GREEN MATERIALS OF CONSTRUCTION – AN EMERGING MARKET SEGMENT

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For the first time, formulated product (adhesives, sealants, coatings, etc.) producers are developing products with environmentally-responsible properties because of the needs of the market, not to meet mandatory governmental regulations. The emergence of specifications and certifications of materials that meet certain environmental criteria is emerging in the building and construction industries of North America and Western Europe. While not overwhelming at this point, the trend has taken hold and is somewhat analogous to the ISO certification trend of the 1980s and 1990s and may become a basic requirement for participating in certain segments of the construction industry in the very near future. ChemQuest forecasts that this trend will be become a factor driving new product development throughout the adhesives and sealants value chain over the next decade.

This article provides an overview of the trend, along with guidance on the facets that impact adhesive and sealant producers and users.

Arguably, the green trend started in the 1970s with the promulgation of the Clean Air Act. This legislation led the Environmental Protection Agency to develop industry- and product-specific regulations limiting certain chemical and particle emissions into the air. Much of the product development activity in the formulated markets has been driven by the single piece of legislation since then. However, the 1990s saw the emergence of non-governmental interests hoping to create a green "industry" with non-regulatory incentives for designers, product manufacturers and builders to create building projects with more regard for the environment. Much effort was placed on building materials, and three organizations have led this trend in North America.

- **Green Seal** promotes the manufacture, purchase and use of environmentally responsible products and services. Green Seal is focused entirely upon specifications and standards for materials of construction, with special emphasis on buildings within the government and institutional markets such as lodging and universities.

- **U.S. Green Building Council** provides a list of standards for environmentally-sustainable design and construction through its Leadership in Energy and Environmental Design (LEED) Green Building Rating System. The LEED program is designed to define, promote, and recognize building projects with sustainable environmental benefits. LEED also encourages "green" competition among building designers and

contractors. LEED is aimed primarily at overall building design and construction methods, and generally defers to and/or mimics other organizations for specific product specifications.

- **Greenguard Environmental Institute** replaced the AQSpec List in 2001 and, much like Green Seal, provides product certification of materials of construction based upon proven emission standards with the goal of improving interior air quality. Greenguard's original goals focused on emissions but recently expanded to certify design, materials and construction methods to reduce the risk associated with mold.

The green industry continues to struggle with clearly defining the attributes associated with environmentally responsible building products. The industry debate ranges from air quality attributes (e.g. VOC, greenhouse gases, mold generation) to recycle content, product longevity, manufacturing and application energy requirements, renewable sources of raw materials, maintenance and operating costs, etc.

Green Seal has taken a comprehensive approach to specifying those product attributes that are generally considered environmentally responsible. The specific standard of interest to the adhesives industry is GS-36 (http://www.greenseal.org/certification/standards/commercialadhesives.cfm) which covers adhesives use for ABS/PVC pipe, carpet pad, ceramic tile, floor coverings, cove base, construction, contact bonding, roofing, wood flooring and glazing (see Table 1).

Table 1

Green Seal Adhesive Requirements

1. Carcinogens -
   The product shall not be formulated with any carcinogens. Any carcinogen that is known to be present as a contaminant shall not exceed 0.1% by weight of the product.
2. Reproductive Toxins -
   The product shall not be formulated with any reproductive toxins. Any reproductive toxin that is known to be present as a contaminant shall not exceed 0.1% by weight of the product.
3. Persistent, Bioaccumulative, and Toxic Compounds (PBTs) -
   The product shall not be formulated with any persistent, bioaccumulative, and toxic compounds (PBTs). Any PBT that is known to be present as a contaminant shall not exceed 0.1% by weight of the product.
4. Ozone-Depleting Substances (ODSs) -
   The product shall not be formulated with any ozone-depleting substances. Any ozone-depleting substance that is known to be present as a contaminant shall not exceed 0.1% by weight of the product.
5. Volatile Organic Compounds – (see below)

Adhesive Type	VOC weight in grams/liter minus water
ABS Welding	400
Carpet Pad Installation	150
Ceramic Tile Installation	130
Contact Bond	250
Contact Bond-Specialty Substrates	400
Cove Base Installation	150
CPVC Welding	490
Indoor Floor Covering Installation	150
Multipurpose Construction	200
Nonmembrane Roof Installation/Repair	300
Other Plastic Cement Welding	510
Outdoor Floor Covering Installation	250
PVC Welding	510
Rubber Floor Installation	150
Single-Ply Roof Membrane Installation/Repair	250
Structural Glazing	100
Perimeter Bonded Sheet Vinyl Flooring Installation	660
Waterproof Resorcinol Glue	170
Wood Flooring Adhesive	150

For Adhesives not listed above and applied to the following substrates, the following limits shall apply:

Adhesives Application Onto Substrate	VOC weight in grams/liter minus water
Flexible vinyl	250
Fiberglass	200
Metal-to-Metal	30
Porous material	120
Plastic Foams	120
Rubber	250
Other substrates	250

Aerosol Adhesives	VOC weight in grams/liter minus water
General purpose mist spray	65% VOCs by weight
General purpose web spray	55% VOCs by weight
Special purpose aerosol adhesives (all types)	70% VOCs by weight

Green Seal Adhesive Requirements - continued
6. Toxic Compounds - The solvent portion of the adhesive shall not be toxic to humans when inhaled. A product is considered toxic if the following lethal dose (LD) criterion applies: Inhalation LC50 < 2,000 ppm of vapor or gas or 20 mg/L of mist, dust, or fumes The toxicity testing procedures shall follow the protocols put forth in the Organization for Economic Cooperation and Development (OECD) Guidelines for the Testing of Chemicals, which includes: Acute Inhalation Toxicity Test (TG 403). To demonstrate compliance with this requirement, a solvent need not be tested if existing toxicological information demonstrates that it complies. Data from the Registry of Toxic Effects of Chemical Substances (RTECS) and from the Hazardous Substances Data Bank (HSDB) will be accepted as well as peer-reviewed primary data.
7. Packaging - Product packaging shall be resealable after the first use except for single-use packaging. Shipping packaging shall be reusable, recyclable or reconditionable. Corrugated shipping packaging shall contain 30% minimum postconsumer recycled content.

Source: Green Seal

U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) is an overall project certification program. The LEED qualifications for adhesives are less direct in that the project receives certification points for the use of materials that meet its standards. The adhesive standard can be found at https://www.usgbc.org/ShowFile.aspx?DocumentID=1095 and is shown below in Table 2 (note the reference to certain portions of the Green Seal specification):

Table 2

US Green Building Council LEED New Construction and Renovation Adhesive Requirements – Version 2.2:

EQ Credit 4.1: Low-Emitting Materials: Adhesives & Sealants - 1 Point

1. Intent –
Reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

2. Requirements –
All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the following reference standards:
• Adhesives, Sealants and Sealant Primers: South Coast Air Quality Management District (SCAQMD) Rule #1168. VOC limits are listed in the table below and correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

Architectural Applications	VOC weight in grams/liter minus water	Specialty Applications	VOC weight in grams/liter minus water
Indoor Carpet Adhesives	50	PVC Welding	510
Carpet Pad Adhesives	50	CPVC Welding	490
Wood Flooring Adhesives	100	ABS Welding	325
Rubber Floor Adhesives	60	Plastic Cement Welding	250
Subfloor Adhesives	50	Adhesive Primer for Plastic	550
Ceramic Tile Adhesives	65	Contact Adhesive	80
VCT & Asphalt Adhesives	50	Special Purpose Contact Adhesive	250
Drywall & Panel Adhesives	50	Structural Wood Member Adhesive	140
Cove Base Adhesives	50	Sheet Applied Rubber Lining Operations	850
Multipurpose Construction Adhesives	70	Top & Trim Adhesive	250
Structural Glazing Adhesives	100		

Substrate Specific Applications	VOC weight in grams/liter minus water	Sealants	VOC weight in grams/liter minus water
Metal to Metal	30	Architectural	250
Plastic Foams	50	Nonmembrane Roof	300
Porous Material (except wood)	50	Roadway	250
Wood	30	Single-Ply Roof Membrane	450
Fiberglass	80	Other	420

Sealant Primers	VOC weight in grams/liter minus water
Architectural Non Porous	250
Architectural Porous	775
Other	750

• Aerosol Adhesives: Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

Source: US Green Building Council

Greenguard has taken an even more specific product approach focused exclusively on the impact materials have on indoor air quality. Rather than limiting formulations, Greenguard limits the impact the product can have on the air quality of the immediate environment in which the product is applied and installed (see Table 3).

Table 3

Greenguard Adhesive Requirements	
Individual VOCs	<0.1 TLV*
Formaldehyde	0.05 ppm
4-phenylcyclohexene	0.0065 mg/m^3
Styrene	0.07 mg/m^3
Total VOCs	0.5 mg/m^3
Total aldehydes	0.1 ppm
Listing of measured carcinogens and reproductive toxins as identified by California Proposition 65, the U.S. National Toxicology Program (NTP), and the International Agency on Research on Cancer (IARC) must be provided.	
Any pollutant regulated as a primary or secondary outdoor air pollutant must meet a concentration that will not generate an air concentration greater than that promulgated by the National Ambient Air Quality Standard (U.S. EPA, code of Federal Regulations, Title 40, Part 50).	
* Any pollutant not listed must produce an air concentration level no greater than 1/10 the Threshold Limit Value (TLV) industrial work place standard (Reference: American Conference of Government Industrial Hygienists, 6500 Glenway, Building D-7, Cincinnati, Ohio 45211-4438).	

Source: Greenguard

ChemQuest expects government regulations to become less important in driving new product development over the next 10 years as the free market mechanisms associated with the green industry trend broaden and grow. The competition that arises from these mechanisms will result in new formulations and new raw materials to support the ever increasing needs of the designer/architect and the builder.

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Michael joined ChemQuest in 1999 after 17 years with DuPont Automotive, where he was Business Manager, Light Industrial Coatings. Prior assignments were in marketing and product management positions with DuPont in the Refinish automotive and fleet aftermarket business. His automotive experience also includes sales and technical experience in the engineering plastics markets. He holds a B.S. in Chemical Engineering from Kansas State University.

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