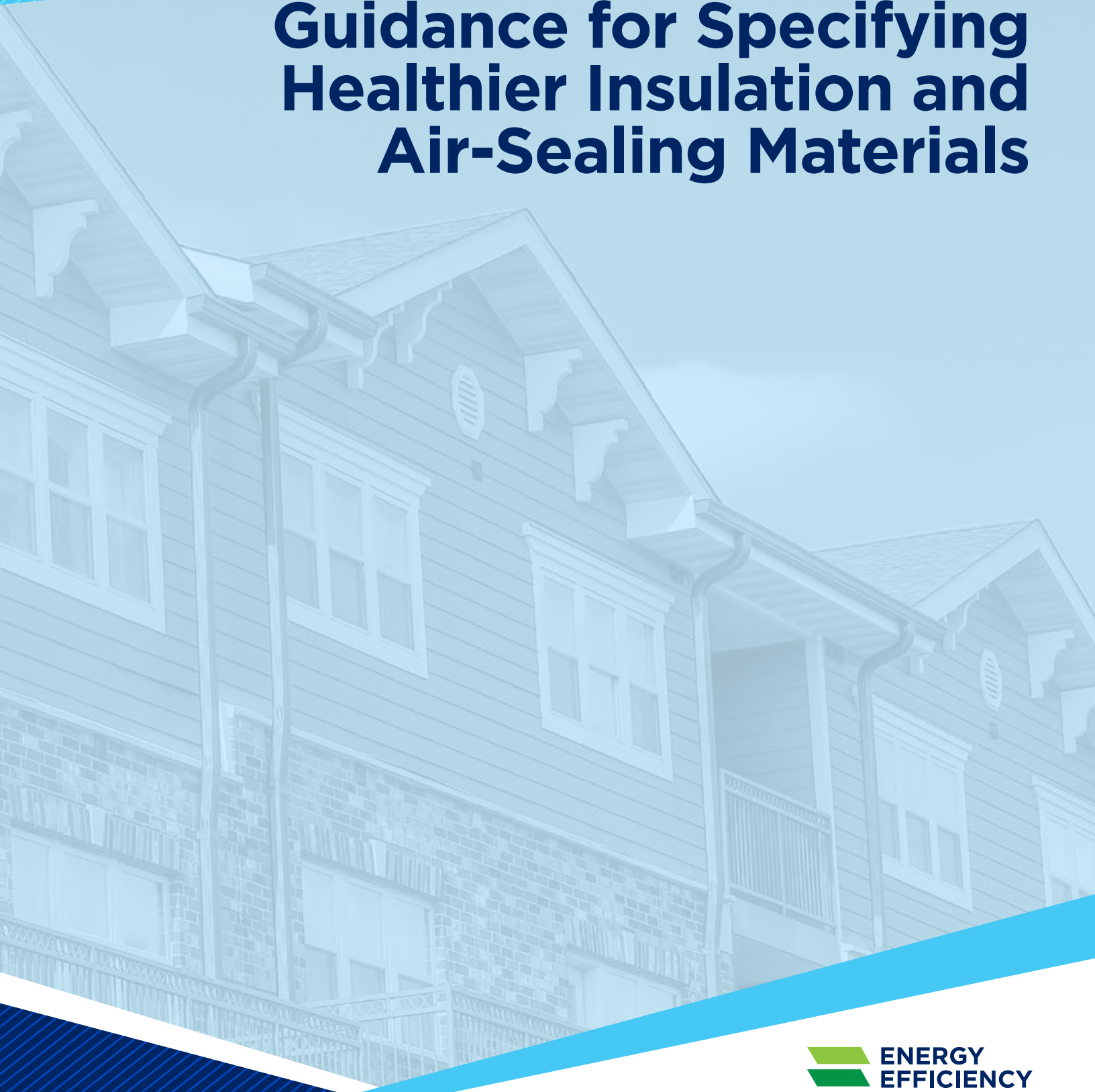


Guidance for Specifying Healthier Insulation and Air-Sealing Materials



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Introduction

This document is a supplement to the report, *Making Affordable Multifamily Housing More Energy Efficient: A Guide to Healthier Upgrade Materials*. It provides information that can be used to evaluate and select healthier products and to write project specifications that incorporate healthier insulation and air-sealing materials. See the full report for information about why it is important to be aware of the use of hazardous chemicals in building products, references to the scientific literature on health impacts of building upgrades and materials, the methodology behind our recommendations, and detailed research into the common content of various insulation and air-sealing materials. General ranking tables from the report are included in the Appendix of this document for reference.

Background

There is no question that investing in energy-efficiency upgrades has the potential to deliver substantial financial, environmental, and health benefits to building owners and residents. Robust evidence demonstrates that interventions such as weatherization and other energy-efficiency upgrades, particularly in poor-quality housing, can significantly improve residents' health by reducing thermal stress, asthma triggers, and energy costs. However, the adverse health impacts produced by chemical emissions from some of the materials commonly used for these upgrades is far less understood and addressed.¹ These materials often contain persistent, bioaccumulative, or toxic chemicals and either show evidence or are suspected of being asthmagens, reproductive or developmental toxicants, endocrine disruptors, or carcinogens.^{2,3} These chemicals of concern not only endanger a building's residents, but also can pose threats over the materials' life cycles to the workers who manufacture, install, and dispose of these products, to the communities adjacent to these facilities, and to the broader environment.⁴ Many of these populations are some of our most vulnerable and have limited access to health care.

Because insulating and air-sealing in upgrade projects can provide significant long-term savings

but also can introduce many chemicals of concern, our research focuses on the materials used for these purposes—on their chemical composition and potential health impacts, as well as on their general performance and relative cost.⁵ Some common types of chemicals found in insulation and air-sealing products that are of the greatest concern are halogenated flame retardants, formaldehyde-based binders, isocyanates, and phthalate plasticizers. The health effects of these chemicals include reproductive and developmental impacts, carcinogenicity, and the ability to cause or exacerbate asthma. Moreover, some of these chemicals persist and accumulate in the environment and in people and thus can have broad-reaching, long-term impacts.

How to use this document

This document provides information that can be used to evaluate, select, and write specifications for products that incorporate healthier insulation and air-sealing materials for energy-efficiency upgrade projects. The information is meant to provide guidance to a purchaser or specifier and should be modified as needed to meet specific project needs. Such modifications may be, for example, language adjustment or inclusion of performance requirements, such as R-value. Some product recommendations may not meet code requirements for all geographic areas or building types. Check that the specified products meet the requirements of your project. Keep in mind that the recommendations and product rankings in this guide are based on the best available information at the time the research was conducted. Some new, promising materials could not be reviewed because of lack of information or lack of availability. For more details, please see “Materials Excluded From Recommendations” in the *Guide to Healthier Upgrade Materials*.

Guidance is provided here in several formats:

1. General summary guidance on healthier insulation and air-sealing materials
2. Tiered recommendations by product category
3. Sample specification language inserts for use in Section 018113 Sustainable Design Requirements and for submittals in insulation and sealant technical sections

The product information in formats 1 and 2 is intended to be used to make decisions about which insulation and air-sealing materials to use or specify. This information, along with the sample submittal language for technical sections in format 3, can be used in the product sections for the relevant MasterFormat® divisions of project specifications.⁶ The Sustainable Design Requirements sample language can be used in conjunction with this information to ensure that the healthier products are used. The recommended product types in formats 1 and 2 are usually free of the banned substances listed in the Sustainable Design Requirements (thereby meeting those requirements). In some cases, recommended product types are known to occasionally contain a banned substance. In these cases, requirements to avoid those substances are specifically called out in formats 1 and 2.

Recommendations by product category are broken into three tiers. “Healthiest Choice” specifications are considered best-in-class based on a comparison of health profiles of products available at the time of analysis and should be given top priority for use. When use of a “Healthiest Choice” product is not possible, the “Preferred Alternate” tier represents the next best option from a health perspective and can be incorporated into specifications directly or managed as a list of acceptable substitutions. In some cases, a “Lesser Alternate” option is also provided. “Lesser Alternate” products are less desirable from a health perspective, but still represent an improvement over some other insulation or air-sealing products. Efforts should be made to use “Healthiest Choice” or “Preferred Alternate” materials whenever possible, but the use of a “Lesser Alternate” still provides an improvement in health profile over other product types that are not recommended.

When our recommendations call for avoidance of specific chemicals or chemical groups or compliance with an emission specification or volatile organic

compound (VOC) content requirement, verify that the specific product you want to use meets these requirements.

- Specific chemicals can be avoided by checking product literature for statements such as “formaldehyde-free” or “phthalate-free.”
- For products that have transparency documents like Health Product Declarations (HPDs) and Declare Labels, check the disclosed content against the recommendations. The Glossary in this guide provides examples of some common chemicals of concern and links to more complete lists in the Chemical Hazard Data Commons.
- Test results for VOC content and emissions are often provided in product literature and can be checked against the healthier material recommendations.

If you are unable to use any of the recommended products or alternatives, we recommend you review the ranking tables in Appendix C for additional information in order to choose the best possible materials for your applications. There are many considerations when making product choices. The tables provide additional information on performance, relative cost, installation considerations, and transparency. If a jump to the top-rated products is too difficult or impossible, incremental improvements from lower- to higher-ranked products can still significantly reduce potential exposures to chemicals of concern. Any step up the ladder of healthier materials can make a difference. In addition, new products are coming on the market all the time and the products that are currently available are continually changing. These recommendations are based on available information as of 2017. As new information becomes available, Healthy Building Network will update the product-type rankings for [insulation](#) or [sealants](#) on its [HomeFree](#) site.

1. Summary Guidance

This section summarizes the recommendations for choosing healthier insulation and air-sealing products presented in the *Guide to Healthier Upgrade Materials*. Some product recommendations may not meet code requirements for all geographic areas or building types. Check that specified products meet the performance and code requirements of your project.

In general, ask for and prefer products that have a public [Health Product Declaration \(HPD\)](#). HPD is the building industry’s collaborative, user-designed open standard for disclosure of product contents and associated health hazards. Full disclosure of product contents and associated hazards allows for more informed choices and helps prevent regrettable substitutions. Prefer products with public HPDs that have all contents characterized, screened, and identified to at least 1,000 ppm. (100 ppm is preferred).

Insulation

- **Our top-ranked insulation is expanded cork board** because it is free of hazardous content, but it is expensive and may not be widely available, so advanced planning may be required to use it.
- **Prefer fiber glass and cellulose insulation or formaldehyde-free mineral wool.** Not all products toward the top of the ranking are expensive or limited in availability. Commonly used fiber glass and cellulose insulations are some of the highest ranked from a health perspective, and have the lowest installed cost for any given R-value. While the R-value per inch is higher for many foam products, the R-value per dollar is not. For applications with few space restrictions, the same insulative performance can be achieved with these healthier materials, and the cost savings per R-value on the insulation may allow for separate air-sealing measures, if needed.
- **Avoid products with formaldehyde-based binders.** Formaldehyde is a carcinogen and respiratory hazard, even at low levels. If products

that contain a formaldehyde-based binder must be used, make sure that they meet the California Department of Public Health (CDPH) Standard Method for Testing and Evaluation of VOC Emissions for residential scenarios.⁷ (See Appendix A for examples of certifications that use this method.)

- If board insulation is required, **prefer rigid mineral wool insulation** that meets the CDPH Standard Method for the Testing and Evaluation of VOC Emissions or consider upgrading to cork.
- **Avoid foam insulation, whether board or spray-applied**, whenever possible. Foam insulations commonly contain highly toxic flame retardants, and spray foam contains asthma-causing isocyanates. If foam insulation must be used, avoid products that are reacted on site, such as spray foam. Also, look for products that do not use halogenated flame retardants. In situations where both air-sealing and insulation properties are desired, consider using a caulk or tape, or both, to seal gaps before installing insulation to achieve both these goals without using spray foam.
- **Use mechanical installation methods, such as fasteners**, whenever possible to avoid unnecessary use of adhesives.





Air Sealing

- **Prefer caulk-type sealants over polyurethane spray foam sealants.**⁸ Spray foam sealants have the lowest relative cost to seal a given space because of their low density, but they contain many chemicals of high concern. Some nonisocyanate (nonpolyurethane) spray foam sealants are becoming available, but because there is little or no public disclosure on their contents, we do not yet know whether they are less toxic than polyurethane spray foam sealants.
- **Prefer foam sealing products that are not reacted on site,** like an expanding polyurethane foam sealant tape or backer rod with a caulk-type sealant, for sealing large gaps where caulk sealants alone are not recommended. For still larger gaps, a piece of drywall can be used, with the edges sealed with a caulk-type sealant.
- **Avoid phthalate plasticizers.** In some categories of sealants, phthalate plasticizers are still used. Make sure the sealants you use are free of these hazardous chemicals.
- **Prefer acrylic-based sealants with very low levels of VOCs** in the absence of product disclosure. Options with ≤ 25 g/L of VOCs are available for many applications.
- **Prefer foil-backed butyl tape for HVAC sealing.** If you must use mastic, ask manufacturers for content information to avoid halogenated flame retardants, and prefer no-VOC products.
- **Avoid products that are marketed as being antimicrobial** or claim to kill germs on surfaces. They have not been shown to have a health benefit, and can have negative impacts on human health and the environment.

2. Recommendations by Product Category

Recommendations of product types by category are provided below. Try to use the “Healthiest Choice” materials. Include the selected materials for your project in the relevant MasterFormat® divisions of project specifications. Suggested submittal inserts for insulation and sealant sections are provided later in this document.⁹

Some product recommendations may not meet code requirements for all areas or building types. Check that specified products meet the performance and code requirements of your project.



BOARD INSULATION

- 1 Healthiest Choice: Expanded cork board insulation
- 2 Preferred Alternate: Mineral wool board that meets the CDPH Standard Method for the Testing and Evaluation of VOC Emissions for residential scenarios. (At the time of this research, no product was commercially available that met this criteria, however manufacturers indicated they were working on it. Customer demand can help this process along. See Appendix A for examples of certifications that use this method.)
- 3 Lesser Alternate: Polyisocyanurate free of halogenated flame retardants

BATT OR BLANKET INSULATION

- 1 Healthiest Choice: Unfaced or kraft-faced fiber glass or formaldehyde-free mineral wool batt insulation
- 2 Preferred Alternate: Cotton or cellulose batt insulation or PSK- or FSK-faced fiber glass batt insulation free of halogenated flame retardants

LOOSE-FILL OR BLOWN INSULATION

- 1 Healthiest Choice: Blown-in fiber glass insulation
- 2 Preferred Alternate: Blown-in cellulose insulation

SPRAY-APPLIED INSULATION

- 1 Healthiest Choice: Spray-applied fiber glass insulation
- 2 Preferred Alternate: Spray-applied cellulose insulation

PIPE INSULATION

- 1 Healthiest Choice: Unfaced formaldehyde-free fiber glass pipe insulation¹⁰
- 2 Preferred Alternate: Faced formaldehyde-free fiber glass pipe insulation, free of halogenated flame retardants
- 3 Lesser Alternate: Polyethylene foam pipe insulation

DUCT INSULATION

- 1 Healthiest Choice: Unfaced formaldehyde-free fiber glass duct wrap¹¹
- 2 Preferred Alternate: Faced formaldehyde-free fiber glass duct wrap, free of halogenated flame retardants

STANDARD SEALANTS FOR SMALL GAPS

- 1 Healthiest Choice: Acrylic latex or siliconized acrylic sealant with VOC content of ≤ 25 g/L⁺
- 2 Preferred Alternate: Acrylic latex or siliconized acrylic sealant. Sealants must meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1168.¹²
- 3 Lesser Alternate: Silicone sealant or phthalate-free, modified-polymer sealant. Sealants must meet the requirements of SCAQMD Rule 1168.

⁺Acrylic latex or siliconized acrylic sealant with VOC content of ≤ 25 g/L is available for some applications and would be the Healthiest Choice for these applications.

STANDARD SEALANTS FOR LARGE GAPS

- 1 Healthiest Choice: Preformed foam sealant tape or drywall and acrylic latex or siliconized acrylic sealant with VOC content of ≤ 25 g/L
- 2 Preferred Alternate: Nonisocyanate spray foam sealant with an HPD with all contents characterized, screened, and identified at 1000 ppm or lower threshold. (At the time of this research, none of these products were commercially available with an HPD. Customer demand is needed to make this available.)

FIRE-RATED OR FLAME SPREAD-RATED SEALANTS

Note: Noncombustible sodium silicate caulk is a fireblock sealant. Some acrylic latex or siliconized acrylic sealants have a flame spread rating of ≤ 25 and smoke developed index of ≤ 450 . Verify the products you choose meet code requirements for your application.

- 1 Healthiest Choice: Noncombustible sodium silicate caulk
- 2 Preferred Alternate: Acrylic latex or siliconized



acrylic sealant or intumescent acrylic latex firestop sealant with VOC content of ≤ 25 g/L

- 3 Lesser Alternate: Acrylic latex sealant, siliconized acrylic sealant, or intumescent acrylic latex firestop sealant. Sealants must meet the requirements of SCAQMD Rule 1168.

AIR-DUCT SEALANTS

- 1 Healthiest Choice: Foil-backed butyl tape with VOC content of ≤ 1 g/L
- 2 Preferred Alternate: Foil-backed butyl tape
- 3 Lesser Alternate: Wet-applied mastic sealant, free of halogenated flame retardants and alkylphenol ethoxylates (APEs). (At the time of this research, it was unclear if products free of these chemicals of concern were available. Customer demand is needed for this content information to be made available.)

3. Sample Specification Language

Sample specification language that could be inserted into the Sustainable Design Requirements section is provided below. Using this language can help ensure that healthier insulation and air-sealing products are used in your energy-efficiency upgrade project. We recommend that for each selected product, you also include the product submittal and healthy material requirements (based on the Recommendations by Product Category above and Submittal Inserts for Insulation and Sealant Technical Sections below) in the individual product category section in your specification.¹³

We also recommend that all submitted products and materials with specific banned substance, VOC content, or emission requirements be reviewed by the architect's or building owner's representative prior to approval and installation. Site inspections can also help ensure compliant materials are being used.

Note that this Sustainable Design Requirements language is only meant to apply to insulation and sealant products. The information provided here is intended to serve as a guide and should be incorporated into specification documents at the project team's discretion, and should be modified to meet the specific needs of the project. Some product recommendations may not meet code requirements for all areas or building types. Check that specified products meet the performance and code requirements of your project.

Inserts for Section 01 81 13 Sustainable Design Requirements

PART 1 - GENERAL

Insert into Summary article:

1.1 SUMMARY

- A. This section includes sustainability requirements necessary to align with the healthier product recommendations of the Healthier Affordable Building Materials project as outlined in the report, *Making Affordable Multifamily Housing More Energy Efficient: A Guide to Healthier Energy Efficiency Upgrade Materials*.

Insert into References article:

1.3 REFERENCES

- A. *Making Affordable Multifamily Housing More Energy Efficient: A Guide to Healthier Energy Efficiency Upgrade Materials*
- B. Health Product Declaration Public Repository
- C. Declare Product Database

Insert into Submittals article:

1.4 SUBMITTALS

- A. Banned Substances Submittals, General: Provide certification that materials' product data includes all components identified at 1000 ppm or lower threshold, verifying the absence of banned substances by including one of the following:

Health Product Declaration (HPD).

LBC Declare Label.

Alternative Option – provide one of the following:

Cradle to Cradle (C2C) Products Innovation Institute’s Gold or Platinum Certification or its Material Health Gold or Platinum Certification.

Certification from the manufacturer, such as a letter on the manufacturer’s letterhead, verifying that the prohibited substances are not intentional content in the finished product, or present in quantities greater than the thresholds outlined.

Insert into Products part, note that other product categories may have banned substances as well:

PART 2 - PRODUCTS

2.1 BANNED SUBSTANCES

- A.** Insulation and Sealant Products cannot contain any of the following substances as intentional content or at greater than 0.1% (1000 ppm) by weight in the product.

- B.** Thermal Protection banned substances list:
 1. Halogenated flame retardants
 2. Isocyanates

- C.** Joint Protection and Firestopping banned substances list:
 1. Halogenated flame retardants[^]
 2. Orthophthalates
 3. Isocyanates[^]

- D.** Plumbing Insulation banned substances list:
 1. Halogenated flame retardants
 2. Formaldehyde-based binders
 3. Orthophthalates

- E.** HVAC Insulation banned substances list:
 1. Halogenated flame retardants
 2. Formaldehyde-based binders

- F.** HVAC Air Distribution — duct sealant banned substances list:
 1. Halogenated flame retardants
 2. Alkylphenol ethoxylates

[^]An exception may be made for sealing gaps that are too large for caulk-type sealants and for which there is no access for installation of a prefoamed sealant. In these cases only, one-part spray foam (which commonly contains isocyanates and halogenated flame retardants) may be used.

Submittal Inserts for Insulation and Sealant Technical Sections

The sample specification language above is intended to apply for insulation and sealants. Technical sections that may be affected include:

- 07 20 00 Thermal Protection
- 07 84 00 Firestopping
- 07 90 00 Joint Protection
- 22 07 00 Plumbing Insulation
- 23 07 00 HVAC Insulation
- 23 30 00 HVAC Air Distribution

The language below could be inserted into the appropriate technical sections along with information on specific product types from the Recommendations by Product Category section of this document.

Insert into insulation submittals article:

Insulation Sustainable Design Submittals:

- A. Chemical Content Disclosure Documents: Provide certification that insulation materials' product data includes all components identified at 1000 ppm or lower threshold, verifying the absence of banned substances by including one of the following:
 - Health Product Declaration (HPD).
 - LBC Declare Label.
 - Alternative Option – provide one of the following:
 - Cradle to Cradle (C2C) Products Innovation Institute's Gold or Platinum Certification or its Material Health Gold or Platinum Certification.
 - Certification from the manufacturer, such as a letter on the manufacturer's letterhead, verifying that the prohibited substances are not intentional content in the finished product, or present in quantities greater than the thresholds outlined.
- B. Laboratory Test Reports for Low-Emitting Materials: Where specified for insulation products, provide documentation indicating that products comply with the testing and product requirements of the California Department of Public Health (CDPH), "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.2."

Insert into sealant submittals article:

Sealant Sustainable Design Submittals:

- A. Chemical Content Disclosure Documents: Provide certification that sealant materials' product data includes all components identified at 1000 ppm or lower threshold, verifying the absence of banned substances by including one of the following:
 - Health Product Declaration (HPD).
 - LBC Declare Label.

Alternative Option – provide one of the following:

Cradle to Cradle (C2C) Products Innovation Institute’s Gold or Platinum Certification or its Material Health Gold or Platinum Certification.

Certification from the manufacturer, such as a letter on the manufacturer’s letterhead, verifying that the prohibited substances are not intentional content in the finished product, or present in quantities greater than the thresholds outlined.

- B.** Certification of VOC Content for Sealant Materials: Provide certification verifying satisfaction of specified VOC content requirements by providing one of the following:

Health Product Declaration (HPD) with VOC content disclosure.

LBC Declare Label with VOC content disclosure.

Alternative Option – When the requirement is compliance with South Coast Air Quality Management District (SCAQMD) Rule 1168, provide manufacturers’ product literature verifying that the VOC content complies with SCAQMD Rule 1168.

Appendix A: Referenced Standards and Certifications

A list of standards and certifications referenced in this document follows.

Standards:

- South Coast Air Quality Management District (SCAQMD) Rule 1168, Amended October 6, 2017
- California Department of Public Health (CDPH) “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.2.”

Certifications:

- The following certifications have options for the residential scenario of California Department of Public Health (CDPH) “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.2.”
 - Berkeley Analytical ClearChem Self-Declaration
 - SCS Global Services Indoor Advantage Gold
 - UL Environment GreenGuard Gold

Appendix B: Glossary

This appendix provides definitions for some terms and types of chemicals referenced in the specification guidance. Examples of specific chemicals in the banned chemical groups listed earlier in this document are included below. This is not a comprehensive list but is meant to provide representative examples.

Alkylphenol ethoxylates

Alkylphenol ethoxylates (APEs), including nonylphenol ethoxylates (NPEs) and octylphenol ethoxylates (OPEs), are chemicals of concern commonly used as surfactants. NPEs, OPEs, and their break down products have been shown to have endocrine-disrupting properties.

Examples of alkylphenol ethoxylates include:

Nonylphenol polyethylene glycol ether (CAS 27177-08-8)

Nonylphenol, branched, ethoxylated (CAS 68412-54-4)

Octylphenoxy polyethoxyethanol (CAS 9036-19-5)

For a more complete and up-to-date list of alkylphenol ethoxylates, see the Chemical Hazard Data Commons: <https://commons.healthymaterials.net/chemicals/2089943>.

Antimicrobial/Biocides

Biocides are usually necessary in water-based, wet-applied products to protect them from spoilage prior to installation or compromised performance once installed, or both. These preservatives, however, are considered to be pesticides and therefore carry health and environmental hazards. Some preservatives have higher associated hazards than others. Lower hazard preservatives should be substituted when possible.

Be aware that manufacturers market some products as “antimicrobial,” or claim that the products kill microbes on their surfaces. These claims implying a human health benefit can be misleading. Such products may contain biocides that are not necessary for product preservation or performance, have not been shown to have a health benefit, and can in fact have many negative impacts on human health and the environment. It is not common for insulation products to be marketed as “antimicrobial”, but some sealants may be marketed in this manner and should be avoided.

For more information, see Healthy Building Network’s, *Healthy Environments: Understanding Antimicrobial Ingredients in Building Materials* at: <https://healthybuilding.net/reports/4-healthy-environments-understanding-antimicrobial-ingredients-in-building-materials>.

CASRN or CAS

A Chemical Abstracts Service Registry Number is assigned by the Chemical Abstracts Service of the American Chemical Society to uniquely identify chemical elements, compounds, and other materials and mixtures. Frequently used in Safety Data Sheets, such an identifier is also known as a “CAS number.”

Chemical Hazard Data Commons

The Chemical Hazard Data Commons is a collaborative tool to help identify substances that are hazardous to human and environmental health and find safer alternatives. The Data Commons provides open access to chemical hazard information compiled from human and environmental hazard lists published by governmental and professional scientific bodies and includes GreenScreen Benchmark and List Translator scores. Collaborative tools include a library of scientific chemical hazard and exposure literature and open forum discussions about critical hazard assessment issues. The Data Commons is developed and managed by the Healthy Building Network.

For more information, see: <https://commons.healthymaterials.net>.

Declare Label

Declare is a product database including information about where a product comes from, what it is made of, and where it goes at the end of life. The Declare Label is presented in a nutrition label format and includes a list of contents as well as VOC information. It serves as a certification as to whether the product complies with the Living Building Challenge Red List (a restricted substances list). The Red List is comprised of worst-in-class chemicals that the International Living Future Institute (ILFI) considers the most important to avoid. The chemicals on the ILFI Red List may not be included in products used in construction that seeks to meet the criteria of the Living Building Challenge, unless an exception is allowed. The ILFI Red List v3.1 does not include all the banned substances that this specification guidance includes. For example, isocyanates and octylphenoxy polyethoxyethanol (an alkylphenol ethoxylate) are not on the ILFI Red List v3.1.

For more information, see: <https://living-future.org/declare/declare-about/>.

Halogenated flame retardants

Flame retardants are chemicals added to products to reduce their flammability. Halogenated flame retardants contain chlorine or bromine bonded to carbon (chlorinated or brominated flame retardants). Chemicals in this group are considered very important to avoid because of their toxicity and ability to migrate from products. Many within this class are also persistent in the environment or bioaccumulate in the food chain, or both.

Examples of halogenated flame retardants include:

HBCD (CAS 3194-55-6, 25637-99-4)

TCCP (CAS 13674-84-5)

Chlorinated paraffins (CAS 85535-85-9)

DecaBDE (CAS 1163-19-5)

For a more complete and up-to-date list of halogenated flame retardants, see the Chemical Hazard Data Commons at: <https://commons.healthymaterials.net/chemicals/2072163>.

Health Product Declaration (HPD)

The HPD open standard provides a framework for manufacturers to inventory and disclose the contents of their products and any associated human and environmental hazards. Through the standardized HPD form, manufacturers provide information on both intentional content and impurities within their products. Contents are screened against hazard lists published by governmental and professional scientific bodies. The framework is maintained and updated by the Health Product Declaration Collaborative, which includes representatives from a wide variety of stakeholders, including manufacturers, architectural firms, and ecosystem partners.

For more information, see: <http://www.hpd-collaborative.org/>.

Isocyanates

Isocyanates are used in the creation of polyurethanes. They are potent asthmagens; research suggests that exposure to very small quantities through inhalation or dermal contact can cause the onset of asthma disease. This is a particular concern for polyurethane products that are reacted on site.

Examples of isocyanates include:

MDI (CAS 101-68-8)

PMDI (CAS 9016-87-9)

TDI (CAS 91-08-7, 584-84-9)

For a more complete and up-to-date list of isocyanates, see the Chemical Hazard Data Commons at: <https://commons.healthymaterials.net/chemicals/2072237>.

Orthophthalates or phthalates

Commonly referred to as phthalates, orthophthalates are plasticizers that have historically been added to products like sealants and some foam insulation to make them more flexible. These chemicals of concern are structurally and toxicologically different from terephthalates. Many orthophthalates are known endocrine (hormone) disruptors and have been found to damage reproductive systems and interfere with the normal development of a fetus. They have also been associated with asthma. Alternative plasticizers without these associated health hazards are available, and many manufacturers have made the switch.

Examples of phthalates include:

DIDP (CAS 26761-40-0, 68515-49-1)

DEHP (CAS 117-81-7)

DINP (CAS 28553-12-0, 68515-48-0)

DNOP (CAS 117-84-0)

For a more complete and up-to-date list of orthophthalates, see the Chemical Hazard Data Commons at: <https://commons.healthymaterials.net/chemicals/2072101>.

Plasticizer

A plasticizer is a substance, commonly added to some plastics and sealants, that increases flexibility and decreases brittleness. Plasticizers can migrate out of products over time and some, such as phthalates, are hazardous.

Regrettable substitution

Replacing a chemical listed on a restricted substances list (RSL) with another chemical that is not on the RSL but which is actually equally or more hazardous than the targeted chemical. A regrettable substitution can also occur when a well-studied hazardous chemical is replaced with a less studied chemical whose hazards are not yet known, if that chemical is later found to be equally or more hazardous than the targeted chemical.

Restricted Substances List (RSL)

(also “Red List” or “Banned List”)

A list of chemicals that have been prioritized for avoidance by a program or company. These chemicals are generally included on such lists because they are harmful to living creatures, including humans, or the environment, and because of their prevalence in certain targeted products. Because RSLs are only subsets of all harmful chemicals, there is always a danger of making regrettable substitutions (replacing the listed chemicals with others which are not on the RSL but are hazardous). Several organizations, including Perkins+Will and ILFI, have developed their own RSLs for building products. See the Declare Label glossary entry above for more information on the ILFI Red List.

Surfactant

A surfactant is a compound that lowers surface tension to allow for dispersion or suspension of a solid or immiscible liquid in another liquid. Alkylphenol ethoxylates are examples of hazardous surfactants that may be used in building products.

Volatile organic compounds (VOCs)

VOCs are commonly defined as chemicals that are released as gases into the air during the application and curing of a product. Some VOCs may be released quickly during installation; others can be emitted slowly over time from solid products. Some volatile compounds are exempt from regulatory reporting on product labels and specifications as part of the VOC content if they do not contribute to smog formation. These exempted VOCs, however, may still be hazardous to workers and residents who inhale them during or after installation.

Appendix C: Material Ranking Tables with Cost, Performance, Transparency, and Installation Considerations










The tables in this appendix provide a general ranking of different types of insulation and sealants based on their health profiles, with green indicating the best currently available product type and solid red the worst. Importantly, if a jump to the top-rated products is too difficult, incremental improvements from lower- to higher-ranked products can still significantly reduce potential exposures to chemicals of concern. Any step up the ladder of healthier materials can make a difference.

These tables also reflect our best understanding of typical performance properties for each product type, but there will be variations in specific product performance. Some products may not meet code requirements for all applications for all jurisdictions or building types. Check that any specific products used meet the requirements of your project. See the full report, *Making Affordable Multifamily Housing More Energy Efficient: A Guide to Healthier Upgrade Materials*, for the sources referenced to compile this data.

BUILDING INSULATION – RECOMMENDED AND OTHER MATERIALS, COST, PERFORMANCE, TRANSPARENCY, AND INSTALLATION CONSIDERATIONS

Health-Based Ranking (Green is best; red is worst)	Insulation Type	R-Value per Inch*	Relative Installed Cost per R-Value**	Special Installation Equipment Required	Vapor Retarder^	Air Barrier Material^^	Level of Transparency on Chemical Content^^^ (Less shading indicates more transparency within a product type)
	Expanded Cork Board	3.6-4.2	\$\$\$\$	no	Class III	Information not available	
	Blown-In Fiber Glass						
	Loose-Fill Fiber Glass	2.2-3.1	\$	yes	Vapor permeable	Not an air barrier	
	Dense-Pack Fiber Glass	3.7-4.6	\$\$-\$	yes	Vapor permeable	Not an air barrier but does reduce airflow	
	Spray-Applied Fiber Glass	4.0-4.3	\$\$-\$	yes	Vapor permeable	Not an air barrier but does reduce airflow	
	Fiber Glass Batts/Blankets (Kraft-Faced and Unfaced)	2.9-4.3	\$	no	Kraft-faced: Class II; Unfaced: Vapor permeable	Not an air barrier	
	Fiber Glass Batts/Blankets (PSK or FSK-Faced, Basement Wall Insulation)	Duct wrap: 2.7-3.2# Basement wall insulation: 3.0-3.5	\$\$-\$	no	Class I (except basement wall insulation where facing is perforated to allow for moisture transfer)	Facing may be an air barrier material	
	Cellulose/Cotton Batts and Blankets (Unfaced)	3.5-4.0	\$\$-\$\$\$	no	Vapor permeable	Not an air barrier	

BUILDING INSULATION – RECOMMENDED AND OTHER MATERIALS, COST, PERFORMANCE, TRANSPARENCY, AND INSTALLATION CONSIDERATIONS

Health-Based Ranking (Green is best; red is worst)	Insulation Type	R-Value per Inch*	Relative Installed Cost per R-Value**	Special Installation Equipment Required	Vapor Retarder^	Air Barrier Material^^	Level of Transparency on Chemical Content^^^ (Less shading indicates more transparency within a product type)
	Blown-In Cellulose						
	Loose-Fill Cellulose	2.7-3.4	\$	yes	Vapor permeable	Not an air barrier	
	Dense-Pack Cellulose	3.5-3.8	\$-\$	yes	Vapor permeable	Not an air barrier but does reduce airflow	
	Wet-Blown Cellulose	3.6-3.8	\$-\$	yes	Vapor permeable	Not an air barrier but does reduce airflow	
	Mineral Wool Batts	4.0-4.3	\$	no	Vapor permeable	Not an air barrier	
	Mineral Wool Boards	3.4-4.2	\$\$-\$\$\$	no	Vapor permeable	Not an air barrier	
	Polyisocyanurate (Polyiso)	5.4-6.9	\$\$-\$\$\$	no	Foil-faced: Class I; Fiber-faced: Class II or Class III	Air barrier material	
	Expanded Polystyrene (EPS)	3.1-4.5	\$\$\$	no	Class II or Class III, depending on type and thickness	Not an air barrier	
	Extruded Polystyrene (XPS)	3.9-5.0 ^{##}	\$\$\$	no	Class II or Class III, depending on type and thickness	Air barrier material	
	Spray Foam Insulation (SPF)	Closed cell: 5.8-6.9 Open cell: 3.5-4.5	Closed cell: \$\$\$ Open cell: \$\$\$-\$\$\$	yes	Closed cell: Class II or Class III; Open cell: Class III or vapor permeable, depending on type and thickness	Closed Cell: Air barrier material (at ≥ approx. 1.5" thick); Open Cell: Air barrier material (at ≥ approx. 3.5-5.5" thick)	

* R-values can vary with temperature and are reported here for a standard 75-degree Fahrenheit mean temperature. R-values are as measured under laboratory conditions, and actual performance in a building can often depend on the quality of installation. The range was based on reported R-values per inch or by dividing R-value by thickness for the range of products available. R-value per inch can vary with overall product thickness and density as well as between products. Consult product literature for actual R-values for a given product and thickness.

** Estimate of relative installed cost per square foot per R-value is based on information compiled from various sources. Scale of project, location, and other factors may affect relative costs. Relative costs are not comparable across the different tables in this report.

^ The insulation thickness and facing material may affect the permeability rating. Check specific product literature for details. Permeability levels for different classes of vapor retarders as tested per ASTM E96 (Method A) — Class I: ≤ 0.1 perm (vapor barrier), Class II: > 0.1 to ≤ 1.0 perm (vapor semi-impermeable), Class III: > 1 perm to ≤ 10.0 perm (vapor semipermeable), Vapor permeable > 10.0 perms. Note: The Cellulose Insulation Manufacturers Association (CIMA) does not recommend the use of a vapor barrier with cellulose insulation except for in extremely cold climates and facilities with very high interior moisture levels, like indoor pools. The U.S. Department of Energy notes that, “some building codes don’t recognize sprayed foam insulation as a vapor barrier, so installation might require an additional vapor retarder.”




^^ An air barrier material must have an air permeance of less than 0.02 L/s/m² at 75 Pa (0.004 cfm/ft² at 1.57 psf) per ASTM E2178. Air barrier materials are used as part of an air barrier assembly. Joints must be taped or otherwise sealed to achieve an air barrier. Changes in the dimensions of foam because of temperature changes can compromise the overall seal against vapor, air, and water.

^^^ Level of transparency is based on the percentage of products within a product type that have HPDs or Declare Labels and the level of transparency within those documents. At the time of our analysis, none of the product types had full transparency. For product types with full transparency, the symbol would be completely unshaded.

^# Values are for installed R-value per advertised thickness; out of bag R-value per inch is higher because insulation is intentionally compressed on installation.

Most XPS has an R-value per inch of about 5.0, but ASTM C578 allows for Type XIII XPS with an R-value per inch of 3.9.



PIPE INSULATION - RECOMMENDED AND OTHER MATERIALS, COST, PERFORMANCE, AND TRANSPARENCY

Health-Based Ranking (Green is best; red is worst)	Insulation Type	Thermal Conductivity, BTU-in/(hr-sq ft-F)*	Relative Installed Cost per R-Value	Level of Transparency on Chemical Content^ (Less shading indicates more transparency within a product type)
	Fiber Glass Pipe Insulation NOTE: ONLY FORMALDEHYDE-FREE IS RECOMMENDED	0.23	\$	
	Polyethylene Foam Pipe Insulation	0.23 - 0.26	\$	
	Elastomeric Foam Pipe Insulation	0.25 - 0.27	\$\$	

* Typical R-values are not applicable for cylindrical systems such as pipe insulation. R-values for pipe insulation vary with both insulation diameter and wall thickness. Thermal conductivity values given here are for a mean temperature of 75 degrees Fahrenheit.

^ Level of transparency is based on the percentage of products within a product type that have HPDs or Declare Labels and the level of transparency within those documents. At the time of our analysis, none of the product types had full transparency. For product types with full transparency, the symbol would be completely unshaded.

DUCT SEALANTS - RECOMMENDED AND OTHER MATERIALS, COST, TRANSPARENCY, AND INSTALLATION CONSIDERATIONS










Health-Based Ranking (Green is best; red is worst)	Sealant Type	Relative Material Cost*	Installation Considerations	Level of Transparency on Chemical Content^ (Less shading indicates more transparency within a product type)
	Foil-Backed Butyl Tape	\$\$		
	Wet-Applied Mastic Sealant	\$	Fiber glass mesh tape needed for gaps larger than about 1/8"	

* Estimate of relative material cost per linear foot sealed at a set width. Based on information compiled from various sources. Scale of project, location, and other factors may affect relative costs. Relative costs are not comparable across the different tables in this report.

^ Level of transparency is based on the percentage of products within a product type that have HPDs or Declare Labels and the level of transparency within those documents. At the time of our analysis, none of the product types had full transparency. For product types with full transparency, the symbol would be completely unshaded.

Note on installation considerations: All types of sealants require surfaces to be clean before application.

MULTIPURPOSE SEALANTS – RECOMMENDED AND OTHER MATERIALS, COST, TRANSPARENCY, AND INSTALLATION CONSIDERATIONS

Health-Based Ranking (Green is best; red is worst)	Sealant Type	Relative Material Cost*	Installation Considerations	Level of Transparency on Chemical Content^^ (Less shading indicates more transparency within a product type)
Green	Noncombustible Sodium Silicate Caulk	\$\$\$	Noncombustible backing material needed for large, deep openings; not recommended where there is continuous vibration or in areas expected to come into contact with water	
Yellow	Expanding Polyurethane Foam Sealant Tape	\$-\$\$\$^	Usually expands to fill 1 to 1 1/2"	
Light Orange	Acrylic Latex Sealant	\$\$	Backing material needed for gaps deeper than about 1/2"; not for gaps wider than about 1/2"	
Orange	Siliconized Acrylic Sealant	\$\$	Backing material needed for gaps deeper than about 1/2"; some products can be used for gaps up to 1"	
Light Orange	Intumescent Acrylic Firestop Sealant	\$\$\$\$	Noncombustible backing material needed for large or deep openings	
Orange	One-Component Silicone Sealant	\$\$\$	Backing material needed for gaps deeper than about 1/2"; not for gaps wider than 1"	
Light Orange	Modified Polymer Sealant (STPE Sealant)	\$\$\$	Backing material needed for gaps deeper than about 1/2"; not for gaps wider than 1"	
Light Orange	One-Part Polyurethane Spray Foam Sealant	\$	For gaps up to about 1 1/2"; variations available for gaps of up to about 3"	
Red	One-Component Polyurethane Sealant	\$\$\$	Backing material needed for gaps deeper than about 1/2"; not for gaps wider than about 1 1/2"	

* Estimate of relative material cost per linear foot sealed at a set width and depth. Based on information compiled from various sources. Scale of project, location, and other factors may affect relative costs. Relative costs are not comparable across the different tables in this report.

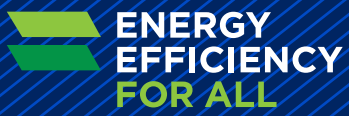
^ There can be a wide variation in cost for expanding polyurethane foam sealant tape. Interior-only sealant tapes are usually cheaper than dual-purpose, interior and exterior tapes. The tape expands to fill the gap that is present, so for smaller gaps, the cost per volume filled will be greater than for larger gaps.

^^ Level of transparency is based on the percentage of products within a product type that have HPDs or Declare Labels and the level of transparency within those documents. At the time of our analysis, none of the product types had full transparency. For product types with full transparency, the symbol would be completely unshaded.

Endnotes

- 1 Throughout this document, we will use the term “upgrade” to refer to a holistic set of interventions to make a building more energy efficient.
- 2 Persistent, bioaccumulative, and toxic are commonly referred to as properties of concern. Persistent chemicals do not break down readily in the environment; bioaccumulative chemicals build up in people and other animals and become more concentrated as they move up the food chain; and toxic chemicals are harmful to living organisms.
- 3 The report on which this document is based, *Making Affordable Multifamily Housing More Energy Efficient: A Guide to Healthier Upgrade Materials*, focuses on a subset of toxicity endpoints, outlined in the methodology section of that report.
- 4 Chemicals of concern are those that may adversely affect human health. Different organizations may define different subsets of chemicals as chemicals of concern. For this report, health-hazard information from the Pharos Chemical & Material Library was used to screen chemicals. Those rated as having high or very high hazard levels for the health endpoints shown in Table 1 of the *Guide to Healthier Upgrade Materials* were considered to be chemicals of concern. In some cases in which research is still emerging, additional sources beyond the Pharos Library were consulted for associated health hazards, and in these cases, the additional sources are cited within that report.
- 5 This analysis is based on health hazards to a person exposed to the contents of the insulation or air-sealing products, but it does not assess the level of exposure to these chemicals. There is potential for exposure to these substances throughout their life cycles. Workers and fenceline community residents can be exposed during manufacturing; workers and nearby occupants can be exposed during installation; building occupants can be exposed when chemicals migrate out of the products during use; and workers and nearby occupants can again be exposed during demolition and disposal. Chemicals that persist in the environment can also travel long distances and have global impacts.
- 6 The Construction Specifications Institute’s (CSI) MasterFormat is a widely used standard for organizing specifications for building projects. It is a master list of numbers and titles used to organize project manuals.
- 7 This standard has been previously known as CA Section 01350. Products should meet the current version of the standard. At the time of publication, this was v1.2-2017.
- 8 Broad use of caulk-type sealants for air sealing versus use of spray foam sealants may have significant cost implications for projects because of increased material or labor costs, or both.
- 9 The recommended product types as listed here are usually free of the banned substances listed in the Sustainable Design Requirements later in this document, thereby meeting those requirements. Specific chemicals requirements as called out in the Recommendations by Product Category must be avoided in order to meet the Sustainable Design Requirements. In addition, while it is not common, some acrylic latex or siliconized acrylic sealants may contain orthophthalates (one of the banned substances). Make sure the products you use are free of these hazardous chemicals.
- 10 Facing is often required for performance reasons. Review the product performance requirements for your project and the specific performance of any product you are considering.
- 11 Facing is often required for performance reasons. Review the product performance requirements for your project and the specific performance of any product you are considering.
- 12 An amended version of SCAQMD Rule 1168 for adhesives and sealants was released in October 2017. The VOC limit for architectural sealants remained 250 g/L until January 2019, when much more restrictive requirements went into effect, i.e., ≤ 50 g/L for most architectural sealants. Requirements in this document are based on the new, more restrictive limits.
- 13 The recommended product types in the lists above are usually free of the banned substances listed in the Sustainable Design Requirements below, thereby meeting those requirements. While it is not common, some acrylic latex or siliconized acrylic sealants may contain orthophthalates (one of the banned substances). Make sure the products you use are free of these hazardous chemicals.





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