distributing confidence, worldwide.™

Guidelines for Selecting and Using ISTA® Test Procedures and Projects

PREFACE

The International Safe Transit Association (ISTA) is a global alliance of shippers, carriers, suppliers, testing laboratories, and educational and research institutions focused on the specific concerns of transport packaging. We help our members control costs, damage, and resources during the distribution of packaged-products by:

1. Creating and publishing laboratory preshipment Testing Procedures
2. Certifying Packaging Laboratories
3. Certifying Packaging Laboratory Professionals
4. Certifying packaged-products
5. Providing education, training, and support.

OUR MISSION is to provide economic and environmental benefits by helping our members prevent product damage and over-packaging during the physical distribution of goods.

OUR VISION is "Just Right Transport Packaging" - packaging which meets the protective needs of the product, as well as meeting the economical and environmental needs of the product's shipper and user. This Just Right Packaging is designed and certified against Just Right preshipment testing which adequately simulates the hazards of actual transportation/distribution.

These Guidelines are intended to provide the user of ISTA® Test Procedures and Projects and other ISTA documents with insight and information on the protocols, and what factors to consider in selection, use, and results interpretation.

GETTING STARTED

Following are four straightforward suggestions to improve protective packaging effectiveness and move toward Just Right Transport Packaging.

1. Test the Package.
If you are not regularly using a laboratory package performance test, start now. Even a simple lab test used wisely is preferable to trial and error or total reliance on field experience.

2. Know Your Distribution Environment.
Find out more about how products move, including the variety of channels used to move your goods. If you are a supplier to shippers, help them explore this information. Use this knowledge to identify sources of distribution hazards and observe or measure them. Use this knowledge to reduce exposure to hazards of distribution, to help specify the performance of packages, and to select an appropriate laboratory test protocol.

3. Continuously Review and Improve.
Distribution hazards change, as do packaging materials. Review and retest even the most successful designs periodically. Rapid situation changes, such as new markets or distribution strategies, require immediate attention.

4. Stay Up to Date.
Take every opportunity to learn more about your products and distribution, learn about new technologies and procedures, and exchange knowledge with others who have similar concerns. Educational opportunities, such as ISTA's annual Transport Packaging Forum, are a good source of update. The ISTA® Certified Packaging Laboratory Professional (CPLP) program is another excellent educational and recognition tool. Find out more from ISTA Headquarters or visit www.ista.org.

TESTING RATIONALE

The need for testing comes from the difficulty of predicting what will happen in large-scale operations, coupled with the requirement to make decisions prior to implementation. Essentially, every test comes from the need to make a decision. The test results provide the decision-maker with information to help maximize correct decisions. The decisions supported by preshipment performance testing of transport packaging are typically about how well the package will protect the contents during distribution.

Testing can also be a mandated activity as part of a package development, new product release, or engineering modification. This testing may be driven by organizational policy (corporate specification, for example), by regulatory application (testing of packaging for hazardous materials and dangerous goods, for example), or by customer requirements (purchase specification, for example). While these situations usually have little flexibility in test selection, they are still in the broad category of supporting decisions on packaging suitability.

Other types of tests are available but a detailed treatment is outside of the scope of this document. Material tests seek to characterize material performance for the use in design and development, such as cushion curves. Engineering tests seek to find a specific performance quantity, such as the deceleration experienced by a product in a package when dropped from some height, as in an instrumented drop test.

TESTING EXPECTATIONS AND OBJECTIVES

An important consideration in the selection of a test protocol is the objective of running the test, i.e., what information is needed to make the decision associated with this test. Broadly put, these specific objectives for each test might be categorized simply as screening or prediction.

A screening test would be used to avoid serious problems in shipment, usually damage to the product. This test objective category is a common one, and can adequately fill the needs of many users. Screening tests give the user confidence that the chances of serious transport damage have been minimized. Screening tests have the following general characteristics:

- *simple and inexpensive to perform*
- *widely available and accepted*
- *utilize simple equipment*
- *accommodate known and suspected severe hazards*
- *are not necessarily a simulation of the hazards of distribution*
- *achieve damage resistance by challenging the strength and robustness of the product and package (a strong product/package resists damage).*

Prediction is a more difficult expectation for a preshipment performance test. While screening seeks to avoid serious problems, prediction must allow the user to foresee more subtle effects, such as minor damage, occasional damage, or non-functional problems with the package. In an ideal prediction situation, the tested samples and representative samples of distributed products would be indistinguishable. This is not always entirely possible given the technology mix available today, but it is approachable.

Prediction allows the user to fine-tune cost and environmental impact as well as helping to avoid damage of all types. By testing incrementally reduced cost and material-content designs, the near-optimum configuration could be achieved. Prediction might also allow the user to design a package for a repeatable low level of damage, consistent with an objective of lowest overall system cost. Without a good prediction test to represent field performance, this trade-off of package cost and damage cost would be largely guesswork.

TESTING AS A DEMONSTRATION OF MINIMUM USE OF PACKAGING

ISTA tests establish lower limits for packaged-product performance, but in general do not set upper limits. Therefore, used in their most straightforward pass/fail fashion, ISTA tests do little to detect over-packaging situations. However, with the addition of a "reduce to damage" or "pass with minimum margin" approach, ISTA testing can be used for the demonstration of minimum use of packaging. "Reduce to damage" means that if a packaged-product passes the test it must be redesigned with less packaging and tested again until an optimum level is reached. "Pass with minimum margin" might involve subjecting a packaged-product which has passed the test to increased severity levels, determining when damage does occur, and then verifying that those levels are not overly excessive.

A "reduce to damage" or "pass with minimum margin" protocol employing screening tests should be used with extreme caution. Since screening tests may not well represent actual field exposure in either intensity or type, the tests cannot be readily shown or proven to have a good relationship to the field damage. Using screening tests can perhaps be effective if coupled with a program of field monitoring and feedback after package redesign. But the far better approach is to use tests which provide a good actual simulation of the distribution hazards.

LABORATORY TESTS AND DISTRIBUTION HAZARDS

Four basic categories of hazards exist in distribution: Shock, Vibration, Compression, and Atmospheric. Each hazard category is reflected in an ISTA laboratory test type, although not all ISTA® Procedures and Projects include all test types. Within each test type are sub-types of more specific tests that are used to simulate specific hazards in distribution. The following table summarizes these relationships.

Distribution Hazard	Major Test Category	Associated Test Types
Handling Drop and Impact	Shock	**Drop** • free-fall • rotational • on hazard • hazard impact **Incline Impact** **Horizontal Impact** **Vertical Impact**
Transportation Vibration	Vibration	**Fixed Displacement** • rotary • vertical linear **Variable Displacement** • vertical • horizontal **Random** • vertical • horizontal • multi-axis
Stacking Load	Compression	**Static (dead load)** **Machine** • apply & release • apply & hold **Dynamic Load Under Vibration**
Atmospheric Conditions	Atmospheric	**Temperature** • constant • cycle **Humidity** • constant • cycle **Pressure** • constant • cycle

Table 1 Hazard Categories and Test Types

It is important to note that test protocols can evaluate the effectiveness of packaging only for hazards represented in the protocol. For example, a test procedure that does not include a compression test is unable to evaluate a packaged product's resistance to warehouse stacking loads. By knowing the distribution environment in detail (see Getting Started, above), users can select an appropriate test to evaluate the performance of packaging in light of all known hazards. Without this selection process, real hazards may not be addressed as part of a package's protective ability, and significant damage could result in spite of a test being passed.

TYPES OF ISTA TESTS

ISTA test protocols are approved by Test Series Groups and by the ISTA Technical Council. New protocols are initially given the designation "Project" during their implementation phase. After a minimum one-year period, a "Project" is evaluated and will either be adopted as an established "Procedure", revised and kept as a "Project" for another period of time, or be dropped. Member labs may use either Procedures or Projects for Package Certification by performing the test protocol with the package passing, and forwarding a completed Report to ISTA Headquarters, except in the case of non-certification procedures that are clearly delineated in their introductions. Shippers who are ISTA members may cause the package to carry the ISTA® Certification Mark (ISTA arrows, also referred to as the Seal) and the package is considered as Certified. Displaying the ISTA® Transit Tested Seal on a distribution package indicates that the packaged-product has passed the particular ISTA protocol. It does not necessarily have a connection to damage claim payments, but shippers that display the Seal are certainly in a better negotiating position.

ISTA has organized its test protocols into Series, as follows:

1 Series:
Non-Simulation Integrity Performance Tests.
Challenge the strength and robustness of the product and package combination. Not designed to simulate environmental occurrences. Useful as screening tests, particularly when used as a consistent benchmark over time.

2 Series:
Partial Simulation Performance Tests.
Tests with at least one element of 3 Series type General Simulation performance tests, such as atmospheric conditioning or mode-shaped random vibration, in addition to basic elements of a 1 Series type Non-Simulation Integrity test.

3 Series:
General Simulation Performance Tests.
Designed to provide a laboratory simulation of the general damage-producing motions, forces, conditions, and sequences of transport environments. Applicable across broad sets of circumstances, such as a variety of vehicle types and routes, or a varying number of handling exposures. Characteristics will include simple shaped random vibration, different drop heights applied to the sample package, and/or atmospheric conditioning.

1 Series protocols can reasonably be expected to be screening tests, with an increasing expectation of predictability through Series 5. Whether this is true in any specific case needs to be evaluated by comparing lab and distribution results. This important validation process should be a part of each user's normal operations.

4 Series:
Enhanced Simulation Performance Tests.
General Simulation tests with at least one element of Focused Simulation, such as test sequence or test conditions linked to actual known distribution. Project 4AB is currently the only protocol in this Series. 4AB is a web-based Enhanced Simulation Test Plan generator, with on-line access available at no charge to all ISTA members. Project 4AB closely ties the tests and sequence to a user-defined pattern of distribution, and includes a broad range of current and quantitative information on distribution environment hazards. See the Project 4AB section of the ISTA® website (www.ista.org) for more details.

5 Series:
Focused Simulation Guides.
Guides for the creation of laboratory simulations based on actual field-measured and observed hazards and levels. The 5-Series are not performance tests per se, but information and instructions related to establishment of user-defined Focused Simulation tests. Guide 5B for Temperature Controlled Packaging is currently the only document in this Series.

6 Series:
Member Performance Tests.
Test protocols created by ISTA members to meet their particular purposes and applications. The tests may be completely original, or may be modifications or variations of ISTA Procedures or Projects or other published and accepted tests. ISTA reviews and accepts these tests, but primary responsibility rests with the originating members.

7 Series:
Development Tests.
These tests are used in the development of transport packages. They can be used to compare relative performance of two or more container designs, but are not intended to evaluate the protection afforded packaged-products.

SPECIALIZED TEST PROTOCOLS DEVELOPED BY ISTA

While a packaged-product weight range identifies many protocols, several ISTA® Projects and Procedures have been developed in response to specific needs of members and the larger packaging community. These include tests for specific distribution modes, such as parcel and LTL delivery and bulk shipments, for package types, such as unitized loads and reusable containers, and for specific product types, such as furniture. All of these are criteria for selection of a test. Test protocols are continuously being worked on and developed by ISTA members and staff, so it is important to keep informed. The latest versions of all tests are available on the ISTA® website, and may supersede those printed in the Resource Book. Table 2 shows one way of organizing and describing current Projects and Procedures.

Procedure 3A for Parcel Delivery System Shipment uses latest information and data to configure the drop, random vibration, top load, and other tests and conditions. 3A overlaps with Procedures 2D (Flat Packaged-Products for Parcel Delivery System Shipment) and 2E (Elongated Packaged-Products for Parcel Delivery System Shipment), although the 3A requirements reflect General Simulation rather than the 2-Series Partial Simulation approaches.

Distribution Type	Package Type				
	Individual Packages		Unitized	Bulk	Reusable
	up to 150 lbs. (68 kg)	over 150 lbs. (68 kg)			
Any	1A, 1C, 1G 2A 2C (Furniture) 4AB	1B, 1D, 1H 2B 2C (Furniture) 4AB	1E 3E	3H 7C	7A 7B
Specialized Furniture	2C	2C	Not Applicable	Not Applicable	Not Applicable
Parcel Delivery	2D (Flat Packages) 2E (Elongated Packages) 3A 5B (Thermal) 7D (Thermal)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
LTL (Less-Than-Truckload) Delivery	2F, 3B	2F, 3B	3B	Not Applicable	Not Applicable
Distribution Center to Retail	3F	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Various	6-Series as appropriate	6-Series as appropriate	See Series	See Series	See Series

Table 2 Test Protocols

MEMBER PERFORMANCE TESTS

The ISTA 6-Series, Member Performance Tests, are protocols created by ISTA members to suit their own particular purposes and applications. The tests may be completely original, or may be modifications or variations of ISTA Procedures or Projects or other published and accepted tests. They are reviewed, approved, and formally accepted by ISTA, and are made available either on a limited basis or generally, as determined by the originators.

The primary responsibility for creation, validation, and maintenance of 6-Series tests rests with the originating members.

Typical uses for Member Performance Tests might be by large retailers to establish unique performance-based packaging requirements for their suppliers and vendors, or by carriers to reflect their particular conditions of distribution.

SPECIAL CONSIDERATIONS FOR ISTA® PROCEDURES AND PROJECTS

Safety

Safety of personnel is a serious and all-important requirement when running ISTA® Test Procedures. Many of the test types used in ISTA procedures are inherently dangerous, involving massive moving objects and test system components. Each laboratory must have a well-designed safety program and monitor tests and conditions to insure safety from injury. Extra care must be taken when testing heavy items, when handling dry ice or any chemical, and when load stability may become an issue.

Catching or Restraining Packaged-Products After Free-Fall Drop Testing

When performing a free-fall drop test sequence, package tipover resulting in secondary impacts should be avoided when possible. This especially applies to tip/tipover-prone package types such as tall, top-heavy, elongated, or flat, and can directly affect pass/fail test results. Since catching could create a safety hazard, care must be taken to ensure personnel safety under all conditions. Clearly document on the Test Report whether or not secondary tipover impacts were prevented, and any possible effects on the test results.

Equipment and Instrument Calibration
Equipment and instrumentation used to control laboratory testing equipment or to record data from tests must be properly calibrated, traceable to national or international standards, to ensure accuracy. Calibration intervals should be established with consideration of:

- Manufacturer's recommendations
- The laboratory's overall Quality Program
- Customer requirements.

ISTA requires equipment and instrument calibration intervals of not greater than one (1) year.

If there is the possibility that an instrumentation component has been damaged (e.g. if an accelerometer is accidentally dropped or impacted), it should be checked and/or re-calibrated before being put back into use.

KNOW YOUR DISTRIBUTION ENVIRONMENT

An important step in the selection and use of ISTA® Procedures and Projects is the user's familiarity with the actual distribution environment for the packaged products under test. Understanding the flow of packages, how they are shipped and handled and stored, is critical to test selection and results interpretation. Users should regularly observe package distribution, both in the manufacturer's facility and in warehouses, transportation facilities, vehicles and customer locations. In some cases, users may use measurement instruments and techniques to determine vibration, drop, compression, and temperature/humidity levels during distribution. This detailed knowledge, observation, or measurement may be very useful in test selection, for example, the use of an individual package test protocol instead of or in addition to a unitized load test protocol when loads are broken down during distribution.

PRODUCT DAMAGE TOLERANCE AND PACKAGE DEGRADATION ALLOWANCE

Before testing begins, a determination must be made as to the definition of damage to products and packages. This determination must include any allowable damage to the product and any allowable change in package condition. These determinations are made to allow the evaluation of packaged-product specimens after performance of all tests, and assignment of pass or fail results. When possible, these determinations should be quantitative in nature to minimize results interpretation. Use of product quality standards, user acceptability information, and other data is encouraged.

ISTA intentionally does not specify what constitutes product damage and package degradation. These determinations are dependent upon the particular product, package, distribution system, market, customers, and other factors and can vary widely. Therefore product damage and allowable package degradation must be defined by the shipper, manufacturer, damage claim group, and/or other stakeholders and interested parties. In most cases, the shipper/manufacturer is in the best position to define product damage due to detailed familiarity with the product. Sometimes others may contribute to these determinations, including carriers and test lab personnel. But in any case, definition and agreement should be reached cooperatively among all entities concerned with safe arrival of the shipment, low damage rates, cost effective packaging, etc.

FACE, EDGE AND CORNER IDENTIFICATION

ISTA® Procedures and Projects use a system of identification for parts of a test specimen package in order to simplify the test sequence and documentation process. Occasionally, users may face the challenge of testing a packaged product that does not fit an identification scheme easily. For example, a package with a hexagonal cross section could have six vertical faces, a top and a bottom. In these situations, the user is advised to develop a logical identification system that fits the test specimen in question, and to document both the identification system and the orientations for all tests conducted. The specified number of drops and drop heights shall be maintained as well as other test levels, and how these tests were applied to the test specimen shall be documented on the Test Report.

SAMPLES

Most ISTA® Procedures and Projects require a minimum of one packaged-product to be tested. A single "pass", however, does not provide high confidence that other seemingly identical packaged-products will also pass the same test. This is due to inherent variation in packaging materials, package components, and the package contents as well as other statistical considerations. ISTA generally recommends replicate testing, using new samples each time. Having three successful tests of identical packaged products helps improve the assurance; five or more are recommended when possible. Even ten successful replicate tests, however, do not guarantee that all future tests will also be successful.

There is no definite rule about appropriate sample size; it may depend on the purposes of testing, the desired confidence level, and the availability of samples. ISTA® Procedures and Projects specify a minimum number of samples required to run the test and achieve package Certification. In addition, a recommendation for replicate testing is generally made. ISTA's policy is that if any sample

fails any of the tests, then the entire test is considered failed.

The additional testing time for larger sample sizes need not be a barrier to better test technique. For example, most vibration test systems will allow the user to test many packages simultaneously, thus saving considerable time. In this way, a sample size of five would have essentially the same elapsed time for vibration testing as a sample size of one.

Occasionally, proper samples are not available to meet minimum requirements for a test protocol. The use of non-functional dummy products is not allowed in most cases, but samples with minor, identifiable damage, such as minor surface scratches, may be acceptable. The key is: when the test is complete, can we determine if the product was damaged according to the Product Damage Allowance statement developed before testing began?

Another technique is to re-use a product for several test sequences with appropriate inspection to insure that the product has not been damaged. The user must be cautious to not re-use a product that has become more susceptible to damage due to prior testing. In this way, one product and three packages could be used to achieve a sample size of three. The test would be run three times, re-packaging the single available product each time.

RETESTING

ISTA test protocols should be repeated periodically or as necessary to maintain the quality characteristics of the packaged product on arrival. In addition, tests must be repeated whenever there is a change in the product, the package, or the process. Some changes are not included in this requirement, but only if the change is not associated with potential performance in any way.

Changes in the product can include changes in:

- Design (configuration, components, accessories, etc.)
- Size / weight (dimensions, shape, mass, center of gravity, etc.)
- Materials (type, construction, fabrication, gage, 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.)
- Size / weight (dimensions, shape, mass, caliper, gage etc.)
- Materials (corrugated, plastic, metal, glass, etc.)
- Components (closures, labels, straps, pallets, skids, wraps, etc.)

Changes in the process can include changes in:

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

When there is any doubt as to whether a change will potentially affect performance, retesting should be done. Determining when retesting is required may involve knowing and tracking specification details of both the package and the product, such as new or changed components, materials, interior packaging, closure methods, etc.

Changing the grade of the corrugated board in the box definitely requires retest, even in those situations where carrier regulations imply the "equivalence" of two grades of corrugated (such as 200 psi burst and 32 lb/in ECT grades). In many instances, corrugated from these two grading systems will be different in construction and performance and thus must be retested on a grade change. Basis weights (weight per unit area) of corrugated board constituents have been shown to be good indicators of box equivalence or change. If the basis weights change, even if the board is rated for the same performance, a retest is appropriate. It is therefore strongly recommended that the measurement and documentation of basis weights in accordance with TAPPI (Technical Association for the Pulp and Paper Industry) T410 and TIP 0308-01, FEFCO (European Federation of Corrugated Board Manufacturers) Testing Method No. 10, ISO (International Organization for Standardization) EN 536, ASTM D646, or other accepted industry standards accompany every packaged-product test where corrugated packaging is involved.

Retesting is also strongly recommended when distribution channels change, as this may mean a different test protocol. An example is the opening of an e-commerce business (to replace or supplement traditional retail distribution) that involves significant shipments direct to customer by small parcel carriers.

REPEATED TESTING

The issue of product returns, especially in specialized channels such as e-commerce, catalog sales, TV sales and similar distribution, is an important one. Return rates for non-traditional retailing have been shown to often be much higher than traditional retailing distribution. Returns happen for many reasons and are not all damage related. Accordingly, a package must be capable of both initial distribution (source to customer) and return distribution (customer to source) in these cases. Consider requiring a sample product and

package to be subjected to additional testing when expected return rates are high or other marketing and distribution factors indicate increasing significance of returns.

LINE EXTENSION POLICY

In some cases, and for ISTA members only, ISTA approves a limited amount of testing to represent more extensive testing. For example, a line of products with 30 models may be able to be certified by testing less than 30 packaged-products. This technique applies when the models and packages are very similar. Use of this technique for certification requires prior approval by ISTA staff, and is considered on a case-by-case basis. Contact ISTA Headquarters for additional information and to discuss your specific needs.

IDENTIFICATION OF PRODUCT AND PACKAGE TESTED

Whether reporting test results to ISTA for Certification or approval, or documenting the test for future reference or a customer report, identifying the test sample is vitally important. Product description should include product name, brand, model number, serial number, place and date of manufacture, and similar information. It is strongly recommended that photographs, detailed drawings, and/or complete specifications of the product and any included accessories accompany the report.

Package description must also be detailed and specific and should include type, style and material of packaging; corrugated board composition; cushion details including performance; film gage and composition; application or package forming details; mold numbers; any pallet or skid; unitization method for unit loads; methods of closure, etc. It is strongly recommended that photographs, detailed drawings, and/or complete specifications of both exterior and interior packaging accompany the report.

TEST PARAMETER TOLERANCES

ISTA test protocols generally do not include tolerances on test parameters such as drop height, impact velocity, compression force, weight, top load, vibration time and intensity, etc. In such cases the requirements given are considered minimums; i.e., no variation or tolerance below the stated values is allowed. If any particular test in a test sequence is below the required minimum, that test does not count and must be repeated.

Where parameter tolerances are given (e.g., temperature and humidity conditioning, etc.), they are required for compliance.

ADDITIONAL CONSIDERATIONS

The following items are specific to certain Procedures, Projects, or tests:

Incline Shock and Horizontal Shock. Note that when conducting an incline shock test, the parameter measured and controlled is the impact velocity. When conducting a horizontal shock test, the parameter to monitor and control is velocity change. Horizontal shock should be programmed to short duration nominal half-sine pulses unless otherwise instructed in the Procedure. Durations around 10 milliseconds are desirable if practical.

Conditioning. If controlled temperature and humidity conditions are required or are to be used in any test Procedure, the best approach is to perform all tests directly in the conditioned atmosphere. If this is not possible, then tests should be performed quickly after removal of test items from the conditioned atmosphere, and test items should be returned periodically to conditioning as necessary to maintain the required control.

The temperature and humidity conditioning times specified in the Procedures are dwell times at the specified conditions, and do not include any time which may be required to transition from one condition to another. Some Procedures (i.e. 7D) specify the transition times (ramp times), and those should be followed.

In certain situations longer temperature and humidity conditioning dwell times may be required. There are packaged-product configurations which may equilibrate extremely slowly with their surrounding atmospheres. For example, hot-filled containers in the interior of dense unitized loads may require a week or more to reach room temperature. If necessary, make measurements or calculations and extend the conditioning times accordingly.

The strength of corrugated board is affected by its moisture content, not directly by the surrounding atmospheric humidity. It may be helpful to measure levels and changes in board moisture content during atmospheric conditioning.

Although "conditioning" usually refers to atmospheric conditioning (temperature/humidity), in ISTA® Procedures other hazard types may be used as conditioning as well. For example Procedure 1C where compression conditioning is used, or Procedure 7D where drop conditioning is used. When using any hazard type to condition a specimen, the objective is not to see how the specimen performs during that conditioning, but rather, to prepare the specimen for a subsequent test which will be used for performance

evaluation. Conditioning situations are appropriately identified in ISTA® Procedures.

Compression Loads/Forces and Vibration Top Loads. Compression loads/forces in the Procedures and Projects are generally calculated from the weight and number of identical packages which could be stacked on the test package in actual distribution, or a stacking density of nominally 200 kg/m^3 (12 lb/ft^3) for mixed loads. These values are then multiplied by Compensating Factors to account for effects not tested, such as temperature/humidity, stacking patterns, long-duration loading, etc. 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), these Compensating Factors can be reduced. If ISTA recommendations for Compensating Factors and/or Compensating Factor ranges are not followed, sufficient justification must be included in the Test Report.

For the application of compression forces with a compression testing machine, all ISTA Procedures require the use of a fixed (not swiveling) platen arrangement in accordance with the "Fixed Platen Testing Machine" paragraph of the "Apparatus" section of ASTM D642. For corrugated boxes and cases, swivel platen testing machines generally cause failure at the specimen's weakest point, whereas fixed platen machines generally cause failure to occur at the specimen's strongest point. Any such item which passes a swiveling platen test at a specified force would therefore pass the same test force requirement using a fixed platen. Use of a swiveling platen may result in test failures at the specified force which might not have occurred using a fixed platen.

For Procedure 3A, the vibration top loads were determined by empirical testing that resulted in correlation between damage in the test lab and damage in the field. It was found that top loads representing average load densities of nominally 200 kg/m^3 (12 lb/ft^3) caused unrealistic failures during lab testing. By experiment, proper correlation was found at 100 kg/m^3 (6 lb/ft^3).

Non-Equivalent Alternatives. In many ISTA Procedures, alternative methods are permitted for performance of some tests. Examples: Drop, Incline Impact, and Horizontal Impact for Shock tests; Fixed Displacement and Random for Vibration tests. It must be recognized that in many cases these alternative methods are not equivalent; i.e., they will not necessarily produce the same results. The alternatives chosen for a particular Procedure should be carefully documented in the Test Report.

SUGGESTED STEPS FOR SELECTING A TEST PROTOCOL

ISTA suggests consideration of the following items when selecting a test protocol.

- Test rationale: required, experimental, decision supported.
- Test objective and expectation: screening, prediction, cost and environmental reduction, comparison to an alternative, or demonstration of a minimum use of packaging.
- Test Series: Non-Simulation Integrity, General Simulation, Focused Simulation, Developmental, or combinations.
- Resources: equipment, budget, time frame, expertise, experience, past history.
- Package type: weight, configuration, application.
- Distribution type: unspecified or varied, special. Know your distribution environment.

REMINDERS FOR USE OF ISTA TEST PROTOCOLS

- Use care in selecting the right test for the situation. In some cases, more than one test should be run and results compared. Field testing (trial shipments) may be used as an adjunct to lab testing.
- **Use the current test.** ISTA® Projects and Procedures are continuously being reviewed, updated and expanded. New and revised tests are available on the ISTA website at www.ista.org and may supersede those in the Resource Book.
- **Use representative samples.** Both products and packages should be as close as possible to actual production items. In some cases this may mean testing a product and package early in the development cycle and then later when production products are available. Samples should not have been previously tested, or shipped to a test lab without over-packaging or other consideration.
- **Review the test before performing it.** Check for new sections, order of tests, documentation requirements.

- **Damage/Degradation determination.** Most ISTA protocols call for determining the Product Damage Tolerance and Package Degradation Allowance before the test begins.

- **Check lab status.** If the package is to be Certified by ISTA, the performing lab must have a current laboratory certification, renewable every two years.

- **Perform all tests, at the correct levels and in the correct order.** ISTA® Procedures and Projects do not allow test levels, times, etc. below the stated values, flexibility in the order of performance, nor the elimination of any tests. Over-tests are permitted if desired, however. For example, certification to an ISTA test may be obtained if all requirements of that test were met and in addition, more or higher drops were conducted, the vibration test was run longer or at a higher level, the compression force used was greater, etc.

  If the purpose of a test does not include ISTA Certification of the packaged-product, then ISTA has no official involvement or responsibility and therefore the test can be modified at the user's discretion. In such situations it is not necessary or desirable to send a Test Report to ISTA.

- **Document results as tests are performed.** Record intermediate results, options selected, calculations made and any deviations. Photo, video and drawings are good documentation tools.

- **Do not alter package condition.** Interior inspection of the product or package (by opening the package) is not allowed during the conduct of an ISTA Test Procedure where packaged-product certification is desired. Doing so may alter the package condition and thereby invalidate the test results. If intermediate inspection is desired, the recommended approach is to perform separate tests for investigation and certification. First test one or more packaged-products, inspecting them as desired to determine intermediate damage. When any issues or problems have been corrected, separately subject one or more new packaged-products to the complete test, without intermediate inspections, to determine pass/fail or for certification.

- **Determine results.** Most procedures require a pass/fail determination. This determination must be made in light of the package and product damage/degradation criteria determined before the test began. Details on how the evaluation was made should be included in the test documentation.

- **Review the test.** Was it the right test? Was it done correctly? Is the documentation complete? Would you understand it and be able to reproduce it two years from now?

- **Finalize.** Distribute documentation. Send report to ISTA for Certification or approval. Make decisions.

- **Monitor Actual Shipments.** If possible, obtain information on performance in actual distribution of the packaged-product tested. This performance, when compared to results from the laboratory tests, can be used to evaluate the effectiveness of tests and guide future testing decisions.

DOCUMENTATION OF TESTS

The following general information, in addition to specific testing details, is required when completing a Certified Laboratory Test Report:

ISTA Certified Testing Laboratory Information

- Complete laboratory name and address
- Test Laboratory ID number
- Test Technician who performed the test
- Test Report submitted by: name and signature

Product Manufacturer/Shipper Information

- Manufacturer/Shipper company name and address
- Test requested by: individual's name
- Manufacturer/Shipper ISTA License Number, if applicable and known

Third-Party Test Request Information

- Test conducted for: company name and address
- Test requested by: individual's name
- Relationship to the product manufacturer/shipper

Test Information

- Test Procedure or Project performed
- Date tested
- Number of samples tested
- Number of replicate tests performed
- Test Number(s) assigned by test laboratory, if applicable
- Appropriate details of tests and findings

Product Description

- Product name, brand, model number, and serial number as appropriate
- Place and date of manufacture
- Photographs, detailed drawings, and/or complete specifications as appropriate

Package Description

- Description of entire shipping unit
- Type or style of package
- List and details of packaging materials used
- Pallet or skid and unitization method, if applicable
- Method(s) of closure, if applicable
- Photographs, detailed drawings, and/or complete specifications as appropriate

Packaged-Product Tested

- Gross weight of packaged-product
- External container size in inches (mm or m): Length x Width x Depth (L x W x D)
- A picture or pictures should be included

Product Damage Tolerance Criteria

- Definition of product damage tolerance
- Name of person who determined definition of product damage tolerance
- Description of the method of determining product damage

Package Degradation Allowance Criteria

- Definition of package degradation allowance
- Name of person who determined definition of package degradation allowance
- Description of the method of determining package degradation

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

COMMUNICATION WITH ISTA

ISTA is very interested in your preshipment performance testing needs and experience. Please let the organization know when you have suggestions, observations or questions.

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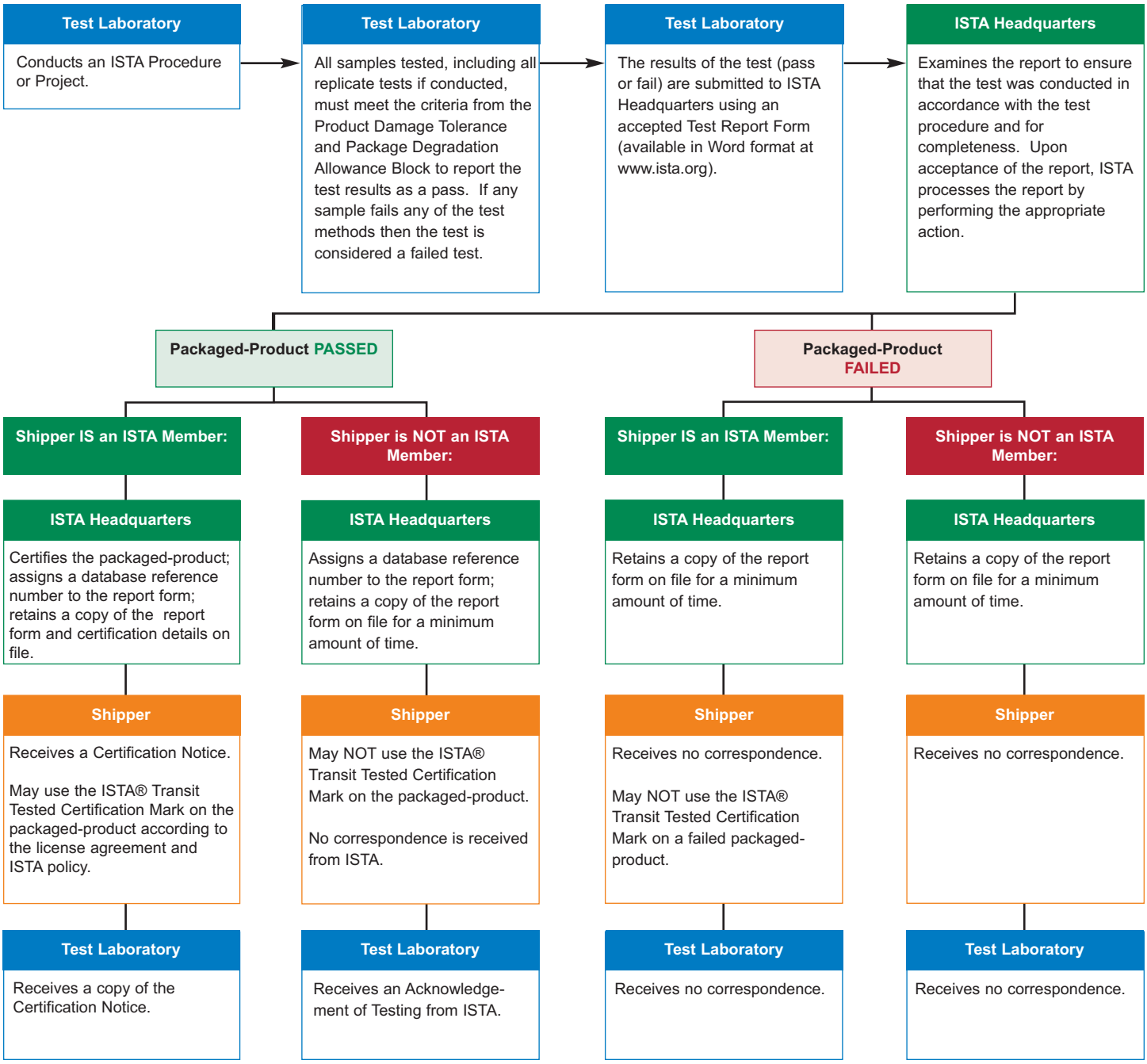
Version date: January 2010

ISTA TEST REPORT PROCESSING



TEST ARE ORGANIZED BY SERIES:

1 SERIES: NON-SIMULATION INTEGRITY PERFORMANCE TESTS

Challenge the strength and robustness of the product and package combination. Not designed to simulate environmental occurrences. Useful as screening tests, particularly when used as a consistent benchmark over time.

2 SERIES: PARTIAL SIMULATION PERFORMANCE TESTS

Tests with at least one element of 3 Series type General Simulation performance tests, such as atmospheric conditioning or mode-shaped random vibration, in addition to basic elements of a 1 Series type Non-Simulation Integrity test.

3 SERIES: GENERAL SIMULATION PERFORMANCE TESTS

Designed to provide a laboratory simulation of the general damage-producing motions, forces, conditions, and sequences of transport environments. Applicable across broad sets of circumstances, such as a variety of vehicle types and routes, or a varying number of handling exposures. Characteristics will include simple shaped random vibration, different drop heights applied to the sample package, and/or atmospheric conditioning.

4 SERIES: ENHANCED SIMULATION PERFORMANCE TESTS

General Simulation tests with at least one element of Focused Simulation, such as test sequence or test conditions linked to actual known distribution. Project 4AB is currently the only protocol in this Series. 4AB is a web-based Enhanced Simulation Test Plan generator, with on-line access available at no charge to all ISTA members. Project 4AB closely ties the tests and sequence to a user-defined pattern of distribution, and includes a broad range of current and quantitative information on distribution environment hazards. See the Project 4AB section of the ISTA® website (www.ista.org) for more details.

5 SERIES: FOCUSED SIMULATION GUIDES

Guides for the creation of laboratory simulations based on actual field-measured and observed hazards and levels. The 5-Series are not performance tests per se, but information and instructions related to establishment of user-defined Focused Simulation tests. Guide 5B for Temperature Controlled Packaging is currently the only document in this Series.

6 SERIES: MEMBER PERFORMANCE TESTS

Test protocols created by ISTA members to meet their particular purposes and applications. The tests may be completely original, or may be modifications or variations of ISTA Procedures or Projects or other published and accepted tests. ISTA reviews and accepts these tests, but primary responsibility rests with the originating members.

7 SERIES: DEVELOPMENT TESTS

These tests are used in the development of transport packages. They can be used to compare relative performance of two or more container designs, but are not intended to evaluate the protection afforded packaged-products.

IMPORTANT

Procedures periodically receive corrections or revisions before the publish date of the next Resource Book. Please visit the ISTA® website at www.ista.org for the most up-to-date procedures and projects. Members receive free and complete online access to all Test Procedures.

ISTA® PROCEDURES AND PROJECTS:

1A Packaged-Products weighing 150 lb (68 kg) or Less

1B Packaged-Products weighing Over 150 lb (68 kg)

1C Extended Testing for Individual Packaged-Products weighing 150 lb (68 kg) or Less

1D Extended Testing for Individual Packaged-Products weighing Over 150 lb (68 kg)

1E Unitized Loads

1G Packaged-Products weighing 150 lb (68 kg) or Less (Random Vibration)

1H Packaged-Products weighing Over 150 lb (68 kg) (Random Vibration)

2A Packaged-Products weighing 150 lb (68 kg) or Less

2B Packaged-Products weighing Over 150 lb (68 kg)

2C Furniture Packages

2D Packaged-Products Considered Flat

2E Packaged-Products Considered Elongated

2F Performance Testing of Shipping Containers for LTL Shipment National Motor Freight Classification Item 180 NCC/LTL

3A Packaged-Products for Parcel Delivery System Shipment weighing 70kg (150 lb) or Less

3B Project: Packaged-Products for Less-Than-Truckload (LTL) Shipment

3E Unitized Loads of Same Product

3F Packaged Products for Distribution Center to Retail Outlet Shipment, 100 lb (45 kg) or Less

3H Performance Test for Products or Packaged-Products in Mechanically Handled Bulk Transport Containers

4AB Project: Packaged-Products for Shipment in Known Distribution Channels

5B Focused Simulation Guide for Thermal Performance Testing of Temperature Controlled Transport Packaging

6 Member Performace Tests - details in 6-Series section.

7A Project: Open Reusable Transport Containers for Loads of 60 lbs (27 kg) or Less and Unitized for Shipment on a Pallet

7B Closed Reusable Transport Containers for Loads of 150 lb (68 kg) or Less

7C Reusable Intermediate Bulk Containers

7D Thermal Controlled Transport Packaging for Parcel Delivery System Shipment

Any Distribution Mode and Individual Packages Weighing…

150 lb (68 kg) or Less	Over 150 lb (68 kg)	Basic Requirements
1A	1B	fixed displacement vibration & shock testing
1C	1D	fixed displacement or random vibration, shock testing and compression conditioning (optional atmospheric conditioning)
1G	1H	random vibration and shock testing
2A	2B	atmospheric conditioning, compression, fixed displacement or random vibration, and shock testing

Small Parcel Delivery Mode and Individual Packages

Test	Package Type	Basic Requirements
3A	70 kg (150 lb) or Less Small, Standard, Flat, Elongated	atmospheric conditioning, shock, and random vibration testing (with & without top loads)
2D	Flat	fixed displacement vibration and shock testing
2E	Elongated	fixed displacement vibration and shock testing

Less-Than-Truckload (LTL) Delivery Mode

Test	Package Type	Basic Requirements
3B	Standard, 200 lb (91 kg) or less	atmospheric conditioning, shock, impact, random vibration with top load, tip/tipover
3B	Standard, over 200 lb (91 kg)	atmospheric conditioning, shock, impact, random vibration with top load, tip/tipover
3B	Cylindrical	atmospheric conditioning, shock, impact, random vibration with & without top loads
3B	Palletized or Skidded	atmospheric conditioning, shock, impact, random vibration with top load, tip/tipover, fork lift handling

Any Distribution Mode and Unitized as a Single Load

Test	Package Type	Basic Requirements
1E	Unitized	vertical linear or random vibration and shock
3E	Unitized	atmospheric conditioning, compression, random vibration, and shock testing

Any Distribution Mode and Reusable Systems

Test	Package Type	Basic Requirements
3H	Mechanically Handled Bulk	atmospheric conditioning, random vibration & shock testing (optional compression testing)

Other

Test	Package Type	Basic Requirements
2C	Furniture Packages	atmospheric conditioning, top load vibration, and shock testing
2F	LTL Shipments (NMFC Item 180)	atomspheric conditioning, compression/vibration, vibration, shock testing
3F	Non Unitized DC to Retail 100 lb (45 kg) or Less	atmospheric conditioning, compression, random vibration, and shock testing
4AB	Varies	Web-based Enhanced Simulation Performance Test
5B	Thermal Performance	focused simulation development
6 Series-Member Performance Test	Varies	Requirements set by member. See 6 series section.

Development Tests

Test	Package Type	Basic Requirements
7A	Open Container 60 lb (27 kg) or Less	compression and shock (optional atmospheric conditioning)
7B	Closed Container 150 lb (68 kg) or Less	fixed displacement and random vibration, shock, compression, atmospheric conditioning
7C	Intermediate Bulk Container	atmospheric conditioning, compression, random vibration, and shock testing
7D	Thermal Performance	atmospheric conditioning (optional vibration conditioning and shock testing)