

# Product and Package Testing Requirements for Transportation, Storage and Delivery

**MN2-810.13**

**Revision 16**  
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**Created By:**

David Batz	Xerox Packaging Engineering Services
Chris Donnelly	Xerox Packaging Engineering Services
Mark James	Xerox Office Group (XOG) Package Engineering
Dave Leinberger	Xerox Office Group (XOG) Package Engineering
Paul McKenzie	Xerox European Packaging Group
Bill Vertner	Xerox Office Group (XOG) Environmental Test Labs

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Revision	Date	Changes
14	14-MAR-06	Major revision of content and format.
15	07-DEC-06	<ul style="list-style-type: none"> <li>• Corrected error in metric conversion of top load for Offset Top Load Vibration</li> <li>• Revised Temperature/Humidity Test</li> <li>• Revised Vertical Vibration Test profile</li> <li>• Removed 12.5 mm (0.5 in) deflection failure criteria from Static Compression Test</li> <li>• Added pallet to figures in Rotational Edge and Rotational Corner Tests</li> <li>• Added diagram of package categories in Section 5.0</li> </ul>
16	18-DEC-08	<ul style="list-style-type: none"> <li>• Section 5.0 – Updated table.</li> <li>• Section 7.0 - Clarified increase in <math>L_R</math> when testing sample sizes of less than 5 non-production boxes.</li> <li>• Section 8.0 – Clarified top load height and containment to reduce test variability</li> <li>• Section 11.0 – Clarified that package should be allowed to rotate unrestricted onto a flat surface after initial impact onto corner or edge. Changed from rotational edge to rotational flat drops on &gt; 91 kg (200 lb) packaged products. Added a heavy weight category</li> <li>• Section 16.0 - Added pallet integrity tests</li> <li>• Section 19.0 – Clarified that product does not have to roll over 25 mm (1”) obstruction. Clarified procedure for ramping test.</li> <li>• Section 20.0- updated table</li> </ul>

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## 1.0 PURPOSE

- Establish standardized test methods and procedures to ensure that all products experience adequate environmental evaluation. This evaluation is intended to minimize the risk of introducing packaged products incapable of withstanding and functioning in the expected distribution environment.

## 2.0 SCOPE

- This standard applies to all Xerox organizations and third party suppliers.
- The requirements are applicable to new and remanufactured products, options (e.g. second feeders, finishers, etc.), subsystems (e.g. IOT, IIT, 3TM, etc.), complete products tested as systems (i.e. fully configured product), subassemblies, customer replaceable units, consumables (e.g. toner, ink, developer, photoreceptor, etc.), tools and spares.
- This standard applies to primary, secondary, unit load and bulk packages.

## 3.0 GENERAL CONDITIONS

- All new products, or variants, shall be tested as early as possible in the design stage.
- Program engineering personnel should witness the physical test elements of the test program and be responsible for the visual and functional checks at each phase of the test. This is to ensure that qualified personnel observe any failure and pursue corrective action.
- The product to be tested shall be as representative as possible of the final design at the time of test. Changes in product or package configuration shall require additional testing during the product development cycle. Testing shall reflect the shipped configuration as well as the final delivery configuration if different.
- The product shall be prepared and secured internally and externally, as required, for type of test to be conducted. Photoreceptors, consumables, fuser oil, etc., shall be in place in accordance with the product distribution shipping strategy.
- Tests / inspections shall be carried out as necessary during the test sequence.
- A full post-test analysis shall be conducted.

## 4.0 ACCEPTANCE CRITERIA

Packaged product is considered to fail if any of the following occur:

- Permanent buckling or creasing of the box during static compression, split top load vibration, and offset top load vibration tests.
- 20% or greater fall-off in static compression strength before reaching required load ( $L_R$ ).
- Product damage or performance reduction.
- Leakage or contamination of product by consumables and/or packaging. Examples:
  - Excessive toner leakage within or outside of product.
  - Foam particles from cushions that migrate into product.
- Package no longer continues to protect product. Examples:
  - Packaging degrades so product is no longer in its intended position within pack design.
  - Cushion breaks and migrates out of position.
  - Glue joint failure in box.
  - Broken or missing parts that compromise the structural integrity of pallet.
  - Missing bands, clips, or wraps used to secure shipping box to pallet.
- Any change in package condition that creates a safety hazard. Examples:
  - Compression damage that creates an unstable pallet load.
  - Failure of hand hole in box.
  - Protruding nails in pallet.

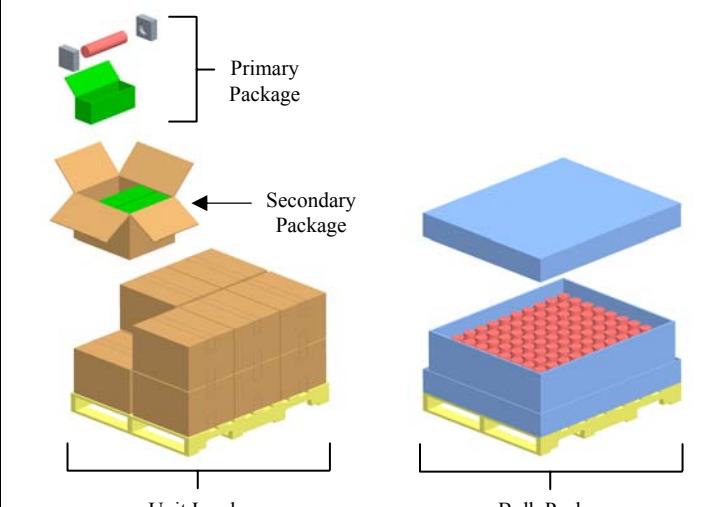
**5.0 SUMMARY OF TEST REQUIRMENTS**

Packaged Product				
TEST DESCRIPTION	Packaged Product Weight			
	Primary, Secondary, Bulk Packages and Unit Loads*			
	< 32 kg < 70 lb	32 - 68 kg 70 - 150 lb	> 68 - 91 kg > 150 - 200 lb	> 91 kg > 200 lb
Static Compression	•	•	•	•
Split Top Load Vibration		•	•	•
Offset Top Load Vibration		Palletized Packaged Products ≥ 32 kg [70 lb]		
Vertical Vibration	•	•	•	•
Free-fall Drop	•	•	•	•
Incline Impact			•	•
Package Stability		•	•	•
Temperature and Humidity	•	•	•	•
Atmospheric Pressure	•	•	•	•
Pallet Integrity Tests	All Pallets			
Unpackaged Product				
Products with castors that could travel through the distribution channel in part without a package and/or pallet				
Vertical Vibration	•	•	•	•
Free-fall Drop	•	•	•	•
Handling Hazards	•	•	•	•

NOTES:

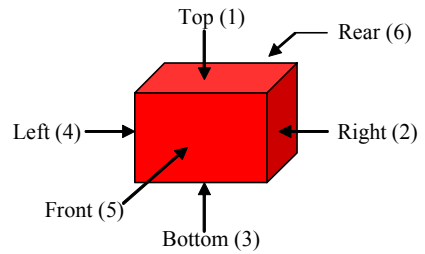
1. Products shipped attached to a pallet but without over packaging (i.e. CONTRAN) should not be subjected to static compression and top load vibration tests.
2. Cumulative testing: Free-fall drop test should immediately follow vertical vibration test using the same product and package (i.e. no substitutions). If the packaged product fails either test, follow-up testing must repeat both tests. All other tests can be performed independently.
3. Precondition package for minimum of 24 hours at 22° ± 1°C [72° ± 2°F] and 50% ± 5% RH prior to testing.

(\* ) All primary and bulk packages must be tested and pass. All secondary and unit loads must be capable of passing.



**6.0 IDENTIFICATION OF TEST SURFACES**

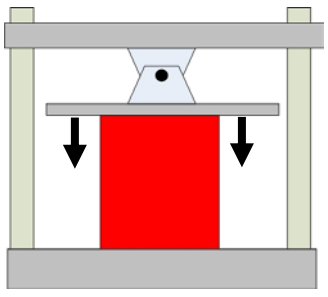
<b>3 = Bottom</b>	Surface on which the package will typically rest during transportation. It is the largest surface unless dictated otherwise by the presence of a pallet and/or directional arrows printed on the exterior of the shipping carton.
<b>1 = Top</b>	Surface opposite bottom.
<b>5 = Front</b>	The next largest surface other than the bottom. Choice of front and rear is determined by individual performing test.
<b>6 = Rear</b>	Surface opposite front.
<b>2 = Right</b>	Dictated by the figure.
<b>4 = Left</b>	Dictated by the figure.



**7.0 STATIC COMPRESSION**

<b>Reference</b>	ASTM D4577, D642
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**Package Weight: All**

<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Precondition package for a minimum of 24 hours at <math>22^{\circ} \pm 1^{\circ}\text{C}</math> [<math>72^{\circ} \pm 2^{\circ}\text{F}</math>] and <math>50\% \pm 5\%</math> RH</li> <li>2. Place package on compression table.             <ul style="list-style-type: none"> <li>▪ Package should be tested in its normal shipping orientation.</li> <li>▪ Package may be tested empty or with product.</li> <li>▪ Open mail slots/trap doors in package (keep open during test).</li> </ul> </li> <li>3. Apply pre-load to top surface (surface #1).             <ul style="list-style-type: none"> <li>▪ 22.7 kg [50 lb] for single wall corrugated.</li> <li>▪ 45.4 kg [100 lb] for double wall corrugated.</li> <li>▪ 227 kg [500 lb] for triple wall corrugated.</li> <li>▪ 45.4 kg [100 lb] for returnable plastic containers.</li> </ul> </li> <li>4. Calculate required load (<math>L_R</math>).             <ul style="list-style-type: none"> <li>▪ Increase load 10% if testing non-production boxes (e.g. samples, non printed, etc.).</li> <li>▪ Minimum of 5 packages should be tested. Increase load 10% if testing less than 5 samples.</li> <li>▪ The total increase should be 20% when testing less than 5 non-production sample boxes.</li> </ul> </li> <li>5. Apply <math>L_R</math> at a maximum rate of <math>12.7 \pm 2.5</math> mm [<math>0.5 \pm 0.1</math> in] per minute until failure or required load is reached.</li> </ol>	
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<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanent buckling or creasing of the box during compression test.</li> <li>▪ 20% or greater fall-off in compression strength before reaching <math>L_R</math>.</li> <li>▪ All packages must meet or exceed required load without failure.</li> </ul>
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<b>Required Load (<math>L_R</math>)</b>	Metric Units	English Units
	$N = 5000 / h$ $L_R = W (N - 1) S$	$N = 197 / h$ $L_R = W (N - 1) S$
	$L_R$	= Required load ( $\text{kg}_f, \text{lb}_f$ )
	N	Number of packages in 5000 mm [197 in] stack. Round down to the nearest whole number (i.e. no fractions of a package). Example: <ul style="list-style-type: none"> <li>▪ Testing: 23 kg, 480 mm high package on a floating platen.</li> <li>▪ <math>N = 5000 / 480 = 10.4</math> packages. Round down to 10.</li> <li>▪ <math>L_R = (23)(10 - 1)(4) = 828</math> kg.</li> </ul>
	W	= Weight of shipping unit (kg, lb)
	h	= Height of shipping unit (mm, in)
	S	= Safety Factor = 4.0 for Swivel/floating platen compression test machines 4.6 for Fixed platen compression test machines



**9.0 OFFSET TOP LOAD VIBRATION**

**Palletized Package Weight ≥ 32 kg [70 lbs]**

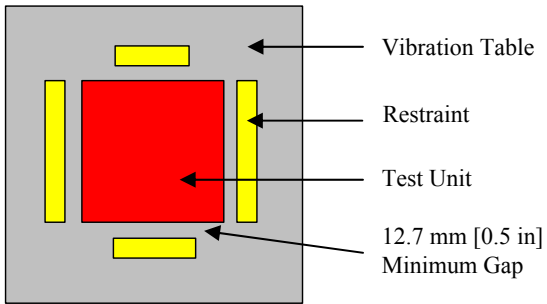
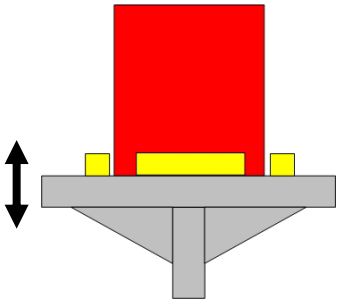
**NOTE** Perform on palletized packaged products weighing ≥ 32 kg [70 lb].

- Procedure**
1. Precondition package a minimum of 24 hours at 22° ± 1°C [72° ± 2°F] and 50% ± 5% RH.
  2. Place packaged product on vibration table. Open mail slots/trap doors (keep open during test).
  3. Calculate required load (L<sub>R</sub>).
  4. Apply L<sub>R</sub> through pallet of same construction and design. Load can consist of actual packaged product or a simulated load using weights on top of a pallet.
  5. Offset L<sub>R</sub> 50 mm [2 in] in both length and width dimensions (see set-up). Offset in most critical direction. Use engineering judgment if unknown.
  6. Vibrate packaged product under load for 15 minutes at specified random vibration spectrum.

	Metric Units	English Units
	$L_R = (N - 1)(W)$ $N = 2790 / h$	$L_R = (N - 1)(W)$ $N = 110 / h$
<b>Required Load (L<sub>R</sub>)</b>	L <sub>R</sub> = Required load (lb, kg)	
	N = Number of packages in 2790 mm [110 in] stack. Round down to the nearest whole number (i.e. no fractions of a package). If N < 2, then L <sub>R</sub> = 200 kg [440 lb] to simulate over-stowing of other commodities. Example: <ul style="list-style-type: none"> <li>▪ Testing: 23 kg, 500 mm high packaged product.</li> <li>▪ N = 2790 / 500 = 5.58 packages. Round down to 5.</li> <li>▪ L<sub>R</sub> = (5 - 1)(23) = 92 kg.</li> </ul>	
	h = Height of packaged product (mm, in)	
	W = Weight of packaged product (kg, in)	

Random Vibration Spectrum		Set-Up
<b>Break Point Frequency (Hz)</b>	<b>Power Spectral Density (g<sup>2</sup>/Hz)</b>	
1	0.00005	
2	0.0007	
3	0.0033	
4	0.01	
16	0.01	
40	0.001	
80	0.001	
200	0.00001	
Overall Vibration Level: 0.52GRMS		
<b>Tolerances:</b> <ul style="list-style-type: none"> <li>▪ Vibration conducted in accordance with ASTM 4728.</li> <li>▪ PSD ≤ ± 3 dB at any frequency.</li> <li>▪ Sigma clipping ≥ 3 Sigma if used.</li> <li>▪ Overall GRMS: ± 15%.</li> </ul>		

**10.0 VERTICAL VIBRATION**

<b>Reference</b>	ASTM D4728, ASTM D3580	
<b>Procedure</b>	<ol style="list-style-type: none"> <li>Place packaged product on vibration table and restrain on all (4) sides with a minimum gap of 12.7 mm [0.50 in] around package/pallet.</li> <li>Vibrate product at specified random vibration spectrum for specified duration.</li> </ol>	
		

**Package Weight ≤ 68 kg [150 lb]**

Test Duration				Random Vibration Spectrum	
Test Sequence	Surface against vibration table	< 45 kg [100 lb]	> 45 - 68 kg [100 - 150lb]	Break Point Frequency (Hz)	Power Spectral Density (g <sup>2</sup> /Hz)
1	3 - Bottom	15 minutes	30 minutes	1	0.0001
2	5 - Front	15 minutes	15 minutes	2	0.0014
3	6 - Rear	15 minutes	15 minutes	3	0.0067
4	2 - Right	15 minutes	15 minutes	4	0.02
5	4 - Left	15 minutes	15 minutes	16	0.02
6	1 - Top	15 minutes	None	20	0.01
<b>Tolerances:</b> <ul style="list-style-type: none"> <li>Vibration conducted in accordance with ASTM 4728.</li> <li>PSD ≤ ± 3 dB at any frequency.</li> <li>Sigma clipping ≥ 3 Sigma if used.</li> <li>Overall GRMS: ± 15%.</li> </ul> <b>Note:</b> Properly operating test will cause test item to separate from vibration table.				100	0.01
				200	0.001
				Overall Level: 1.20 GRMS	

**Package Weight > 68 kg [150 lb]**

Test Duration			Random Vibration Spectrum	
Test Sequence	Surface against vibration table	> 68 kg [150 lb]	Break Point Frequency (Hz)	Power Spectral Density (g <sup>2</sup> /Hz)
1	3 - Bottom	90 minutes	1	0.00005
<b>Tolerances:</b> <ul style="list-style-type: none"> <li>Vibration conducted in accordance with ASTM 4728.</li> <li>PSD ≤ ± 3 dB at any frequency.</li> <li>Sigma clipping ≥ 3 Sigma if used.</li> <li>Overall GRMS: ± 15%.</li> </ul> <b>Note:</b> Properly operating test will cause test item to separate from vibration table.			2	0.00071
			3	0.00335
			4	0.01
			100	0.01
			250	0.00003
			300	0.00001
			Overall Level: 1.075 GRMS	



## 11.0 FREE-FALL DROP

**Reference** ASTM D5276, ASTM D6179, Methods A & B

### Package Weight ≤ 91 kg [200 lb] (Sample Size < 9)

<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Raise package to height specified below.</li> <li>2. Orient package so its center of gravity is over corner or edge being tested.</li> <li>3. Allow package to free fall onto test surface.</li> <li>4. When dropping onto a corner or edge, package must be allowed to rotate unrestricted onto a flat surface after initial impact.</li> </ol>	
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Package Weight		≤ 11 kg [ 25 lb]	> 11 - 32 kg [> 25 - 70 lb]	> 32 - 45 kg [> 70 - 100 lb]	> 45 - 68 kg [> 100 - 150 lb]	> 68 - 91 kg [> 150 - 200 lb]
Drop	Orientation	mm [in]	mm [in]	mm [in]	mm [in]	mm [in]
1	Bottom (3)	763 [30]	610 [24]	457 [18]	305 [12]	305 [12]
2	Edge (3/5)	763 [30]	610 [24]	457 [18]	305 [12]	305 [12]*
3	Edge (3/6)	763 [30]	610 [24]	457 [18]	305 [12]	305 [12]*
4	Edge (3/2)	763 [30]	610 [24]	457 [18]	305 [12]	305 [12]*
5	Edge (3/4)	763 [30]	610 [24]	457 [18]	305 [12]	305 [12]*
6	Corner (3/2/6)	763 [30]	610 [24]	457 [18]	305 [12]	* For this category only, when dropping onto an edge, package must be oriented such that it rotates unrestricted onto surfaces 2, 4, 5 or 6 after initial impact.
7	Corner (3/4/5)	763 [30]	610 [24]	457 [18]	305 [12]	
8	Edge (2/5)	763 [30]	610 [24]	457 [18]	305 [12]	
9	Edge (4/6)	763 [30]	610 [24]	457 [18]	305 [12]	
10	Front (5)	763 [30]	610 [24]	457 [18]	305 [12]	
11	Rear (6)	763 [30]	610 [24]	457 [18]	305 [12]	
12	Left (4)	763 [30]	610 [24]	457 [18]	305 [12]	
13	Right (2)	763 [30]	610 [24]	457 [18]	305 [12]	
14	Top (1)	763 [30]	610 [24]	457 [18]		
15	Corner (1/2/5)	763 [30]	610 [24]			
16	Corner (1/4/6)	763 [30]	610 [24]			

### Package Weight > 91 kg [200 lb]

<b>Procedure</b>	<p><u>Bottom Drop</u></p> <ol style="list-style-type: none"> <li>1. Raise package to height specified below.</li> <li>2. Allow package to free-fall onto test surface.</li> </ol> <p><u>Rotational Flat Drop</u></p> <ol style="list-style-type: none"> <li>1. Place one edge of package on test surface.</li> <li>2. Raise opposite edge to the height specified below. Allow edge to free-fall onto test surface.</li> </ol> <p><u>Rotational Corner Drops</u></p> <ol style="list-style-type: none"> <li>1. Raise one corner of package to 152 mm [6 in].</li> <li>2. Raise opposite corner to the height specified below. Allow corner to free-fall onto test surface leaving opposite corner at 152 mm [6 in].</li> </ol> <p>* To be performed on palletized products only</p>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Rotational Flat</p> </div> <div style="text-align: center;"> <p>Rotational Corner</p> </div> </div> <p style="text-align: center;">Drop height (h)</p>
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Package Weight	Drop Height (h)	Drop Type	Number of Drops
> 91 - 120 kg [> 200 - 264 lb]	254 mm [10 in]	Bottom Drop	2
	152 mm [6 in]	Rotational Flat Drop	Each Bottom Edge (4 total)
		Rotational Corner Drop	Each Bottom Corner (4 total)
> 120 - 240 kg [> 264 - 528 lb]	203 mm [8 in]	Bottom Drop	2
	152 mm [6 in]	Rotational Flat Drop	Each Bottom Edge (4 total)
		Rotational Corner Drop	Each Bottom Corner (4 total)
> 240 - 450 kg [> 528 - 990 lb]	152 mm [6 in]	Bottom Drop	2
	152 mm [6 in]	Rotational Flat Drop	Each Bottom Edge (4 total)
		Rotational Corner Drop	Each Bottom Corner (4 total)
> 450-909 kg [> 990 - 2000lb]	102 mm [4 in]	Bottom Drop	2
	152 mm [6 in]	Rotational Flat Drop	Each Bottom Edge (4 total)
		Rotational Corner Drop	Each Bottom Corner (4 total)
> 909 kg [> 2000lb]	51 mm [2 in]	Bottom Drop	2
	102 mm [4 in]	Rotational Flat Drop	Each Bottom Edge (4 total)
		Rotational Corner Drop*	Each Bottom Corner (4 total)*

## 11.1 FREE-FALL DROP

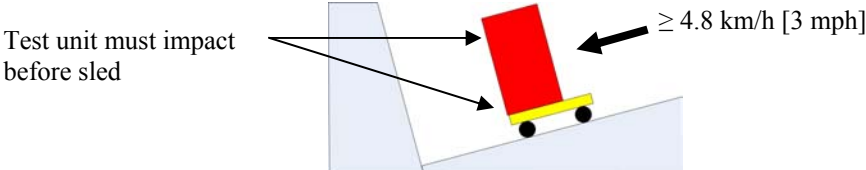
<b>Reference</b>	ASTM D5276	
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Raise package to height specified below.</li> <li>2. Orient package so its center of gravity is over corner or edge being tested.</li> <li>3. Allow package to free fall onto test surface.</li> <li>4. When dropping onto a corner or edge, package must be allowed to rotate unrestricted onto a flat surface after initial impact.</li> </ol>	
<b>Drop Heights</b>	<p><b>Green Cells = 914 mm [36 in]</b></p> <p><b>White Cells = 457 mm [18 in]</b></p>	

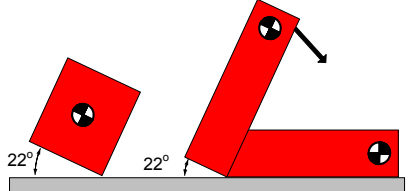
**Package Weight < 11 kg [25 lb]**  
(Sample Size ≥ 9)

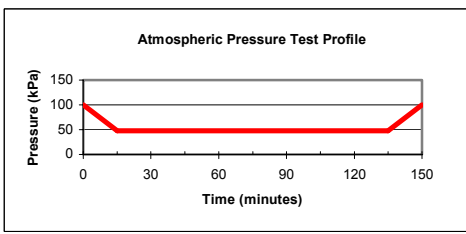
Drop	Sample Package								
	1	2	3	4	5	6	7	8	9
1	Edge 3-4	Edge 2-3	Edge 3-4	Edge 3-4	Corner 1-2-5	Edge 3-4	Edge 3-4	Edge 3-4	Edge 3-4
2	Edge 3-6	Edge 3-6	Edge 3-6	Face 3	Edge 3-4	Edge 3-6	Edge 3-6	Edge 3-6	Corner 1-2-6
3	Corner 1-4-5	Face 3	Face 1	Edge 3-5	Edge 3-6	Face 4	Face 5	Face 5	Edge 3-6
4	Face 2	Face 1	Face 2	Face 2	Face 2	Edge 3-5	Face 4	Face 4	Face 4
5	Face 1	Face 2	Face 3	Face 4	Face 5	Face 6	Edge 1-2	Edge 2-3	Edge 3-4
6	Face 3	Corner 3-4-6	Edge 3-5	Face 5	Edge 2-3	Face 1	Edge 2-3	Face 2	Face 2
7	Corner 3-4-5	Corner 3-4-5	Face 3	Corner 2-3-6	Corner 2-3-5	Edge 2-3	Face 3	Edge 3-5	Edge 3-5
8	Face 4	Face 6	Edge 2-3	Face 4	Face 3	Corner 2-3-5	Edge 3-5	Face 1	Face 1
9	Edge 2-5	Edge 2-6	Face 5	Edge 2-3	Edge 3-5	Corner 2-3-6	Face 6	Corner 2-3-6	Face 3
10	Face 5	Edge 1-6	Edge 4-6	Corner 3-4-6	Face 4	Face 3	Corner 3-4-6	Edge 2-3	Edge 2-3
11	Edge 4-6	Edge 4-5	Edge 2-6	Edge 1-4	Corner 3-4-5	Edge 4-5	Face 3	Corner 2-3-5	Face 5
12	Edge 4-5	Face 4	Face 4	Face 6	Edge 4-6	Corner 1-4-5	Edge 4-6	Face 3	Corner 3-4-6
13	Edge 3-5	Edge 1-5	Edge 2-5	Edge 4-5	Edge 3-6	Edge 1-6	Edge 2-6	Edge 4-6	Edge 1-4
14	Edge 1-2	Edge 2-5	Corner 2-3-5	Corner 2-3-5	Face 1	Edge 1-5	Face 2	Edge 2-6	Edge 2-5
15	Corner 2-3-6	Face 5	Corner 3-4-6	Corner 1-4-6	Edge 2-5	Face 2	Corner 2-3-6	Face 6	Corner 3-4-5
16	Face 6	Corner 1-4-6	Face 6	Face 1	Face 6	Face 5	Face 1	Corner 3-4-5	Face 6

**≥ 11 kg [25 lb] - 32 kg [70 lb]**  
(Sample Size ≥ 9)

1	Edge 3-4	Face 6	Face 5	Corner 2-3-6	Corner 1-2-5	Edge 3-4	Face 3	Edge 3-4	Face 2
2	Face 5	Edge 3-6	Edge 3-5	Face 3	Face 1	Corner 2-3-5	Edge 3-6	Edge 3-5	Corner 1-2-6
3	Corner 1-4-5	Face 3	Face 2	Face 5	Face 3	Face 4	Face 5	Face 5	Edge 3-6
4	Face 2	Face 1	Face 3	Face 2	Face 2	Corner 3-4-5	Face 4	Face 2	Face 4
5	Face 1	Face 2	Face 3	Face 4	Face 5	Face 6	Edge 1-2	Edge 2-3	Edge 3-4
6	Edge 3-5	Edge 2-6	Face 1	Face 4	Edge 3-5	Corner 2-3-6	Face 6	Corner 2-3-6	Face 3
7	Face 6	Face 5	Edge 4-6	Corner 1-4-6	Face 4	Face 3	Corner 2-3-5	Edge 2-3	Edge 2-3
8	Face 4	Corner 1-4-6	Corner 3-4-6	Edge 2-3	Corner 3-4-6	Edge 4-5	Face 3	Corner 3-4-5	Face 6
9	Corner 2-3-5	Face 4	Face 6	Face 6	Edge 2-5	Edge 2-3	Corner 3-4-6	Face 3	Corner 3-4-5
10	Face 3	Edge 1-5	Edge 2-5	Edge 4-5	Edge 3-6	Edge 1-6	Edge 2-6	Edge 4-6	Edge 1-4

12.0 INCLINE IMPACT	
<b>Reference</b>	ASTM D880
<b>Package Weight &gt; 68 kg [150 lb]</b>	
<b>Procedure</b>	<ol style="list-style-type: none"> <li>Place package on sled of test equipment so package will impact before sled.</li> <li>Release sled allowing package to impact test surface.</li> <li>Sled must be traveling <math>\geq 4.8</math> km/h [3 mph] at impact.</li> <li>Repeat for remaining package orientations.</li> </ol>
<b>Procedure</b>	<p>Test unit must impact before sled</p> 
<b>Impact Surfaces</b>	<ul style="list-style-type: none"> <li>Each vertical surface for total of 4 impacts, Right (2), Left (4), Front (5) <u>and</u> Rear (6).</li> <li>One vertical edge, 2-5, 2-6, 4-5 <u>or</u> 4-6. Choose most critical edge.</li> </ul>
<b>NOTE</b>	A 152 mm [6 in] free-fall drop can be substituted for the incline impact if incline impact test equipment is unavailable.

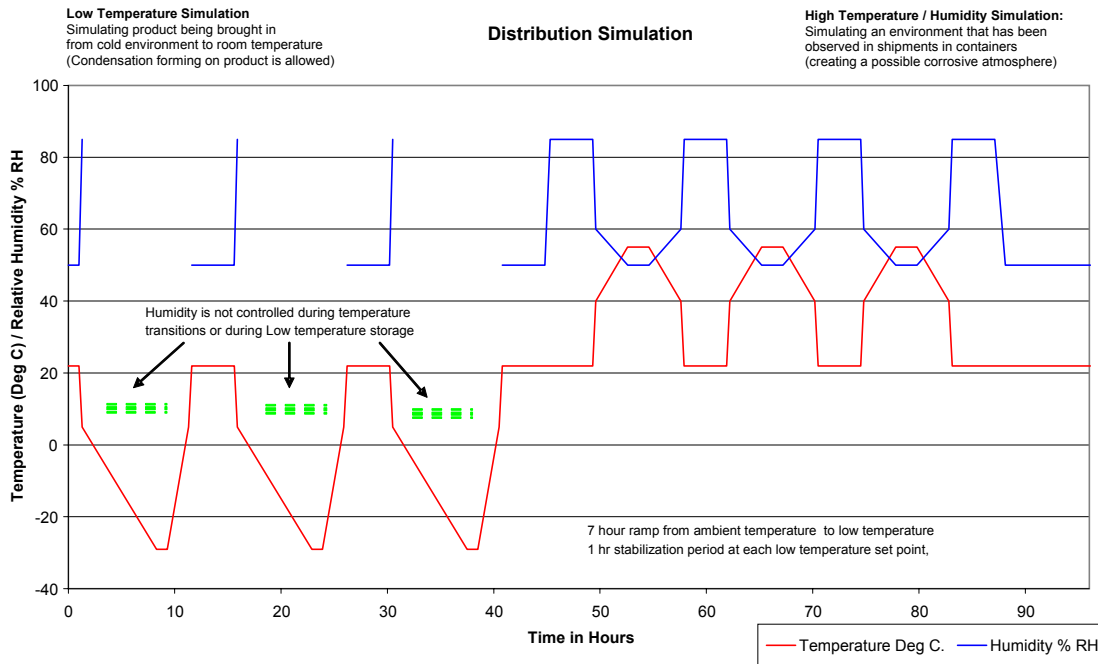
13.0 PACKAGE STABILITY																
<b>Reference</b>	ASTM D6179, Method F															
<b>Package Weight <math>\geq 32</math> kg [70 lb]</b>																
<b>Procedure</b>	<ol style="list-style-type: none"> <li>Lift package <u>bottom</u> to 22° along 3/5 edge.</li> <li>If package does not tip over, then gently place back onto bottom (do not free-fall drop).</li> <li>If package tips over, then allow to free-fall onto front.</li> <li>Repeat for remaining surfaces</li> </ol>															
<b>Procedure</b>	<table border="1" style="display: inline-table; vertical-align: top;"> <thead> <tr> <th>Stand On</th> <th>Tip Edge</th> <th>Topple Onto</th> </tr> </thead> <tbody> <tr> <td>Bottom (3)</td> <td>3/5</td> <td>Front (5)</td> </tr> <tr> <td>Bottom (3)</td> <td>3/6</td> <td>Rear (6)</td> </tr> <tr> <td>Bottom (3)</td> <td>3/2</td> <td>Right (2)</td> </tr> <tr> <td>Bottom (3)</td> <td>3/4</td> <td>Left (4)</td> </tr> </tbody> </table> 	Stand On	Tip Edge	Topple Onto	Bottom (3)	3/5	Front (5)	Bottom (3)	3/6	Rear (6)	Bottom (3)	3/2	Right (2)	Bottom (3)	3/4	Left (4)
Stand On	Tip Edge	Topple Onto														
Bottom (3)	3/5	Front (5)														
Bottom (3)	3/6	Rear (6)														
Bottom (3)	3/2	Right (2)														
Bottom (3)	3/4	Left (4)														

14.0 ATMOSPHERIC PRESSURE	
<b>Reference</b>	ASTM D6653
<b>Package Weight: All</b>	
<b>NOTE</b>	Perform test on any packaged product that may be sensitive to atmospheric pressure.
<b>Procedure</b>	<ol style="list-style-type: none"> <li>Ramp up to altitude to 6,092 m, 349.253 mm/Hg [20,000 ft] and dwell for <u>2 hours</u>. Altitude change rate from ambient to test level should be 7.6 m/s [1500 ft/min].</li> <li>Reduce pressure to <u>ambient</u> conditions and dwell for <u>2 hours</u>. Altitude change rate from test level to ambient should be 7.6 m/s [1500 ft/min].</li> <li>Inspect product at ambient conditions.</li> </ol>
	

**15.0 TEMPERATURE AND HUMIDITY**

**Package Weight: All**

**Procedure** Apply transportation temperature and humidity test to any packaged products that may be sensitive to changes in temperature or humidity using the following profile:

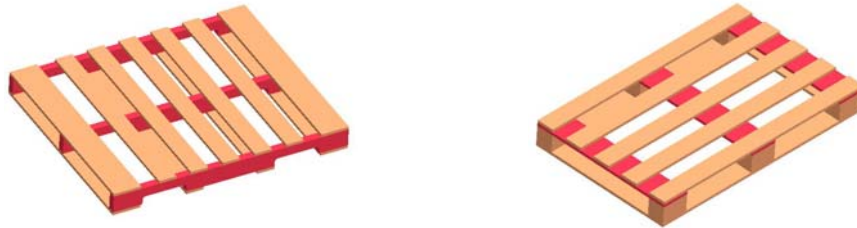


Step	Duration	Total Time (hours)	Temperature		Relative Humidity (% RH)
			°C	°F	
1	1 hr. hold	1	22	72	50
2	17 min ramp	1.3	5	41	85
3	7 hr ramp	8.3	-29	-20	Uncontrolled
4	1 hr hold	9.3	-29	-20	Uncontrolled
5	2 hr ramp	11.3	5	41	Uncontrolled
6	17 min ramp	11.6	22	72	50
7	4 hr hold	15.6	22	72	50
8	Repeat steps 2 – 7	30.1			
9	Repeat steps 2 – 7	44.7			
10	30 min ramp	45.2	22	72	85
11	4 hr hold	49.2	22	72	85
12	18 min ramp	49.5	40	104	60
13	3 hr ramp	52.5	55	131	50
14	2 hr hold	54.5	55	131	50
15	3 hr ramp	57.5	40	104	60
16	18 min ramp	57.8	22	72	85
17	4 hr hold	61.8	22	72	85
18	Repeat steps 12 -17	74.4			
19	Repeat steps 12 -17	87			
20	1 hr ramp	88	22	72	50
21	8 hr hold for testing	96	22	72	50

**Total Time: 96 hours = 4 Days**

**16.0 PALLET INTEGRITY TESTS****General Information:**

1. Minimum sample size of three pallets is recommended. Each pallet is expected to pass tests 16.1 through 16.7 cumulatively.
2. **Pallet categories:**
  - a. **Individual pallets:** pallet quantity is always one. (example: machines packaged 1 per pallet) Individual machine pallets greater than 1270 mm [50 in] are exempt from pallet integrity tests.
  - b. **General use pallets:** pallet quantity is greater than one (examples: Any items loaded two or more per pallet including machines, options, consumables, spares and MN8 boxes.)
3. Load bars must be rigid, 50 mm [2 in] wide, and extend beyond pallet on both ends. Square steel tube and aluminum extrusions are acceptable.
4. Load to be applied using a floating platen. Deflection is to be measured from the center of the floating platen. Alternately, dead load can be used. If dead load is used, deflection is to be measured from the point of maximum deflection.
5. For some tests, pallet orientation is determined relative to stringer direction. Stringers for common pallet construction are shown below in red.



**16.1 PALLET CORNER DROP**

<b>Reference</b>	ASTM D1185	
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Measure corner to corner dimension diagonally across pallet deck. Use corners not being impacted.</li> <li>2. Drop 1 meter [39.4 in] onto a vertical edge as shown.</li> <li>3. Re-measure corner to corner dimension diagonally across pallet deck</li> <li>4. Total number of drops: 1</li> </ol>	
<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanently deformed or broken pallet members.</li> <li>▪ Deflection exceeding 2% of pallet diagonal.</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>	

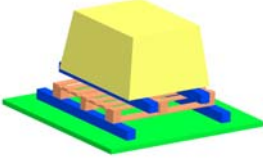
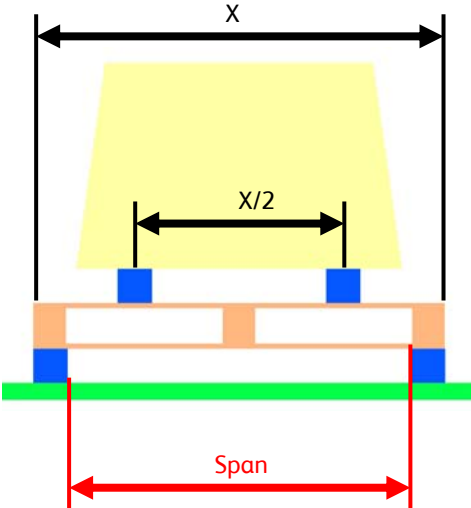
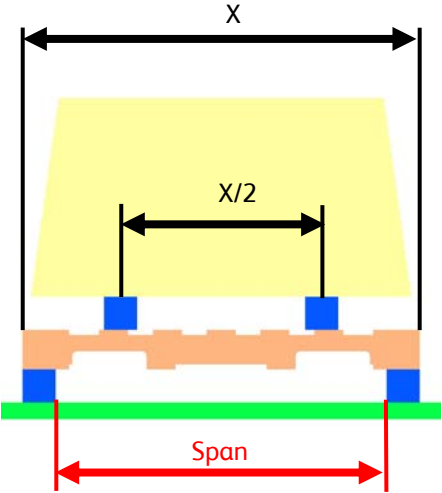
**16.2 PALLET EDGE DROP**

<b>Reference</b>	ASTM D1185	
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Measure angle between top deck and stringer/block before impact.</li> <li>2. Position pallet with center of gravity aligned directly over bottom edge. Drop from 1 meter [39.4 in] onto either bottom edge adjacent to impacted corner from 16.1.</li> <li>3. Re-measure angle between top deck and stringer/block before after impact.</li> <li>4. Repeat on other adjacent bottom edge</li> <li>5. Total number of drops: 2</li> </ol>	
<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanently deformed or broken pallet members.</li> <li>▪ Angular change exceeding 5 degrees from normal (square) position.</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>	

**16.3 PALLET DROP ONTO HAZARD**

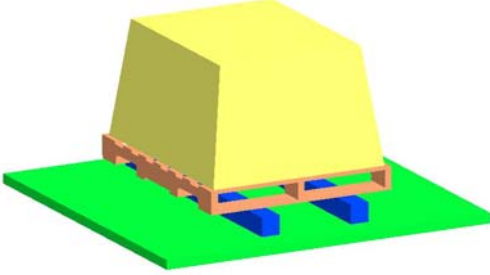
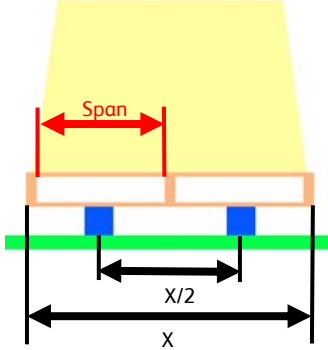
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Drop onto hazards from 1 meter [39.4 in] onto both sides not previously tested.</li> <li>2. Hazards shall be 100 mm [4 in] wide square steel tube symmetrically spaced half the pallet side dimension apart.</li> <li>3. Total number of drops: 2</li> </ol>	
<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanent deflection exceeding 6 mm [0.25 in]</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>	

**16.4 PALLET RACKING STRENGTH**

Reference	ASTM D1185, ISO 8611			
Procedure				
				
	<ol style="list-style-type: none"> <li>Place pallet on top of load bars as shown parallel to stringers.</li> <li>Calculate and actual load (<math>L_A</math>) and minimum load (<math>L_M</math>). For individual pallets, test using actual load (<math>L_A</math>). For general use pallets, test using the greater of actual load (<math>L_A</math>) or minimum load (<math>L_M</math>).</li> <li>Apply datum load of 50 kg [110 lb]</li> <li>Apply test load at a rate of <math>12.7 \pm 2.5</math> mm [<math>0.5 \pm 0.1</math> in] per minute until required load is reached or failure occurs.</li> <li>Measure deflection from datum load position through duration of test.</li> <li>Maintain load for one hour. Test can be stopped early and considered to pass if peak deflection is less than 1% of pallet span after 20 minutes.</li> <li>Repeat test with load bars rotated 90 degrees to stringers.</li> </ol>			
Failure Criteria	<ul style="list-style-type: none"> <li>Permanently deformed or broken pallet members.</li> <li>Deflection exceeding 2% of pallet span.</li> <li>Any change that makes the pallet unsafe for use.</li> </ul>			
Actual Load ( $L_A$ ) For individual and general use pallets	Metric Units		English Units	
	$L_A = m \times (1.5/h_1) \times S$		$L_A = m \times (59/h_1) \times S$	
	$L_A$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> ) pallet	$h_1$	= Pallet load height (meter, inch) not to exceed 1.5 m [59 in]
$m$	= Mass of loaded pallet (kg, lb)	$S$	= Safety Factor: 1.25	
Minimum Load ( $L_M$ ) For general use pallets only	Metric Units		English Units	
	$L_M = 264 \times l \times w \times S$		$L_M = 0.37 \times l \times w \times S$	
	$L_M$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> )	$w$	= Width of pallet (m, in)
$l$	= length of pallet (m, in)	$S$	= Safety Factor: 1.25	

**16.5 PALLET BOTTOM STRENGTH**

**Reference** ASTM D1185, ISO 8611

<b>Procedure</b>		
	<ol style="list-style-type: none"> <li>1. Place pallet on top of load bars as shown parallel to stringers. Note: Pallet can be tested upside down to simplify setup</li> <li>2. Calculate and actual load (<math>L_A</math>) and minimum load (<math>L_M</math>). For individual pallets, test using actual load (<math>L_A</math>). For general use pallets, test using the greater of actual load (<math>L_A</math>) or minimum load (<math>L_M</math>).</li> <li>3. Apply datum load of 50 kg [110 lb]</li> <li>4. Apply test load at a rate of <math>12.7 \pm 2.5</math> mm [<math>0.5 \pm 0.1</math> in] per minute until required load is reached or failure occurs.</li> <li>5. Measure deflection from datum load position through duration of test.</li> <li>6. Maintain load for one hour. Test can be stopped early and considered to pass if peak deflection is less than 1% of pallet span after 20 minutes.</li> <li>7. If the pallet has bottom boards in both directions, the test shall be carried out in both parallel and perpendicular to pallet stringers</li> </ol>	

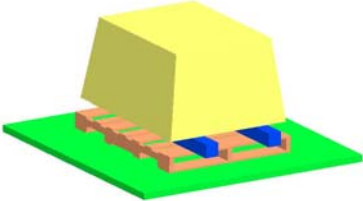
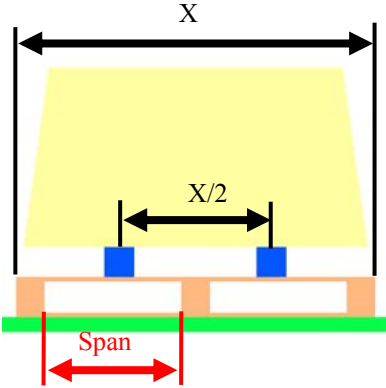
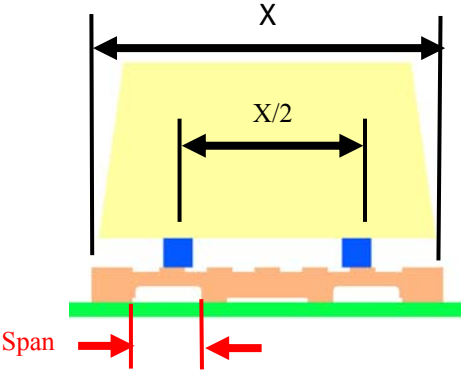
<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanently deformed or broken pallet members.</li> <li>▪ Deflection exceeding 2% of pallet span.</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>
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<b>Actual Load (<math>L_A</math>) For individual and general use pallets</b>	Metric Units		English Units	
	$L_A = m \times (1.5/h_1) \times S$		$L_A = m \times (59/h_1) \times S$	
	$L_A$	= Minimum load ( $kg_f, lb_f$ ) pallet	$h_1$	= Pallet load height (meter, inch) not to exceed 1.5 m [59 in]
	$m$	= Mass of loaded pallet (kg, lb)	$S$	= Safety Factor: 1.25

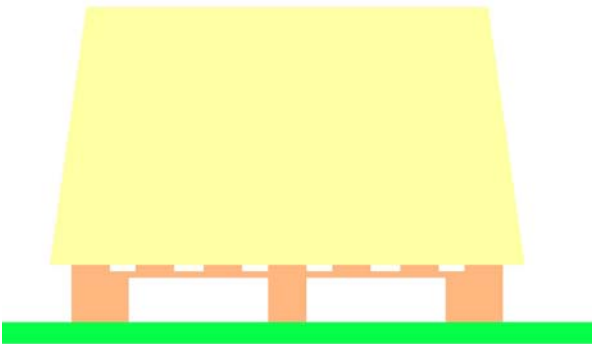
<b>Minimum Load (<math>L_M</math>) For general use pallets only</b>	Metric Units		English Units	
	$L_M = 264 \times l \times w \times S$		$L_M = 0.37 \times l \times w \times S$	
	$L_M$	= Minimum load ( $kg_f, lb_f$ )	$w$	= Width of pallet (m, in)
	$l$	= length of pallet (m, in)	$S$	= Safety Factor: 1.25



**16.6 PALLET TOP DECK STRENGTH**

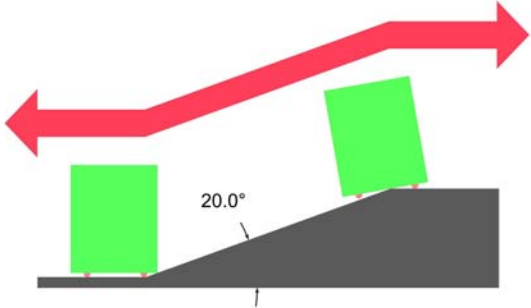
Reference	ASTM D1185, ISO 8611			
Procedure				
				
	<ol style="list-style-type: none"> <li>1. Place load bars on top of pallet as shown parallel to stringers</li> <li>2. Calculate and actual load (<math>L_A</math>) and minimum load (<math>L_M</math>). For individual pallets, test using actual load (<math>L_A</math>). For general use pallets, test using the greater of actual load (<math>L_A</math>) or minimum load (<math>L_M</math>).</li> <li>3. Apply datum load of 50 kg [110 lb]</li> <li>4. Apply test load at a rate of <math>12.7 \pm 2.5</math> mm [<math>0.5 \pm 0.1</math> in] per minute until required load is reached or failure occurs.</li> <li>5. Measure deflection from datum load position through duration of test.</li> <li>6. Maintain load for one hour. Test can be stopped early and considered to pass if peak deflection is less than 1% of pallet span after 20 minutes.</li> <li>7. Repeat test with load bars rotated 90 degrees to stringers.</li> </ol>			
Failure Criteria	<ul style="list-style-type: none"> <li>▪ Permanently deformed or broken pallet members.</li> <li>▪ Deflection exceeding 2% of pallet span.</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>			
Actual Load ( $L_A$ ) For individual and general use pallets	Metric Units		English Units	
	$L_A = m \times 2.5 / h_1 \times S$		$L_A = m \times 98.4 / h_1 \times S$	
	$L_A$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> ) pallet	$h_1$	= Pallet load height (meter, inch) not to exceed 2.5 m [98.4 in]
$m$	= Mass of loaded pallet (kg, lb)	$S$	= Safety Factor: 1.25	
Minimum Load ( $L_M$ ) For general use pallets only	Metric Units		English Units	
	$L_M = 458 \times l \times w \times S$		$L_M = 0.64 \times l \times w \times S$	
	$L_M$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> )	$w$	= Width of pallet (m, in)
$l$	= length of pallet (m, in)	$S$	= Safety Factor: 1.25	

**16.7 TOP LOAD**

<b>Reference</b>	ASTM D1185, ISO 8611				
<b>Procedure</b>	<div style="text-align: center;">  </div> <ol style="list-style-type: none"> <li>1. Calculate and actual load (<math>L_A</math>) and minimum load (<math>L_M</math>). For individual pallets, test using actual load (<math>L_A</math>). For general use pallets, test using the greater of actual load (<math>L_A</math>) or minimum load (<math>L_M</math>).</li> <li>2. Apply datum load of 50 kg [110 lb]</li> <li>3. Apply test load at a rate of <math>12.7 \pm 2.5</math> mm [<math>0.5 \pm 0.1</math> in] per minute until required load is reached or failure occurs.</li> <li>4. Measure deflection from datum load position through duration of test.</li> <li>5. Maintain load for one hour. Test can be stopped early and considered to pass if peak deflection is less than 2 mm [0.08 in] after 20 minutes.</li> </ol>				
<b>Failure Criteria</b>	<ul style="list-style-type: none"> <li>▪ Permanently deformed or broken pallet members.</li> <li>▪ Deflection exceeding 4 mm [0.16 in].</li> <li>▪ Any change that makes the pallet unsafe for use.</li> </ul>				
<b>Actual Load (<math>L_A</math>) For individual and general use pallets</b>	Metric Units		English Units		
	$L_A = m \times 5 / h_1 \times S$		$L_A = m \times 197 / h_1 \times S$		
	$L_A$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> )	$h_1$	= Pallet load height (meter, inch) not to exceed 5 m (197 in)	
	$m$	= Mass of loaded pallet (kg, lb)		$S$	= Safety Factor: 1.25
<b>Minimum Load (<math>L_M</math>) For general use pallets only</b>	Metric Units		English Units		
	$L_M = 943 \times l \times w \times S$		$L_M = 0.98 \times l \times w \times S$		
	$L_M$	= Minimum load (kg <sub>f</sub> , lb <sub>f</sub> )		$w$	= Width of pallet (m, in)
	$l$	= length of pallet (m, in)		$S$	= Safety Factor: 1.25

17.0 VERTICAL VIBRATION - UNPACKAGED PRODUCT																					
<b>NOTE</b>	Only performed on products with castors that could travel through the distribution channel in part without a package and/or pallet.																				
<b>Reference</b>	ASTM D4728, ASTM D3580																				
<b>Procedure</b>	<ol style="list-style-type: none"> <li>Place product on vibration table, cover with shipping blanket and strap to vertical wall.</li> <li>Vibrate product at specified random vibration spectrum for 60 minutes.</li> </ol>																				
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> </div> <div style="width: 50%;"> <table border="1"> <thead> <tr> <th colspan="2">Random Vibration Spectrum (Overall Level: 0.52 Grms)</th> </tr> <tr> <th>Break Point Frequency (Hz)</th> <th>Power Spectral Density (g<sup>2</sup>/Hz)</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.00005</td></tr> <tr><td>2</td><td>0.0007</td></tr> <tr><td>3</td><td>0.0033</td></tr> <tr><td>4</td><td>0.01</td></tr> <tr><td>16</td><td>0.01</td></tr> <tr><td>40</td><td>0.001</td></tr> <tr><td>80</td><td>0.001</td></tr> <tr><td>200</td><td>0.00001</td></tr> </tbody> </table> <p><b>Tolerances:</b> Vibration conducted in accordance with ASTM 4728. PSD ≤ ± 3 dB at any frequency. Sigma clipping ≥ 3 Sigma if used. Overall Grms: ± 15%.</p> </div> </div>		Random Vibration Spectrum (Overall Level: 0.52 Grms)		Break Point Frequency (Hz)	Power Spectral Density (g <sup>2</sup> /Hz)	1	0.00005	2	0.0007	3	0.0033	4	0.01	16	0.01	40	0.001	80	0.001	200	0.00001
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40	0.001																				
80	0.001																				
200	0.00001																				

18.0 FREE-FALL DROP - UNPACKAGED PRODUCT			
<b>NOTE</b>	Only performed on products with castors that could travel through the distribution channel in part without a package and/or pallet.		
<b>Procedure</b>	<p><u>Bottom Drop</u></p> <ol style="list-style-type: none"> <li>Raise product to height specified below.</li> <li>Allow product to free fall onto test surface.</li> </ol> <p><u>Rotational Bottom Edge Drops</u></p> <ol style="list-style-type: none"> <li>Raise one edge of product to 51 mm [2.0 in].</li> <li>Raise opposite edge to 51 mm [2.0 in]. Allow corner or edge to free-fall onto test surface leaving opposite edge at 51 mm [2.0 in].</li> </ol>		
<b>Orientation</b>	<b>Product Weight</b>	<b>Drop Height</b>	<b>Number of Drops</b>
<b>Bottom Drop</b>	< 18 kg [40 lb]	76 mm [3.0 in]	2
	18 kg [40 lb] - 45 kg [100 lb]	64 mm [2.5 in]	2
	> 45 kg [100 lb] - 136 kg [300 lb]	51 mm [2.0 in]	2
	> 136 kg [300 lb]	25 mm [1.0 in]	2
<b>Rotational Bottom Edge</b>	> 45 kg [100 lb]	51 mm [2.0 in]	1 per Each Lower Edge (4 total) (3-5, 3-6, 3-2, 3-4)

19.0 HANDLING HAZARDS – UNPACKAGED PRODUCT	
<b>NOTE</b>	<ul style="list-style-type: none"> <li>Perform on products with castors that could travel, in part, without a package and/or pallet. This includes the distribution channel and installation at the customer’s premises.</li> </ul>
<b>Acceptance Criteria</b>	<ul style="list-style-type: none"> <li>Product must be able to withstand the following handling hazards without damage, performance reduction, leakage or contamination of consumables.</li> <li>Product must not present an unsafe condition during the handling hazard (e.g. unstable).</li> </ul>
<b>Ramping</b>	<ul style="list-style-type: none"> <li>Push product onto and off ramp. With the exception of the castors, product can not contact ramp or horizontal surfaces. Prevent product from tipping as necessary.</li> <li>Ramp length must exceed product dimensions.</li> </ul> 
<b>Rough Surfaces</b>	<ul style="list-style-type: none"> <li>Traverse a distance of 15.3 m [50 ft] in both directions (steering castors leading and fixed castors leading) at a rolling speed of 4.8 km/h [3.0 mph] over conglomerate surfaces.</li> <li>If none of the castors are fixed, then all four (4) directions must be tested.</li> </ul>
<b>Mobility / Obstructions</b>	<ul style="list-style-type: none"> <li>Two (2) impacts at a speed of 4.8 km/h [3.0 mph] in each long axis (both leading and trailing castors) straight into or over the following hazards.</li> <li>If none of the castors are fixed, then all four (4) directions must be tested.             <ol style="list-style-type: none"> <li><u>Rigid obstruction</u> rising 90° and 25.4 mm [1.0 in]. Product does not have to pass over obstruction.</li> <li><u>Horizontal gap</u> of 44.5 mm [1.75 in] wide and 51 mm [2.0 in] deep.</li> </ol> </li> </ul>
<b>Product Stability</b>	<ul style="list-style-type: none"> <li>Floor standing products shall be capable of self-righting in all four directions when tilted to an angle of 10°.</li> </ul>

## 20.0 QUICK REFERENCE

### Packaged Product Tests

<b>Package Identification</b>																																																																	
<b>Static Compression</b>	Metric Units $N = 5000 / h$ (round down) $L = W(N - 1)S$	English Units $N = 197 / h$ (round down) $L = W(N - 1)S$	$L$ = Required load, kg [lbs] $W$ = Package weight, kg [lbs] $h$ = Package height, mm [in] $S$ = 4.0 for floating, 4.6 for fixed platen	Preload for: <u>Single wall</u> = 22.7 kg [50 lb] <u>Double wall</u> = 45.4 kg [100 lb] <u>Triple wall</u> = 227 kg [500 lb] <u>RPC</u> = 45.4 kg [100 lb]																																																													
<b>Split Top Load Vibration</b>	16 drops from various orientations 13 drops from 457 mm [18 in] and 3 drops from 914 mm [36 in]		10 drops from various orientations 7 drops from 457 mm [18 in] and 3 drops from 914 mm [36 in]																																																														
<b>Offset Top Load Vibration</b>	<ul style="list-style-type: none"> <li>Palletized or un-palletized packaged products <math>\geq 32</math> kg [70 lb]</li> <li>15 minutes at 0.52 GRMS</li> <li>Divide <math>L_R</math> into 4 equal parts</li> <li><math>L_R</math> (Metric) = <math>(192.6)(2.743 - h)(l)(w)</math></li> <li><math>L_R</math> (English) = <math>(12)(108 - h)(l)(w) / 1728</math></li> </ul>		<table border="1"> <thead> <tr> <th colspan="2">0.52 GRMS</th> <th colspan="2">1.2 GRMS</th> <th colspan="2">1.075 GRMS</th> </tr> <tr> <th>Hz</th> <th><math>g^2/Hz</math></th> <th>Hz</th> <th><math>g^2/Hz</math></th> <th>Hz</th> <th><math>g^2/Hz</math></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.00005</td> <td>1</td> <td>0.0001</td> <td>1</td> <td>0.00005</td> </tr> <tr> <td>2</td> <td>0.0007</td> <td>2</td> <td>0.0014</td> <td>2</td> <td>0.0007</td> </tr> <tr> <td>3</td> <td>0.0033</td> <td>3</td> <td>0.0067</td> <td>3</td> <td>0.0035</td> </tr> <tr> <td>4</td> <td>0.01</td> <td>4</td> <td>0.02</td> <td>4</td> <td>0.01</td> </tr> <tr> <td>16</td> <td>0.01</td> <td>16</td> <td>0.02</td> <td>100</td> <td>0.01</td> </tr> <tr> <td>40</td> <td>0.001</td> <td>20</td> <td>0.01</td> <td>250</td> <td>0.00003</td> </tr> <tr> <td>80</td> <td>0.001</td> <td>100</td> <td>0.01</td> <td>300</td> <td>0.00001</td> </tr> <tr> <td>200</td> <td>0.00001</td> <td>200</td> <td>0.001</td> <td></td> <td></td> </tr> </tbody> </table>			0.52 GRMS		1.2 GRMS		1.075 GRMS		Hz	$g^2/Hz$	Hz	$g^2/Hz$	Hz	$g^2/Hz$	1	0.00005	1	0.0001	1	0.00005	2	0.0007	2	0.0014	2	0.0007	3	0.0033	3	0.0067	3	0.0035	4	0.01	4	0.02	4	0.01	16	0.01	16	0.02	100	0.01	40	0.001	20	0.01	250	0.00003	80	0.001	100	0.01	300	0.00001	200	0.00001	200	0.001		
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<b>Vertical Vibration &lt; 45 kg [100 lb]</b>	<ul style="list-style-type: none"> <li>15 minutes on each of 6 surfaces (90 minutes total)</li> <li>1.2 GRMS</li> </ul>		<ul style="list-style-type: none"> <li>Vibration conducted in accordance with ASTM 4728.</li> <li>PSD <math>\leq \pm 3</math> dB at any frequency.</li> <li>Sigma clipping <math>\geq 3</math> Sigma if used.</li> <li>Overall GRMS: <math>\pm 15\%</math>.</li> </ul>																																																														
<b>Vertical Vibration 45-68 kg [100-150 lb]</b>	<ul style="list-style-type: none"> <li>30 minutes bottom, 15 minutes each of 4 sides, no top (90 min total)</li> <li>1.2 GRMS</li> </ul>																																																																
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<b>Incline Impact</b>	<ul style="list-style-type: none"> <li>Packaged products &gt; 68 kg [150 lb]</li> <li>Speed <math>\geq 4.8</math> km/h {3 mph} onto each vertical surface and one vertical edge. Choose most critical vertical edge.</li> </ul>																																																																
<b>Package Stability</b>	<ul style="list-style-type: none"> <li>Lift bottom to 22°. Gently place back onto bottom if it does not tip over. Allow to drop if it does tip over.</li> </ul>																																																																
<b>Atmospheric Pressure</b>	<ul style="list-style-type: none"> <li>6092 m, 349.253 mm/Hg [20,000 ft] for 2 hours</li> </ul>																																																																
<b>Temperature and Humidity</b>	3 Cold Cycles 3 Hot Cycles	From 22°C [72°F] 22°C [72°F]	50 % RH 85 % RH	To -29°C [-20°F] 55°C [131°F]	uncontrolled RH 50 % RH																																																												
<b>Pallet Integrity</b>	Drop test @ 1 meter [39.4 in.]			Racking Strength	Bottom Deck Strength																																																												

<b>Unpackaged Product Tests</b> – Perform on products with castors that could travel, in part, without a package and/or pallet. This includes the distribution channel and installation at the customer’s premises.				
<b>Vertical Vibration</b>	<ul style="list-style-type: none"> <li>Product strapped to vertical wall and vibrated for 60 minutes on bottom per 0.52 grms spectrum listed above.</li> </ul>			
<b>Free-fall Drop</b>	W < 18kg [40lb]	18 [40] – 45 kg [100lb]	> 45 [100] - 136 kg [300lb]	> 136 kg [300 lb]
	2 bottom drops @ 76 mm [3 in]	2 bottom drops @ 64 mm [2.5 in]	<ul style="list-style-type: none"> <li>2 bottom drops @ 51 mm [2 in]</li> <li>Rotational bottom edge drops (4 total) @ 51 mm [2 in]</li> </ul>	<ul style="list-style-type: none"> <li>2 bottom drops @ 25 mm [1 in]</li> <li>Rotational bottom edge drops (4 total) @ 51 mm [2 in]</li> </ul>
<b>Handling Hazards</b>	Ramping	Safely move on 20° ramp		
	Rough Surfaces	4.8 km/h [3 mph ] over conglomerate surface		
	Mobility / Obstructions	Rigid Obstruction: 4.8 km/h [3 mph] into 25 mm [1 in] high barrier.		
		Horizontal Gap: 4.8 km/h [3 mph] over 44.5 mm [1.75 in] wide, 51 mm [2 in] deep gap.		
Product Stability	Must self right at 10°			