



Chemical & Material Library (CML)

Full system description – December 14, 2017

Summary

The Chemical and Material Library (CML) is an extensive online catalog of substances that identifies key health and environmental hazard information and process chemistry for chemicals, polymers, metals and other substances, plus extinction threat information about tree and plant species. The CML was developed by the **Healthy Building Network** to support its Pharos building product selection system but is designed to be a comprehensive resource that may be used on a standalone basis to evaluate chemicals, woods and other materials in products of any type.

The CML is designed for use by a wide range of users from green building design and construction professionals, to product formulators, to policy makers and researchers. This library of over 51,000 chemicals, polymers, metals, wood species and other substances are cataloged against:

- 45 authoritative chemical hazard lists for human and environmental health concerns,
- 32 restricted substance lists and
- 5 endangered wood species lists

The CML provides a quick review of how a substance has been characterized by these lists indicating the health endpoints identified, such as cancer or reproductive toxicity, and color-coded level of hazard using the benchmark system of the **GreenScreen™ for Safer Chemicals**¹. The CML further describes and provides direct links to these lists, all of which have been developed by state, national and international governmental agencies and other reputable, science-based non-governmental organizations. The CML includes all lists required for product disclosure by the **Health Product Declaration (HPD)**² and for use of the **GreenScreen List Translator**. It also supports screening against red lists for a variety of programs, including the **Living Building Challenge** and **Cradle to Cradle Certified**.

The CML addresses the following issues:

- o **Direct health hazards:** Pharos screens chemical substances and other materials by CAS number against authoritative hazard lists to identify hazards they may present to human health or to ecosystems directly exposed to the material.
- o **Process Chemistry health hazards:** The Pharos team researches key materials to identify additional chemicals used, created and emitted during manufacturing. These chemicals are then screened to identify potential health hazards to the workers and local communities near where the raw materials are extracted or grown and then manufactured into products. Pharos staff conducts a preliminary literature review of life cycle chemicals for most contents of Pharos listed products and more in-depth research on select common ingredients
- o **Endangered species:** Pharos screens forestry products and other biobased materials against authoritative lists that identify trees and other timber plant species that are directly endangered or are frequently harvested from threatened forest habitats.
- o **Regulatory or voluntary restrictions:** Pharos screens chemicals and other materials by CAS number against a set of restricted substance lists which identify substances that may be subject to governmental regulation or avoidance policies of companies and nonprofits.

¹ <http://www.greenscreenchemicals.org/>

² <http://www.hpdcollaborative.org/>

The CML is an evolving tool. Many of the approximately 80,000 chemicals in commerce have not yet been thoroughly tested for their direct health impacts and our research on the life cycle associations for each material is an ongoing project. Nonetheless, about half of the substances in the Pharos Project Chemical and Material Library have been associated with hazard information from the authoritative hazard lists, making the CML the most powerful tool available to help specifiers and formulators alike avoid identified potential hazards in materials in use and in their life cycle. We welcome your data submissions and suggestions.

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Chemical Hazard

Hazard identification and restricted substance lists³

Contrary to popular belief, there is no comprehensive governmental testing program that assures that substances are “safe” before they are allowed on the market. The vast majority of chemicals have not been fully tested for human health impacts, and the process of identifying unacceptable chemical risks and restricting or banning use is so arduous that it has rarely succeeded.

Despite this lack of a comprehensive program, scientists have used modeling, epidemiology, and human and animal testing to identify associations between thousands of chemicals, metals and other substances and significant hazards for the environment and for the health of humans exposed to them. Lists generated from this work provide important early warnings of danger to human health and the environment, and also important market signals to specifiers, owners and product manufacturers who want to get ahead of the curve before the next chemical scandal makes news. Attention to these lists, for example, would have signaled mounting concern and evidence about a range of substances used in building materials, including flame retardants, stain repellents and vinyl softeners, long before the US EPA ultimately announced in December of 2009 that they would subject certain “Chemicals of Concern” to new regulatory scrutiny.⁴

There are two main types of lists associated with chemical hazards in the CML: **chemical hazard lists** and **restricted substance lists (RSLs)**. A variety of state, national and international governmental bodies and non-governmental organizations (NGOs) maintain authoritative *chemical hazard lists*. These are lists of substances for which an authoritative body of scientists has undertaken a systematic review of scientific evidence and categorized the substances as having an association with a specific health or environmental hazard. There are lists for persistent bioaccumulative toxicants (PBTs) and chemicals associated with specific human health endpoints, such as carcinogens, mutagens, reproductive toxicants. This category of lists also includes lists specific to aquatic toxicants, ozone depleters, global warming gases and chemicals associated with other specific environmental impacts. Sometimes the lists will also categorize the strength of scientific evidence and certainty of the hazard (e.g., differentiating whether a substance is a “known” or “suspected” carcinogen) or the potency of a toxicant indicating the level of hazard.

In addition to lists that simply identify and categorize hazards based upon a specific health endpoint or environmental impact, there are also *restricted substance lists* (RSLs) which are primarily policy tools for the management of chemicals by governments, non-profits or companies. RSLs frequently take into account multiple endpoints and may be based upon other authoritative hazard listings and precautionary assessments of the scientific literature. An example of a governmental RSL is the European Commission’s Directive on the Restriction Of the use of certain Hazardous Substances (ROHS) which controls the use of heavy metals in electronics. An example of a non-profit RSL is the Red List of chemicals that must be excluded from Living Building Challenge projects.⁵

Some RSLs are not linked to evidence of one or more chemical hazards, but rather to evidence of the absence of certain hazards. This includes *exempt lists*, such as the US EPA - Exempt VOCs. list which exempts certain VOCs from regulations if they are not ozone reactive. This also includes broader *positive lists*, such as the US

³ This section describes the use of lists in the CML that address human and environmental health hazards. For information on the endangered wood species listings, refer to the Endangered Species section below.

⁴ See Signal Blog “EPA’s “[Chemicals of Concern](#)” In [Green Building Products](#)” and CML [Chemicals of Concern Action Plan](#) list for more on the EPA announcement.

⁵ View the [Living Building Challenge Red List](#) in the Pharos CML for a full description of the list and how it is applied.

EPA - DfE Safer Chemical Ingredients List (SCIL) which rates chemicals to determine safer alternatives for various functional uses.

Looking ahead, EU countries implementing a law known as REACH have begun the long process of gathering more information about chemicals in use. Still, the majority of chemicals in use remain very minimally evaluated and regulated, if at all. In the US, the Toxics Substances Control Act (TSCA), has been overhauled to provide the US Environmental Protection Agency (US EPA) with more tools to obtain information about chemical health hazard and regulate their use. However, it is expected that it will be many years yet before such legislation can be implemented at a scale which will truly protect society from hazardous chemicals. Private efforts to evaluate chemical hazard and determine avoidance will remain critical for decades to come.

Assessing substances using the CML

The CML makes the disparate information from a wide range of hazard lists available in a comprehensive user-friendly format by:

- Compiling into one searchable database the most significant published hazard lists and
- Providing a consistent hazard display to provide guidance for product screening to avoid the most hazardous substances.

The CML draws from governmental hazard lists such as the US EPA's lists of PBTs and the World Health Organization's Cancer Monographs. It also draws from non governmental organizations' work such as Association of Occupational and Environmental Clinics list of asthmagens. All lists required for assessing chemical hazard under the **GreenScreen for Safer Chemicals**⁶ are included in the Pharos CML. All lists required for public content hazard disclosure by the **Health Product Declaration (HPD)**⁷ are also included in the Pharos CML. See the "*Hazard lists in Pharos*" section below for the complete list.

The CML provides information describing each of the included hazard lists, how it is categorized for level of concern within the Pharos scoring system, and when the list was last updated as well as providing links directly to the website of the issuer of the list.

The list will continue to grow as the Pharos team evaluates new lists for acceptance into the Library.

Chemical and Materials search page

(<https://www.pharosproject.net/material/chemical>)

The main chemical and material page lists all substances in the Library. The CML can be searched by name, synonym, species, or CAS number.⁸ It also can be filtered to display only those substances that meet various criteria, including type (biobased, chemical, compound group, etc.), product category if it is found in the Pharos Building Product Library (BPL), whether it has a GreenScreen full assessment, and inclusion or exclusion on various Restricted Substance Lists (RSLs). The user can also select whether to include residuals in the filter criteria.

⁶ The **GreenScreen for Safer Chemicals** is a benchmarking system for chemical hazards upon which the Pharos framework for assessing chemicals and products is based. More information about the GreenScreen is available at <http://www.greenscreenchemicals.org>.

⁷ The **Health Product Declaration (HPD)** is a standardized format for disclosure of product content and associated health hazard developed for the building industry and managed by the Health Product Declaration Collaborative. More information on the HPD is available at <http://www.hpdcollaborative.org>

⁸ CAS number – a unique identifier assigned by the Chemical Abstract Service of the American Chemical Society to uniquely identify chemical elements, compounds, polymers, and other materials and mixtures. Frequently used in Material Data Safety Data Sheets (MSDSes). Also known as CASRN

Chemicals listings include display of:

- CAS number
- Name of the substance
- Three separate hazard indicators for
 - the substance itself
 - its likely residuals
 - manufacturing process chemicals
- GreenScreen

Hazard indicators

(used in both Chemicals and Materials, and Building Products sections)

The colored dots used in this section represent relative levels of hazard, derived from authoritative hazard lists. The relative hazard levels range from dark red(highest concern) through red, yellow, green, and dark green(lowest concern). Grey indicates that the authoritative hazard listing is ambiguous and covers a wide range of possible hazard levels. Blue indicates that the substance is referenced on a restricted substance list (RSL) rather than an authoritative hazard list. For more information on the colors see the "Hazard Levels & color-coded Priority Levels" section below.

The hazard indicators for the Chemical and Materials section are as follows:

- Substance - This color reflects the highest hazard associated directly with a substance by an authoritative hazard list. For the source of this hazard color, see the "Hazard" tab on the chemical / material's page.
- Residual - This color reflects the highest hazard associated with residuals that HBN research indicates may be present with a chemical. These residuals consist of all process chemicals in the following categories:
 - Monomers
 - Catalysts
 - Nonreactive Additives
 - Pollutants and Contaminants
 - Other known residuals

Hazards are drawn from process chemistry chemicals far upstream in the manufacturing process as well as the immediate precursors to this chemical. For the source of this hazard, see the "Life Cycle Research" tab on the chemical / material's page.

- Manufacturing - This color reflects the highest hazard associated with chemicals that our research categorizes as "frequent" or "integral" to the production of a chemical. The manufacturing score is included to surface potential hazards far upstream in the manufacturing process as well as the immediate precursors to this chemical. For the source of this hazard, see the "Life Cycle Research" tab on the chemical / material's page.

The Building Products section uses the same hazard indicators, with the following changes:

- Substance - This column covers hazards of intentionally added contents.
- Residuals - This column covers hazards of potential residuals in intentionally added contents.
- Manufacturing - This column covers hazards of chemicals used to produce the intentionally added contents

For information on the GreenScreen, see the relevant section below.

Chemicals and Materials Display:

Clicking on a substance name will return a Chemical Profile, which may contain both direct and process chemistry warnings. For an example see, <https://pharosproject.net/material/show/2008361> . Elements of the Chemical Profile include:

The **General Information** tab includes synonyms, product categories, a description, and the VOC designation.

The **Hazards tab** is organized by human and environmental health endpoints. Under each endpoint, Pharos lists one or more authoritative hazard lists or restricted substances lists that associate the chemical with the endpoint. In some cases, the association can be made through a compound group rather than a specific chemical listing (see section below on Compound Groups for more information on how these groups are populated and used in Pharos). Each listing includes:

- The highest concern listing for each endpoint. See “Trumping Rules for List Display” below for how lists are prioritized.
- A GreenScreen icon when the list is included in the List Translator. Additional info is available in a rollover.
- An HPD icon when the list is required to be displayed in an HPD
- Issuing organization
- Title of the list, with a link to the Pharos description of the list
- Specific statement on the list that qualifies this substance
- A grey “+x” button to display any additional hazard lists for the endpoint.

Hazards are divided into two groups:

- Direct Hazards are associated with the chemical or compound group
- Potential Residual Hazards are associated with chemicals upstream in the manufacturing process in the following lifecycle categories:
 - Monomers
 - Catalysts
 - Nonreactive Additives
 - Pollutants and Contaminants
 - Other known residuals

If Pharos has no hazard warnings associated with this chemical, then the page will state “None identified”

The **Compound Group Members** tab is only present when viewing a compound group, and displays the members (chemicals and compounds groups) of this compound group.

The **Compound Groups** tab displays the compound groups of which this chemical or compound group is a member.

The **GreenScreen** tab displays the GreenScreen Assessment of the chemical, if publicly available. If no Assessment is available, it displays the GreenScreen List Translator score. For more information on the GreenScreen benchmarking system, see the GreenScreen section below.

The **Lifecycle Research** tab lists chemicals upstream in the manufacturing of this chemical. The dots display the hazard endpoints and level of concern for each process chemistry chemical. The tab also includes the function and frequency of use in the manufacturing process. See the section below on “Life cycle health hazards” for explanation of the Pharos research and assessment of lifecycle chemicals.

Trumping Rules for List Display: The hazard tab displays the highest concern listing for each endpoint. This listing is determined using the GreenScreen authority categories, followed by the hazard level. First, lists are sorted by level of authority:

1. Authoritative lists (designated by GreenScreen)
2. Priority lists proposed for GreenScreen
3. Screening lists (designated by GreenScreen)
4. Lists not included in or proposed for GreenScreen

If there are multiple lists of the highest authority level, they are then sorted by hazard level, and the list with the highest hazard is selected for display. For more on hazard levels, see “Hazard Levels & color-coded Priority Levels” below.

Use of the CML in the Pharos product assessment system: Each product in the Pharos database has a Product Profile with a number of tabs. The listing all of the known material contents for the product is located in the “Contents” tab. Each content item has color-coded hazard indicators for substance, residual, and manufacturing concerns. Clicking on the chemical name or placing the cursor over the colored dot will display the relevant endpoint (such as “Cancer” or “PBT”). These indicators are described in greater detail above in the section Hazard Indicators.

Absence of a hazard listing does *not* assure safety. Many of the approximately 80,000 chemicals in commerce have not yet been thoroughly tested and evaluated for their direct health impacts, and their absence from authoritative hazards lists does not suggest that they have been tested and found not to pose such a hazard. Listings that positively indicate low hazard for an endpoint for a material are coded in green in the CML. Only a full GreenScreen assessment, however, can actually confirm that a material has low hazard across all endpoints. To identify chemicals with GreenScreen assessments, go to the Chemicals and Materials tab, click the checkbox “Has a full GreenScreen assessment” and then click “Filter results”.

List Updates:

Some of the hazard lists in the CML are established and published once and never revised. Others are revised every few months. Other are somewhere in between. HBN staff finds changes in at least one week on average every other week. For updating procedures, hazard lists are divided into two categories. Lists that are static or have not been updated in the past five years are checked quarterly (every three months). All others are checked every two weeks. [View all list update timeframes.](#)

The Published date is the date that the source published or updated the list, when available. When the source publishing date is not evident it will be the date that HBN staff accessed it for updates.

Endpoints addressed in the CML - human health, ecotoxicity, physical hazard & environmental fate

Pharos addresses each of the human health and ecotoxicity endpoints used in the GreenScreen for Safer Chemicals and the US EPA's Design for the Environment (DfE). The GreenScreen and DfE include all of the endpoints required for assessment by the Globally Harmonized System (GHS) plus several additional critical endpoints that are currently missing from the GHS. Pharos includes all of these endpoints plus several additional important environmental endpoints.

- **Group I Human**
 - **Carcinogenicity** – ability to cause or increase the risk of cancer
 - **Mutagenicity/Genotoxicity** – ability to cause or increase the rate of mutations, which are changes in genetic material in cells.
 - **Reproductive Toxicity** – ability to disrupt the male or female reproductive systems, changing sexual development, behavior or functions, decreasing fertility, or resulting in loss of the fetus during pregnancy.
 - **Developmental Toxicity** incl. developmental neurotoxicity – ability to cause harm to the developing child including birth defects, low birth weight and biological or behavioral problems that appear as the child grows.
 - **Endocrine Activity** – ability to interfere with hormone communication between cells which controls metabolism, development, growth, reproduction and behavior (the endocrine system). *Not currently included in GHS.*
- **Group II Human**
 - **Acute Mammalian Toxicity** – ability to be fatal on contact or ingestion for humans and other mammals.
 - **Systemic Toxicity/Organ Effects** incl. immunotoxicity-single exposure – ability to cause serious damage on contact or ingestion.
 - **Neurotoxicity**-single exposure – ability to cause damage to the nervous system including the brain. *Not currently included in GHS.*
 - **Eye Irritation/Corrosivity** – ability to cause irritation or serious damage to the eye.
 - **Skin Irritation/Corrosivity** – ability to irritation or serious damage to the skin.
- **Group II* Human**
 - **Systemic Toxicity/Organ Effects** incl. immunotoxicity-repeated exposure - ability to cause serious damage on contact or ingestion on long term repeated exposures.
 - **Neurotoxicity** - repeated exposure - ability to cause serious damage on contact or ingestion on long term repeated exposures.
 - **Respiratory Sensitization** – ability to result in high sensitivity such that small quantities trigger asthma, rhinitis or other allergic reactions in the respiratory system.
 - **Skin Sensitization** – ability to trigger allergic reactions on the skin.
- **Ecotoxicity**
 - **Acute Aquatic Toxicity** - a single exposure in a day may result in severe biological harm or death to fish or other aquatic organisms.
 - **Chronic Aquatic Toxicity** - long term exposure of months or years may result in irreversible harm to fish or other aquatic organisms
 - **Terrestrial Ecotoxicity** – ability to cause harm to land based plants, animals or microorganisms
- **Physical Hazard**
 - **Flammability** - easily ignited and capable of burning rapidly.
 - **Reactivity** - may spontaneously ignite or explode on its own or in contact with water.

- **Environmental fate**
 - **Persistent** - does not break down readily from natural processes. *Not currently included in GHS.*
 - **Bioaccumulative** - accumulates in organisms concentrating as it moves up the food chain. *Not currently included in GHS*
 - **Persistent Bioaccumulative Toxicant (PBT)** – Does not break down readily from natural processes, accumulates in organisms concentrating as it moves up the food chain, and is harmful in small quantities. Pharos does not currently include any listings which address Persistence or Bioaccumulation individually. *Not currently included in GHS.*
 - **Global Warming** – ability to absorb thermal radiation, increasing the temperature of the atmosphere and contributing to climate change. *Not currently included in GreenScreen or GHS.*
 - **Ozone Depletion** – ability to contribute to chemical reactions that destroy ozone in the earth's upper atmosphere. *Not currently included in GreenScreen or GHS.*
- **Multiple** - list specifies more than one of the above endpoints.

Hazard lists included in the CML

Pharos includes the following authoritative chemical hazard lists⁹:

1. **AOEC - Asthmagens**. AOEC Exposure Codes - Asthmagen List, Association of Occupational and Environmental Clinics (AOEC)
2. **Australia - GHS**. Australia - GHS, Safe Work Australia
3. **Boyes - Neurotoxicants**. Chemicals with occupational exposure standards based on nervous system effects (Boyes 2001), Patty's Toxicology: author William K Boyes
4. **CA EPA - Prop 65**. Chemicals Known to the State to Cause Cancer or Reproductive Toxicity - California Proposition 65 - Safe Drinking Water and Toxic Enforcement Act Of 1986, California Environmental Protection Agency (CA EPA)
5. **CHE - Toxicant Database**. Toxicant and Disease Database, Collaborative on Health and the Environment (CHE)
6. **ChemSec - SIN List**. SIN (Substitute It Now) List, ChemSec, The International Chemical Secretariat
7. **EC - CEPA DSL**. Canadian Environmental Protection Act (CEPA) - Environmental Registry - Domestic Substances List (DSL), Environment Canada & Health Canada (EC)
8. **EHP - San Antonio Statement on BFRs & CFRs**. San Antonio Statement on Brominated and Chlorinated Flame Retardants, Environmental Health Perspectives
9. **EU - Annex VI CMRs**. Classification, Labelling and Packaging Regulation (CLP) - Classification and Labelling Inventory - CMRs, European Union / European Commission (EU EC)
10. **EU - ESIS PBT**. European chemical Substances Information System (ESIS) - PBT List, European Union / European Commission (EU EC)
11. **EU - GHS (H-Statements)**. Regulation on the Classification, Labelling and Packaging of Substances and Mixtures (CLP) Annex 6 Table 3-1 - GHS Hazard code criteria, European Union / European Commission (EU EC)
12. **EU - Ozone depletion substances**. Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer - Controlled substances and new substances, European Union / European Commission (EU EC)
13. **EU - Priority Endocrine Disruptors**. EU Community Strategy for Endocrine Disruptors - Priority List, European Union / European Commission (EU EC)
14. **EU - R-phrases**. Substances with EU Risk & Safety Phrases (Commission Directive 67-548-EEC), European Union / European Commission (EU EC)
15. **EU - REACH Annex XVII CMRs**. Restrictions On The Manufacture, Placing On The Market And Use Of Certain Dangerous Substances, Preparations And Articles - Carcinogens, Mutagens & Reproductive Toxicants, European Union / European Commission (EU EC)
16. **EU - SCCS Fragrance Allergens**. EU Scientific Committee on Consumer Safety - Fragrance Allergens, European Union / European Commission (EU EC)
17. **EU - SVHC Authorisation List**. Substances of Very High Concern for REACH Annex XIV Authorisation (Article 59), European Union / European Commission (EU EC)
18. **G&L - Neurotoxic Chemicals**. Developmental neurotoxicity of industrial chemicals, List of 201 Chemicals known to be neurotoxic in man, Lancet: authors Philippe Grandjean & Phil Landrigan
19. **IARC**. Monographs On the Evaluation of Carcinogenic Risks to Humans, International Agency for Research on Cancer, World Health Organization (IARC)
20. **IPCC - Global Warming Chemicals**. Intergovernmental Panel for Climate Change (IPCC) Third Assessment Report, 2001, Intergovernmental Panel for Climate Change (IPCC)
21. **Japan - GHS**. Japan GHS Classifications, Government of Japan
22. **Korea - GHS**. Korea GHS Classification and Labelling for Toxic Chemicals, Republic of Korea - National Institute of Environmental Research (NIER)
23. **MAK**. List of Substances with MAK & BAT Values & Categories, MAK Commission of Germany (Deutsche Forschungsgemeinschaft)

⁹ An up to date catalog of all lists scanned in the CML can be found at <https://www.pharosproject.net/hazard/>

24. **Malaysia - GHS.** Malaysia - GHS, Malaysia Department of Occupational Safety and Health
25. **New Zealand - GHS.** New Zealand HSNO Chemical Classifications, New Zealand Environmental Protection Authority (NZ EPA)
26. **OR DEQ - Priority Persistent Pollutants.** Priority Persistent Pollutant (P3) List, Oregon Department of Environmental Quality (ORDEQ)
27. **OSPAR - Priority PBTs & EDs & equivalent concern.** Chemical Lists of Priority Action & Possible Concern, Oslo-Paris Convention Commission (OSPAR)
28. **Quebec CSST - Asthma Agents.** Agents Causing Occupational Asthma With Key References, Québec Workplace Health and Safety Commission (Commission de la santé et de la sécurité du travail (CSST))
29. **Québec CSST - WHMIS 1988.** WHMIS-SIMDUT: Controlled Products Classifications, Québec Workplace Health and Safety Commission (Commission de la santé et de la sécurité du travail (CSST))
30. **Silent Spring - Breast Cancer Chemicals.** Mammary Carcinogens Review Database, Silent Spring Institute
31. **TEDX - Potential Endocrine Disruptors.** TEDX (The Endocrine Disruption eXchange) List of Potential Endocrine Disruptors, The Endocrine Disruption Exchange (TEDX)
32. **UNEP Stockholm Conv - Persistent Organic Pollutants.** Stockholm Convention on Persistent Organic Pollutants (POPs) - Annex A, B & C and under Review, United Nations Environment Programme (UNEP)
33. **US CDC - Occupational Carcinogens.** NIOSH Carcinogen List, US Centers for Disease Control (US CDC)
34. **US EPA - EPCRA Extremely Hazardous Substances.** Extremely Hazardous Substances - EPCRA Section 302, US Environmental Protection Agency (US EPA)
35. **US EPA - Global Warming Potentials.** Global Warming Potentials of Ozone Depletors and Substitutes, US Environmental Protection Agency (US EPA)
36. **US EPA - IRIS Carcinogens.** Integrated Risk Information System Database (IRIS), US Environmental Protection Agency (US EPA)
37. **US EPA - OPP - Registered Pesticides.** Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Registered Pesticides (Selections), US Environmental Protection Agency (US EPA)
38. **US EPA - Ozone Depleting Substances.** Ozone-Depleting Substances (ODS) Class I & Class II, US Environmental Protection Agency (US EPA)
39. **US EPA - PPT Chemical Action Plans.** Risk Management Actions & TSCA Work Plans, US Environmental Protection Agency (US EPA)
40. **US EPA - Priority PBTs (NWMP).** Priority Chemicals List, US Environmental Protection Agency (US EPA)
41. **US EPA - Priority PBTs (PPT).** Priority PBT Profiles (Pollution Prevention and Toxics), US Environmental Protection Agency (US EPA)
42. **US EPA - Toxics Release Inventory PBTs.** TRI PBT Chemical List, US Environmental Protection Agency (US EPA)
43. **US NIH - Report on Carcinogens.** Report on Carcinogens, US Department of Health & Human Services - National Institutes of Health (US NIH)
44. **US NIH - Reproductive & Developmental Monographs.** Expert Panel Reports & Monographs on Reproductive and Developmental Toxicity, US Department of Health & Human Services - National Institutes of Health (US NIH)
45. **WA DoE - PBT.** Chapter 173-333 WAC Persistent Bioaccumulative Toxins, Washington State Department of Ecology (WA DOE)

All substances on each of these authoritative lists are included in the Pharos CML if a CAS number was provided by the list issuer. When no CAS number was provided, Pharos staff has exercised professional judgment to associate a CAS number where possible. Poorly defined substances with no CAS number association are not included in the CML at this time.

Some of the lists reference **compound groups**, such as lead based compounds, in addition or instead of identifying specific chemicals by CAS number. HBN staff is in the process of populating compound groups to associate more of these related chemicals with these warnings. This is an ongoing process. See the section below on *Compound Groups* for more information. Pharos staff updates the listings from the original issuer source

on a varying base dependent on the frequency of changes by the issuer. For more information about updates see “List Updates” above in the “Assessing substances using the CML” section

Information describing each list, contact information for the issuer and its update status is available at http://www.pharosproject.net/material_list/hazard/.

The GreenScreen and GreenScreen List Translator

The GreenScreen® for Safer Chemicals is a benchmarking system to rank the relative hazard level of chemicals and encourage progress toward safer alternatives. The benchmark is based on ranking a chemical for level of hazard on a set of health endpoints and measures of environmental fate. The Pharos Chemical and Material Library (CML) uses the GreenScreen in three ways:

1. The CML serves as a repository for full GreenScreen assessments that are in the public domain.
2. The CML serves as a tool to determine the GreenScreen List Translator score for a chemical or product, based on the most current GreenScreen version (1.4).
3. The CML’s Hazard and Priority Levels are informed by the GreenScreen methodology.

The first two roles are described in this section. The third role is described below in the section: Hazard Levels & color-coded Priority Levels.

GreenScreen Assessments

The GreenScreen protocol establishes a four-step benchmark system with Benchmark 1 indicating a chemical of High Concern and Benchmark 4 indicating an ideal chemical of Low concern. Chemicals must undergo a full GreenScreen assessment before they are given a Benchmark score. From the highest concern to the lowest concern these are:

- Benchmark 1: Avoid Chemical of High Concern
- Benchmark U: Unspecified Due to Insufficient Data
- Benchmark 2: Use but Search for Safer Substitutes
- Benchmark 3: Use but Still Opportunity for Improvement
- Benchmark 4: Prefer Safer Chemical

The protocol is public, free, and transparent, and can be performed by anyone. For an assessment to be Certified, however, it must be produced by a Licensed GreenScreen Profiler. Almost two hundred public domain GreenScreen assessments are currently available. These assessments can be found in a chemicals and materials search (<https://pharosproject.net/material/chemical>) by clicking the “Has a full GreenScreen assessment” box. They can then be viewed in the GreenScreen tab of each Chemical Profile.

GreenScreen List Translator

The GreenScreen List Translator (GSLT) compares the criteria used by each of the authoritative hazard lists against the GreenScreen criteria to determine a level (or range) of hazard for the health endpoint(s) addressed by the list. For example, the GSLT rates IARC [Group 1 \(Agent is Carcinogenic to Humans\)](#) as High hazard for carcinogenicity and Group 2B (Possibly carcinogenic) as Medium hazard.

Pharos uses these endpoint hazard ratings and the GSLT method to calculate a GSLT score, which indicates the likelihood of a substance receiving a Benchmark 1 score in a GreenScreen full assessment. All chemicals in the Pharos database are automatically screened in this manner. Scores in order from highest concern to lowest concern are:

- LT-1 - List Translator Likely Benchmark 1
- LT-P1 - List Translator Possible Benchmark 1
- LT-UNK - List Translator Benchmark Unknown
- NoGS - No List Translator or public GreenScreen scoring

Designating a chemical as a Likely GreenScreen Benchmark 2 or higher is not possible based on lists alone because of the data gaps inherent in the list based approach.

LT-1: Likely Benchmark 1. The criteria for the hazard lists to which this substance or its compound groups are associated is equal to or more stringent than the GreenScreen criteria for a Benchmark 1, meaning it is highly likely that a full GreenScreen assessment would result in a Benchmark 1 score..

LT-P1: Possible Benchmark 1. The criteria for the hazard list overlap with the GreenScreen criteria for a Benchmark 1. Therefore there is a strong possibility that this substance would receive a Benchmark 1, but a full GreenScreen assessment would be required to confirm.

LT-UNK: The hazard listings found are insufficient to determine if the substance may be a Benchmark 1. Any substance listed in one of the GreenScreen List Translator hazard lists that does not get scored as a Likely Benchmark 1 (LT-1) or Possible Benchmark 1 (LT-P1) gets listed in the CML as a LT-UNK. An LT-UNK is not an indication of safety as it listed for one or more Group II Human Health Effects, possibly including high hazard(s) and/or Ecotoxicity, Physical Hazard or Environmental Fate.

NoGS: A chemical receives this GreenScreen designation if the chemical and its compound groups are not identified on any GreenScreen List Translator hazard lists and there is no public GreenScreen assessment available.

GreenScreen assessments trump results from List Translator scoring. These scores can be viewed in the GreenScreen tab of the Chemical Profile.

Products in the Building Product Library (BPL) often contain multiple substances with different Benchmarks and List Translator scores. The highest concern score is selected for display in the product summary. GreenScreen scores in order from highest to lowest concern are:

- Benchmark 1
- LT-1 - List Translator Likely Benchmark 1
- LT-P1 - List Translator Possible Benchmark 1
- LT-UNK - List Translator Benchmark Unknown
- Benchmark U
- Benchmark 2
- Benchmark 3
- Benchmark 4

For more information visit www.greenscreenchemicals.org.

Hazard Levels & color-coded Priority Levels & the GreenScreen

There is currently no single, comprehensive governmental list or database that assesses and rates all chemicals across all chemical hazards. The Pharos CML begins to address this problem by combining many single endpoint lists into one combined database that provides a view across endpoints. The CML then applies a hazard ranking system based largely on the protocol of the GreenScreen for Safer Chemicals.

The first step of this ranking process starts is to characterize the **Hazard level** of a chemical for a single health endpoint – the potential of the chemical to trigger the human health problem, such as cancer or asthma, an ecotoxicity problem or an environmental fate such as persistence or bioaccumulation. Hazard is ranked on a five-step scale from Very High to Very Low.

Hazard Level (High to Low)

- Very High Hazard
- High Hazard
- Moderate Hazard
- Low Hazard
- Very Low Hazard
- Potential Concern

Pharos assigns a level of hazard for a substance relative to an endpoint based on its potency and on scientific certainty. For most of the endpoints in Pharos, these levels are defined by the GreenScreen protocol which in turn is largely aligned with the US EPA Design for the Environment program levels. In these schemes, some endpoints are only ranked on three or four levels of the Very High-High-Medium-Low-Very Low scale.¹⁰ The **GreenScreen List Translator**¹¹ assigns hazard levels to each of the lists used in the GreenScreen. Pharos uses the List Translator hazard levels for all shared lists. Where the range is too large for the GreenScreen to establish a benchmarking level and is left unspecified, Pharos generally tags the listing with “Potential Concern” but establishes levels for some lists by expert judgment¹². The GreenScreen generally does not establish benchmarking hazard levels for hazard lists which are based upon multiple endpoints (such as PBT lists). Pharos uses staff expert judgment to establish the hazard level for these and for lists not evaluated in the GreenScreen List Translator.

¹⁰ Cancer, mutagenicity, reproductive toxicity and endocrine disruption stop at High hazard level and only PBT, ODP & GWP have a Very Low hazard level

¹¹ See GreenScreen List Translator for GreenScreen associations of lists and hazards with hazard levels and benchmarks. List Translator available at <http://www.greenscreenchemicals.org>

¹² For many of listings which do not rate GreenScreen Benchmark 1 (i.e., Possible BenchMark 1 and BenchMark Unspecified) the GreenScreen provides a range instead of an absolute hazard level. Refer to the GreenScreen List Translator to confirm if the Hazard level is an absolute or a range. In certain of the range cases, such as Asthmagens - a high priority for many Pharos users - Pharos may take the precautionary step of benchmarking the listing at the higher of the two in the range instead of the GreenScreen norm of the lower. Also where the range is Moderate or Low, the Pharos may exercise judgment to categorize it at Moderate to indicate some remaining concern.

Priority level (color codes)

Purple	Urgent Concern to avoid
Red	Very High Concern to avoid
Orange	High Concern to avoid
Yellow	Moderate concern to avoid
Grey	Wide range of possible hazard levels
Blue	Potential Concern. Included on a Restricted Substances List for avoidance, monitoring, or careful management
Green	Low Concern for this endpoint

Pharos uses a color-coded ranking system to prioritize between similar hazard levels for multiple health endpoints. This system provides guidance for how to prioritize chemicals of concern for avoidance and substitution.

Pharos bases its rankings on the GreenScreen for Safer Chemicals protocol that rates toxicants that are persistent and bioaccumulative and/or have a high hazard of certain chronic diseases that tend to do irreversible damage (the Group I Human health endpoints including cancer, mutagenicity, reproductive and developmental toxicity and endocrine activity) as a higher concern than chemicals that break down rapidly or are related to other more reversible human health problems. In Pharos, The PBTs rank highest. The result is that:

- A high hazard PBT (persistent bioaccumulative toxicant) is rated at the highest priority level – a **purple** Urgent Concern.
- A high hazard carcinogen will be rated at the next highest priority level - a **red** Very High Concern.
- A high hazard respiratory sensitizer will be rated at the next highest priority level - an **orange** High Concern.
- A high hazard skin irritant will be rated at the second lowest priority level – a **yellow** Moderate Concern

The following chart indicates how very low to very high hazard levels for endpoints are prioritized into levels of concern for substitution. “Potential concern” is discussed later in this document

	PBT	Ozone & GW	CMR+E	Single Exposure	Repeated exposure	Physical hazard	Ecotoxicity
Purple Urgent Concern	vH/H	vH					
Red Very High Concern	*vH/H	H	H				
Orange High Concern	M	M	M	vH	vH/H	vH/H	vH
Yellow Moderate Concern		M		M/H	M	M	M/H
Green Low Concern	L/L	L/L	L	L	L	L	L

PBT = Persistent Bioaccumulative toxicant * PBTs identified as vH or H by modelling instead of direct measurement
Ozone & GW = Ozone depletion & global warming
CMR+E = GreenScreen Group I Human: Cancer, Mutagenicity / Genotoxicity, Reproductive toxicity, Developmental toxicity, Endocrine activity
Single exposure = GreenScreen Group II Human: Acute Mammalian Toxicity, Systemic Toxicity/Organ Effects-Single Exposure, Neurotoxicity-Single Exposure, Eye Irritation and Skin Irritation.
Repeated Exposure = GreenScreen Group II* Human: Systemic Toxicity/Organ Effects-Repeated Exposure (including Immune System Effects), Neurotoxicity-Repeated Exposure, Respiratory Sensitization, Skin Sensitization
Physical Hazard = Flammability & Reactivity
Ecotoxicity = Acute & chronic toxicity

In the following sections, each Priority level is described in detail to outline which health endpoints and hazard levels are included in that Priority level

Purple

Urgent Concern to avoid – Material of urgent concern due to combinations of known high persistence, bioaccumulation and/or toxicity (PBT) or extremely high global warming or ozone depletion potential. Avoid immediately.

PBT substances in the Pharos Purple *Urgent Concern* level do not break down rapidly in the environment to more benign substances therefore accumulate and concentrate as they work up the food chain. These chemicals are those classified as known to be one of the following:

- Persistent, Bioaccumulative and Toxic (PBT)
- or any two of the criteria in combination:
- very Persistent and very Bioaccumulative (vPvB)
- very Persistent and Toxic (vPT), or
- very Bioaccumulative and Toxic (vBT)

The authoritative lists which Pharos uses to categorize chemicals at Pharos Purple *Urgent Concern* level also generally are categorized at a Benchmark 1 by the GreenScreen. Pharos differs from GreenScreen in separating PBT listed chemicals from other priority human health listed chemicals. This is because the fact that these chemicals are persistent and/or bioaccumulative means they will tend to be distributed more widely in geography and time before being broken down into more benign forms and hence have more opportunity to do harm.

Global warming and ozone depletion are not included in GreenScreen at this time but are rated by Pharos. Gases with very high hazard due to their potency with GWP greater than 10,000 or ODP greater than 0.2 – are categorized at the Pharos Purple *Urgent Concern* priority level.

Red

Very High Concern to avoid - Material of very high concern due to its likelihood of causing priority human health effects or of its very high global warming or ozone depletion potential or its extremely high acute environmental toxicity. High priority to eliminate.

The criteria for the Pharos Red *Very High Concern* level are aligned with the single endpoint criteria for **GreenScreen Benchmark 1: Avoid - Chemical of High Concern:**

- **Very High or High hazard** of a priority human health endpoint (**GreenScreen Group I Human**)

Other GreenScreen Benchmark 1 criteria address combinations of persistence and bioaccumulation with toxicity. Pharos categorizes all substances listed on authoritative PBT lists in the Pharos Purple *Urgent Concern* category described above. Pharos does not provide assessments by multiple endpoints at this time. As full GreenScreen assessments are published, however, substances which are assessed at a GreenScreen Benchmark 1 will be categorized at the Pharos Red *Very High Concern* level unless they are already categorized at the Pharos Purple *Urgent Concern* level by authoritative listing.

Substances are categorized at the Pharos Red *Very High Concern* level if they have been identified as known or likely to lead to a **priority human health effect**, defined as a **high hazard** of the **GreenScreen Group I Human** hazard endpoints:

- **Cancer** (carcinogenicity)
- **Gene mutation** (mutagenicity/genotoxicity)
- **Reproductive or developmental toxicity** (harms the reproductive system, interferes with reproduction or development of the fetus or young developing child. The above group of effects is sometimes referred to as “CMRs”) and
- **Endocrine activity** (interferes with hormones and other endocrine functioning)

“Known or likely potential” of the effects are typically characterized on a hazard list with any of the following terms:

- “Known” (as in “Known carcinogen”)
- ”Known to be” (as in “Known to be carcinogenic”)
- “Is”
- “Probable”
- “Likely”
- “Presumed”
- “Reasonably anticipated”
- “Strong” (strength of evidence in CHE list)

Substances may also be categorized at the Pharos Red *Very High Concern* level if they have been identified as:

- **likely PBTs, through modeling** activities, such as QSAR,¹³ or screening level testing, but not yet confirmed by controlled testing, or
- having significant **PBT characteristics** in scientific studies, but have not yet been listed by a governmental hazard listing organization.

Global warming and ozone depletion gases of high hazard due to their potency with GWP between 1,000 and 10,000 and ozone depletion gases with ODP less than 0.2 – also are categorized at the Pharos Red *Very High Concern* level.

Unlike GreenScreen Benchmark 1, **acute aquatic toxicants with extremely high potency** (EU H-Statement M Factor of 100 or greater) are also included in the Pharos Red *Very High Concern* level. Note that acute aquatic toxicants can receive a GreenScreen Benchmark 1 if they are also very high persistence or very high bioaccumulation or high persistence and bioaccumulation. Pharos does not support this type of multiple factor assessment at this time.

Orange

High Concern to avoid – Possible association with priority health effects or high potency for other acute or chronic human health effects or very high ecotoxicity or high global warming potential, flammability or reactivity. Next priority for substitution.

The criteria for the Pharos Orange *High Concern* level are aligned with the single endpoint criteria for **GreenScreen Benchmark 2: Use but Search for Safer Substitutes:**

- **Moderate hazard** of a priority human health effect (**GreenScreen Group I Human**) or
- **Very High or High hazard** of other chronic human health effects (**GreenScreen Group II* Human**)
- **Very High or High hazard** of **flammability or reactivity**
- **Very high hazard** of **ecotoxicity**
- **Very high hazard** of other acute human health effects (**GreenScreen Group II Human**)

Substances are categorized at the Pharos Orange *High Concern* level if they have been classified as suspected to possibly lead to any of the **priority human health effects** listed above under the Red *Very High Concern* level (the GreenScreen Group I Human health effects category). “Suspected association” with the priority health effects can be characterized on a hazard list with any of the following terms:

- “Possible”
- “Suggestive”
- “Suspected”
- “May cause”
- “Limited evidence”
- “Danger of”
- “Good ” (strength of evidence in CHE list)

¹³ QSAR which identify structural similarity between the targeted substance and other known toxicants

Substances are categorized at the Pharos Orange *High Concern* level if their level of potency for the following acute and chronic human health effects is defined as

a **very high hazard** of the **GreenScreen Group II Human** hazard endpoints:

- Acute Mammalian Toxicity
- Systemic Toxicity/Organ Effects-Single Exposure
- Neurotoxicity-Single Exposure
- Eye Irritation and Skin Irritation.

or

a **high hazard** of the **GreenScreen Group II* Human** hazard endpoints:

- Systemic Toxicity/Organ Effects-Repeated Exposure (including Immune System Effects)
- Neurotoxicity-Repeated Exposure
- Respiratory Sensitization
- Skin Sensitization

Substances are also categorized at the Pharos Orange *High Concern* level if they meet GreenScreen Benchmark 2 criteria for ecotoxicity, flammability or reactivity –

a **high hazard of flammability or reactivity**

or

a **very high hazard of ecotoxicity**, including:

- Acute Aquatic Toxicity
- Chronic Aquatic Toxicity
- Ecotoxicity

Substances may also be categorized at the Pharos Orange *High Concern* level if they have been identified through modeling activities, such as QSAR, or screening level testing, as likely associated with a priority health concern but not yet confirmed by controlled testing, or

Global warming gases of medium hazard due to their potency with GWP between 100 and 1000 – also are categorized at the Pharos Orange *High Concern* level.

Other GreenScreen Benchmark 2 criteria address combinations of persistence and bioaccumulation with toxicity. Pharos does not provide assessments by multiple endpoints at this time. As full GreenScreen assessments are published, however, substances which are assessed at a GreenScreen Benchmark 2 will be categorized at the Pharos Orange High Concern level.

Pending the publication of full GreenScreen assessments of chemicals, categorization in this level of concern is determined solely by the use of authoritative lists, not by the full toxicological assessment as defined under the GreenScreen. A Pharos Orange High Concern level categorization should not be assumed to be a final assessment of the level of concern, but rather is a minimum rating of concern. Substantial gaps exist in data for most chemicals in use today. It is possible that with further study, any orange chemical may be demoted to the red or even purple level either due to its listing on an authoritative list or due to the publication of a GreenScreen assessment that identifies further hazards than authoritative listings have previously revealed.

Chemicals on lists assessed by GreenScreen at Possible GreenScreen Benchmark 1 will be categorized at least in the Pharos Orange High Concern level categorization and may move up to red or purple if they meet criteria above.

Yellow

Moderate concern to avoid - Known acute health effects, known ecotoxicity, suspected other chronic (non priority) health effects, moderate global warming or very preliminary data of possible association with priority health effects. Avoid when possible.

The criteria for this category are aligned with the criteria for **GreenScreen Benchmark 3: Use but Still Opportunity for Improvement**. Criteria are:

- **Moderate or High hazard of ecotoxicity**
- **Moderate hazard** of other chronic human health effects (GreenScreen Group II or II* Human) or
- **Moderate flammability or reactivity**

Substances are categorized at the Pharos Yellow High Concern if their level of potency for the following acute and chronic human health effects is defined as

a **high or moderate hazard** of the **GreenScreen Group II Human** hazard endpoints:

- Acute Mammalian Toxicity
- Systemic Toxicity/Organ Effects-Single Exposure
- Neurotoxicity-Single Exposure
- Eye Irritation and Skin Irritation

or

a **moderate hazard** of the **GreenScreen Group II* Human** hazard endpoints:

- Systemic Toxicity/Organ Effects-Repeated Exposure (including Immune System Effects)
- Neurotoxicity-Repeated Exposure
- Respiratory Sensitization
- Skin Sensitization

This category is informed by the GreenScreen Benchmark 3: *Use but Still Opportunity for Improvement*, but is determined solely by the use of authoritative lists pending the publication of full GreenScreen assessments of chemicals, not by full toxicological assessment as required under the GreenScreen and should not be assumed to be a final assessment of concern, but rather is a minimum rating of concern. Substantial gaps exist in data for most chemicals in use today. It is possible that with further study that any yellow chemical may be demoted to the orange, red or even purple level either due to its listing on an authoritative list or due to the publication of a GreenScreen assessment that identifies further hazard than authoritative listings have previously revealed.

This category also includes substances about which sufficient concern about a potential priority health effect has been raised for them to be considered by at least one of the governmental hazard listing organizations, but the organization has not yet found adequate data to characterize the hazard. Substances in this category can be characterized on a hazard list with any of the following terms:

- “Unknown”
- “Not classifiable”

Substances are also categorized at the yellow moderate concern category if they have been listed by a governmental hazard listing organization for a priority health effect, but subsequently delisted due to a determination that evidence does not reach the threshold for listing, but which have not been clearly established to *not* be associated with the health effect.

If there are preliminary indications of concern for priority health endpoints but only from a small number of tests with too little data to confidently determine higher concern, such as substances on lists derived from a literature searches (like CHE) that characterize the data as:

- “Weak” or “Limited”

Global warming gases of medium hazard due to their potency with GWP between 10 and 100 – also are categorized at the Pharos Yellow *Moderate Concern* level.

- Grey: Lists are colored Grey for one of a few reasons
- The sublist covers 3 or more hazard levels or
 - The sublist hazard level is ambiguous (e.g. “inadequate information to assess carcinogenic potential”)
 - a hazard warning on an authoritative list that has been suspended or temporarily withdrawn or
 - a hazard warning with an ambiguous hazard level or
 - a listing where the conclusion of the agency is that the evidence was insufficient for a conclusion about the hazard level of the substance or or
 - The sublist endpoint is Persistent (but not Bioaccumulative) or
 - The sublist endpoint is Bioaccumulative (but not Persistent)

Grey

Uncertain Concern - Lists can be colored Grey for one of a number of reasons:

- The sublist covers 3 or more hazard levels
- The sublist hazard level is ambiguous (e.g. “inadequate information to assess carcinogenic potential”)
 - a hazard warning on an authoritative list that has been suspended or temporarily withdrawn
 - a hazard warning with an ambiguous hazard level
 - a list included in the GreenScreen List Translator with an “Unspecified” hazard level
 - a listing where the conclusion of the agency is that the evidence was insufficient for a conclusion about the hazard level of the substance
- The sublist endpoint is Persistent (but not Bioaccumulative)
- The sublist endpoint is Bioaccumulative (but not Persistent)

Green

Low Concern - Material studied and found not to cause the specifically listed health impact. Not an indicator of likelihood of other health impacts *unless* the chemical has passed **GreenScreen Benchmark 4 Prefer – Safer Chemical**. Watch for other hazards.

This category identifies that the issuer of the hazard list has reviewed testing of the substance and determined that there is sufficient evidence that the substance does not cause the health impact listed. This judgment is limited to the specifically identified health effect and does not in any way imply that the substance is ‘green’ or safe in regard to other health effects. There may be other health impacts associated with this material. For example a chemical may get a green code on cancer, but a red code on reproductive toxicity.

Exposure & Risk: The Pharos color coding characterizes a relative hazard concern level based upon the manner in which the substance is listed on each authoritative hazard list. Presence is sufficient and is not adjusted by concentration or amount. Exposure pathways and risk assessment are not a factor. The relatively low concern color codes (yellow and green) imply no warranty of the overall safety of the substance.

Restricted Substance lists & the Blue Concern Level

Chemical hazard lists color-coded as indicated in the previous section identify an authoritative scientific judgment on the relationship between a substance and one (or a specific limited set) of health endpoints. Chemical hazard lists may be regulatory or they may just be informative. An additional color is reserved, however, for indications of potential concern with a substance which cannot be pegged to a specific concern level in the above protocol. Lists of chemicals may be included here in the near future with associations due to preliminary science which has not been reviewed through the consensus bodies engaged with most of the above authoritative hazard warning lists. The blue color code, however, is currently primarily used for tagging Restricted Substance Lists (RSL). RSLs are primarily policy decisions, rather than scientific judgments, identifying substances for avoidance, monitoring or careful management.

Blue

Potential Concern – A substance identified for avoidance, monitoring and/or careful management on a Restricted Substance List (RSL), generally due to multiple endpoints and/or other hazard lists or being identified as raising preliminary concerns due to emerging science.

This formerly was also used to indicate the following hazards, which have now been assigned to “Grey”

- a hazard warning on an authoritative list that has been suspended or temporarily withdrawn or
- a hazard warning with an ambiguous hazard level or
- a listing where the agency states that the evidence was insufficient for a conclusion about the hazard level of the substance

RSLs may reflect a policy statement by a:

- non profit organization such the International Living Future Institute Living Building Challenge Red list or
- for profit company, such as Perkins + Will Architecture Precautionary List or
- governmental agency, such as the European Commission’s Directive on the Restriction Of the use of certain Hazardous Substances (ROHS).

RSLs are often based upon a synthesis of scientific judgments, but most do not add new scientific assessment about a substance’s relationship to a specific health endpoint. These RSLs receive the blue level of concern color and are not included in the Pharos scoring system, but are provided solely for informational purposes.

There are two categories of RSLs in which new assessment is involved and the blue color is not used.:

Some RSLs are color-coded with a purple to yellow specific level of concern instead of the blue level when the listing has been assigned a specific hazard level and Benchmark in the GreenScreen.

Some RSLs are color-coded green when they are positive lists that exempt a substance from regulation or management due to an inherently low hazard in one or more endpoints or characteristics. This should not be interpreted as necessarily meaning that the substance has been cleared of concern at all endpoints unless a full GreenScreen has been undertaken. Watch for other flags.

The blue color-coded concern level is not displayed in the Material Contents list of a product profile unless no other colors trump it in the display.

RSL lists currently scanned include:

1. **BIFMA - e3/level Annex B list of chemicals.** BIFMA - e3/level Annex B list of chemicals, Business and Institutional Furniture Manufacturers Association (BIFMA)
2. **C2C Certified - Banned List v3.** Cradle to Cradle Certified Product Standard v3 Banned List, Cradle to Cradle Products Innovation Institute (C2CPII)
3. **C2C Certified - Basic RSL v4.** Cradle to Cradle Certified Product Standard v4 Basic Restricted Substances Lists - v4, Cradle to Cradle Products Innovation Institute (C2CPII)

4. **CA SCP - Candidate Chemicals. Safer Consumer Product Candidate Chemicals**, California Department of Toxic Substance Control (CA DTSC)
5. **CPA - Chemical Footprint CoHC 2016/17**. Chemical Footprint Project - Chemicals of High Concern (CFP CoHC) 2016 & 2017, Clean Production Action (CPA)
6. **EC - CEPA Toxic Substances (Sched 1)**. Canadian Environmental Protection Act (CEPA) - Environmental Registry - Toxic Substances List (Schedule 1), Environment Canada & Health Canada (EC)
7. **EC - Virtual Elimination List**. Canadian Environmental Protection Act (CEPA) - Environmental Registry - Virtual Elimination List, Environment Canada & Health Canada (EC)
8. **EU - Cosmetics Regulation Annex II**. EU - Cosmetics Regulation Annex II, European Union / European Commission (EU EC)
9. **EU - PACT-RMOA Substances**. Public Activities Coordination Tool for Risk Management Option Analysis, European Union / European Commission (EU EC)
10. **EU - REACH Annex XVII non-CMRs**. Restrictions On The Manufacture, Placing On The Market And Use Of Certain Dangerous Substances, Preparations And Articles - Excluding Carcinogens, Mutagens & Reproductive Toxicants, European Union / European Commission (EU EC)
11. **EU - REACH Exemptions**. Commission Regulation (EC) No 987/2008 Annex I & 2 Exemptions from the Obligation to Register in accordance with REACH article 2(7)a, European Union / European Commission (EU EC)
12. **EU - ROHS**. Directive on the Restriction Of the use of certain Hazardous Substances in electrical and electronic equipment ANNEX II Version 2.0, European Union / European Commission (EU EC)
13. **German FEA - Substances Hazardous to Waters**. Administrative Regulation on the Classification of Substances hazardous to waters into Water Hazard Classes (Verwaltungsvorschrift wassergefahrdende Stoffe - VwVwS), German Federal Environment Agency (FEA)
14. **GSPI - Six Classes of Problematic Chemicals**. Six Classes of Problematic Chemicals, Green Science Policy Institute (GSPI)
15. **HBN - Priority Asthmagens**. HBN Priority Building Material Asthmagens List, Healthy Building Network (HBN)
16. **Health Canada - Cosmetic Ingredient Hotlist**. Health Canada - Cosmetic Ingredient Hotlist, Health Canada
17. **Living Future - Living Building Red List**. Living Building Challenge 2.1 - Red List of Materials & Chemicals, International Living Future Institute (ILFI)
18. **Living Future - Living Building Red List**. Living Building Challenge 3.0 - Red List of Materials & Chemicals, International Living Future Institute (ILFI)
19. **MDH - Chemicals of High Concern and Priority Chemicals**. Minnesota Department of Health - Chemicals of High Concern and Priority Chemicals, Minnesota Department of Public Health
20. **ME DEP - Chemicals of High Concern and Priority Chemicals**. Maine Department of Environmental Protection - Chemicals of High Concern and Priority Chemicals, Maine Department of Environmental Protection
21. **P+W - Precautionary List**. Precautionary List, Perkins+Will (P+W)
22. **SCHF - Hazardous 100**. Hazardous 100+ List of Chemicals of High Concern, Safer Chemicals, Healthy Families (SCHF)
23. **SCJ - Potential Skin Allergens**. Potential Skin Allergens in SC Johnson products, SC Johnson
24. **UNEP - PIC Annex III**. Rotterdam Convention Prior Informed Consent (PIC) Annex III Chemicals, United Nations Environment Programme (UNEP)
25. **US EPA - DfE SCIL**. Safer Chemical Ingredients List (Positive List), US Environmental Protection Agency (US EPA)
26. **US EPA - Exempt VOCs**. VOCs exempt from smog regulation because of negligible photochemical reactivity, US Environmental Protection Agency (US EPA)
27. **US EPA - Hazardous Air Pollutants**. Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants, US Environmental Protection Agency (US EPA)
28. **US FDA - Antimicrobials Banned in Antiseptic Washes**. US FDA - Antimicrobials Banned in Antiseptic Washes, US Food and Drug Administration
29. **US OSHA - Carcinogens**. TRI Carcinogens, US Department of Labor

30. **USGBC - LEED Pilot Credits.** LEED Pilot Credits: Chemical Avoidance in Building Materials, US Green Building Council (USGBC)
31. **WA DoE - Chemicals of High Concern to Children.** WA Department of Ecology - WA - Chemicals of High Concern to Children, Washington State Department of Ecology (WA DOE)
32. **ZDHC - MRSL V1.1.** ZDHC Manufacturing Restricted Substances List V1.1, Zero Discharge of Hazardous Waste Chemicals Programme

Compound groups

Many materials are identified on chemical hazard lists individually and referenced by their specific CAS Registry Number (often called just CAS number or CASRN). Currently the CML provides complete listings of all chemicals listed directly by CAS number in the hazard list. In other cases, a hazard list will identify a group of structurally similar compounds (such as lead compounds) as all having the same hazard. In rare cases, a hazard list provides an exclusive list of chemicals to populate its group, so Pharos designates that group as 'fixed' and no other chemicals are added. More often than not, the hazard list does not specify the members of these groups, so in those cases the Pharos staff has populated the groups using a variety of strategies:

1. If the group is based on a common structure or element, that is used to search chemical databases such as PubChem for matches, and the matches are imported into Pharos to populate the group.
2. When a group's structure is too complex or varied for a chemical search, Pharos staff use lists compiled by government and other authoritative sources to populate the group. For example, [Highly Fluorinated Substances](#) was populated using multiple sources including a Swedish Chemicals Agency (KEMI) Report, and [Nonylphenol ethoxylates \(NPEs\)](#) was populated using multiple sources including the 2016 Global Automotive Declarable Substance List (GADSL)..

Click [here](#) for a full list of chemical groups in Pharos. You can see the definition of a group (how it was populated) on its General Information tab, eg [Lead Compounds](#). The members of the group are shown in the Compound Group Members tab. The Compound Groups tab on the Chemical Profile page indicates the name of any compound group of which this material is a member. Hazard warnings are tagged to indicate if they are applied to a substance because of its membership in a compound group.

Populating these groups is an ongoing project. Contact Michel Dedeo at HBN for more information on this project.

Process Chemistry health hazards (formerly Life Cycle)

Summary

Pharos displays process chemistry information in the Process Chemistry Research tab of the Chemical Profile. The page is broken into three tables:

1. "Known and Potential Residuals" lists the upstream process chemicals that our research indicates were used to make the chemical in question, and are more likely to be present as residuals.
2. "Other" lists the upstream process chemicals that our research indicates were used to make the chemical in question, but are less likely to be present as residuals.
3. "This material is used in the process chemistry of" lists the downstream chemicals that the chemical in question may be used to synthesize.

Clicking on the icon in the "Notes" column displays the reference(s) used to assign a process chemistry relationship. The logic for how process chemicals are divided into "Known and Potential Residuals" vs "Other" is described in the table below.

Background

HBN compiles information on the process chemicals involved in the production of key materials in the Pharos database. These process chemicals are used, created and emitted during the extraction, harvesting and manufacturing of a material and may pose occupational safety hazards to those who work in the mines, agricultural fields, and factories, and those who live in the nearby communities. Pharos does not currently address chemicals involved in the disposal or degradation of products.

Primary resources for this research are:

- the National Library of Medicine's Hazardous Substances Databank at: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> and
- the NREL US LifeCycle Inventory Database at <http://www.nrel.gov/lci/database/default.asp> and a variety of other governmental and non governmental information sources.

Each chemical record is a work in progress and does not necessarily represent all chemicals that may be used, in the production of a material. We welcome submissions and suggestions to improve our process chemistry inventory data.

The process chemistry information listed here is for generic versions of the material. In cases where there are multiple chemical synthesis pathways for manufacturing the material, the record may include information on multiple pathways and will indicate which chemicals are integral and hence used all the time and which ones represent options and will only be used in some instances. Manufacturers will have the option to improve scoring of a product by providing product specific process chemistry information when they can document that their supply chain does not use certain chemicals of concern.

Focusing on the chemicals used in building products, Pharos attempts to record all chemical inputs at all steps from the chemical transformation of the feedstocks through to the end of manufacture of the final material. These characterizations vary widely in their detail and level of completeness. Chemicals are categorized using the 14 process chemistry material types tabulated below:

Process Chemistry Type	Definition	Example	Known and Potential Residual
Reactant	A chemical that reacts to form another chemical that is not a polymer. Formerly feedstocks and intermediates.	Chlorine is a reactant in the synthesis of chloroprene.	No
Monomer	A chemical that reacts to form a polymer	Vinyl chloride is a monomer of polyvinyl chloride	No
Catalyst (homogeneous/unstructured unknown)	Substance that increases the rate of a reaction without being consumed. Usually used in small amounts relative to the reactants. Homogeneous catalysts are generally more difficult to separate from a reaction	Sodium hydroxide is a catalyst when making biodiesel	Yes
Catalyst (heterogeneous/structured)	Substance that increases the rate of a reaction without being consumed. Usually used in small amounts relative to the reactants. Heterogeneous/structured catalysts are a different phase from the reactants and designed to be separated from their reaction. These would therefore be less likely to be present at relevant levels in the final product.	Supported Nickel is a catalyst for hydrogenated soybean oil	No
Additive nonreactive	Chemical that is added to provide specific characteristics to the final compounds and remains in the form in which it was added	Phthalate plasticizers are nonreactive additives to soften plastics	Yes
Additive reactive	Chemical that is added to a compound and reacts with another additive to produce a different compound	TBBPA is a reactive additive in printed circuit boards	No
Byproduct	Substance generated from production that is not useful to production of the target material and that is used in other processes or managed as waste or released into the work environment or released to the outdoor environment.	Glycerol is a byproduct of making biodiesel from vegetable oil	Yes
Pollutant/Contaminant	Unintentional and unwanted substance that comes mixed with the target material. May originate from contaminants to the original feedstock or as a byproduct of the chemical processes that are used to create the material.	2,4dichlorophenol is a pollutant/contaminant for Triclosan	Yes
Unknown role	A chemical whose role is unknown.		No
Process aid	Chemical added to provide specific characteristics	Lead is used as a	Yes

	during manufacturing	process aid in PVC processing	
Product of a reversible reaction	Reactants that reappear because they are part of a reversible reaction / equilibrium process.	Formaldehyde released from urea/phenol formaldehyde resin	Yes
Solvent	Liquid (usually) used to dissolve chemicals and facilitate a reaction. Also present as the 'fluid' in fluid applied products	Benzene is a solvent for polyethylene	No
Component	An often desirable chemical present in a mixture that does not undergo reaction. Like a contaminant but makes up a larger fraction of the mixture.	Benzene is a component of petroleum distillates	Yes
Initiator	A chemical used to initiate a chain reaction, common in polymerizations	Hydrogen peroxide is an initiator for polytetrafluoroethylene	No

All of these chemicals create potential exposure issues for the workers and to neighboring communities (if emitted). The reactants, monomers, structured catalysts, reactive additives, solvents, and initiators generally do not end up in products so are not an exposure concern for users. Unstructured catalysts, byproducts, contaminants, process aids, products of reversible reactions, and components sometimes end up in products, usually in trace amounts. Non reactive additives are frequently intended to end up in products in amounts that range from trace to very large percentages.

Lifecycle Frequency: a substance's use or creation in the manufacturing process is characterized by how common it is. The frequency determines if the hazard is included in the Manufacturing Hazard dot.

Frequency	Definition	Included in Manufacturing Hazard dot?
Unknown	No known use in manufacturing or unclear.	No
Occasional/Rare	A substance that is only infrequently used – found in less than one third of the manufacturing processes references researched.	No
Frequent	A substance that is commonly used associated with at least one third of the manufacturing process references researched	Yes
Integral	A substance that is necessarily inherent to the manufacture of this material and without which it would be a different material or for which no alternatives have been demonstrated.	Yes

Known Residual

Known residuals are chemicals from any source that testing consistently shows are residuals in another chemical. This is indicated by the word "(known)" in the frequency column of the process chemistry table. The hazards of known residuals are incorporated into the Residual Hazards dot.

Endangered Species

Endangered species identification and lists

Use of biobased materials whether from agricultural plants or from trees is appealing due to their renewable nature. Overharvesting, plantation farming, chemical use and other problems, however, threaten many species of trees with extinction as well as threatening entire forest habitats and the animals and humans that depend upon them.

A variety of state, national and international governmental bodies and non governmental organizations (NGOs) maintain endangered species identification lists. These are lists of plant and animal species for which an authoritative body has reviewed assessments of the health and distribution of the species and pressures on their native environment to identify species that are threatened with extinction and then categorized the species to identify the level of threat.

Pharos screens forestry products and other biobased materials against these authoritative lists to identify trees and other timber plant species that are directly endangered or are frequently harvested from threatened forest habitats. Some warnings are for a specific species and others are for groups of species

Wood is often very ambiguously named. Scientific names (genus and species, where species are names for related plants within a larger species group) should provide a consistent way of identifying a specific type of plant, but botanists frequently do not agree on the scientific naming of a plant. Trade names can be even more ambiguous. The same common trade name may refer to many different related species of wood and sometimes even totally unrelated species from a different genus. The Pharos staff is working to identify the different synonyms and scientific names that may apply to commercially available woods and cross-indexing them in the CML tool.

The CML may be searched by common trade names and by scientific names (genus & species). Pharos then searches based upon the variations on the common name and different applicable genus and species combinations to provide a range of possible warnings that may apply to the named wood. These warnings are color-coded to indicate the relative level of concern in Pharos of that warning. See the section below on “Pharos species warning levels of concern” for explanation of the color coding system.

Any wood species with an orange warning or higher should be avoided entirely unless its harvest was certified by a robust independent sustainable forestry certification system such as the FSC or better. Even yellow coded species should be used with caution and avoided when possible due to possible threats to endangered species and destruction of critical forest habitats.

Absence of a warning listing does not assure that a species is free of threats.

Wood naming is ambiguous and subject to confusion. Synonyms are prolific for many species. Many species have not yet been adequately assessed and building of this database is an ongoing process. Nonetheless for those wood needs for which supplies of sustainably harvested timber certified by FSC or better, this Library is the most comprehensive index of threat status for species of woods used in construction.

Species list status

As of the publication of this document, there were over 1000 species of trees and other building related plants in the biobased portion of the Library with hazard warnings on the majority of them. The following lists are scanned:

1. **IUCN Red List of Threatened Species** - International Union for Conservation of Nature and Natural Resources, Species Survival Commission
2. **UNEP WCMC CITES-listed Trees** - United Nations Environment Programme - World Conservation Monitoring Centre (WCMC)
3. **USDA Threatened & Endangered Trees Database** – US Department of Agriculture, Natural Resources Conservation Service
4. **WWF Tropical Wood Guide** - World Wildlife Federation
5. **FOE Good Wood Guide** – Friends of the Earth

Information describing each list, contact information for the issuer and its update status is available at <http://www.pharosproject.net/hazard>

Note that HBN is not currently updating the species lists.

Pharos species warning levels of concern

Species warnings are color-coded to indicate the Pharos system's prioritization of concern based upon the degree of the threat to the species. One of the most widely accepted criteria sets for rating the threat to endangered species is the IUCN Red List Categories and Criteria prepared by the Species Survival Commission of the IUCN (International Union for Conservation of Nature and Natural Resources).¹⁴ Pharos structures its prioritization of the relative significance of threats based upon the IUCN categories.

Purple

Extinct (EX) or Critically Endangered (CE) - species is extinct or facing an extremely high risk of extinction. Species that have been listed as extirpated in one or more US states (that is are locally extinct but may still be extant in other locations) are also included in this category.

Red

Endangered (EN) - species is facing a facing a very high risk of extinction. Pharos also places most endangered species warnings from organizations that do not use the IUCN classification system into this category. This also includes species that are endangered in one of more states, even if they may be abundant in other locations.

Orange

Vulnerable (VU) - species is facing a high risk of extinction. Frequently referred to as Threatened.

Yellow

Near Threatened (NT) - species is not yet considered vulnerable or endangered, but is close to qualifying for or is likely to qualify for a threatened category in the near future. Species not yet evaluated (NE) are included here. Data deficient species (DD) are also included in this category where more information is required and the possibility that future research will show that threatened classification is appropriate

Green

Least Concern (LC) – species is still widespread and abundant.

¹⁴ http://www.iucnredlist.org/about/red-list-overview#redlist_criteria