INTERNATIONAL

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Standard Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems[1]

This standard is issued under the fixed designation D4003; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods are intended to determine the ability of a package or product to withstand laboratory simulated horizontal impact forces.

1.2 The horizontal impacts used in these test methods are programmed shock inputs that represent the hazards as they occur in the shipping and handling environments. The environmental hazards may include rail switching impacts, lift truck marshalling impacts, and so forth. The following test methods apply:

1.2.1 *Method A, Rail Car Switching Impact*—This test method simulates the types of shock pulses experienced by lading in rail car switching, with the use of a rigid bulkhead on the leading edge of the test carriage, to simulate the end wall of a railcar and shock programming devices to produce representative shock pulses. With the use of backloading, this test method may also be used to simulate compressive forces experienced by lading loads during rail car switching. It is suitable for tests of individual containers or systems as they are shipped in rail cars. It may also be used to evaluate the effectiveness of pallet patterns to determine the effect of interaction between containers during rail switching operation impacts.

1.2.2 *Method B, Marshalling Impact Tests of Unit Loads*—This test method assesses the ability of unit loads to withstand the forces encountered during marshalling or loading operations.

1.3 The test levels may be varied to represent the mode on shipping and handling used for the item under test.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D996 Terminology of Packaging and Distribution Environments

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

D5277 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acceleration*—the rate of change of velocity of a body with respect to time measured in in./s^2 (m/s^2).

3.2.2 *backload*—a duplicate specimen similar to the test package or weights to simulate the other lading in the transport vehicle.

3.2.3 *shock pulse*—a substantial disturbance characterized by a rise of acceleration from a constant value and decay of acceleration to the constant value in a short period of time.

3.2.4 *shock pulse programmer*—a device to control the parameters of the acceleration versus time-shock pulse generated by a shock test impact machine.

[1] These test methods are under the jurisdiction of ASTM Committee D10 on Packaging and are the direct responsibility of Subcommittee D10.21 on Shipping Containers and Systems - Application of Performance Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.5 *velocity change*—the sum of the impact velocity and rebound velocity (the area under the acceleration—time curve).

4. Significance and Use

4.1 These test methods provide a measure of a shipping container's ability to protect a product from failure due to horizontal impacts. These measures are based on controlled levels of shock input and may be used for arriving at the optimum design of a container or system to protect a product against a specified level of shipping environment hazard.

4.2 These test methods provide a measure of a packaged product's ability to withstand the various levels of shipping environment hazards. These measures may be used to prescribe a mode of shipping and handling that will not induce damage to the packaged product or to define the required levels of protection that must be provided by its packaging.

4.3 Test Method A is intended to simulate the rail car coupling environment. Refer to Methods D5277 for simulating the standard draft gear portion of that environment.

5. Apparatus

5.1 *Horizontal Impact Test Machine:*

5.1.1 The impact test machine shall consist of a guided test carriage with a flat test specimen mounting and an upright bulkhead that is at a 90° angle ±30 min (½ °) to the specimen mounting surface. The carriage should be of sufficient strength and rigidity so that the test specimen mounting surface and bulkhead remain rigid under the stresses developed during the test.

5.1.2 The impact test machine shall provide some means of moving the test carriage in a single guided horizontal direction of motion. The motion of the carriage shall be controlled in such a manner that its velocity change is known after the moment of impact.

5.1.3 The machine shall be equipped with programmable devices to produce shock pulses at the carriage bulkhead when the carriage strikes the impact reaction mass.

5.1.4 The machine shall have an impact reaction mass, sufficient in size to react against the force of impact from the carriage. The prescribed shock pulse limits will provide the controlling factor as to the design or concept of the reaction mass required.

5.1.5 Means shall be provided to arrest the motion of the carriage after impact to prevent secondary shock. The design shall prevent excessive lateral or over turning motion that could result in an unsafe condition or invalidate the test.

5.1.6 *Machine Setting*—Since the desired shock pulses are influenced by the response of the test specimen, pretest runs should be conducted with duplicate test specimens with equivalent dynamic loading characteristics and backload, if required, prior to actual test to establish the approximate machine equipment settings.

5.1.6.1 The control parameters that must be specified include:

5.1.6.2 The desired velocity change (impact plus rebound velocity of the test carriage),

5.1.6.3 The desired pulse, shape, duration, and acceleration levels, and

5.1.6.4 The desired backload weight/friction relationship.

5.2 *Specimen Backload Equipment:*

5.2.1 During some horizontal impacts, the forces that test units encounter include both the shock forces of the acceleration as well as compressive forces resulting from other products impacting against them. This will necessitate sufficient carriage strength and platform space to provide a location for the desired backload weights.

5.2.2 Specially adapted backloading fixtures may be used to provide an even loading of the backload weight over the entire back surface area of the test specimen, or additional product samples may be used to create the desired backload.

5.2.3 The backload weight and frictional characteristics must be specified for each test procedure and reported.

5.3 *Instrumentation:*

5.3.1 An accelerometer, a signal conditioner, and a data display or storage apparatus are required to measure the acceleration-time histories. The velocity change is obtained by integrating the impact shock record measured on the carriage bulkhead.

5.3.2 The instrumentation system shall be accurate to within ±5 % of the actual value. The long pulse durations involved in this test method require an instrumentation system with good low-frequency response. As an alternative, instrumentation capable of recording direct current (dC) shall be acceptable. For short pulse durations the high-end frequency response should be twenty times the frequency of the pulse being recorded. For example, the 10-ms pulse has a full pulse duration of 20 ms and a frequency of 50 Hz. Therefore, the instrumentation system should be capable of measuring 1000 Hz. (20 × 50 Hz).

NOTE 1—As a guide, the following equation may be used to determine the adequacy of instrumentation low-frequency response:

$$\text{low} - \text{frequency response point (LFRP)} = 7.95/\text{pulse width (PW) (ms)} \quad (1)$$

where *LFRP* is the low frequency 3-db attenuation roll-off point, expressed in hertz (cycles per second), of an instrumentation system that will ensure no more than 5 % amplitude error, and *PW* is the pulse width of the acceleration pulse to be recorded, measured in milliseconds at the baseline. For example, an intended shock acceleration signal with a duration of 300 ms, the *LFRP* of the instrumentation would have to be at least equal to or lower than 0.027 Hz.

5.3.3 Optional instrumentation may include optical or mechanical timing devices for measuring the carriage image and rebound velocities for determining the total velocity change of the impact. This instrumentation system, if used, shall have a response accurate to within ±2.5 % of the actual value. Total velocity change must be measured to within ±5.0 % of its total value.

6. Precautions

6.1 These test methods may produce severe mechanical responses in the test specimen. Therefore, operating personnel must remain alert to the potential hazards and take necessary safety precautions. The test area should be cleared prior to each impact. The testing of hazardous material or products may