



## Wire and Cable: Untangling Complex Environmental Issues

**E**VEN THE GREENEST OF ARCHITECTS and builders seldom give much consideration to wiring in buildings. Sure, we'd like to use products with minimal environmental and health impacts, but how significant can wiring be? We don't really install that much wiring, relative to other materials. And there isn't much choice anyway, is there? Don't fire codes pretty much dictate what we have to use?

Before we started investigating this topic, our primary concern was a vague one concerning the polyvinyl chloride (PVC) sheathing used on many wires. A presentation at the Pittsburgh Greenbuild conference by researcher Gail Vittori of the Center for Maximum Potential Building Systems opened our eyes to a number of additional issues with wiring.

Hundreds of Internet searches, weeks of reading everything we could get our hands on, and dozens of conversations later, we have learned, first of all, just how complex the issue of wiring is. More important, we have become concerned about conventional practice today—especially regarding communications and data cabling and the rapidly growing use of fluoropolymer insulation and jacketing. And we have become alarmed about the growing risk of lead dust accumulation in the ceiling and floor plenums of commercial buildings from the 11 million miles (18 million km) of existing data cabling, most of which contains PVC that is heat-stabilized with lead.

Read on to learn more about these issues and some potential solutions.

### Understanding Wire and Cable

First some definitions. As used in this article, *wire* refers to an individual strand of material used for conducting electrical current; *cable* refers to two or more wires twisted together. Non-insulated wire and cable used for structural purposes will not be addressed here. Virtually all wire used for transmitting electric current or data is wrapped in plastic *insulation*. Most electrical and data cables are made by bundling multiple insulated wires and sheathing all of the wires in an additional *jacket*.

(continued on page 7)



Calgary, Alberta-based Critical Mass uses miles of data cables for its Web design and Internet consulting business. Cables are run in a Haworth/SMED access floor.

Photo: Haworth/SMED

### In This Issue:

#### Feature Article ..... 1

- *Wire and Cable: Untangling Complex Environmental Issues*

#### mail@BuildingGreen .. 2

- *Greenbuild and Emissions*
- *Flammability and Nysan Shade Screening*

#### What's Happening ..... 3

- *Apollo Alliance Aims for Energy Independence*
- *EPA Launches SmartWay Transport Partnership*
- *LEED for Existing Buildings Out for Comments*
- *Newsbriefs*
- *Awards & Competitions*

#### Product News & Reviews ..... 6

- *Toyotomi's Wall-Vented, Oil-Fired Space Heater*
- *Product Briefs*

#### From the Library ..... 15

- *Two New Books on Green Homes*

#### Calendar ..... 16

#### Quote of the month:

**"There is no significant difference in toxicity among the types of material [used for wire insulation and jacketing]. All materials that burn are toxic."**

Patrick Lindner,  
Global Business Manager,  
DuPont Communications  
Cabling Solutions,  
defending fluoropolymers

(page 9)

## Environmental Building News

**Executive Editor** · Alex Wilson

**Editor** · Nadav Malin

**Associate Editor** · Jessica Boehland

**GreenSpec Managing Editor** · Tori Wiechers

**Interns** · Mark Piepkorn, Alex Stadtner

**Art Director** · Joy Wallens-Penford

**Publisher** · Dan Woodbury

**Outreach Director** · Jerelyn Wilson

**Director of Online Services** · Jim Newman

**Webmaster** · Ethan Goldman

**Financial Manager** · Willie Marquart

**Circulation Department**

Charlotte Snyder, Mgr. · Martha Swanson

### Advisory Board

John Abrams, Chilmark, MA

Bob Berkebile, FAIA, Kansas City, MO

Terry Brennan, Rome, NY

Bill Browning, Hon. AIA, Snowmass, CO

Nancy Clanton, P.E., Boulder, CO

Bruce Coldham, AIA, Amherst, MA

Dr. Raymond Cole, Vancouver, BC

David Eisenberg, Tucson, AZ

Pliny Fisk, Austin, TX

Carol Franklin, ASLA, Philadelphia, PA

Harry Gordon, FAIA, Washington, DC

David Gottfried, San Francisco, CA

B.J. Harris, Santa Fe, NM

John L. Knott, Jr., Dewees Island, SC

Gail Lindsey, FAIA, Raleigh, NC

Steve Loken, Missoula, MT

Joseph Lstiburek, P.E., Westford, MA

Sandra Mandler, AIA, San Francisco, CA

Mike Nicklas, FAIA, Raleigh, NC

Greg Norris, Ph.D., N. Berwick, ME

Marc Rosenbaum, P.E., Meriden, NH

Michael Totten, Washington, DC

ENVIRONMENTAL BUILDING NEWS (ISSN 1062-3957) is published monthly by BuildingGreen, Inc. EBN does not accept advertising. Subscriptions are \$99/year, \$199 for companies with 25 or more employees. Outside North America add \$30. Periodicals postage paid at Brattleboro, Vt. and at additional mailing offices. POSTMASTER: Send address changes to *Environmental Building News*, 122 Birge St., Ste 30, Brattleboro, VT 05301.

Copyright © 2004, BuildingGreen, Inc. All rights reserved. No material in this newsletter may be photocopied, electronically transmitted, or otherwise reproduced by any means without written permission from the Publisher. However, license to photocopy items for internal use or by institutions of higher education as part of collective works is granted, provided that the appropriate fee is paid directly to Copyright Clearance Center, Inc., 222 Rosewood Dr., Danvers, MA 01923, USA; 978-750-8400.

### Disclaimer

Every effort has been made to ensure that the information presented in *EBN* is accurate and that design and construction details meet generally accepted standards. However, the information presented in *EBN*, by itself, should not be relied on for final design, engineering, or building decisions. New or unusual details should be discussed with building officials, architects, and/or engineers.

### Editorial & Subscription Office

122 Birge St., Suite 30, Brattleboro, VT 05301

802-257-7300 · 802-257-7304 (fax)

ebn@BuildingGreen.com · www.BuildingGreen.com



Printed on New Leaf Opaque paper, 80% recycled (60% post-consumer), process chlorine free, with soy-based inks.

mail@BuildingGreen

## Greenbuild and Emissions

Thank you for the excellent article on the U.S. Green Building Council's Greenbuild conference (Vol. 12, No. 12). I would like to take issue, however, with the claim that the conference was free of carbon dioxide (CO<sub>2</sub>) emissions.

The chart accompanying the article shows that this claim was made because USGBC received a donation of over 10 million pounds of CO<sub>2</sub> credits from DuPont Antron—an amount which more than offset the calculated CO<sub>2</sub> created by the conference, including emissions resulting from the energy used by attendees to travel over 7.5 million miles to and from the conference site in Pittsburgh.

Receiving donated credits from corporate sponsors does not mean that USGBC and/or conference participants did anything at all to reduce air pollution or “net out” the energy and atmospheric impacts associated with the conference and all that travel. DuPont deserves praise for its conservation efforts, but I don't see how credit for that can be transferred to USGBC or the conference. This feels like greenwash and is very disappointing, especially coming from USGBC.

If USGBC is serious about mitigating the environmental impacts of its conferences, it should assess a mandatory “green fee” from attendees which would be sufficient in and of

itself to finance, incentivize, or leverage new conservation measures equal to the anticipated emissions impact of the conference.

Walter Simpson, CEM

LEED-Accredited Professional  
Energy Officer, SUNY Buffalo  
Buffalo, New York

## Flammability and Nysan Shade Screening

Please explain what makes “polyester yarn ... impregnated with an acrylic-based material” fire resistant, as claimed in the article “PVC-Free Interior Shade Screening from Nysan” (Vol. 12, No. 12). As far as we know, polyester and acrylics are both flammable.

Tim Burns, President

The Vinyl Institute  
Arlington, Virginia

**Editors' response:** We checked with Nysan Shading Systems, Ltd., who says that while they describe the material as “acrylic-based,” it is actually a Trevira® CS polyester to which a polyurethane coating has been applied. The company describes the polyurethane coating as being similar to acrylic in its application, but, as you note, quite different from acrylic relative to flame resistance. All of Nysan's GreenScreen® PVC-free fabrics have been tested in accordance with the North American and European fire standards, according to the company, and all have passed.

## Correction on Water Consumption by Toilets

In our article on toilets (Vol. 13, No. 1), we reported on page 7 that toilets consume an average of 20.1 gallons of water per day in households where water-conserving fixtures have not been installed and 9.6 gal-

lons per day in households where water-conserving fixtures have been installed. Those are actually *per-capita* figures. The average household water usage by toilets is two to two-and-a-half times as great. The percent figures we provided are correct. Our *Find the Hidden Error* award goes to Terry Brennan.

**What's Happening**

**Apollo Alliance Aims for Energy Independence**

The Apollo Alliance, a unique coalition of labor, environmental, civil rights, business, and political leaders, has announced its vision of achieving energy independence in ten years. According to a study released by the Apollo Alliance in January, a \$300 billion federal investment in renewable energy and green buildings over ten years would create 3.3 million new high-wage jobs, more than paying for itself through increased federal tax revenues from higher earnings; stimulate \$1.4 trillion in new gross domestic product; and produce \$284 billion in net energy cost savings. Dr. Ray Perryman, a corporate economist who prepared an economic analysis of the proposal, showed that the project would position the U.S. to take the lead in fast-growing markets and reduce the trade deficit. The plan would also reduce air pollution, America's contribution to global climate change, and dependence on imported oil.

The Apollo ten-point energy plan calls for investing in green homes and buildings, reinvesting in smart urban growth, promoting hybrid vehicles and other alternative means of transportation, expanding renewable-energy development and the use of hydrogen, increasing the use of efficient appliances, modernizing the electrical infrastructure, and preserving regulatory protections.

Evoking President Kennedy's original Apollo program of the 1960s, which landed a man on the moon within the decade, creators of this "New Apollo Project" aim to rally the nation around a commitment to energy independence. "At the time of Kennedy's moon shot, we were in a space race with the Soviet Union," said Senator Maria Cantwell (D-WA).

"Now we are in an economic race with the Europeans and Japanese." The Apollo Alliance plans to play a role in the upcoming presidential election. Bracken Hendricks, executive director of the Alliance, noted that "the public is demanding a forward-looking plan to rebuild our economy and a positive solution to our energy insecurity. A bold approach like Apollo is the kind of leadership we need from our next President." – JB

**For more information:**

The Apollo Alliance  
202-955-5665  
feedback@apolloalliance.org  
www.apolloalliance.org

**EPA Launches SmartWay Transport Partnership**

According to the U.S. Environmental Protection Agency (EPA), freight trucks and locomotives use 35 billion gallons (1.5x10<sup>11</sup> liters) of diesel fuel each year, emitting over 350 million metric tons of carbon dioxide. Facing a predicted 25% increase in these numbers by 2012, EPA launched a new program in February focused on making America's freight industry more efficient and less polluting.

The SmartWay<sup>SM</sup> Transport Partnership was designed with three components. In the first, EPA is establishing partnerships with companies that carry freight and with shippers that hire those carriers. EPA has developed the FLEET (Freight Logistics Environmental and Energy Tracking) Performance model to help companies assess their current environmental performance (defined by the model as carbon dioxide and other emissions), evaluate a variety of improvements, and track their progress. Under the partnership, carriers com-

mit to improving the environmental performance of their operations, and shippers commit to supporting SmartWay carriers for the majority of their shipping needs. Suggested strategies for carriers include using wide-base tires and low-viscosity lubricants, and reducing highway speeds and idling times. Suggested strategies for shippers include selecting the most efficient mode of transportation, combining orders to create full truckloads, and scheduling raw-material pick-ups to coincide with product deliveries. Each participating company must submit an outline of its strategy for improved performance and regularly report on its progress.

The second component of SmartWay is to establish a National Idle-Free Corridors Program. Through this program EPA plans to educate and guide operators of trucks, locomotives, truck stops, ports, borders, terminals, and rail yards, and to fund some idling-reduction demonstration projects. The third component of SmartWay is to maximize the use of America's railways for transporting freight, and to improve the efficiency of rail operations. Department of Transportation data indicate that

**Energy Efficiency by Mode of Transport**

Type of Transport	Btu/ton-mile	KJ/tonne-km
Trucks	3,337	2,410
Waterborne Commerce	444	321
Class I Railroads	346	250

Note: Due to several variables, truly comparable energy-intensity data is unavailable; use data with caution.

Source: *The Transportation Energy Data Book: Edition 23*, Oak Ridge National Lab, Oak Ridge, Tennessee

trains are, on average, nearly ten times more efficient than trucks in terms of energy use per ton-mile.

EPA's goals for SmartWay are four-fold: to reduce the fuel consumption of trucks and locomotives (thereby improving the nation's energy security), to reduce the operating costs associated with freight delivery, to

reduce the emissions of carbon dioxide and other greenhouse gases, and to reduce the emissions of nitrogen oxides, particulate matter, and other air pollutants (thereby improving environmental justice). EPA anticipates that, by 2012, SmartWay will be saving up to 150 million barrels of oil annually while preventing the release of between 33 and 66 million metric tons of carbon dioxide emissions and up to 200,000 tons of nitrogen oxide emissions. – JB

**For more information:**

SmartWay<sup>SM</sup> Transport Partnership  
U.S. Environmental Protection Agency  
Office of Transportation and Air Quality  
[www.epa.gov/smartway](http://www.epa.gov/smartway)

## LEED for Existing Buildings Out for Comments

At the beginning of March 2004, the U.S. Green Building Council released a draft of the LEED<sup>®</sup> for Existing Buildings (LEED-EB) Rating System for review by Council members during a 30-day comment period. LEED-EB is designed to certify the ongoing operations and maintenance of facilities, including upgrades to building systems. It is not intended to encompass major renovations, which are the purview of LEED for New Construction (LEED-NC). After the comment period a final draft will be prepared for member ballot, which the Council hopes will be approved in time to become the second LEED rating system during the summer.

The newly released comment draft differs substantially from the version of LEED-EB that was published in January 2002 and used as the basis of the pilot program. The pilot version was modeled very closely on LEED-



Photo: IdleAire Technologies Corporation, [www.idleaire.com](http://www.idleaire.com)

*IdleAire Technologies Corporation has developed a window-mounted system that allows truck drivers to turn off their engines when they are not driving. IdleAire's Advanced Travel Center Electrification technology provides each parking space with telephone, television, and Internet access; outlets for appliances, oil heaters, and engine heaters; and an external, thermostatic heating and air-conditioning unit. Service is available at 13 sites in 6 states; 16 additional sites are under construction.*

NC and included two “free” points for using an existing building (corresponding to the points in LEED-NC for reusing an existing building and for selecting a low-impact site). Those points have now been eliminated in favor of points for documenting operating costs and for tracking occupant medical bills and absenteeism.

Other substantive differences include three new credits for “sustainable purchasing” in the materials and resources section. One of these credits, good for up to five points, replaces five separate material selection credits from LEED-NC. The second credit, with four points available, replaces LEED-NC’s indoor environmental quality credit for using low-emitting materials. And the third credit, for up to four points, promotes the purchasing of greener janitorial supplies.

Also new to this draft is an innovative calculation to limit the amount of mercury used in lamps. The new formula in this LEED-EB prerequisite takes into account both mean light output and projected lamp life. It establishes a maximum average

mercury content of 90 picograms per lumen hour for all mercury-containing lamps in the facility. Low-mercury linear fluorescent lamps from major manufacturers meet this threshold, but most compact fluorescent lamps, high-intensity discharge (HID) lamps, and conventional fluorescent tubes do not. – NM

**For more information:**

U.S. Green Building Council  
[www.usgbc.org](http://www.usgbc.org)

## Newsbriefs

The Green Meeting Industry Council (GMIC) was launched in December 2003, initiated by Meeting Strategies World-

wide, of Portland, Oregon. Recognizing that over a million meetings and events, and over 12,000 tradeshow, are held each year, GMIC is committed to “balancing economic, environmental, and community objectives as they relate to the meeting industry” by promoting a variety of green strategies. The organization hopes to play a parallel role in the meetings industry to that played by the U.S. Green Building Council (USGBC) in the building industry; with the help of Terri Stewart, GMIC interim board member and USGBC vice president for finance and operations, GMIC plans to develop a standard and certification system for green meetings. More information is available from Amy Spatrisano, at 503-731-8971 or [amy@greenmeetings.info](mailto:amy@greenmeetings.info).

A new program is making it easier for Puget Sound residents to make their homes more efficient. Through a partnership with Efficiency Services Group (a division of Portland General Electric), HomeStreet Bank has started the **Mortgage Options for Resource Efficiency (MORE<sup>TM</sup>)** program. Participants in the pro-

gram receive custom home energy analyses to help them determine which water- and energy-saving upgrades make the most sense, and then add \$4,000 worth of improvements directly to their mortgages. Common improvements include replacing clothes washers, toilets, and showerheads, and upgrading insulation and airtightness. Homeowners typically save far more money on water and energy bills each month than the mortgage payment increase. See [www.homestreet.com](http://www.homestreet.com).

In a unique agreement, the leaders of four architectural institutions have committed to sustainable design. The "**Barcelona Declaration on Sustainable Design**" was signed at the Construmat Fair in Barcelona, Spain by Jaime Lerner, representing the International Union of Architects (and former mayor of Curitiba, Brazil); Paul Hyett, for the Royal Institute of British Architects; Carlos Hernandez Pezzi, for the Consejo Superior de los Colegios de Arquitectos de España; and Daniel Williams, FAIA, for The American Institute of Architects. In recognition of the role that design plays in both the health of the natural environment and the quality of human life, the declaration calls for cooperation among design and building professionals worldwide, "so that they may contribute with ever greater effect to the delivery of a built and natural landscape which is safe for children and the children's children of all species and communities."

The **Home Builders Association of Metro Denver**, which recently trademarked the name Built Green® for its residential green building program (the largest in the nation), has issued a cease and desist request against Vermont's **Building for Social Responsibility (BSR)** over its

use of the name Vermont Built Green for its own fledgling program (see *EBN* Vol. 12, No. 7). BSR seems to be retreating quickly and is considering other names, including Vermont Building Greener. The Denver program is online at [www.builtgreen.org](http://www.builtgreen.org). The Vermont program is online at [www.bsr-vt.org](http://www.bsr-vt.org).

Continuing a trend of rapid growth, the **U.S. Green Building Council** announced in early February that it had accepted its 4,000th member. USGBC membership—which is open only to companies and organizations, not to individuals—hit 2,000 in September of 2002 and 3,000 in May of 2003.

Interface Flooring has sold more than a million square yards (840,000 m<sup>2</sup>) of climate-neutral **Cool Carpet™** since its introduction in August 2003 (see *EBN* Vol. 12, No. 10). Through the Cool Carpet initiative, customers are funding greenhouse-gas reduction projects to offset the emissions

resulting from the carpet throughout its life cycle. According to the Climate Neutral Network, a third-party certifier, the sales of Cool Carpet have already offset more than 16,000 metric tons of carbon dioxide. Details are at [www.interfaceflooring.com](http://www.interfaceflooring.com).

A recent design team solicitation from the Architect of the Capitol placed a whopping **25% of its selection criteria on the teams' green design capabilities**. "We believe this level of emphasis is a new high-water mark for the federal government," said Terrel Emmons, FAIA, director of Planning and Programming. The project, being procured under the General Service Administration's Design Excellence in Public Architecture program, involves updating the master plan for the U.S. Capitol Complex, including the Capitol, all Senate and House office buildings, all Library of Congress buildings, the Supreme Court facilities, the Botanic Gardens, and more. The announcement, solicitation GS11P04MKC0022, is online at [www.fedbizopps.gov](http://www.fedbizopps.gov). For details, contact Chrischanda Smith at 202-358-3573 or at [chrischanda.smith@gsa.gov](mailto:chrischanda.smith@gsa.gov).

## Awards & Competitions

The architecture firm **KMD (Kaplan, McLaughlin and Diaz)**, based in San Francisco, has been awarded the prestigious *MIPIM Architectural Review Future Projects Award* for the design of the Jie Fang Daily News and Media Group headquarters in Shanghai, China. The project employs numerous green systems, relying heavily on natural ventilation and daylighting. Currently in the design development stage, the Jie Fang headquarters was awarded "Best of Class" in the office category. The award will be presented in Cannes, France on March 11, during MIPIM, the primary



Photo: Kaplan, McLaughlin and Diaz

*The Jie Fang headquarters building was designed to foster a connection to nature and the surrounding community. Construction is set to begin in the fall of 2004 (see Awards).*

market for real estate trade professionals. Further details may be found online at either [www.mipim.com](http://www.mipim.com) or [www.kmd-arch.com](http://www.kmd-arch.com).

—●—

**CertainTeed's MemBrain™** vapor retarder, which changes permeability according to relative humidity, has been awarded an *Innovative Housing Technology Award* in the energy category from the NAHB Research Center and EH Publishing. CertainTeed is online at [www.certainteed.com](http://www.certainteed.com). See *EBN* Vol. 12, No. 11 for a review of MemBrain.

—●—

**Interface Flooring** has won a *2003 Product Prize* from the American Society of Interior Designers (ASID). Interface was recognized for its leadership in the sustainability movement. "Ray Anderson's passion and role as a spokesperson for the movement has been infectious," noted the ASID awards jury. ASID is online at [www.asid.org](http://www.asid.org). Interface is at [www.interfaceflooring.com](http://www.interfaceflooring.com).

—●—

The community of **Civano**, in southeast Tucson, Arizona, was named *Best New Community* in *Sunset Magazine's* annual Best Places to Live story. The 818-acre (330 ha), mixed-use community was designed around New Urbanist ideals, with a strong



Photo: Geo Advertising & Marketing

sense of community and place (see *EBN* Vol. 9, No. 7). The homes use 50% less energy and 65% less water than comparable, conventional homes. Further details are available online at [www.civano.com](http://www.civano.com).

## Product News & Reviews

### Toyotomi's Wall-Vented, Oil-Fired Space Heater

Many of us living and working in parts of the country without access to inexpensive natural gas rely on fuel oil for heating. In the Northeast, for example, 36% of homes and 38% of commercial buildings are heated with oil. The Upper Midwest also uses a lot of fuel oil, while Alaska relies on both heating oil and kerosene. It was in Alaska in mid-2003 that I first saw Toyotomi's high-efficiency, oil-fired space heaters.

The Japanese company Toyotomi introduced its OM-22 oil-fired, pilotless, wall-mount space heater in the U.S. in 2001. It is designed to operate on No. 2 fuel oil or kerosene (No. 1 fuel oil) and relies on an external fuel tank (typically installed in a basement). Like Rinnai wall-mount space heaters, this is a through-the-wall-venting product with sealed combustion. The OM-22 has three output levels: 8,000, 15,000, and 22,000 Btu/hour. The efficiency, at 90%, is high for oil-fired heating equipment, and the combustion is relatively clean. According to Patrick Miller, of Nelson & Small, Inc., the distributor of Toyotomi products for the Northeast, the OM-22 vaporizes the fuel and burns the vapor, rather than directly burning the liquid fuel. A porcelain rod is heated electrically to initiate that vaporization. The unit uses 275 watts of electricity in the preheat mode and 46 watts during operation (primarily for the fan).

Researcher Dr. C. R. Krishna of Brookhaven National Laboratory, who studies fuel oil combustion, calls vaporization the "holy grail" of oil heating. If it's done right, vaporization results in very low emissions of nitrogen oxides (NO<sub>x</sub>) and very low soot production, according to

Krishna. Conventional oil combustion (sometimes referred to as "yellow-flame" combustion) involves "pressure atomization," and it generally results in high NO<sub>x</sub> emissions. With "blue-flame" combustion, achieved through vaporization, emissions are significantly reduced. While Krishna was unfamiliar with the Toyotomi system, he said that manufacturers have long tried to perfect this type of oil combustion. Problems have included carbon deposits where the fuel is vaporized and carbon monoxide production if the flame becomes destabilized. If Toyotomi has solved these issues, the OM-22 could be a winner. Toyotomi could not provide *EBN* with NO<sub>x</sub> emissions data.

Home Energy Products of Belmont, New Hampshire has installed more than 300 of these units since 2001, says Dick Dargy of the company. He has been extremely pleased with the product. He has had zero callbacks due to equipment problems. "That's amazing," he told *EBN*. "With a new product like that, you always have problems." He says Toyotomi did its homework through field testing before introducing it. "They're really, really good," he said. In fact, Dargy now heats his house with two of the units and has seen his heating bills drop in half so far this winter. He estimates that about 80% of their installations are being used with No. 2 heating oil; the other 20% use kerosene (primarily because kerosene was already being used in those homes).

As for maintenance, Randy Stone, the service manager at Toyotomi USA in Brookfield, Connecticut, recommends cleaning every one to two years. A small window lets you inspect the burner. Any carbon deposits will glow orange and result in flame that varies from the normal blue. Dargy says his company has so far found deposits in the equipment



The Toyotomi OM-22 is the first high-efficiency, wall-vented space heater that can burn heating oil.

Photo: Toyotomi U.S.A., Inc.

to be very light, though he recommends annual servicing. As for how clean the flue gases are, he says that he has white siding and, so far, there have been no soot deposits at all where the flue gases are vented.

The Toyotomi sells for about \$1,200, according to Patrick Miller. Toyotomi USA says they have sold about 3,000 units since introducing the OM-22 in the U.S. Note that Toyotomi also produces and sells Kero-Sun unvented kerosene heaters, which *EBN* does not recommend. Unvented heaters are unsafe in any indoor application (see *EBN* Vol. 5, No. 3).

Toyotomi also produces an oil-fired demand water heater, Model OM-148. The product operates on either No. 2 heating oil or kerosene, relies on electronic ignition (no pilot light), burns at 88% efficiency, and produces 148,000 Btu/hour (43 kW). With a 60°F (33°C) temperature rise, the OM-148 can produce 4.0 gallons per minute (0.25 l/s); with an 80°F (44°C) temperature rise, the maximum flow rate drops to 3.0 gpm (0.19 l/s). For background on demand water heaters, see *EBN* Vol. 11, No. 10. — AW

#### For more information:

Toyotomi U.S.A., Inc.  
P.O. Box 176  
Brookfield, CT 06804  
203-775-1909  
[www.toyotomiusa.com](http://www.toyotomiusa.com)

## Product Briefs

The **Hayward Corporation**, which produces FSC-certified wood products and other green building materials (see *EBN* Vol. 9, No. 6 and Vol. 10, No. 4), has achieved a LEED® v2 Gold rating for its Hayward Building Systems plant in Santa Maria, California. The 55,000 ft<sup>2</sup> (5,100 m<sup>2</sup>) facility includes a 118 kW photovoltaic system producing about 50% of the plant's electrical needs; rainwater harvesting and non-water-using urinals reduce the building's consumption of potable water; and all of the framing lumber is FSC-certified Douglas Fir. The building includes office space and a manufacturing facility for wooden roof and floor trusses and panelized wall systems.

— ● —

**Bonded Logic, Inc.**, manufacturer of UltraTouch cotton-fiber insulation (see *EBN* Vol. 9, No. 11), plans to build its newest manufacturing facility, in Chandler, Arizona, according to LEED® standards. Charlie Popeck, cohost of the PBS show *Build It Green!*, is acting as green building consultant on the 108,000 ft<sup>2</sup> (10,000 m<sup>2</sup>) facility. "We look forward to experiencing the LEED rating program from both perspectives," said Scott Tonkinson, Bonded Logic's marketing and advertising manager, "as a supplier of LEED-eligible insulation and now as a building owner trying to achieve LEED certification." The company's Web address is [www.BondedLogic.com](http://www.BondedLogic.com).

— ● —

**Obex, Inc.**, manufacturer of NovaWood® landscape timbers, fencing, and pavers made from 100% post-consumer plastics, closed its doors in February. The Stamford, Connecticut company survived perennial capital shortages over its 15 years until an accident last April left owner Celeste Johnson unable to maintain sales streams, which plummeted more than 70%. More information about the company's history and its closure is online at [www.obex.com](http://www.obex.com).

## Wire and Cable (from page 1)

Insulated wire and cable represents an annual \$20.5 billion market in the U.S. that is projected to grow by over 5% per year through 2006, according to a 2002 report from the Freedonia Group. Common uses of insulated wire and cable in buildings include power distribution, telecommunications (voice and data transmission), appliances and other equipment, and portable power cords. Insulated wire and cable come in a tremendous variety of types and almost as many performance standards and ratings that govern how and where those products can be used.

In general terms, power cables in commercial buildings must be either sheathed in metal armor (BX cable) or protected within metal conduit. In residential buildings, power cables can be jacketed in plastic—this type of cable is commonly referred to by the Southwire Company tradename Romex®. Data or communications cables can be installed in most buildings without metal protection, but a specialized plenum rating is required for installation in ceiling and floor plenums.

### Materials Used in Insulated Wire and Cable

The primary materials used in insulated wire and cable are reviewed below.

#### Conductor material

Because of its high electrical conductivity and flexibility, copper is the dominant core material, or conductor, used in insulated building wire and cable. According to the Copper Development Association (CDA), approximately 60% of copper in the U.S. is used for applications dependent on electrical conductivity, and 80% of that is for wiring applications in buildings. The copper for wire and cable is nearly all newly mined (virgin) material; recycled copper is rarely used for wiring because impu-

urities in the recycled material can reduce its conductivity or cause breakage in the manufacturing process. Annual copper use for building wire totals about 1.5 billion pounds (over 680 million kg) per year, according to CDA.

Aluminum is also used as the conductor in insulated wire and cable, though much less widely than copper. It is lighter and less expensive than copper, but its conductivity is lower, so more material is required for the same electrical capacity. Aluminum has 30% of the weight and 61% of the conductivity of copper. While some aluminum cable is used in buildings, most is used for utility power transmission.

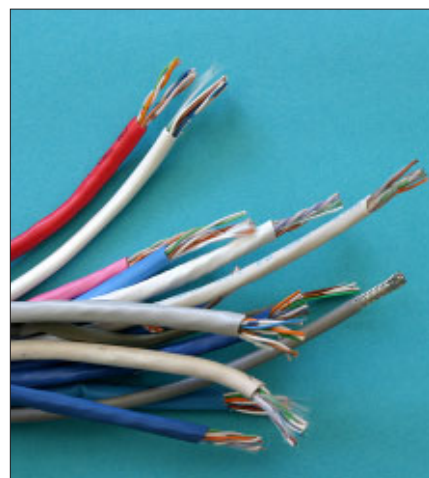
Fiber-optic cable is also used for certain applications that are commonly served by insulated wire and cable, but these are fundamentally different. Rather than conducting *electrical current*, fiber-optic cables transmit light signals, which can carry data. They are lighter, less expensive, and more energy-efficient than copper for data transmission. Indeed, the use of fiber-optic cables for voice and data transmission is rapidly growing. They are made out of glass and, because they do not carry electric current, insulation requirements are not as great as for copper and aluminum conductors.

### Resins for wire insulation and jacketing

Copper and aluminum wire is typically insulated with a nonconductive material that allows wires to be in contact with one another without conducting electric current between them. The ability of wire insulation to contain electric current is measured as the dielectric strength of the material. The most common resins used for insulating wire are polyethylene (PE), polyvinyl chloride (PVC), and fluoropolymers. Nylon, various rubber compounds, silicone, and polyurethane are also used for insulation and jacketing, but less widely.

The most common insulation resins in the U.S. wire and cable market are shown in Table 1.

**Polyethylene.** Polyethylene is the most common type of insulation and jacketing for high-voltage power transmission cables, as well as for non-plenum-rated data cables, radio frequency wiring, and audio wiring. Various types of PE used in wire insulation include low-density (LDPE), linear low-density (LLDPE), medium-density (MDPE), high-density (HDPE), and cross-linked (XLPE) polyethylene. Polyethylene has ex-



A sampling of data cables. Photo: Alex Wilson

cellent dielectric properties, which makes it very good for power distribution applications, but it is inherently less flame resistant than other common wire insulations. As a result, it is rarely used for power in buildings, and when it is used, other materials may need to be added to improve flame resistance. It is widely used for data cable installations that do not require flame resistance, such as wire runs in conduit or behind fire-rated barriers.

**PVC.** Polyvinyl chloride (PVC) is the most common insulation and jacketing material for wiring in buildings, owing largely to its good flame resistance and low cost. In Romex-type wiring, for example, PVC is typically used both as the insulation on indi-

vidual conductors and as the jacketing that surrounds the bundle of individual wires. PVC has significantly greater flame resistance than PE, but other additives are required to make it flexible and stable (see below).

In the past ten years, PVC has come under attack by health and environmental groups, including Greenpeace and the Healthy Building Network, because of a variety of health and environmental concerns. The biggest concern is dioxin production during manufacture, accidental fire, or incineration at the end of its life. According to the National Institute of Environmental Health Sciences (NIEHS), the family of chemicals referred to as dioxins is known to be highly toxic to laboratory animals, causing cancer and altering reproductive, developmental, and immune functions. There are also concerns about PVC's need for stabilizers and plasticizers, some of which have significant impacts. In addition to potentially generating dioxin in the event of a fire, PVC also releases the toxic and corrosive gas hydrogen chloride (HCl) when exposed to extreme heat. This gas can be released both before and after PVC ignites.

**Fluoropolymers.** Various fluorine-containing polymers, especially fluorinated ethylene propylene (FEP), are increasingly common in data wiring applications owing to their exceptional dielectric properties, superb flame resistance, heat resistance, chemical inertness, durability, and flexibility. For plenum-rated (CMP) data cable, FEP-insulated wire is often the only option allowed by code, due to fire-safety concerns. FEP-insulated data cables are most commonly wrapped in a PVC jacket, though the newer, more stringent "limited combustible" ratings require FEP jacketing.

In addition to these performance benefits of FEP, the polymer can be recycled, according to DuPont. "Recycling FEP simply requires remelting and re-extruding the FEP into a

form that is suitable for re-use,” according to Patrick Lindner, the Global Business Manager for DuPont Communications Cabling Solutions. “DuPont believes that this is a unique advantage for FEP over other wire and cable materials, such as PVC and polyolefins—including LSOH (low-smoke, zero halogen)—which often contain fillers and additives that may preclude cost-effective recycling,” says Lindner.

While superb performance properties have been fueling rapid growth in the use of FEP-insulated wire and cable, some significant environmental and health concerns have arisen about FEP and the whole class of fluoropolymer materials (see sidebar on page 10). While FEP does not easily burn, it can emit toxic gases when it gets very hot—even without actual combustion. The primary gas emitted is hydrogen fluoride (HF). This is considerably more dangerous than the hydrogen chloride (HCl) given off by overheated PVC, and in a fire a great deal more is released—up to 49% of the weight of FEP wire insulation can be released as HF. The nine-page Material Safety Data Sheet (MSDS) from DuPont on HF lists a raft of health hazards, ranging from mild skin burns, to eye injury that can include blindness, to severe lung injury and even death.

Along with hydrogen fluoride, other much more toxic chemicals can be given off by FEP in the event of a fire. These poorly understood thermal degradation products have been referred to collectively by some in the cabling industry as “the supertoxin.” Researchers at Borealis, a large European manufacturer of polyolefin plastics, describe these compounds as unsaturated perfluoroaliphatics, which are fluorine versions of the phosgene gas used in World War I as a chemical weapon. The compounds are described as more toxic to rats than phosgene. According to

the white paper “Combustion Atmosphere Toxicity of Polymeric Materials Intended for Internal Cables,” this “extreme toxicity” is not observed when FEP wire decomposes through fully engaged, flaming fires. These highly toxic compounds are most likely to form “when fluoropolymers are overheated to temperatures between 400 and 465°C in a confined space or where secondary heating occurs.”

DuPont, the largest manufacturer of FEP (under the Teflon® brand), lists in the MSDS for FEP the chemical perfluoroisobutylene (PFIB) as a

**Table 1. Volume of US Thermoplastic Resins in Wire and Cable, 2000**

Thermoplastic Resin	Million lb (kg)	Percent
Polyethylene and copolymers	578 (262)	46%
PVC	486 (220)	39%
Nylons	74 (34)	6%
Fluoropolymers	50 (23)	4%
Polypropylene	16 (7)	1%
Other	53 (24)	4%
TOTAL	1,257 (570)	100%

Source: BCC, Inc. 2000 P-133R

degradation product that can be released in very small quantities at temperatures above 720°F (380°C). The National Institute for Occupational Safety and Health (NIOSH) notes that “inhalation of this gas may cause lung oedema. Exposure may result in death.”

DuPont dismisses concerns about the toxicity of FEP. Lindner told *EBN* that “there is no significant difference in toxicity among the types of material [used for wire insulation and jacketing]. All materials that burn are toxic. The key is to use materials that don’t burn.”

In addition to the toxicity concerns, the heat degradation products given off by FEP (and to a lesser extent by PVC) are highly corrosive. An article by Stephen Saunders, “Cabling: What

You Don’t Know Can Kill You,” which is posted online at [www.wireville.com](http://www.wireville.com), suggests that it is the *corrosivity* of halogen-insulated wiring that may ultimately shift us away from halogen-based wire insulation and jacketing. He claims that even a relatively small fire can cause millions of dollars in damage to computer circuitry. Saunders quotes Michael Keogh, of Union Carbide Corporation, who calls corrosivity “the Achilles’ heel of halogen cables.”

Again, DuPont dismisses suggestions that FEP is more damaging to electronic equipment than other materials. “Corrosivity is not the best measure of damage to electronic equipment,” said Lindner. He explained that Underwriters Laboratory (UL) measures the loss of electrical signal in the event of a fire. Plenum-rated cable and limited combustible cable perform the best. “While [FEP] does generate acid, it’s not the acid that’s most damaging to circuit boards,” claims Lindner. Carbon deposits from the smoke are the biggest culprit, he says. Because FEP is so resistant to

burning, Lindner argues that it’s a safer product relative to equipment.

Frank Bisbee, a data cable consultant and editor of [www.wireville.com](http://www.wireville.com), suggests that how good or bad a particular type of cabling looks—relative to both toxicity and damage to electronic equipment—is highly dependent on how the tests are set up. If the humidity is very low, for example, there won’t be enough water vapor to convert hydrogen fluoride into hydrofluoric acid, or hydrogen chloride into hydrochloric acid, and acid corrosion will be less of a problem. Depending on the amount of oxygen in a fire situation, the resultant emissions will vary tremendously. Bisbee says that the outcome of toxicity and corrosivity testing is manipulated by those who control the testing protocols, and he argues

that some companies, such as DuPont, have undue control over those testing protocols.

### Plasticizers

As noted above, PVC's flame resistance makes it an attractive material for wire and cable insulation. PVC is a rigid plastic, though, and before it can be used as wire insulation, plasticizers must be added to make it

flexible. The most common plasticizers used in PVC are phthalate compounds, including diisodecyl phthalate (DIDP) and di-2-ethylhexylphthalate (DEHP). For wire and cable insulation, DIDP is the phthalate of choice because it is less volatile than DEHP. However, because DIDP has lower plasticizing efficiency than DEHP, larger quantities must be used.

Phthalate plasticizers have come under fire because they mimic natural hormones in humans and other animals, causing reproductive problems and birth defects. The issue of endocrine disruptors was brought to public attention by the book *Our Stolen Future* (see *EBN* Vol. 5, No. 6). Polyolefins, including polyethylene, polypropylene, and copolymers of polyolefins, do not require the use of plasticizers.

### Is Fluorine Worse than Chlorine?

There is growing evidence that fluoropolymers represent a significant health and environmental threat. According to some environmental and health advocates, they may be even worse than chlorinated polymers, such as PVC.

Fluorine, chlorine, and bromine all belong to the halogen family of elements. Halogens form very strong bonds, which makes the resultant compounds very durable and often quite inert (one of the features of chlorofluorocarbons or CFCs). But this longevity also allows halogenated compounds to accumulate in biological systems, and many halogenated compounds are quite toxic.

Fluoropolymers are comprised almost entirely of carbon and fluorine. Fluoropolymers go by many different names. Perfluorooctanoic acid (PFOA) is the precursor used in producing most fluoropolymers. It is often found in a salt form, such as ammonium perfluorooctanoate (APFO). Perfluorooctyl sulfonate (PFOS) is closely related. And this whole family of fluoropolymers is sometimes referred to as perfluorochemicals (PFCs). They exhibit properties that have made them extremely successful for a wide range of applications, from non-stick surfaces to stain-shedding fabric treatments to wire insulation. Teflon<sup>®</sup>, or polytetrafluoroethylene (PTFE), was the first of this class of compound to be developed and marketed. Other well-known fluoropolymers include Scotchguard<sup>®</sup>, StainMaster<sup>®</sup>, and Gore-Tex<sup>®</sup>.

In the late 1990s, 3M discovered that PFOA, used in producing its highly popular Scotchguard, was showing up in humans and wildlife worldwide, and in May 2000 the company announced that they would voluntarily pull it off the market (see *EBN* Vol. 9, No. 6). PFOA is used in producing virtually all fluoropolymers in use today. 3M did not present evidence of health risks of PFOA, but pulled it from the market because it was accumulating in biological systems, and evidence of health risks could emerge in the future.

In an online report, "PFCs: A Family of Chemicals that Contaminate the Planet," the Environmental Working Group (EWG) writes that "PFCs seem destined to supplant DDT, PCBs, dioxin, and other chemicals as the most notorious, global chemical contaminants ever produced." While probably the most vocal critic, EWG isn't alone in raising concerns about fluoropolymers.

In April 2003, the U.S. Environmental Protection Agency (EPA) released a preliminary risk assessment for PFOA, noting that "studies recently evaluated by the Agency have raised a number of potential toxicity concerns." With evidence of the widespread presence of these chemicals in the U.S. population (at low levels), the EPA decided that further research was in order. The Agency has solicited information about PFOA from industry and the scientific community, and fluoropolymer manufacturers have voluntarily agreed to reduce

emissions, to study their products to determine if they contribute to the widespread PFOA pollution, and to take steps to reduce exposure of workers and the environment.

While 3M has ceased production of PFOA, DuPont, which had purchased some PFOA from 3M, has continued to produce the chemical to fuel its \$1.5 billion fluoropolymer business. DuPont downplays health and environmental concerns about PFOA but also points out that their Teflon products, such as FEP, do not contain the compound. "There is no PFOA in the FEP that leaves our plant," according to Patrick Lindner of DuPont.

While DuPont claims that its fluoropolymer products are safe, the company also posts consumer warnings on its Web site—for example, about the use of Teflon cooking pans. One such warning describes *polymer fume fever*, a "temporary flu-like condition that occurs as a result of exposure to significantly overheated fluoropolymer materials." DuPont also warns against keeping pet birds near kitchens where Teflon-coated cooking pans are used. "These fumes can be hazardous to birds because birds are small and have very sensitive respiratory systems," according to DuPont.

An information sheet from DuPont includes a strong rebuttal to EWG's concerns about the safety of Teflon and other fluoropolymers. Included on the sheet is a spirited defense of Teflon by Terrence Scanlon, the former chairman of the U.S. Consumer Products Safety Commission. Yet Scanlon can hardly be considered an unbiased source. He runs the Capital Research Center, a Washington-based organization committed to discrediting left-leaning foundations and environmental organizations. Prior to being appointed to the CPSC by President Reagan, Scanlon was vice president for corporate relations for the Heritage Foundation.

Teflon warnings on other Web sites are far more alarming than those on DuPont's site. Teflon poisoning of birds is widespread. Twenty-one birds in the San Antonio Zoo's outdoor aviary were killed, for example, when they congregated around lamps installed to keep them warm. (Many incandescent bulbs are Teflon-coated as a "safety precaution.")

Several recent peer-reviewed papers in *Environmental Health Perspectives* heighten concerns about fluoropolymers—including potential health effects. In a September 2003 paper, "Neuroendocrine Effects of Perfluorooctane Sulfonate in Rats," the authors presented evidence that PFOS can function as an endocrine inhibitor. In the December 2003 issue, a paper with an even longer title showed that out of 645 blood samples collected at random from six Red Cross blood banks around the country, all but one had measurable levels of PFOS, with a median concentration of 35.8 parts per billion (ppb). These fluoropolymers, of which there are no natural sources, are now found in human blood virtually anywhere we look for them, and health concerns are growing.

## Stabilizers

Stabilizers are added to certain plastics to increase resistance to heat, sunlight, moisture, and other stresses during manufacture and use. PVC is particularly prone to heat degradation in applications such as wire and cable insulation; stabilizers slow down the heat degradation of PVC that releases hydrogen chloride and can lead to wire insulation cracking or otherwise failing.

The most common stabilizers used in wire and cable insulation and jacketing are lead compounds, including lead sulfate, lead phthalate, and lead stearate. In typical wire insulation and jacketing, lead compounds constitute 2–5% of the total weight—in the past, lead was as much as 10% of the weight. PVC is the only widely used wire insulation resin for which lead stabilizers are needed; they are also used in some less common rubber and elastomeric materials.

Other stabilizers beginning to appear for use in wire and cable insulation and jacketing include salt-metal blends, such as barium/zinc and calcium/zinc; organotin compounds; and metal-free organic compounds. Cable manufacturer Mohawk/CDT is one of the companies pioneering the shift to lead-free PVC. According to Michael Rubera, Mohawk's director of technical support, the company primarily uses polyolefin insulation and lead-free PVC jacketing on its non-plenum-rated data cables.

## Fillers

Certain fillers are commonly used in PVC and polyolefin resins to reduce costs and improve electrical resistance of the material. These fillers, including calcium carbonate, talc, mica, carbon black, and kaolin (a type of clay), are generally considered safe from both health and environmental perspectives.

## Flame retardants

Flame retardants are added to plastics to slow the spread of a fire, re-

duce the amount of heat and smoke emitted during a fire, and cause a fire to self-extinguish. Flame retardants function through a variety of mechanisms. Some reduce the fuel content of the material—by adding noncombustible halogens or fillers to the polymer, for example. Others raise the decomposition temperature of the polymer by more tightly bonding (cross-linking) the molecules. Still others emit water at high temperature.

PVC and fluoropolymer resins like FEP are inherently flame resistant due to the halogen content of the polymer resin. FEP is more flame resistant than PVC, but the hydrofluoric acid released by the heat decomposition of FEP is also more toxic than the hydrochloric acid released by decomposing PVC. FEP does not begin to break down until it reaches a temperature of about 530°F (275°C), compared with about 320°F (160°C) for PVC. While PVC is inherently flame resistant, the phthalate plasticizers added to PVC are not, so additional flame retardants have to be added to PVC for use in some wiring applications.

Three classes of flame retardants are commonly used in wire and cable insulation: halogenated compounds (based on bromine, fluorine, or chlorine), inorganic compounds (such as antimony), and phosphorous compounds. Among halogenated flame retardants, bromine-containing flame retardants are more effective than chlorine-containing compounds, because bromine forms a weaker bond to carbon and thus interferes more effectively with the combustion process. A number of brominated flame retardants are commonly added to polyolefin wire and cable insulation—either alone or mixed with an antimony compound. Some wire insulation is 10–20% flame retardant by weight.

Chlorine is also sometimes added to polyethylene in wire insulation—producing chlorinated polyethylene (CPE). CPE is relatively inexpensive

and fairly stable, but the high percentages of chlorine required can affect other performance properties of the polymer, and, as with PVC, it may release HCl or dioxin in the event of a fire. While fluoropolymers are used as wire insulation and jacketing, fluorinated compounds are not known to be used as flame retardants in other polymers.

The most common inorganic flame retardants are metal hydrates, antimony compounds, and zinc borate. Metal hydrates work by introducing water to the fire. Aluminum hydroxide (also called alumina trihydrate, ATH) is widely used in plastics such as polyethylene. At temperatures above 480°F (250°C), the compound degrades into water and alumina, slowing flame spread or extinguishing the fire. Magnesium hydroxide is similar but degrades at a higher temperature 625–645°F (330–340°C); it is more commonly used with polypropylene. When they are used, metal hydrates can be compounded with the resin or packed in around the wires as the cable is manufactured.

Antimony flame retardants are generally most effective when combined with halogens. Antimony trioxide is commonly added to PVC, for example. Halogen acid, released during a fire, reacts with the antimony compound and produces char, which acts as a physical barrier to flame spread. Antimony-halogen reactions in a fire also keep oxygen from easily combining with the fuel contributed by the polymer.

Zinc borate, alone or in combination with aluminum hydroxide, is used as a flame retardant in a variety of halogen-free polymers, such as polyethylene, EPDM, epoxy, and acrylics. Zinc borate is relatively inexpensive and sometimes used as a partial substitute for the antimony oxide flame retardant in PVC cable jacketing.

Phosphorous-containing flame retardants are very versatile. Many different phosphorous compounds are used, though the most common are

phosphate esters (used in flexible PVC) and chlorinated phosphates (used in polyurethanes).

### Lubricants

Lubricants are added to wire and cable insulation to improve processing. The most common lubricant is stearic acid, which is added to PVC. These compounds are not considered harmful. Lead in PVC also acts as a processing lubricant, which is one of the reasons that manufacturers have been reluctant to phase it out in favor of other stabilizers. "Lead increased production of extrusion machines significantly; from 1984 onward the use of lead took off," says Bisbee.

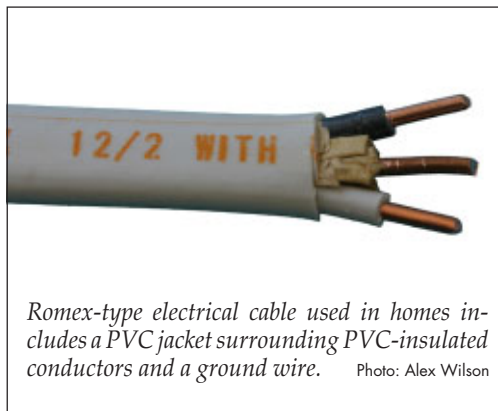
### Colorants

Pigments and dyes are widely used in wire and cable insulation to aid in identification. Dyes are organic compounds that are soluble in the resin, while pigments are insoluble compounds that are dispersed throughout the resin. Some inorganic pigments, such as titanium dioxide, zinc sulfide, and carbon black, are fairly innocuous. Other pigments are made from heavy metals and contribute to the toxicity of wire and cable insulation. Lead chromate is used for making some yellow and orange pigments; cadmium for reds, yellows, and oranges; and chromium oxide for greens. While some pigments used in wire and cable are hazardous, the quantities of pigment are small, so this is generally a lower environmental priority than stabilizers and flame retardants. Some manufacturers have eliminated all heavy-metal pigments from their wire and cable.

## The Search for Greener Wire and Cable

Searching for greener wire and cable can be frustrating. There has been relatively little attention paid to health and environmental concerns with wiring. One of the exceptions is

the Massachusetts Toxics Use Reduction Institute (TURI), which was established by the Commonwealth's Toxics Use Reduction Act of 1989. On the international level, according to TURI deputy director Liz Harriman, there are significant drivers—especially from the European Union. The EU directive on Waste Electrical and Electronic Equipment (WEEE) and the Restriction of Hazardous Substances Directive (RoHS) will ban all lead from electrical equipment and electronics by 2006, and some manufacturers are moving even more quickly. "TURI is working with the wire and cable industry and their suppliers in Massachusetts to keep them competitive in the global marketplace," Harriman told *EBN*.



*Romex-type electrical cable used in homes includes a PVC jacket surrounding PVC-insulated conductors and a ground wire.* Photo: Alex Wilson

PVC has so far been the focus of most attention, due largely to the efforts of Greenpeace and others. FEP-insulated wire and cable is sometimes suggested as an alternative to PVC, but, as addressed above, fluoropolymers have their own environmental, health, and safety issues that some suggest may be more significant than those of PVC.

In terms of fire-safety, U.S. codes rely exclusively on test standards for flammability and flame spread, ignoring the risks of toxic and corrosive gases released both before and after ignition. This approach differs from some European codes, which assume that incapacitation from irritating gases can be a major factor in whether or not people can escape from a building fire.

There is clearly interest in some circles in specifying halogen-free wiring (avoiding not only PVC but also other sources of chlorine, bromine, and fluorine). The clear alternatives to halogenated wire and cable are polyolefin (polyethylene and polypropylene) products. To use polyolefins for insulation and jacketing, compounds are typically added for flame resistance as described above. Borealis Compounds, LLC, the U.S. division of the Danish company Borealis A/S, offers such products in the U.S., but sales are limited. The primary applications are subway systems and other locations where the acid emissions from halogenated compounds are not acceptable.

The manufacturing costs of flame-resistant polyolefin wiring are significantly higher than those of PVC, according to a Borealis engineer *EBN* spoke with. Regulatory changes would probably be required to bring about a significant shift toward polyolefins from PVC.

Another option for specifying greener wire and cable is to search for PVC wiring without lead or other heavy metals. Manufacturers, including Mohawk/CDT, are increasingly advertising "lead-free" product. Demanding lead-free or heavy-metal-free PVC cable can hasten the transition away from these toxins—note that heavy metals can show up both as heat stabilizers and as pigments.

Yet another approach is to specify polyolefin cable with less stringent flame resistance, and place that cable in a fire-protected environment. This means putting it in metal conduit or cellular cores of concrete floor panels. This will add significantly to the total project cost, however, and the trends are generally in the other direction: specifying plenum-rated, FEP-insulated cable that can be installed in ceiling and floor plenums without additional protection.

For data and voice, fiber-optic cables and wireless technologies are in-

creasingly viable options, though fiber-optic cables still require protective jacketing. Because they can transmit so much data, one fiber-op-

tic cable can replace many copper cables in high-capacity applications. Wireless data networks are already taking over from hard-wired connec-

tions in highly mobile settings, such as cafés, classrooms, and meeting rooms. A preliminary investigation into concerns about higher energy use for wireless hubs indicates that their energy demand differs very little from the energy demand of wired hubs and routers.

## Greener Wiring: A Checklist for Action

### GENERAL WIRING GUIDELINES

**Design for easy access.** Install wiring in readily accessible wiring chases to simplify future modifications.

**Minimize wiring runs.** Reduce material use by installing high-capacity runs to local hubs rather than connecting each workstation directly to a central hub. Local hubs can connect to workstations via wireless or short wired connections.

**Avoid wiring in exterior walls.** Especially in residential buildings, limit wiring runs and receptacle placement in exterior walls. Such installations interfere with insulation and can result in significant air leakage.

**Avoid the need for plenum-rated and limited combustion cable.** Run data cable in metal conduit, sealed wiring chases, or cellular raceways of concrete decking to avoid the need for highly flame-resistant cable.

**Go wireless.** Use wireless data connections instead of hard-wired ones for maximum flexibility and minimum material use. Wireless connections may be usable in some local areas, even if they are not usable building-wide.

**Don't overwire.** Design for future wiring needs, but avoid installing wires unless there is an immediate need for them. Future needs are hard to predict.

**Label wires.** Label all wires carefully at both ends to ensure that they will be utilized effectively.

**Design for future removal.** Design wiring installations so that wire can be easily removed when not in use.

**Minimize EMF.** Rely on "prudent avoidance" strategies to minimize exposure of building occupants to electromagnetic fields. See *EBN* Vol. 3, No. 2 for recommended practices.

### WIRING SPECIFICATIONS

**Plan for future needs.** Install voice-data-video (VDV) cable that can serve upgraded networks—with faster data transfer speeds than your current network—so that the cable will not become obsolete as quickly.

**Eliminate use of lead stabilizers in wire**

**insulation and jacketing.** With PVC wire and cable, specify lead-free product that does not contain lead stabilizers. Some PVC wire insulation and jacketing are comprised of 5–10% lead by weight.

**Do not install lead-stabilized cable loose in plenums.** To keep lead dust out of the building air, cable that is stabilized with lead—including most plenum-rated cable—should be installed in metal conduit and not directly exposed to the conditioned air circulating through a ceiling or floor plenum.

**Specify halogen-free wire and cable.** Wherever possible, specify wire and cable insulation and jacketing that do not contain halogens. This includes PVC, chlorinated polyethylene, FEP, and products containing brominated flame retardants.

**Specify heavy-metal-free wire and cable.** Even wire and cable that is free of lead stabilizers is often pigmented with lead, cadmium, chromium, and other heavy metals. Specify cable that is free of all heavy metals, including pigments.

**Use fiber-optic cable where possible.** Fiber-optic cable is widely used for carrying voice and data signals. Because light rather than electric current is being carried and because the primary component is glass, less insulation and jacketing are required than for copper wiring. It may be possible to run fiber-optic trunk lines to smaller copper distribution lines and thus reduce total insulated cable use.

### WIRING REMOVAL

**Remove old cable.** Whenever new cable is being installed in a building, remove any old cable that is not being used or will not be usable in the future, as per the 2002 revisions to the National Electrical Code.

**Follow proper safety precautions in removing old cable.** Old cable contains high levels of lead dust, and significant care must be taken during removal. Ensure that workers wear the proper respirators for lead dust, and seal removed cable in plastic bags.

**Recycle old cable.** Deliver old cable removed from buildings to facilities where the cable is properly recycled. NEVER burn old cable to recover copper.

## Other Environmental Issues with Wiring

Specification of wire and cable is not the only issue of interest to environmentally concerned designers and builders. Dealing with wire removal, the impacts of rewiring, and the minimization of electromagnetic fields (EMF) should also be considered.

### Dealing with abandoned cable

One factor that is causing many building owners and tenants to rethink how they wire offices is a new requirement in the 2002 National Electrical Code (NEC)—article 800—that abandoned cables must be removed from all plenum spaces. The concern is that leaving old cables in place when new ones are added leads to dangerous fuel loading in plenums. The code defines "abandoned cable" as any cable that is not in use and doesn't have connectors and labels at both ends so that it can easily be used.

The burden of removing abandoned cable—as much as 11 million miles (17.7 million km) nationwide, by some estimates—is a challenge for building owners. The new code is already being enforced in some jurisdictions, while in others it has yet to be adopted. Generally, the requirement to remove abandoned cables kicks in with any remodeling of the space. In occupied spaces, removing abandoned cables without damaging those that are in use can be a huge challenge. At least one company is being formed solely to remove abandoned cable ([www.Article800.com](http://www.Article800.com)).

An issue that has not yet gained much attention in this push to remove old cables is the amount of

toxic lead dust that is being released. Since 1984, most cable jackets have been made with lead-stabilized PVC, according to Bisbee. As the plasticizer leaches out over time, these jackets become brittle, and the lead migrates to the surface. Thus, as the cables are extracted they leave behind particles with lead content that is "much higher than 10% on the surface," says Bisbee. Loose in the space above dropped ceilings or in floor plenums, this dust can easily reach building occupants. In spite of the obvious concern and anecdotal experience of this lead dust problem, there does not appear to be any concerted effort to study—much less to address—this potentially serious health hazard. "Have we built an asbestos problem for the future here?" Bisbee asks.

It appears that cables in plenum spaces represent a toxic hazard whether they are left in place or removed. The good news is that the new NEC requirement forces building owners and occupants to consider their responsibility for removing cables when they put them in. Many building owners are now specifying in leases that when tenants leave, they are required to remove any cables they have installed. This requirement should lead to more frugal use of cable, the installation of systems that facilitate the removal of old cable, and better labeling of cables that are installed.

Once old wire and cable is removed, what can be done with it? The various additives in PVC, as well as the PVC itself, raise concerns about incineration. While less attention has been paid to brominated flame retardants and to fluoropolymer resins (FEP), similar concerns about incineration apply.

So how practical is recycling? Fortunately, copper is a valuable commodity, so old wiring is commonly recycled for the copper. According to Bisbee, old wire is typically shipped to India and Pacific Rim countries,

where it is run through stripper machines to recover the copper. The insulation and jacketing, however, are much more difficult to recycle. The additives, including lead stabilizer, make PVC wire insulation and jacketing virtually impossible to recycle. Cross-linked polyethylene is a thermoset plastic, so it is not easily recycled, though some other forms of polyethylene may be recyclable. Of all the wire insulation and jacketing materials, FEP is the most recyclable—though recycling programs for old FEP-insulated wiring are not known to exist. Frank Bisbee argues that the cost of identifying and separating different types of cable so that FEP could be recycled would be very high; he does not expect to see this option appearing anytime soon.

### Electromagnetic fields

Finally, there remain some concerns about exposure to EMF in buildings. While there have been no conclusive studies about the health effects of EMF exposure, some studies continue to identify this as a risk. For more on EMF and "prudent avoidance" strategies for EMF, refer to the still-relevant *EBN* article in Vol. 3, No. 2.

### Final Thoughts

Wiring remains a huge challenge for designers and builders who want to do the right thing relative to health and the environment. Acceptable wiring alternatives are heavily controlled by building codes that focus almost exclusively in this country on flame spread and smoke developed, with no attention given to the toxicity of wire and cable products. Whether toxicity will be actively considered in the fire-safety testing of wire and cable remains uncertain. The PVC and fluoropolymer industries have a great deal riding on the outcome.

We can be sure that research will continue on the safety of the newest class of wire insulation materials: fluoropolymers. EPA's investigations into PFOA could well be just the tip of the iceberg.

We can also be sure that new materials will come along. "Stay tuned for new, innovative materials that are halogen-free and flame retardant to hit the market," says Harriman. "There are significant drivers for their development, even if not from the building industry."

In the meantime, refer to the Checklist on page 13 for some steps that concerned designers and builders can take to improve the safety and environmental performance of wiring installations.

— Alex Wilson

### For more information:

Frank Bisbee, President  
Communication Planning Corporation  
4160 Southside Boulevard, Suite 3  
Jacksonville, FL 32216  
904-645-9077  
[www.wireville.com](http://www.wireville.com)

Gail Vittori  
Center for Maximum Potential  
Building Systems  
8604 F.M. 969  
Austin, TX 78724  
512-928-4786  
[www.cmpbs.org](http://www.cmpbs.org)

Massachusetts Toxics Use Reduction  
Institute  
University of Massachusetts—Lowell  
1 University Avenue  
Lowell, MA 01854  
978-934-3275  
[www.turi.org](http://www.turi.org)

Borealis Compounds, LLC  
176 Thomas Road  
Port Murray, NJ 07865  
908-850-6200  
[www.borealisgroup.com](http://www.borealisgroup.com)

DuPont Fluoroproducts  
Chestnut Run Plaza  
P.O. Box 80702  
Wilmington, DE 19880  
800-207-0756, 302-479-7731  
[www.teflon.com](http://www.teflon.com)

Southwire Company  
1 Southwire Drive  
Carrollton, GA 30119  
800-444-1700, 770-832-4645  
[www.mysouthwire.com](http://www.mysouthwire.com)

Mohawk/CDT  
9 Mohawk Drive  
Leominster, MA 01453  
978-537-9961  
[www.mohawk-cdt.com](http://www.mohawk-cdt.com)

## From the Library

### Two New Books on Green Homes

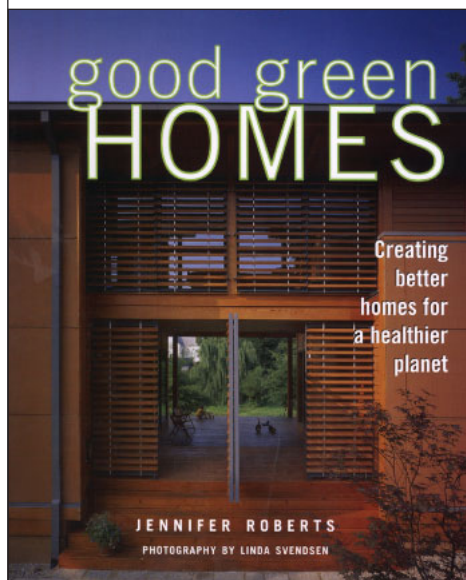
#### **Good Green Homes: Creating Better Homes for a Healthier Planet**

by Jennifer Roberts. Gibbs Smith Publishers, Layton, Utah, 2003; 160 pages, hardcover, \$39.95

#### **Green by Design: Creating a Home for Sustainable Living**

by Angela Dean. Gibbs Smith Publishers, Layton, Utah, 2003; 136 pages, softcover, \$24.95

Homeowners wanting to understand what a green home is and custom home builders wanting to introduce green home ideas to potential clients could benefit greatly from these two recently published books from Gibbs Smith Publishers. While both books make extensive use of case studies to



convey the essence of green home building, they are quite different.

*Good Green Homes* offers a broad overview of green building with an emphasis on the philosophical reasons for building green. The book is

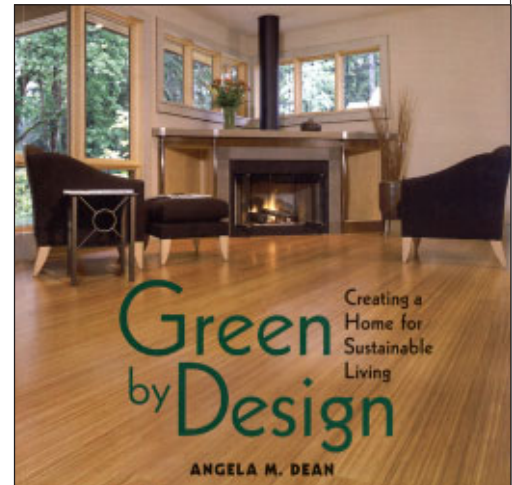
organized into seven key “paths” to creating a good green home:

- Know Where You Are – on the relationship between place and sustainability;
- Size Matters – on why smaller, more compact houses are better for the environment and often better for homeowners;
- You Have the Power – on energy-efficient design, heating and cooling, and making use of renewable energy sources;
- Build for Today and Tomorrow – on durability, maintenance, and other strategies for ensuring the longevity of homes;
- Clean Living: Protecting Our Air and Water – on creating homes that will protect the health of occupants and use water efficiently;
- Build a Better Wall – on both conventional and alternative building methods (with greater focus on alternative techniques, such as building with straw and earth); and
- Use the Right Stuff – on material selection, with significant focus on salvaged materials, FSC-certified wood, and rapidly renewable building materials.

Each of these paths, or chapters, includes concise prose outlining the basic issues, checklists of more detailed information (Good Green Recommendations), and beautifully illustrated home profiles. A useful glossary and listings of some of the more useful resources round out the quick-to-read book. Author Jennifer Roberts, who with Chris Hammer creates the e-mail-distributed *Green Clips* newsletter, has a clearly demonstrated grasp of green buildings.

In *Green by Design*, author Angela Dean approaches the issues of green

design quite differently. The four primary chapters cover design intent, design process, design strategies, and design specifics. Each of these chapters provides some information in the main text, then conveys a lot more information through detailed case studies. The final chapter, Design Specifics, provides the most de-



tailed information of the four, but none goes into significant depth.

Most of the houses profiled in the book are custom homes in the West or Southwest, though a few are in other regions. Many of the designers of these homes will be familiar to those who have followed the green building movement. As with *Good Green Homes*, *Green by Design* emphasizes alternative construction systems, such as straw-bale.

After reading these two books and observing the fundamental similarities—both using case studies of custom homes to illustrate the principles discussed—I was surprised to discover that both were put out by the same publisher, particularly since the two are not designed as companion books. We recommend either book (or both) for providing a general overview of green building and for illustrating these ideas through actual homes. Neither includes enough detail to make it a useful *reference* on green building for designers and builders, but both succeed admirably as idea books. – AW

## Calendar

### MARCH

**14-16 • National Green Building Conference**, Austin, TX. *Sponsor:* National Association of Home Builders. *Information:* 800-368-5242 x8338; [www.nahb.org](http://www.nahb.org).

**17-20 • Greenprints 2004**, Atlanta, GA. *Sponsor:* Southface Energy Institute and Georgia Environmental Facilities Authority. *Info:* 404-872-3549 x114; [www.greenprints.org](http://www.greenprints.org).

**20 • Green Strategies for Historic Buildings**, Boston, MA. *Sponsor:* National Preservation Institute. *Information:* 703-765-0100; [www.npi.org/sem-green.html](http://www.npi.org/sem-green.html).

**26-27 • Integrated Design, Integrated Development**, Durham, NH. *Sponsor:* NH Chapter of AIA. *Information:* 603-357-2863; [www.aianh.org/action/idid.shtml](http://www.aianh.org/action/idid.shtml).

**27 • Designing High Performance Commercial Buildings**, Warren, VT. *Sponsor:* Yestermorrow Design/Build School and Efficiency Vermont. *Information:* 888-496-5541; [www.yestermorrow.org](http://www.yestermorrow.org).

### APRIL

**1 • GreenWorld™: What Makes it Green?**, Seattle, WA. *Sponsor:* IIDA Washington State Chapter, AIA Seattle Committee on the Environment. *Information:* [www.iida-wa.org](http://www.iida-wa.org); [www.aiaseattle.org](http://www.aiaseattle.org).

**1-2 • The Frontiers of Forest Certification**, Vancouver, BC. *Sponsor:* Forest Certification Watch™. *Information:* 877-273-5777; [www.CertificationWatchConference.org](http://www.CertificationWatchConference.org).

**6-8 • Green Building Technologies Conference**, Pomona, CA. *Sponsor:* Assoc. for

Efficient Environmental Energy Systems. *Info:* 530-750-0135; [info@aeees.org](mailto:info@aeees.org) (e-mail).

**21-23 • EnvironDesign8**, Minneapolis, MN. *Sponsor:* Interiors & Sources. *Information:* 561-627-3393; [www.environdesign.com](http://www.environdesign.com).

**26-May 1 • Affordable Comfort 2004**, Minneapolis, MN. *Sponsor:* Affordable Comfort, Inc. *Information:* 800-344-4866 x10; [www.affordablecomfort.org/html/2004.html](http://www.affordablecomfort.org/html/2004.html).

**28-May 1 • Closing the Loop: Post-Occupancy Evaluation – The Next Steps**, Windsor, U.K. *Sponsor:* CIBSE. *Information:* +01865 484075; [windsor@brookes.ac.uk](mailto:windsor@brookes.ac.uk).

### MAY

**2-7 • 5th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings**, Toronto, ON, Canada. *Sponsor:* CIB, National Research Council Canada. *Info:* 613-993-0435; [www.cib2004.ca](http://www.cib2004.ca).

**18-20 • 12th National Conference on Building Commissioning**, Atlanta, GA. *Sponsor:* Portland Energy Conservation, Inc. *Information:* [www.peci.org/ncbc/2004/index.html](http://www.peci.org/ncbc/2004/index.html).

**18-28 • Sustainable Building Summer Study**, Maho Bay, St. John, VI. *Sponsor:* Colorado State University's Inst. for the Built Env't. *Info:* [midge.toomey@aol.com](mailto:midge.toomey@aol.com); [www.ibe.colostate.edu/programs/maho.htm](http://www.ibe.colostate.edu/programs/maho.htm).

### JUNE

**2-4 • Greening Rooftops for Sustainable Communities Conference, Awards, and Tradeshow**, Portland, OR. *Sponsor:* Green Roofs for Healthy Cities and City of Portland. *Info:* 416-686-5887; [www.greenroofs.ca/grhcc/trade\\_show.htm](http://www.greenroofs.ca/grhcc/trade_show.htm).

**10-12 • AIA National Convention & Design Expo**, Chicago, IL. *Sponsor:* The American Institute of Architects. *Information:* 800-242-3837; [www.aia.org](http://www.aia.org).

**14-16 • NeoCon: World's Trade Fair 2004**, Chicago, IL. *Sponsor:* Merchandise Mart. *Info:* 800-677-6278; [www.neocon.com/neocon/](http://www.neocon.com/neocon/).

**26-July 3 • Natural Building Colloquium-East**, Bath, NY. *Sponsor:* Gaiatecture Design. *Info:* 585-624-2540; [www.gaiatecture.com](http://www.gaiatecture.com).

### JULY

**11-14 • Solar 2004**, Portland, OR. *Sponsor:* ASES, Solar Energy Association of Oregon, U.S. DOE. *Info:* 303-443-3130; [www.ases.org](http://www.ases.org).

**20-23 • Engineering Green Buildings**, Cleveland, OH. *Sponsor:* HPAC Engineering. *Information:* 216-931-9575 (Kathy Lambrix); [www.hpac.com/products/egb.htm](http://www.hpac.com/products/egb.htm).

### AUGUST

**8-11 • Energy 2004**, Rochester, NY. *Sponsor:* U.S. DOE/FEMP, DOD, GSA. *Info:* 703-921-1719; [www.energy2004.ee.doe.gov](http://www.energy2004.ee.doe.gov).

**21-22 • SolFest 2004**, Hopland, CA. *Sponsor:* Solar Living Institute. *Information:* 707-744-2108; [www.solarliving.org](http://www.solarliving.org).

**22-27 • Summer Study: Breaking Out of the Box**, Pacific Grove, CA. *Sponsor:* ACEEE. *Information:* 302-292-3966; [www.aceee.org](http://www.aceee.org).

### NOVEMBER

**10-12 • Greenbuild International Conference & Expo**, Portland, OR. *Sponsor:* U.S. Green Building Council. *Information:* 202-828-7422; [www.usgbc.org](http://www.usgbc.org).

### DECEMBER

**5-10 • Performance of Exterior Envelopes of Whole Buildings IX: Integration of Building Envelopes**, Clearwater Beach, FL. *Sponsor:* Oak Ridge National Laboratory. *Info:* 865-574-7267; [www.ornl.gov/buildings](http://www.ornl.gov/buildings).

More info and listings are online at:  
[www.BuildingGreen.com](http://www.BuildingGreen.com)



448 pages  
of useful information

NEW!

### GREENSPEC® DIRECTORY 4th Edition

Revised and updated

More than 1,750  
listings of green  
building products

Guideline specifications

**\$89 plus shipping**

\$5 U.S. & Canada, \$12 elsewhere

Order your copy today! Call toll-free:

800/861-0954 x191



## Environmental Building News

122 Birge St., Suite 30 · Brattleboro, VT 05301

A publication of BuildingGreen, Inc. · [www.BuildingGreen.com](http://www.BuildingGreen.com)

0403