ISTA 2 Series Partial Simulation Performance Test Procedure

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

Preface

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ISTA 2 Series tests are a combination of basic test elements from ISTA 1 Series (Non-Simulation Integrity Performance Testing) and advanced test elements from ISTA 3 Series (General Simulation Performance Testing).

- They challenge the capability of the package and product to withstand transport hazards, but
- They only simulate some 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.

NOTE:
National Motor Freight Classification (NMFC) Item 180 is copyrighted by the National Motor Freight Traffic Association, Inc. (NMFTA) and its inclusion in Procedure 2F is with expressed permission of the NMFTA. To be certified under National Motor Freight Classification (NMFC) Item 180, the testing laboratory must register with the National Classification Committee (NCC). Test reports must be submitted to the NCC's Packaging Engineer with the required information as specified in the NMFC. Successful completion of ISTA Procedure 2F will not imply automatic approval or certification under NMFC Item 180.

OVERVIEW OF PROCEDURE 2F

Test Procedure 2F is a partial simulation test for individual packaged-products, including palletized loads.

- It provides an alternative to: The National Motor Freight Classification Test Shipment Permit Program (Item 689): other NMFC packaging Rules except those relating to drums, pails and bags; and numbered Packages in the NMFC.
- It can be used to qualify as passing NCC/LTL ITEM 180 for NMFC Certification
- 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.
- It should be considered for the evaluation of packaged-products intended for Less-than-Truck Load shipment.
- 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.

2F

OVERVIEW OF PROCEDURE 2F

Scope

Test Procedure 2F covers testing of individual packaged-products, including palletized loads, except for drums, pails and bags, when prepared for Less-than-Truck Load (LTL) shipment.

It is recommended for solving chronic damage problems and for providing an acceptable assurance level of packaging for articles of great value. In order to qualify as authorized methods of packaging under Procedure 2F and NCC Item 180, shipping containers, including palletized loads, must be preshipment tested and successfully pass the following prescribed performance test requirements and meet the acceptance criteria as indicated.

Shippers will be required to perform the specified minimum test as often as necessary to maintain a satisfactory performance level of the packaged article (see Test Report section). Multiple test specimens are recommended when available.

Shippers will be required to perform the specified minimum tests as often as necessary to maintain a satisfactory performance level of the packaged article. Multiple test specimens are recommended when available and all specimens tested must pass. This Rule does not purport to address all of the safety issues, if any, associated with its use. It is the responsibility of the user of this Rule to establish appropriate safety and health practices and to determine the applicability of regulatory limitations or requirements prior to use.

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.

OVERVIEW OF PROCEDURE 2F

The tests sequence will vary depending upon the configuration of the package or package system. The tests shall be performed on each test sample in the sequence indicated in one of the corresponding tables below:

Table 1: An individual container weighing less than 200 lb (91 kg) with no skid or pallet attached and not part of a unitized load

Table 2: An individual container weighing 200 lb (91 kg) or more with no skid or pallet attached and not part of a unitized load

Table 3: An individual container with definite skid or pallet whether integral or external

Table 4: A palletized load made up of multiple numbers of containers or Unitized loads of bulk configuration

Table 1

An individual container weighing less than 200 lb (91 kg) with no skid or pallet attached and not part of a unitized load

Sequence Number	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient	Optional
2	Atmospheric Conditioning TEST BLOCK 1	Controlled Temperature and Humidity	23°C (73°F) @ 50% RH Minimum 24 hr for Paper-Based Packaging All Others: Min. 12 hrs	Required
3	Vibration Under Dynamic Load TEST BLOCK 2	Random Vibration with a Top Load	Calculated Test Load Overall G_{rms} level of 0.52	Required (Alternative sequence allowed: you may select to conduct Sequence 4 and 5 in lieu of 3)
4	Compression TEST BLOCK 3	Machine Apply and Release	Calculated Test Force	Required (Alternative allowed)
		Constant Load		
5	Vibration TEST BLOCK 4 or TEST BLOCK 5	Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required (Alternative allowed)
		Random	Overall G_{rms} level of 0.52	
6	Shock TEST BLOCK 6	Drop	Height varies with packaged-product weight	Required

OVERVIEW OF PROCEDURE 2F

An individual container weighing 200 lbs. or more with no skid or pallet attached and not part of a unitized load

Sequence Number	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient	Optional
2	Atmospheric Conditioning TEST BLOCK 1	Controlled Temperature and Humidity	23°C (73°F) @ 50% RH Minimum 24 hr for Paper-Based Packaging All Others: Min. 12 hrs	Required
3	Vibration Under Dynamic Load TEST BLOCK 2	Random Vibration with a Top Load	Calculated Test Load Overall G_{rms} level of 0.52	Required (Alternative sequence allowed: you may select to conduct Sequence 4 and 5 in lieu of 3)
4	Compression TEST BLOCK 3	Machine Apply and Release	Calculated Test Force	Required (Alternative allowed)
		Constant Load		
5	Vibration TEST BLOCK 4 or TEST BLOCK 5	Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required (Alternative allowed)
		Random	Overall G_{rms} level of 0.52	
6	Shock (Alternative methods allowed – select one test type) TEST BLOCK 6 or TEST BLOCK 7	Drop	Drop height of 6.0 in (150 mm)	Required
		Incline Impact (Conbur)	Impact Velocity 5.75 ft/sec (1.75 m/s)	
		Horizontal Impact	Impact Velocity 5.75 ft/sec (1.75 m/s)	
7	Shock TEST BLOCK 9	Rotational Edge and Corner Drop	Drop height of 6.0 in (150 mm)	Required

OVERVIEW OF PROCEDURE 2F

An individual container with definite skid or pallet whether integral or external

Sequence Number	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient	Optional
2	Atmospheric Conditioning TEST BLOCK 1	Controlled Temperature and Humidity	23°C (73°F) @ 50% RH Minimum 24 hrs for Paper-Based Packaging All Others: Min. 12 hrs	Required
3	Vibration Under Dynamic Load TEST BLOCK 2	Random Vibration with a Top Load	Calculated Test Load Overall G_{rms} level of 0.52	Required (Alternative sequence allowed: you may select to conduct Sequence 4 and 5 in lieu of 3)
4	Compression TEST BLOCK 3	Machine Apply and Release	Calculated Test Force	Required (Alternative allowed)
		Constant Load		
5	Vibration TEST BLOCK 4 or TEST BLOCK 5	Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required (Alternative allowed)
		Random	Overall G_{rms} level of 0.52	
6	Shock TEST BLOCK 10	Rotational Flat Drop	Height varies with packaged-product weight	Required
7	Shock (Alternative methods allowed – select one test type) TEST BLOCK 11	Incline Impact (Conbur)	Impact Velocity 4.0 ft/sec (1.2 m/s)	Required
		Horizontal Impact	Impact Velocity 4.0 ft/sec (1.2 m/s)	

OVERVIEW OF PROCEDURE 2F

A palletized load made up of multiple numbers of containers or Unitized loads of bulk configuration

Sequence Number	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient	Optional
2	Atmospheric Conditioning TEST BLOCK 1	Controlled Temperature and Humidity	23°C (73°F) @ 50% RH Minimum 24 hr for Paper-Based Packaging All Others: Min. 12 hrs	Required
3	Vibration Under Dynamic Load TEST BLOCK 2	Random Vibration with a Top Load	Calculated Test Load Overall G_{rms} level of 0.52	Required (Alternative sequence allowed: you may select to conduct Sequence 4 and 5 in lieu of 3)
4	Compression TEST BLOCK 3	Machine Apply and Release	Calculated Test Force	Required (Alternative allowed)
		Constant Load		
5	Vibration TEST BLOCK 4 or TEST BLOCK 5	Fixed Displacement	1 in (25mm) peak to peak at a frequency to be determined	Required (Alternative allowed)
		Random	Overall G_{rms} level of 0.52	
6	Shock TEST BLOCK 10	Rotational Flat Drop	Height varies with packaged-product weight	Required
7	Shock (Alternative methods allowed – select one test type) TEST BLOCK 11	Incline Impact (Conbur)	Impact Velocity 4.0 ft/sec (1.2 m/s)	Required
		Horizontal Impact	Impact Velocity 4.0 ft/sec (1.2 m/s)	Required
8	Shock (Alternative methods allowed – select one test type) TEST BLOCK 12 or TEST BLOCK 13	Fork Truck Course	Course as described	Required
		Fixed Displacement	Synchronous 30° Out-of-Phase motion	

EQUIPMENT REQUIRED FOR PROCEDURE 2F

Equipment Required Atmospheric Conditioning

Atmospheric Conditioning:

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

Equipment Required Compression

The following equipment is 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 or Floating platen acceptable
Constant Load	Compression test system or Dead Weight	ASTM 4577

CAUTION:

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

Equipment Required Vibration

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

Random Vibration Test:

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

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.
- The unitized load test requires non-synchronous motion from a vibration Test System with 1 in (25 mm) fixed displacement complying with Method A2 of the apparatus section of ASTM D 999.
- 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.

NOTE:

For tall or unstable shipping units, random or vertical-linear vibration may be preferred.

Equipment Required Vibration Under Dynamic Load

NOTE:

This vibration under dynamic load test requirement is:

- a performance test, but not
- a predictor of warehouse stacking capability.

Top-Load simulates assorted freight on top of a floor loaded shipping unit in a 108 in (2.7 m) trailer at 10 lb/ft^3 (160 kg/m^3)

The Top-Load apparatus container(s) shall be (see Figure 1 on next page)

- One, two or four separate loading systems and
- Larger than the test specimen, but
- Shall not overhang the specimen by more than 1.5 in (38 mm) and
- Shall distribute the calculated Top-Load (TL) evenly over the test specimen.

To determine if more than one Top-Load apparatus is required, follow the instructions below:

If the packaged-product top surface exceeds 18 in (0.46 m) in...	Then there shall be...
only one dimension	two Top-Load apparatus of equal size and weight along the long edge
both dimensions	four Top-Load apparatus of equal size and weight

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EQUIPMENT REQUIRED FOR PROCEDURE 2F

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The Top-Load container(s) shall have the following specifications:

- Corrugated trays or HSC-style containers of doublewall construction having a corrugated medium maximum basis weight of 33 lb (15 kg) and
- a plywood sheet with a minimum thickness of ½" 0.5 in (13 mm) resting inside the container on the complete area of the bottom inner flaps of the container and
- a block of lead or sand contained in plastic bag(s) evenly distributed over the bottom surface of the container to complete the required calculated load [sand weighs approximately 110 lb/ft 3 pcf (50 kg/m3)]

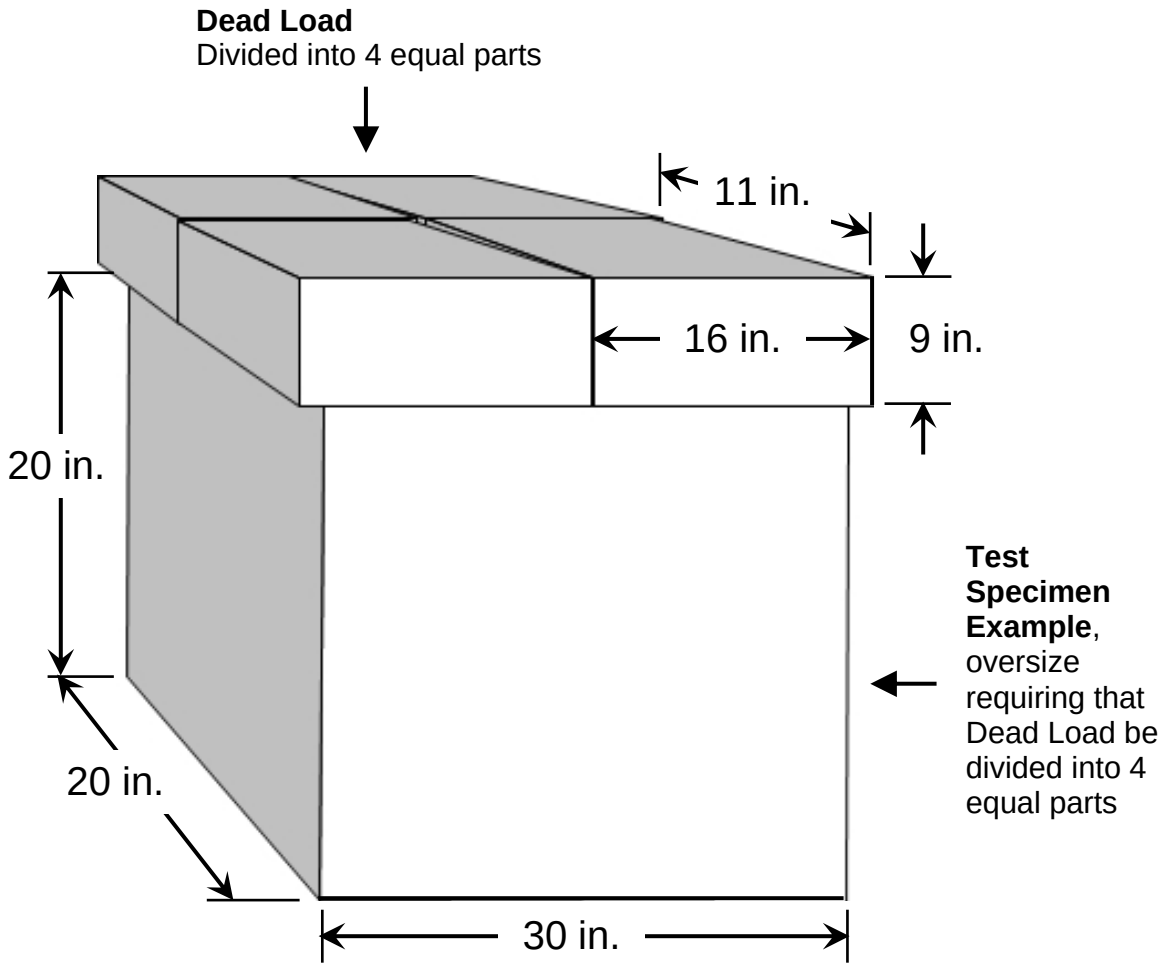


Figure 1. Example of Concentrated Top Load on Test Specimen for Random Vibration Test. Test Specimen shown in example measures 30 in x 20 in x 20 in, larger than 18 in (.46 m) in 2 dimensions, requiring that the Top Load be divided into 4 equal parts.

CAUTION:

When using a Top-Load apparatus use extreme care to prevent injury.

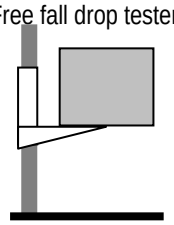
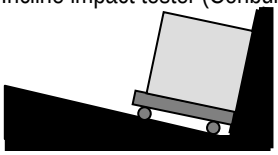
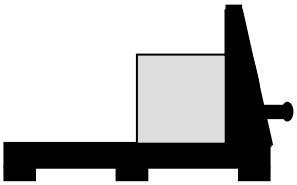
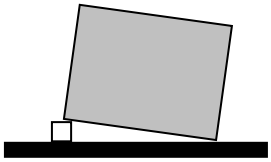
A restraining device or devices shall be used with the vibration test system to:

- 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.

Equipment Required Shock

EQUIPMENT REQUIRED FOR PROCEDURE 2F

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

Type of Shock Test	Type of Equipment	In compliance with the apparatus section of ...
Drop Test	Free fall drop tester 	ASTM D 5276
Alternative Incline Test	Incline impact tester (Conbur) 	ASTM D 880
Alternative Horizontal Test	Horizontal impact test system 	ASTM D 4003
Rotational Edge Test		ASTM D 6179
Fork Truck Fork Truck Course		ASTM D 6055

Equipment Required Fork Truck Obstacle Course

Fork Truck Course

The fork truck test course should include at least

- One (1) right angle turn on a rigid flat surface representative of carrier terminals and warehouses.
- An Obstacle, a modified 2 in x 6 in board with long edge beveled full height at 45 degrees *(see Figure 2)* placed on the course in a position where both lift truck wheels on one side must pass over it during each handling sequence, and
- A second modified 2 in x 6 in board shall be placed on the course after the right angle turn in such a position that both lift truck wheels on the opposite side must pass over it during each handling sequence.

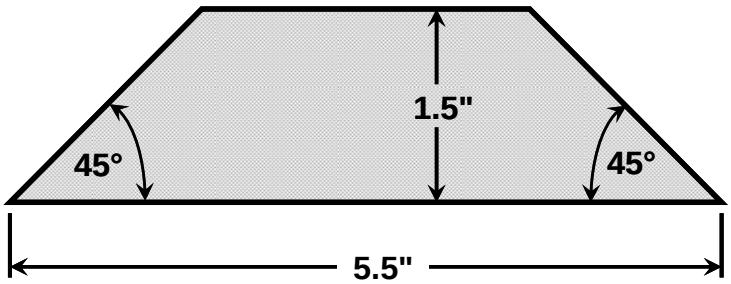


Figure 2 Obstacle