3H

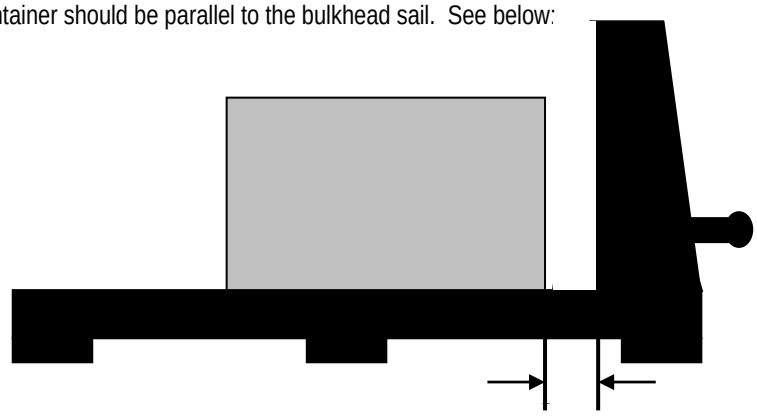
TEST BLOCK 6
Shock
(Rotational
Edge Drop)

SHOCK - ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Support edge 3-5 with a timber or support 3.5 to 4.0 in (90 to 100 mm) in height and width.
	3	Lift the edge 3-6 four (4) in (100 mm) off the surface.
	4	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 7 (Vibration).	

TEST BLOCK 7
Vibration

VIBRATION - RANDOM	
Step	Action
1	Put the bulk container on the vibration table so that face 3 rests on the platform.
2	Start the vibration system to produce the random vibration spectrum determined in the Before You Begin Block.
3	Stop the vibration testing at the end of the test time indicated in the anticipated transport miles chart in the Before You Begin Block.
4	Vibration testing is now complete. Go to TEST BLOCK 8 (Shock – Horizontal Impact).

TEST SEQUENCE FOR PROCEDURE 3H

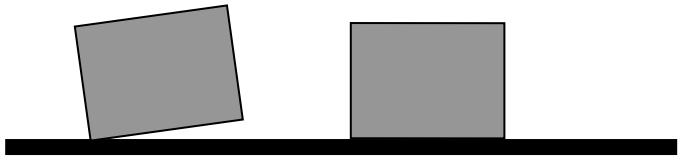
<table>
<tr><th colspan="2">SHOCK - HORIIZONTAL IMPACT</th></tr>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Will the mechanically handled bulk container with products be shipped via rail?
• If Yes, go to the next Step.
• If No, then go to TEST BLOCK 9 (Shock – Horizontal Impact).</td></tr>
<tr><td>2</td><td>Determine the possible loading orientations from the Before You Begin Block and perform the appropriate action as indicated in the table below:
<table>
<tr><th>Could and would the only loading orientation for the bulk container be with the …</th><th>Then in the next Step use the column labeled …</th></tr>
<tr><td>Longest faces (2 and 4) parallel to the end walls of the trailer, container or railcar.</td><td>Longest Face to be Shocked</td></tr>
<tr><td>Shortest faces (5 and 6) parallel to the end walls of the trailer, container or railcar.</td><td>Shortest Face to be Shocked</td></tr>
<tr><td>Longest or shortest faces parallel to the end walls of the trailer, container or railcar.</td><td>Longest Face to be Shocked and then the Shortest Face to be Shocked
ALTERNATIVE:
If only the longest faces are tested now, then at the conclusion of the tests, a new bulk container or the one previously tested filled with product that has no damage shall be tested by performing the atmospheric conditioning and all shock tests in the same sequence.</td></tr>
</table></td></tr>
<tr><td>3</td><td>Conduct a horizontal test on the bulk container according to the levels and sequence in the table below.
<table>
<tr><th>Sequence #</th><th>Pulse Shape</th><th>Duration in milliseconds</th><th>Velocity Change in mph (m/s)</th><th>Longest Face to be Shocked</th><th>Shortest Face to be Shocked</th><th>Gap* in inches (mm)</th></tr>
<tr><td>1</td><td>Trapezoidal</td><td>300</td><td>4 (1.8)</td><td>2</td><td>5</td><td>0</td></tr>
<tr><td>2</td><td>Trapezoidal</td><td>300</td><td>4 (1.8)</td><td>4</td><td>6</td><td>0</td></tr>
<tr><td>3</td><td>Trapezoidal</td><td>300</td><td>6 (2.7)</td><td>4</td><td>5</td><td>4 (100)</td></tr>
<tr><td>4</td><td>Trapezoidal</td><td>300</td><td>6 (2.7)</td><td>2</td><td>6</td><td>4 (100)</td></tr>
</table>
*Gapped pulses are used to simulate void space that may be present in rail shipments. Gap is defined as the distance in inches between the test sample and the bulkhead sail prior to the actual shock. The test face of the container should be parallel to the bulkhead sail. See below:
 </td></tr>
<tr><td>4</td><td>This Shock Test is now complete. Go to TEST BLOCK 9 (Shock – Horizontal Impact).</td></tr>
</table>

TEST SEQUENCE FOR PROCEDURE 3H

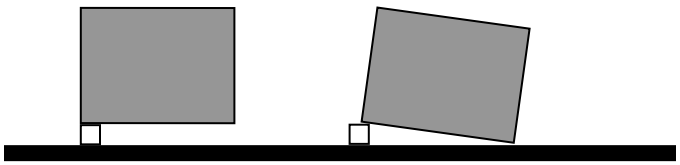
TEST BLOCK 9
Shock
(Horizontal
Impact)

SHOCK - HORIZONTAL IMPACT						
Step	Action					
1	Conduct a horizontal test on the bulk container according to the levels and sequence in the table below.					
	Sequence #	Pulse Shape	Duration in milliseconds	Velocity Change in mph (m/s)	Surface to be Shocked	Gap in inches (mm)
	1	Half Sine	15	2 (0.9)	2	0
	2	Half Sine	15	2 (0.9)	5	0
	3	Half Sine	15	2 (0.9)	4	0
	4	Half Sine	15	2 (0.9)	6	0
2	This Shock Test is now complete. Go to TEST BLOCK 10 (Shock – Rotational Flat Drop).					

TEST BLOCK 10
Shock
(Rotational
Flat Drop)

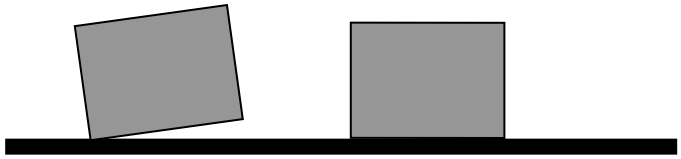
SHOCK - ROTATIONAL FLAT DROP		
Step	Action	
1	Perform a rotational flat drop.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Lift edge 3-4 four (4) in (100 mm) off the surface.
	3	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 11 (Shock – Rotational Edge Drop).	

TEST BLOCK 11
Shock
(Rotational
Edge Drop)

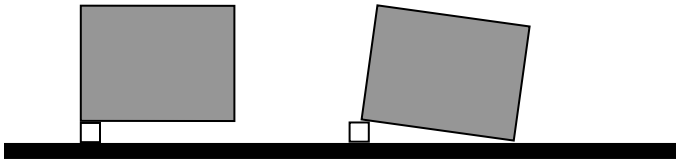
SHOCK - ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Support edge 2-3 with a timber or support 3.5 to 4.0 (90 to 100 mm) in height and width.
	3	Lift the edge 3-4 four (4) in (100 mm) off the surface.
	4	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 12 (Shock – Rotational Flat Drop).	

TEST SEQUENCE FOR PROCEDURE 3H

TEST BLOCK 12
Shock
(Rotational
Flat Drop)

SHOCK - ROTATIONAL FLAT DROP		
Step	Action	
1	Perform a rotational flat drop.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Lift edge 3-6 four (4) in (100 mm) off the surface.
	3	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Go to TEST BLOCK 13 (Shock – Rotational Edge Drop).	

TEST BLOCK 13
Shock
(Rotational
Edge Drop)

SHOCK - ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the bulk container onto a flat, rigid surface such as steel or concrete.
	2	Support edge 3-5 with a timber or support 3.5 to 4.0 in (90 to 100 mm) in height and width.
	3	Lift the edge 3-6 four (4) in (100 mm) off the surface.
	4	Release the edge so that it falls freely onto a flat, rigid surface. 
2	This Shock Test is now complete. Did you determine that you will perform the Optional Compression Testing? • If Yes, then go to TEST BLOCK 14 (Optional Compression Testing) • If No, then all testing is now complete. Go to the Reporting an ISTA Test section at the end of this Procedure.	

TEST SEQUENCE FOR PROCEDURE 3H

COMPRESSION		
Step	Action	
1	Testing is to be conducted using the test force or load from Step 4 of Before You Begin Compression and by performing the appropriate action as indicated in the table below:	
	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 bulk container 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 Test Force value determined in Step 4 of Before You Begin Compression. Then go to Step 5.
	Apply and Hold Test	Increase the force until it reaches the Test Force value determined in Step 4 of Before You Begin Compression. Then go to Step 6.
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 bulk container 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 bulk container.	
9	Add weight to the load spreader to bring the total weight up to the Test Load determined in Step 4 of Before You Begin Compression and maintain for one (1) hour.	
10	Remove the weight and load spreader.	
11	All testing is now complete. Go to the Reporting an ISTA Test section at the end of this Procedure.	

REPORTING AN ISTA TEST

ISTA Test Report Forms may be downloaded from www.ista.org. Custom forms with additional information are acceptable, but information on an official ISTA Report Form is considered to be the minimum.

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 Test Procedures and Projects.*

ISTA Transit Tested Program

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 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 can include changes in:

- Design (configuration, components, accessories, etc.) or
- Size / weight (dimensions, shape, mass, center of gravity, etc.) or
- Materials (type, construction, fabrication, gage, etc.)

Changes in the process can include changes in:

- Manufacturing / assembly (vendor, location, automation, etc.) or
- Filling (equipment, speed, automation, etc.) or
- Distribution system (parcel delivery, LTL, intermodal, etc.)

Changes in the package can include changes in:

- Configuration (individual package or unit load, container type and sub-type, style, design, interior packaging, etc.) or
- Size / weight (dimensions, shape, mass, caliper, gage etc.) or
- Materials (corrugated, plastic, metal, glass, etc.) or
- Components (closures, labels, straps, pallets, skids, wraps, etc.)

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.

This Test Procedure is published by:
International Safe Transit Association
1400 Abbot Road, Suite 160, East Lansing, Mi 48823-1900 USA

Order Information: Additional copies of this Test Procedure and the ISTA® *RESOURCE BOOK* (in print or on CD-ROM) may be ordered online at www.ista.org or by contacting ISTA at (+1) 517.333.3437. A listing of current procedure version dates is available at www.ista.org.