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UPDATE OF RECYCLING INTERIOR AND EXTERIOR FINISH MATERIALS

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Facilities Engineering
Environmental

UPDATE OF RECYCLING INTERIOR AND EXTERIOR FINISH MATERIALS

1. Purpose

a. This Public Works Technical Bulletin (PWTB) updates previously published information on recycling or reusing interior and exterior finish materials. This bulletin provides information and incentive to implement increased recycling as required by various Army guidance documents.

b. This PWTB updates PWTB 200-1-17 and 200-1-44 which are now obsolete.

c. All PWTBs are available electronically at the National Institute of Building Sciences' Whole Building Design Guide webpage, which is accessible through this link:

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability

This PWTB applies to engineering activities at all US Army facilities, particularly in managing areas of waste, recycling, or construction.

3. Guidance

a. Army Regulation (AR) 200-1, "Environmental Protection and Enhancement," Department of the Army, revised 13 December 2007.

b. Memorandum of Understanding (MOU), “Federal Leadership in High Performance and Sustainable Buildings” (including Guiding Principles), 06 March 2006.

c. Executive Order (EO) 13514, “Federal Leadership in Environmental, Energy, and Economic Performance,” 5 October 2009.

d. Engineering and Construction Bulletin (ECB) 2008-14, “Construction and Demolition (C&D) Waste Diversion – Applicability Information,” Headquarters US Army Corps of Engineers (USACE), 22 April 2008.

e. Unified Facilities Guide Specifications (UFGS), Division 09, “Finishes;” Section 09 68 00 “Carpeting;” US Department of Defense United Facilities Criteria Program, updated November 2013.

4. Discussion

a. AR 200-1 contains policy for solid waste management, including participation in recycling programs and the sale of recyclables.

b. The federal MOU updates the Guiding Principles for Sustainable New Construction and Major Renovations, establishes separate Guiding Principles for Sustainable Existing Buildings, clarifies reporting guidelines for entering information in the Federal Real Property Profile (FRPP) database, and explains how to calculate the percentage of buildings/square footage that are compliant with the Guiding Principles.

c. EO 13514 expands on energy reduction and environmental performance requirements for federal agencies. Specifically, it requires that federal agencies achieve a 50% or higher diversion rate of nonhazardous solid waste and C&D materials by FY2015. It also directs agencies to ensure that at least 15% of existing buildings and leases (>5,000 gross sq ft) meet the Guiding Principles by FY2015, with continued progress towards 100% goal.

d. ECB 2008-14 provides guidance, clarification, and additional information to meet the US Army Assistant Chief of Staff for Installation Management (ACSIM) policy mandating that Army military construction, renovation, and demolition projects achieve a minimum of 50 % diversion of C&D waste.

e. UFGS 09 68 00 covers the contract requirements for broadloom carpet, modular tile carpet, and entrance carpet. It specifies that “carpet containing recovered material is designated in 40 CFR[1] 247.12 and subsequent Recovered Materials Advisory Notices (RMAN) as an affirmative procurement item.”

f. Across the country, federal, state, and local government agencies are promoting recycling on every level by establishing programs that give preference in specifications to recyclable building materials. Recycling C&D waste or selling salvaged building materials prevents waste disposal costs and can provide income.

g. While most C&D recycling involves structural materials (e.g., steel, wood, and concrete), a significant fraction of building components are non-structural finish materials (i.e., decorative or surface coverings) which are usually replaced multiple times over a building's life span.

h. Appendices A, B, C, and D provide details on carpeting, ceiling tile, roofing, and siding finish materials.

i. Appendix E presents the case for designing products with recycling in mind, and Appendix F gives conclusions and recommendations.

j. Appendices G–I contain supplemental information, including references used in this document, recycling resources, and a glossary of abbreviations used in this document.

5. Points of Contact.

a. Headquarters, US Army Corps of Engineers (HQUSACE) is the proponent for this document. The point of contact (POC) at HQUSACE is Mr. Malcolm E. McLeod, CEMP-CEP, 202-761-5696, or e-mail: Malcolm.E.Mcleod@usace.army.mil.

b. Questions and/or comments regarding this subject should be directed to the technical POC:

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[1] Code of Federal Regulations

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FOR THE COMMANDER:

For JAMES C. DALTON, P.E., SES
Chief, Engineering and Construction
U.S. Army Corps of Engineers

APPENDIX A: CARPET

Interior finish materials such as carpet and ceiling tiles are often removed from Army buildings either when replaced or during demolition. Recarpeting accounts for over half of all carpet sold across the U.S. and annually generates approximately four billion pounds of waste in this country. As of 2012, the majority of carpet waste in the United States was landfilled (Inform 2009).

Carpet waste accounts for 1% by weight (2.5 million tons; USEPA 2014a) or about 2% by volume of municipal solid waste (MSW; USEPA 2012b). Although carpet waste appears to be a small percentage of MSW, it is just one of millions of products placed in landfills every day, making the amount of waste still considerable from carpet.

As the number of landfills decreases, the cost to use landfills generally is predicted to continue increasing. The bulkiness of carpet and padding not only makes disposal very costly, but carpet also takes over 50 years to decompose (USEPA 2010) therefore, some landfills no longer accept carpet. Thus, it continues to be true that more alternatives to disposal need to be found for carpet waste.[2]

Recarpeting produces a relatively homogenous waste stream consisting of carpet, carpet pad, miscellaneous packaging, fasteners, and adhesives. This waste is often put into a dumpster at the job site. The other two-thirds of postconsumer carpet waste is removed from homes or small businesses. The majority of this carpet waste is taken back to the carpet retailer’s or installer’s place of business, where it also is put into a dumpster. Any carpet not taken back is usually placed on the curb for MSW pickup. Carpet disposed of this way is difficult to collect for recycling and usually ends up in a landfill.

While the basic components of the carpeting waste stream are fairly homogeneous, the composition of individual carpet is not. Carpet is a product made from several different components including face fiber, primary and secondary backings, and an

[2] Incineration of carpeting with MSW is usually not a viable option since it is very dense, non-compactable, and can contain non-combustibles such as dirt.

adhesive layer. Manufacturers make different brands of carpet from different face fibers, making carpet recycling programs more challenging because most carpet recyclers only accept carpet made from a particular type of face fiber. Carpet pad, on the other hand, is generally a homogenous product, such as polyurethane foam or rubber, and better lends itself to recycling.

Carpet Types

Broadloom

Broadloom carpet is the most widely used carpet in both homes and businesses, but it is best used for residential applications. Face fibers are woven into a backing material and held together with “glue” that stiffens the backing. It comes in rolls and is typically placed over padding.

Vinyl-backed

Vinyl-backed carpet is far less common than broadloom carpet and is mainly used in commercial applications. Vinyl-backed carpet differs from broadloom in that the face fibers, typically nylon, are integrally molded into a vinyl backing. This type of carpet does not require padding and may come in tile squares or on a roll.

Carpet Face Fibers

California's Department of Resources Recycling and Recovery reports that 99% of all carpet used in the United States is manufactured from synthetic fibers (calrecycle.ca.gov 2014). The most common face fibers used in the manufacturing of carpets are nylon, polyester, Olefin (a synthetic fiber that can be made from polypropylene [PP]), and other materials such as acrylic or wool. In the residential sector, the residential face fiber mix is: Nylon 6 (40%), Nylon 6,6 (25%), a new type of polyester known as polyethylene terephthalate (PET; 15%), and PP (20%) as shown by Figure A-1. These branded fibers have known performance in carpet applications and are backed by their respective manufacturers. Use of unbranded fibers could result in unacceptable carpet performance.

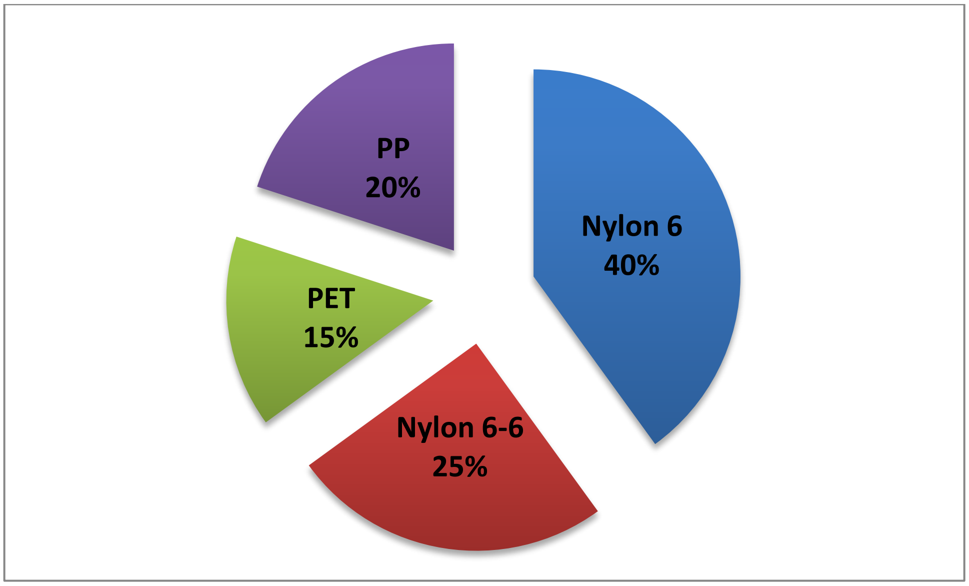

Figure A-1. Residential face fiber mix 1995-2000 as a percentage of total weight (USEPA 2012a).

Nylon

Nylon is used for 70% of commercial carpets, making it the dominant fiber for commercial and institutional applications. This popularity is because of the synthetic fibers nylon offers the best performance characteristics. It has the greatest resistance to crushing and matting and is easy to maintain. Nylon carpets have different molecular constructions and are made of either Nylon 6 or Nylon 6,6. Nylon 6 is softer and easier to dye, and Nylon 6,6 is more resilient and more stain resistant.

The nylon produced in the United States is supplied to carpet manufacturers by companies like DuPont and Shaw Industries. Fibers produced by these companies are given brand names and are made available to any carpet manufacture.

Polyester

Polyethylene Terephthalate (PET) is a category of polyester commonly used for residential carpet. It has superior color clarity because the plastic fiber is an excellent conduit of light. Carpet made from PET is resistant to water-soluble stains and is permanently static resistant. It is not as resilient as nylon carpets, and it crushes and mats easily. Carpets made with polyester typically are replaced after 2–5 yr. Newer polyester formulations, such as Shaw’s ClearTouch, may prove to last longer.

PET is one of the main carpet fibers made today with significant recycled content. Recycled PET is principally derived from postconsumer soft drink bottles. About 40 two-liter soda bottles are recycled per square yard of carpeting. The manufacturing process begins when discarded PET containers are cleaned and then ground into tiny chips. The chips are next heated to the melting point and extruded into high-quality carpet fiber. Finally, the fiber is spun into yarn and tufted into carpet. The use of virgin, fossil-fuel raw materials is not required. This production process alone eliminates the need for several million barrels of crude oil per year as raw material for fiber production.

Olefin (Polypropylene)

Olefin fiber is also called polypropylene, and it is very popular in Berber-type carpeting. Olefin carpets are strong and highly resistant to static, stains, and moisture. Color is added during fiber production, making these carpets colorfast. Olefin, however, is very low in resilience and is not recommended for heavy traffic areas. It is less expensive than nylon and is often used for projects with tight budgets or for short-term installations.

Other Fiber Types

Wool and acrylic are two other common carpet types. Acrylic offers the appearance and feel of wool without the cost. Acrylic fiber has a low static level and is resistant to moisture and mildew, but mats and soils easily. It is not recommended for commercial applications. Wool is a natural fiber known for its luxury and performance. Its major disadvantage is the high initial cost. Blends such as wool/nylon are less expensive and are also used to provide desired performance characteristics Table A-1 outlines various fiber performance characteristics.

Table A-1. Fiber performance characteristics (AFCEE 2002).

Characteristic	**Nylon**	**Olefin**	**Polyester (PET)**	**Wool**
Color	Excellent	Limited	Good	Limited
Abrasion Resistance	Excellent	Excellent	Good	Fair
Resilience	Excellent	Poor	Poor	Excellent
Soiling	Very Good	Good	Fair	Good

Characteristic	Nylon	Olefin	Polyester (PET)	Wool
Cleaning	Very Good /Good	Excellent	Fair/Good	Good
Spot Removal	Fair/Good	Excellent	Good	Fair/Good
Pilling	Excellent	Excellent	Poor	Good
Static Electricity	Poor/Very Good	Good	Good	Bad/Good
Allergy Problems	Good	Good	Good	Fair
Chemical Resistance	Good	Good	Good	Fair

Alternatives to Carpet Disposal

Carpet manufacturers are concerned about the environmental impacts of their products and keeping used carpet out of landfills. Some manufacturers “lease” carpeting as part of a service arrangement, and remove and recycle the carpet at the conclusion of its service life. Other companies are refurbishing used carpet tiles. Several companies have collection sites in place and are developing the means to separate carpet components and recover polymers. The industry is working toward recycling these materials into new carpet fiber.

Lease

One trend in materials selection is to lease a product from the manufacturer instead of purchasing it, similar to the way furniture and office equipment can be leased. Carpet leasing is a good alternative to purchasing new carpeting, as it takes into consideration all aspects of total ownership and spreads the expense over a longer time. As with any standard lease, users pay a monthly fee and eliminate their role in maintenance, which saves on capital costs and allows them to concentrate on business.

In addition, an environmental lease is one in which the supplier provides and installs the product, arranges for maintenance as required, and removes and recycles the product at the end of its service life. As an example, Interface, Inc. has a lease program in which customers lease carpet tiles instead of purchasing the carpet. By using carpet tiles, only the area that is worn or damaged is removed and replaced instead of the entire floor. By leasing the carpet squares, Interface is able to ensure that the carpet is returned to one of their facilities where it can be either reconditioned or recycled into new carpet. Several other manufacturers offer leases for carpet use and are responsible for repairing and recycling the product. Some used carpet can be recovered, cleaned, and resold, depending on the condition. A credit may also be given toward the lease or purchase of new carpet.

Reuse

Carpet replacement sometimes yields usable waste carpet. Reuse is preferable to recycling or other processing, although there are practical limitations. Carpet reuse is limited by the age of the carpet, its condition, and the contamination of the carpet by animal fur, dander, or waste. Rips and stains are undesirable and cleaning cannot remove animal residues. Also, reused carpet must have the appropriate style and aesthetics to be considered acceptable for the new application.

Floor covering can sometimes be removed and repurposed within the same building or establishment, to be used in break rooms or storage areas. The carpet can also be given away or donated to local nonprofit organizations. Various operations across the country recover carpet and clean, trim, and resell it. Carpet typically undergoes a reconditioning process prior to its reuse that includes cleaning, deodorizing, and possibly dyeing and retexturing.

Carpet Pad Recycling

Padding is the cushion placed beneath carpet to improve its insulation properties, reduce the impact of foot traffic or furniture indentation, enhance comfort, and prolong appearance. Padding is available in a variety of thicknesses – the most common being ¼- and ½-in. Carpet padding is used in both residential and commercial settings.

Carpet padding is composed of a single material that can be visually identified. Most carpet padding is environmentally friendly because it is made from either recycled materials or materials that are recyclable. Carpet cushions made from bonded urethane, jute, synthetic fiber, and rubber can be made from recovered materials (USEPA 2001).

The most common type of padding, bonded polyurethane foam, accounts for 80% of the domestic market (Carpet Cushion Council, 2012). About 90% of the raw material that goes into the processing of bonded polyurethane carpet padding is derived from recycled flexible polyurethane scrap (Carpet Cushion Council 2012). Polyurethane padding is easily recycled by shredding and gluing it back together to make new “rebound” carpet pad, a widely accepted product that is competitive with new foam padding.

Natural felt carpet cushion is almost always made from recycled burlap bags. Synthetic felt carpet cushion is manufactured almost entirely from recycled carpet waste. Carpet cushion can be made from recycled clothing and other postconsumer textile fibers. Postconsumer scrap from automotive recycling and carpet installations is also recycled to make bonded carpet padding.

Recycling carpet padding is a relatively common practice. The success of pad recycling can be attributed to the homogeneity and market dominance of polyurethane pad and the well-established market and the collection infrastructure for used padding. This gives padding a commodity value in the recyclables market that provides an economic incentive for waste generators to bring used padding to recycling collection points.

Carpet Recycling

The carpet recycling industry is still in its infancy in the United States. As of 2010, 7.7% of the carpet discarded was recycled (Herald Tribune.com 2012). Carpet recycling is driven primarily by resin producers who seek a low-cost feedstock material and by certain large carpet manufacturers that use carpet recycling as a promotional tool to increase carpet sales (Beck 2000). From an environmental standpoint, however, the need for carpet recycling is great. Virgin nylon is relatively inexpensive, but the carpet manufacturing process uses a large amount of energy. This consumption of natural resources, coupled with sensitivity to the vast amount of carpet waste being landfilled, is the reason for the increasing popularity of carpet recycling.

Carpeting is more difficult to recycle than carpet padding because of: (a) the material complexities of carpeting; (b) the logistics of fiber identification, collection, and transportation; and (c) the limitations of industry sorting and reclaiming technologies.

The following are the four major obstacles to carpet recycling.

Obstacle: Composition

As previously stated, a variety of fibers are used in manufacturing carpet, but only a small amount of these fibers are recyclable. Once identified as recyclable, the face fiber must be separated from the backing, which presents greater difficulty to a recycler. The remaining carpet components have little value and must be disposed of or recycled. Trying to recycle products not designed for recycling is difficult. Making carpet out of a single material and using an easily removed adhesive would enhance the recycling process.

Obstacle: Collection

High collection costs can dominate the economics of recycling due to the complex handling practices for carpet waste. While collecting more carpet will make recycling more economically feasible, shipping the used carpet to the recycler becomes costly. A 40-foot semi-trailer carries only 10 tons of carpet and may have to travel across the country to reach a processing facility.

Obstacle: Reclamation

Another barrier to carpet recycling is the limitation of technologies for sorting and reclamation. Also, as much as 70% of the carpet collected for recycling may not contain marketable fibers. Identifying valuable facing fibers for recycling is difficult. Many carpets look alike, but most have one-of-a-kind formulations. Thus, carpet fiber type must be identified, either through testing or by its label, if available.

To identify the carpet’s fiber type, a tool has been developed that uses using infrared technology to analyze carpet fiber. The CarPID tool[3] allows identification of carpet types in the field. This portable instrument is simply placed on the face side of a carpet and a light illuminates the carpet. The reflected light is measured and analyzed; since materials absorb light differently in various areas of the spectrum, it is then possible to identify the face fiber.

[3] CarPID is available for lease through Evergreen Recycling LLC of Augusta, Georgia, and the device must be used to reclaim Nylon 6 carpet for Evergreen’s nylon carpet recycling program.

To identify carpet by labeling, the Carpet and Rug Institute (CRI) developed an identification system in 1996 that makes sorting carpet fiber and backing compounds much easier and more efficient. This 7-character code, called the Carpet Component Identification Code (CCIC), is printed either directly on the back of the carpet or on an attached barcode label. Using a key for the CCIC allows simple visual identification and enables recyclers to target only the desired carpet types for collection. As of 2010, many companies and entrepreneurs around the United States were using this code (Dalton Daily Citizen 2010) but with carpet lasting between 8–12 yr, the amount of waste carpet likely to have a label with the code on it could continue to remain low until more time has passed.

Obstacle: Markets

Recycling carpet into new carpet has been a technical challenge. Recycling processes should produce an existing material if at all possible, because new materials face marketing problems. As previously stated, markets must exist before the recycled carpet product or recycling will be successful on a large scale.

Carpet Recycling Methods

As stated, carpet cannot be recycled before it has been sorted by face fiber type. Following identification of fiber type, there are several types of recycling methods: chemical processing, closed-loop programs, mechanical processing (whole and shredded carpet method), and waste-to-energy processing. These methods are further described below.

Chemical Processing

Depolymerization is the chemical method of breaking down plastics to their basic building blocks called “monomers.” These monomers are reacted with other virgin chemical molecules and purified so that virgin-equivalent recycled plastic resin is produced. This technology has been around since the early 1980s. However, it has taken significant technological advancements to achieve a depolymerization process that can accept postconsumer carpet that contains highly contaminated nylon. New carpet can be made from these purified fiber resins for closed-loop recycling (recycling old carpet into new carpet).

Closed-Loop Programs

At present, some types of carpet can be recycled into new carpet in what is called a closed-loop system. For example, several companies have developed technology to process recycled nylon carpet into other useful products such as automotive parts and carpet backing.

DuPont is one of the companies utilizing a closed loop system. It has developed “ammonolysis,” which can depolymerize mixtures of both Nylon 6 and Nylon 6,6. DuPont uses this technology to manufacture a Type 6,6 fiber that contains postconsumer recycled content. The fibers from this process can be used to make new carpet, thus enabling nylon to be recycled over and over.

Another example is the reclaimed and recycled content material for modular carpet from Tandus, trademarked “ER3.” The modular carpet has a 98% recycled-content cushion construction and 100% recyclable content backing (Tandus n.d.).

Mechanical Processing

Materials from carpet can also be recycled through mechanical means. The mechanical method to remove carpet fibers begins with pounding and beating the carpet to separate the face fiber from the backing. Once separated, face fibers can be pelletized for use as a recycled resin. The resin produced in this process is not as pure as the resin produced in the depolymerization process. By using a series of shredders, grinders, screens, and, in some cases, wash systems, recyclers are able to produce a resin that is 95% pure. This resin can then be used in plastic applications such as making automobile parts that do not require 100% virgin-equivalent material.

Whole Carpet Processing

In this recycling process, whole carpet is treated as one basic material that is downcycled into new products. The carpet is ground up, blended, and melted to manufacture plastic products. Recycled carpet has been used in products that include carpet installation tack strips, plastic lumber, and parking stops.

Shredded Carpet Processing

Carpet is shredded and then processed by a machine that rips and tears carpet to produce individualized fibers. This process would be primarily for non-nylon carpet, since carpet made from nylon fibers already has other recycling outlets.

Carpet that has been shredded to finger-sized lengths (less than 1-in. thick), has end uses for absorbents in animal bedding, for sound deadening, and for road stabilization. Larger strips (less than 6 sq in.) are easier to make by using a shear shredder, and they can be used with soil as an alternative daily cover (ADC) at landfills, or blended with other combustibles as a refuse-derived fuel (RDF) for waste-to-energy (WTE) recovery. With the right equipment, carpet shredding is relatively simple compared to other technologies that require removal of contaminants prior to processing.

Waste-to-Energy Processing

Carpet can also be recycled into energy at WTE facilities. Although WTE is not the preferred method of disposal, it is acknowledged as a renewable energy source. By combusting solid waste like carpet into inert, nonhazardous ash, WTE typically generates enough electricity to power its own facilities and sell the balance to local utilities. This WTE process can waste volume by 90%.

Reclamation and Processing of Specific Fibers

Nylon

Nylon is the largest single component of the carpet stream. Virgin nylon fiber, the most valuable resin used to make new carpet, commands premium pricing compared to other plastics. Recycled resin production is costly; however, because virgin nylon is made from petrochemicals and consumes natural resources, reclaiming the nylon is a primary driver in carpet recycling.

Currently, Nylon 6 is the only carpet fiber in demand for recycling. Through the chemical process of depolymerization, Nylon 6 carpet can be broken down into caprolactum, the building block for new Nylon 6. In a closed-loop recycling process, these pure fiber resins are then used to make new carpet.

Nylon 6,6 requires higher temperatures, pressures, and expensive catalysts to depolymerize. Therefore, Nylon 6,6 carpets are mechanically ground up and contaminants are removed. The material is partially melted into pellets and then sold to automotive parts manufacturers that re-engineer the resin. Closed-loop recycling programs are difficult because Nylon 6,6 is not easily or cost effectively broken down. Many companies are in the process of taking steps to set up this type of program, however, to reduce the use of depletable forms of raw materials.

PET (Polyester) and Polypropylene

PET carpets may be made of recycled material, but they are not yet recyclable into new products. As a fiber, PET is renewable and requires no additional petrochemicals to be made into carpet. PET is not valuable enough, however, to justify the cost of separating it from other fibers once it is in a carpet. Therefore, used polyester carpets are typically landfilled.

Polypropylene, by nature of the way it is made, cannot be depolymerized. However, several manufacturers are experimenting with end uses for the polypropylene from carpet backing.

Carpet Recycling Programs

Numerous companies within the carpet industry support reuse and recycling, which has resulted in the independent development of a variety of programs. There are four main sectors within the fiber industries that are developing recycling and reuse programs: industry-wide, individual carpet mills, fiber manufacturers, and private recyclers.

Industry-Wide

The carpet industry has been fairly proactive in developing solutions to the environmental concerns inherent with their industry products (Midwestern Workgroup 2000). In January 2002, a voluntary agreement aiming to eliminate landfill disposal and incineration of used carpet was signed by carpet and fiber manufacturers, the CRI, state governments, nongovernmental organizations, and the US Environmental Protection Agency (USEPA). This “Memorandum of Understanding for Carpet Stewardship” encourages product stewardship by asking manufacturers to meet goals for reuse and recycling of waste carpet. This approach is expected to reduce the environmental impacts of carpet throughout its life cycle—from design to disposal.

To help manufacturers, material suppliers, and local governments efficiently and cost-effectively recycle and reuse carpet, the carpet industry has established a third-party organization known as the Carpet America Recovery Effort (CARE). In accordance with its mandate, CARE is working with the carpet industry and government entities to achieve the goals set forth in the Memorandum of Understanding for Carpet Stewardship.[4]

Carpet Mills

The bulk of the US carpet market (80%) continues to be supplied by mills located within a 65-mile radius of Dalton, GA (Grillo 2006). Recycling programs offered by carpet manufacturers are typically available only to large commercial and institutional establishments that use a competitive contracting approach for replacing their carpet. The larger carpet manufacturers offer in-house recycling programs when their product replaces other carpet, but these programs are not open to retail (residential and small business) carpet recycling jobs.

Fiber Manufacturers

Much of the carpet recycling in the United States is conducted by two carpet manufacturers: Shaw Industries and DuPont.

- Evergreen Nylon Recycling LLC (ENR) is a venture of Shaw Industries in Dalton, GA. This division provides the largest market for used carpet recycling and is designed to recycle between 20%–50% of Nylon 6 carpet per year in the United States (ECO USA 2012). A chemical process converts Nylon 6 carpet into caprolactam, the raw material that is used in new carpets. The recycled caprolactam, marketed under the brand name “Infinity,” is described as an “infinitely renewable nylon resin.”

- DuPont’s “Sorona®” is a thermoplastic material that is used in fiber materials including carpet and carpet tiles. It is stain resistant and shows good potential for recycling as it can be melted and reformed into yarns, carpet backing, as well as into chemical monomers and automobile parts (Dupont 2013a). Of note is its low environmental footprint. According to Dupont, Sorona contains 37% annually renewable plant-based ingredients, uses 30% less energy to produce, and releases 63% fewer greenhouse gas emissions as compared to production of nylon 6. In terms of nylon 6,6, Sorona uses 40% less energy and reduces greenhouse gas emission by 56% (Dupont 2013b).

[4] Annual reports by CARE are available at https://carpetrecovery.org/resources/annual-reports/

Private Recyclers

One of the regional leaders in the recycling of post consumer carpets in north east United States is CarpetCycle, LLC. Located in Dover, New Jersey, CarpetCycle is a carpet and carpet padding recycling company. Since opening its doors in 1999, CarpetCycle has diverted over 20 million pounds of carpet from landfills.

Life-Cycle Cost Factors

Carpet is often replaced because it “uglies out” well before it is actually worn out. Most carpet is engineered to last many years, yet once it is soiled, matted, or out of style, it is often thrown away within 3–5 years (Mertel Carpets 2013).

Looking at life-cycle costs to determine the relative value of a better grade of carpet is the best idea. Life-cycle costing calculates the true cost of carpet over time, to determine the best value for the money. Life-cycle costs should take into consideration the initial cost of installed carpet, its useful life, installation costs, maintenance expenses (which include labor, cleaning supplies, and equipment), removal/disposal costs, plus lost revenues during rehabilitation over the life of the carpet. The “useful life” of carpet should reflect the years the carpet is expected to be on the floor, rather than the length of time it will take for the carpet to wear out. Renovation and scheduled refurbishing of a facility frequently occur even if the carpet is not worn out.

Life-cycle assessment information can be communicated through an Environmental Product Declaration (EPD). EPDs provide a standardized way of communicating the environmental impact of a product or system. They include information on the environmental impact of raw material acquisition, energy use, content of materials and chemical substances, emissions to air, soil and water, and waste generation. Certification bodies and declaration processes conform to international ISO standards to ensure consistent reporting of information (LEED 2013).

Maintenance

Maintenance plays a vital role in efforts to divert material from landfills. Regular maintenance keeps carpet clean and makes it last longer. One of the best ways to benefit the environment is to use products longer before disposal. The longer a product lasts, like carpet, the less it costs. Extending the life of the floor covering increases the value of the investment and delays the environmental impact of any reclamation option.

As part of their overall image, facilities spend millions of dollars on interior design elements, including carpet. Poorly maintained carpet can adversely affect a facility's image, waste thousands of dollars in misdirected cleaning costs, reduce product performance, and accelerate the need for replacement. Regular maintenance makes restorative cleaning unnecessary. Restorative cleaning occurs when carpet has been neglected and its appearance has degenerated to a point where cleaning is an absolute necessity. However, restorative cleaning may not achieve the desired original beauty and appearance of the carpet if the stains and soils are excessive.

Figure A-2 shows two different approaches to carpet maintenance. The “Plan A” program of consistent, regularly scheduled maintenance shows that the carpet retains most of its original appearance over time. “Plan B” illustrates that restorative maintenance, performed only after the appearance of the carpet is totally unacceptable, cannot bring carpet appearance back to the levels maintained in Plan A. With Plan B, carpet life is shortened and life-cycle costs are increased.

For a high-quality carpet, a program of consistent maintenance that extends the life as long as possible is usually the most economical and pays carpet dividends as well. Figure A-2 shows two alternatives that illustrate this point.

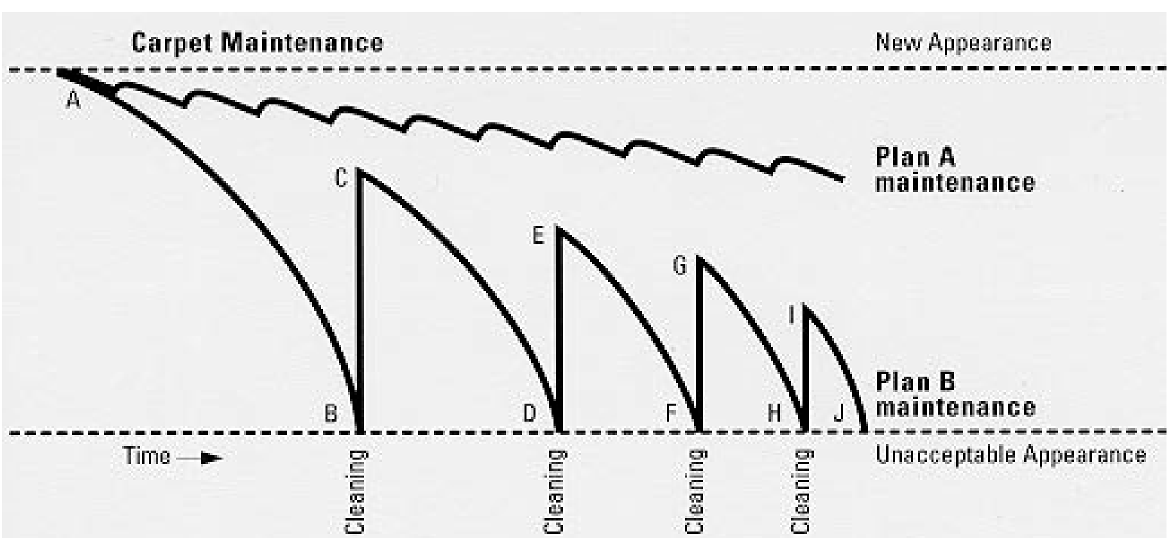

Figure A-2. Carpet maintenance program (Pacificrest.com n.d.).

Carpet Specifications

Long carpet life begins with proper selection of carpet for the specific application, giving consideration to both aesthetics and maintainability. An inexpensive carpet cannot match the durability, performance, and appearance retention of a better-grade carpet.

When carpet is chosen for floor covering, whether in a remodeling project or new construction, any negative environmental impact that might result from its use can be mitigated through appropriate requirements in the procurement specifications. Specifying the appropriate carpet materials and installation methods with the intent to recycle can facilitate recycling. The latest UFGS[5] for all aspects of carpeting projects (UFGS 09 68 00) was released in November 2013 (US DoD 2013), which specifies the use of nylon fiber carpet with a recycled content. UFGS 02 42 51 also explicitly deals with carpet removal and reclamation (US DoD 2012).

The UFGS 09 68 00 has provisions for the use of recycled PET polyester fiber-faced carpet. A note of caution must be given here. Generally, it is known that polyester carpet does **not** wear as well as other carpet types, especially nylon. A premium polyester carpet, if constructed well, should wear just as well as a nylon carpet (Shaw Floors n.d.). These statements are not substantiated and in an environment of low-bid procurement, the likelihood of getting a “premium” polyester carpet, if polyester carpet is allowed as an option, is considered remote. Even if a premium polyester carpet is used in a residential application, its use in high-traffic hallways and stairs is not advisable. Some environmental regulators are pushing the use of carpet made from recycled PET (such as the USEPA’s Comprehensive Procurement Guidelines which are addressed in Appendix E of this bulletin). However, if a recycled PET carpet is selected just to satisfy an environmental guideline but fails prematurely due to inappropriate application for the expected exposure, the end result is a negative environmental effect. This is especially true since this prematurely failed carpet cannot be easily recycled into another high-value product, and certainly it cannot be recycled into another carpet.

[5] http://www.wbdg.org/ccb/browse_cat.php?c=3

The following provisions should also be considered for inclusion in any carpet procurement specification:

- Require old carpets to be cleaned prior to removal to allow offering them to charitable organizations.

- Require a recycling guarantee from the manufacturer.

- Include a reclamation specification in project documentation, to be confident that the contractor removing the old carpet will not send it to a landfill. Specifications would include utilizing a dealer or installer in your area that routinely recycles. Mandate in the specification that the contract winner is responsible for providing proof in writing that the removed carpet was not landfilled.

APPENDIX B: CEILING TILE

Acoustical ceiling tiles have remained popular since their invention in the 1920s. Next to carpet, ceiling tile is one of the most expensive investments in building materials, and it requires periodic maintenance or replacement. Ceiling tiles often become discolored and thus, need to be replaced for aesthetic reasons. A program exists for recycling ceiling tiles that are being replaced, as does a process for refacing tiles to avoid replacement.

Recycling

Armstrong World Industries, Inc. operates a ceiling tile reclamation program.[6] Armstrong recycles acoustical ceiling tiles from commercial building renovations, adding the old tiles to the slurry used for manufacturing new ones. Neither the old tiles nor the new replacement tiles need to be Armstrong products to qualify for the program (Armstrong World Industries Inc. 2013a).

The recycling program involves three steps. First, Armstrong must verify that the old ceiling tiles can be recycled. Then, old tiles must be stacked on pallets and wrapped for pick-up. Once a trailer of old ceiling tiles is full (30,000 sq ft or more), Armstrong is contacted to make arrangements for a truck to pick up the material anywhere in the continental United States, and the company pays the freight to its plant. Contractors find that costs incurred for removing and handling the tiles for recycling are competitive with landfill disposal costs. A recent time analysis proved that the process for recycling old ceilings was nearly as fast as dumping them, so the program should have little, if any, adverse impact on renovation or demolition schedules (Armstrong World Industries Inc. 2013b) With its program of recycling acoustical ceiling panels, Armstrong claims to have saved over 550,000 tons of virgin materials since launching the program in 1999 (Armstrong World Industries Inc. 2013a).

[6] While other manufacturers may recycle ceiling tiles, Armstrong has the only well-known, large-scale program.

Recycled-Content Ceiling Tiles

From the beginning, ceiling tiles have used recycled materials that were inexpensive and widely available (King County 1998). For example, all Armstrong ceiling tiles contain recycled materials. While a portion of the recycled content is old scrap ceiling tiles, the company also uses waste products from other industries — specifically newsprint and mineral wool (a byproduct of steel production). Other companies are making ceiling panels out of natural fibers that can be easily recycled. Additionally, Tectum’s acoustical ceiling tiles have been manufactured in Ohio since 1949 with natural wood fiber produced by shredding thin strands of aspen trees; thus, panel waste from renovation or demolition is nontoxic. As an alternative to landfilling, these panels can be ground up and composted to produce a soil amendment.

Refacing

Acoustic Enterprises, Inc.[7] and other companies have ways to reskin ceiling tile and make them look new. This reskinning process reduces replacement costs, improves utility consumption, and preserves valuable landfill space by extending the life of ceiling tiles by 15 years or more.

[7] www.reskin.com; located in Frederick, Colorado.

APPENDIX C: ROOFING

Introduction

Exterior finish materials such as roofing are expected to protect Army buildings from the elements, so they must prevent rain and snow from penetrating the buildings and causing moisture damage. Exterior finishes are often removed and replaced whenever it is necessary to preserve the durability and structure of the building. More durable materials such as 30-year shingles, metal, slate, or tile roofing can save resources and costs, especially when the costs of installation are considered.

The need for multiple roofs and roof replacement makes roofing a large contributor to the solid waste stream. Across the United States, very year an estimated 7–10 million tons of shingle tear-off waste and installation scrap are generated from roof replacement and another 750,000 to 1 million tons come from from manufacturing plants (USEPA 2012b). However recycling shingles is a viable option that saves landfill space and typically costs $5–$20 less per load for recycling rather than landfill tipping fees (USEPA 2012b). The Construction and Demolition Recycling Association maintains a website with the latest list of shingle recycling companies, as well as technical and regulatory updates.[8]

Sustainable Choices

Building codes often govern or limit roofing material choices. Materials for roof replacement should be durable, with few maintenance requirements. Look for manufacturers that use recovered material in their product or who process postconsumer roofing material into other products. There is a wide variety of roofing products such as tiles and panels that incorporate both manufacturing waste and postconsumer waste.

Waste generation should be reduced throughout the life cycle of a building — from design, through construction, and final disposal. Recyclability should not be the only concern when choosing a material for reroofing, however. Energy efficiency should also be at the top of the list of roofing requirements.

[8] http://www.shinglerecycling.org/.

Environmentally correct alternatives are becoming prominent in the roofing industry.

Asphalt Shingles

Asphalt is one of the most common steep-slope roofing materials. Asphalt shingles are a good choice for a clean look at an affordable price. On the negative side, asphalt shingles do not have the life span of other materials such as tile or metal. Thus, asphalt shingle waste is abundant; roof replacement can generate shingle waste at a rate of at least 2–5 lb per square foot of roof area (NAHB 1998). For World War II (WWII)-era buildings, the Army’s typical practice has been to tear off old shingles before installing new roofing felt (“tar paper”) and shingles. Removing the roof of a typical WWII-era wood Army barracks generates more than 7,000 lb of waste during reroofing (Figure C-1).

Figure C-1. Removal of asphalt shingles during deconstruction of a World War II-era Army barracks.

Asphalt used for roofing shingles usually does not contain postconsumer materials. While shingles can be recycled into other asphalt products, they are typically not recycled back into roofing materials because the cost of doing so is not reasonable and demand is minimal in the United States. Higher-quality versions of shingles made from asphalt and fiberglass offer a more durable option and may be available with recycled content.

Millions of barrels of crude oil are used in the production of asphalt shingles. The Asphalt Roofing Manufacturers Association (ARMA), however, claims that the asphalt itself is a recovered material, because it is a necessary by-product of the oil refining process. Most, if not all, refineries sell their asphalt because a market exists. To help the asphalt recycling effort, the Construction Materials Recycling Association (CMRA) and other industrial and manufacturing organizations, such as the ARMA, the National Asphalt Pavement Association (NAPA), the Asphalt Emulsions Manufacturers Association, and the Asphalt Recycling and Reclaiming Association (ARRA), aggressively promote waste-reduction and recycling programs. Appendix H of this report contains contact information for these and other organizations that promote recycling.

For roof replacement, the old roof is torn off and replaced or covered over (up to three layers). Reroofing produces much larger quantities of waste than the installation of a new asphalt shingle roof, and the waste typically contains a small percentages of foreign materials such as nails, felt underlayment, metal flashings, wood, and waterproofing and insulation materials (Table C-1).

Table C-1. Reroofing waste stream (EPA 2012b)

MATERIAL	WEIGHT (%)
Tear-off waste shingles	85-90
Metal flashing/detailing	5-10
Wood sheathing	<5
“Tar” paper	<5
Paper packaging	<1
Nails	<1

The steep-slope roofing market is dominated by shingle roofing products, especially asphalt-based shingles. Asphalt-based shingles are made from three basic materials – asphalt, sand, and fiber (Table C-2). The exact composition of a particular shingle depends on the manufacturer and the roofing application, but the manufacturing process is similar in each instance.

Table C-2. Components of asphalt shingles (Newcomb 1993).

Component	Approximate Amount (by weight)
Asphalt cement	25-35%
Granular material (aggregate)	60-70%
Fiberglass or cellulose felt backing	5-15%

Recycling Asphalt Shingles

With diminishing landfill space, more and more asphalt roofing waste is being recycled. Virtually the entire roof can be recycled, whether the building project consists of reroofing or demolition. Identifiable waste materials are generated in either process. The asphalt shingles as well as the other roofing wastes such as wood sheathing, nails, metal flashing, and gutters are all potentially recyclable (Figure C-2).

Figure C-2. Tear-off shingle waste.

While tear-off roofing shingle scrap can potentially be recycled, shingles are very abrasive and tough to grind. Roofing scrap also is difficult to process because of contaminants and debris it contains, such as nails, wood, insulation, etc. Any debris must be removed prior to processing to prevent equipment damage during size reduction. A rotating magnet can remove metals while wood and other contaminants can be removed by hand or floated off in a water flotation unit.

Water is often added during shredding to keep the shingles cool and to limit dust. Tear-off roofing is easier to shred than manufacturing scrap because factory scrap tends to become plastic from the heat and mechanical action of the shredding process. Tear-off roofing hardens with age and is less likely to agglomerate during processing. If the shingles begin to stick together from the warm weather or from the heat of the equipment, spraying with water or blending with sand or gravel may help. Grinding the shingles may be easier in the winter when asphalt is more brittle.

Most processors will use simple equipment that has been modified. Crushers, hammer mills, and rotary shredders have been used with varying success to process waste shingles. With the proper equipment and personnel, some grinders can produce up to 80 tons of 3/8-in. minus shingles an hour. Typically, a good effort for an efficient operation is probably in the 40–50 tons per hour range.

Depending on the equipment used, primary grinding may yield 2-in. and smaller pieces. Often the shingles are passed through the processing equipment twice for size reduction. Secondary grinding may be required to make smaller pieces, ¼ in. or more, depending on the intended use. The shingles may also have to be screened after grinding to conform to grading requirements (Figure C-3).

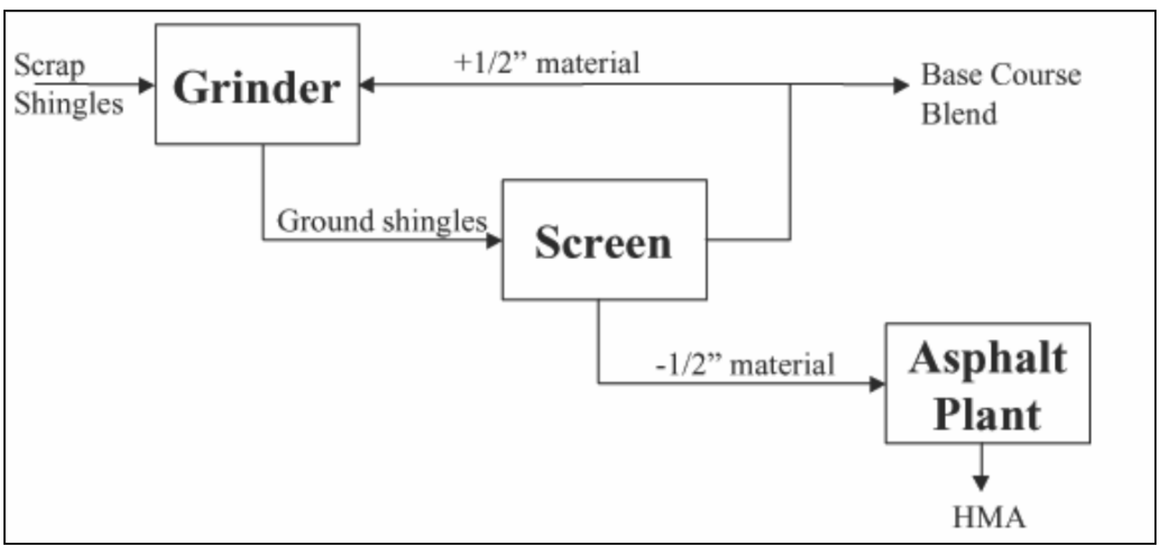

Figure C-3. Asphalt shingle recycling process.

Asphalt roofing shingles have a high potential for recycling because they can be used in a variety of products, as listed below.

- aggregate base
- asphalt pavement
- cold patch for potholes, sidewalks, utility cuts, driveways, ramps, bridges, and parking lots
- road and ground cover
- new roofing
- fuel oil

Aggregate Base

Since asphalt roofing shingles are comprised of asphalt, sand, and fiber, it makes sense to use shingle waste in a related bituminous material. The largest shingle reuse market is as aggregate base for road construction. Shingles are not commonly used alone as base, but are processed and mixed with recycled asphalt pavement (RAP) and concrete by some recyclers to make a road base product. Course-ground shingles (2½ in. minus) can be added to aggregate materials as part of the lower pavement layers, known as the sub-base or binder courses.

It is suspected that the addition of recycled asphalt shingles may improve the compaction of the sub-base. Testing by the California Department of Transportation (Caltrans) has shown that, when up to 10% recycled asphalt shingles were substituted for virgin aggregate in the blend, the mixture met Caltrans specifications for durability (CIWMB 1999). Allowing asphalt shingles in construction specifications for road base would open large markets for tear-off shingle waste.

Hot-Mix Asphalt

Ground asphalt shingles can be easily incorporated into hot-mix asphalt (HMA) and other asphalt patching (Figure C-4). In fact, this market is considered by many to be the best potential use for recycled asphalt shingles. Laboratory and field testing has shown that both manufacturer’s scrap and tear-off scrap can be used successfully in HMA. Based on this testing, the Minnesota Department of Transportation has issued specifications that allow for up to 5% shingle scrap in HMA (Minnesota Pollution Control Agency 2011).

Figure C-4. Hot-mix asphalt.

The technology to recycle asphalt shingles for use in pavement is widely available and cost effective. The asphalt and aggregate content components of shingles are very similar to those of asphalt paving materials, making recycled shingles a desirable additive or feedstock substitute in pavement materials. Generally, the smaller the shreds, the better they will be incorporated into the HMA mix. Finely ground shingles smaller than one-half inch are typically added to the HMA at 5%–10% by weight (Decker 2002). This substitution, however, usually requires the use of a softer virgin asphalt to offset the effect of adding the harder asphalt of the recycled shingles.

A typical HMA plant can produce several hundred tons of mix per hour. The total number of shingles required during a typical working day could be upwards of 50 tons if the shingles used are 5% by weight of the formula (Decker 2003). By setting this requirement, all recyclable shingles could be diverted from landfills to a product where they can be used again and again (Turley 2001).

Numerous potential benefits result from the use of waste shingle material in asphalt mixtures. Some of these benefits are listed below.

- a reduction in the cost of shingle waste disposal

- an environmental benefit from conservation of landfill space
- a reduced cost to produce HMA concrete because of reduced use of new materials
- an improved resistance to pavement cracking and rutting

Taking roofing waste to a recycling facility for a lower tipping fee than a landfill can reduce disposal costs. Recycler’s tipping fees are typically $5 to $20 less (EPA 2012b) than at landfills. With the high cost of transportation, roofers cannot afford to haul waste long distances. Transportation factors, along with local landfill capacity and tipping fees, will affect disposal choices. If tipping fees are large enough, there will be an economical incentive for waste generators to change their practice from landfill disposal to recycling.

Certain properties of asphalt pavement have been shown to improve with the addition of recycled asphalt shingles. Mixing shingles and paving asphalt can increase a pavement's resistance to wear and moisture, decrease rutting, and reduce both thermal and fatigue cracking.

Unsurfaced Roads

Recycled asphalt shingles also may be ground and mixed into gravel used to cover rural, unpaved roads to minimize dust, reduce the loss of gravel into side ditches, and reduce noise (Shinglerecycling.org 2010). Specifications for these types of applications are less strict than those for HMA.

The processed shingles are spread over bare ground and compacted for an easily installed surface on which to drive. However, postconsumer shingles often contain nails and other metals that need to be removed from the mix if it is going to be used for temporary pavement. A magnet on the grinder will typically remove these metals, but some roofing nails may get through. To avoid tire punctures, the product should be ground to 1/4-in. rather than 3/8-in. size to keep nails from getting through the screen (Turley 2001).

Cold Patch

Recycled asphalt shingles have been used extensively as an ingredient in cold-applied maintenance mixtures. One of the primary uses of “cold patch” is to fill potholes, but it can also be used to construct sidewalks, fill utility cuts, and repair driveways, ramps, bridges, and parking lots. Cold patch consists of asphalt, aggregate, and a solvent; it can be made with either recycled manufacturing scrap shingles or up to 25% recycled tear-off roofing shingles. The fibers in the asphalt shingles add to the structural integrity of the patch, resulting in performance higher than HMA and traditional cold mixes (CIWMB 2001).

Shingles can be ground to 1/4- to 1/2-in. minus size and used as a cold patch material alone or combined with virgin asphalt or other materials, including RAP. When tear-off shingles are used, a solvent is added to rejuvenate the old, oxidized asphalt. In some instances, these patches last longer than virgin patch materials and are less expensive.

Recycled-shingle cold patch is also easier to use than traditional patches because of its lighter weight, slow set-up time, and no requirement for equipment. With its lower weight-to-volume ratio, the crack or pothole is simply filled with the cold patch and tamped down with a shovel (Figure C-5). This material hardens more slowly than HMA, so there is no hurry to use it, and traffic can drive over it right away (CIWMB 2001).

Figure C-5. Pot hole filled with cold-patch.

Fuel

The market for the recovery of energy content from waste shingles, while well-established in Europe, is starting to make headway in the United States. In the 1980s, researchers tried to burn roofing waste to recover the energy as steam. However, equipment production efficiencies posed significant hurdles (Snyder 2000). Due to concerns over air pollution, this market is very limited. Yet with safe technology existing in Europe and the rising fuel costs in the United States, this fuel market may become more lucrative in the future.

Market Concerns

A report showed that adding up to 20% recycled shingles did not affect the new shingles manufacturing (Salari 2012). Significant energy savings were shown by using recycled asphalt shingles. According to a report in 2011, at least one-third of the US waste shingle supply was being recycled to make new shingles (Gibson 2011).

Asbestos Concerns

Until the late 1970s, shingles were produced with asbestos (ShingleRecycling.org 2013). Though the number of manufacturers that included asbestos in their production stream is small, traces of asbestos sometimes show up when tests of shingle waste are conducted. Scrap produced during the asphalt shingle manufacturing process is of a uniform and guaranteed content, based on the manufacturer. In contrast, tear-off waste may be composed of shingles of varying asphalt and aggregate composition and may be from multiple manufacturers.

Between 1963 and 1977, three of the largest shingle manufacturers used asbestos in the fiber mat of their shingles. This amount, however, was small (0.02%–0.00016%) and used in only a portion of production. Although only a small percentage of shingle production involved asbestos over a limited number of years, asbestos-containing roofing material (ACRM) is a potential hazard that recyclers must face. However, because some shingles last up to 20 yr and some roofs are covered by more than one layer, reroofing projects may encounter asbestos-containing materials (ACM) through approximately 2017.

Regulatory issues concerning the presence of asbestos. The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates how ACM is handled during building demolition or renovation. The Asbestos NESHAP, currently found in 40 CFR, Chapter 61, Subpart M

(USEPA 1990), lists asphalt roofing products as materials that may possibly contain asbestos and provides some guidance on the recycling of ACRM.

Below is a list of asphalt roofing products listed by NESHAP as possibly containing asbestos.

- built-up roofing
- asphalt-containing single-ply membrane systems
- asphalt shingles
- asphalt-containing underlayment felts
- asphalt-containing roof coatings and mastics
- asphalt-containing base flashings

In some states, the processing of tear-off shingles is banned because of fears it might contain asbestos and be a health risk to workers handling the material (International Zinc Association 2008). While the shingle is still intact, the material is benign and non-friable. When the shingle is ground, however, the asbestos can become friable and airborne. Rather than deal with the asbestos issue, some state and local regulators are requiring that all postconsumer shingles go straight to a landfill and will not consider recycling alternatives. However, several states have done feasibility studies that have found shingle recycling workable.

Worker environmental safety is regulated under Occupational Safety and Health Administration (OSHA) and USEPA guidelines, regardless of the construction activity. Because deconstruction poses a greater exposure to workers than mechanical demolition, it is prudent to remove all ACM no matter the condition, and regardless of regulation that might allow it. Any materials containing asbestos are not viable for recycling or reuse.

Specifications for Use of Recycled Shingles

Pavement standards vary from state to state and specifications are based on local climatic conditions and other engineering qualifications determined through independent testing by state Departments of Transportation (DOTs). Roofing shingle scrap have been used as an additive in HMA in the United States for more than 15 years since the 1990s (Turgeon 1991). However, some state DOTs do not allow tear-off scrap to be used in HMA for reasons listed below.

- adequate supply of manufacturer scrap
- potential asbestos content in tear-off waste
- quality-control concerns regarding content and condition variability for tear-off waste

Several states have developed specifications for shingle use in HMA mixes, and some HMA plant operators have created their own mix designs that use postconsumer shingle waste for "off-spec," non-highway jobs. The states listed below have incorporated recycled asphalt shingles into HMA specifications (Northeast Recycling Council 2012).

- Georgia – no more than 5% of total weight of HMA; recyclers using post consumer shingles are required to certify that the recycled shingle is asbestos free.
- Indiana – no more than 25% by weight of total binder content for any HMA mixture; has standard specifications allowing use of recycled asphalt shingle in HMA, including tear-off shingle scrap.
- Maine – allows for use of asphalt shingles in road construction materials.
- Maryland – up to 5%, manufacturers’ shingles scrap in pavement.
- Massachusetts – allows for use of asphalt shingles in road construction materials.
- Minnesota –allows up to 5% of pre- and post-consumer recycled asphalt shingle of total weight of HMA.
- Missouri–allows up to 7%, recycled, manufacturers,’ or tear-off shingle in HMA.
- New Hampshire – allows for use of asphalt shingles in road construction materials.
- North Carolina – issued new specifications for post-consumer recycled asphalt shingles as of October 2011.

- Ohio – up to 5% recycled asphalt shingle by dry weight of mix; has approved specification for use of both manufacturers', tear-off shingles, and shingle scrap.

- Oregon – investigated the use of shingles in HMA and has approved recycled asphalt in road paving mix.

- Pennsylvania – Centre County Solid Waste Authority has begun accepting asphalt shingles.

- Texas – allows use of both pre- and post-consumer asphalt shingles in paving projects.

- Wisconsin – recycling of asphalt roofing shingles has increased over the past five years.

The key to opening large markets for recycled asphalt shingles is to allow their incorporation in DOT specifications. The American Association of State Highway and Transportation Officials (AASHTO), whose mission is to advocate transportation policies and facilitate institutional change, has adopted a specification, "Standard Practice for Design Considerations When Using Reclaimed Asphalt Shingles (RAS) in New Hot Mix Asphalt (HMA)" that focuses specifically on this application (AASHTO 2009).

Built-Up Roofs

For the low-slope commercial market, modified bitumen and conventional built-up roofing (BUR) are the best-performing systems. BURs are used most commonly. This simple, yet effective system consists of multiple layers alternating liquid asphalt with felt or fiberglass. The final surface layer is commonly covered with pea gravel. A BUR can generally be expected to last 10–20 yr.

BURs are preferred when heavy traffic is expected or the potential exists for mechanical abuse on the roof, because the roof membrane tends to be thicker and more substantial than other systems. Gravel surfacing makes the roof highly resistant to normal traffic and multiple layers mean redundancy in the roof.

Low-slope roofs on some warehouse designs also have been covered with various types of membrane roofing, which is difficult to remove if it is fully adhered. As these materials have no value, their removal represents all cost with no economic return.

During reroofing, both the insulation and the built-up membrane are typically landfilled.

Metal Roofing

Asphalt has been the traditional material of choice for new roofs due to its low initial cost. However, metal roofs are growing in popularity for new and reroofing applications. Metal roofing is environmentally friendly due to its recyclability and recycled content. Metal roofs can last 50 yr or more, compared with 20 yr for asphalt-shingle roofs. There is also a wide range of metal choices – copper, galvanized steel, stainless steel, steel alloys, aluminum, and other coated metals.

Some metal roofing is corrugated and used like fiberglass, and some metal shingles are designed to look like other types of roofing materials. Normally, these types of roof coverings have a galvanized coating or are factory-coated with another highly durable finish.

Metal roofing is lightweight, allowing it to be installed over existing roofs in many cases. This installation minimizes the need to tear off and dispose of existing materials, and can produce monetary and ecological savings. In addition to being lightweight and durable, metal roofing is nearly 100% recyclable. In fact, as steel is recycled, it maintains its strength and integrity so that it can be made into one quality product after another.

Metal roofing can be used for many types of roofs. Vertically installed steel panels joined together edge-to-edge onsite (called standing-seam roofing) is among the most popular metal roofing options. While metal roofing can cost a little more initially, compared with asphalt shingles and some other types of roofing, building owners are seeing a payoff in the form of lower maintenance costs and longer life (“Metal Roofing Makes Inroads” 2003). The sheet-metal roofing-panel industry has a number of products that provide not only increased life expectancy (relative to traditional metal roofing) but also a greater choice of color and patterns (IRC [Institute for Research in Construction] 2001).

Steel Roofing

Steel is unique among exterior building materials because all steel products, including steel roofing, contain recycled steel. Steel roofing contains a minimum of 25% recycled steel. For the steel industry, using old steel products to produce new steel lowers costs by reducing the energy used in the steel-making process by 75%. That is why more than 50% of steel used in the United States over the past 50 years has been recycled in the steel production process (American Iron and Steel Institute 2013).

In contrast to many other building materials, steel is routinely collected from construction and demolition sites and recycled into new steel products. Recycling scrap metal from a construction site is usually a daily occurrence. Scrap metal is separated and taken to dealers for recycling, and revenue is received for these materials. Local scrap dealers often have collection systems in place for large-scale scrap recycling. If there is enough volume, a scrap metal dealer may provide collection bins and may pick up at the site.

The scrap market offers a much better sustainability outcome for a metal roof compared with a roof of asphalt shingles, which is more likely to be landfilled. After demolition, steel roofing scrap can be sold to processors who buy the scrap from building dismantlers and a variety of other sources, including industrial plants, government facilities, farms, auto dismantlers, railroads, shipyards, and municipalities (ISRI 1993).

Copper Roofing

Copper roofs have been used for many years in the United States. Before the 1800s when the first shingle machine was invented, the building industry used copper and flat tin for roofing. Sheet metal and copper roofs are still being installed today as well as “prepainted” metal roofs, which are treated and painted prior to being installed (Todd 1998).

The United States has historically been a steady but modest market for copper roofing. Over the years, copper has gained in popularity, most notably in the early 1990s when sales showed a marked increase (Copper Development Association Inc. 1998). Although sales of copper roofing have since decreased, the material has gained in popularity for small office structures, shopping malls, sports arenas, and even residential homes (Copper Development Association Inc. 2013).

Copper roofing sheet is predominately made from recycled copper scrap; much of the copper scrap is bought directly by mills that produce roofing sheet. Copper that is no longer useable, such as old wiring, plumbing tube, and roofing from demolished or renovated buildings, is collected by scrap dealers who sort and prepare it for market. Refineries buy the recycled metal and convert it back to pure copper. The United States has two primary copper roofing sheet producers, who rely heavily on scrap copper as one of their raw materials.

In 2012, slightly less than 40% of the copper produced in the United States was derived from scrap (Copper Development Association Inc. 2013). Copper, like other metals, has an infinite recyclable life. By itself or in any of its alloys such as brass or bronze, copper is used over and over again. Because of its long life, and because older homes have less copper in them than today's structures, only a small amount of scrap copper is available from the building and construction sector. This limits the supply of copper scrap to be used for recycling.

Recycled copper scrap also is used for making wrought copper and copper alloys. These alloys are then fabricated into products such as sheets, tubes, rods, and pipes. The amount of scrap used to make roofing sheet varies, depending on the availability and price of scrap and new copper as well as the smelting and refining processes used by the various producers. Because of these factors, during the past 10 years in the United States, the range in annual average copper content for direct melt copper-based scrap has been 83% to 85% of the gross weight (Copper Development Association 2013).

Wood Shingles and Shakes

Wood shingles and shakes come in a variety of sizes and styles. These shingles are more difficult to install than asphalt shingles. Wood shingles are long-lasting (up to 40-yr life) and made from a renewable resource.

Wood is harvested and replanted in a continually regenerating cycle, while nonrenewable resources such as iron ore are mined on a depleting basis. Wood requires less energy to manufacture, it produces much less air and water pollution, and it helps combat the greenhouse effect. Specifying a product that can be easily recycled or reused minimizes the environmental impact of a building project.

Unfortunately, wood roofing is not inexpensive and can typically cost up to three times more than a premium asphalt roof. It also requires periodic treatment with preservatives to keep the wood from drying out, warping, and cracking. Wood is also more susceptible to discoloration, mildew, fungus, rot, and wind-driven fire.

Slate and Clay

Slate shingles and clay tile are durable, attractive, environmentally benign, and can be easily recycled or salvaged for reuse. Although the initial costs for materials and installation are high, the long-term cost is low. A tile roof can last more than 50 yr. The biggest consideration for reroofing with slate or clay is the weight of the tile itself. Roof trusses may need to be reengineered to handle the extra weight of the tiles. Roofs often need to be built up to hold the extra weight.

It rarely makes sense to replace a roof with tile unless historical authenticity is critical. Salvaged tiles will be more affordable than new, and composites made from stone and concrete conserve natural resources. If a slate or clay roof needs replacement, some of the expense can be avoided by locating companies that will salvage and resell the slate and clay tiles. Firms that stock clay tile or slate roofing are always looking to purchase tiles being removed.

APPENDIX D: SIDING

Introduction

Unlike interior wall treatments and floor coverings, which are subject to change based on fashion trends, siding is permanent in most cases. Selecting the right product, however, is not easy. Many options are available, and a wrong choice can be disappointing and costly. Durability is important and, although durable products can be more expensive initially, they offer many long-term benefits through avoided maintenance and replacement costs.

When specifying exterior building materials, the tendency to select natural materials should not overlook the long-term benefits of other types of materials. Affordability, environmental performance, and durability are all important in the selection of siding.

There are many choices when it comes to siding — wood, vinyl, stucco, fiber-cement, and others. Because siding forms a building’s protective exterior, as well as being the part that is most visible, the decision of which siding to use is not one to take lightly. Table D-1 describes common siding type. Each type is discussed in more detail in sections that follow.

Table D-1. Comparison of common siding alternatives.

Siding Material	Cost*	Warranty	Maintenance Requirements	Comments
Vinyl	$	40 yr to life of the building	Periodic cleaning	Inexpensive, dent resistant, will not rust. Can be installed over most existing siding.
Wood	$$$	15 yr	Painting/staining every 3-5 years. Two-coat system may last as long as 10 years.	Natural material. High maintenance and susceptible to termite damage.
Brick	$$-$$$	Lifetime	Repairs to brick and mortar, tuck pointing	Expensive, but long lifespan.

Siding Material	Cost*	Warranty	Maintenance Requirements	Comments
Aluminum	$	40 yr to life of the building	Periodic cleaning; may need to be painted after 15-20 years.	Lightweight, will not rust, can be installed over most existing siding, dents easily.
Steel	$$	40 yr to life of the building	Low maintenance.	Fireproof, strong – resists denting.
*Dollar symbols refer to initial cost of purchase and installation of these materials relative to other roofing materials. No actual numerical dollar values are implied.				

Aluminum Siding

Nearly 40% of all aluminum used today is remelted metal (The Aluminum Association 2011). However, this percentage does not give a true picture of the recovery rate that can be achieved in the construction and demolition industry, as the durability of aluminum building materials makes the material unavailable for recycling for many years (Azom.com 2013).

Aluminum has been used in the construction industry since the 1800s (Aluminum Leader n.d.) Aluminum siding appeared on houses in the late 1950s, and it was used mostly to cover previous siding materials. Aluminum siding is an easily fabricated metal that also is often used for flashing and other roofing materials.

Common uses of aluminum are listed below.

- doors and windows
- screen frames and screening
- awnings and canopies
- siding, soffits, and fascia
- roofing and siding
- flashing
- pre-engineered buildings and structures

- manufactured housing
- ducting
- louvers and vents
- other heating and ventilating equipment
- curtain wall, store front, and entrances
- structural framing profiles
- highway and street signs
- lighting and parking meter pipe stands
- gutters and downspouts
- shower and tub enclosures
- builder’s hardware
- venetian blinds
- swimming pools

Aluminum Recycling

In addition to a particularly long service life, aluminum can be either reused or recycled. Thus, rather than contributing to the landfill space problem, aluminum can be recycled indefinitely to produce new building materials. Every pound of aluminum recycled saves 4 lb of bauxite ore, which is aluminum’s main ingredient.

Although aluminum is less than 1.4% of the nation’s solid waste stream (USEPA 2013), it remains one of the most valuable recyclable materials due to its high scrap value. Used aluminum beverage cans remain one of the most recycled items in the United States (The Aluminum Association 2008). One of the reasons for aluminum’s recycling popularity is that there is no limit to the number of times it can be recycled (The Aluminum Association 2008). Nevertheless, other types of aluminum also can be recycled such as siding, gutters, storm window frames, and lawn furniture. Thus, aluminum has a high scrap value that can contribute significantly toward reducing demolition costs.

Aluminum doors, windows, and siding are major sources of recycled aluminum, and recycled aluminum also is increasingly used in their production (Figure D-1). In general, aluminum construction products do not need protective coatings that other materials may require. They are therefore a good source of metal for recycling without any preprocessing. Aluminum scrap from building construction products typically goes to secondary aluminum smelters who supply aluminum for the beverage or automotive industry.

The infrastructure required for collection and recycling of scrap aluminum is already well established. Aluminum is easily separated from other metal scrap. Once ferrous scrap is removed using magnetic devices, aluminum scrap can then be sorted. Specialized equipment and sorting machines separate the scrap according to density or by using magnets that repel metals such as aluminum and copper.

Figure D-1. Salvaged aluminum windows.

New Construction

Aluminum’s light weight, high strength, and durability make it attractive to contractors. Building construction over the past two decades represented the third biggest market for aluminum products (The Aluminum Association 2011). Between the years 2008–2010, the percentage of aluminum used in the building construction market ranged from 11%–11.9% (ibid.). In addition, aluminum has been used in bridge construction since 1933 (Das and Kaufman 2007).

Aluminum or steel siding is considered a step up from vinyl in durability. The material and installation costs of aluminum are less than for steel, but both materials cost more than vinyl.

Both metals are 100% recyclable, making them environmentally-friendly choices for siding and other exterior building products.

Aluminum products make efficient use of energy and resources. The material’s light weight results in low energy use during machining, transportation, and handling. Aluminum’s excellent resistance to corrosion and weathering reduces maintenance and extends the life of the building product. Finally, when used materials are recycled, remelting uses only 5% of the energy required to produce primary metal.

Vinyl Siding

Vinyl is virtually maintenance-free. The color does not peel, blister, or flake, so there is never a need to paint. A thicker and more rigid vinyl product better resists warping and cracks from impact. Other advantages are that vinyl siding does not contribute to termite infestation, rotting, or moisture buildup. Its popularity continues to grow because of new product offerings and features such as wood-like textures, shingle- and shake-style panels, more appealing trim components, and a wide range of colors. Those advantages result in aluminum siding being virtually replaced by vinyl siding for residential applications.

Vinyl siding is often applied over existing exterior finishes such as masonry or wood, to give the building a clean appearance. Many buildings within the Army installations that were originally built as barracks, administrative facilities, mess halls, recreation buildings, medical buildings, and similar lumber-framed buildings were commonly adapted with vinyl siding on the exterior to cover their neglected wood siding (Figure D-2). It takes approximately 4,000 sq ft of vinyl siding to cover a typical two-story barracks.

Compared to traditional building materials, vinyl products yield significant cost savings. Vinyl is by far the least expensive of siding options. Of course, prices can vary dramatically among different regions, and installation costs vary as well.

Figure D-2. Vinyl-sided, two-story Army barracks.

Contractors, builders, and remodelers generate vinyl siding scrap at the construction site, but this type of scrap has a high recycling potential because it can be kept separate and fairly clean. Research indicates that relatively little waste is generated from vinyl siding installations. In fact, it is estimated that the average scrap rate for all vinyl installations is 1.9% of the total construction waste for a 2,000 sq ft home with vinyl siding on three sides (Radzinski 2013).

Recycled vinyl siding can be reused in such applications as packaging, pipe, siding, parking stops, outdoor furniture, floor tiles, and traffic cones, or it can be reprocessed to make more siding. Millions of pounds of post-consumer vinyl are recycled each year, and approximately one billion pounds more come from the post-industrial sector (The Vinyl Institute 2013).

Several resources are available to help with finding potential markets for vinyl siding scrap. Through the American Plastics Council's (APC's) website,[9] those interested in recycling can

[9] plastics.americanchemistry.com

access nationwide information on companies that are currently involved in recycling plastics (American Chemistry Council, Inc. 2013).

The process for recovering and recycling vinyl siding is simple. First, a hauler collects the siding scrap from the construction or demolition site. Then the scrap is taken to a broker who consolidates scrap from a variety of sources and sells it to a processor or end user. Typically, a processor runs a facility where the scrap is turned into a form useable for a new product, and an end user uses the reprocessed scrap to manufacture recycled goods.

Before being recycled, the vinyl scrap must be cleaned and ground by the processor. Contaminants are removed by hand before being fed by conveyor into a granulator, which grinds the vinyl into granules of uniform and non-uniform size, depending on the processor (Recycling Today 2007). The flakes are then fed into an extruder where the vinyl is melted and rolled out or molded to form the new product.

Wood Siding

Wood siding is often the most desired but also the most expensive siding choice. While wood siding is aesthetically pleasing and works with many building types, it is not always the most practical choice. Wood siding requires the most maintenance because it must be painted or stained, which can add several thousand dollars to the cost of the job and to future maintenance expenses. Solid wood siding is also susceptible to rotting, splitting, mold, mildew, and insect damage.

One of the benefits of wood siding is that, when properly cared for, it can essentially last forever. Among all the exterior building materials available in the United States, only wood products come from a renewable resource, and wood is the only material that is 100% reusable, recyclable, and biodegradable. It also takes less energy to produce wood siding than other building materials such as aluminum, vinyl, and wood composites.

A significant number of existing military buildings in the United States were constructed with siding manufactured from solid wood. These structures were built before or during WWII, when steel and masonry building materials were being redirected to other parts of the war effort. Most of these buildings are now targeted for removal under Base Realignment and Closure (BRAC) initiatives and the Facility Reduction Plan (FRP), to reduce building inventory.

Generally, WWII-era buildings were built with high-quality lumber and, in some cases, lumber from old-growth wood, especially on the West Coast. Old-growth wood is denser and has tighter rings than comparable species harvested from today’s second- or third-generation forests. Because the most desirable and durable materials come from old-growth trees, this type of siding was generally of a higher grade than framing lumber. This now makes recycled or salvaged siding materials from old-growth wood valuable. Some species, such as old-growth longleaf pine, command much higher prices than similar new lumber. Most of the buildings targeted for demolition have been well-maintained and contain large quantities of potentially reusable wood siding materials. A typical two-story Army barracks contains approximately 4,000 sq ft of 1x8 drop-lap wood siding (23/32-in. thickness; Figure D-3).

Figure D-3. Two-story, World War II-era, wood-sided Army barracks.

Wood Salvage and Recycling

Demolition projects (compared to deconstruction projects) generate a far-less-desirable form of wood waste due to the crushing and mixing of materials that occurs from the use of heavy equipment for demolition. However, a major factor in a successful recycling operation is a low degree of contamination of the material. Each wood waste processor has its own criteria for accepting wood waste. The final use for wood waste often determines how clean and consistent the feedstock must be. Generally, wood processing plants accept only “clean” wood (untreated and unpainted) that is also free of dirt, rock, concrete, plastic, metal, and other contaminants that can damage wood-waste processing equipment. Some processors will accept loads with contaminants, but at a higher fee to accommodate the costs of separation.

Lead-Based Paint Concerns

The presence of lead-based paint (LBP) on the exterior siding face poses a challenge in recycling or reprocessing, to prevent exposing both processors and reusers to lead's harmful effects (Falk et al. 2006). Exposed elements of a building, such as wood siding, have often been painted for appearance and protection. If the structure was built before 1978, there is the likelihood that the paint contains lead (Figure D-4); of buildings in the United States built before 1978, 83%–86% have LBP in them (CDC 2013). The older the building, the more likely it is to contain LBP and to have a higher concentration of lead in the paint, presenting potential health hazards to processors and workers. Processors who handle wood contaminated with LBP may find it necessary to dispose of scrap materials as a Resource Conservation and Recovery Act (RCRA) hazardous waste. Employee health must also be protected per OSHA requirements for airborne lead dust. Finally, the presence of a hazardous contaminant in a recycled product could create liability issues, depending upon the intended use. A good practice used by many salvaged material retailers is to notify purchasers of the lead content and provide a USEPA pamphlet on LBP safety. This notice is similar in concept to the Dept. of Housing and Urban Development (HUD) LBP disclosure requirement for homebuyers.

Figure D-4. Salvaged wood siding containing lead-based paint.

Many processors will not accept wood that has been chemically treated with chrome, copper, and arsenic (CCA) or coated with LBP, because of the health risks. Treated wood is not suitable for incineration or for composting. As recycling technology is improving, however, some recycling centers are now accepting painted wood. However, if LBP has been chemically or physically removed from the wood siding, then the paint waste should be evaluated independently from the building material to determine if it is hazardous and to identify the proper management practice (refer to preceding section on LBP).

Processing Wood Waste

Wood waste, once it has been separated from other wastes, is cleaned by removing contaminants and fasteners, and then processed through grinding or chipping. However, ideally a use can be found in which the wood waste will undergo the least amount of processing before it is reused. Thus, the most desirable option for wood waste would be to reuse the wood again in its original form. Architectural elements such as casings, banisters, and moldings can be salvaged and reused in new buildings or renovations of existing buildings. Salvaged and recycled wood can add character to an existing structure.

If wood siding is not salvageable in its original form, the wood can be recycled and processed for the uses listed below.

- remilled lumber
- particle board
- pulp and paper product
- mulch and animal bedding
- biofuel

Remilling

Through deconstruction, wood siding can be carefully removed by hand and salvaged for reuse. A number of independent lumber mills have retooled their operations to accommodate and process reclaimed lumber (Turley 2002). Salvaged lumber is a high-quality material and a good candidate for remilling (because it is dry, seasoned, and is not going to twist. (Remilling is the process of reshaping material at a saw mill for uniformity.)The overriding constraint on potential reuse is the thickness of the siding.

Research has been done to assess the viability of using conventional and specially designed woodworking equipment to remove LBP coatings from wood siding that has been salvaged from military buildings in a manner that could enable its reuse in a marketable new wood product (Falk et al. 2006). Building codes usually consider wood siding a non-structural material and place few restrictions on its use. In addition, model codes do not require that it be grade stamped (WWPA [Western Wood Products Association] 2007).

In their results, Falk et al. (2006) concluded that even wood siding covered with LBP could be safely machined into value-added products, including tongue-and-groove flooring (Figure D-5), V-groove paneling, and bevel siding. Flooring is the most promising reuse, as short pieces of siding can be used without a loss in their recycled market value. Additionally, the nail holes present in the salvaged siding do not significantly affect market value of the flooring (Falk et al. 2006).

Figure D-5. Tongue-and-groove flooring (foreground) reclaimed from painted wood siding (background).

Particleboard

If reusing the wood is not an option, the next most desirable alternative is to grind wood waste to use as a feedstock for engineered wood products such as particleboard (wood product manufactured by gluing together particle-sized wood residue), laminated wood, and plywood. The processing requirements for all these products are similar.

These applications require that the wood is clean and free from contaminants and that it meets industry specifications; however, this is often not the case with wood siding waste. Generally, most of the raw materials for particleboard and hardboard in the United States have consisted of virgin wood fiber or residue from sawmills and plywood mills rather than demolition waste.

Pulp and Paper

In certain parts of the country, pulp and paper applications represent the greatest potential for growth in utilizing wood waste. Because of strong prices and a limited supply of virgin material, construction and demolition wood waste sources are becoming increasingly attractive as mills struggle to meet long-term fiber needs. Additionally, secondary wood fiber can have longer and stronger fibers than some of the virgin pulp on the market, which is an additional plus for the paper and pulp industry. The limitations, however, are that pulp and paper end uses require very clean material. Recyclers must be able to limit the number of contaminants in the wood waste, and this may be impossible to accomplish with salvaged wood siding.

Mulch and Animal Bedding

Clean, ground wood is also an excellent bulking agent and moisture regulator, which makes the product useful for mulch or animal bedding. Several companies recycle waste wood for this purpose that would otherwise go to landfills; most is untreated pine, fir, spruce, or other softwood. The wood products are ground or shredded, with nails and other metals removed.

In addition, wood waste from cedar shakes and shingles is often sold for landscaping bark or used to make pet beds that are essentially fabric sacks full of cedar chippings. Shake and wood shingle roofing material is separated from its felt paper and ground to the desired size.

Fuel

The current market for wood reuse is dominated by fuel applications. Most wood siding waste ends up being used as boiler fuel if the wood can neither be reused nor recycled in other ways. Wood waste from construction and demolition activities is attractive as a fuel because of its low moisture content.

Brick

Brick continues to be one of the most popular exterior claddings in America. As one of the most durable building materials, brick requires very little maintenance and will last throughout the life of the building.

Brick may be salvaged from a particular building because of its historical significance and then reused because of its appearance and low initial cost. Unless they have a vintage appeal, salvaged bricks are usually less expensive than new bricks. However, the main advantage to salvaging bricks is the reduced volume and weight of debris being hauled to a landfill (Figure D-6).

Figure D-6. Pallets of salvaged bricks.

Brick Salvage

Removing bricks in mortar can be easy or difficult, depending on how hard the mortar is. Thus, not every pile of rubble with brick is going to be worth salvaging due to the labor involved in removing the mortar. Typically, bricks must be at least 50 yr old or the mortar will be too difficult to remove.

Before reusing bricks, they must be properly cleaned. If the old mortar is not completely removed from the brick surfaces, the new bond can be negatively impacted. The only current method of cleaning that enables salvaged bricks to be made suitable for reuse in their original form involves removing old mortar by hand.

Unbroken bricks are cleaned by using a small, blunt, hand axe to chip away the mortar from the bricks. Bricks that are cleaned in this manner still tend to have small amounts of mortar remaining. When bricks are initially placed in contact with mortar, they absorb some particles of the cementitious materials, and it is virtually impossible to use the hand axe to completely clean these absorbed particles from the surfaces of the brick units. The pores of the bricks, therefore, may be filled with old mortar, lime particles, dirt, or other deleterious materials; even with careful cleaning, the bond of new mortar to these units will be reduced.

Bricks that were laid in lime mortar usually can be easily reclaimed. However, after the 1920s, the use of lime mortar (at least in large buildings) was discontinued in favor of Portland cement mortar. But bricks set with Portland cement are more firmly in place and, thus, very difficult to salvage. However, there has been investigation into a new technology that involves using pressure waves to break the bond between the mortar and the brick. At this time, any mortar containing Portland cement is usually too strong and too difficult to remove without damaging the bricks.

Brick Marketing

Reclaimed bricks with the mortar carefully removed are an asset. They are often used for aesthetic reasons in new construction. Common red brick from the Chicago area is salvaged from demolition projects, cleaned, palletized onsite, and shipped to the South for use in exclusive homes. Salvaged bricks can also be used for interior walls and fireplaces within a home. Rarely do the older brick present trouble for these types of interior uses because the brick would then be out of the elements and other normal agents of decay. Salvaged brick generally should not be used for chimneys, paving, or in other high-exposure areas, because it just will not endure.

For repairs in small areas, using salvaged bricks should not present a problem. In many cases, however, walls made from salvaged brick will not be durable because of the questionable bond of the new mortar to the salvaged bricks and the quality of the bricks themselves. Some problems commonly experienced in walls built of reclaimed brick include decay, spalling, efflorescence, and rain penetration. When reclaimed bricks are used externally, careful attention must be paid to the design of the wall to afford it as much protection as possible from the rain and other moisture.

Bricks that are difficult to clean may be taken to the landfill or crushed for aggregate. Crushed brick rubble may be used as an aggregate for lightweight concrete, reducing the requirement for virgin aggregate. Recycled brick aggregate concrete could be used in road sub-bases and certain types of foundations where low-strength concrete is required. Crushed masonry aggregate in some regions of the United States is popular as a landscaping rock. Experiments appear to be ongoing for exploring the possibilities of using crushed brick as an aggregate for grouting new concrete masonry walls (Kesegic et al. 2008).

A lime mortar instead of a Portland cement mortar is recommended for laying reclaimed brick. Lime mortar is composed of lime and sand, and is generally low in salt content that can cause efflorescence on the brickwork. Such mortar is also highly plastic and is thus more likely to achieve a good bond with the porous bricks (Ritchie 1971). However, mortar made of lime is also relatively weak compared to cement, which can make walls of salvaged brick less durable than walls constructed of new brick masonry units.

APPENDIX E: DESIGN FOR RECYCLING

Manufacturers should plan for the eventual recycling of every product they develop so that all products can be efficiently and safely recycled. Despite the economic and environmental advantages derived from recycling exterior building materials, many scrap processors are finding it challenging to handle the items because so many are manufactured with hazardous components that make recycling either extremely difficult or impossible in some instances. To ensure the growth rather than the demise of recycling, the end-of-life management of building products should be considered from the very start.

Manufacturers in the carpet industry, for example, have begun to make products that can be remade into the same products at the end of their useful lives. Buildings can also be made more panelized (e.g., with prefabricated factory-made wall sections), to make them easier to take apart and reuse. As of 2011, panelized building construction represented 2% of new construction; despite this small number, the category is holding steady (Maynard 2011).

Materials carefully salvaged from existing buildings during remodeling or deconstruction can often be reused in another building. One of the most environmentally-responsible of building materials is any material that has already been used. Reuse saves all the energy and resources that would be required to make a new product, and it also keeps used building products from becoming waste. Reused materials can lend special character to a project because they may be materials that are unavailable or unaffordable in new form. Incorporating environmental guidelines into contracts and specifications encourages the use of recyclable assemblies and products that can be easily deconstructed at the end of their useful lives.

Much of the waste that is taken to a landfill is from discarded building materials due to the materials’ short service lives. Roofing and floor coverings make up the majority of this waste category. Specifying highly durable and weather-resistant cladding and roofing can substantially reduce long-term waste. Roofing and claddings made from metals or natural aggregate are the most weather-resistant and have a service life several times that of asphalt and vinyl materials. Durable materials initially cost more, but save the building owner and tenant over the long term.

Comprehensive Procurement Guidelines

The Comprehensive Procurement Guideline (CPG) program[10] is part of USEPA's continuing effort to promote the use of materials recovered from solid waste. Buying recycled-content products ensures that the materials collected in recycling programs will be used again in the manufacture of new products. The USEPA is required to designate products that are or can be made with recovered materials, and to recommend practices for buying these products. Once a product is designated, procuring agencies are required to purchase it with the highest recovered material content level practicable. To make it easier to buy recycled products, the USEPA updates the CPG every two years.

CPG requirements apply to all federal agencies. The program's website[11] describes the USEPA's effort to facilitate the procurement of products containing recovered materials, in a program known as Environmentally Preferable Purchasing (EPP). The EPP program's website[12] endorses green products and thereby uses the federal government's buying power to stimulate market demand. This site is geared towards federal purchasers as well as green businesses (large and small) and consumers. It employs an easy index to:

- provide information about green products and services;
- establish federal green purchasing requirements;
- calculate the benefits and costs of buying choices; and
- manage green purchasing processes.

To help expand markets for recyclable materials, it is important to increase purchases of building supplies that contain recycled materials. Some of these materials have been used for years by the construction industry, but they have not been advertised as recycled. Information about the products available and how to purchase them can be obtained by consulting some of the resources listed in Appendix H.

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[10] For information on or copies of the CPG, contact the RCRA Hotline at 800-424-9346 or access the CPG Web site at http://www.epa.gov/cpg.

[11] http://www.epa.gov/epawaste/conserve/tools/cpg/index.htm

[12] http://www.epa.gov/epp/

Carpet Procurement

The definition of recycled carpet may be different among manufacturers. Some call their carpet recycled if the backing is recycled, while others focus on the face fiber. The USEPA has designated carpet as an affirmative procurement item, and defines recycled carpet as having at least 25% of the face fiber manufactured from PET.

The USEPA recommends that procuring agencies establish minimum content standards for use in purchasing polyester carpet for light- and moderate-wear applications. This recommendation does not include polyester carpet for use in heavy-wear or severe-wear applications. However, procuring agencies are encouraged to evaluate the suitability of polyester carpet in those applications (USEPA 2001).

Choosing New Carpet

How and where the carpet will be used is very important to fiber selection. However, the use of recycled content in carpets reduces solid waste. Several environmentally responsible carpet choices each have their own merits and considerations, and choices will depend on specific need, location, and use. The following are all points to consider when choosing carpet.

- Purchasing a carpet with recycled-content backing that also is recyclable is worth considering. Sixty percent of the carpet material is backing, which is often made of plastics from petroleum, a nonrenewable resource associated with high-energy consumption and pollution.

- Environmentally responsible carpet should include a face fiber with some post-industrial or postconsumer recycled content. Recycled-content carpet fiber is said to be more resilient and colorfast (Home Innovation Research Labs n.d.) than virgin-fiber carpet. Recycled-content carpet has the same look, feel, and price as virgin-fiber carpet, but takes advantage of postconsumer recycled material.

- Carpet with recycled PET from soda bottles is durable, naturally stain resistant, and a better choice for residential needs. When deciding on new carpet, consider not only recycled content but also recyclability. Most carpets produced today can be recycled or downcycled to some degree.

- In order to acquire a recycling guarantee, it is necessary to add a section on carpet reclamation and recycling to your project specifications (see section on Carpet Specifications).

- Look for the CRI's Green Label and Green Label Plus when selecting carpet. This labeling program has been developed to assist consumers in the selection of carpet, cushion, and adhesives with low chemical emissions. The CRI's Indoor Air Quality Carpet Testing Program green and white logo displayed on carpet samples in showrooms shows the product type has been tested by an independent laboratory and has met the criteria for very low emissions.

- Perhaps the best environmental choice is to use carpet only where necessary, and then maintain and clean it properly so that its maximum life is realized. As stated earlier, frequent and good maintenance is the key to long-lasting and good-looking carpet.

- Other ideas include using carpet tiles rather than rolls for spot replacement and longer life. Also, leasing carpet is a relatively new idea in floor covering, putting the responsibility for carpet maintenance and replacement on the manufacturer. Leased carpet is typically recycled at the end of its lease period, making this an environmentally preferable option.

Carpet Padding

The USEPA's recommendations do not preclude a procuring agency from purchasing another type of carpet padding. However, when purchasing bonded polyurethane, jute, synthetic fiber, or rubber carpet cushions, agencies should consider these items made with recovered materials when these items meet applicable specifications and performance requirements (Table E-1; USEPA 2001).

Table E-1. CPG recycled content for carpet padding (USEPA 2001).

Product	Material	Postconsumer Content (%)	Total Recovered Materials Content (%)
Bonded polyurethane	Old carpet cushion	15-50	15-50
Jute	Burlap	40	40

Synthetic fibers	Carpet fabrication scrap	—	100
Rubber	Tire rubber	60-90	60-90

The General Services Administration (GSA) Advantage website lists manufacturer contracts for floor coverings and includes listings for recycled carpet.[13]

Carpeting: What's New

Newer developments include carpets made from Sorona and Clear Touch, both made from renewably sourced fibers. These products are synthetic polyesters manufactured by DuPont and Shaw Industries, respectively, and can be spun into fibers and yarns that are hard wearing and easy to clean. Sorona fibers, for example, feel like wool and perform as well as or better than Nylon 6,6. These carpets will wear better and last longer than Nylon 6,6 carpets, thus requiring replacement less often.

A variety of actions are changing the attractiveness of recycling nylon carpet. The industry is changing manufacturing processes to make carpet more recyclable, as well as improving technology for carpet recycling. Actions by federal and state environmental organizations to ban discarded carpets from landfills are forcing manufacturers to look for ways to better recycle carpets. Local ordinances or practices that refuse to collect discarded carpet with MSW would force individuals or stores selling replacement carpet to deliver the discarded carpet to a recycler.

Roofing Procurement

The most recent CPG update in September 2013,[14] designated eight new items that are or can be made with recovered materials. For example, roofing materials are included as one of the designated items. This designation specifically covers roofing materials containing steel, aluminum, fiber, rubber, plastic or plastic composites, and cement. Table E-2 shows the recommended recycled-content levels for purchasing roofing materials.

[13] https://www.gsaadvantage.gov/advantage/s/search.do?q=1:4ADV.FUR.301617*

[14] http://www.epa.gov/wastes/conserve/tools/cpg/

A procuring agency is not precluded from purchasing roofing materials manufactured from another material. The designation, however, requires that, when purchasing steel, aluminum, fiber, rubber, plastic, wood, or cement roofing materials, a procuring agency must purchase these items made with recovered materials when these items meet applicable specifications and performance requirements.

Table E-2. Recovered materials content recommendations for roofing materials (USEPA*).

Material	Postconsumer Content (%)	Total Recovered Materials Content (%)
Steel (basic oxygen furnace process)	16	25-30
Steel (electric arc furnace process)	67	100
Aluminum	20-95	20-95
Fiber (felt) for fiber composite	50-100	50-100
Rubber	12-100	100
Plastic or Plastic/rubber composite	100	100
Wood/Plastic Composite	--	100
Cement	Refer to cement and concrete recommendations in C-3 of the USEPA's Recovered Materials Advisory Notice (RMAN).	

* http://www.epa.gov/waste/conserve/tools/cpg/products/construction.htm#roofing

Leadership in Energy and Environmental Design

The US Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED) rating system to provide guidelines to follow in qualifying buildings as environmentally sound. LEED includes standards on topics such as maximizing the salvage of existing structures, maximizing recycling and reuse during construction, and specifying recycled or reused building materials. Elements of the LEED standards can be incorporated into contract specifications without going through the entire LEED rating process. New military construction (MILCON) projects and major renovations must be certified LEED Silver by the Green Building Certification Institute (USACE 2011).

Reusing existing building materials, incorporating recycled products, and recycling C&D waste may contribute to earning certification points under the LEED system. For example, a point may be earned for building reuse by maintaining existing walls, floors, and roof. Other points can be earned for construction waste management and recycled content. Complete information is available on the USGBC LEED web site at http://www.usgbc.org.

Life-Cycle Costs

Life-cycle costing calculates the true cost over time to determine the best value for money spent. It is a comparative analysis that evaluates the direct and indirect environmental burdens associated with a product system throughout its life cycle. Too often, projects and building systems are evaluated on initial cost, rather than life-cycle costs. While it is an important factor, initial cost is not the only factor. Roofing and siding decisions based on a complete life-cycle analysis must also include the expected life of the system and costs for scheduled maintenance, energy, and disposal.

Reliable, high-quality roofing and siding simply lasts longer and has lower maintenance expenses over their lifetime. Many so-called “bargains” last only a decade or so, and if a building needs to be reroofed or resided every 10 years, then the life-cycle cost over 30 years ends up being more than three times the initial price paid. Quality roofing and siding should last 25 years or more, so its cost would be much less than the cost of an inferior product, even if the initial installed cost is more (Spencer 1997).

Using life-cycle analysis as a measure for quality helps isolate factors that contribute to better roofs and siding and sorts out the best practices from many available options. It would be wonderful if life-cycle costs were considered as a matter of course in building design, but they are not. Unfortunately, those in the building profession are forced to deal almost solely with first-cost in justifying projects.

APPENDIX F: CONCLUSION AND RECOMMENDATIONS

Government legislation, costs for landfill space, and increased public awareness continue to move manufacturers and building owners toward green product engineering and recycling. Arguments can be made for having the consumer, manufacturer, or both be made responsible for making sure building product is recycled at the end of its useful life. Unfortunately, while this issue is being discussed, landfills are accepting material that does not have to be there. A growing lack of space means the type of material accepted into landfills needs to decrease, and it is very possible that landfilling in the future will be restricted to materials that cannot be disposed of in any other manner.

Growing concern for the environment has prompted recycling efforts in many directions. As consumer demand increases for environmentally friendly products, manufacturers are pursuing programs that reduce, reuse, and recycle raw materials. One area that is growing at a rapid rate is the recycling of exterior finish materials from building debris.

In summary, options to consider for interior and exterior building materials are listed below. These options are not only environmentally sound but in many cases, they also offer considerable cost savings.

1. Use carpet made with recycled materials.

2. Use carpet cushion made from recycled materials.

3. Select the fiber type and construction appropriate for the application. Polyester carpets should not be used in any high-traffic wear areas.

4. Use a program that reconditions and restores old carpet and/or ceiling tiles for reuse.

5. Use a program that sends old carpet or ceiling tiles back to the manufacturer for recycling, rather than to landfills.

6. Use exterior building materials with recycled content.

7. Select roofing and siding types based on the application and life-cycle costs.

8. Develop a plan that sends old roofing or siding back to the manufacturer or local processor for recycling, rather than to landfills.

9. Implement regular cleaning and other maintenance to maximize the useful life of all building materials.

10. Construction waste plans are required per UFGS 01 74 19,[15] and they should call out specific handling strategies for finish materials encountered.

[15] http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2001%2074%2019.pdf

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APPENDIX H: RESOURCES AND SUPPLIERS

The information here is accurate to the best of our knowledge. Inclusion in this listing does not represent an endorsement by the US Army Corps of Engineers.

- **Carpet Industry Recycling Resources**

A&M Carpet

160 E. Bullard Ave.
Fresno, CA 93710-5121
(559) 448-1000

4230 W. Shaw Ave.
Fresno, CA 93722-6226
(559) 276-4222

http://www.aandmflooring.com/

A&M recycles foam padding by sending old materials back to the manufacturers, where it is reprocessed.

Atlas Carpet Mills

2200 Saybrook Avenue
City of Commerce, CA 90040

(213) 622-2314
(800) 372-6274

www.atlascarpetmills.com

Carpets using DuPont's Antron recyclable nylon fiber

Barnet USA

William Barnet & Son, LLC
1300 Hayne Street
P.O. Box 131
Arcadia, SC 29320

(864) 576-7154

www.barnet.com

Buys, supplies, processes, and recycles fibers, polymers, and yarns worldwide. Company uses carpeting and rugs for concrete/asphalt/paper reinforcement and polymer compounds.

Bliss by Beaulieu

1502 Coronet Drive
PO Box 1248
Dalton, GA 30722

(800) 227-7211

http://www.blissflooring.com/bliss/about/environment/commitment.aspx

Beaulieu products featuring OmniLoc™ Modular backing or Green Smart® carpet fiber are both superior and ecologically sound.

Carpet Cycle

16 Herbert Street
Newark, NJ 07105

973-732-4858

www.carpetcycle.com

(973) 659-9595

Provides rip-up and haul-away service, or collection after carpet has been ripped up for a $50 flat fee. Carpet and padding materials are baled and shipped to plants where they are recycled.

Carpet Solutions, Inc. (CSI)

413 NE Van Loon Lane
Suite 101
Cape Coral, FL 33909

(239) 574-5394
(800) 845-3499 for free estimate

DuPont Sorona and Carpet Recycling

(770) 420-7791
(800) 4-DUPONT

http://www.dupont.com/products-and-services/fabrics-fibers-nonwovens/fibers/articles/sorona-and-carpet-recycling.html

Sorona® is a thermoplastic material that is intended for use in any type of carpet, including carpet tiles, and it can be melted and reformed. Though existing carpet recycling facilities do not accept polytrimethylene terephthalate (PTT) fiber for recycling today, there are many materials this product can be recycled into including flooring, yarn, automobile parts, and fuel.

Foamex Carpet Cushion

www.fxi.com

Makes natural felt carpet cushion; synthetic felt carpet cushion; textile fiber carpet cushion; bonded carpet cushion; prime polyurethane and rubber carpet cushion.

Heritage Environmental Services

7901 W Morris St.
Indianapolis, IN 46231

877-436-8778

http://store.heritage-enviro.com/

Heritage has partnered with Owens Corning to recycle tear-off asphalt shingles. Through the partnership, Heritage is implementing an efficient recycling method for collecting, hauling, and processing asphalt tear-off shingles on a nationwide basis, with drop-off sites in multiple states.

Image Industries (now Mohawk Industries

800-722-2504

Carpets with 100% recycled PET as carpet face fibers and also a combination of PET fibers and nylon.

http://www.berkshirepartners.com/image-industries

Interface, Inc.

800-336-0225

http://www.interfaceglobal.com

Is a leader in design, production, and sales of "environmentally-responsible" modular carpet for commercial, institutional, and residential markets.

J&J Industries, Inc.

818 J&J Drive
PO Box 1287
Dalton, GA 30722

706-278-4454
800-241-4585

Invision

800.241.4585

www.jj-invision.com

Environmental program that includes the recycling of dye waste water as well as the reclamation of used carpet with guarantees that the carpet will not reach landfill.

Midwest Shingle Recycle

7455 Hall Street
St. Louis, MO 63147

314-382-4200

http://midwestshinglerecycling.com

Expects to remove 20,000^{+} tons of asphalt shingles from landfills per year.

MilliCare Environmental Services

1-888-88M CARE

www.millicare.com

Perpetual floor plan called "Earth Square" that rejuvenates and restyles modular carpet. A division of Sylvan Chemical Co.

Milliken & Company

201 Lukken Industrial Drive
LaGrange, GA 30240

706-880-3221
877-E2RENEW

www.earthsquare.com

Carpet tiles are returned for reconditioning, including cleaning, retexturizing, and imprinting of a new pattern.

Mohawk Industries

800-266-4295

Mohawk Industries converts PET (plastic) bottles to carpet fiber and markets residential carpet made with recycled PET recovered from the bottles. More than 500 Mohawk products contain recycled materials.

http://www.mohawkflooring.com/greenworks/recycling.aspx

The Mohawk Group's Recover Carpet Recycling Program offers recycling or reuse applications for any carpet removed from the job site.

http://www.themohawkgroup.com/sitefiles/PDFs/Recover%20Recycling%20Program.pdf

RD Weis Companies

Corporate Headquarters
200 William St.
Port Chester, NY 10573

914-937-9337
888-RDWEIS9

http://rdweis.com

Serves the Northeast (NY, NJ, CT, MA, MI)

Old carpet cleaned and reinstalled or recycled through their reclaim system.

SelecTech

33 Wales Ave., Ste F
Avon, MA 02322

508-583-3200

www.selectechinc.com

Manufactures FreeStyle Flooring, a heavy duty flooring product made from recycled plastics.

Shaw Floors

http://shawfloors.com/about-shaw/press-releases-archives/2006/shaw-completes-100-ownership-of-evergreen

800-441-7429

Shaw Industries, Inc.

PO Drawer 2128
616 E Walnut Ave.
Dalton, GA 30722-2122

800 441-7429

www.shawinc.com

Recycles nylon at the Evergreen plant in Georgia. The recycling system is designed to utilize post-consumer carpets in a closed-loop process. It can recycle nylon fibers over and over again without the loss of any aesthetic or performance properties.

Tandus

311 Smith Industrial Boulevard
P.O. Box 1447
Dalton, GA 30722-1447
(800) 248-2878

http://www.tandus.com/global/us/content/environmental-responsibility/infinity-initiative/processes

The Infinity Initiative Program is a closed-loop recycling program. This program will recycle all post-consumer take-back products and pre-consumer manufacturing carpet waste into new recycled content floor coverings

wTe Corp.

Corporate Headquarters
7 Alfred Circle
Bedford, MA 01730

781-275-6400
E-Mail: ccfwte@aol.com

www.wte.com

Investigated viability of using old carpet as fuel supplement to coal in large industrial and utility boilers.

- **Interior Finish Suppliers Using Recovered Materials**

This list will help buyers identify carpet, carpet cushion (padding), and acoustical ceiling tile products made with recycled materials. The information here is accurate to the best of our knowledge. No effort has been made to investigate the performance of the companies listed, nor their products. Inclusion in this listing does not represent an endorsement by the US Army Corps of Engineers.

Carpet

Marglen Industries, Inc.

1748 Ward Mountain Road
Rome, GA 30161

706-295-5621

www.marglen.us

Martin Color-Fi

P.O. Box 469
Edgefield, SC 29824

800-843-6382
803-637-7000

Talisman Mills, Inc.

6000 West Executive Drive
Mequon, WI 53092

800-482-5466
414-242-6183

www.talismancarpets.com

Carpet Cushion

Carpenter Company

5016 Monument Ave.
P.O. Box 27205
Richmond, VA 23261

804-359-0800

http://carpenter.com

Dixie Manufacturing Corporation

100 Colley Avenue
Norfolk, VA 23510

757-625-8251

DURA Undercushions, Ltd.

8525 Delmeade Road
Montreal, Quebec
H4T 1M1
Canada

800-295-4126
514-737-6561

www.duracushion.com

Leggett & Platt

100 Leggett Drive
Villa Rica, GA 30180

770-459-1800

www.lpurethane.com

Ceiling Tiles

Armstrong World Industries

P.O. Box 3001
Lancaster, PA 17603

717-397-0611

www.armstrong.com

Tectum, Inc.

P.O. Box 3002
Newark, OH 43058-3002

888-977-9691
740-345-9691

www.tectum.com

USG Interiors Inc.

550 W. Adams Street
Chicago, IL 60661

312-606-4000

www.usg.com

- **Exterior Finishes – Resources for Roofing and Siding**

Asphalt Recycling and Reclaiming Association (ARRA)

#3 Church Circle – PMB 250
Annapolis, MD 21401

410-267-0023
Fax: 410-267-7546

www.arra.org

Asphalt Roofing Manufacturers Association (ARMA)

750 National Press Building
529 14th Street NW
Washington, DC 20045

202-591-2450

www.asphaltroofing.org

The Brick Industry Association

1850 Centennial Park Drive
Suite 301
Reston, VA 20191

703-620-0010
Fax: 703-620-3928.

www.gobrick.com

Cedar Shake & Shingle Bureau

P.O. Box 1178
Sumas, WA 98295-1178

604-820-7700
Fax: 604-820-0266

www.cedarbureau.org

Construction & Demolition Recycling Association (CDRA)

1585 Beverly Court
Suite 112
Aurora, IL 60502

630-585-7530
Fax: 630-585-7593

www.cdrecycling.org

Institute for Scrap Recycling Industries, Inc.

1615 L Street NW
Suite 600
Washington DC 20036-5610

202-662-8500
Fax: 202-626-0900

www.isri.org

Leadership in Energy and Environmental Design (LEED) of the US Green Building Council

2101 L Street NW
Suite 500
Washington, DC 20037

800-795-1747

www.usgbc.org/leed/

National Asphalt Pavement Association (NAPA)

5100 Forbes Blvd.
Lanham, MD 20706-4407

888-468-6499

www.asphaltpavement.org

National Roofing Contractors Association (NRCA)

10255 W. Higgins Road
Suite 600
Rosemont, IL 60018-5607

847-299-9070
NRCA's InfoExpress:
866-ASK-NRCA (275-6722)
Fax: (847) 299-1183

www.nrca.net

Recycled Materials Resource Center

University of Wisconsin
rmrc.wisc.edu

University of Florida

Powell Center for Construction and Environment
Rinker Hall Room 304
PO Box 115703
Gainesville, FL 33711-5703

352-273-1172

www.cce.ufl.edu

US Environmental Protection Agency (USEPA) – Comprehensive Procurement Guidelines

Office of Resource Conservation and Recovery
(5305P)
1200 Pennsylvania Avenue NW
Washington, DC 20460

www.epa.gov/cpg

US Green Building Council (USGBC)

2101 L Street NW
Suite 500
Washington, DC 20037

800-795-1747
Fax: (202) 828-5110

www.usgbc.org

Vinyl Siding Institute (VSI)

1201 15th Street NW
Suite 220
Washington, DC 20005

888-FOR-VSI-1 (888-367-8741)

www.vinylsiding.org

Western Wood Products Association (WWPA)

522 SW Fifth Avenue
Suite 500
Portland, OR 97204-2122

503-224-3930
Fax: 503-224-3934

www2.wwpa.org

APPENDIX I: ACRONYMS AND ABBREVIATIONS

Term	Meaning
AASHTO	American Association of State Highway and Transportation Officials
ACM	asbestos-containing materials
ACRM	asbestos-containing roofing materials
ACSIM	Army Chief of Staff for Installation Management
ADC	alternative daily cover
ADPSR	Architects, Designers, Planners for Social Responsibility
AEI	Army Enterprise Infostructure
APC	American Plastics Council
AR	Army Regulation
ARMA	Asphalt Roofing Manufacturers Association
ARRA	Asphalt Recycling and Reclaiming Association
ARRC	Asphalt Roofing Recycling Center
BRAC	Base Realignment and Closure
BUR	built-up roofing
CalRecycle	California Department of Resources Recycling and Recovery
CalTrans	California Department of Transportation
CARE	Carpet America Recovery Effort
CCA	chrome, copper, arsenic
CCIC	Carpet Component Identification Code
C&D	construction and demolition
CECW	Directorate of Civil Works, US Army Corps of Engineers
CEMP-CE	Directorate of Military Programs, US Army Corps of Engineers
CERL	Construction Engineering Research Laboratory
CFR	Code of Federal Regulations

Term	Meaning
CMRA	Construction Materials Recycling Association
CPG	Comprehensive Procurement Guideline
CRI	Carpet and Rug Institute
DOT	Department of Transportation
ECB	Engineering Construction Bulletin
E2	Earthwise Ennovations
ENR	Evergreen Nylon Recycling
EO	Executive Order
EPP	environmentally preferred purchasing
ERDC	Engineer Research and Development Center
ER3	reclaimed and recycled Tandus modular carpeting trademark
FRP	Facility Reduction Plan
FRPP	Federal Real Property Profile
GSA	General Services Administration
HMA	hot-mix asphalt
HQUSACE	Headquarters, United States Army Corps of Engineers
HUD	Housing and Urban Development
IRC	Institute for Research in Construction
LBP	lead-based paint
LEED	Leadership in Energy and Environmental Design
MOU	memorandum of understanding
MSW	municipal solid waste
NAHB	National Association of Home Builders
NAPA	National Asphalt Pavement Association
NESHAP	National Emission Standards for Hazardous Air Pollutants
OSHA	Occupational Safety and Health Administration

Term	Meaning
PET	polyethylene terephthalate
POC	point of contact
PTT	polyimethylene terephthalate
PWTB	Public Works Technical Bulletin
RAP	recycled asphalt pavement
RAS	reclaimed asphalt shingles
RCRA	Resource Conservation Recovery Act
RDF	refuse-derived fuel
RMAN	Recovered Materials Advisory Notices
UFGS	Unified Facilities Guide Specifications
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGBC	US Green Building Council
WTE	waste-to-energy
WWII	World War II
WWPA	Western Wood Products Association