



**Introduction:** This document contains the Vertical Deformation requirements for several standards commonly used to evaluate indoor sport, dance surfaces and track surfaces. This document is specific to indoor sport and dance surfaces including natural (Maple, Beech, Bamboo) as well as synthetic surfaces (Full Pour Urethane, Rubber, Pad and Pour Urethane, Vinyl and Marley) and running tracks. It does not address artificial turf.

Standards change and the reader should verify that all of the information within this document is still correct. ASET will make all efforts to keep this information current, but we may not make changes or be notified of changes immediately.

All of the standards in this document use identical equipment and computations. Their only differences are the values required to pass or achieve certain type ratings, and their uniformity requirements.

***As a reminder, performance reports do not offer any guarantee that the surface will deliver the specified or required performance to the actual installation. Small changes in the installation can result in significantly different performance levels.*** Closely monitoring materials and installation methods to make sure they match those provided in the Suitability report is one way to help ensure that the proper performance is delivered. Commission testing of new surfaces to ensure that the specified performance levels were delivered is another option.

## Review of Vertical Deformation Requirements

**DIN 18032-2:** There are two versions of this standard used by manufacturers within North America. There are significant differences between them. The older standard applied requirements only to the average values obtained on a floor. The newer pre-standard applied values to every test point. Both standards have been effectively repealed and replaced by EN 14904 (a unified CEN standard throughout Europe). These standards are still found within several specifications in North America and occasionally in other regions of the globe.

Standard Surface Type	Requirement		Uniformity
	Average	All Points	
<b>DIN 18032-2 (1991)</b>			No Uniformity Requirement
Area Elastic	≥53% (lab) ≥50% (On Site)		
Point Elastic	≥51% (lab) ≥50% (On Site)		
Combined Elastic	≥58% (lab) ≥56% (On Site)		
<b>DIN 18032-2 (2001)</b>			No Uniformity Requirement
Area Elastic		≥2.3 mm	
Point Elastic (Cat 1)		≥3.5 mm	
Point Elastic (Cat 2)		≥3.0 mm	
Combined Elastic		≥3.0 mm, ≤ 5.0 mm	
Mixed Elastic		≥2.3 mm	

**EN 14904:** This standard replaced DIN 18032-2. The results are applied to the average values. The standard places a requirement that vertical deflection levels be less than 5.0 mm. Several optional performance classes are defined within the standard as well. We have listed both the required and optional performance requirements.

Mandatory Requirements				
All Systems	VD ≤ 5.0 mm - No Uniformity Requirements			
	Type 1	Type 2	Type 3	Type 4
Point Elastic	≤ 2.0 mm	≤ 3.0 mm	≤ 3.5 mm	
Mixed Elastic			≤ 3.5 mm	≤ 3.5 mm
Area Elastic			≥ 1.8 mm, < 3.5 mm	≥ 2.3 mm, < 5.0 mm
Combination Elastic			≥ 1.8 mm, < 5.0 mm VD <sub>p</sub> ≥ 0.5 mm, < 2.0 mm	≥ 2.3 mm, < 5.0 mm VD <sub>p</sub> ≥ 0.5 mm, < 2.0 mm
Where VD <sub>p</sub> = The vertical deflection of the point elastic playing surface only.				

**ASTM F2772:** This standard was developed in response to both DIN 18032-2 and EN 14904. North American user groups, labs and manufacturers had no voice in the development of European (EN) Standards. The open nature of ASTM's standard development process allowed all to contribute to its development. It is commonly referenced in synthetic sports surface specifications but it is not often used for courts with wood playing surfaces. The performance 'Types' within this section of the standard apply to all surface types.

Standard Surface Type	Average Performance Requirement		Uniformity
	Minimum	Maximum	
<b>ASTM F2772</b>			<b>All Points Within ±0.7 mm Of the Average</b>
Point Elastic		<3.5 mm	
Area Elastic (Class A)	≥1.8 mm	≤5.0 mm	
Area Elastic (Class B)		< 1.8 mm	
Combined Elastic (Class A)	≥1.8 mm	≤5.0 mm	
Combined Elastic (Class B)		< 1.8 mm	

**ANSI E1.26 :** ANSI E1.26 or Entertainment Technology - Recommended Testing Methods and Values for Shock Absorption of Floors Used in Live Performance Venues was developed by the Entertainment and Services Association, or ESTA. This is a general standard and within the Recommendations Section (5), it does provide some guidance for the vertical deformation properties of the surface:

- Uniformity: The section states that all values will be within 5% of the average. This is unrealistic for this property and it is thought that the writers intended for this section to refer to force reduction levels only.
- Acceptable vertical deformation levels shall be a maximum of 5.0 mm

While these levels may have been intended to be requirements, they are within the recommendations section.

**FIBA 2014:** The International Federation of Basketball (FIBA) has adopted rules for basketball surfaces. The newest version of their rules was published in 2014. This was a revision from rules published in 2011, with the main change being that the performance requirements were switched from applying to the average value to applying to every test point, similar to DIN 18032 (2001). Not all surfaces are clearly defined within the rules.

Standard Surface Level/Type	Requirements at All Points	Uniformity
	Minimum	
<b>FIBA 2014</b>		All Points Within ±0.7 mm Of the Average
Level 1 (permanent wood)	≥ 2.3 mm, < 5.0 mm	
Level 1 (mobile wood)	≥ 1.5 mm, < 5.0 mm	
Levels 2 & 3 (permanent synthetic)	≤ 3.5 mm	
Note: The published rules from FIBA do not include uniformity requirements for Level 2 & 3 Permanent Synthetic surfaces. This is believed to be an oversight since the other Levels include this and because EN 14904 includes this requirement for all surfaces.		



**MFMA PUR™**: The Maple Flooring Manufacturer's Association, or MFMA, has adopted a PUR™ Standard for Maple sport and dance surfaces. The MFMA has set performance requirements using a range of activities. These standards were developed by the flooring manufacturers. ASET is unaware if any input from user groups, or research/test organizations were used to determine these levels.

Standard Surface Level/Type	Requirements at All Points Minimum	Uniformity
<b>MFMA PUR</b>		<b>All Points Within ±5% Of the Average</b>
Basketball	≥ 2.3 mm	
Portable	≥ 1.5 mm	
Aerobics	≥ 2.3 mm	
Dance	≥ 2.3 mm	
Volleyball	≥ 2.3 mm	
Squash	≥ 1.5 mm	
Racquetball	≥ 1.5 mm	
Handball	≥ 1.5 mm	



**IAAF (2008):** The International Association of Athletic Federation, or IAAF, last published the Track and Runway Synthetic Surface Testing Specifications in 2016. This organization governs international Track and Field competition. The equipment used to measure Vertical Deformation in Section 2.5 of this manual is identical to that used in the other standards referenced in this document with one exception. However they are exploring the AAA method as an alternative.

The IAAF facilities manual requires shock absorption, or Vertical Deformation, be between 0.6 mm and 2.5 mm at any temperature between 10° C and 40° C. A review of this standard did not find any reference to uniformity requirements.

**ASTM F2157:** Standard Specification for Running Tracks (2009) is based on the IAAF (2008) methods. This standard establishes 3 different classes of tracks.

Standard Surface Type	Average Performance Requirement	
	Minimum	Maximum
<b>ASTM F2157</b>		
Class A	≥0.6 mm	≤2.5 mm
Class B	≥0.6 mm	≤2.8 mm
Class C	≥0.5 mm	≤3.0 mm



**Notes:**

- 1- All of the standards listed in this document are valid for laboratory and on-site testing.
- 2- Vertical Deformation is believed to measure a surface's ability to respond during foot-floor contact, and is thought to be related to foot stability. At this time ASET is unaware of any study that links Vertical Deformation performance to a reduction in injuries or an improvement in performance.
- 3 – The standard test to evaluate Vertical Deformation involves a 20 kg (44 lb) mass that is dropped from 120 mm (4.72”). Athletes and users come in all different shapes and sizes. The test provides a standard method for testing the surface, but the results do not correlate equally to all user groups. A dancer with a slight build and no shoes for example interacts with the surface in ways that are significantly different than a professional basketball player wearing sports shoes.