



Document Number and Revision: 950-1291-01 Rev M

Packaged Product Test Specification

Overview

All Oracle hardware packaged products shipped to OCI or Oracle external customers must demonstrate compliance to this specification. This requirement includes all packaged products designed and/or manufactured by Oracle, JDMs (Joint Development Model), EMs (External Manufacturers) and OEM (Original Equipment Manufacturer) suppliers.



Audience

Oracle Hardware Development Packaging Engineering
Oracle, JDMs (Joint Development Model), EMs (External Manufacturers) and OEM (Original Equipment Manufacturer) suppliers.

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1.0 OVERVIEW

1.1 Scope

- All Oracle hardware packaged products shipped to OCI or an Oracle external customer, must demonstrate compliance to this Specification. This requirement includes all packaged products designed and/or manufactured by Oracle, JDMs (Joint Development Model), EMs (External Manufacturers) and OEM (Original Equipment Manufacturer) suppliers.
- The test levels and test types described in this document represent conditions that may be found in normal mechanical handling, manual handling, transportation, and storage environments.
- This specification ensures that all Oracle packaged products, or packaged products purchased by Oracle in vendor supplied packaging, shall be tested in a consistent manner.
- The tests shall be conducted in the order listed in this specification unless stated otherwise within an individual test description or packaged product test plan.

1.2 Area of Responsibility

- The Oracle Hardware Development Packaging Engineering is responsible for maintaining this document.

1.3 Definitions

- In this document, the terms “Product” and “Packaged Product” are used to represent the item to be tested. It may be any of the following: full system, assembly, component, X-option (conversion bill), kit, upgrade, spare part [FRU (field replaceable unit), CRU (customer replaceable unit) or DRU (Direct Replacement Unit)], test item, test specimen, test article or test sample.
- **Product:** In this document the term Product is used to represent the item to be tested without packaging. The product shall include all lock downs, brackets and internal bracing.
- **Unit Under Test (UUT):** The product (above) is also sometimes called the Unit Under Test or UUT.
- **Transportation Testing:** The combination of Packaged Random Vibration and Package Drop Testing of a Product or a UUT in its packaging.
- **Packaged Product:** Any product with protective packaging necessary for shipment. Required protective product packaging for each product level is as follows:
 - **Non-palletized:** Consists of all required cushions, bags and containers for shipment.
 - **Palletized:** A Packaged Product which has a unique integrated pallet defined as part of its design. Multiple Packaged Products which are placed on pallets for unitization should not be considered palletized and must be tested without a pallet.

Rack with integrated pallet: Rack packaging shall be tested/qualified configured with dummy weighted 1RU trays to simulate the maximum potential weight of configured product that is intended to ship in that rack.

UUT (Unit Under Test) installed in a rack with an integrated pallet: Product that is intended to ship installed or configured in a rack shall be package tested/qualified configured in the rack mounted on the racks integrated pallet. Rather than performing Transportation testing with a UUT installed in the rack by itself, it is recommended to configure the rack with 25% (quarter populated) of the maximum RUs or OUs filled with dummy weighted trays (dummy trays shall be weighted to the

agreed upon maximum RU or OU Server weight at the time of the test) i.e. a 42RU tall rack shall have the UUT installed, plus quantity 10, 1RU or OU dummy weighted trays. This additional weight will help to load the foam blocks in the pallet, so the foam is less stiff and acts as a cushion, which ultimately reduces the vibration and shock inputs into the rack and correspondingly into the UUT, making it easier for the UUT to pass rack Transportation testing.

- **Castered (non-palletized):** In rare cases a rack style product may be delivered by truck on its casters without a pallet. These castered products must be tested to additional tests contained in the appendix. The castered product will be tested with all internal lock downs, bags and containers for products that ship on casters.
- **Test Segment:** Is a complete section of this document. For example: Random Vibration requirements are defined in section 4.

1.4 Reference Conditions and Tolerances

- Temperature: 23 degrees C., +/- 5 degrees C (except where specifically indicated)
- Humidity: 30% to 70% RH (not controlled, except where specifically indicated)
- Tolerance of Test Conditions:
 - Stability: + 1.0° / -0.0°
 - Lift Truck Velocity: + 0.0 fps / - 0.5 fps
 - Random Vibration Spectrum: ±0.05 Grms
 - Vibration amplitude (sinusoidal): ±2% or ±½ Hz below 25 Hz.
 - Drop Height: + 0.25 inch / -0.0 inch
 - High Temperature Storage Test: Temperature ±2.0° / Humidity ±2%

1.5 Acceptance/Failure Criteria

- The product shall have failed the test when any of the following occur:
 - The product shows degradation in mechanical or functional performance beyond specified limits, or permanent cosmetic damage after being subjected to these tests.
 - Functional parameters deviate beyond specified limits.
 - Unable to complete functional diagnostic (e.g. SunVTS) after test segment.
 - Structural failure.
 - Any malfunction which would cause a customer to call Oracle Customer Service Engineering for maintenance.
 - PCIe (or other PCI card variants) card dislodges from edge card connector slot by more than 1.5 mm during Drop or Random Vibration testing.
 - Any deviations from acceptable criteria established for the test.
 - Deterioration, corrosion or changes which could in any manner prevent the product from meeting operational, service or maintenance requirements.
 - Any damage viewed from minimum of 3 feet under normal lighting to painted or cosmetic surfaces during packaged product qualification.
- The packaging shall have failed the test when any of the following occur:
 - The product is no longer constrained within the packaging as designed.
 - The packaging materials are damaged to the point that they can no longer function as designed.
 - Complete fracture or breakage of the foam that puts the product at risk.
 - The package transmits G levels greater than the fragility rating of the product at the required drop height.

- The package does not have a compressive resistance greater than the minimum required level.
- Where applicable, the packaged product fails the stability, tip-over, lay-over and/or high temperature storage requirements.

1.6 Performance of Test

- Pretest Performance

All products must be functionally tested and the characteristic data recorded prior to packaged-product testing for comparison with post-test data. Functional tests are to be determined and agreed upon by all parties prior to package product testing. The product must be test ready and visually inspected prior to package product testing.

- Performance Check Between Test Segments

The units under test shall be inspected and functionally tested between each major segment of the test series. For example a functional test is required after random vibration and before drop testing.

- Test Suspension and Test Resumption

A test may be suspended to examine the condition of the product or packaging. If no changes are made the test can be resumed from the point of the suspension. If changes to the product or packaging are made then the test segment must be restarted.

- Loose hardware or components can be re-seated or tightened to torque requirements but, the test segment must be restarted.
- Packaging materials can be replaced because of non-related deterioration but, the test segment must be restarted.

- Post Test Performance

At the completion of all testing the product must be functionally tested to assure the unit is performing to defined requirements. The equipment under test must be carefully inspected for structural, permanent cosmetic and mechanical damage. The product is to be disassembled to the sub-assembly level during the final post-test inspection process to assure identification of any structural damage or loose hardware.

- Test Data

See appendix for test data requirements. Test data shall include complete identification (with photographs) of all test equipment, instruments, accessories and configuration of the product. The data shall include the actual test sequence used and ambient test conditions recorded periodically during the test period.

1.7 Entrance and Exit Criteria

- Testing should commence in accordance with the related test plan; in the absence of a test plan, testing should follow section 2.0 “Table of Applicability”.
- Testing shall be concluded when the test plan has been fully executed, the related required tests designated by the Table of Applicability have been completed or upon product or packaging failure as defined in section 1.6.

1.8 Samples

- Final validation tests must be conducted with production level (production ready) products and packaging.

- The sample size must be large enough to ensure that all required package surfaces are vibration tested and that all package faces, corners and edges are drop tested.
- Fragility testing Method A (Section 12.1) requires two samples per axis/face and Fragility testing Method B (Section 12.2) requires one sample per axis/face. Three axis or six face Fragility testing is recommended. If only one sample is available, then only the minimum overall fragility can be determined.

1.9 Packaging Materials

- New packaging material can be used at the start of each test segment. The packaging must be examined after each test segment and replaced with new packaging if the performance of the packaging is compromised. If failure occurs during a test segment, the packaging can be replaced but the test segment must be restarted.
- The package assembly or any package component, as well as the product or any product component may not be replaced during the test segment, with one exception: Fresh packaging may be used after drop 15 to complete the drop test segment for packaged products weighing up to 150 lbs (refer to table 5).
- Final Validation drop tests are to be performed after the Random Vibration testing per Section 4.0, using the same package assembly and product.

2.0 PACKAGED PRODUCT TESTS:

- To determine which packaged product tests are required, first determine your Packaged Product type from the definitions above:
 - Packaged Product **Non Palletized** (manually handled by 1 or 2 persons)
 - Packaged Product **Palletized** (handled with mechanical equipment: fork lift, pallet jack)
 - Packaged Product **Castered Non-Palletized**
 - Packaged **Battery**
- The next variable to consider is the Packaged Product weight. Use both of these variables to determine which tests are required.

Table of Applicability (Required Tests)

Use the following table to determine the applicable tests for the packaged product to be tested.

Table 9. Table of Applicability

Packaged Product Tests	Section	Packaged			Castered non-palletized
		<150 lbs	<150 lbs Palletized	150 to 300 lbs	>300 lbs
Stability / Tip Angle	3.0				Required
Random Vibration	4.0	Required	Required	Required	Required
Drop	5.1	Required	Required	Required	Required
Tip-Over/Roll-Over	5.2	Optional	Interchangeable#	Interchangeable#	Based*
Horizontal Impact (HITS)	5.3		Interchangeable#	Interchangeable#	Required
Strain Measurement	5.4	Required	Required	Required	Required
Lay Over	6.0				300-500 lbs Required
High Temperature Storage	7.0	100+ Required	Required	Required	Required
Additional Tests					
Compression	9.0	Optional	Optional	Optional	Optional
Lift Truck Handling	10.0				Stability Based*
Castered Drop	11.1				Required
High Center/Ramp Clearance	11.2				Required
Diamond Deck Rolling	11.3				Required
Fork Lift Pick-Up	11.4				Required
Fragility Assessment A	12.1	Optional	Optional	Optional	Optional
Fragility Assessment B	12.2	Optional	Optional	Optional	Optional
Random Vibration Endurance	12.3	Optional	Optional	Optional	Optional
Horizontal Random Vibration	12.4	Optional	Optional	Optional	Optional
Resonance Search	12.5	Optional	Optional	Optional	Optional
#	Tip Over and Horizontal Impact tests are interchangeable for these packaged products (one or the other is required).				
*	Tip/Roll-Over tests are not required for this category of packaged products if the Stability test is passed.				

3.0 STABILITY/TIP ANGLE MEASUREMENT

Note: Rack Packaged Products > 300 lbs are REQUIRED to pass this test.

Tip Angle Requirement:

- The packaged product must have a center of gravity such that the unit can be tipped twenty-two (22) degrees from the normal shipping orientation, onto each of the four bottom edges, without tipping over. The tip test will be applied in all directions of permitted travel or fork lift pallet entry. Actual degree measurement will be recorded.

Test Procedure

- **CAUTION** should be taken in this test so that the product does not tip completely over, resulting in personal injury or product damage.
- The packaged product, with all internal lock downs and bracing in place, will be positioned against a stop and sufficient force will be applied to establish the maximum tip angle for the device in each of four sides. Swivel casters must be rotated in the most tip prone direction.

4.0 RANDOM VIBRATION TESTS

Packaged Products < 150 lbs and Non-Palletized Packaged Products

- Secure the packaged product to the vibration table without affecting the dynamic characteristics of the package.
- Some palletized packaged products utilize a cushion system, including foam, within the pallet. Ensure the method used to secure such a palletized packaged product does not interfere with the ability of the cushion system to perform.
- Each packaged product must be tested in all six orientations, such that all six surfaces are tested face-down on the vibration table. Each orientation shall receive 30 minutes of random vibration input.
- Total Test Duration: 180 minutes
- Level: 1.0 Grms
- Spectrum: Refer to Table 2 and Figure 1

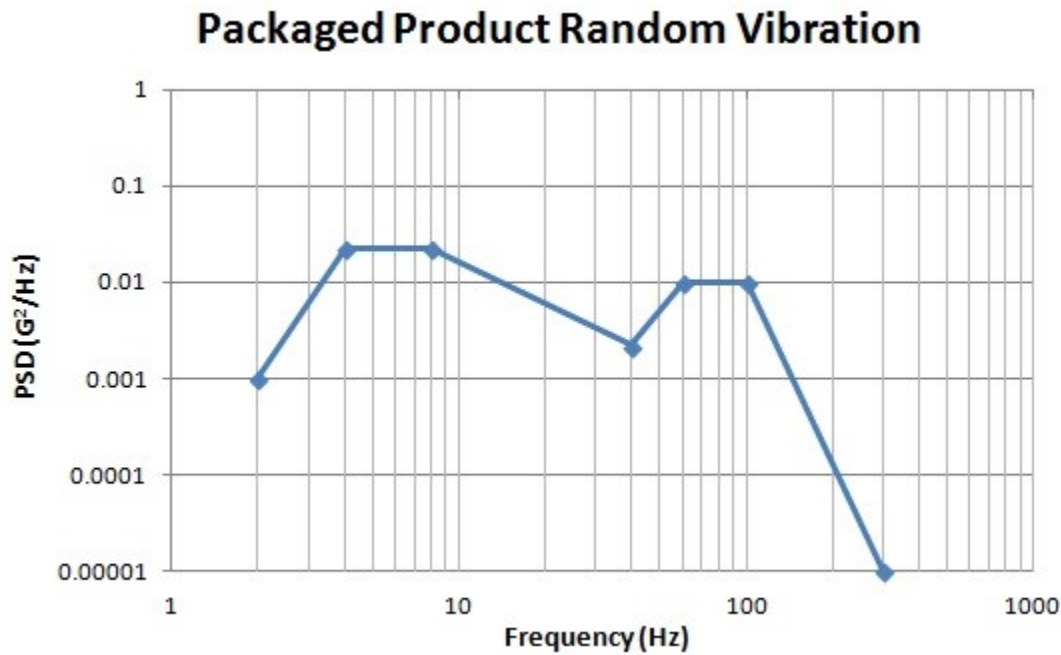
Palletized Packaged Products > 150 lbs

- Secure the packaged product to the vibration table without affecting the dynamic characteristics of the package.
- Some palletized packaged products utilize a cushion system, including foam, within the pallet. Ensure the method used to secure such a palletized packaged product does not interfere with the ability of the cushion system to perform.
- Vertical Random Vibration Test to be performed in the normal shipping orientation only (base-down). This orientation shall receive 45 minutes of random vibration input.
- Total Test Duration: 45 minutes
- Level: 1.00 Grms
- Spectrum: Refer to Table 2 and Figure 1

Table 10. Vertical Random Vibration (1.00 Grms)

FREQUENCY (HZ)	PSD LEVEL (G2/HZ)
2	0.001
4	0.022
8	0.022
40	0.0022
60	0.01
100	0.01
300	0.00001

Figure 1. Random Vibration Spectrum



5.0 SHOCK TESTING: DROP AND IMPACT TESTS

Table 11. Required (Applicable) Tests for Shock/Drop Testing

MASS (LBS)	MODE	DROP TEST	TIP OVER	HITS
0-150	Manual	Required	Optional	Not Required
	Pallet	Required	Interchangeable 1 (either TIP OVER or HITS required)	
150-300	Pallet	Required	Interchangeable 1 (either TIP OVER or HITS required)	
300+	Castered, Non-Palletized	Required	Stability Based	Optional
	Pallet	Required	Stability Based	Optional

Note: *1- Either Tip Over Test or Horizontal Impact Test (HITS) must be conducted on this category of products.

5.1 Drop Test

Table 12. Drop Height versus Packaged Product Weight

MASS LBS	DROP HEIGHT INCH	HANDLING MODE	VELOCITY CHANGE (IN/SEC)	DROP SEQUENCE	MASS (KG)	DROP HEIGHT (MM)
0 - 10	42	Manual (One Person)	180	Refer to Section 5.1.1	[0] - [4.5]	[1067]
> 10 - 25	36	Manual (One Person)	167	Refer to Section 5.1.1	> [4.5] - [11.3]	[914]
> 25 - 60	30	Manual (One Person)	152	Refer to Section 5.1.1	> [11.3] - [27.2]	[762]
> 60	24	Manual (One Person)	136	Refer to Section 5.1.1	> [27.2]	[610]
> 60 - 150	18 / 12 ^{*3}	Palletized	118 / 96	Refer to Section 5.1.2	> [27.2] - [68.0]	[457] / [305] ^{*3}
> 150 - 300	12 ^{*4}	Palletized	96	Refer to Section 5.1.2	> [68.0] - [136.1]	[305] ^{*4}

> 300	6	Palletized	68	Refer to Section 5.1.2	> [136.1]	[152.4]
All	1 / 3	Castered non-palletized	28 / 48	Refer to Section 5.1.3	All	[25.4] / [76.2]
All	48	Batteries	192	Refer to Section 5.1.4	All	[1219]

*1- Palletized material is handled with mechanical equipment (example: fork lift, pallet jack).

*2- Palletized material < 60 pounds [27.2 kg] shall be dropped according to the manual handling mode drop heights.

*3- The drop height for bottom flat drops shall be 18 inches [457mm]. The drop height for the bottom corners and bottom edges shall be 12 inches [305mm]. Drop heights for Tip-Over tests to be performed from the equilibrium point or Horizontal Impact.

*4- All bottom drops (flats, rotational corners and rotational edges) to be performed from a drop height of 12 inches [305 mm]. Drop heights for Tip-Over tests to be performed from the equilibrium point or Horizontal Impact Test.

Drops can be conducted Freefall or with a Programmed Shock Machine with impact velocities using 2ms (± 0.5) half-sine inputs.

5.1.1 Manually Handled Packaged Products: 0 – 150 lbs

Table 13. Manually Handled Packaged Products: Drop Sequence and Type

DROP #	DROP TYPE	DROP SEQUENCE (REFER TO FIGURE 2. TO DETERMINE IMPACT SURFACE)
1	Flat	Bottom, Surface 3 (normal shipping orientation)
2	Flat	Right, Surface 2
3	Flat	Front, Surface 5
4	Corner	Bottom Corner, 2-3-5
5	Edge	Shortest edge radiating from above corner
6	Edge	Next longest edge radiating from above corner
7	Edge	Longest edge radiating from above corner
8	Flat	Top, Surface 1
9	Flat	Left, Surface 4
10	Flat	Back, Surface 6
11	Corner	Top Corner, 1-4-6 (diagonally opposite from previous corner, Drop 4)
12	Edge	Shortest edge radiating from above corner

13	Edge	Next longest edge radiating from above corner
14	Edge	Longest edge radiating from above corner
15	Flat	Bottom, Surface 3 (normal shipping orientation)
Additional new/fresh packaging may be used to complete testing on the remaining corners and edges		
16	Corner	Bottom Corner, 3-4-5
17	Edge	Shortest edge (not previously impacted) radiating from above corner
18	Edge	Next longest edge (not previously impacted) radiating from above corner
19	Corner	Top Corner, 1-2-6 (diagonally opposite from previous corner, Drop 16)
20	Edge	Shortest edge (not previously impacted) radiating from above corner
21	Edge	Next longest edge (not previously impacted) radiating from above corner
22	Corner	Bottom Corner, 3-4-6
23	Edge	Edge not previously impacted radiating from above corner
24	Corner	Top Corner, 1-2-5 (diagonally opposite from previous corner, Drop 22)
25	Edge	Edge not previously impacted radiating from above corner
26	Corner	Bottom Corner, 2-3-6
27	Corner	Top Corner, 1-4-5 (diagonally opposite from previous corner, Drop 26)

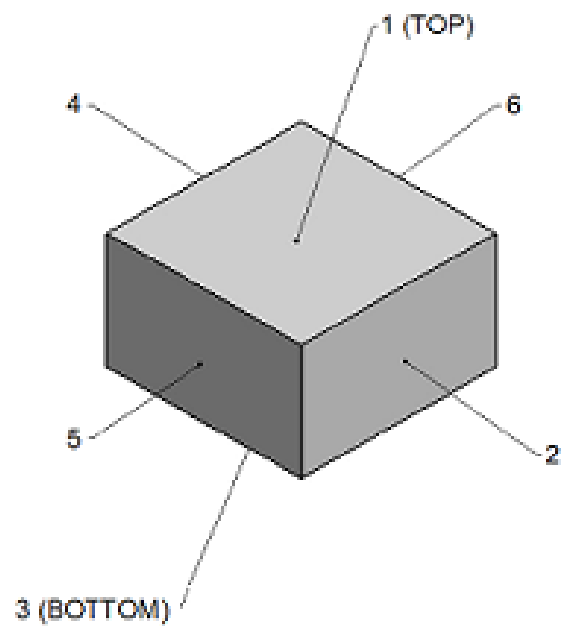


Figure 2. Drop Test Impact Orientation Identification

Identify surfaces according to the figure.

Identify corners using the numbers of the three faces that meet to form that corner.

Example: Corner 2-3-5 is the corner formed by surface 2, surface 3 and surface 5 of the packaged product.

The packaged product's center of gravity shall be positioned over edge or corner subjected to testing.

5.1.2 Palletized Packaged Products: >60 - >300 lbs

Table 14. Palletized Drop Sequence and Type

DROP #	DROP TYPE	DROP SEQUENCE (IMPACT SURFACE)
1	Flat	Bottom (normal shipping orientation)
2	Rotational Corner	Corner 1
3	Rotational Edge	Edge 1 (longest edge radiating from Corner 1)
4	Rotational Corner	Corner 2 (adjacent to Edge 1)
5	Rotational Edge	Edge 2 (adjacent to Corner 2)
6	Flat	Bottom (normal shipping orientation)
7	Rotational Corner	Corner 3 (adjacent to Edge 2)
8	Rotational Edge	Edge 3 (adjacent to Corner 3)
9	Rotational Corner	Corner 4 (adjacent to Edge 3)
10	Rotational Edge	Edge 4 (adjacent to Corner 4)

Packaged Product Weight of 60 - 150 lbs (27.2 – 68.0 kg): All bottom drops (flats, rotational corners and rotational edges) to be performed from a drop height of 18 inches (305 mm).

Packaged Product Weight of 150 - 300 lbs (90.7 - 136.1 kg): All bottom drops (flats, rotational corners and rotational edges) to be performed from a drop height of 12 inches (305 mm).

Packaged Product Weight of 300 lbs (136.1 kg) or more: All drops (flats, rotational corners and rotational edges) to be performed from a drop height of 6 inches (152 mm). **See section 1.3 UUT (Unit Under Test) installed in a rack with an integrated pallet**

Rotational Drop Procedure: Raise test subject to defined drop height, place block(s) under opposite edge/corner, release/drop test subject so that the desired edge/corner impacts flat surface first. Test subject is permitted to shift off block(s) after first impact.

The packaged product may be restrained to prevent additional drops after the intended drop.

5.1.3 Castered Non-Palletized Products: Drop Sequence and Type

The following tests are required if a castered product will ship on its casters without a pallet.

- The castered, packaged product with all internal lock downs and bracing in place, is to be fixtured in its normal shipping and handling orientation to a shock test machine and withstand a velocity change of 28 in/s (equivalent to a 1 inch drop height with product material having a coefficient of restitution (e) of zero), seven times, using 2ms (± 0.5) half-sine inputs to the vertical axis.
- The castered, packaged product with all internal lock downs and bracing in place, is to be fixtured in its normal shipping orientation to a shock test machine and withstand a velocity change of 48 in/s (equivalent to a 3 inch drop height with product material having a coefficient of restitution (e) of zero), three times, using 2ms (± 0.5) half-sine inputs to the vertical axis.

Note: Caster Impact Testing shall be conducted in addition to this testing. Consult Environmental Test Engineering Threshold testing for details.

5.1.4 Batteries: Drop Sequence and Type

- The following test is required if the test subject is classified as Batteries per the current IATA-Dangerous Goods Regulations or equivalent.
- Drop Packaged Batteries from 48 inches (1219 mm) using the drop sequence in table 5.

5.2 Roll-Over/Tip-Over Test (Dynamic)

The Tip-Over test or the Horizontal Impact test (see section 5.3) is required to meet the following requirements.

- Non-palletized Packaged Product

- The Tip-Over test is required on all packaged products that have a length larger than 1.5 times the drop height specified in table 4; Sequence of drops per table 7.

Note: This test would be required regardless of the stability of the packaged product.

- The rotational drop height would never exceed 42 inches, drop from equilibrium point or 42 inches whichever is lower.
- Lower impact surface of container so that the closest edge is 42 inches from floor and let it fall naturally to the floor.

- Palletized and Castered Packaged Product

- Palletized Products weighing 60 – 300 lbs

- Palletized Products with length less than or equal to 42 inches [1067mm] shall be subjected to the Tip-Over Test. Horizontal Impact Test (see section 5.3) is recommended for Palletized Products with length exceeding 42 inches [1067mm]; Sequence of drop tests per table 7.

Palletized and Castered Products exceeding 300 lbs

Palletized and Castered Products: Only packages exceeding 300 lbs which do not meet the Stability (section 2.0) shall be subjected to the Tip-Over test.

The package shall be subjected to one (1) Tip-Over drop, from the equilibrium point, on each flat side of the container which did not meet the Stability requirement.

Packaged Products with an integrated pallet >300 lbs which have passed Stability (section 2.0) do not need to perform Tip-Over Testing.

Packaged Rack Products are REQUIRED to pass Stability and should NOT be tipped over.

- Test Procedure

- **CAUTION** should be taken during the tip-over test so that the product does not cause personal injury.
- Place packaged product, with all mechanical features for blocking and bracing in place, in the upright position, on a rigid, flat, smooth surface. Tip the product slowly to the equilibrium point and let it fall naturally to the floor. No pre-acceleration is to be applied to the packaged product during tip-over test.

Table 15. Tip-Over Sequence and Type

DROP #	DROP TYPE	TIP OVER DROP SEQUENCE (IMPACT SURFACE)
1	Tip-Over	From bottom face to one of the length panels
2	Tip-Over	From above length panel to the top face
3	Tip-Over	From top face to remaining length panel
4	Tip-Over	From above length panel back to bottom face
5	Tip-Over	From bottom face to one of the width panels
6	Tip-Over	From above width panel to the top face

7	Tip-Over	From top face to remaining width panel
8	Tip-Over	From above length panel back to bottom face

5.3 Horizontal Impact Test (HITs):

- The Horizontal Impact test or the Roll-Over/Tip-Over test (see section 5.2) is required for palletized products per table 3.
 - All castered (non-palletized) products (300+ lbs) and palletized packaged products (60 – 300 lbs) shall undergo impact testing on each of four vertical faces.
 - The product shall be fixtured to a Horizontal impact test machine and withstand a horizontal shock input consisting of a velocity change of 5 miles/hour (equivalent to a 12 g - 30 msec. half-sine pulse).
 - Horizontal Impact and Threshold Testing may be complimentary tests. Consult Environmental Test Engineering Requirements for details.

5.4 Strain Measurement

- As required, strain measurements shall be taken during drop testing in accordance with the latest version of "WWOPS Test: Strain Gauge Test Procedure," 914-1739-XX.

6.0 LAY-OVER TESTS (STATIC)

- Test Procedure:
 - Packaged products with a weight between 300 lbs and 500 lbs shall be subjected to this test.
 - The packaged product shall be laid down onto a flat surface, one (1) time on each of the normally vertical surfaces of the package.
 - The package must remain intact, and there can be no damage to the product.
 - This test is designed to determine if a container and the contained product can be laid on their side without damage resulting to the product or severe degradation to the package. This test is not intended to determine if the package can be dropped or shipped in the non-base down orientations.

7.0 HIGH TEMPERATURE STORAGE TESTS

High Temperature Storage testing is performed to verify the performance of packaging materials under high temperature and humidity conditions seen during transportation. This may include testing for foam creep, performance of adhesive bonds, corrosion etc.

- a) At a minimum, all packaged products with a weight exceeding 100 lbs shall be subjected to this test. The test is to be conducted in the normal shipping orientation.
- b) The packaged product shall be subjected to 70 degrees C [158 °F] / 50% Relative Humidity, for duration of 72 hours.
- c) Prior to the test, measure the height of the cushioning material and compare to the height after the test. A loss of height greater than 30% constitutes a failure.
- d) Any change to the packaging materials that would inhibit the performance (product protection and/or unpacking) is considered a failure.

APPENDIX A

8.0 FIXTURING AND MONITORING METHODS

8.1 Fixturing Methods

The following guidelines should be used where practical:

Stability: Fully packaged with all accessories, banding, blocking and bracing. Position the product on a flat surface with edge to be tested against a stop.

Random Vibration: Fully packaged with all accessories, banding, blocking and bracing. Products should be securely affixed to the test table at a location that will assure test input is directly applied to the core structure of the test item.

Some palletized packaged products utilize a cushion system within the pallet. Ensure the method used to secure such a palletized packaged product does not interfere with the ability of the cushion system to perform.

Unsecured packaged products with an enclosure surrounding the packaged products is not recommended

Drop Testing

- **Swing Arm:** The packaged product shall be placed unrestrained on the swing arm and shall be oriented to contact the desired axis. If the desired axis is not contacted:

Note the axis that was impacted and do not test on that axis. Attempt to impact on the desired side.

If the second attempt is unsuccessful then do not attempt again.

- **Shock Table:** The packaged product should be securely affixed to the shock table in the desired axis.
- **Quick Release:** Use 2 inch straps for lifting. Restrain chain from contacting top of package. Use full width plywood on top of packaged product.

Tip Over/Roll Over/Horizontal Impact: Fully packaged with all accessories, banding, blocking, and bracing.

Lay-Over: Fully packaged with all accessories, banding, blocking, and bracing.

High Temperature Storage: Fully packaged with all accessories, banding, blocking, and bracing tested in its normal shipping orientation.

- Packaged Product qualification testing will be performed with the most suitable fixturing methods to replicate the actual field condition. Regard will be given to the particular axis of desired excitation to assure that the required test input is fully imparted into the test item.
- Products should be securely affixed to the test table at a location that will assure test input is directly applied to the core structure of the test item. Care should be taken to avoid damage to externally mounted components of test items. Fixturing to isolate such superficial features may be utilized where applicable. Product casters, feet, or loading pads must be applied during operational testing, but may be removed for non-operational tests to best suit the desired test condition. The designed mounting surface and mechanical means of securing a product will always be a primary method for fixturing an item in test.

Compression: Fully packaged with all accessories, banding, blocking, and bracing.

Lift Truck Handling: Fully packaged with all accessories, banding, blocking and bracing. Position the packaged product against the fork lift mast but do not secure the packaged product to the mast. **CAUTION** should be taken in this test so that the product does not tip over, resulting in personal injury or machine damage. An outrigger may be added to the pallet to prevent tip-overs.

8.2 Monitoring Methods

- Vibration or Shock Control Accelerometer

A control accelerometer mounted to the test table will be used to control shock or vibration input to pre-determined test levels. In some cases of large test table, test item size, or difficult-to-control test demand profiles additional monitor accelerometer may be used and an averaging control strategy should be applied.

- Product Response Accelerometer

A test response accelerometer mounted on the tested product may be used to determine realized test input on or within the test item. The quantity of response accelerometers may vary to produce test output data from desired product locations.

APPENDIX B

9.0 COMPRESSION TESTS

- Compression Strength Performance Requirement:

$$F = W \times 3.5 [(180 \text{ inches} - PH) / PH]$$

Where:

F = Minimum Compression Strength (lbs-f)

W = Weight of the packaged product (lbs)

PH = Package Height (Outside Dimension) in inches

- Compression Test Conditions:
 - Floating platen compression test equipment shall be used for all testing.
 - Test five empty, replicate printed production packages.
 - Each container to be taken to failure.
 - Compressive rate of 0.5 inch per minute.
 - The average compression strength value must be equal to or greater than the calculated Compression Strength Performance Requirement.
 - Pre-load the package under test to:
 - 50 pounds force - Single wall
 - 100 pounds force - Double wall
 - 500 pounds force - Triple wall
 - Reference ASTM D642 and/or D4577 for more information.

APPENDIX C

10.0 LIFT TRUCK HANDLING TESTS

General Requirements

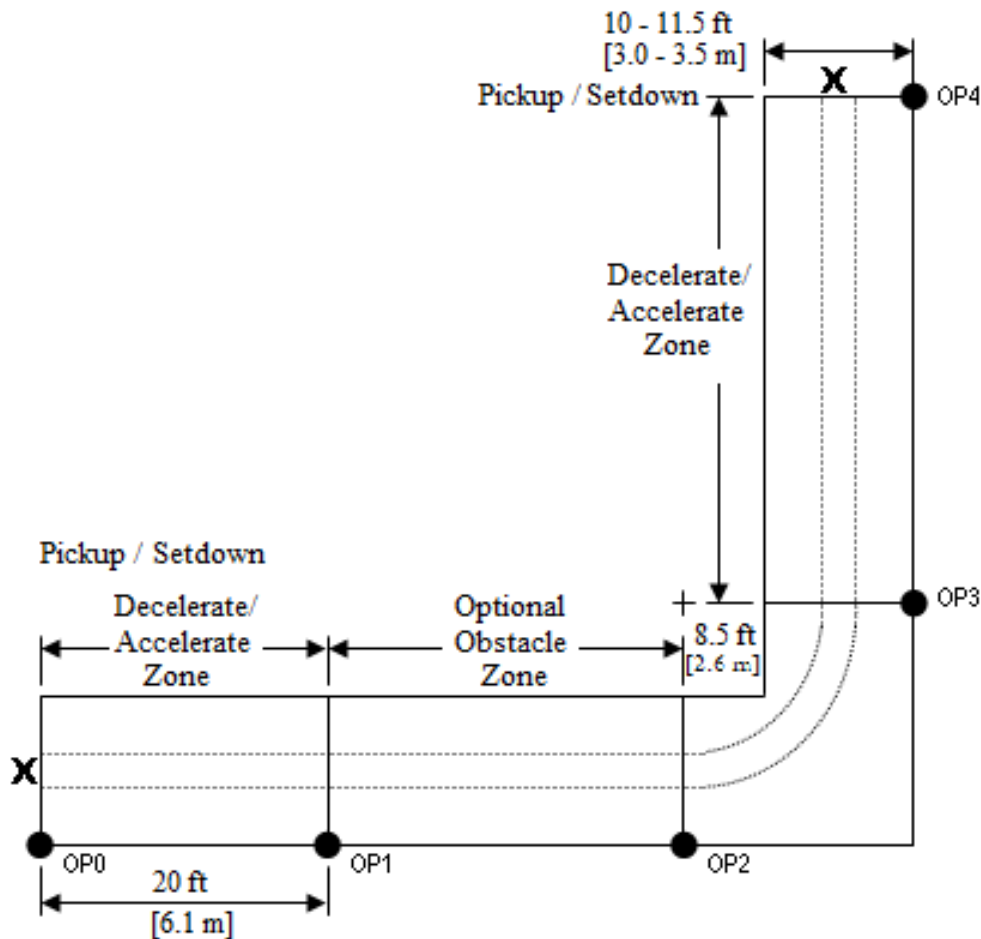
- **Packaged Products exceeding 300 lbs** which do not meet the Stability requirements (section 2.0) may be subjected to this test.
- **Orientation:** The package shall be subjected to this test using a fork lift in up to 4 orientations based on the number of fork lift/pallet jack openings in the package. The orientations that did not pass the stability test, represent the minimum number of orientations that must be subjected to the lift truck handling test.
- **Course:** The "L" shaped course shall include 10 to 11.5-ft (3 to 3.5m) wide aisles with a 90° turn, appropriate acceleration/deceleration zones, and observation points (OP-0 through OP-4). See Figure 4.
- **Velocity:** The velocity of the lift truck in the turn shall be 3.25 ft/s (1.0m/s).

Test Procedure

- The package under test shall be examined after each cycle of handling (pickup/transport/set down).
- User-defined test course obstacles may be used and are at the user's option. Lift truck velocity through this area with or without obstacles shall be uniform "walking" speed not to exceed 5 ft/s (1.5m/s).

- A standard course shall be established on a flat rigid surface representative of worst-case warehouse conditions. The forks of the lift truck shall be positioned as close to each other and the center of the pallet as possible.
- Place the product on the forklift with the orientation to be tested on the outside corner of the course.

Figure 3. Lift Truck Handling Course



APPENDIX D

11.0 CASTERED PRODUCT TESTS

A product may be shipped on its castered (non-palletized) if it passes the tests in this section. As a general rule, castered products shipped by air transportation require a pallet; therefore the product would have to be tested as a castered product and a palletized product.

11.1 Castered Non-Palletized Drop Test

Castered Packaged Product Shock Test (Non-Operating)

- The castered, packaged product with all internal lock downs and bracing in place, is to be fixtured in its normal shipping and handling orientation to a shock test machine and withstand a velocity change of 28 in/s (equivalent to a 1 inch drop height with product material having a coefficient of restitution (e) of zero), seven times, using 2ms (± 0.5) half-sine inputs to the vertical axis.
- The castered, packaged product with all internal lock downs and bracing in place, is to be fixtured in its normal shipping orientation to a shock test machine and withstand a velocity change of 48 in/s (equivalent to a 3 inch drop height with product material having a coefficient of restitution (e) of zero), three times, using 2ms (± 0.5) half-sine inputs to the vertical axis.

11.2 High Center (Ramp Clearance)

High Center Test (Non-Operating; Castered Product)

- Determine and measure the following dimensions:

R = Radius of caster wheel
L = Distance between caster wheel centers in rolling orientation
C = Clearance Height of machine
- Clearance must be greater than the following formula:
$$C > [(L/2)\tan 15^\circ] + [(R)\tan 15^\circ \sin 15^\circ]$$
- Repeat High Center test on all sides that permit travel.

11.3 Diamond Deck Rolling Test

(Non-Operating; Castered Product)

- Caution should be taken in this test so that the product does not tip over, resulting in personal injury or machine damage.
- Packaged product on casters must be pushed across a five foot minimum length diamond deck horizontal surface at walking speed (approximately 2 ft/sec).
- Diamond deck surface will be a “large pattern” type with pattern height measuring between 0.075 and 0.095 inch above the flat metal base surface.
- Repeat diamond deck rolling test for all sides for all permitted directions of travel (up to four total).
- Product must still roll smoothly and must pass all functional tests.

11.4 Fork Truck Pick Up Test

(Non-Operating; Castered Product)

- Caution should be taken in this test so that the product does not tip over, resulting in personal injury or product damage.
- Packaged product on casters must be picked up off the ground by a fork truck. Forks are to be set such that there is 2 inches between outside of each fork and equipment casters. Fork thickness will be up to 2 inches. Castered products must have a minimum measure of 2 ¼ inches from the frame lowermost member to the ground under casters. Forks will extend completely under product. Product must be lifted approximately 2 inches and then set back down.
- Repeat fork truck pick up test for all sides (up to four) if dimensionally possible to insert forks (at least two sides).
- Product must remain stable on the fork lift.
- Product must pass all functional tests, and must not have any cosmetic damage which would render the item unmanufacturable, off-standard or unable to be sold.

APPENDIX E**12.0 MECHANICAL INTEGRITY TESTS****12.1 Fragility Assessment Method A**

(Non-Operating; Products and Major Assemblies)

The item will be evaluated for failure levels due to mechanical shock. Product items will be tested without protective packaging. Internal lock downs and bracing or isolators used in the non-operational item may be allowed. Rubberized or elastomer feet and pads external to the item will be negated by the test fixturing so that the shock wave is directly input to the item's structural framework. Testing will be done with the item hard-mounted on a dual-wave programmable shock test machine. The required shock wave forms will be as follows:

Table 16. Fragility Type A

WAVE FORM	DURATION	INCREASE BY	CRITICAL READINGS
Half Sine	2ms (±0.5)	Drop Height	Velocity Change (Δv)
Square	Will Vary	Gas Pressure	Peak Acceleration (g's)

- Test in the vertical axis only for items over 75 pounds that will be palletized.
- Test in all three axes for items up to 75 pounds.
- Beginning with half sine input, increase input severity, through increasing drop heights, until failure occurs. Note this velocity change (Δv) and plot this on the appropriate log form. This will be critical velocity change.
- Using square wave input, program a pulse with (Δv) at twice the previously determined critical velocity change or the drop height specified in Table 6; whichever is less. The pulse should be set at an acceleration level which the test participants are confident will not damage the item. Shock the item and evaluate for damage. Repeat at successively higher acceleration levels until failure occurs. This acceleration level is the critical acceleration; plot this level on the appropriate log form.
- The plots of critical velocity change (Δv) and critical acceleration (g's) on the log form will depict a damage boundary region which may be used in design efforts of both the product and packaging engineers.
- Failure is to be interpreted as functional, mechanical, electrical, or cosmetic changes which render the item unmanufacturable, off-standard or unable to be sold.

12.2 Fragility Assessment Method B

(Single Test Sample) Assessment (Non-Operating; Products and Major Assemblies)

The item will be evaluated for failure levels due to mechanical shock. Product items will be tested without protective packaging. Internal lock downs and bracing or isolators used in the non-operational item may be allowed. Rubberized or elastomer feet and pads external to the item will be negated by the test fixturing so that the shock wave is directly input to the item's structural framework. Testing will be done with the item hard-mounted on a dual-wave programmable shock test machine. The required shock wave forms will be as follows:

Table 17. Fragility Type B

WAVE FORM	DURATION	INCREASE BY	CRITICAL READINGS
Square	Will Vary	Gas Pressure	Peak Acceleration (g's)

- Test in the vertical axis only for items over 75 pounds that will be palletized.
- Test in all three axes for items up to 75 pounds.
- Determine velocity change (Δv) based upon item weight using Table 4. For maximum efficiency, the Δv should be large enough so as to provide a reasonable level of confidence that damage to the product would occur. For this purpose, multiply the Δv by 2.0. This will be the Assumed Critical Velocity Change.
- Using square wave input, program a pulse with Δv as determined in section 7.2.5. The pulse should be set at an acceleration level which the test participants are confident will not damage the item. Shock the item and

evaluate for damage. Repeat at successively higher acceleration levels until failure occurs. This acceleration level is the critical acceleration; plot this level on the appropriate log form.

- The plots of Assumed Critical Velocity Change (Δv) and critical acceleration (g's) on the log form will depict a damage boundary region which may be used in design efforts of both the product and packaging engineers. Note that this damage boundary region will be relevant only with regard to critical acceleration; the third (upper left) quadrant will represent a critical velocity change and critical acceleration range in which damage may or may not occur.
- Failure is to be interpreted as functional, mechanical, electrical, or cosmetic changes which render the item unmanufacturable, off-standard or unable to be sold.

12.3 Random Vibration Endurance Test

- (Non-Operating; Unpackaged Spare Parts and Major Assemblies; All Classes).
- This testing applies to ruggedized assemblies which must withstand handling, movement and transport with minimal package protection provided.
- For items weighing 75 pounds or less, vibration will be 30 minutes per each of three axes.
- For items exceeding 75 pounds which will ship exclusively on casters or pallets, vibration will be 1.5 hours 45 minutes and will be input to the bottom of the product in the vertical axis.

Truck Random excitation will consist of 0.52 g RMS Power spectral density (See Table 10) and will be as follows:

Table 18. Vertical Random Vibration - Truck (0.52 Grms)

FREQUENCY (HZ)	PSD LEVEL (G ² /HZ)
1	0.0001
4	0.01
16	0.01
40	0.001
80	0.001
200	0.00001

Air Random excitation will consist of 1.05 g RMS Power spectral density (See Table 11) can be used in place of the combined spectrum and will be as follows:

Table 19. Vertical Random Vibration - Air (1.05 Grms)

FREQUENCY (HZ)	PSD LEVEL (G ² /HZ)
1	0.0003
3	0.00055
12	0.01
100	0.01
400	0.000003

Combined Random spectrum which consists of 1.00 g RMS Power spectral density (See section 4.3) can be used in place of the Air spectrum.

12.4 Packaged Product Horizontal Random Vibration Test

(Non-Operating; All Classes)

The product when packaged for truck or air/export shipment, must withstand the following horizontal vibration inputs experienced in distribution at 0.08 g RMS for 1.0 hours per two adjacent faces. (See Table 12).

Table 20. Horizontal Random Vibration (0.08 Grms)

FREQUENCY (HZ)	PSD LEVEL (G ² /HZ)
4	0.0001
40	0.0001
200	0.00000175

12.5 Resonance Search

(Non-Operating; Products, Major Assemblies; All Classes)

- Apply a 5 - 500Hz sweep at a sweep rate of 1.0 octave/minute and amplitude between 0.125 and 0.5 g sinusoidal input.

Orientation:
1. Equipment 250 pounds or less: Three axes.
2. Equipment over 250 pounds: Vertical axis only
- Identify product/item's resonant frequencies of components. Item's response should be determined for components using an accelerometer. Visual and auditory observations are frequently useful, but should not be relied upon for critical work when an accelerometer can be used. It may also be useful to reverse and stop the sweep for short periods to accurately observe resonances. Amplitude may be varied in the specified range to aid in observation but not so as to incur damage.

APPENDIX F

13.0 Reports

- All Packaged Product tests must be documented in a product specific test report. Test reports shall be created by or provided to the appropriate engineer in the Oracle Packaging Engineering Group.
- All Packaged Product tests of OEM supplier specified designs must be documented in a product specific test report by the supplier. The test reports, along with samples and package component drawings must be provided to the Oracle Packaging Engineering Group for approval.
- All Packaged Product Test Reports must include the following information as applicable:
 - 1) General information
 - a) Date of Test
 - b) Location of Test
 - c) Report Number
 - d) Test Engineer
 - e) Applicable Test Specification
 - f) Purpose
 - g) Performance Requirement (Pass/Fail Criteria)
 - h) Deviations and Notes
 - i) Summary and Conclusions
 - 2) Specific information (as applicable)
 - a) Product Description
 - (1) Product Name
 - (2) Product Configuration

- (3) Product Serial Number
 - (4) Modifications Made to the Product
 - (5) Product Weight
- b) Package Description
 - (1) Package Component Description
 - (2) Package Component Part Number, including revision/version
 - (3) Package Component Material
 - (4) Package Component Weight
 - (5) Modifications Made to the Package
 - (6) Ship Kit Contents
 - (7) Package to Product Orientation Relationship
 - (8) Packaged Product Weight
- c) Stability Test Details
 - (1) Direction Tested
 - (2) Measured Stability Angle
- d) Random Vibration Test Details
 - (1) Random Spectrum
 - (2) Test Duration per Orientation
 - (3) Test Sequence by Package or Product Orientation
 - (4) Package and Product Condition per Orientation tested
- e) Shock/Drop Test Details
 - (1) Drop Height
 - (2) Test Sequence by Package or Product Orientation
 - (3) Test Type (Free Fall, Rotational Corner, or Rotational Edge)
 - (4) Package and Product Condition per Drop
 - (5) Acceleration Results (if applicable) (Acceleration, Duration, and Velocity Change)
 - (6) Whether or not fresh packaging was used after drop 15
- f) Roll-Over/Tip-Over/Horizontal Impact Test Details
 - (1) Direction Tested
 - (2) Package and Product Condition per Tip-Over
- g) Lay-Over Test Details
 - (1) Direction Tested
 - (2) Package and Product Condition per Lay-Over
- h) High Temperature Storage Test Details
 - (1) Temperature
 - (2) Duration
 - (3) Package and Product Condition
- i) Compression Test Details
 - (1) Container Manufacturer
 - (2) Container Manufacture Date
 - (3) Container Inside Dimensions
 - (4) Container Outside Dimensions
 - (5) Maximum Packaged Product Weight
 - (6) Calculated Minimum Compression Strength Performance Requirement
 - (7) Individual and Average Compression Strength Measurements

Revision History

REV	ECO NO	DESCRIPTION	DATE
A	4806	Production Release	02/17/89
B	WO_00986	Enhancements	01/29/91
C	WO_06431	Revisions Per Industry Assessment	05/12/94
D	WO_07317	Revisions to Compression Test & Addition of the Performance Drop Test Sequence	02/06/96
E	WO_19081	Revisions Per Field Assessments	02/06/01
F	WO_35440	Add Fork Lift Handling Test, Clarify Requirement for Drops 16-27 in Table 3	03/28/07
G	WO_36939	Added Diagram & Changed Verbiage for Drop Sequence 3.2	04/20/07
H	WO_42204	Added "JDM's & EM's" in Section 1.1.1 and Strain Measurement information in Section 5.0.4.	09/18/09
J	E0019167	Complete Rewrite, Incorporated Storage Group Requirements	01/15/14
K	E52546	Change Stability Tip Angle from 26 to 22	11/15/19
L	E56951	AQP Reformat Stability testing required >300 lbs, and remove option for passing Lift Truck Handling Tests. Move Lift Truck Handling Tests to Appendix	04/02/22
M	E61639	Added definitions in section 1.3	01/16/24

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