

ISTA 3 Series
General Simulation
Performance
Test PROJECT*

VERSION
DATE
January
2011
Initial Release

Last
EDITORIAL
Change:
JANUARY
2017

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

ISTA, Distributing Confidence, Worldwide™

ISTA® 3-Series tests are advanced tests and are designed to:

- J Challenge the capability of the package and product to withstand transport hazards, but
- J Utilize general simulation of actual transport hazards, and
- J Do not necessarily comply with carrier packaging regulations.

When properly executed, ISTA procedures will provide tangible benefits of:

- J Product to market time reduction
- J Confidence in product launch
- J Reduction in damage and product loss
- J Balanced distribution costs
- J Customer satisfaction contributing to increased market share

There are two sections to this procedure: Overview and Testing

- J Overview provides general knowledge required before testing and
- J Testing presents the specific instructions to undertake laboratory testing.

Weights and measures system - Familiarity with the following units and symbols used in this document is required:

For measuring	Metric units and symbols
Weight	kilograms (kg) or grams (gm)
Distance	metres (m) or millimetres (mm)
Volume	Cubic centimetres (cm ³)
Density	kilograms per cubic metre (kg/m ³)
Temperature	Celsius (°C)

VERY IMPORTANT:

The entire document shall be read and understood before proceeding with a test.

* Notes Regarding ISTA "Projects" and "Procedures"

- J ISTA 3K is currently an ISTA "Project", first released in January 2011. New ISTA test protocols are given the designation "Project" during their implementation phase. After a minimum one-year period and required evaluation, a "Project" will either be adopted as an established "Procedure", revised and kept as a "Project" for another period of time, or be dropped. Therefore, a "Project" is potentially subject to greater and more frequent revision than a "Procedure".
- J Comments regarding this Project and its use are encouraged and welcome. Please contact ista@ista.org.
- J ISTA members may use either Procedures or Projects for package certification.

Project History:

The testing detailed in this procedure is as per methods first developed through a multi-client research project that was established and managed by Smithers Pira. The Smithers Pira research project examined real life supply chain conditions and processes, and included a program of laboratory validation testing to benchmark test results against real life packaged product performance. Smithers Pira shares these methods with ISTA in order to support the packaging and testing communities in assessing packaging performance, and to support progression towards greater sustainability in packaged grocery products distribution. Smithers Pira and ISTA acknowledge the co-sponsors of the original Smithers Pira research project in allowing this test method to be published by ISTA.

Preface

Project 3K is a general simulation test for fast moving packaged consumer products shipped through the multiple-retail supply chain environment in Europe. Project 3K is appropriate for the range of packages commonly merchandised through large retailer stores and large retail chain convenience stores, and where retailer operations include shipment of store-specific mixed loads in roll cages or as mixed pallets. This retail environment is common within western European countries, including (but not exclusive to) Sweden, Norway, Denmark, UK, France, Belgium, Netherlands, Germany, Austria, Switzerland, Spain and Italy; thus the scope of this project applies primarily to these countries. The scope also applies to similarly developed European states that are not listed but where large multiple-retail environment infrastructure is developed. Note large multiple-retail environment infrastructure involving shipment of mixed-loads is growing in other European countries and so this project may also apply in those cases. Many European grocery packages are in shelf-ready format; this method applies equally to shelf ready and non-shelf ready packages. In this procedure the term 'package' is used to describe a collation of primary packs. Common package formats that appear in the retail supply chain are presented below to clarify the scope of this method (this list is not exhaustive):

Package Formats

- J Small shrink wrap tray, for example
 - o collation of 6 or 12 deodorant aerosols
 - o collation of 6 glass jars of a sauce product
- J Large shrink wrap trays, for example
 - o tray of 24 cans of a beverage product
 - o tray of 12 stand-up-pouches of washing detergent product
- J Small corrugated cases or wraps, for example
 - o shelf ready corrugated case for a snack product
- J Large corrugated cases or wraps, for example
 - o collation of 20 glass bottles of a beverage product
 - o tray of 12 aseptic drinks cartons
- J Shrink wrap without tray, for example
 - o collation of 6 large bottles of mineral water
 - o collation of rolls of an absorbent kitchen towel product
- J Bags, for example
 - o 10kg or 20kg bag of pellet pet food product
 - o Collation of 12 bags of flour or sugar product.

The following package type definitions are required for selecting specific tests where test options are detailed:

Type 1: Single hand lift/carry – closed ends

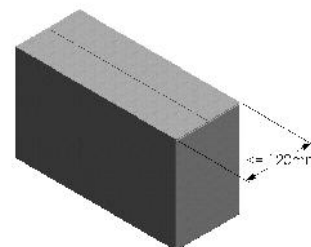
Weight \leq 4.5kg

AND

One principal dimension \leq 120mm

AND

No opening in the outer package materials | 60 x | 40mm with flexibility or space behind so at least 3 fingers could be inserted (i.e. the package is a closed corrugated case or carton, or is a shrink wrap collation that can't be lifted by inserting the hand in to the opening in the wrap at one end of the package).



Type 2: Double hand lift/carry – closed ends

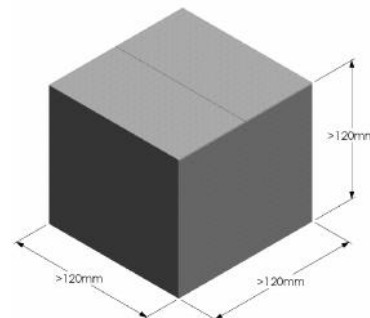
All principal dimensions \geq 120mm

AND / OR

Weight > 4.5kg

AND

No opening in the outer package materials | 60 x | 40mm with flexibility or space behind so at least 3 fingers could be inserted (i.e. the package is a closed corrugated case or carton, or is a shrink wrap collation that can't be lifted by inserting the hand in to the opening in the wrap at one end of the package).



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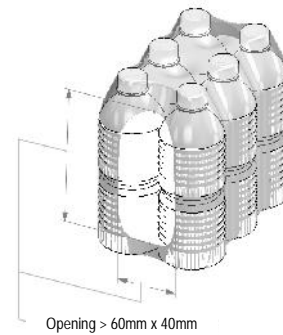
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Type 3: Single hand lift/carry - open ended

Weight TM7kg

AND

Opening at one (or more ends) Ψ 60mm x Ψ 40mm with flexibility or space behind so at least 3 fingers can be where there is sufficient space to insert the hand within an opening in the wrap) inserted for lifting (i.e. normally a shrink wrap collation).

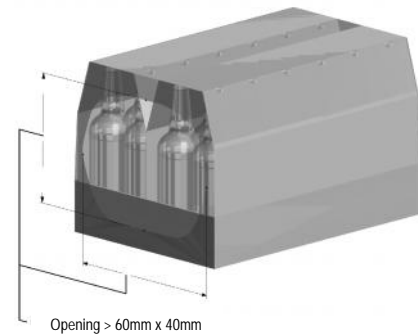


Type 4: Double hand lift/carry - open ended

Weight > 7kg

AND

Opening at two opposing ends Ψ 60mm x Ψ 40mm with flexibility or space behind so at least 3 fingers can be inserted for lifting (i.e. normally a shrink wrap collation where there is sufficient space to insert at least 3 fingers within an opening in the wrap at either end of the package).



NOTE:

Within this procedure the term 'sample' is also used as a common description for the various types of packages described above (i.e. one 'sample' is the same as one 'package', consisting of a number of primary packs in a collation).

General

- J Testing can be used to evaluate the fitness for purpose of a packaged-product or the protective performance of packaging with respect to the common hazards of the European retail supply chain.
- J Tests and test levels are based on observation of various brand owner and retailer distribution and in-store systems, and correlation between specific damage occurrences observed in the field and damage produced using laboratory testing during a validation exercise; however the test may not represent any specific distribution system.
- J The package and product are considered together and not separately.
- J Some conditions of transit, such as moisture, pressure, careless handling or unusual handling may not be covered.

Other ISTA Procedures or Projects may be appropriate for different conditions or to meet different objectives.

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

NOTE:

Hazardous material packaging that passes this test procedure may not meet international, national or other regulatory requirements for the transport of dangerous goods or hazardous materials. This test is not a substitute for United Nations and/or any other required test standards for the transport of dangerous goods or hazardous materials, but may be used as an additional test in conjunction with them.

Scope

Project 3K covers the testing of packaged-products prepared for sale through multiple-retail environments. From the point of manufacture of finished packaged goods, this supply chain commonly involves unit load (full pallet) storage, unit load shipment and unit load handling within the brand owner controlled part of the supply chain, leading to delivery of unit loads of product to a retailer distribution centre. This is commonly followed by a series of steps controlled by the retailer, involving order picking and mixed load building at the retailer distribution centre, mixed load delivery to store and in-store handling leading to loading of packaged-products on to the store shelf.

This test method relates only to the retailer controlled parts of this supply chain. Separate testing should be undertaken at the unit load level to determine fitness with respect to full pallet shipment commonly controlled by the brand owner.

Research shows that the hazards of distribution are commonly more severe in the retailer controlled parts of the supply chain (largely due to the complex product mix); however successful performance in this test method does not eliminate the need for evaluating packaged-product performance at the unit load level.

Specifically the test investigates the following processes occurring at the package (case or tray) level:

- Pyramid-pick/Overhang stack (representing the way a package is often partially supported on the unit load at the pick face at retailer distribution centre, occurring as a result of the way other packages are selected from the unit load)
- Drag (representing pulling of a package from a unit load at the pick face at retailer distribution centre)
- Carry (representing lifting and carrying of a package over short distance from the pick face to the mixed load, including, as appropriate to the pack design/format, carrying packs without supporting the base and carrying using openings in shrink wrap)
- Placement-drop and Drop-on impact (representing impacts occurring to packages during building of the mixed load)
- Package horizontal impacts (representing impacts occurring through automated conveyor operations at automated retailer distribution centres) - where it is known or possible that packages will pass through a retailer distribution centre with conveying/package level automated systems this test should be conducted.

Specifically the test investigates the following processes occurring for mixed loads (mixed pallets or roll cages):

- Both mixed pallet and mixed roll cages are commonly used in retailer distribution in Europe. Based on observation it is deemed that roll cage mixed loads experience more significant hazards because packs are able to press against the roll cage sidewalls as well as other packs (other than this, mixed load hazards are similar between the mixed load pallet and mixed load roll cage formats); the presence of sidewalls provides a horizontal load on packs that is less significant in mixed pallets. Because both mixed pallet and roll cage formats are used widely, the worst case of the two formats was selected for the test.
- Horizontal impact of mixed load (representing horizontal cage to cage (or mixed pallet to mixed pallet) impacts, or impacts between a mixed load and other fixed object, occurring during vehicle loading, road journey and handling at store)
- Vibration of mixed load (representing the road journey segment of the mixed load life cycle, but also representing more aggressive vibration occurring during loading/unloading where mixed loads are moved over chequer-plate ramps or rough surfaces within receiving bay areas, normally at the store)
- Vertical impact of mixed load (representing higher level transient shocks occurring during road shipment and vertical shocks occurring during marshalling/movement of mixed loads over rough surfaces or over door thresholds, normally at the store).

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
- ⌋ acceptable package condition at the conclusion of the test.

For additional information on these determinations refer to Guidelines for Selecting and Using ISTA Test Procedures and Projects.

Samples should be untested actual package and product, but if one or both are not available, the substitutes shall be as representative as possible to actual items.

Multiple test samples are required, but they should be identical. The exact number is dependent on the size of the sample. To provide an indication of the total number of samples needed for testing, establish the number of samples required to build a stack measuring at least 0.8m x 0.8m x 1.6m without significant gaps in the stack. Take this number and multiply it by 2; the resultant provides a guide to the total number of samples required. For example for a sample measuring 0.4m x 0.4m x 0.2m, 16 samples would be required to build the stack described above, so a total of 32 samples would be required for testing.

For this procedure the samples are classified and utilized in three (3) ways:

- J Test packages are used from the start through to the end of testing; when multiple identical test packages are tested, all test packages must pass all tests.
- J Dummy packages are used in various parts of the procedure to allow effective simulation of the real life hazard in the test (so that the real life hazard is correctly applied to the test package). Specifically, dummy packages are used in Test Blocks 1, 2, 3, 6 and 13. If a dummy package becomes degraded to the point that it does not maintain its shape or provide resistance to test packages it should be replaced with another dummy package, but dummy packages are not subject to inspection or pass/fail assessment as part of the test. Note: dummy packages are different from Roll Cage Fill packages described below.
- J Roll Cage Fill packages are used only in Test Blocks 8, 9 and 10 to enable building of the mixed load in the roll cage around the test packages. Dummy packages used during Test Blocks 1- 6 should not be used as Roll Cage Fill packages for Test Blocks 8, 9 and 10. Upon completion of Test Block 10 Roll Cage Fill packages are set aside for later assessment (and pass/fail judgment), so should not be used as Dummy packages in Test Blocks 11-13.

To enable effective tracing of samples throughout the procedure, Test package samples should be identified with "TP", Dummy package samples as "DP" and Roll Cage Fill package samples with "RCF". The exact number of each classification will vary depending on the size and type/format of package, so this identification is to be applied to each pack during testing at the point where a Test package, Dummy package or Roll Cage Fill package is required according to the details in the Test Block.

Refer to Guidelines for Selecting and Using ISTA Test Procedures and Projects for additional information on statistical sampling.

NOTE:

In order to ensure testing in perfect condition, products and packages shipped to an ISTA Certified Laboratory for testing shall be:

- J Adequately over-packaged for shipment or
- J Repackaged in new packaging at the laboratory.

NOTE:

It is important to thoroughly document the configuration, materials, and construction of the tested product and package. Significant variations in performance can sometimes be caused by seemingly insignificant differences. Photo documentation is strongly recommended to supplement detailed written descriptions.

Basis Weight

Basis Weights of Corrugated Board

When the outer package is a corrugated box, it is strongly recommended that the basis weights of the papers/paperboards used to make the box be determined and documented. If the nominal basis weights change, even if the board is rated for the same performance, a retest is appropriate.

Refer to Guidelines for Selecting and Using ISTA Procedures and Projects for additional information on documentation and basis weight determination.

Test sample selection and sample flow through the test sequence are detailed within the TESTING part of this PROJECT

Format	Test Category	Test Type	Test Level	For ISTA Certification
Package	Atmospheric Preconditioning TEST BLOCK 1	Temperature and Humidity	Ambient, frozen or chilled (to be selected as appropriate for the distribution and merchandising channel for the packaged product being tested)	Required
Package	Picking TEST BLOCK 2	Pyramid Pick (Overhang stack)	5 minute test duration	Required
Package	Picking TEST BLOCK 3	Drag	900mm drag distance at 1.0 m/s	Required
Package	Picking TEST BLOCK 4	Carry	10 seconds static plus 5 cycles carry-oscillation	Required
Package	Shock TEST BLOCK 5	Placement drop	5 impacts in various orientations, 150mm	Required
Package	Shock TEST BLOCK 6	Drop-on	Impacting top of lower package, base of upper package, 150mm	Required
Package	Shock (OPTIONAL) TEST BLOCK 7	Impact	8 impacts at 1.35m/s	Optional
Mixed load	Shock TEST BLOCK 8	Impact	4 impacts at 0.91m/s	Required
Mixed load	Vibration TEST BLOCK 9	Random Vibration	Overall G _{rms} level of 0.28 for 40 minutes followed by 0.517 for 60 seconds	Required
Mixed load	Shock TEST BLOCK 10	Flat drop	1 drop from 60mm	Required
Package	Shock TEST BLOCK 11	Placement drop	4 impacts in various orientations, 150mm	Required
Package	Shock (INVESTIGATIVE) TEST BLOCK 12	Drop	4 impacts in various orientations, 300mm	Advised (Optional)*
Package	Shock (INVESTIGATIVE) TEST BLOCK 13	Drop-on	Impacting top of lower package, base of upper package, 300mm	Advised (Optional)*
Assessment	Package Assessment BLOCK 14	No testing involved	Inspection and assessment of test and roll cage fill packages	Required

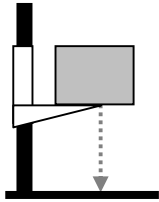
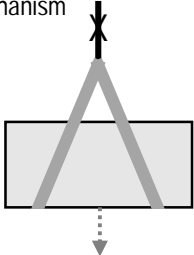
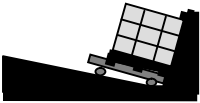
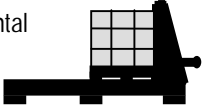
* In certain situations, the 300mm drop or drop-on test may not be appropriate. 300mm drops represent 'worst of normal' handling and should be conducted to investigate the performance of packages under more severe (but still within the range of normal) conditions; not every package will experience free fall impact from 300mm, but a small quantity of packages will be exposed to this level of hazard such that its effect should be investigated. If the drops are NOT performed, this should be shown in the test report.

Equipment
Required
Atmospheric
Conditioning

Atmospheric Conditioning:

- J Humidity recorder complying with of the apparatus section of ISO 2233 or ASTM D 4332.
- J Temperature recorder complying with the apparatus section of ISO 2233 or ASTM D 4332 .
- J Chamber and Control apparatus complying with the apparatus section of ISO 2233 or ASTM D 4332 .

Equipment
Required
Shock

Type of Shock Test	Type of Equipment	In compliance with the apparatus sections of...	Comments
Free-Fall Drop Tests	Fork-type free-fall drop tester 	ISO 2248 or ASTM D 5276	If available, use this drop apparatus as the preferred option for all package drop tests (from 150mm and 300mm) and for the 60mm mixed load drop test. Some drop tester designs do not allow for drops as low as 150mm or 60mm – in this case use alternative apparatus described below.
Free-Fall Drop Tests (Alternate)	Drop by hand using a reference measure to maximise repeatability of drop height	N/A	Preferred alternative option for 150mm package drop tests
Free-Fall Drop Tests (Alternate)	Slings and Quick-Release mechanism 	ISO 2248 or ASTM D 5276	Preferred alternative option for 60mm mixed load drop test
Impact Tests	Incline  Horizontal 	ISO 2244 or ASTM D 880 or ASTM D 4003	

Equipment
Required
Vibration

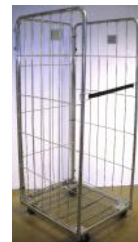
Random Vibration:

- J Vertical Random Vibration Test System complying with the apparatus section of ISO 13355 or ASTM D 4728 .
- J Means must be provided to prevent the test item from moving off the vibration system's platform, without restricting the vertical motion of the test item.

Equipment
Required
Mixed Load

Mixed Load:

- J A four wheeled metal roll-cage measuring approximately 800mm X 700mm in the horizontal axes and 1800mm in height (from the underside of the wheels to the top of the metal cage). A mid-shelf in the roll cage may be required – see bottom of page 11 for further details.
- J Cage to have three fixed sides and one open side, plus two elastic or fabric straps to contain product on the open side face.



EQUIPMENT REQUIRED FOR PROJECT 3K

Type of Package/Carry	Type of Equipment	Drawing/Detail	Comments
Picking Drag	Wedge	A wedge approximately 70 mm wide, 150mm long, with one end 2 mm high and the other end 20 mm high.	Ensures the front edge of top package is supported by the test package
Single hand lift/carry packages (Type 3 package, as defined in the Preface)	One single-dummy hand required	<p>Dimensions = mm</p>	It is most suitable to construct this dummy hand in mild or stainless steel. To undertake the oscillation part of the lift/carry tests using the single dummy hand, secure the single hand to a rigid frame or assembly (described below in "For the oscillatory part of the carry test"). Drill a hole at the top of the single dummy hand to enable the dummy hand to be hung freely on the rigid frame/assembly.
Double hand lift/carry packages (Type 4 package, as defined in the Preface)	A pair of double-dummy hands required	<p>Dimensions = mm</p>	It is most suitable to construct this dummy hand in hardwood timber or in aluminium or stainless steel. To undertake the oscillation part of the lift/carry tests using the double dummy hands, secure the dummy hands to a rigid frame or assembly (described below in "For the oscillatory part of the carry test"). Drill a hole at the top of each dummy hand to enable the dummy hand to be hung freely on the rigid frame/assembly.
For the oscillatory part of the carry test	Oscillation may be effected using a vibration table with <u>fixed frequency</u> sinusoidal control, and with the package supported on a rigid frame or assembly such that the test item hangs clear of the table platform during the test. The rigid frame/assembly can be of any construction as long as there is no flex in the construction as a result of the oscillation during test, and as long as the frame and vibration table platform do not interfere with the test package during oscillation.	Complying with the apparatus section of ISO 13355 or ASTM D 4728 would be suitable – other smaller scale sinusoidal oscillation producing apparatus may also be suitable	Will require displacement and frequency to achieve peak acceleration of 0.2g, delivered with peak to peak displacement of no less than 40mm and no more than 80 mm (corresponds to frequency no more than 1.6Hz and no less than 1.1Hz)