HEALTHY BUILDING NETWORK

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TO: State of California, Department of Toxic Substances Control
RE: Proposal to List Spray Polyurethane Foam Systems with Unreacted Methylene Diphenyl Diisocyanates as a Priority Product (Document ID: 11831)
FR: Tom Lent, Policy Director, Healthy Building Network
DT: June 6, 2017
Submitted online via CalSAFER

The Healthy Building Network is pleased to submit comments to the California Department of Toxic Substances Control in support of the Listing of Spray Polyurethane Foam (SPF) Systems With Unreacted Methylene Diphenyl Diisocyanates (MDI) as a Priority Product.

The Healthy Building Network is a non-profit organization that researches the contents and health impacts of building materials and encourages the use of inherently safer materials. Our comments in this letter are in support of the proposed listing of SPF systems with unreacted MDI as a Priority Product.

In our research of isocyanates in SPF, we find that the curing of SPF is poorly understood and poorly controlled and hence highly likely to lead to exposures for workers and occupants alike with serious health effects, including potentially to unborn children.

We further find that the use of SPF in buildings is unnecessary. While there are few direct chemical alternatives to the isocyanate formulation in SPF, there are many technologies already on the market that accomplish the physical functions provided by SPF, plus some promising new emerging technologies that could add to the available options.

The comments and evidence supporting our findings are drawn largely from HBN's Dec. 2013 report, *Full Disclosure Required: A Strategy to Prevent Asthma*,[1] supplemented by the research we undertook in support of "Flame Retardant Alternatives for Hexabromocyclododecane (HBCD)"[2] our Pharos Project Building Product Library,[3] and our work on a forthcoming guide to insulation and sealants developed in a collaboration led by the Natural Resources Defense Council.

The State of California and the US EPA have made clear that unreacted isocyanates in spray polyurethane foam pose a serious occupational safety problem that is not easily resolved with protective measures. This type of chemistry is challenging to bring reliably and safely to completion without serious exposure problems in the controlled environment of the factory that have resulted in widespread bronchial problems and occasionally death. Bringing SPF manufacture into people's homes, schools, offices and other buildings, where working environments are far less regulated than factories, increases the likelihood that workers and occupants will be exposed to hazardous levels of unreacted components during and after installation.

Isocyanates have been the subject of intensive federal government scrutiny in recent years:

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[1] Lott, Sarah and Jim Vallette, "Full Disclosure Required: A Strategy to Prevent Asthma", Healthy Building Network December 2013 http://www.healthybuilding.net/reports/asthmagens/HBN_Report_Full_Disclosure_Asthma.pdf
[2] US Environmental Protection Agency, Design for the Environment "Flame Retardant Alternatives for Hexabromocyclododecane (HBCD)".June 2014 http://www.epa.gov/dfe/pubs/projects/hbcd/about.htm
[3] Pharos Project, Healthy Building Network, online tool. www.pharosproject.net

- The Environmental Protection Agency (EPA) is researching “source issues of spray polyurethane foams (SPF) manufactured on site.”[4]

- In June 2013, the Occupational Safety and Health Association (OSHA) initiated a National Emphasis Program to identify and reduce or eliminate the incidence of adverse health effects associated with occupational exposure to isocyanates.[5]

OSHA identifies isocyanates as respiratory, eye, and gastrointestinal irritants. “Hypersensitivity pneumonitis (inflammation in the lungs caused by exposure to an allergen)” has been reported in workers exposed to isocyanates, with symptoms experienced months or even years after exposure ends, according to the agency. ”Deaths have occurred due to both asthma and hypersensitivity pneumonitis from isocyanate exposure,” according to the agency.[6]

Isocyanate exposures may occur through inhalation or touch. According to OSHA, “Studies indicate that dermal exposure is a significant cause of respiratory sensitization. Thus, workers with skin contact to isocyanates may develop sensitivity, resulting in asthma attacks with subsequent exposures.” Isocyanates are also allergic sensitizers, sometimes leading to “cross-sensitization” where exposure to one isocyanate leads to the development of an allergy to another isocyanate.[7]

Curing time and completeness

The SPF industry has provided reassurances that field applied SPF products cure rapidly and completely. However, we have found no industry or government source that reliably documents how much time is needed until occupants can safely return to a building in which polyurethane insulation or adhesives have been installed.

The National Institute for Occupational Safety and Health (NIOSH) requested field data to help answer this essential question in 2012.

An ASTM committee opened a work item in 2013 to develop “a new test method for estimating chemical emissions from SPF insulation.” The committee’s scoping document notes that “Currently, there are no standardized test methods that adequately address measuring the chemical emissions of SPF insulation products.” The group has not completed its work on developing this test.[8]

In 2017, the same ASTM committee formed another work group related to SPF, this time specifically to develop better tests for isocyanate emissions. It suggests that existing procedures may significantly underreport these releases, stating, “Commonly used emission testing protocols (e.g. micro chamber, FLEC, conventional small scale chamber) have been found to be problematic for measuring MDI emissions due to adsorption to the

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[4] “Minutes of the Webinar/Meeting for 13-February-2013,” *Federal Interagency Committee on Indoor Air Quality*, Accessed February 13, 2013, www.epa.gov/iaq/ciaq/02_13_13meeting_minutes.pdf.

[5] “OSHA announces new National Emphasis Program for occupational exposure to isocyanates,” *Office of Communications, Occupational Safety & Health Administration,* Accessed June 25, 2013, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=NEWS_RELEASES&p_id=24273

[6] Occupational Safety and Health Administration, “National Emphasis Program - Occupational Exposure to Isocyanates,” *OSHA Instruction CPL 03-00-017,* Last updated June 20, 2013, https://www.osha.gov/OshDoc/Directive_pdf/CPL_03-00-017.pdf. (OSHA 2013)

[7] OSHA 2013.

[8] http://www.astm.org/database.cart/workitems/wk40293.htm There appear to be several standards currently being developed. The only standard that is active is "Standard Practice for Spraying, Sampling, Packaging, and Test Specimen Preparation of SPF Insulation for Testing of Emissions Using Environmental Chambers." Access to new standards is also at: https://www.astm.org/COMMIT/SUBCOMMIT/D2205.htm

chamber walls, resulting in significant bias."[9]

The amount of time it takes to complete the chemical reactions in polyurethane systems, called the "cure rate," appears to be determined by the amine catalysts used in the "B-side" of the two part system. Varying types and amounts of amine catalysts used in a given SPF formulation make predicting cure times difficult. This makes projecting safe re-entry time a guessing game.[10]

David A. Marlow, a NIOSH industrial hygiene engineer, says his agency is trying to determine the "actual amount of time before the area is void of harmful levels of vapors. The idea that the area needs to be clear for 24 hours is anecdotal and has no scientific underpinning."[11]

A recent case report may represent the tip of the iceberg of residential exposures to isocyanates. A couple had SPF installed in the attic of their home. An array of asthma-related symptoms started immediately upon their return home after evacuating for the installation.

The couple's doctors reported, "The SPF used in our patients' home was a two-component SPF system (Sealection® 500; Dimilec USA, LLC, Arlington, TX) that contained polymeric diphenylmethane diisocyanate (MDI) (50% to 60%), 4,4'-MDI (35% to 45%), and 2,4'-MDI (1% to 5%) in side A. Both patients were diagnosed with asthma or reactive airway dysfunction syndrome induced by exposure to isocyanates and were treated with bronchodilators and inhaled steroids.... *Our patients were told to return 4 hours after the application was completed, and thus were likely exposed to high concentrations of MDI*."[12] (emphasis added). This is only one of many anecdotal reports of occupant impacts.

An EPA presentation in 2013 notes that "SPF Insulation component chemicals can migrate to other areas of the building" and that isocyanates "can trigger severe or fatal asthma attacks in sensitized persons upon further exposure, even at very low levels."[13]

A current suit against the world's largest isocyanates producers charges that the defendants knew (and have failed to disclose) "that a very small quantity of TDI, MDI, or PMDI on the skin - as little as one drop or 50 microliters - could cause permanent respiratory injury in humans." Each of the defendants, they charge, " denied as recently as February 2013 that dermal exposures are even 'thought to contribute to the development of isocyanate asthma.'"[14]

In comments submitted to EPA in 2014, the American Chemistry Council (ACC, the industry's trade association) failed to answer questions about curing rates and safe re-occupancy times.

"There are various ways to define when SPF insulation is fully cured," the ACC wrote to EPA. "Some look at certain physical properties of the installed SPF and believe when these have been achieved the insulation is

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[9] https://www.astm.org/DATABASE.CART/WORKITEMS/WK58355.htm

[10] Spence, Mark, "The Current MDI Industrial Hygiene Data on Spray Foam," Presentation at the American Chemistry Council Polyurethanes Technical Conference, National Harbor, MD, October 5-7, 2009.

[11] David A. Marlow, "Help Wanted: Spray Polyurethane Foam Insulation Research," NIOSH Science Blog, March 21, 2012 (1:55 p.m.), http://blogs.cdc.gov/niosh-science-blog/2012/03/21/sprayfoam/ .

[12] Tuang, Wayne and Yuh-Chin Yuh, "Asthma Induced by Exposure to Spray Polyurethane Foam Insulation in a Home," *Journal of Occupational and Environmental Medicine* 54, no. 3 (2012): 272-273. (Tuang and Yuh 2012)

[13] Anjali Lamba, "Spray Polyurethane Foam (SPF): EPA Considerations," Office of Pollution Prevention and Toxics, US EPA, 2013

[14] United States of America, Ex rel. Kasowitz, Benson, Torres & Friedman LLP, Plaintiff, v. BASF Corporation; Bayer Material Science, LLC, f/k/a Miles, Inc. f/k/a Mobay Chemical Company; The Dow Chemical Company; and Huntsman International LLC, f/k/a Imperial Chemical Industries PLC and f/k/a ICI Americas, Inc., Case No. 4:15-cv-02262-DMR (n.d.)., pages 4 and 33. This case has been transferred to US District Court in the District of Columbia (Case No. 1:16-cv-02269-RMC).

cured (the SPF is tack-free within several minutes of application, and may achieve its desired physical properties within 24 hours of application). Others may look at the amount of unreacted isocyanate (which appears to be below the limit of detection on the surface of the foam within 15 minutes and below the limit of detection in the air within 2 hours after application). Additional discussion may be needed in this area to agree on an exact definition of cured SPF.... Also, while curing time and re-occupancy time may be related, they are not necessarily one in the same."[15]

The Occupational Health Clinical Centers in New York has observed that "possible improper application of the foam; inadequate respiratory protection and ventilation for workers; spray foaming when the building was occupied; re-occupying too soon (estimated at 23-72 hours but there is little evidence to support current recommendations); and lack of warning about the health hazards of spray foam insulation for the home owners and workers."[16]

Neonatal exposures

Into this uncertainty enters another troubling hypothesis: that neonatal exposures to isocyanates in polyurethane products may cause asthma. In 2003, a research team looked for isocyanates in polyurethane medical materials used in a New Zealand neonatal unit, found that the "opportunities for dermal exposures to polyurethane products and isocyanates are numerous." They noted that isocyanates "are notable because of their capacity to elicit respiratory response at extremely low levels of exposure," and that the skin of young children is "thin, delicate, and susceptible to alterations in integrity... "Thus, we theorize that neonatal exposure to polyurethane products containing isocyanate residue may contribute to an immune system imbalance and predispose children to asthma development."[17]

Some animal studies have also found associations between prenatal exposure to MDI aerosols and developmental toxicity phenomena[18]

Exposure pathways may begin even sooner than early childhood. The new field of epigenetics is exploring the roles environmental exposures to certain chemicals may have in gene transcription. In a study of mice, the offspring of mothers exposed to TDI before becoming pregnant had an increased susceptibility to asthma.[19]

Isocyanates are low vapor pressure substances and are not assessed in IAQ testing protocols. As a result, the California DPH VOC tests that are the backbone of IAQ certifications provide no protection for users of spray foam insulation systems from unsafe level of isocyanates.

In conclusion, we find that the curing of SPF is poorly understood and poorly controlled and hence highly likely to lead to exposures for workers and occupants alike with serious health effects, including potentially to unborn children.

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[15] American Chemistry Council Diisocyanates Panel, "RE: Toluene Diisocyanate (TDI) And Related Compounds Action Plan, RIN 2070-ZA15, April 2011," February 26, 2013, http://www.regulations.gov/contentStreamer?objectId=090000648120ceac&disposition=attachment&contentType=pdf

[16] Lax, Michael, Greg Siwinski, and Dorothy Wigmore. "Comments on Green Seal GS-54 Proposed Standard." Occupational Health Clinical Centers, March 2016.; "Attachment for Comments about SG-54: OHCC Experiences with Isocyanate Foam Insulation Episodes as of December, 2015," March 2016.

[17] Krone, Cheryl, Tom Klingner, and John Ely, "Polyurethanes and childhood asthma," Medical Science Monitor, 2003; 9(12): HY39-43.

[18] A. O. Gamer, J. Hellwig, J. E. Doe, R. W. Tyl; Prenatal Toxicity of Inhaled Polymeric Methylenediphenyl Diisocyanate (MDI) Aerosols in Pregnant Wistar Rats. *Toxicol Sci* 2000; 54 (2): 431-440. doi: 10.1093/toxsci/54.2.431 https://academic.oup.com/toxsci/article/54/2/431/1654159/Prenatal-Toxicity-of-Inhaled-Polymeric

[19] Lim et al. 2007.

Alternatives

There are numerous alternative technologies that can accomplish the functions of SPF. SPF is used in building construction projects to accomplish one or both of two functions: air sealing and thermal insulation.

SPF is a relatively new addition to the arsenal of tools used by contractors to air seal houses. A wide range of caulking materials have been used for decades, including silicones, latexes, acrylics and clay rope. Air sealing tapes made of polyethylene, polypropylene, butyl acrylate, Tyvek and other adhesives and polyurethane gaskets are more recent and equally effective technologies.[20] Tapes and gaskets used in conjunction with house wrap can be particularly effective. Many of these alternatives do not react or dry on site and typically contain less hazardous content than SPF. These solutions have a range of human health and environmental impacts which also should be taken into account in any alternatives assessment. See the Healthy Building Network's Pharos database for evaluations of these substances' impacts.[21]

On the insulation side there are many options. Open vertical cavities can be filled with blanket insulations made of fiberglass, rockwool (mineral fibers), recycled cotton, wool, silica aerogels and various polymer fibers or sprayed insulations made of cellulose or fiberglass. Rigid board foam insulations made from EPS, XPS, polyisocyanates, perlite, fiberglass, rockwool, calcined coke (carbon foam), phenolics and from sand, limestone and soda ash (foamglas) can also be used in these applications. A new mycelium based rigid board insulation product emerging on the market shows great promise to be far and away the least toxic board insulation product yet.[22] Closed cavities and horizontal open cavities and vertical open cavities with a restraining mesh can use loosefill or blown cellulose or fiberglass or beads of aerogel or perlite. Again, HBN's Pharos database provides product content and health impact information about many of these potential alternatives.

Some of these insulation alternatives now are beginning to be packaged with air sealing technologies as a system approach, such as a latex sealant and fiberglass batt marketed by Knauf under the EcoSeal label. More content disclosure is needed on these systems to insure avoidance of related chemicals of concern. For example, we are still investigating an MSDS reference to hydrogen bromide released from EcoSeal during combustion that may indicate the presence of brominated flame retardants.

Cementitious foam made from magnesium oxide is the closest technology on the market to match the approach of SPF. Unlike SPF it also does not require hazardous flame retardants. In fact many of these alternative insulations and air sealants are far less hazardous than SPF.

Another technology that is near market ready that uses the same approach as SPF (insulating and adhering to the walls to seal air) is the previously mentioned mycelium based insulation product now also being developed in a grow-in-place application by the Ecovative company in New York.

Alternative technologies and approaches abound for air sealing and insulation. It is highly justified to go forward with the alternatives assessment process for isocyanates in SPF. Eliminating this exposure could have a tremendous benefit to many thousands of workers and occupants without a negative impact on important energy considerations in the building.

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[20] Holladay, Martin "Air-Sealing Tapes and Gaskets" Green Building Advisor, March 8, 2013
http://www.greenbuildingadvisor.com/blogs/dept/musings/air-sealing-tapes-and-gaskets

[21] www.pharosproject.net

[22] Lott, Sarah, Looking Forward to 2014: Growing the Built Environment, Healthy Building Network
http://www.pharosproject.net/blog/detail/id/178/growing-the-built-environment

Hierarchy of controls

Given the challenges in ensuring use of PPE by workers, the high uncertainties about safe re-entry times, the major risks of serious health effect to both workers and unprotected occupants and their children in the womb, and the availability of alternative technologies, it is clearly time to invoke the hierarchy of controls for workplace safety and prioritize elimination and substitution.[23] The controls currently recommended by the SPF industry - PPE, administrative controls (such as policies and training), and engineering controls (like ventilation) - are unlikely to be consistently and adequately applied in the field and hence are clearly inadequate to the task."[24] The hazards in the two component systems that are available for general consumer purchase raise even and the greater danger here since installers may not be trained or at all aware of the precautions necessary

Tools for analysis

The Pharos Project developed by the Healthy Building Network provides several online tools that may be useful to DTSC in the discovery and assessment of alternative products and chemistries.

The Pharos Building Product Library houses Common Product profiles that catalog and assess the most common content of building products and associates those contents with potential health hazards. It currently includes about 140 Common Product profiles, including an extensive catalog of insulation and air sealing products. See below for a list of relevant Common Product profiles and links to access them.

The Pharos Chemical and Material Library provides associations for over 46,000 substances and 70 up to date authoritative hazard lists and restricted substance lists. It also provides process chemistry information on a subset of those substances.

Thank you for the opportunity to provide this testimony. We applaud the important work of the DTSC on this critical issue and are pleased to offer our experience and assessment tools to forward the effort.

Sincerely,

Attachment: Relevant Common Product profiles available in Pharos Project Building Product Library:

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[23] "Hierarchy of Controls." *NIOSH Workplace Safety & Health Topics*, July 18, 2016. https://www.cdc.gov/niosh/topics/hierarchy/.

[24] Guo, Dennis Fengmao, Lynn Nakayama Wong, Valerie Hanley, Julia Gress, and Jesse Schnell. "Summary of Technical Information and Scientific Conclusions for Designating Spray Polyurethane Foam Systems with Unreacted Methylene Diphenyl Diisocyanates as a Priority Product." Safer Products and Workplaces Program. Department of Toxic Substances Control - California Environmental Protection Agency, February 2017. http://www.dtsc.ca.gov/SCP/upload/SPF-Systems-Summary-of-Technical-Information.pdf.

Relevant Common Product profiles available in Pharos Project Building Product Library

Insulation

Common Product: Expanded Cork Board Insulation - https://pharosproject.net/material/show/2085578
Common Product: Unbonded Blow-in Fiber Glass Insulation - https://pharosproject.net/material/show/2086034
Common Product: Spray-applied Fiber Glass Insulation - http://pharosproject.net/material/show/2086293
Common Product: Unfaced Fiber Glass Batt Insulation - https://pharosproject.net/material/show/2080060
Common Product: Kraft-faced Fiber Glass Batt Insulation - https://pharosproject.net/material/show/2085494
Common Product: FSK-faced Fiber Glass Duct Wrap - http://pharosproject.net/material/show/2086301
Common Product: Blown-in Cellulose Insulation - https://pharosproject.net/material/show/2085584
Common Product: Unfaced Cellulose/Cotton Batt Insulation - https://pharosproject.net/material/show/2086071
Common Product: Wet-Blown Cellulose Insulation - https://pharosproject.net/material/show/2085582
Common Product: Mineral Fiber Batt Insulation - https://pharosproject.net/material/show/2085502
Common Product: Mineral Wool Board Insulation - http://pharosproject.net/material/show/2086296
Common Product: Polyisocyanurate Wall Insulation Board - http://pharosproject.net/material/show/2085579
Common Product: EPS Insulation (Expanded Polystyrene) - http://pharosproject.net/material/show/2079007
Common Product: XPS Insulation (Extruded Polystyrene) - http://pharosproject.net/material/show/2078867
Common Product: Spray Foam Insulation - http://pharosproject.net/material/show/2079008

Sealants

Common Product: Non-Combustible Sodium Silicate Caulk - http://pharosproject.net/material/show/2086267
Common Product: Flame Retardant Polyurethane Foam Window/Door Seal - http://pharosproject.net/material/show/2078859
Common Product: Acrylic Latex Sealant - http://pharosproject.net/material/show/2086268
Common Product: Siliconized Latex Sealant - http://pharosproject.net/material/show/2086269
Common Product: Intumescent Firestop Sealant - http://pharosproject.net/material/show/2085504
Common Product: One-Component Silicone Sealant - http://pharosproject.net/material/show/2086291
Common Product: Silyl-terminated Polyether Sealant - http://pharosproject.net/material/show/2086299
Common Product: Single Component Spray Polyurethane Foam - http://pharosproject.net/material/show/2086088
Common Product: Fireblock Single Component Spray Polyurethane Foam - http://pharosproject.net/material/show/2086089
Common Product: Single Component Polyurethane Sealant - http://pharosproject.net/material/show/2086292