

# IN•TOUCH®

## INFORMATION ON FLEXIBLE POLYURETHANE FOAM

IN•TOUCH® is a regular publication of the Polyurethane Foam Association. It covers topics of interest to users of flexible polyurethane foam and is designed as a quick reference for background information on key issues. To get more detailed information about a particular topic, consult a PFA member.

### The Case For Prime Polyurethane Carpet Cushion

This issue of IN•TOUCH® is intended for use throughout the carpet cushion distribution channel. It contains information to support decision-making and development of merchandising strategies by carpet cushion retailers, distributors and cushion manufacturers. Various flexible polyurethane foam chemical and mechanical production technologies are discussed to support an understanding of the many performance and comfort options afforded by prime carpet cushion products.

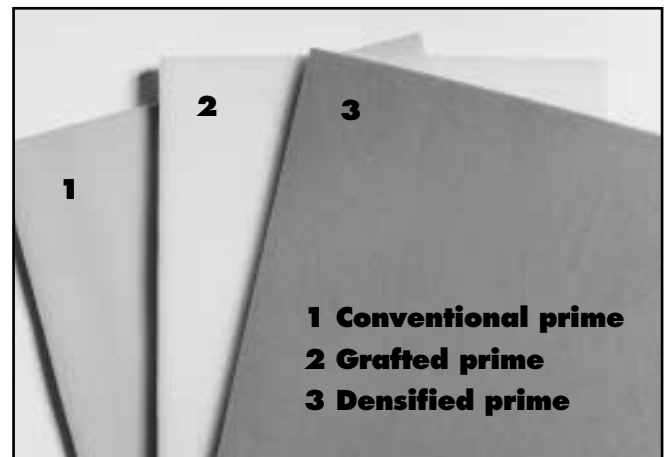
Certain information contained in this publication may relate to subjects addressed in other IN•TOUCH® issues. Such references are shown in the text with parentheses<sup>(2)</sup> as noted below.

#	SUBJECT	ISSUE	TITLE
(1)	Basic Properties	Vol. 1, No. 1	"Flexible Polyurethane Foam: A Primer"
(2)	Density	Vol. 1, No. 2	"Importance of Density"
(3)	Carpet Cushion	Vol. 1, No. 4	"Flexible Polyurethane Foam Carpet Cushion"
(4)	PFA Walk-On Test	Vol. 3, No. 2	"Composite Carpet System Performance Testing"
(5)	Firmness	Vol. 4, No. 3	"How Foam Firmness Affects Performance"

### Defining Prime

Within the carpet cushion business, the term **prime** is used to describe a family of underlayment products which includes conventional prime, grafted prime and densified prime.<sup>(3)</sup> All prime products share certain characteristics. Prime cushioning is always produced from flexible polyurethane foam slabstock chemistry. Additives may be blended into the chemistry to enhance support or firmness characteristics, or to improve durability. When solid performance modifiers are added to prime cushioning, they are finely ground or liquefied to flow through the pumps, narrow feed lines and the mixing head. Permanent colors may also be added to the chemical mixture to help identify products having different physical properties and performance features.

Prime carpet cushion is normally produced in 6 foot sheet width with a specified thickness (typically 1/4" to 9/16").



**Although all prime carpet cushion products are similar in appearance, the feel underfoot can be distinctively different.**

### Conventional Prime Cushioning

As the word "conventional" indicates, this group of prime cushion products represents the basic industry technology. In the simplest terms, conventional polyols are mixed with isocyanates and water to begin a rapid chemical reaction. The reaction causes carbon dioxide gas to form tiny bubbles throughout the fluid mixture. As the gas expands, the polymeric material rises, much like a loaf of bread. Within minutes, the bubbles burst and the carbon dioxide escapes from the foam, leaving a uniform cellular structure.

Each foam cell consists of an air-filled compartment with multiple open windows formed from the surrounding network of elastic struts.

Physical characteristics such as **polymer density** (weight per cubic foot exclusive of fillers) and **firmness** (CFD) have a great effect on cushioning durability and comfort under foot.<sup>(1)(2)(5)</sup> Both polymer density and firmness should always be specified when ordering prime polyurethane carpet cushion.

As with any performance product, specification of carpet cushion properties below recommended quality levels may result in catastrophic cushion failure. Consult your carpet cushion supplier or a PFA member for minimum quality recommendations in specific cushion applications.

## Grafted Prime Cushioning

In grafted prime cushioning, a special polyol is substituted for all or part of the conventional polyol. This special polyol, called polymer polyol, graft polyol or copolymer, contains minute polymer particulate made from styrene and other monomers which are grafted into the polymer molecule.

With the addition of these reinforced polyols, the hardness range can be extended well beyond the limits of conventional prime.

Some grafted prime products have an unusual cell structure that can contribute to product performance. Unlike the uniformly shaped foam cells found in conventional prime cushioning, certain grafted prime products have irregularly shaped foam cells. The random shaped cell structure allows some cell struts to compress under slight foot fall impact, while others resist compression. In this manner, grafted prime products with irregular foam cell structure can be extremely firm and supportive without uncomfortable stiffness.

Other grafted prime products have very small, uniformly shaped foam cells. The reinforcing agents grafted into the foam molecules provide a high level of support combined with surface comfort. Both types of grafted prime carpet cushion products are capable of providing a distinctive feel under foot.

## Densified Prime

Through the use of mechanical or chemical technologies, it is possible to limit the foam rising action. This is the basic concept of densified foam. In essence, vertical struts are stunted and cell shape flattened with directional orientation.

Densified prime also provides a unique feel under foot. As vertical compression is limited by the oriented cell thickness, at a specified firmness, thickness and density, there may be less "give" on impact than with conventional or grafted prime products.

In combination with carpet, all three prime cushion products are capable of providing different "feels" under foot. The wide range of feels available with quality prime cushion can become a valuable selling tool for retailers attuned to the consumer demand for lasting comfort.

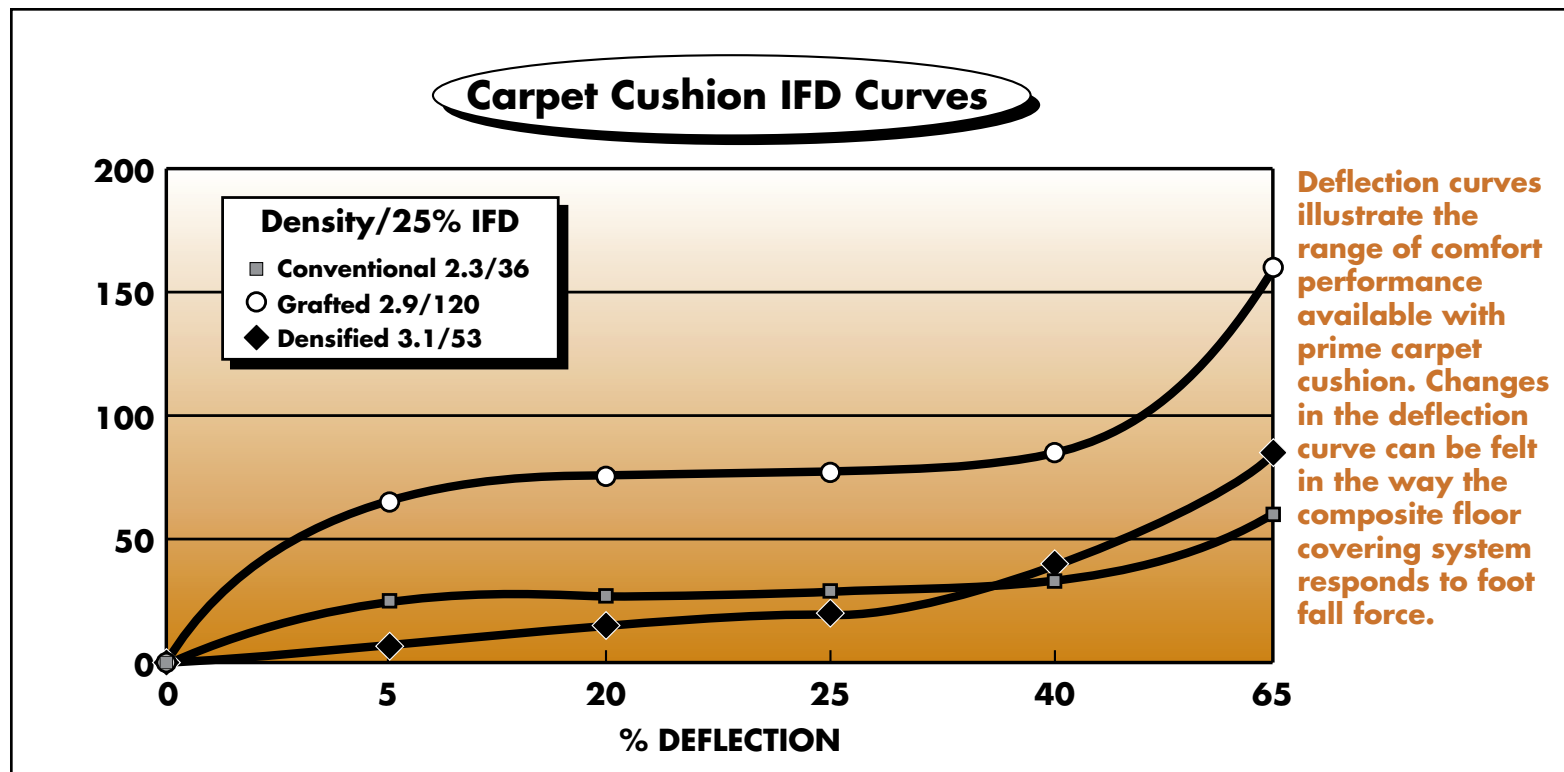
## Comfort: Providing A Subjective Choice

The fact is, there is no standard for comfort. It's an entirely subjective preference that's high on the scale of consumer buying considerations. What feels soft and responsive to one customer may feel hard and unyielding to another. A little difference in the foam's deflection curve (graph of resistance to vertical compression under increasing weight load) can greatly influence consumer buying decisions. Changes in the

foam chemistry or processing technology can affect the deflection curve, and the feel of the composite floor covering system.

## Engineered Feel: A Prime Advantage

In producing polyurethane foam for prime carpet cushioning, a number of performance properties can be controlled within ranges. Several properties are closely controlled whenever flexible polyurethane foams are produced.<sup>(1)</sup> These basic properties include: density



and firmness; compression modulus (support factor); dynamic and static fatigue; compression set; tensile, tear, and elongation strength; resilience; hysteresis;<sup>2</sup> and air flow. Beyond the primary properties, there are additional control options that can greatly influence carpet cushion feel and its overall comfort. Some of the more sophisticated foam properties that can be varied through specialized chemical and mechanical processing technologies include cell size and cell shape.

## Cell Structure Affects Cushion Performance

"High performance" technologies can be used to control cell size and shape. One such approach produces foam cells with very small compartments and windows. Air flow is impeded within the foam cell structure allowing the cushion to act as a shock absorber. Trapped air absorbs some of the foot fall force, creating a different feel under foot.

Another technology creates a cell structure capable of deflecting in a "straight line" curve under force, providing yet another comfort feel. And, there are many other "high performance" options within the family of prime cushion products.

## How Energy Is Absorbed In A Composite Floor Covering System

A composite floor covering system consists of carpet, carpet cushion and the flooring/subflooring structure. Foot fall force is a primary cause of carpet wear. The energy applied must be absorbed throughout the composite floor covering system. Since the flooring/subflooring is a solid immovable object in most installations, foot fall energy is mainly

absorbed by the carpet and cushion. While the carpet must bear the initial impact, the cushion absorbs the most force.

In addition to momentary force applied during foot fall, the cushion is also under constant load from the weight of the carpet. Generally, the more energy that can be absorbed by the cushion, the less wear on the carpet.

Based on the fact that the carpet underlayment is bearing the majority of the force responsible for carpet wear, a convincing case can be made for replacing old carpet cushion with each new carpet installation. Therefore, it is important to provide cushioning products capable of carrying the majority of the load. Your carpet cushion supplier can show you a variety of prime cushion products with different comfort feels capable of providing outstanding installation performance.

## UM72a Provides Minimum Performance Standards

In August, 1993 the U.S. Department for Housing & Urban Development (HUD/FHA) published UM72a, a set of minimum performance

requirements for carpet cushion installed in HUD/FHA housing programs. The standards were developed in conjunction with the Carpet Cushion Council after extensive small-scale performance tests (ASTM D3571-91 method). Two classes of residential carpet cushion are specified. Class 1 is used for light and moderate traffic such as living, dining, bed and recreational rooms. Class 2 may be used in Class 1 applications, but is specified for multifamily facilities, lobbies, corridors and all stair applications.

Additional tests of composite floor covering systems were conducted by the Polyurethane Foam Association at Georgia Institute of Technology using the PFA Residential Walk-On Test Protocol. These full-scale tests confirmed that prime cushion with minimum UM72a specifications provided carpet wear protection comparable to the best grades (6 lbs. density) of bonded cushion products.<sup>(4)</sup>

UM72a Requirements For Prime Carpet Cushion			
	CLASS 1	CLASS 2	
<b>Conventional Prime</b>			
characteristics ~	polymer density lbs./cu. ft. ±5%	2.2	
	thickness in. ±5%	0.375	not recommended
	comp. set max. % at 50% deflection	15.0	for Class 2
	tensile strength, psi. min.	10.0	
	elongation % min.	100.0	
<sup>2</sup> CFD psi. at 65% deflection min.	0.7		
<b>Grafted Prime</b>			
characteristics ~	polymer density lbs./cu. ft. ±5%	2.7	2.7
	thickness in. ±5%	0.375	0.25
	comp. set max. % at 50% deflection	15.0	15.0
	tensile strength, psi. min.	10.0	10.0
	elongation % min.	100.0	100.0
<sup>2</sup> CFD psi. at 65% deflection min.	1.4	1.4	
IFD lbs./50 sq. in. at 4 in. max.	120.0*	120.0*	
<b>Densified Prime</b>			
characteristics ~	polymer density lbs./cu. ft. ±5%	2.2	2.7
	thickness in. ±5%	0.313	0.25
	comp. set max. % at 50% deflection	15.0	15.0
	tensile strength, psi. min.	10.0	10.0
	elongation % min.	100.0	100.0
<sup>2</sup> CFD psi. at 65% deflection min.	.7	1.30	

\* Increased IFD firmness is allowed in proportion to density.

## Merchandising Prime Cushion Options

Unlike other underlayment products, prime cushion can be engineered to provide a broad range of comfort feels that are important to retail merchandising success. In addition to basic "good-better-best" strategy, offering a selection of prime flexible polyurethane cushioning products with different performance characteristics affords consumers an opportunity to express subjective comfort feel preferences. This is compatible with current efforts by carpet manufacturers to differentiate carpet performance and comfort benefits.

For best results, prime cushion comfort options should always be demonstrated under foot on a hard surface together with a selected carpet product.

## Product Availability

Since prime cushion products are fabricated from flexible slabstock polyurethane foam production, availability is not subject to the material shortages that may affect other types of carpet cushion products. Purchase of specific prime products can be programmed at regular intervals through your supplier.

## Summary

Prime polyurethane carpet cushion includes conventional prime, grafted prime, and densified prime products. At recommended performance levels, prime cushion provides the following benefits for retailers, distributors and manufacturers:

- ▶ 1. Can be engineered to provide desired feels using state-of-the-art flexible polyurethane foam production technology.
- ▶ 2. Appeals to subjective consumer comfort preferences with options for different firmnesses and feels.
- ▶ 3. Helps extend carpet wear by absorbing the force of foot traffic while bearing carpet weight.

- ▶ 4. Conforms to U.S. government performance standards for various traffic applications.
- ▶ 5. Competes favorably in preventing wear with the best grades of bonded cushion.
- ▶ 6. Not subject to material shortages that may affect shipment of other cushion products.

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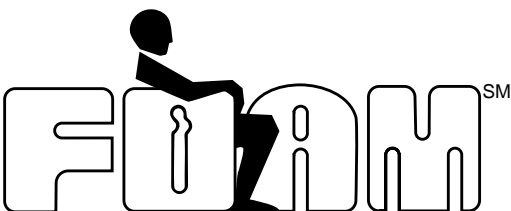
This information is provided as a service of the Polyurethane Foam Association to improve the understanding of key issues that affect flexible polyurethane foam cushioning. To learn more about specific foams, contact your foam supplier.

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**Polyurethane Foam Association**

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