Tools for safer chemicals – from chemicals to products to organizations

February 25, 2021
Need to dramatically reduce the risks—the adverse human health and environmental effects—of toxic chemicals.

But preventing exposure to toxic chemicals through the development and use of inherently safer alternatives is difficult.

Therefore need tools that simplify the complexity of toxicity, and guide developers and users to safer alternatives.
Outline

• Clean Production Action (CPA) intro
• Key trends
• Chemical hazard-based tools to reduce risks

Chemical assessment
Product assessment
Organization assessment
Poll

• Have you heard of any of these chemicals or chemical classes before? Check all that you have heard of before:
  – Bisphenol A
  – Brominated flame retardants
  – Cadmium
  – Lead
  – Organohalogenes
  – Per- and poly-fluoroalkyl substances (PFAS)
  – Phthalates
The production, use and trade of chemicals are growing in all regions.

Chemical-intensive products and complex global supply chains create challenges for circularity.

Large amounts of chemical pollutants are released from production, products and wastes, illustrating the inefficient use of resources.

Chemical pollutants are ubiquitous in the environment and in humans.

Chemical pollution threatens biota and ecosystem functions.

The burden of disease from chemicals is high, and vulnerable populations are particularly at risk.

Deaths (total: 1.6 million) attributed to selected chemicals in 2016 (adapted from WHO 2018, p. 2)
Endocrine Disrupting Compounds (EDCs)

- Review of hundreds of studies on EDCs (2020)
- Growing evidence of adverse effects associated with exposure to EDCs — including per- and polyfluoroalkyl substances (PFAS), phthalates, bisphenols, organophosphate pesticides, and polybrominated flame retardants.
- Adverse effects include: obesity, diabetes, cardiovascular disease, IQ loss and intellectual disability, infertility, reduced semen quality, and cancer.


BOOK by Leonardo Trasande, MD, MPP
Sicker, Poorer, Fatter: The urgent threat of hormone-disrupting chemicals to our health and future ... and what we can do about it (2019)
NEW BOOK by Shanna H. Swan, PhD
Count Down: How our modern world is threatening sperm counts, altering male and female reproductive development, and imperiling the future of the human face (2021)
Persistence, Mobility, & PFAS

**Persistence** as a very important attribute of chemicals and materials (e.g., plastics & PFAS)

Mobile substances are of ‘equivalent concern’ to PBTs, say scientists
- PMTs (persistent, mobile, and toxic) chemicals
- very persistent, very mobile (vPvM)
- Equivalent to persistent, bioaccumulative and toxic (PBT) substances; and very persistent, very bioaccumulative (vPvB) substances

**PFAS** and their breakdown products are: very Persistent (vP), mobile (M), and/or toxic
- ~5000 substances = OECD
- Possibly >8000 substances
Chemical Classes of Concern— avoid regrettable substitutes

• Alkylphenols and Alkylphenol Ethoxylates
• Antimicrobials
• Azo dyes
• Bisphenols
• Metals and their compounds (e.g., antimony, cadmium, lead, organotins)
• Phthalates (ortho-phthalates)
• Organohalogens, including PFAS and halogenated flame retardants
• Siloxanes (cyclic volatile methyl siloxanes)
• Solvents (e.g., methylene chloride)
Drivers

- Regulations
- Market demands
- Financial risks

Global Regulations by subject: Cumulative totals
Trends in Chemicals Management

Hazard assessment: progress in information generation and hazard characterization

Assessment of chemical and non-chemical alternatives: focusing on solutions

The role of retailers in influencing upstream supply and procurement

The role of downstream product manufacturers and brands

Scaling up effective corporate governance and sustainable supply chain management

Using metrics to track progress and increase accountability
Q&A
Chemical Hazard Assessment

https://www.greenscreenchemicals.org/learn/full-greenscreen-method
Risk Assessment – dominant chemicals management and regulatory paradigm

Hazard
- Eliminate
  - by using safer alternatives to hazardous chemicals

Exposure
- Reduce
  - with PPE or engineering controls

Risk

More effective

Less effective

Reduce

15
Chemical Hazard-based Tools

Chemical hazard assessment: scores individual chemicals from 1-red to 4-green based on 18 endpoints

Product certification: evaluates all chemicals in a product based on a Restricted Substances List (RSL), List Translator Score, and hazard assessment benchmark score

Preliminary chemical hazard assessment score based on authoritative & screening lists

2007

2012

2017
# GreenScreen Hazard Endpoint System

<table>
<thead>
<tr>
<th>Human Health Group I</th>
<th>Human Health Group II and II*</th>
<th>Environmental Toxicity &amp; Fate</th>
<th>Physical Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinogenicity</td>
<td>Acute Toxicity</td>
<td>Acute Aquatic Toxicity</td>
<td>Reactivity</td>
</tr>
<tr>
<td>Mutagenicity &amp; Genotoxicity</td>
<td>Systemic Toxicity &amp; Organ Effects</td>
<td>Chronic Aquatic Toxicity</td>
<td>Flammability</td>
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<tr>
<td>Reproductive Toxicity</td>
<td>Neurotoxicity</td>
<td>Other Ecotoxicity studies when available</td>
<td></td>
</tr>
<tr>
<td>Developmental Toxicity</td>
<td>Skin Sensitization</td>
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<td>Persistence</td>
</tr>
<tr>
<td>Endocrine Activity</td>
<td>Skin Irritation</td>
<td></td>
<td>Bioaccumulation</td>
</tr>
<tr>
<td></td>
<td>Eye Irritation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hazard Assessment

GreenScreen® for Safer Chemicals

Benchmark Scores

- **Benchmark 1**: Avoid – Chemical of High Concern
- **Benchmark 2**: Use but Search for Safer Substitutes
- **Benchmark 3**: Use but Still Opportunity for Improvement
- **Benchmark 4**: Prefer – Safer Chemical

**Benchmark U** = Undetermined due to insufficient data
<table>
<thead>
<tr>
<th>Chemical</th>
<th>CASRN</th>
<th>Benchmark Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylene chloride</td>
<td>75-09-2</td>
<td>1</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>100-51-6</td>
<td>2</td>
</tr>
<tr>
<td>2-(2-butoxyethoxy) ethanol</td>
<td>112-34-5</td>
<td>2</td>
</tr>
<tr>
<td>Dimethyl sulfoxide (DMSO)</td>
<td>67-68-5</td>
<td>3</td>
</tr>
<tr>
<td>1,3-dioxolane</td>
<td>646-06-0</td>
<td>2</td>
</tr>
<tr>
<td>Estasol (dibasic esters mixture)</td>
<td>95481-62-2</td>
<td>2</td>
</tr>
<tr>
<td>d-Limonene</td>
<td>5989-27-5</td>
<td>2</td>
</tr>
<tr>
<td>Acetone</td>
<td>67-64-1</td>
<td>2</td>
</tr>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>1</td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>1</td>
</tr>
<tr>
<td>Formic acid</td>
<td>64-18-6</td>
<td>2</td>
</tr>
<tr>
<td>Caustic soda</td>
<td>1310-73-2</td>
<td>2</td>
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</table>
## GreenScreen® Evaluation of Methylene Chloride and Alternatives

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CASRN</th>
<th>Group I Human</th>
<th>Group II &amp; II Human</th>
<th>Ecotox</th>
<th>Fate</th>
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<tr>
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<td>M</td>
<td>R</td>
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<td>E</td>
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<td>NE</td>
<td>DG</td>
<td>DG</td>
<td>M</td>
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<tr>
<td>Benzyl alcohol</td>
<td>100-51-6</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>DG</td>
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<td>DG</td>
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<td>NA</td>
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<td>L</td>
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</tbody>
</table>
# TCO Certified Accepted Substance List

<table>
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<tr>
<th>Substance name/Trade name</th>
<th>CAS</th>
<th>Type</th>
<th>Benchmark</th>
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<tbody>
<tr>
<td>Aluminum diethylphosphinate</td>
<td>225789-38-8</td>
<td>FR</td>
<td>3</td>
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<tr>
<td>Aluminum Hydroxide</td>
<td>21645-51-2</td>
<td>FR</td>
<td>2</td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td>7723-14-0</td>
<td>FR</td>
<td>2</td>
</tr>
<tr>
<td>Bisphenol A diphosphate</td>
<td>181028-79-5; 5945-33-5</td>
<td>FR, PL</td>
<td>3</td>
</tr>
</tbody>
</table>

[https://tcocertified.com/accepted-substance-list/](https://tcocertified.com/accepted-substance-list/)
GreenScreen List Translator Automated Tools
Extruded Aluminum Louver with Fluropon Pure Finish by Industrial Louvers Inc.

CLASSIFICATION: 08 90 00
PRODUCT DESCRIPTION: This HPD was based on a model 653XP storm performance custom-sized but the material ingredients are the same regardless of size.

Section 1: Summary

CONTENT INVENTORY

Inventory Reporting Format
- Nested Materials Method
- Basic Method
Threshold Disclosed Per
- Material
- Product

Threshold level
- 100 ppm
- 1,000 ppm
- Per GHS SDS
- Per OSHA MSDS
- Other

Residuals/impurities
- Residuals/impurities Considered in 3 of 4 Materials
Are All Subs.
- Yes
- No

Character: Percent We

Screened
- Using Prior Results

Identified
- Name and i

Material | Substance | Residual or Impurity | GreenScreen Score | Hazard Type
--- | --- | --- | --- | ---
6063 ALUMINUM EXTRUSION | 6063 ALUMINUM (6063 ALUMINUM) | LT-P1 | END | PHY | TYPE 3003 ALUMINUM | 3003-H14 ALUMINUM (3003-H14 ALUMINUM) | LT-P1 | RES | PHY | END | FLUROPON PURE - EXTRUSION | POLYVINYLIDENE FLUORIDE (1,1-DIFLUOROETHENE HOMOPOLYMER) | LT-P1 | TITANIUM DIOXIDE | LT-1 | CAN | END ACRYLIC RESIN | NoGS | 2,2,4-TRIMETHYL-1,3-PENTANEDIOL DIISOBUTYRATE | LT-P1 | END BARIUM SULFATE | BM-2 | CAN ACRYLIC-MELAMINE RESIN | NoGS | TRIPHOSPHORIC ACID, ALUMINUM SALT | LT-UNK | STRONTIUM CARBONATE | LT-UNK | SILICA, AMORPHOUS | LT-P1 | CAN ALUMINIUM HYDROXIDE OXIDE | LT-UNK | WOLLASTONITE | LT-UNK | ZINC 5-NITROISOPHTHALATE | LT-UNK | ALUMINA TRIHYDRATE | BM-2 | RES | CELLULOSE ACETATE BUTANOATE, AVERAGE MOLECULAR WEIGHT 15000 - 65000 G/MOL | LT-UNK | FUMED SILICA, CRYSSTALLINE-FREE | LT-UNK | IRON HYDROXIDE OXIDE YELLOW | LT-UNK | CHROMIUM IRON OXIDE | LT-UNK | CHROMIUM (III) OXIDE | LT-P1 | FERRIC OXIDE | BM-2 | CAN CARBON BLACK | LT-1 | CAN C.I. PIGMENT BLUE 28 LT-UNK | 5,12-DIHYDROQUINO(2,3-B)ACRIDINE-7,14-DIONE LT-UNK | PHTHALOCYANINE GREEN LT-UNK | 5,12-DIHYDROQUINO(2,3-B)ACRIDINE-7,14-DIONE | LT-UNK | BISMUTH VANADIUM TETRAOXIDE LT-P1 | MUL C.I. PIGMENT BLUE 15 BM-3 | PYRROLO[3,4-C]PYRROLE-1,4-DIONE,3,6-BIS(4-CHLOROPHENYL)-2,5-DIHYDRO | LT-UNK | C.I. PIGMENT GREEN 50 LT-1 | RES | CAN | GEN RUTILE, ANTIMONY CHROMIUM BUFF LT-UNK | C.I. PIGMENT BLACK 28 LT-UNK | C.I. PIGMENT BLUE 36 LT-UNK | HEMATITE, CHROMIUM GREEN BLACK LT-UNK | MOLYDATE (M0424-), CALCIUM (1:1), (T-4)- LT-UNK | NICKEL RUTILE YELLOW LT-UNK | 2-(2-BUTOXYETHOXY)ETHANOL LT-P1 | EYE | END | 18-8 TYPE 304 STAINLESS FASTENERS | 304 STAINLESS STEEL (304 STAINLESS STEEL) NoGS
GreenScreen End Users

- Oregon Health Authority
- DSM
- Levi's
- Department of Ecology, State of Washington
- US Green Building Council
- Ø ZDHC
- HP
- HPDC
- H&M
- Apple
Hazard Assessment Summary

Hazard assessment

- Identify endpoints (e.g., 18 in GreenScreen)
- Specify levels of concern (e.g., High/Moderate/Low) and criteria for each level for each endpoint

Safer chemical

- Roll up endpoints into tiers ranging from high concern (Benchmark-1) to low concern (Benchmark-4)

https://www.greenscreenchemicals.org/learn/full-greenscreen-method
Product Assessment – based on chemical hazards

- Chemical inventory
- Restricted Substances List (RSL)
- Chemical hazard assessment & elimination of chemicals of concern
- Analytic testing
Simplify the complexity of toxicity for purchasers & provide manufacturers with incentives for disclosing chemicals in products, assessing hazards of those chemicals, and using safer chemicals
GreenScreen Certified™ for Firefighting Foam

1. All chemicals disclosed under confidentiality

2. Product meets Restricted Substances List requirements

3. All chemicals assessed for hazard using GreenScreen hazard assessment or List Translator

4. Product meets analytical testing requirements

Technical Peer Reviewers

Audrey Rossard, Technical Manager, Bio-Ex
Erika Schreder, Science Director, Toxic-Free Future
Holly Davies, Senior Toxicologist, Washington State Department of Health
Ian Ross, Global PFAS Lead, Arcadis
John Payne, Foam Research and Development Manager, Angus International Safety Group
Nigel Holmes, Principal Advisor Incident Management, Queensland Department of Environment and Science
Pamela Miller, Executive Director Alaska Community Action on Toxics and IPEN Co-Chair
Ted Schaefer, Principal Consultant, Global Foam Technology PL
William L. Scogin, President & CEO, Verde Environmental, Inc. (Micro-Blaze)
Chemicals Disclosed under Confidentiality

All chemicals disclosed under confidentiality:

- Intentionally added > 0 ppm
- Impurities > 100 ppm
Restricted Substances List (RSL)

1. Zero Discharge of Hazardous Chemicals MRSL (manufacturing RSL)
2. Alkylphenols and alkylphenol ethoxylates
3. Siloxanes: Cyclic volatile methyl siloxanes
4. PFAS: Per- and polyfluoroalkyl substances
5. Organohalogens
Product Analytical Testing Requirements

1. Acute aquatic toxicity
2. Total organic fluorine
Acute Aquatic Toxicity Testing

- Measured on product as sold
- Results required for fish, aquatic invertebrates, and algae
- LC50 or EC50 > 10 mg/L for all three types of organisms
Total Organic Fluorine Testing

• Measured on the product as sold (i.e., concentrate)
• Samples: Test samples from three different lots or batches
• **Requirement:** < 1 mg/kg (< 1 ppm) total organic fluorine
• Laboratory: international commercial laboratory
• Method: Combustion ion chromatography
Firefighting Foam:
- Launched in January 2020
- Certified 10 products

<table>
<thead>
<tr>
<th>Product</th>
<th>Company</th>
<th>Standard</th>
<th>Version</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondol ATF 3/3: Class B Foam Concentrate</td>
<td>Angus Fire Ltd.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>Jetfoam ICAO-C 6%: Class B Foam Concentrate</td>
<td>Angus Fire Ltd.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>Jetfoam ICAO-C 3%: Class B Foam Concentrate</td>
<td>Angus Fire Ltd.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>ECOPOL: Class B Foam Concentrate</td>
<td>BIOEX</td>
<td>Firefighting Foam</td>
<td>v1.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>GREENFIRE® FIREFIGHTING FOAM (GFF): Class B Foam Concentrate</td>
<td>Fire Suppression Innovations</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>UniversalF3 Green X3: Class B Foam Concentrate</td>
<td>National Foam, Inc.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
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<td>MuniF3 Green Plus 3%: Class B Foam Concentrate</td>
<td>National Foam, Inc.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
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<tr>
<td>AvioF3 Green KHC 6%: Class B Foam Concentrate</td>
<td>National Foam, Inc.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>AvioF3 Green KHC 3%: Class B Foam Concentrate</td>
<td>National Foam, Inc.</td>
<td>Firefighting Foam</td>
<td>v2.0</td>
<td>Bronze</td>
</tr>
<tr>
<td>Micro-Blaze Out: Class A&amp;B Wetting Agent</td>
<td>Verde Environmental, Inc</td>
<td>Firefighting Foam</td>
<td>v1.0</td>
<td>Bronze</td>
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</table>
## Summary Product Assessment Requirements for Firefighting Foam

<table>
<thead>
<tr>
<th>SECTION #</th>
<th>REQUIREMENTS</th>
<th>BRONZE</th>
<th>SILVER</th>
<th>GOLD</th>
</tr>
</thead>
</table>
| 6. Product Inventory | Product Inventory includes: 
  a. Additives Inventory: 100% of additives in the product are identified; and 
  b. Chemical Inventory: All intentionally added chemical compounds (present > 0 ppm) and impurities present at or above 0.01% by weight (100 ppm) in the additives are identified | ✓ | ✓ | ✓ |
| 7.1 Chemical Hazard Assessment | Intentionally added chemical compounds (>0 ppm) and impurities at or above 0.01% by weight (100 ppm) in the product are screened with GreenScreen List Translator™ | ✓ | ✓ | ✓ |
| | Intentionally added substances (>0 ppm) and impurities present at or above 0.01% by weight (100 ppm) in the product are assessed with GreenScreen | ✓ | ✓ | ✓ |
| | None of the chemical compounds screened have a GreenScreen List Translator™ score of LT-1 | ✓ | ✓ | ✓ |
| | None of the substances assessed have a GreenScreen score of Benchmark-1 | ✓ | ✓ | ✓ |
| | None of the substances assessed have a GreenScreen score of Benchmark-1, Benchmark-2, Benchmark-2_opt, or Benchmark-2_tr | ✓ | ✓ | ✓ |
| | Each substance meets US EPA Master Criteria for Environmental Toxicity and Fate | ✓ | ✓ | ✓ |
| | Each substance meets US EPA Safer Choice Criteria for Environmental Toxicity and Fate for Chemicals in Direct Release Products | ✓ | ✓ | ✓ |
| 7.2.1 Restricted Substances List | Product meets all Restricted Substances List (RSL) criteria and thresholds | ✓ | ✓ | ✓ |
| 7.2.2 Requirements for Microorganisms | Product meets requirements for microorganisms (if present) | ✓ | ✓ | ✓ |
| 7.2.3 Analytical Testing—Total Organic Fluorine | Product meets analytical testing requirements for total organic fluorine | ✓ | ✓ | ✓ |
| 7.2.4. Analytical Testing—Acute Aquatic Toxicity | Product-level acute aquatic toxicity LC50 or EC50 > 10 mg/L for each of the following groups of organisms: fish, aquatic invertebrates, and algae | ✓ | ✓ | ✓ |
Q&A
Organization assessment to safer chemicals
Chemical Footprint Project (CFP) Survey—holistic & hazard-based framework for assessing chemicals management in organizations

<table>
<thead>
<tr>
<th>Management Strategy</th>
<th>Chemical Inventory</th>
<th>Footprint Measurement</th>
<th>Disclosure &amp; Verification</th>
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<tr>
<td>20 points</td>
<td>30 points</td>
<td>30 points</td>
<td>20 points</td>
</tr>
<tr>
<td>4 questions</td>
<td>6 questions</td>
<td>5 questions</td>
<td>4 questions</td>
</tr>
<tr>
<td>26 potential actions</td>
<td>23 potential actions</td>
<td>26 potential actions</td>
<td>11 potential actions</td>
</tr>
</tbody>
</table>
$2 trillion in assets under management
- Investors = 46
  - Legal & General Investment Management
  - Aviva Investors
  - Bank J Safra Sarasin
  - Parnassus Investments
  - Impax Asset Management
  - Calvert Research and Management

$800 billion in purchasing power
- Health care = 14
- Retailers = 7
  - CVS Health
  - Dollar Tree
  - Rite Aid
  - Staples
  - Target
  - Walmart
  - Whole Foods Market

NGOs = 9
Governments/universities = 2

Signatories total = 78
New Responders

**MANAGEMENT STRATEGY**
- **Chemicals policy** includes reducing chemicals on chains and preference for safer alternatives in products.
- **Business strategy** includes screening for CoHCs in chemicals/materials.
- **External engagements** that support the reduction and disclosure of chemicals in products.
- **Accountability** actions include chemicals management responsibilities.

**CHEMICAL INVENTORY**
- **Restricted Substances List (RSL):** has a list of chemicals.
- **Compliance with RSL:** trains suppliers about how to comply.
- **Data collection:** collects chemical ingredient information.
- **Chemical Ingredient data management:** has integrated chemical information requirements.
- **Supplier conformance:** has an audit program to ensure compliance.

**FOOTPRINT MEASUREMENT**
- **Hazard assessment:** uses a system or tool to evaluate chemical risks.

*Returning responders excluding front-runners.*

32%
Returning Responders

*Returning responders excluding front-runners.
Front-runners

- Beautycounter
- Herman Miller
- HP
- Humanscale
- Naturepedic
- RB
- Seventh Generation
Front-runners

- Senior management leadership
- Board level engagement
- Restricted substances list (RSL) and manufacturing RSL (MRSL) disclosure
- Chemical footprint measurement
- Safer alternatives to CoHCs
- CFP Survey responses and score disclosure

>80%
Disclosure Leaders

- Beautycounter
- BD
- GOJO
- Herman Miller
- HP
- Humanscale
- Naturepedic
- Seventh Generation
- Walmart

https://www.chemicalfootprint.org/results/disclosure-leaders
Summary

- Chemical assessment
- Product assessment
- Organization assessment
Thank You!  Questions?

Mark S. Rossi, PhD
Executive Director
Clean Production Action
mark@cleanproduction.org