

GREEN REPORT

GREEN SEALS' S
Choose

CARPET

We walk on carpet almost every day—yet the appealing colors and patterns and the cushioning comfort it provides are often taken for granted. We notice when it's worn or soiled, but we seldom, if ever, think about how this ubiquitous product is made, how it affects indoor air quality during use, and what happens to it when it is discarded and replaced. Fortunately, the carpet industry has been doing some serious thinking about the complex environmental choices among carpet materials, production processes, and recycling opportunities and offers an array of products that represent greener choices.



Carpet is usually made from synthetic fibers, such as nylon, which are produced from petroleum, a non-renewable resource. Petrochemical processes for synthetic fiber production require high inputs of energy and water and produce harmful air emissions (hazardous air pollutants and volatile organic

Carpet sent to landfills each year covers an area greater than New York City.



compounds (VOCs) that contribute to smog). Carpet production itself is energy and water intensive, and toxic dyes have been used to produce the attractive colors we demand, which sometimes end up in streams. Carpet has also been identified as a contributor to indoor air pollution, particularly from adhesives used for installation. Finally, old carpet has been typically disposed of in landfills, taking up valuable landfill space and wasting resources that could be reused or recycled. The carpet industry continues to address each of these major environmental impacts with different approaches depending on the company and the type of carpet being manufactured.

INDUSTRY FACTS

- Over **1.9 billion square yards** of carpet were produced in the United States in 1999. This is nearly **5 million tons** (based on an average of 5 pounds per square yard).
- The carpet industry currently uses an average of **10.1 gallons of water per square yard of carpet** produced.
- The average **energy use is 23,000 British Thermal Units (BTUs)** per square yard of carpet produced.
- Approximately **2.44 million tons** of old carpet were **landfilled** in 1999. The carpet waste generated in just one year at the current level, if laid flat on the ground, would be **more than enough to completely cover New York City**.

There are around 240 carpet manufacturing plants currently operating in the U.S. located in 21 states. Of these, about 174 plants are located within a 65-mile radius of Dalton, Georgia, which is known as the "Carpet Capital" of the

world. The total industry sales in 1999 were approximately \$12 billion. The United States supplies 45% of the world's carpet. Of the total carpet market, 74% is residential and 26% commercial.

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Putting It All Together

Mostly Tufted

The two main types of carpet produced in the U.S. are tufted and woven, with tufted accounting for most of the production (more than 90%). Tufting is a process that grew out of the chenille bedspread industry and involves using a series of needles to insert loops of pile yarn into a primary backing, which is commonly made of polypropylene. The loops are secured to the primary backing with an adhesive compound, typically styrene butadiene rubber (SBR), or other chemical binders. Most carpet products have a secondary backing of polypropylene for increased strength and stability and may have a synthetic foam cushion attached. Secondary backings are typically attached using smaller

amounts of SBR. Woven carpets are made on huge looms by taking the face and backing yarns together and weaving them into a thick fabric. A latex coating is usually applied to the underside to impart stability.

On the Face of It

Face fiber is used to produce the pile yarn, which is tufted or woven to form the carpet pile. Over 3.5 billion pounds of face fiber are consumed each year by the carpet manufacturing industry. The largest manufacturer alone uses over 2 million pounds of face fiber a day. The face fiber is predominantly made from synthetic materials (such as nylon,

TILES VS. BROADLOOM

Carpet is produced in two forms: broadloom (typically 6- and 12-foot width rolls) and modular tiles. Carpet tile is carpet that has been processed into squares, usually 17"x17" or greater. This type of floorcovering allows for easy access to the subfloor, unique designs on the floor, and ease of storage as it is shipped in cartons usually containing 20 tiles each. Tiles use more material initially because of the need for a thicker backing but, in the long run, the use of modular tiles can save materials because worn or soiled tiles can be replaced individually instead of replacing the whole carpet.

olefins, and polyester) in the U.S. today, with carpets made from natural fibers (mostly wool, which is more costly than any of the synthetic fibers) representing only a small percentage of total production. Other natural fibers used in very small quantities include cotton, sisal, jute, hemp, and coir.

Backing It Up

While polypropylene is predominantly used as the primary and secondary backing material for carpet, some non-woven materials may be used as primary backing for carpet tiles. Jute is sometimes used as primary backing in woven woolen carpets. The binders used for attaching primary and secondary backings are synthetic rubber (SBR latex), polyurethane, polyvinyl chloride (PVC), and ethylene vinyl acetate (EVA). The backing can contribute up to 60% of the carpet material by weight.

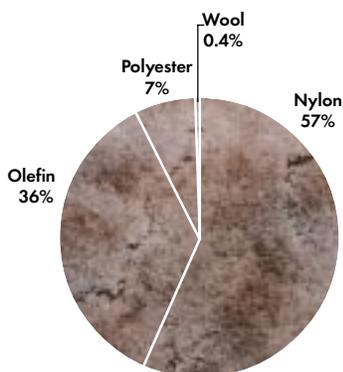
How Green Is My Carpet?

Fibers Are a Mixed Bag

Both synthetic and natural fibers have their advantages and drawbacks, and both create different types of environmental impacts. In the case of synthetic fibers, the manufacturing impacts, such as energy use and air emissions generated prior to carpet making, are typically more significant. All synthetic fibers are petroleum-based and, for that reason, they



MARKET SHARE BY FIBER TYPE



bring with them the environmental impacts associated with petroleum exploration and refining. Petroleum is a non-renewable resource, and using it to produce synthetic fibers requires large amounts of energy and generates considerable pollution. On the other hand, agricultural impacts (and grazing impacts in the case of sheep's wool) result from use of natural fibers. Wool also involves the use of water and energy for washing, and water pollution and solid wastes are generated from the wool-washing process. Additionally, methane releases from sheep could contribute to global warming. Wool, however, is a renewable resource and requires less energy to produce than synthetics.

- Nylon is the most commonly used synthetic fiber for carpets. It is durable, can be easily cleaned, is lightweight, and has a good texture. Two closely related forms of nylon (nylon 6 and nylon 6,6) are used in carpet facing. Some manufacturers believe that nylon 6,6 offers better performance characteristics, such as stain resistance. From

an environmental standpoint, nylon requires high energy to produce, and its production involves the precursors benzene (a known human carcinogen, for nylon 6) and hydrogen cyanide gas (which is extremely poisonous, for nylon 6,6). The manufacturing of nylon releases volatile organic compounds (VOCs), nitrogen oxides and ammonia.

- Olefins, such as polypropylene, are generally less expensive, require less energy to produce than other synthetic fibers typically used in carpets, have good color-fastness and tend to generate less static electricity than other fibers. While polypropylene is quite durable, its drawbacks include less texture retention and less resilience than nylon.
- Polyester (polyethylene terephthalate—PET) is another fiber used for making carpets. It's not as durable as nylon and, therefore, is best suited for use in light or medium traffic areas only. The major environmental advantage of PET is that it can be manufactured from post-consumer recycled plastic packaging (soft drink bottles), thus providing an end product with a high recycled content.

Purchasers should select the carpet fiber best suited for their applications. Wool makes an excellent choice when price is not a major concern. Nylon can be used for heavy-duty, high-traffic applications. Olefins can be used where texture and resilience are not as critical. And polyester should be considered for light-to-medium traffic applications.

Toxics Lurk Behind

All synthetic backing materials used in carpet manufacturing have known environmental drawbacks. PVC, a commonly used backing material, is produced from vinyl chloride monomer, a potent human carcinogen. PVC contains stabilizers, such as lead (a toxic metal), and also contains plasticizer chemicals (usually phthalates) that may be released into the indoor environment throughout the life of the carpet. Moreover, if carpets are incinerated for energy recovery, PVC backing can release dioxins, compounds that are potent carcinogens and can cause immune system damage. PVC, however, can be recycled into new vinyl carpet backing through existing programs.

The manufacture of synthetic rubber (styrene butadiene rubber or SBR) involves toxic chemicals such as polystyrene and 4-phenylcyclohexene (4-PC), a by-

product with a very low odor threshold. The production of polyurethane, another commonly used backing material,

involves the use of methylenediphenyl isocyanate (MDI), which could be hazardous for workers, although controls to prevent exposure are generally in place. MDI can cause dermatitis and respiratory diseases in workers and may alter the immune system, resulting in sensitization of the respiratory system and asthma-like reactions. MDI is not considered a carcinogen in humans, however, and does not present an exposure risk in the finished carpet products. There are no current commercial-scale recycling processes for polyurethane-backed carpet, but recycling options exist for polyurethane padding.

Carpets, by nature, trap dust, dirt, fumes, and other contaminants.

reduction in the average quantity of water consumed per square yard of carpet from 14.1 gallons to 10.1 gallons in the last four years. Because energy use and wastewater release have been issues of environmental concern for carpet mills for a long time, these are major focus areas for environmental improvements by the industry.

Dyeing methods such as solution dyeing are less burdensome to the environment and should be preferred. Solution dyeing is a process in which color is added to the molten polymer solution from which the fibers are extruded. Solution dyeing does not involve any aqueous dye solutions or drying steps, thereby considerably reducing the amount of energy and water usage that is typically associated with vat dyeing. Moreover, solution-dyed nylon has better color fastness and improved resistance to cleaning chemicals, including dilute bleach.

RECYCLED CONTENT DEFINITIONS

Post-Consumer: A material or finished product that has served its intended use and has been diverted or recovered from waste destined for disposal, having completed its life as a consumer item.

Post-Industrial: Materials generated in manufacturing and converting processes, such as manufacturing scrap and trimmings/cuttings, that have been recovered or diverted from solid waste.

Solutions To Dye For

Dyeing (by wet methods) is inherently an environmentally burdensome process. Though the chemicals used differ from process to process and fiber to fiber, the benzidine-based azo dyes in particular are considered carcinogenic. Carpet dyeing by wet methods consumes huge amounts of energy and water and involves wastewater and dye releases to the environment. Steam fixing and drying of the carpet is highly energy-intensive, while wastewater is generated mainly from spent dye solutions and washing. According to industry reports, carpet manufacturers are constantly finding ways to reduce water usage, resulting in a

Taking the Breath Away

Air pollution within the home or workplace has assumed greater significance as buildings became more airtight to improve energy efficiency. Carpets, by nature, trap dust, dirt, fumes, and other contaminants. Proper vacuuming is necessary to remove dust and other contaminants from the carpet for better indoor air quality as well as longer carpet life. Moreover, the chemical makeup of the carpet assembly can release Volatile Organic Compounds (VOCs) for 48 to 72 hours after installation. Adhesives, seam sealants, and carpet padding all contribute to VOC off-gassing, but adhesives are generally the largest

source of VOCs. To address these concerns and to identify carpet products that are truly low-VOC, the Carpet and Rug Institute (CRI) has established a labeling program. The “green label” CRI Indoor Air Quality Carpet Testing Program for carpets assures the consumer that the product has been tested and meets the criteria for low emissions.

The current criteria for the CRI green label, which appear below, are based on maximum allowable emission factors for finished carpet, adhesives, and cushion.



Pollutant	Carpet mg/m ² -hr	Adhesive mg/m ² -hr	Cushion mg/m ² -hr
2-Ethyl-1-Hexanol		≤ 3.0	
4-PC (4-Phenylcyclohexene)	≤ 0.05		≤ 0.05
BHT (Butylated hydroxytoluene)			≤ 0.3
Formaldehyde	≤ 0.05	≤ 0.05	≤ 0.05
Styrene	≤ 0.4		
Total Volatile Organic Compounds	≤ 0.5	≤ 10.0	≤ 1.0

Note: Formaldehyde is not used in carpet or adhesives, but levels are tested to demonstrate that formaldehyde is not an issue in carpets (Source: CRI).

In the past, volatile organic solvents have been used to emulsify or liquefy the bonding resin in adhesives. More recently, manufacturers have begun using heat instead of volatile solvents to emulsify their resin. Some manufacturers now sell low-VOC products, and some claim to have reduced VOCs to zero. Adhesives are primarily used in commercial, not residential, installation. Some products, like “peel and stick” carpet tiles, do not require an additional application of adhesives during installation, which reduces the amount of off-gassing that occurs at the installation site. Green Seal’s consensus standard for industrial adhesives calls for VOC levels of no more than 150g/l for flooring adhesives.

Getting In the Loop

Few reuse and recycling options have traditionally existed for carpet. Though high enough in BTU value, carpet’s bulky nature and the associated high transportation costs make it a poor candidate for waste-to-energy incineration. As a result, more than 2 million tons of carpet are landfilled in the U.S. each year. However, there are some additional options available now to keep carpet out of landfills altogether or, at least, to

*Buy
refurbished
carpet whenever
possible.*

extend the time before it is landfilled. Problems that affect the viability of reuse and recycling of carpet are the costs of collection, sorting, and transportation to the reuse or recycling facility. Sorting carpet by material for recycling has been facilitated by the development of instruments for automated determination of material content.

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Make It As Good As New

Carpet is often replaced for aesthetic reasons, because it “looks” old or has lost its “new” appeal. Refurbishment involving cleaning and re-dyeing gives carpet a new lease on life. Milliken Carpet is one company that takes back its modular carpet tiles and, through its “Earth Square” process, restores them to “like new” condition. The process involves super-heated cleaning, retexturing, and re-

design. The reconditioned tiles cost 40–45% less than new ones and come with a 10-year warranty. Good quality used carpet can also be sold or donated to charities rather than being discarded.

Carpet tiles make it easy to renew areas of worn or soiled carpet, extending the life of the overall floorcovering.

Lease and Use Less

Carpet leasing programs that result in the carpet being brought back to the manufacturer at the end of its life may increase the refurbishment, reuse, and recycling of carpet. If environmental benefits are of interest to the consumer, the manufacturer should be queried in order to ensure that this is an intended result of such a program. A company that leases “carpet service” by the square foot is Interface, through its Evergreen Lease program. The worn-out tiles are replaced and taken back by Interface for recycling. This ensures that, for a monthly lease fee, the customer will have good carpet all the time. Most other carpet companies can offer leasing options for their products, though at this time, many are strictly financing options that have little impact on the management of end-of-life carpet.

Closing the Loop Is Best

“Carpet-to-carpet” is considered the best form of recycling because the resources and energy used to manufacture the original carpet are utilized again to produce new carpet that lasts another lifetime, instead of being wasted. But

recycling does not come without its own environmental burdens. The particular recycling process used dictates the amount of energy consumed to convert the material back into a usable form. Not enough data are available to compare specific recycling processes, but closed-loop recycling in general is preferable because it avoids a number of initial steps (extraction and materials processing) required to prepare the material for use in carpet manufacture.

There are two forms of closed-loop recycling: chemical recycling and materials recycling. In chemical recycling the nylon face fiber is physically or chemically separated from the backing and other materials and then subjected to a depolymerization process to convert it back into caprolactam, the monomer from which it was made. The caprolactam can then be used to make fresh nylon 6, making it an almost infinitely renewable nylon resin system. BASF is the only company that currently recycles nylon 6. BASF collects and recycles carpets through its own “6ix Again” program. BASF accepts any end-of-life product bearing the 6ix Again back stamp at no charge and, after shaving the nylon 6 face fiber off, recycles it through its patented recycling process. Honeywell (formerly Allied Signal), through a joint venture called Evergreen Nylon Recycling located in Augusta, GA, manufactured the “Infinity” brand recycled nylon 6.

The plant had the capacity to keep up to 200 million pounds of nylon 6 waste out of U.S. landfills each year. According to recent reports, however, higher-than-expected production and development costs combined with current business and economic conditions forced the plant to temporarily suspend operations in September 2001. It will remain closed for an indefinite period of time.

While Nylon 6 has been the only type of nylon that could be recycled so far, Solutia Inc. has developed a closed-loop process to recycle nylon 6,6 from post-industrial materials (under the



brand name *Ultron Renew*). This fiber is currently being used by carpet manufacturers, including Interface (in its “Sabi” collection).

In closed-loop materials recycling, carpet materials are recycled into new carpet through mechanical and thermal processes without changing the chemical form of the materials. The “Infinity Initiative” of Collins and Aikman Floorcoverings (C&A) involves recycling old carpet into new carpet backing. Used vinyl-backed carpet is collected, reduced to small pellets, mixed with post-industrial carpet waste, and re-extruded to form a 100% recycled

carpet tile backing. Some materials suppliers incorporate post-industrial recycled content into the nylon fibers they produce (e.g., Solutia Inc., Dupont).

Recycle Down If Need Be

If reuse or closed-loop recycling are not possible, the next alternative is to recycle the carpet materials into other applications and products. This process is called “open-loop recycling” or “downcycling.” One example is the DuPont Carpet Reclamation program. Begun in 1990 by DuPont, the company that invented nylon, the program accepts carpet of any type for melt-processing into automobile parts, industrial flooring, soundproofing material, soil enhancement material, and padding. The program has a large number of reclamation locations throughout the country where installers can drop off used carpet at a cost comparable to that of landfilling.

Buy Recycled

In addition to recycling post-consumer carpet to the maximum extent possible, it is also desirable to use recycled content to manufacture it in the first place. Closed-loop recycling automatically ensures that recycled content is used, but there are certain varieties of carpet that can be made either completely from, or incorporate a high content of, post-consumer or post-industrial recycled material. An example is the polyester carpet



Two cases of soft drink bottles diverted from the waste stream will make a square yard of polyester carpet.

“Envirelon” made from PET soda pop bottles diverted from the waste stream by Talisman Mills. It takes about two cases of recycled bottles to make a square yard of carpet.

NATIONAL AGREEMENT FOR CARPET STEWARDSHIP

After two years of dialogue and work by industry, state and federal government, and environmental groups, a national agreement on carpet stewardship has been signed. This agreement is the first voluntary, multi-stakeholder product stewardship in the United States. It commits the signatories to achieving a landfill diversion goal of 40% by 2012, to be accomplished primarily through increased reuse and recycling of post-consumer carpet. To meet the goals of the agreement, the carpet industry has already established a third-party organization, called the Carpet America Recovery Effort (CARE). In addition to responsibility for meeting the goals, CARE will help develop the collection infrastructure for carpet and will develop and perform quantitative measurement and reporting requirements on progress towards the goals.

POWERBOND ER3

Collins and Aikman (C&A) Floorcovering’s Powerbond ER3 modular tiles come with a 100% recycled content backing and are available with the company’s low VOC “peel and stick” adhesive system. The products contain between 31–50% overall recycled content (depending on the style), of which a minimum of 23% is material from recycled carpet, 7% of which is post-consumer. C&A has a carpet collection/ recovery system and a currently operational, commercial-scale, recycling process to recycle vinyl-backed carpet. C&A can recycle any vinyl-backed carpet regardless of the original manufacturer. Carpet recycled in the process is used to produce ER3, 100% recycled content carpet backing. All C&A products are 100% recyclable in the patented process. C&A provides customers with a written guarantee that carpet returned for recycling will never be landfilled, incinerated (waste-to energy), or disposed of in any other way.

Checklist

SHOPPING FOR GREEN CARPET

To reduce the environmental impacts of your carpet choice, consider the following when it comes time to buy:

- Buy refurbished carpet whenever possible.
- Specify carpet with high overall recycled content (in the face fiber and backing), preferably post-consumer. EPA's Comprehensive Procurement Guidelines (CPG) designate a 25 -100 % total recovered materials content (all post-consumer) for polyester carpet face fiber. The guidelines for nylon carpet are currently available only in draft form, but they recommend that the face fiber should have a total recovered materials content of 25-100% (1-100% of it post-consumer) and that the backing should be made of 100% recovered materials (with a post-consumer content of 35-70%).
- Ask whether environmental leasing or take-back programs are provided, to ensure that the carpet will be replaced only as necessary and reused or recycled by the producer.
- Use carpet tiles where appropriate to extend the life of the installed floorcovering.
- Buy carpet made from recyclable materials and likely to be easily accepted for recycling under existing programs. Carpet containing nylon 6 face fiber and vinyl-backed carpets are currently recyclable. No recycling programs currently exist for polyester carpet.
- Consider purchasing carpet made of wool or other natural fibers if your primary concern is the use of non-renewable resources.
- Buy carpet that is solution-dyed.
- Buy carpet that meets CRI Indoor Air Quality standards (Green Label program).
- Ensure that low VOC adhesives (CRI certified) are used during installation.
- Buy a carpet product that is consistent with the desired performance level, expected use pattern, and replacement schedule.
- Select an appropriate color for the carpet application. Light colors tend to get soiled easily and may require the frequent use of harsh cleaning chemicals and/or replacement.



Recommended Carpet Brands

MANUFACTURER BRAND	FIBER TYPE	RECYCLED CONTENT	DYEING METHOD	VOLATILE ORGANIC EMISSIONS	RECYCLABILITY
Beaulieu <i>Caladium</i>	Polyester	100% recycled PET recovered from bottles	Beck	CRI standard	No current programs for polyester carpet
Brintons U.S. Axminster <i>Custom Woven</i>	80/20 Wool/ Nylon	None	Yarn	CRI standard	Into other applications
Colin Campbell <i>Nature's Carpet</i>	Wool from organically-raised sheep	None	Carpet is sold un-dyed, or the yarn dyed using vegetable dyes or non-acid dyes	Negligible VOCs detected by lab tests	Biodegradable; puts nitrogen back into the soil
Collins and Aikman <i>Powerbond E3</i>	Nylon 6,6	Vinyl backing contains 100% recycled content (mix of PC and PI materials); 31% to 50% overall recycled content	Solution/ Yarn	CRI standard	All vinyl-backed products are 100% recyclable into carpet backing
Interface <i>"Sabi" and "Prairie School Collection"</i>	Nylon 6,6	100% recycled content GlasBac RE vinyl backing + high recycled content nylon 6,6 face fiber; 51% overall (22% PC + 29% PI) for Sabi and 55% overall (22% PC + 33% PI) for Prairie School	Solution/ Yarn	CRI standard	Recyclable Evergreen leasing program recycles used carpet tiles.
J&J <i>Encore SD Ultima</i>	Nylon 6	25% of face fiber (7% PC + 18% PI content)	Solution/ Yarn	CRI standard	J&J's Carpet Reclamation Program
Lees <i>Unibond, Lees6, Lees Squared</i>	Nylon 6,6	4%-60% of face fiber	Solution/ Yarn	CRI standard	DuPont Carpet Reclamation Program
Mannington <i>Infinity Backing Series</i>	Nylon 6,6	25%-40% in the backing + recycled content face fiber by DuPont	Solution/ Yarn	CRI standard	DuPont Carpet Reclamation Program
Milliken <i>Earth Square (Attitudes, Movements)</i>	Nylon 6,6	Renewed and refurbished product has 100% PC content	Solution, Injection	CRI standard	Renewable
Mohawk <i>ColorStrand Infinity</i>	Nylon 6	50% of face fiber (25% PC + 25% PI content)	Solution	CRI standard	Nylon 6 closed-loop; other materials downcycled
<i>Image (light duty)</i>	Polyester	100% PC face fiber from PET bottles	Piece	CRI standard	No current programs for polyester carpet
Shaw <i>EcoSolution Q fiber + Ecoworx olefin backing</i>	Nylon 6	Face fiber has 25% PC and PI recycled content	Solution	CRI standard	Yarn into yarn; backing into backing
Talisman <i>Envirelon</i>	Polyester	100% face fiber from PC soft drink bottles	Skein	CRI standard	No current programs for polyester carpet

Notes:

- Most manufacturers offer leasing options, if desired by the customer. However, the customer should make sure that the manufacturer commits not to landfill or incinerate the carpet taken back, but instead to refurbish or recycle it.
- Beck dyeing* is a wet process in which carpet sewn into a loop is continuously rotated and immersed in a heated dye vat for several hours (commonly used for cut-pile carpet). *Beck dyeing* is a *piece dye* method.
- Yarn dyeing* is another wet process in which the finished yarn is dyed prior to carpet assembly.
- Skein (or "package" dyeing)* is a wet process that involves reeling the yarn into "skeins" or winding it onto a "package" (on a perforated tube), and dyeing in vats.
- Injection dyeing* involves the use of micro jets to inject dye into the face of the finished carpet.
- PC = Post-consumer
- PI = Post-industrial

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Beaulieu of America	(706) 278-6666	www.beaulieu-usa.com
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Colin Campbell and Sons	(800) 667-5001	www.colcam.com
Collins and Aikman Floorcoverings	(800) 248-2878	www.powerbond.com
Interface Flooring Systems	(800) 336-0225	www.interfaceinc.com/us
J&J Industries	(800) 241-4586	www.jjindustries.com
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Milliken Carpet	(877) E2 RENEW	www.millikencarpet.com
Mohawk Industries	(800) 554-6637	www.mohawkcarpets.com
Shaw Industries	(800) 441-7429	www.shawinc.com
Talisman Mills	(800) 482-5466	