HBN Commentary on Proposed Green Seal for Architectural Thermal Insulation Materials (GS-54)

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Endorsements: Forty organizations formally requested to endorse HBN's proposals on the Standard. About half of them are members of architecture, engineering, or development firms or otherwise directly engaged in the design and specification process in the AEC community. The full list is in the appendix at the end of this document.

Overall

We have long counted Green Seal (GS) among the leaders in rewarding reduced toxic chemical content in building products. Green Seal did important early work to identify and certify leadership positions among wet-applied products in reduced volatile organic compound (VOC) content and, importantly, also to go beyond VOCs to avoidance of other critical chemicals of concern. Their Paints and Coatings standard (GS-11), for example, offers an industry-best menu of prohibited substances.

Green Seal positions its draft insulation standard (GS-54) as a leadership standard, which is the stated mission of all of its standard development work.[1] Indeed, some of the requirements of this standard do push manufacturers beyond regulatory requirements. In many cases, however, we think the standard is missing significant opportunities to reward market leadership.

In the broad category of insulation, there are great differences in potential hazards to human health and the environment from the various chemistries used in different product types. For some types of insulation, the hazards from the industry's standard technologies are so extensive that the Healthy Building Network can not recommend their use, categorically. In the draft standard, Green Seal has chosen to create a pathway to certify insulation types, particularly spray polyurethane foam and polystyrene, that will introduce high hazard substances into buildings, and potentially expose installers and occupants.

We respectfully suggest that providing the Green Seal approval on these technologies, regardless of how manufacturers promise to label them, sends a dangerous message to both

[1] "Green Seal is a non-profit organization whose mission is to use science-based programs to empower consumers, purchasers, and companies to create a more sustainable world. **Green Seal sets leadership standards that aim to reduce, to the extent technologically and economically feasible, the environmental, health, and social impacts** throughout the life-cycle of products, services, and companies. The standards may be used for conformity assessment, purchaser specifications, and public education." (page 2 of the Draft Standard)

manufacturers and users about the safety of these formulations and the urgency of implementing safer substitutes.

We have had a constructive dialogue with Green Seal staff about our concerns. In response, Green Seal has indicated that their standard is not designed to incentivize the cutting edge by rewarding best in class products; but rather, is crafted to allow the purchasers in the mass market to be able to choose from a selection of environmentally preferable choices that, ideally, represent the top twenty percent of the available products.[2] We understand that Green Seal is positioning this standard to inform specifiers and purchasers for whom green may be a secondary criterion.

In some cases, however, the draft standard reflects only standard practice and/or regulatory minimums, not better than average. In the following comments, for some types of insulation, we identify opportunities for the standard to better reflect the top quartile of products in a given category. For other types, we make the case that there are no products currently on the market that represent "environmentally preferable" choices.

- ***The Draft Standard Has Too Much Faith in Regulatory Agencies for Product Safety***

The standard relies upon regulations to determine whether a product is "safe." The foreword reads, "Provisions for safety have not been included in this standard, since they are overseen by regulatory agencies."

As a leadership standard, Green Seal should recognize that the marketplace typically precedes regulatory action. The federal government, for example, has never banned the use of formaldehyde binders in residential fiberglass insulation; instead, consumers, incentivized by leadership standards like the Green Guide for Health Care, pushed manufacturers to eliminate them, which the industry finally did as of last year.

Similar scenarios are unfolding with Spray Polyurethane Foam (SPF) insulation, which is loaded with problematic substances - particularly isocyanates and halogenated flame retardants - and Extruded Polystyrene (XPS) insulation - particularly blowing agents which are under increasing regulatory scrutiny. (Details below).

HBN Recommends… That Green Seal save its approval for insulation that does not contain toxic substances to which insulation installers and/or building occupants are exposed.

[2] Personal communications, March 28 and 29, 2016.

- **Section 3.4 - *VOC scenarios are ambiguous and should be clarified***

The draft standard states that insulation products used in interiors "shall meet the requirements of the emission testing method for California Specification 01350, using a relevant scenario *(*classroom, office, or residential)." (Section 3.4) This does not clarify which of these modelling scenarios would be used to determine compliance with its volatile organic compound emissions standard. The standard does not explain how to determine the "relevant scenario," it simply provides these three scenarios as options for all insulation.

The residential scenario is far more protective than the classroom or office scenarios. Meeting the office and school scenarios are standard practice in the fiberglass batt market, where the most insulation certifications have already been done. The residential scenario, however, is the only one that is protective for any product in a residential setting and hence should be the default unless the product is only marketed for use in non-residential applications.

In our discussions, Green Seal stated that because many insulation products are intended for the commercial market, requiring them to conform to residential calculations is unnecessary, and that, regardless of the setting, complying with any of the three scenarios is preferable to insulation that hasn't been tested.

This position, however, assumes that the untested product is higher emitting. Insulation products marketed for use in residential settings should be certified for VOC emissions using the residential protocol. Those that are not, should indicate that they are not certified on VOC emissions for residential use. Otherwise the VOC emissions requirement could provide a false sense of security.

HBN Recommends… That Green Seal require use of the residential scenario to determine compliance with the volatile organic compound emissions standard for any product marketed for residential settings and require labelling of other products that they are not certified on VOC emissions for residential use.

While there may not be many products currently on the market with a certification by the residential scenario, this is not a significant obstacle as it requires no new testing or re-certification processes, just a recalculation of the modelling for the current certification to confirm meeting the requirement. Hence it should be attainable by many products currently on the market at little extra cost or time and with a significant benefit in ensuring protection in a large sector of the marketplace. **Specifically, HBN recommends the adoption of the following language**:

> *Products that are not explicitly labeled for use in external portions of commercial structures shall meet the requirements of the emission testing method for California Specification 01350. Products shall meet the Specification using the residential scenario except for products which are only marketed for use in commercial structures, and*

labelled as such. They shall also be labelled as not certified on VOC emissions for residential use. (Section 3.4)

- ***Toxic Substances Do Not Remain Behind Walls***

A commonly held misperception is that, because it is usually behind a wall, insulation presents less potential for exposure than other interior products. In its rationale, the draft's authors assert, "Once the insulation materials are installed, most of them are closed inside the building envelope and direct contact with occupants is limited."[3]

But building material scientists say that is hardly the case. "Both air and moisture move through a building fabric, regardless of how tightly they are constructed," noted a team of scientists looking at halogenated flame retardants in insulation. "Substances within building cavities have the potential to migrate out of those cavities via movement driven by air, liquid and/or water vapour that occurs due to temperature, air and vapour pressure differentials. Chemicals may be present in dust from abraded materials or could volatilize and then settle in indoor dust to which building occupants could be exposed."[4]

Industry sponsored studies of insulation behind drywall barriers have also shown significant emissions through drywall, even *exceeding* the rate of emissions from bare insulation over time.[5] This not only demonstrates the lack of protection from drywall but illustrates the importance using the more protective residential modelling scenario for emissions testing.

HBN Recommends… That Green Seal recognize the potential for substances of concern - including Semi-Volatile Organic Compounds like halogenated flame retardants - to migrate from insulation into indoor dust, during installation, use and demolition.

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[3] Green Seal Inc. "GS-54 Rationale For Proposed Green Seal(TM) Standard for Architectural Thermal Insulation Materials." Green Seal Inc., February 2, 2016. http://www.greenseal.org/Portals/0/Documents/Standards/GS-54%20Development/Rationale%20-%20GS-54,%20Proposed%20Insulation%20Standard%20-%20Green%20Seal.pdf Page 11 in reference to Section 3.7.

[4] Babrauskas, Vytenis, Donald Lucas, David Eisenberg, Veena Singla, Michel Dedeo, and Arlene Blum. "Flame Retardants in Building Insulation: A Case for Re-Evaluating Building Codes." Building Research & Information 40, no. 6 (November 26, 2012): 738–55. http://dx.doi.org/10.1080/09613218.2012.744533.

[5] The surprisingly higher emissions at longer time periods may be due to slower initial offgassing immediately after installation." Lent, Tom. "Formaldehyde Emissions from Fiberglass Insulation with Phenol Formaldehyde Binder." Healthy Building Network, August 26, 2009. http://healthybuilding.net/uploads/files/formaldehyde-emissions-from-fiberglass-insulation-with-phenol-formaldehyde-binder.pdf.

- ***The list of prohibited and restricted substances is not very restrictive***

The draft standard prohibits certain substances, but many are not used in modern insulation. It prohibits substances that certain authoritative agencies have identified as carcinogens, but it does not consider as many authoritative lists as does the Green Seal-11 standard for paints. It prohibits substances that cause certain types of health effects that are recognized under the Global Harmonized System, but it does not recognize other health effects recognized by other authoritative agencies. For substances that it does restrict, no matter how toxic, they are still allowed if they are present in an insulation product at a concentration of up to 0.1% by weight, or 1,000 parts per million. And it creates blanket exemptions for the most commonly used isocyanate and flame retardant in SPF. It appears these restrictions were designed specifically to allow the certification of standard SPF and XPS products. We explore each of these issues below, and provide recommendations for improvements.

- **Section 3.7 - *Green Seal's draft insulation standard allows higher concentrations of restricted substances than allowed under its standard for paint (GS-11).***

The draft standard allows restricted substances to be present in the product at concentrations of up to 0.1% by weight (1,000 parts per million), except components within blowing agents, which are allowed at up to 1% by weight of the blowing agent (Section 3.7). Compared to GS-11 (the paint standard), this is a much higher (easier to achieve) threshold by an order of magnitude. GS-11 says "prohibited compound(s)...shall not be intentionally added to the product as an ingredient, defined as greater than 0.01% in the product or 100 ppm."

The 0.1% threshold for non-blowing agent components potentially allows critically high levels of toxic content, above established safety thresholds. Many heavy metals and biocides have toxic impacts at the 0.01% level (100 ppm, which the GS-11 standard uses, along with the GreenScreen, Cradle to Cradle, US EPA Design for the Environment, Health Product Declaration, LEED and others), or even lower.

Recycled glass and plastics, unscreened for contamination, often contain toxic heavy metals at levels above 100 parts per million, which is a threshold that government agencies have identified as a being minimally protective of human health for metals like lead. To prevent this kind of contamination, many states have adopted Toxics in Packaging laws that restrict total heavy metals to a total of 100 ppm (0.01%).

Another example: imidacloprid is a highly toxic insecticide that manufacturers commonly add to expanded polystyrene (EPS) insulation at concentrations of 0.02%, or 200 ppm.[6] A 2016 EPA study classifies imidacloprid "as very highly toxic to adult honey bees" at very low levels of exposure. "The level of imidacloprid in nectar at or below which no effects would be expected to the colony is determined to be 25 micrograms per liter," or 0.025 parts per million (25 parts per

[6] Quartz Project. "EPS Insulation." Quartz Database, October 2015. http://www.quartzproject.org/p/CP120-a01/q/Imidacloprid#cp.

billion), the agency concluded earlier this year.[7] Polystyrene insulation manufacturers commonly add insecticides to combat termites, especially in exterior and below grade insulation. Imidacloprid migrates from exterior building materials into water and soil.[8] In addition to being a honeybee killer, according to a new GreenScreen assessment, imidacloprid is known to be neurotoxic in people.[9]

Green Seal says they use the 0.1% threshold to be consistent with Globalized Harmonized Substances cutoff levels, and that they are attempting to be practical given the level of information that manufacturers say they can provide.[10]

Using GHS cutoff levels is another example of using a regulatory requirement rather than a leadership standard requirement. Many industries require suppliers to disclose a lot more than what this draft insulation standard considers. The global automobile industry, for example, requires suppliers to disclose the presence of nearly 750 substances at levels of 0.01% or even less.[11] Many of these substances are found in insulation, including the flame retardant, hexabromocyclododecane (HBCD), which manufacturers in the US still use, even though it is banned in Europe (more on this below).[12]

Insulation manufacturers are more willing to disclose their products' ingredients than perhaps Green Seal assumes. Many of them participate in leading chemical toxicity programs in the building space, such as Cradle-to-Cradle, GreenScreen and the Health Product Declaration, which instead set the threshold for disclosure an order of magnitude lower (0.01%) for most substances, and even lower for some particularly potent substances such as lead. They are participating in these systems, and disclosing to these levels.

HBN Recommends… That Green Seal uses the same 0.01% threshold for restricted substances that it has in its paint standard.

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[7] EPA's preliminary risk assessment identified a residue level for imidacloprid of 25 ppb, which sets a threshold above which effects on pollinator hives are likely to be seen, and at that level and below which effects are unlikely. US Environmental Protection Agency. "EPA Releases the First of Four Preliminary Risk Assessments for Insecticides Potentially Harmful to Bees." *EPA Newsroom*, January 6, 2016. http://yosemite.epa.gov/opa/admpress.nsf/0/63E7FB0E47B1AA3685257F320050A7E3.

[8] Vallette, James. "Common Decking and Insulation Pesticide Is a Honeybee Killer." *Healthy Building News*, January 21, 2016. https://www.healthybuilding.net/news/2016/01/21/common-decking-and-insulation-pesticide-is-a-honeybee-killer.

[9] ToxServices. "Imidacloprid (CAS# 138261-41-3). GreenScreen® for Safer Chemicals (GreenScreen®) Assessment. Prepared for: Natural Resource Defense Council," January 7, 2016. https://pharosproject.net/uploads/files/gs/e9dcac89576036c3c38341ce82cff495f14b8c55.pdf.

[10] Personal communication, March 29, 2016.

[11] "Global Automotive Declarable Substance List (GADSL)." Spreadsheet. American Chemistry Council, April 2, 2014.

[12] Exiba. "After Sunset - according to REACH, HBCD Is Banned after 21st of August 2015," September 24, 2015. http://www.exiba.org/hbcd-banned.

- **Section 3.7 - *Green Seal's draft insulation standard uses fewer carcinogen classifications than its standard for paint (GS-11).***

The draft standard categorically restricts substances that are classified as "known or probable carcinogens by IARC (Class 1or 2A), the National Toxicology Project (Group K and R), EPA Integrated Risk Information System (Group A, B1, or B2), or OSHA (29 CFR 1910.1003(a)(1)); [continued below]

GS-11 for paints also includes IARC Class 2B, and EPA IRIS Group C.

HBN Recommends… That Green Seal uses the same carcinogen classifications that it has in its paint standard.

- **Section 3.7 - *Green Seal's draft insulation standard considers reproductive toxicants, but not carcinogens, listed by California Proposition 65.***

The draft standard states that any components present at 0.1% (or >1% for blowing agents) shall not be listed by California Proposition 65 as a reproductive toxin."

Some of the California Prop 65 listings are derivative of the cancer lists indicated above. California does, however, do independent assessments of the literature by its panel of scientists as well using similar criteria. The Green Seal certification should utilize all of Prop 65.

Additionally, toxicologically, a "toxin" is specifically a poison created by a living organism, like snake venom. Prop 65 uses the more proper term of "toxicant".

HBN Recommends... That the standard adopt this language:

"Components present at 0.01% (or >0.1% for blowing agents)' shall not be listed by California Proposition 65 as a carcinogen or reproductive toxicant."

- **Section 3.7 - *Green Seal's draft insulation standard does not consider many substances that cause asthma, including styrene and isocyanates.***

Asthmagens -- substances that cause the onset of asthma disease, and trigger its symptoms -- are known to trigger health problems for insulation workers and building occupants. However, Green Seal relies upon a European Chemical Agency list of respiratory sensitizers that does not yet include isocyanates or styrene, despite the fact that these are widely-recognized as some of the asthmagens with the largest impact in the workplace by industrial hygienists and toxicologists. Residual isocyanates and styrene are commonly present in SPF and polystyrene insulation. Styrene is present as a residual in expanded polystyrene insulation, at about 700

ppm[13], and SPF insulation is known to offgas isocyanates long after it has been installed (see below). There is no known lowest threshold of safe exposure to asthmagens.

HBN Recommends... That Green Seal restricts substances that are on the AOEC list of asthmagens. The list is provided as an appendix to these comments.

- **Section 3.7 - *The draft standard's categorical exemption allowing methylene diisocyanates in SPF is a serious concern.***

Green Seal allows methylene diphenyl diisocyanate (MDI, CAS 101-68-8) "as a functional ingredient in spray polyurethane foam and polyisocyanurate foam products." (Section 3.7) In its webinar presentation, Green Seal states that the problems with MDI are limited to a few bad installations.[14] There are many indications otherwise, that those cases are the tip of the iceberg, with many more unreported or underreported cases of acute problems and far more chronic exposure issues.

Isocyanate vapors cause the onset of asthma disease and trigger asthma episodes. EPA warns that isocyanate vapors from SPF insulation "can migrate throughout the building if the area is not isolated and properly ventilated. After application, vapors may linger in a building until ventilated and thoroughly cleaned." Even then, there is no time certain when SPF installed in a building stops off-gassing vapors. And, any cutting or trimming of SPF insulation may generate dust containing isocyanates that also may linger in a building.[15] For these reasons, EPA warns that "individuals with a history of skin conditions, respiratory allergies, asthma, or prior isocyanate sensitization should carefully review product information when considering the use of spray polyurethane foam (SPF) products and may want to consider safer alternatives."[16]

The state of California has targeted SPF systems containing unreacted MDI as a top priority for alternatives assessment in its Safer Consumer Product program. This program is designed to move inherently safer alternative materials into the marketplace.[17]

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[13] Quartz Project. "EPS Insulation." Quartz Database, October 2015. http://www.quartzproject.org/p/CP120-a01.
[14] Green Seal Inc. "Transcript. Webinar: Choosing Greener Insulation, March 3, 2016.," March 3, 2016. http://www.greenseal.org/Portals/0/Documents/Standards/General/GS-54%20Webinar%20Transcript.pdf.
[15] US Environmental Protection Agency. "Potential Chemical Exposures From Spray Polyurethane Foam." *Safer Choice*, October 14, 2015. https://www.epa.gov/saferchoice/potential-chemical-exposures-spray-polyurethane-foam.
[16] US Environmental Protection Agency. "Health Concerns about Spray Polyurethane Foam." Government Agency. *Health Concerns about Spray Polyurethane Foam*, October 14, 2015. https://www.epa.gov/saferchoice/health-concerns-about-spray-polyurethane-foam.
[17] California Department of Toxic Substances Control. "Initial Priority Product List." *What Is the Initial Priority Product List?*, March 13, 2014. https://www.dtsc.ca.gov/SCP/InitialPriorityProductList.cfm .

The US EPA and the California Office of Environmental Health Hazard Assessment do not consider the industry's installation protocols, which Green Seal relies upon, to be adequate ways to address the inherent dangers of this potent asthmagen.

A study by the University of California found that a wide range of alternatives to MDI are in development - not yet capitalized but in some cases, close to market ready.[18]

We understand that the Green Seal program is designed to reward technologies currently in the marketplace and is not structured to directly incentivize the development of new technologies. However, there is no neutral option here. By providing a green seal of approval to MDI based foam systems, Green Seal is actively *dis*incentivizing the development of alternative technologies and sending signals to buyers contrary to those the State of California is providing. By giving MDI a free pass, and putting its logo on a product type for which the EPA and the State of California are urging people to seek alternatives, Green Seal is risking its reputation with those who seek healthy building materials, and those who may be adversely impacted by this insulation. As there are no top tier products now, only some firms who put out more warning manuals than others, Green Seal should hold off on certifying SPF insulation until safer formulations are on the market.

HBN Recommends… That Green Seal delete its exemption for MDI, and categorically decline to certify spray polyurethane foam insulation until safer formulations are available. Specifically, the standard should adopt this language:

> "Due to significant problems with respiratory injury to workers and occupants from isocyanates in spray polyurethane foam insulation, Green Seal certification is not available for the spray foam insulation category at this time."

- **Section 3.7 - *The draft standard restricts irrelevant, and allows the most common, chlorinated and brominated flame retardants.***

The draft standard prohibits only certain flame retardants: polybrominated diphenyl ether (PBDE) flame retardants, brominated paraffin flame retardants, and short-chain (C10-C13) chlorinated paraffin flame retardants, tris(1,3-dichloro-2-propyl)phosphate and tris(2-chloroethyl)phosphate. (Section 3.7)

HBN research indicates that these are not used in insulation products currently on the market. Given the regulatory environment, they are not likely to be used in the future. In the regulatory world and other certification systems, efforts to ban specific flame retardants one at a time have led to whack-a-mole process with new flame retardants - particularly halogenated ones - being regularly introduced that have proven to be as problematic for health as the ones they are replacing.

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[18] University of California, Berkeley Center for Green Chemistry. "Safer Spray-Foam Insulation." December 5, 2014. http://bcgc.berkeley.edu/sites/default/files/SPF%20Final%20Presentation.pdf .

Despite evidence of considerable health and environmental concerns, the draft standard allows the use of two very common flame retardants: tris(1-chloro-2-propyl) phosphate (TCPP) and hexabromocyclododecane (HBCD). Green Seal states that it does not restrict TCPP and HBCD because these substances are not restricted by regulators.[19]

Like the CFCs of yore, halogenated flame retardants used in today's insulation are tomorrow's legacy contaminants. Flame retardants like HBCD and TCPP are substances of global concern: they are among the most toxic, persistent, and bioaccumulative substances used in building products.

TCPP is the flame retardant most commonly used in polyurethane foam board and SPF insulation. Green Seal says it decided to exempt TCPP from restriction because it is "a common flame retardant that is not restricted by the health codes."[20] While technically true that "health codes" do not yet restrict TCPP regulation, these codes often lag evidence of exposure and harm. TCPP is found in household dust. TCPP is structurally similar to other chlorinated flame retardants that are recognized carcinogens, mutagens, reproductive and developmental toxicants, neurotoxicants, and endocrine disruptors.

Halogen-free flame retardants are now on the market for many applications, including polyurethane insulation. For example, in 2014, Johns Manville brought to market a polyisocyanurate (polyurethane) roofing board insulation that is halogen-free.[21] "Industry has provided acceptable technical solutions for the replacement of certain organohalogens which have the potential to evaporate or migrate out of products. These alternative flame retardants represent applications where is it is possible to replace a significant volume of such semi-volatile organohalogen flame retardant," Clariant Corp. told the Consumer Products Safety Commission in December 2015. "Currently, many thousands of tons of organohalogens (e.g. TCPP) are used for insulation in buildings throughout North America. A commercial technical solution already exists using a reactive halogen-free flame retardant."[22]

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[19] Green Seal Inc. "Transcript. Webinar: Choosing Greener Insulation, March 3, 2016.," March 3, 2016. http://www.greenseal.org/Portals/0/Documents/Standards/General/GS-54%20Webinar%20Transcript.pdf .

[20] Ibid.

[21] Johns Manville. "Energy 3.E - JM Roofing Insulation Board." *Insulation and Cover Boards*. Accessed March 31, 2016. http://www.jm.com/en/building-materials/commercial-roofing/insulation-and-coverboards/ENRGY-3-E/..

[22] Reilly, Timothy. "Oral Comments to United States Consumer Product Safety Commission [Docket No. CPSC-2015-0022] Petition Requesting Rulemaking on Products Containing Organohalogen Flame Retardants: Oral Comments of Timothy Reilly on Behalf of Clariant Corporation (Charlotte, North Carolina)." US Consumer Product Safety Commission, December 9, 2015. http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2016/PresentationsPublicHearingOrganohalogens.pdf.

Polystyrene insulation also contains significant amounts of flame retardants.[23] **HBCD** is the standard flame retardant treatment in both XPS (Extruded Polystyrene) and EPS (Expanded Polystyrene) insulation.[24] In 2015, the Healthy Building Network reviewed content data sheets for almost every polystyrene insulation product made in North America. All literature named either HBCD or unspecified "halogenated flame retardant systems."[25]

HBCD is a persistent, bioaccumulative toxicant (PBT). It has been found in human breast tissue, adipose tissue and blood. It is highly toxic to aquatic animals and biomagnifies in the environment. The flame retardant has been detected in the environment worldwide, even remote locations with no local sources. According to the US EPA, "HBCD also presents human health concerns based on animal test results indicating potential reproductive, developmental, and neurological effects."[26]

Studies indicate that the general population may be exposed to HBCD from household air and dust and that exposure due to its presence in food is likely because of bioaccumulation in the food chain.[27] In 2012 the University of Texas School of Public Health in Dallas tested 36 food samples for traces of HBCD. Of the 36 tested, 15 samples showed detectable levels of the flame retardant. Although the level of HBCD was below levels considered dangerous by government agencies, the report points out, "Exposure and health outcome research should continue because of the lack of data regarding levels of HBCD in food, human dietary and other intake levels, and health effects."[28]

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[23] Some sub-grade polystyrene insulation manufactured in Europe do not contain flame retardants, but these products are not yet available in North America. Coffin, Melissa. "Cracking the (Building) Code on Flame Retardants." *Pharos Signal*, September 18, 2014. https://www.pharosproject.net/blog/show/187/cracking-the-code.

[24] Extruded Polystyrene Foam Association, *XPSA - Q&A on flame retardants and XPS foam insulation*, http://www.xpsa.com/pdf/XPSA_QA_on_HBCD_and_DfE_Report_Final.pdf; and EPS Industry Alliance, *Flame Retardants: Fire Resistance In Building and Construction Applications,* 2012. http://www.epsindustry.org/sites/default/files/Polystyrene%20Industry%20Flame%20Retardants%20Bulletin%20-%20EPSIA.pdf

[25] XPS product information naming HBCD as content includes data sheets for Owens Corning's FOAMULAR®, DiversiForam's CertiFoam, and Kingspan's GreenGuard® Extruded Polystyrene Insulation Board. (Dow lists only "halogenated flame retardants" as content in its STYROFOAM(™) insulation. EPS product information naming HBCD as content includes DiversiFoam's RayLite, StyroVent, and StyroStud, ACH Foam Tech's Foam-Control, Plasti-Fab's DuroFoam and PlastiSpan, and Polar Industries' PolarGuard.

[26] US Environmental Protection Agency. "Flame Retardant Alternatives For Hexabromocyclododecane (HBCD). Final Report.," June 2014. https://www.epa.gov/sites/production/files/2014-06/documents/hbcd_report.pdf.

[27] US EPA, "Partnership to Evaluate Flame Retardant Alternatives to HBCD," last updated April 28, 2015, http://www2.epa.gov/saferchoice/partnership-evaluate-flame-retardant-alternatives-hbcd; United Nations Environment Programme, *Report of the Persistent Organic Pollutants Review Committee on the work of its seventh meeting, Addendum Risk management evaluation of hexabromocyclododecane*, Nov. 8, 2011, http://echa.europa.eu/documents/10162/18074545/a4a_comment_551_1_attachment_en.pdf

[28] Arnold Shecter et. al., "Hexabromocyclododecane (HBCD) stereoisomers in US food from Dallas, Texas," *Environmental health perspectives* 120, no. 9 (2012): 1260 http://www.ehp.niehs.nih.gov/wp-content/uploads/2012/08/ehp.1204993.pdf

The majority of HBCD produced is used for polystyrene insulation. In 2011 the United Nations Report of the Persistent Organic Pollutants Review Committee stated that the global annual production of HBCD was 28,000 tonnes (30,800 tons). The report further states that over 90% of the HBCD produced is used by the EPS and XPS insulation markets. This makes over 27,700 tons of HBCD being used by the polystyrene insulation market.[29]

Very recently, there have been moves to phase-out HBCD in polystyrene insulation. As noted above, it was banned for use in Europe, and XPS insulation sold there no longer contains HBCD.[30]

In June 2014, the US EPA released its final report on flame retardant alternatives to HBCD in polystyrene building insulation. It identifies a butadiene styrene brominated copolymer as having low hazards for human and aquatic toxicity. While the health and environmental impacts are believed to be lower than HBCD, there are still data gaps for this particular substance which should be further explored. The production of this alternative is not yet at full capacity, although it is being used in XPS produced by Dow in Japan. The EPA indicates it will take three to five years to meet the demand within the polystyrene insulation market.[31]

The Johns Manville Company won a green building award during 2014 with its first-to-market halogen-free insulation board.[32] It is now possible for the building industry to replace them, and for Green Seal to reward manufacturers that have done so.

HBN recommends… That Green Seal prohibit all halogenated compounds.

- **Section 3.7 - *The draft standard's prohibition on binders containing formaldehyde should be maintained, and expanded to include nonylphenol ethoxylates.***

The draft standard restricts the use of **"**chemical compounds containing formaldehyde, including formaldehyde, urea-formaldehyde, phenol-formaldehyde and urea-extended phenol formaldehyde." (Section 3.7)

We applaud this prohibition which effectively provides market distinction for insulation using alternatives to formaldehyde binders. As of 2015, all lightweight fiberglass insulation

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[29] UNEP, *Report of the Persistent Organic Pollutants Review Committee on the work of its seventh meeting, Addendum Risk management evaluation of hexabromocyclododecane*, November 8, 2011, http://echa.europa.eu/documents/10162/18074545/a4a_comment_551_1_attachment_en.pdf

[30] Exiba. "After Sunset - according to REACH, HBCD Is Banned after 21st of August 2015," September 24, 2015, http://www.exiba.org/hbcd-banned.

[31] Stamm, Rebecca. "More Impending Changes in the Insulation Market." *Pharos Signal*, November 6, 2015. https://www.pharosproject.net/blog/show/203/polystyrene-changes.

[32] Johns Manville. "Energy 3.E - JM Roofing Insulation Board." *Insulation and Cover Boards*. Accessed March 31, 2016. http://www.jm.com/en/building-materials/commercial-roofing/insulation-and-coverboards/ENRGY-3-E/.

manufactured in the US and Canada is free of these binders.[33] However, other types of insulation - mainly mineral fiber batt and high density fiberglass -- still contain formaldehyde.

In the case of mineral fiber insulation, Knauf is leading the way with alternative binder technology. Knauf's Earthwool Insulation Board does not use a formaldehyde-based binder. It is used for a variety of applications including "metal and masonry walls, wall and roof panel systems, curtain wall assemblies and cavity walls."[34] Another formaldehyde-free Knauf product is "specifically designed as an interior insulation material for heating, ventilating and air conditioning plenums and sheet metal ducts."[35]

There is still room for potentially significant differentiation amongst the manufacturers making formaldehyde alternatives. In addition to the restriction for formaldehyde, Green Seal should also prohibit nonylphenol ethoxylates (NPEs). While disclosure of the alternative formulations has been inadequate to date, we can see from NPE emissions at one fiberglass factory using acrylic binder in lightweight fiberglass production that NPEs are in use. Nonylphenol and its ethoxylates are endocrine disruptors -- chemicals that affect the hormone system. The US EPA includes them in its Chemical Action Plans for developmental and reproductive toxicants. The Oslo-Paris Convention considers NPEs to be persistent, bioaccumulative toxicants, and a priority for action.[36] NPEs "mimic the sex hormone estrogen… are highly toxic to aquatic life, degrade into a long-lived chemical that builds up in the food chain, and may harm reproduction and development in humans," according to the Environmental Health Strategy Center.[37] A residential fiberglass insulation manufacturer in Edmonton reported releasing 6.4 kilograms of NPEs into the air in 2014.[38]

HBN recommends… That Green Seal maintain this prohibition on formaldehyde based binders. HBN suggests adding to the prohibitions:

Nonylphenol ethoxylates

- **Section 3.7 - *The draft standard's list of restricted ortho-phthalates is too narrow***

[33] Vallette, James. "Residential Fiberglass Insulation Transformed: Formaldehyde Is No More." *Healthy Building News*, October 30, 2015. https://www.healthybuilding.net/news/2015/10/30/residential-fiberglass-insulation-transformed-formaldehyde-is-no-more.

[34] Knauf Insulation. "Earthwool® Insulation Board." Accessed March 31, 2016. http://www.knaufinsulation.us/en/content/earthwool-insulation-board.

[35] Knauf Insulation. "Knauf Data Sheet: Rigid Plenum Liner with ECOSE® Technology," August 2014. http://www.knaufinsulation.us/sites/us.knaufinsulation.com/files/CI-DLR-DS%20WEB.pdf.

[36] Pharos Project, *Nonylphenol ethoxylates (NPE) and related substances*, last updated May 1, 2015, https://www.pharosproject.net/material/show/2072100

[37] Environmental Health Strategy Center, *Poison in Paints, Toxics in Toys*, 2011. https://web.archive.org/web/20120308064101/http://www.healthystuff.org/documents/Poison-in-Paint-Toxics-in-Toys.pdf

[38] Environment Canada, Historical Substance Reports NPRI database search, Company/Facility information: Owens Corning Insulating Systems Canada LP/Edmonton Plant (2014), http://ec.gc.ca/inrp-npri/donnees-data/index.cfm?do=facility_history&lang=En&opt_npri_id=0000001251&opt_report_year=2014

The draft standard restricts the following phthalates: di (2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate. (Section 3.7).

While HBN is not yet aware of any extensive use of phthalates in insulation, it is important that, when restricting phthalates, to ensure that all ortho-phthalates are restricted, not just the handful that have been regulated in Europe.

While many manufacturers, driven by customer concern, have shifted from ortho-phthalates to other plasticizers generally considered to be more benign, some have chosen to instead use other ortho-phthalates that are not yet regulated, even though they have similar structures to the regulated ones.

According to Mike Belliveau, executive director of the Environmental Health Strategy Center, "Several phthalates have not yet received adequate scrutiny from the scientific community and regulatory authorities, yet they are being produced in high volumes, and some evidence indicates that human exposure is increasing. Given what's known about other phthalates, it's reasonably prudent to call for efforts to reduce exposure while more data are sought on these phthalates.

"For example, di(2-propylheptyl) phthalate (DPHP), is a fast-growing general purpose plasticizer used to replace DEHP. Between 50 and 100 million pounds of DPHP were produced in the U.S. in 2011, tied for fourth in greatest production volume, according to the Chemical Data Reporting (CDR) database maintained by the U.S. Environmental Protection Agency. Schutze et al. (2015) documented an increased frequency of human exposure to DPHP since 1999 in a German study population. Although several of these are higher molecular weight phthalates, the absence of hazard and exposure data should not add comfort. We know that another high molecular weight phthalate, DINP, is anti-androgenic [it impacts male hormones], for example, and that exposure to DPHP is increasing. Given high production volumes, human exposure is likely significant for all of these phthalates."[39]

Safer alternatives are widely available, and many major building product manufacturers use them.[40] Industry leadership is better represented by those manufacturers who are avoiding ortho-phthalates entirely and doing GreenScreen assessments of their alternatives to ensure safety.

HBN Recommends… That Green Seal prohibit all ortho-phthalates from use in insulation and other certified products. (See Appendix for a list of ortho-phthalates.)

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[39] Personal communication

[40] Lott, Sarah. "Phthalate-Free Plasticizers in PVC." Healthy Building Network, September 2014. http://healthybuilding.net/uploads/files/phthalate-free-plasticizers-in-pvc.pdf.

- **Section 3.2 - *The draft standard's restriction on blowing agents has one major exemption that should be eliminated.***

The draft standard restricts the use of blowing agents that have a "Global Warming Potential" (GWP) above 140, meaning that the agent's climate impact is 140 times more powerful than carbon dioxide. However, it exempts blowing agents for XPS (extruded polystyrene) that have GWP as high as 1,500 until the end of the year 2020.

Its exemption supports the ongoing use of a potent hydrofluorocarbon (HFC), HFC-134a, which is the most common blowing agent in XPS, and has a GWP of 1,430.[41]

This exemption for an extremely high GWP blowing agent in XPS is very concerning and unnecessary. It also goes no further than the status quo, and what the US Environmental Protection Agency already requires. In July 2015, the EPA ordered XPS manufacturers to use alternative blowing agents by January 1, 2021.[42]

Analysis by *BuildingGreen* has demonstrated that high GWP blowing agents in foam insulations eliminate the climate benefits of the energy savings from the use of these foams. In an influential article published in 2010, Alex Wilson, founder of BuildingGreen, noted, "Insulation is key to reducing carbon emissions from buildings. But the blowing agents in extruded polystyrene and spray polyurethane foam offset much of that benefit."[43]

Alternatives are already on the market. Alternative blowing agents, hydrofluoroolefins (HFOs), are already in use in XPS made in Europe. An EPA rule enacted in July 2015 will require XPS manufactured in the US to use these same alternatives by the year 2021. The primary replacement, HFO-1234ze, has far less global warming potential (six).

According to a June 2015 *Green Building Advisor* article, HFO blowing agents have been used in XPS made in Europe "for some time" but not yet in North America.[44] HFOs are far less potent greenhouse gases than HFCs. The most commonly cited replacement, HFO-1234ze, has a global warming potential of 6 (that is, the GWP is six times greater than carbon dioxide). HFC-

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[41] Greenhouse Gas Protocol. "Global Warming Potential Values." Accessed March 31, 2016. http://www.ghgprotocol.org/files/ghgp/tools/Global-Warming-Potential-Values.pdf.

[42] 40 CFR Part 82: Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program; Final Rule, July 20, 2015, http://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf.

[43] Wilson, Alex. "Avoiding the Global Warming Impact of Insulation." *Environmental Building News* 19, no. 6 (June 2010). https://www2.buildinggreen.com/article/avoiding-global-warming-impact-insulation-0.

[44] Gibson, Scott. "Friendlier Foam Insulation On the Way, Eventually." Green Building Advisor, June 2, 2015. http://www.greenbuildingadvisor.com/blogs/dept/green-building-blog/friendlier-foam-insulation-way-eventually.

134a, the most common current XPS blowing agent, has a GWP of 1,430 - more than 200 times more powerful than HFO-1234ze.[45]

A European Commission website suggests that HFOs overall have GWPs of between 4 and 9, and that "Major manufacturers of XPS insulation boards have already converted their production facilities to organic solvents or HFOs. The remaining users of HFCs are currently switching to HFOs."[46] The HFO blowing agent was profiled as one of *Building Green*'s products of the year, 2015.[47]

HBN Recommends….That the draft standard's remove its exemption for high GWP blowing agents for extruded polystyrene foam effective immediately.

- **Section 3.5 / Annex A - *The draft standard's sustainable forestry standards require no more than legal minimum performance.***

Green Seal's definition for "sustainably sourced" treats all wood fiber certifications equally. It reads:

> *"Products made from wood-based fiber that is sustainably derived, as certified by FSC (Forest Stewardship Council), SFI (Sustainable Forestry Initiative), ATFS (American Tree Farm System), other PEFC (Programme for the Endorsement of Forest Certification)-recognized labels, or equivalent." (Section 3.5. Raw Material Sourcing)*

It treats the Forest Stewardship Council's (FSC) certification system as "equivalent" to three industry standards (SFI, ATFS, and PEFC) for sustainable sourcing of wood fibers. But there are vast differences between these certification systems. FSC is the only leadership standard of this group created by a diverse set of stakeholders. The other three standards (SFI, ATFS and PEFC) named in the draft are industry creations, which are overall much closer to industry norms.

In personal communication with HBN, Green Seal staff said that its position is that all certification programs are better than uncertified fiber.

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[45] US EPA, "Global Warming Potentials and Ozone Depletion Potentials of Some Ozone-Depleting Substances and Alternatives Listed by the SNAP Program," *epa.gov,* last updated November 6, 2014, http://www3.epa.gov/ozone/snap/subsgwps.html

[46] European Commission. "Climate-Friendly Alternatives to HFCs and HCFCs," March 29, 2016. http://ec.europa.eu/clima/policies/f-gas/alternatives/index_en.htm.

[47] Ehrlich, Brent. "BuildingGreen Announces Top 10 Products for 2016." Environmental Building News, December 2015. https://www2.buildinggreen.com/article/buildinggreen-announces-top-10-products-2016. And, Lapolla Industries. "Lapolla Industries' 4th Generation Foam Recognized in Green Builder® Media," February 23, 2016. http://www.businesswire.com/news/home/20160223006715/en/Lapolla-Industries%E2%80%99-4th-Generation-Foam-Recognized-Green.

In fact, however, even that is not the case. There are gradations within the SFI/PEFC set of certifications, the lower tiers of which impose no meaningful restrictions and have not been demonstrated to be any better than uncertified fiber produced at legal minimum practices.

The USGBC decisively determined, long ago, that only FSC represented a reliable leadership standard and rejected incorporation of the others. We are concerned to see Green Seal taking a lower road than LEED. This inclusive approach supports the industry's long-term efforts to undermine FSC.

***HBN Recommends…* that the Standard only allow wood-based fiber that is sustainably derived, as certified by FSC (Forest Stewardship Council The definition of "sustainably sourced" should read:**

> ***Products made from wood-based fiber that is sustainably derived, as certified by FSC (Forest Stewardship Council).***

- **Section 3.1 -** ***The draft standard's recycled content requirements do not reflect available leadership products in some categories.***

The draft standard requires that insulation products contain certain levels of recycled content (Section 3.1). By type, it requires 80% "recovered content" for cotton and paper cellulose insulation, 75% for rock wool insulation, 40% for fiberglass, 25% for perlite, 20% for XPS, 10% for EPS, and none for SPF.

Some of these recycled content proportions reflect standard practice (and EPA sustainable purchasing guidelines) rather than upper echelon performers and differ little from industry averages. The standard also does not make the vital distinction between post-consumer and pre-consumer (manufacturing waste) content. It is also important to ensure that the recycled content does not introduce legacy contaminants. For this to be effective, Green Seal's standard must specifically apply to recycled content as well as standard virgin feedstocks and must screen out contaminants of high concern in recycled content by using the 0.01% threshold for restricted content, as discussed earlier in our commentary.

More specifically, we have found that:

- The target percentages in the Standard for recycled content for cotton, cellulose, and rock wool reflect best practices, and are reasonable. We have not researched perlite insulation.
- In fiberglass insulation, many fiberglass insulation facilities, when using clean sources of recycled glass, produce insulation with over 50% post-consumer recycled content.[48]

[48] According to product information analyzed by HBN for the Blue Green Alliance Foundation in 2015: Knauf Insulation's Jet Stream ULTRA Glasswool Loosefill Blowing Insulation made in Shasta Lake, California, contains between 62% and 70% post-consumer cullet. Owens Corning's FIBERGLAS® Blown-in Insulation, AttiCat® Expanding Blown-in Insulation, and EcoTouch™ QuietZone® PINK® FIBERGLAS™ Insulation made in Edmonton, Alberta, and Toronto, Ontario contains 64% post-consumer

Rewarding this level would reflect leadership in the sector, further incentivize healthier cullet supplies (higher levels of contamination decrease the ability of manufacturers to incorporate cullet), and increase recycling rates.

For other forms of insulation with recycled content requirements listed above (polystyrene[49] and SPF[50]), due to toxicity concerns with all formulations currently on the market, HBN cannot recommend any certification, regardless of recycled content.

HBN Recommends… That the standard require

- **Recycled content not contain heavy metals at more than 100 parts per million as defined by state Toxics in Packaging laws.**
- **Fiberglass batt percent minimum recovered content should be increased to 50% post consumer content for faced, and 60% post consumer for loose-fill/blown fiberglass.**

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cullet. CertainTeed Sustainable Insulation (unfaced) made in Redcliffe, Alberta contains 58% post-consumer content. Knauf Insulation Jet Stream ULTRA Glasswool Loosefill Blowing Insulation made in Shelbyville, Indiana contains up to 55% post-consumer cullet.

[49] Plastics industry literature creates an impression that product manufacturers are actively using post-consumer polystyrene, that the only barriers to the increased usage are public will and recycling infrastructure. In reality, efforts to use post-consumer recycled content in polystyrene insulation have been sporadic at best due to technical, economic, and ecological challenges. The Healthy Building Network researched product literature for dozens of XPS and EPS insulations on the market. No current product literature of either type advertises the presence of any post-consumer material. Almost every XPS insulation on the market (11 of the 12 that we researched) claims the use of 20% pre-consumer material. Most EPS insulation lists no recycled content.

[50] In SPF insulation, one manufacturer (Lapolla) claims to contain "a meaningful level of Post Consumer Recycled Content (recycled plastic bottles)." (Lapolla Industries. “Lapolla Industries Is the First Globally to Develop and Commercially Release the Fourth Generation Wall Foam System - Foam-Lok 2000 4G.” Accessed March 31, 2016. http://www.lapolla.com/foam-lok-2000-4g/).
Polyols - one of the many substances used in SPF installations - sometimes are derived from plastic bottles. (Recycling Today. “ACC Announces Winners of Its 2015 Innovation in Plastics Recycling Awards,” November 13, 2015. https://www.recyclingtoday.com/article/acc-2015-innovation-plastics-recycling-awards)

APPENDICES

ENDORSEMENTS:

The following is a list of individuals and organizations who requested to endorse HBN's analysis and comments as of 4/6/2016. Some of them read and reviewed the entire HBN comment document here and others were endorsing based upon the summary of concerns described in the HBN News article by Tom Lent of March 30, 2016 "Take Action for Healthier Building Materials" http://www.healthybuilding.net/news/2016/03/30/take-action-for-healthier-building-materials. This list includes comments submitted to HBN along with the endorsement by some individuals.

1. Alicia Culver, Executive Director, **Responsible Purchasing Network** (RPN) "I'd rather see a smaller number of products that we can trust."
2. Alicia Daniels Uhlig Principal, Director of Sustainability **GGLO Architecture**
3. Amanda Kaminsky, Founder, **Building Product Ecosystems LLC**
4. Amy Ziff, Founder & Executive Director, **Made Safe & NonToxic Certified**
5. Anthony Bernheim, FAIA, LEED Fellow, President, **Bernheim + Dean** (architecture)
6. Avery Lindemann, Deputy Director, **Green Science Policy Institute** (& submitted own comments)
7. Bryna Dunn, Vice President, **Moseley Architects**
8. Carol Westinghouse, President, **Informed Green Solutions**
9. Cate Leger, Principal, **Leger Wanaselja Architecture**, *"I am very concerned about so many aspects of these proposed standards that you outline: inclusion of non-FSC certified wood, lower thresholds for recycled content, and allowance for isocyanates. I am particularly alarmed by the allowance of high global warming potential blowing agents and halogenated flame retardants. Studies by Building Green and others have shown that insulating with insulation made with high global warming potential can have such a high carbon footprint that it can take many decades or longer to pay back with energy savings--decades we just don't have. I am concerned about the halogenated flame retardants because many of them are persistent, bioaccumulative and toxic, and the new HFRs have chemical structures very similar to the problematic ones being phased out. What I find most concerning is that insulations exist now that work well and can meet a very high green standard will not be prioritized by this standard and should be. For all building types there are ways to insulate to very high levels without using materials with high global warming potential, halogenated flame retardants, low or non recycled content materials, non FSC certified wood, etc. Please pass on my comments to Green Seal. I encourage them to set the bar high. We don't need any more greenwashing.*
10. Chris Hellstern, **Miller Hull Partnership**, LLP
11. Chris Magwood, Director, **Endeavour Centre** (sustainable building school)
12. Hilton Tudhope, **Moving Minds** (corporate sustainability consultancy) *"In our view, their proposals seriously compromise not only the integrity of the Green Seal brand but also the mission of the organization. "*
13. Joel Sigler, CSP, HEM, Senior Manager of National Environmental, Health & Safety, **Kaiser Permanente** *"The GS-54 current green seal draft does not sufficiently address our environmental criteria concerns, and thus would have very limited value to our organization. We have reviewed the recommendations submitted by the Healthy Building Network, and they would address our concerns, and make the standard much more useful to our organization.*
14. Jason Grant, Forest Certification and Green Building Team, **Sierra Club**
15. Jeff Gearhart, Research Director **Ecology Center**
16. Jeff Frost, Integrated Design Specialist, **SERA Architects**
17. Jim Ace, Senior Campaigner, **Stand** (formerly ForestEthics) *Jim has supplied a number of documents from analyses that ForestEthics (now STAND) has made determining that an SFI certification is not a reliable indicator of better than industry norm forestry practices*
18. John C. Locke, Senior Associate, **Perkins Eastman Architecture**

19. Judy Braiman, President, **Empire State Consumer Project**, Inc
20. Kathleen Burns, Ph.D., Director., **Sciencecorps**
21. Kathleen A. Curtis, Executive Director. **Clean and Healthy New York**
22. Kristi Ennis, **Boulder Associates Architects**
23. LaVerne Williams, **Environmental Associates Architects & Consultant**s "As we (Environment Associates) work with individuals having MCS (Multiple Chemical Sensitivities) and compromised immune systems as well as young and growing families and older folks who strive for healthy living, we need insulation products we can rely upon that do not harm our clients. Should Green Seal allow this insulation standard as drafted to be adopted, we will have no choice but to advise our clients and the audiences that follow our work and attend our workshops and seminars that Green Seal has evolved into an organization that engages in greenwash and that their Green Seal can no longer be relied upon.
24. Lee Canel, Real Estate and Sustainability Consultant
25. Mark S. Rossi, PhD, Executive Director, **Clean Production Action**
26. Michael Belliveau, Executive Director, **Environmental Health Strategy Center**
27. Mike Manzi, Specifications Manager, **BORA Architects**
28. Nathan Donley, Ph.D, Staff Scientist, **Center for Biological Diversity**
29. Pamela Miller, Executive Director, **Alaska Community Action on Toxics**
30. Paul Bogart, Executive Director, **Health Care Without Harm**
31. Penny Bonda, Principal, **Ecoimpact Consulting**, *"It's more important that the standard is rigorous and reliable. Health and safety is what we stand for."*
32. Priscilla J. Mattison, Esq., LEED AP Homes, Counsel, **Bernard M. Resnick, Esq., P.C**.
33. Rachel Emrick
34. Rick Hind, Legislative Director, **Greenpeace USA**
35. Robert Phinney, Associate Principal, **Page Southerland Page Architects**
36. Russell Perry FAIA, LEED Fellow, Vice President and Co-Director of Sustainable Design, **SmithGroupJJR** (engineering & architecture) *" "I enthusiastically support your analysis of the proposed Green Seal Standard for Architectural Thermal Insulation Materials. I look forward to a more rigorous standard coming out of this review."*
37. Sarah Miller, **ZGF Architects, "***The Green Seal label/certification will be diluted if they allow spray foam insulations with isocyanates, halogenated flame retardants and other known hazards to be included in the products that may receive a label. The label is a tool for designers who need to specify "healthy" products, especially in applications like healthcare facilities. It would be ethically wrong to give the impression that materials with this label are healthy, when in fact they have been proven to be hazardous to human health. It is incredibly important to keep people healthy, and allowing these products to be in our buildings, under the false pretense that they are green, would be disastrous."*
38. Stet Sanborn, **Integral Group** (engineering & architecture) *"I absolutely feel like restrictions on halogenated flame retardants and high GWP expanding agents should be excluded from any product getting any "green" seal."*
39. Sunshine Mathon, **Foundation Communities** (affordable housing developer)
40. Tracy Gregoire, Healthy Children's Project Coordinator, **Learning Disabilities Association of Maine**
41. William Bucholz, **independent specifier,** "*Green Seal certification is supposed to be a leadership standard – not a business-as-usual standard that is no better than the regulatory minimums. Please strengthen the GS-54 draft standard by following HBN's recommendations."*

The following lists are found in the Pharos Chemical and Materials Library, a database maintained by the Healthy Building Network, at http://www.pharosproject.net.

Association of Occupational and Environmental Clinics (AOEC) asthmagens

CAS RN	Material Name
2746-19-2	(1_,2_,3_,6_)-1,2,3,6-tetrahydro-3,6-methanophthalic anhydride
111-41-1	(2-AMINOETHYL)ETHANOLAMINE
68391-01-5	(C12-C18) ALKYLDIMETHYLBENZYL AMMONIUM CHLORIDE
68155-39-5	(C14-C18) AND(C16-C18) UNSATURATED ALKYLAMINE, ETHOXYLATE
123-77-3	1,1'-AZOBIS(FORMAMIDE)
693-23-2	1,10-DECANEDICARBOXYLIC ACID
694-83-7	1,2-CYCLOHEXANEDIAMINE
85-42-7	1,2-CYCLOHEXANEDICARBOXYLIC ACID ANHYDRIDE
9072-91-7	1,2-Ethanediol, polymer with 1,3-diisocyanatomethylbenzene
26590-20-5	1,2,3,6-tetrahydromethylphthalic anhydride
117-08-8	1,3-DIOXY-4,5,6,7-TETRACHLOROISOBENZOFURAN
4035-89-6	1,3,5-TRIS(6-ISOCYANATOHEXYL)BIURET
110-85-0	1,4-DIAZACYCLOHEXANE
822-06-0	1,6-HEXAMETHYLENE DIISOCYANATE
124-09-4	1,6-HEXANEDIAMINE
108-01-0	2-DIMETHYLAMINOETHANOL
999-61-1	2-HYDROXYPROPYL ACRYLATE
97-63-2	2-METHYL-2-PROPENOIC ACID, ETHYL ESTER
7585-41-3	2-NAPHTHALENECARBOXYLIC ACID, 4-((5-CHLORO-4-METHYL-2-SULFOPHENYL)AZO)-3-HYDROXY-, BARIUM SALT (1:1) (9CI)
16079-88-2	2,4-IMIDAZOLIDINEDIONE, 1-BROMO-3-CHLORO-5,5-DIMETHYL-
584-84-9	2,4-TOLUENE DIISOCYANATE (2,4-TDI)
17095-24-8	2,7-NAPHTHALENEDISULFONIC ACID, 3,6-(BIS(4-((2-HYDROXYETHYL)SULFONYL)PHENYL)BIS(AZO))-5-AMINO-4-H-YDROXY-, DI(HYDROGEN SULFATE) ESTER, TETRASODIUM SALT
16691-43-3	3-AMINO-5-MERCAPTO-1,2,4-TRIAZOLE
109-55-7	3-Aminopropyldimethylamine
957-68-6	7 ACA
24209-38-9	7-Amino-3-(1-methyltetrazol-5-ylthiomethyl)-3-cephem-4-carboxylic acid
9000-01-5	ACACIA
30560-19-1	ACEPHATE
64-19-7	Acetic acid 30%
64-19-7	Acetic acid, 3 to 10 %
69103-01-1	Acetic acid, esters with turpentine-oil myrcene fraction terpene alcs.
64-19-7	ACETIC ACID, GLACIAL
61790-12-3	ACIDS, TALL OIL
79-10-7	ACRYLIC ACID

9003-56-9	ACRYLONITRILE-BUTADIENE-STYRENE COPOLYMER
80-43-3	ACTIVE DICUMYL PEROXIDE
9048-46-8	ALBUMIN, BOVINE, FRACTION V
8001-54-5	ALKYL DIMETHYLBENZYLAMMONIUM CHLORIDE
68424-85-1	ALKYL(C12-16)DIMETHYLBENZYLAMMONIUM CHLORIDE
9000-90-2	alpha-Amylase
7429-90-5	ALUMINUM
7446-70-0	ALUMINUM CHLORIDE, ANHYDROUS
7429-90-5	ALUMINUM COMPOUNDS
1344-28-1	ALUMINUM OXIDE
1344-28-1	Aluminum oxide, fibrous dust (variant of 1344-28-1)
9014-06-6	Amidase, penicillin
7664-41-7	AMMONIA
1336-21-6	Ammonia solution, in water, 10 to 35% ammonia
1336-21-6	Ammonia solution, in water, with 35 to 50% ammonia
1336-21-6	Ammonia solution, in water, with more than 50% ammonia
7789-09-5	AMMONIUM DICHROMATE
16919-58-7	AMMONIUM HEXACHLOROPLATINATE (IV)
1336-21-6	Ammonium hydroxide
69-53-4	AMPICILLIN
9000-85-5	Amylase, bacterial
9032-08-0	Amylase, gluco-
68038-66-4	Bacillus licheniformis
68038-70-0	BACILLUS SUBTILIS
68989-00-4	BENZALKONIUM CHLORIDE
68607-20-5	BENZALKONIUM CHLORIDE
122-18-9	BENZALKONIUM CHLORIDE
124737-31-1	BENZENEDIAZONIUM, 4-(DIMETHYLAMINO)-, SALT WITH 2-HYDROXY-5-SULFOBENZOIC ACID (1:1)
122-19-0	BENZYLDIMETHYLSTEARYLAMMONIUM CHLORIDE
9074-98-0	Beta-glucanase
1675-54-3	BISPHENOL A DIGLYCIDYL ETHER (BADGE)
9001-00-7	BROMELAIN
53516-76-0	BTC 776
8045-22-5	BTC 927
141-32-2	BUTYL ACRYLATE
2425-06-1	CAPTAFOL
13466-78-9	CARENE
9000-71-9	CASEIN
15686-71-2	Cefadroxil
72558-82-8	Ceftazidine
9012-54-8	CELLULASE
66592-87-8	Cephalexin
127-65-1	CHLORAMINE-T, TRIHYDRATE

55-56-1	CHLORHEXIDINE
7782-50-5	CHLORINE
1897-45-6	Chlorothalonil
2921-88-2	CHLORPYRIFOS
7440-47-3	Chromium
1308-38-9	CHROMIUM (III) COMPOUNDS
18540-29-9	CHROMIUM (VI)
1333-82-0	CHROMIUM (VI) OXIDE
9004-07-3	CHYMOTRYPSIN
2611-82-7	Cibachrome Brilliant Scarlet 3R
68650-43-1	Cichorium intybus
51481-61-9	CIMETIDINE
7440-48-4	COBALT
7440-48-4	COBALT COMPOUNDS
76-57-3	Codeine
1302-74-5	CORUNDUM
5989-27-5	D-LIMONENE
561-27-3	Diacetyl morphine
333-41-5	DIAZINON
100-34-5	Diazonium Chloride
3400-09-7	DICHLORAMINE
62-73-7	DICHLORVOS
7173-51-5	Didecyl dimethyl ammonium chloride
111-42-2	DIETHANOLAMINE
60-51-5	DIMETHOATE
68956-79-6	DIMETHYL ETHYL BENZYL AMMONIUM CHLORIDE
139-07-1	DODECYL-DIMETHYL-BENZYLAMMONIUM CHLORIDE
51811-44-0	DRIMAREN BRILLIANT BLUE K-BL
Eastern White Cedar	
9001-63-2	Egg Lysozyme
9025-57-4	endo-1,4-Xylanase (from Trichoderma viride)
13838-16-9	ENFLURANE
142443-98-9	EPO 60
9073-77-2	Esperase
141-43-5	Ethanolamine
107-15-3	ETHYLENE DIAMINE
111-76-2	Ethylene glycol monobutyl ether (EGBE)
75-21-8	ETHYLENE OXIDE
8000-48-4	EUCALYPTUS OIL
97-53-0	EUGENOL
68476-25-5	FELDSPAR
22224-92-6	FENAMIPHOS
55-38-9	FENTHION
68990-15-8	FENUGREEK

79622-59-6	FLUAZINAM
7782-41-4	FLUORINE
50-00-0	FORMALDEHYDE
9011-05-6	Formaldehyde compounds, Urea formaldehyde based
50-00-0	Formol
9013-01-8	FUNGAL AMYLASE
98-00-0	FURFURYL ALCOHOL
25212-86-6	FURFURYL ALCOHOL RESIN
111-30-8	GLUTARALDHYDE
9000-30-0	GUAR
151-67-7	HALOTHANE
9025-56-3	Hemicellulase (from Aspergillus niger)
83-72-7	HENNA
70-30-4	HEXACHLOROPHENE
100-97-0	HEXAMETHYLENETETRAMINE
86-54-4	HYDRALAZINE
7647-01-0	Hydrochloric acid 0.036 % in aqueous solution
7647-01-0	Hydrochloric acid 0.36 % in aqueous solution
7647-01-0	Hydrochloric acid 28 % in aqueous solution
7647-01-0	Hydrochloric acid 3.6 % in aqueous solution
7647-01-0	Hydrochloric acid 31.45 % in aqueous solution
7647-01-0	Hydrochloric acid 35,2 % in aqueous solution
125-29-1	Hydrocodone
7647-01-0	HYDROGEN CHLORIDE (HCl)
25311-71-1	ISOFENPHOS
26675-46-7	Isoflurane
54-85-3	ISONICOTINIC ACID HYDRAZIDE
2855-13-2	ISOPHORONE DIAMINE
4098-71-9	ISOPHORONE DIISOCYANATE (I{PDI)
70210-42-3	Lanasol Blue 3G
71838-44-3	Lanasol Orange R
39354-69-3	Lanasol Red 2G
12239-68-8	Lanasol Red 5B
12226-32-3	Lanasol Red B
70210-00-3	Lanasol Red G
12270-86-9	Lanasol Scarlet 2R
70247-70-0	LANASOL YELLOW 4G
73468-57-2	LEPTINOTARSA DECEMLINEATA
51811-45-1	Levafix Goldgelb E-3GA
9001-62-1	Lipase, triacylglycerol
121-75-5	MALATHION
108-31-6	MALEIC ANHYDRIDE
89-78-1	MENTHOL
76-38-0	METHOXYFLURANE

28983-56-4	METHYL BLUE
80-62-6	METHYL METHACRYLATE
119-36-8	METHYL SALICYLATE
555-30-6	METHYLDOPA
101-68-8	METHYLENE BISPHENYL DIISOCYANATE (PURE MDI)
10599-90-3	MONOCHLORAMINE
57-27-2	Morphine
109-02-4	N-METHYLMORPHOLINE
25551-28-4	NAPHTHALENE DIISOCYANATE (NDI)
77907-32-5	Navy Blue HER
7440-02-0	Nickel
7440-02-0	NICKEL COMPOUNDS
7440-02-0	NICKEL COMPOUNDS, INSOLUBLE
10025-85-1	NITROGEN TRICHLORIDE
90-43-7	O-PHENYLPHENOL
643-79-8	O-PHTHALALDEHYDE
8008-51-3	Oils, camphor
68917-18-0	Oils, mint, Mentha arvensis piperascens
76-42-6	Oxycodone
106-50-3	P-PHENYLENEDIAMINE
8049-47-6	PANCREATIN
9001-73-4	PAPAIN
58-74-2	PAPAVERINE
61-25-6	PAPAVERINE HYDROCHLORIDE
8012-95-1	PARAFFIN OIL
30525-89-4	PARAFORMALDEHYDE
56-38-2	PARATHION
9000-69-5	PECTIN
9001-75-6	PEPSIN
9025-48-3	Pepsin B (pig stomach)
70851-98-8	Peptidase (from enterobacterium Serratia)
79-21-0	PEROXYACETIC ACID
15092-81-6	Persulfate salts
25265-76-3	PHENYLENEDIAMINE
85-44-9	PHTHALIC ANHYDRIDE
37288-11-2	Phytase from Aspergillus niger
142-64-3	PIPERAZINE DIHYDROCHLORIDE
64265-57-2	POLYFUNCTIONAL AZIRIDINE
9016-87-9	POLYMERIC MDI (PMDI)
9011-14-7	POLYMETHYL METHACRYLATE (PMMA)
1066-17-7	POLYMYXIN E
9003-07-0	POLYPROPYLENE
9002-86-2	POLYVINYL CHLORIDE (PVC)
65997-15-1	PORTLAND CEMENT

9036-06-0 Pronase E
28523-86-6 Propane, 1,1,1,3,3,3-hexafluoro-2-(fluoromethoxy)-
31218-83-4 PROPETAMPHOS
89-32-7 Pyromellitic Dianhydride
61789-71-7 QUATERNARY AMMONIUM COMPOUNDS, BENZYLCOCO ALKYLDIMETHYL, CHLORIDES
73049-75-9 QUATERNARY AMMONIUM COMPOUNDS, BENZYLDI-C12-18-ALKYLMETHYL, CHLORIDES
QUATERNARY AMMONIUM COMPOUNDS, NOS
7440-02-0 Raney Nickel
71838-95-4 Remazol Brilliant Orange FR
129898-77-7 Remazol Brilliant Yellow 4GL
90597-79-8 Remazol Gold Yellow RNL
147826-71-9 Remazol Marine Blue GG
9042-08-4 Rennet
7440-16-6 RHODIUM
61901-80-2 Rifazol Brilliant Orange 3R
81-07-2 SACCHARIN
7681-52-9 SODIUM HYPOCHLORITE
7681-52-9 Sodium hypochlorite 12%
7681-52-9 Sodium hypochlorite 4%
7681-52-9 Sodium hypochlorite 6%
7681-57-4 SODIUM METABISULFITE
90320-57-3 SOYBEAN LECITHIN
8025-81-8 SPIRAMYCIN
100-42-5 STYRENE
9014-01-1 SUBTILISINS (PROTEOLYTIC ENZYMES...)
7664-93-9 SULFURIC ACID
8014-95-7 SULFURIC ACID (FUMING)
7664-93-9 Sulfuric acid 0.049% (0.01N)
7664-93-9 Sulfuric acid 0.098% (0.02N)
7664-93-9 Sulfuric acid 0.49% (0.1N)
7664-93-9 Sulfuric acid 0.98% (0.2N)
7664-93-9 Sulfuric acid 12.25% (2.5N)
7664-93-9 Sulfuric acid 2% (0.4N)
7664-93-9 Sulfuric acid 4.9% (1N)
8002-26-4 TALL OIL
8052-10-6 TALL OIL ROSIN
9003-74-1 TERPENE
60-54-8 TETRACYCLINE (INTERNAL USE)
7696-12-0 TETRAMETHRIN
70816-59-0 TETRAZENE
31330-63-9 tetrazene explosive
115-37-7 Thebaine

59-43-8 Thiamine
89-83-8 THYMOL
7440-31-5 TIN
9000-65-1 TRAGACANTH
56-35-9 TRIBUTYLTIN OXIDE (TBTO)
102-71-6 TRIETHANOLAMINE
112-24-3 TRIETHYLENETETRAMINE
2451-62-9 TRIGLYCIDYL ISOCYANURATE (TGIC)
552-30-7 TRIMELLITIC ANHYDRIDE
15625-89-5 TRIMETHYLOLPROPANE TRIACRYLATE
144-29-6 tripiperazine dicitrate
9002-07-7 TRYPSIN
12070-12-1 TUNGSTEN CARBIDE
8006-64-2 TURPENTINE
1405-54-5 TYLOSIN TARTRATE
1404-90-6 VANCOMYCIN
Western Red Cedar
37278-89-0 Xylanase
7440-66-6 ZINC
7440-66-6 Zinc (powder)
37300-23-5 ZINC CHROMATE WITH ZINC HYDROXIDE AND CHROMIUM OXIDE (9:1)
7440-66-6 ZINC COMPOUNDS
1314-13-2 ZINC OXIDE
9051-29-0 α-lactalbumin

Halogenated flame retardants

[87-84-3] 1,2,3,4,5-PENTABROMO-6-CHLOROCYCLOHEXANE
[855993-01-0] 1,2,3,9-Tetrabromo-1,2,3,4-tetrahydro-1,4-methanonaphthalene (1 of 2 CAS#s)
[855992-98-2] 1,2,3,9-Tetrabromo-1,2,3,4-tetrahydro-1,4-methanonaphthalene (1 of 2 CAS#s)
[77098-07-8] 1,2-BENZENEDICARBOXYLIC ACID, 3,4,5,6-TETRABROMO-, MIXED ESTERS WITH DIETHYLENE GLYCOL AND PROPYLENE GLYCOL
[37853-59-1] 1,2-BIS(2,4,6-TRIBROMOPHENOXY)ETHANE (BTBPE))
[25713-60-4] 1,3,5-Triazine, 2,4,6-tris(2,4,6-tribromophenoxy)-
[75795-16-3] 1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1,3-bis(2,3-dibromopropyl)-5-(2-propen-1-yl)-
[57829-89-7] 1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1-(2,3-dibromopropyl)-3,5-di-2-propen-1-yl-
[52434-90-9] 1,3,5-tris(2,3-dibromopropyl)-1,3,5-triazine-2,4,6(1H,3H,5H)-trione
[117-08-8] 1,3-DIOXY-4,5,6,7-TETRACHLOROISOBENZOFURAN
[191680-81-6] 1,3-Propanediamine, N,N''-1,2-ethanediylbis-, reaction products with cyclohexane and peroxidized N-butyl-2,2,6,6-tetramethyl-4-piperidinamine-2,4,6-trichloro-1,3,5-triazine reaction products

[31977-87-4] 1,4,-Bis(2,4,6-tribromophenoxy)-2,3-dibromobutene
[115-27-5] 1,4,5,6,7,7-HEXACHLORO-ENDO-5-NORBORNENE-2,3-DICARBOXYLIC ANHYDRIDE
[13560-92-4] 1,4:5,8:9,10-Trimethanoanthracene, 1,2,3,4,5,6,7,8,12,12,13,13-dodecachloro-1,4,4a,5,8,8a,9,9a,10,10a-decahydro-
[31107-44-5] 1,4:6,9-Dimethanodibenzofuran, 1,2,3,4,6,7,8,9,10,10,11,11-dodecachloro-1,4,4a,5a,6,9,9a,9b-octahydro- Dec 602 31107-44-5
[4351-70-6] 1-(Bis(2-chloroethoxy)phosphinyl)ethyl 2-chloroethyl (1-(((2-chloroethoxy)(2-chloroethyl)phosphinyl)oxy)ethyl)phosphonate
[1522-92-5] 1-Propanol, 3-bromo-2,2-bis(bromomethyl)-
[1084889-51-9] 1H-Indene, 4,5,6,7-tetrabromo-2,3-dihydro-1,1,3-trimethyl-3-(2,3,4,5-tetrabromophenyl)-
[446255-22-7] 2,2',3,3',4,5',6-HEPTABROMODIPHENYL ETHER (BDE-175)
[189084-68-2] 2,2',3,4',5,6'-HEPTABROMODIPHENYL ETHER (BDE-183)
[207122-16-5] 2,2',3,4,4',5',6-HEPTABROMODIPHENYL ETHER (OCTABDE BDE-183)
[182346-21-0] 2,2',3,4,4'-PENTABROMODIPHENYL ETHER (BDE 85)
[68631-49-2] 2,2',4,4',5,5'-HEXABROMODIPHENYL ETHER (BDE-153)
[207122-15-4] 2,2',4,4',5,6'-HEXABROMODIPHENYL ETHER (BDE-154)
[60348-60-9] 2,2',4,4',5-PENTABROMODIPHENYL ETHER (BDE-99)
[189084-64-8] 2,2',4,4',6-PENTABROMODIPHENYL ETHER (BDE-100)
[5436-43-1] 2,2',4,4'-TETRABROMODIPHENYL ETHER (BDE-47)
[67888-96-4] 2,2',4,5,5'-PENTABROMOBIPHENYL
[68928-70-1] 2,2'-[(1-METHYLETHYLIDENE)BIS[(2,6-DIBROMO-4,1-PHENYLENE)
[1047637-37-5] 2,2-Bis(chloromethyl)-1,3-propanediol
[36483-57-5] 2,2-dimethylpropan-1-ol, tribromo derivative
[23488-38-2] 2,3,5,6-Tetrabromo-p-xylene
[35109-60-5] 2,3-DIBROMOPROPYL-2,4,6-TRIBROMOPHENYL ETHER (DPTE or TBP-DBPE)
[41318-75-6] 2,4,4'-TRIBROMODIPHENYL ETHER (BDE-28)
[59080-40-9] 2,4,5,2',4',5'-HEXABROMOBIPHENYL
[118-79-6] 2,4,6-TRIBROMOPHENOL
[3278-89-5] 2,4,6-tribromophenyl allyl ether (TBP-AE or ATT)
[71342-77-3] 2,4,6-TRIBROMOPHENYL TERMINATED CARBONATE OLIGOMER
[615-58-7] 2,4-dibromophenol
[183658-27-7] 2-ETHYLHEXYL-2,3,4,5-TETRABROMOBENZOATE (TBB or EH-TBB)
[20566-35-2] 2-HYDROXY-PROPYL-2-(2-HYDROXY-ETHOXY)-ETHYL-TBP
[59447-55-1] 2-propenoic acid, (pentabromo)methyl ester
[55205-38-4] 2-Propenoic acid, 1,1'-[(1-methylethylidene)bis(2,6-dibromo-4,1-phenylene)] ester
[66710-97-2] 2-Propenoic acid, 1,1'-[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxy-2,1-ethanediyl]] ester
[134237-50-6] ALPHA-HEXABROMOCYCLODODECANE (α-HBCD)
[37853-61-5] Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-methoxy- [Di-Me-TBBPA is proba-bly not produced and used specifically as a flame retardant but may be a primary but very minor degradation product of TBBPA in the environment, although results are inconc
[497107-13-8] Benzene, 1,1'-[oxybis(methylene)]bis[2,3,4,5,6-pentabromo- (9CI)

[42757-55-1] Benzene, 1,1'-sulfonylbis[3,5-dibromo- 4-(2,3-dibromopropoxy)-
[70156-79-5] Benzene, 1,1'-sulfonylbis[3,5-dibromo-4-methoxy-
[3555-11-1] Benzene, 1,2,3,4,5-pentabromo-6-(2-propen-1-yloxy)-
[58495-09-3] Benzene, 1,2,3,4,5-pentabromo-6-(chloromethyl)-
[39569-21-6] Benzene, 1,2,3,4-tetrabromo-5-chloro-6-methyl-
[31780-26-4] Benzene, dibromoethenyl-
[88497-56-7] BENZENE, ETHENYL-, HOMOPOLYMER, BROMINATED
[1195978-93-8] benzene, ethenyl-, polymer with 1,3- butadiene, brominated
[38521-51-6] benzene, pentabromo(bromomethyl)-
[134237-51-7] BETA-HEXABROMOCYCLODODECANE (β-HBCD)
[34571-16-9] Bicyclo[2.2.1]hept-2-ene, 1,2,3,4,7,7-hexachloro-5-(2,3,4,5-tetrabromophenyl)-
[76025-08-6] BIS(1-CHLORO-2-PROPYL) 2-CHLORO-1-PROPYL PHOSPHATE
[7415-86-3] Bis(2,3-dibromopropyl) phthalate
[5412-25-9] BIS(2,3-DIBROMOPROPYL)PHOSPHATE
[76649-15-5] BIS(2-CHLORO-1-PROPYL) 1-CHLORO-2-PROPYL)
[26040-51-7] BIS(2-ETHYL-1-HEXYL)TETRABROMOPHTHALATE (TBPH or BEHTBP)
[4162-45-2] BIS(2-HYDROXYETHYL ETHER) (TBBPA)]
[90075-91-5] Bis(pentabromobenzyl) terephthalate
[82001-21-6] Bis(pentabromobenzyl) tetrabromophthalate
[135229-48-0] Brominated epoxy resin end-capped with tribromophenol
BROMINATED FLAME RETARDANTS (BFR)
[60371-14-4] Bromkal 70-5DE
[2052-07-5] BROMOBIPHENYL
[94334-64-2] CARBONIC DICHLORIDE, POLYMER WITH 4,4'-(1-
METHYLETHYLIDENE)BIS(2,6- DIBROMOPHENOL) AND PHENOL
[115-28-6] CHLORENDIC ACID
CHLORINATED FLAME RETARDANTS (CFR)
[13674-87-8] Chlorinated Tris (TDCPP, TDCP)
[138257-18-8] CYCLODODECANE, 1,2,5,6,9,10- HEXABROMO-, (1R,2R,5R,6S,9R,10S)-
[3194-57-8] Cyclooctane, 1,2,5,6-tetrabromo-
[13654-09-6] Decabromobiphenyl
[1163-19-5] DECABROMODIPHENYL ETHER (DECABDE BDE-209)
[84852-53-9] DECABROMODIPHENYLETHANE (DBDPE)
[13560-89-9] DECHLORANE PLUS (DP)
[92-86-4] DIBROMOBIPHENYL
[148993-99-1] DIBROMOSTYRENE COPOLYMER (FIREMASTER CP44-HF & PBS-64HW)
[25357-79-3] DISODIUM TETRABROMOPHTHALATE
[32588-76-4] ETHYLENE BIS(TETRABROMOPHTHALIMIDE) (BTBPIE)
[134237-52-8] GAMMA-HEXABROMOCYCLODODECANE (γ-HBCD)
[68928-80-3] HEPTABROMODIPHENYL ETHER (HEPTABDE)
[87-82-1] HEXABROMOBENZENE (HBB)
[36355-01-8] HEXABROMOBIPHENYL
[25495-98-1] HEXABROMOCYCLODECANE (HBCD)
[25637-99-4] HEXABROMOCYCLODODECANE (HBCD, HBCDD)

[3194-55-6] HEXABROMOCYCLODODECANE (HBCDD)
[36483-60-0] HEXABROMODIPHENYL ETHER (HEXABDE)
[77-47-4] HEXACHLOROCYCLOPENTADIENE (HCCPD)
[51936-55-1] HEXACHLOROCYCLOPENTADIENYL-DIBROMOCYCLOOCTANE (DBHC-TCTD or HCDBCO)
[85535-85-9] MEDIUM-CHAIN CHLORINATED PARAFFINS (MCCP) - ALKANES, C14-17, CHLORO
[2385-85-5] MIREX
[63936-56-1] NONABROMODIPHENYL ETHER (NONABDE)
[1025956-65-3] OBTrMePhIn
[32536-52-0] OCTABROMODIPHENYL ETHER (OCTABDE)
[3072-84-2] Oxirane, 2,2'-[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxymethylene]]bis-
PBDEs in Commercial Octabromodiphenyl Ether
PBDEs In Commercial Pentabromodiphenyl Ether
[59447-57-3] PENTABROMO-BENZYL-ACRYLATE, POLYMER
[608-90-2] Pentabromobenzene
[32534-81-9] PENTABROMODIPHENYL ETHER (PENTABDE)
[85-22-3] PENTABROMOETHYLBENZENE (PBEB)
[608-71-9] Pentabromophenol
[87-83-2] PENTABROMOTOLUENE (PBT)
[3296-90-0] PENTAERYTHRITOL DIBROMIDE
[67990-32-3] PHENOL, 2,4,6-TRIBROMO-, CARBONATE (2:1)
[168434-45-5] Phenol, 2,4,6-tribromo-3-(tetrabromopentadecyl)-
[33798-02-6] Phenol, 4,4'-(1-methylethylidene)bis[2,6-dibromo-, 1,1'-diacetate
[37419-42-4] Phenol, 4,4'-(1-methylethylidene)bis[2,6-dibromo-, dipropanoate (9CI)
[39635-79-5] Phenol, 4,4'-sulfonylbis[2,6-dibromo-
[125997-20-8] PHOSPHORIC ACID, MIXED 3-BROMO-2,2-DIMETHYLPROPYL AND 2-BROMOETHYL AND 2-CHLOROETHYL ESTERS
POLYBROMINATED DIPHENYL ETHERS (PBDE)
[97416-84-7] Pyroguard SR-130; SR-130
[71011-12-6] SHORT CHAIN CHLORINATED PARAFFINS (SCCP) - ALKANES, C12-13, CHLORO
[85535-84-8] SHORT CHAIN CHLORINATED PARAFFINS (SCCP), C10-13
[60044-24-8] TETRABROMOBIPHENYL
[79-94-7] TETRABROMOBISPHENOL A (TBBPA)
[21850-44-2] TETRABROMOBISPHENOL A BIS(2,3-DIBROMOPROPYL) ETHER (TBBPA-DBPE)
[25327-89-3] Tetrabromobisphenol A diallyl ether (TBBPA-DAE)
[40088-47-9] TETRABROMODIPHENYL ETHER (TETRABDE BDE-47)
[3322-93-8] TETRABROMOETHYLCYCLOHEXANE [TBECH]
[632-79-1] TETRABROMOPHTHALIC ANHYDRIDE
[72625-95-7] Tetrabromophthalic anhydride or 4,5,6,7-tetrabromo-2-benzofuran-1,3-dione
[58965-66-5] TETRADECABROMO (P-DIPHENOXYBENZENE)

[38051-10-4] TETRAKIS(2-CHLOROETHYL)DICHLOROISOPENTYLDIPHOSPHATE (V6)
[147-82-0] Tribromoaniline
[49690-94-0] TRIBROMODIPHENYL ETHER
[57137-10-7] TRIBROMOSTYRENE
[126-72-7] TRIS (2,3-DIBROMOPROPYL) PHOSPHATE
[19186-97-1] TRIS (TRIBROMONEOPENTYL) PHOSPHATE
[40120-74-9] Tris(1,3-dichloropropyl) phosphate
[13674-84-5] TRIS(1-CHLORO-2-PROPYL)PHOSPHATE (TCPP, TMCP)
[78-43-3] TRIS(2,3-DICHLORO-1-PROPYL)PHOSPHATE
[66108-37-0] TRIS(2,3-DICHLORO-1-PROPYL)PHOSPHATE
[115-96-8] TRIS(2-CHLOROETHYL) PHOSPHATE (TCEP)
[6145-73-9] TRIS(2-CHLOROPROPYL) PHOSPHATE

Ortho-phthalates

[85-68-7] BUTYL BENZYL PHTHALATE (BBP)
[117-81-7] DI(2-ETHYLHEXYL)PHTHALATE (DEHP)
[84-75-3] DI-N-HEXYLPHTHALATE (DnHP)
[117-84-0] DI-N-OCTYL PHTHALATE (DNOP)
[131-18-0] DI-N-PENTYL PHTHALATE (DNPP)
[68515-42-4] Dialkyl(C7-11-branched and linear) Phthalate (DHNUP)
[84-74-2] DIBUTYL PHTHALATE (DBP)
[84-61-7] Dicyclohexyl phthalate
[84-66-2] DIETHYL PHTHALATE (DEP)
[84-69-5] DIISOBUTYL PHTHALATE (DIBP)
[26761-40-0] DIISODECYL PHTHALATE (DIDP)
[68515-49-1] DIISODECYL PHTHALATE (DIDP)
[71888-89-6] DIISOHEPTYL PHTHALATE (DIHP)
[146-50-9] DIISOHEXYL PHTHALATE
[71850-09-4] DIISOHEXYL PHTHALATE
[68515-48-0] Diisononyl phthalate (DINP-1, mixture of isomers as manufactured)
[28553-12-0] Diisononyl phthalate (DINP-2 or DINP-3, mixture of isomers as manufactured)
[27554-26-3] DIISOOCTYL PHTHALATE (DIOP)
[96507-86-7] DIISOUNDECYL PHTHALATE (DIUP)
[117-82-8] Dimethoxyethyl phthalate (DEMP)
[131-11-3] DIMETHYL PHTHALATE (DMP)
[131-16-8] DIPROPYL PHTHALATE (DPP)
[53306-54-0] DIPROPYLHEPTYL PHTHALATE (DPHP)
[119-06-2] DITRIDECYL PHTHALATE (DTDP/DITP)
[3648-20-2] DIUNDECYL PHTHALATE (DUP)
[16883-83-3] Texanol benyzl phthalate
[4782-29-0] Tributyltin phthalate
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