# **Product stewardship and chemicals of concern:** Challenges and strategies

Product Stewardship Centre of Excellence

WHITE PAPER

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Rachael Wakefield-Rann

## SUMMARY

Taking responsibility for hazardous chemicals along supply chains is an integral part of product stewardship. However, a number of challenges including lack of transparency, inadequate and inconsistent regulation, and lack of knowledge mean that many chemicals of concern remain in products. While government and consumer awareness around the issues are increasing, the challenge is even more pressing in a circular economy considering the potentially adverse impacts of circulating hazardous chemicals into recycled materials. This white paper outlines some of the key challenges associated with chemicals of concern and product stewardship and considers a few of the strategies being employed by government and industry to address them.

## INTRODUCTION

Safeguarding the long-term health of humans and the environment is an integral part of product stewardship. At present, there are still a range of chemicals of concern used across product[1] supply chains – from material extraction and manufacturing, to use and disposal – that are significantly impacting human and environmental health. Chemicals of concern are found in a high percentage of product supply chains, but have recently been flagged as particularly concerning in products such as toys, electronics, cosmetics, textiles, and packaging and containers that come in contact with food. As Australia moves further towards a circular economy, new concerns are emerging related to how these chemicals transition into second-life products through recycling and reuse, and how legacy chemicals accumulate in materials over repeated lifecycles in industrial and natural environments. Chemicals of concern are estimated to cost recycling industries billions of dollars each year in lost revenue and significantly undermine public and business trust in the circular economy.[2]

This white paper characterises the current issues for product stewardship associated with chemicals of concern both in Australian and global supply chains, and highlights some of the industry strategies and international regulatory measures being adopted to address the issue. As the European Union (EU) are currently leading the world in terms of a harmonized, cross-jurisdictional approach to addressing chemicals of concern in supply chains, many of the examples and lessons that could be instructive for Australian industry and government are drawn from the European experience.

In the Australian context, these issues will be relevant to the implementation and ongoing revision of the recently enacted national Industrial Chemicals Environmental Management Standard (IChEMS) and roadmap, which will begin to be incorporated into regulatory frameworks from late 2022.[3]

### *Defining chemicals of concern*

While no standard definition of chemicals of concern exists, they can be broadly understood as chemicals that have an adverse impact on human health and/or the environment. One commonly cited reference for the classification of hazardous chemicals is the Restricted or “Substances of Very High Concern” (SVHC) under the European Union’s Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulatory framework. REACH is often considered to be currently the most comprehensive and rigorous regulatory system for chemicals globally. However, chemicals that are not SVHCs are not safe by default, and new chemicals are added into product and material supply chains each year. Inadequate data on the impacts of most chemicals in use, and the challenges associated with testing remain significant hurdles for regulators. It is important that chemicals are not considered safe on the basis of insufficient data.

Given the time and resources required to assess new chemical candidates for authorisation as SVHCs, non-government organisations have developed independent testing based on the criteria for SVACs to develop more comprehensive lists. For example, ChemSec’s SIN (Substitute It Now) List is a globally used database of chemicals that fulfil the SVHC criteria, optimised into a useful tool for progressive chemicals management for industry. ChemSec[4] also suggest that given known hazards and data gaps products cannot be considered safe if they include chemicals with the following properties, or if these properties have not been examined:

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[1] We use the term product to refer to a finished good that is produced for a particular purpose. In Australian legislation, this is often referred to as an ‘article'. Further details of this definition can be found here: https://www.industrialchemicals.gov.au/business/getting-started-registration-importing-and-manufacturing/what-article

[2] ChemSec (2020) What Goes Around: Enabling the circular economy by removing chemical roadblocks. https://chemsec.org/app/uploads/2021/02/What-goes-around_210223.pdf

[3] The roadmap for the implementation of IChEMS can be viewed here: https://www.dcceew.gov.au/sites/default/files/documents/ichems-roadmap_0.pdf

[4] ChemSec (2021) Safe and sustainable by design chemicals. Updated 29 June 2021. https://chemsec.org/app/uploads/2021/06/ChemSec-Safe-and-Sustainable-by-Design-Chemicals-2021-06-29.pdf

- Carcinogens, Mutagens and Reproductive toxicants, Categories 1a, 1b and 2
- Persistent, Bioaccumulative and Toxic (PBT), and very Persistent and very Bioaccumulative (vPvB)
- Persistent, Mobile, and Toxic (PMT) and Very Persistent and Very Mobile (vPvM) substances
- Endocrine Disrupting Chemicals
- Respiratory sensitisers, Category 1
- Skin sensitisers, Category 1
- Specific Organ Toxicity, Categories 1, 2 (repeated exposure and single exposure) and 3 (single exposure)
- Acute Health Hazards, Category 1 and 2
- Acute Aquatic Toxicity Category 1
- Chronic Environmental Hazards, Categories 1-4
- Ozone Depleting Compounds

## Complex chemical effects

A particular challenge emerges due to the different ways chemicals interact once they enter products, systems and bodies, often causing harm that cannot be measured using product-based or substance-based safe dose limits.

**Cocktail Effects**

Also known as 'mixture toxicity' refers to the way chemicals often have different effects when mixed together either in a product or once they enter an organism, to when assessed on their own.

**Cumulative effects**

Refers to one's cumulative risk of adverse health effects that is influenced by exposure to more than one chemical and/or long-term exposure through multiple pathways over time. Product-based safe dose limits cannot account for cumulative effects when exposure occurs through multiple pathways.

**Low-dose effects**

It has been found that some chemicals, such as some endocrine disrupting chemicals interact with organisms in completely different ways at low doses. For examples, some endocrine disrupting chemicals are able to 'trick' an organism's hormonal system into registering it as a natural hormone at a low dose, where the body may not be fooled at a higher dose. Threshold and dose limits for chemical cannot account for this phenomenon

Chemicals of concern are associated with a range of adverse health and environmental impacts. By volume, 62% of the chemicals on the EU market are classified as being hazardous to human health or the environment.[5] The World Health Organization has estimated that 2 million lives and 53 million disability-adjusted life-years were lost in 2019 owing to exposure to hazardous chemicals.[6]

Projections suggest that chemical production will double between 2017 and 2030, making the imperative to address chemical safety particularly pressing.[7] Public concern is also increasing, with 84% of Europeans reportedly worried about the impact that chemicals in consumer products have on their health, and the environment.[5] Ignoring the risks posed by chemicals of concern consequently presents a significant reputational risk to companies and governments into the future.

## CHALLENGES FOR PRODUCT STEWARDSHIP

While some progress has been made in advancing responsible chemicals management in certain jurisdictions and industries, there are a number of challenges that must be overcome to enable businesses to address chemicals of concern across supply chains. Some of these are highlighted below with brief examples from different industries. The following section will then outline some of the strategies that can help address these issues.

### *Data, transparency and knowledge sharing*

One of the key challenges for industry in removing chemicals of concern from their products is the lack of data on chemicals of concern, and transparency and ingredient disclosure along supply chains. There is currently an absence of standardised methods to be used when gathering data preventing companies from being able to effectively benchmark against each other. Often companies are also unaware of the chemicals used in the substances or materials they procure, and there are limited mechanisms and obligations to help them find out. Moreover, even where ingredient lists are included, there is often contamination with other chemicals that are not listed, but that have effects along the supply chain.

Understanding the active and latent chemicals in products is essential for companies concerned about product stewardship because it influences how the products should be managed at End of Life (EoL), in addition to any potential for harm in the production, use and reuse phases of the product lifecycle.

Lack of disclosure and transparency are presenting particular challenges for product stewardship approaches that involve recycling. The quality of recyclate decreases as a result of contamination and the safety of products cannot be guaranteed if the producer does not know what is in them. Even if a chemical has been deemed safe for one purpose, it is not necessarily safe in second life applications. A notable example is the finding that toys made from some recycled plastics, in particular black plastic from electronic waste, contained levels of toxic chemicals comparable to levels found in hazardous wastes, such as ash from incinerators.[8]

In addition to safety concerns, lack of transparency regarding chemical constituents significantly inhibits recycling. For example, ChemSec reports that a key reason only 1-3% of the 1.6 million tonnes of carpet waste generated each year in Europe is recycled is due to an absence of knowledge regarding chemical constituents and contaminants.[9]

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[5] ChemSec (2020) *What Goes Around: Enabling the circular economy by removing chemical roadblocks.* https://chemsec.org/app/uploads/2021/02/What-goes-around_210223.pdf

[6] WHO (2021) *The public health impact of chemicals: knowns and unknowns - data addendum for 2019* https://www.who.int/publications/i/item/WHO-HEP-ECH-EHD-21.01

[7] ChemSec (2020) *What Goes Around: Enabling the circular economy by removing chemical roadblocks.* https://chemsec.org/app/uploads/2021/02/What-goes-around_210223.pdf
Box 1: Svingen, T., & Vinggaard, A. M. (2016). "The risk of chemical cocktail effects and how to deal with the issue." *Journal of Epidemiology and Community Health*, 70(4), 322.

[8] Budin, C., Petrlik, J., Strakova, J., Hamm, S., Beeler, B., Behnisch, P., Besselink, H., van der Burg, B. and Brouwer, A. (2020). "Detection of high PBDD/Fs levels and dioxin-like activity in toys using a combination of GC-HRMS, rat-based and human-based DR CALUX® reporter gene assays." *Chemosphere*, 251, 126579.

[9] Tan, SL. (2018) *Circular economy needs trust, transparency and traceability*. ChemSec. https://chemsec.org/circular-economy-needs-trust-transparency-and-traceability/

## The challenge of safe substitutes for PFAS in food contact materials

**Forever Chemicals**

PFAS is short for perfluoroalkyl and polyfluoroalkyl substances, and includes more than 4000 chemicals known as PFOS, PFOA and GenX. PFAS has attracted concern because they are the most persistent synthetic chemicals identified to date, and are associated with numerous adverse effects in wildlife and humans, including cancer, and disorders of the immune, reproductive and hormone systems. Traces of PFAS have been found all over the world, including in remote marine and land ecosystems and species.

PFAS can resist heat, oil, stains and water and are consequently found in a range of consumer products, including non-stick cookware, clothing, carpets, furniture, car seats, cosmetics, and cleaning products. They are particularly concerning in food-contact materials due to the migration into food, including baking paper, popcorn bags, paperboard and takeaway food packaging.

In the joint report by eight NGOs published in 2021, *Throwaway Packaging, Forever Chemicals: European-wide survey of PFAS in disposable food packaging and tableware*, measurable levels of PFAS were found in all items analysed, including those that had not been intentionally treated with PFAS.

PFAS is not the only concern. Analysis of Food Contact Chemical (FCC) lists issued by legislatures, industry, and NGOs indicates that around 12,000 different FCCs are used in the manufacture of food contact materials. EU Member State regulations list a total of 8,030 substances, while the United States allow 10,787 substances as direct or indirect food additives.

All FCCs that migrate from packaging into food have inherent toxicity properties that can cause different effects at different doses, in combination with other chemicals and depending on the timing of exposure. Many of the chemicals used in the manufacture of food contact materials have not been tested for hazard properties at all, or the available data are limited.

In addition to intentionally used chemicals, food contact materials also contain non-intentionally added substances (NIAS) that manufacturers may not be aware of – impurities, additives, or reaction by-products produced along the entire supply chain.

A harmonised approach is needed to improve data and design hazardous chemicals out of food contact materials.

### *Circulating hazardous chemicals*

Even in cases where transparency and disclosure are less concerning, the types and diversity of chemical additives used in many products makes reuse or recycling challenging, expensive and impossible in many cases. In a 2020 report by ChemSec, available and proposed recycling methods, and their ability to tackle and eliminate chemicals of concern from input waste materials, were critically examined.[10] The report found that the mixtures of chemicals, combined with lack of chemical traceability and contamination, are significantly inhibiting recycling efforts, and that while new recycling technologies would improve the situation, it would not do so substantially. This finding indicates that the impact of chemical content on recyclability must be considered from the design phase of the product. Importantly, they found that the role of chemicals of concern in inhibiting

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[10] ChemSec (2020) *What Goes Around: Enabling the circular economy by removing chemical roadblocks.* https://chemsec.org/app/uploads/2021/02/What-goes-around_210223.pdf

recycling has a significant financial cost. In the case of plastic, they found an increase of 30% in the recycling of packaging would correspond to an annual increase in EU market value of €7.7 billion.

### *Regrettable substitution*

Because most chemicals are not tested individually for their possible long-term adverse effects prior to entering the market, many chemicals are only discovered to be hazardous once they have been incorporated into a product; often as a central functional ingredient. As a result, manufacturers are often faced with the difficult challenge of trying to find a replacement chemical that provides the exact same functional qualities in a product as the offending chemical. This has resulted in a situation that has been termed 'regrettable substitution', whereby a chemical identified as hazardous is replaced with a closely related chemical with similar functional properties, but less data on its potentially hazardous properties. In many cases, regrettable substitution results in a cycle of restriction and replacement as companies try to find alternatives. One of the most prominent examples of this is the replacement of Bisphenol A (BPA) with Bisphenol S (BPS) in many food packaging applications. Subsequent to research emerging about the endocrine disrupting properties of BPA, initial research into BPS has revealed that the replacement is likely to be equally hazardous.[11] As a result, many scientists and NGOs are calling for all bisphenols to be restricted in food packaging applications.

The problem of regrettable substitution highlights the limitations of a substance-by-substance based approach to chemical management, particularly in the absence of regulations that stipulate all chemicals must be tested prior to entering the market. Given that there are an estimated 350,000 chemicals on the market and production is anticipated to double between 2017 and 2030, comprehensively evaluating the long-term effects of each chemical prior to use is generally considered to be impractical. Many regulators and health advocates are consequently advocating for a class-based approach that restricts substances based on them being closely related to known hazardous substances. This is discussed further in the following section.

In some cases, safer alternatives are already available. Tools such as ChemSec's 'Sinmilarity' database and the US EPA's Safer Choice Program are designed to help companies avoid regrettable substitution and find safer alternatives. There are also examples of chemicals being removed entirely without any adverse effects for consumers or the company. For example, PFAS was removed as a coating in furniture textiles in several cases without consequence for product safety or consumer appeal, and IKEA no longer uses these treatments at all.[12] However, the key challenge in avoiding regrettable substitution emerges where safe alternatives are not known. In this case, companies are faced with the decision to remove the product entirely, or consider a fundamental redesign of the product in a way that delivers the same function or service in a new way. Some examples of this are discussed in the section on 'sustainable by design' below.

### *Inconsistent definitions and regulations across jurisdictions*

The ways that hazardous chemicals are defined and regulated differs substantially across national and international jurisdictions and product categories. This inconsistency makes it challenging for industry to know what to restrict and when. One of the objectives of REACH has been to harmonise approaches within the European Union. However, divergent cross-jurisdictional policies and requirements continue to present challenges to industry and undermine consistency in approaches.

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[11] Žalmanová, T., Hošková, K., Nevoral, J., Prokešová, Š., Zámostná, K., Kott, T., & Petr, J. (2016). Bisphenol S instead of bisphenol A: a story of reproductive disruption by regrettable substitution–a review. Czech Journal of Animal Science, 61(10), 433-449.

[12] IKEA (2017) highly fluorinated chemicals.
https://www.ikea.com/us/en/files/pdf/41/81/41810e8b/ikea_faq_highly_fluorinated_chemicals.pdf

Box 2 : Muncke, J., Andersson, AM., Backhaus, T. et al. Impacts of food contact chemicals on human health: a consensus statement. Environ Health 19, 25 (2020). https://doi.org/10.1186/s12940-020-0572-5

Straková, J., Schneider, J., Cingotti,. N (2021) *Throwaway Packaging, Forever Chemicals: European wide survey of PFAS in disposable food packaging and tableware* https://arnika.org/en/publications/throwaway-packaging-forever-chemicals-european-wide-survey-of-pfas-in-disposable-food-packaging-and-tableware

There have also been attempts to harmonise approaches to regulating hazardous chemicals within certain product categories. For example, the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive which came into force in 2011 restricts the use of ten substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE), bis(2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP) and diisobutyl phthalate (DIBP).[13] All products with an electrical and electronic component have to comply with these restrictions unless specifically excluded.

While multinational companies operating across jurisdictions will often use the regulations set by the most stringent legal context as their standard for all products, it has also been found that many companies continue to adopt lower standards for products sold in jurisdictions with less stringent regulations.[14]

## STRATEGIES TO ADDRESS CHEMICALS OF CONCERN: REGULATION AND INDUSTRY ACTION

There are a number of actions that can be taken now by governments, businesses and product stewardship organisations to help ensure that chemicals of concern do not undermine product stewardship objectives and inhibit transition to a safe circular economy. While harmonised definitions, regulation and improved data across local and global supply chains will be essential to ensure best practice, there are voluntary actions that industry can adopt now to mitigate against the harm and expense of chemicals of concern in Australia. We first look at some of the key elements required for such a harmonised approach, before outlining key actions and principles relevant to both government and industry. The relative strength of each of these strategies may differ based on the stage of the product lifecycle.

### *Coordinated and harmonised policy and regulation*

Harmonisation refers to the process of creating common standards and protocols across a market or region. An effective approach to coordination and harmonisation to address chemicals of concern across jurisdictions and industries requires a number of elements:

1. **Establish a single assessment process**. At present, in most jurisdictions chemicals are assessed differently according to the legal framework relevant to their intended use. The EU has recognised that this differential treatment of chemicals across different applications or uses was causing contradictory outcomes in terms of what was restricted and when, in addition to creating a substantial burden for companies, which often had to address multiple frameworks. Moreover, assessing substances based on the potential exposure risk in their use phase does not account for chemical emissions linked to production and management at EoL. As a result, a "one substance one assessment" process has been proposed under the new EU Green Deal and the Chemicals Strategy for Sustainability. This approach would require a uniform hazard assessment between all frameworks based on the inherent properties of the chemical. Research looking at the impacts of fragmented risk-based assessment processes on the impacts of hazardous chemicals on freshwater environments found that the assessment of relevant chemicals was inconsistent between frameworks covering 1) medicines for human use, 2) veterinary medicines, 3) pesticides, 4) biocides and 5) industrial chemicals, resulting in continued emissions.[15] This approach will be enabled under the umbrella of the amended EU Classification, Labelling and Packaging (CLP) Regulation, grounded in the specifications of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

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[13] European Commission (2021) Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) https://ec.europa.eu/environment/topics/waste-and-recycling/rohs-directive_en

[14] Dubash, J., Wakefield-Rann, R., Prentice, E., Giurco, D., and Latimer, G. (2018): Chemical Management for Consumer Products – Industry landscape and recommendations for progress. Institute for Sustainable Futures, UTS.

[15] van Dijk, J., Gustavsson, M., Dekker, S. C., & van Wezel, A. P. (2021). Towards 'one substance–one assessment': An analysis of EU chemical registration and aquatic risk assessment frameworks. Journal of Environmental Management, 280, 111692.

2. **Harmonise classification and labelling**. Another aspect of the CLP is the notification obligation for manufacturers and importers to submit classification and labelling information for the substances they are placing on the market. CLP sets detailed criteria for the labelling elements that must always be applied to specific substances across industries, these include: pictograms, signal words and standard statements for hazard, prevention, response, storage and disposal, for every hazard class and category.[16] It also sets packaging standards to ensure the safe management of hazardous substances.

3. **Consistency and standardisation**. The development and application of equivalent chemical requirements for recycled and virgin materials will be necessary to facilitate a safe and effective circular economy. Similarly, applying the same regulation to imported products and those produced locally will be important to ensure human and environmental health, particularly in the context of products and materials circulating through multiple uses.

4. **Shift from risk to hazard**. It has been proposed by numerous NGOs and scientists[17] that a shift from a risk-based approach (where chemicals are assessed in relation to exposures associated with their proposed application or use) to a hazard-based approach (where chemicals are assessed based on their inherent properties) would help address the problem of predicting the exact application and use of a product throughout its life cycle(s). This is the basis for the EU CLP. Understanding that all uses cannot be reliably anticipated is especially important in a circular economy, where products and materials will be reused and recycled multiple times. Moreover, it is important to consider that hazardous chemicals not only cause damage in their use phase, but in activities associated with their production and disposal. For this reason, looking at inherent properties rather than intended use may be more effective in achieving a safe and harmonised approach.

### *Information, transparency and certification*

Collaboration between industry, researchers and government is required to improve information on chemicals of concern and enable effective tracing throughout product lifecycles and EoL. A pioneering recent example in Australia is a product stewardship initiative led by The Australian Furnishing Association (AFA), with support from GECA (Good Environmental Choice Australia), and the Australian Government through the National Product Stewardship Investment Fund (NPSIF). The initiative examines the key chemicals of concern in the furniture and furnishings industry to help improve data and assess avenues to improve the safety of products across the industry.

A key barrier to collaboration, transparency and traceability to date has been the need to protect ingredient information classified as a 'trade secret'. Keeping knowledge about formulas secret is central to the success of many businesses. To help overcome this issue, platforms for 'material passports' such as Excess Materials Exchange and ECHA's Unique Formula Identifier[18], provide transparency to particular agents, while protecting secret recipes.

In the context of Australia, there are many eco-certification schemes, voluntary standards and industry initiatives focused on enabling improved product stewardship and a circular economy. The Recycling and Waste Reduction Act 2020 provides a framework to manage the environmental and health and safety impacts of products, and substances contained within products throughout the life cycle. The Act covers voluntary, co-regulatory and mandatory product stewardship arrangements and is administered by the Commonwealth Department of Climate Change, Energy, the Environment and Water. Currently there is about 32 active collective schemes and 17 schemes in development supported by the NPSIF, as well as many more individual business initiatives. Most of these schemes are voluntary industry-led and they are focused on the collection and recycling of products at EoL.

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[16] ECHA (2021) Understanding CLP. https://echa.europa.eu/regulations/clp/understanding-clp

[17] ChemSec (2016) Hazard vs. Risk – What is best practice when assessing chemicals? https://chemsec.org/hazard-vs-risk-what-is-best-practice-when-assessing-chemicals/

[18] https://poisoncentres.echa.europa.eu/ufi-generator

These initiatives could be expanded to include provisions for chemicals of concern, including transparency and disclosure in chemical use and the exclusion of chemical classes that meet the criteria for Substances of Very High Concern (see Box 3 for the case of textiles).

### Safe and sustainable by design

Designing chemicals of concern out of products and materials will be the most important strategy to prevent harm from hazardous chemicals into the future. There are numerous synergies between design for a circular economy and safer products. To realise these synergies, safe and sustainable design will need to move beyond simple substitution in many cases to consider how the essential services and functions of products can be met in new ways. For example, "non-permanent" food packaging materials, such as paperboard and plastic, generally contain several chemicals additives that act as colorants, plasticizers and grease and water repellents (e.g. PFAS), which commonly migrate into food. In addition, while recycling these products is desirable, they need to be supplemented with virgin materials as they degrade and lose their properties, and because chemical additives and contaminants make recycling into high quality products problematic. For example, for fibre based and compostable food packaging the presence of PFAS in these products can potentially transfer into recycled products through recovery systems.[19] Reusable food packaging made from "permanent", inert materials, such as glass or metal help support a circular economy by eliminating single-use products, and due to their stability and low chemical migration, reduce exposure to chemicals of concern. In this case, the most sustainable by design option does not necessarily involve finding a safer chemical to provide the same function in the same product, but a redesign of food packaging as a product-service system. Examples of organisations leading the way in this space include the Australian company Returnr[20] which seeks to eliminate single use takeaway and grocery food packaging, and TerraCycle Loop[21], a circular shopping platform that replaces single-use disposable packaging with durable, reusable packaging in partnership with mail services and retailers, such as Woolworths. Both of these organisations use clever packaging design and logistics to enable more sustainable and safe food packaging.

There are a number of principles and mechanisms that can help guide industry and government to implement sustainable design practice and eliminate chemicals of concern. Three are discussed here:

### Essential use

The concept of "essential use" has been adopted as part of the EU Chemicals Strategy to help ensure that chemicals of concern are only used when absolutely necessary. Its purpose is to "ensure that the most harmful chemicals are only allowed if their use is necessary for health, safety or is critical for the functioning of society and if there are no alternatives available from the standpoint of environment and health".[22] This concept was also used in the Montreal Protocol, which limited the use of ozone depleting compounds to essential uses only. The parameters of essential use are currently being debated on the basis on the question "when is it justified to use a hazardous chemical?" Consultation around its inclusion in REACH and the criteria for determining what is essential is ongoing.

Even in the absence of regulation, the concept of essential use, based on the question "when is it justified to use a hazardous chemical?" can help progress product stewardship by driving company and industry initiatives towards determining harmonised criteria for when and how chemicals of concern can be used.

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[19] APCO (2021) PFAS in fibre-based packaging, Version 1 December 2021: https://documents.packagingcovenant.org.au/public-documents/PFAS+in+Fibre-Based+Packaging

[20] https://returnr.org/

[21] https://www.terracycle.com/en-AU/

[22] European Comission (2020) Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions. Chemicals Strategy for Sustainability. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0667&rid=4

### A class-based approach

The problem of regrettable substitution, limited data and the impossibility of testing all substances of the market for their long-term effects in the real world, has led many scientists, NGOs and regulators to call for a class-based approach to restricting chemicals of concern. This approach involves restricting a substance that has known harmful properties and all of the closely related substances that act in a similar way.

Perhaps most notably, multiple jurisdictions and businesses have declared over the past couple of years to restrict the entire class of PFAS (that includes more than 4000 chemical compounds) including Denmark and the states of Maine, Vermont and California. Their ban is also being considered under EU REACH regulations for all but essential uses. Australia has outlined a “nationally unified vision” for reducing future PFAS use in the 2019 PFAS National Position Statement.[23] Consumers can also now access databases of businesses that have banned PFAS.[24]

Numerous resources have been created to help industry find alternatives when they restrict a class of chemicals. The Green Science Policy Institute has created tools[25] for regulators and industry, while ChemSec Marketplace “gathers all green chemistry innovations in one place, making it easier for companies to choose safer solutions”.[26]

## Textiles leading the way

#### Certification

Within the textiles industry several voluntary standards have been developed to address chemicals of concern. Some of these include: OEKO-TEX, Global Organic Textile Standard (GOTS), Better Cotton Initiative (BCI), Cradle to Cradle and the EU Ecolabel.

#### Collaboration

There have also been a number of industry-led initiatives such as the ZHDC; a coalition of fashion brands and value chain associates that emerged from the Greenpeace Detox Campaign in 2011. Their Mission is “to enable brands and retailers in the textile, apparel, and footwear industries to implement sustainable chemical management best practice across the value chain.” They are achieving this through a Roadmap to Zero Programme, which outlines a clear path to achieving safer chemical use across the industry, and the provision of a Manufacturing Restricted Substances List for textiles. This compliments other lists such as the AFIRM (Apparel and Footwear International RSL Management) Restricted Substances List.

#### Improving data

In 2021 H&M Group and Inter IKEA completed a large-scale databank to help improve understanding of the potential and challenges posed by chemical contamination in recycled textiles. This initiative was motivated by their recognition that chemicals of concern were hampering their targets to use 100% recycled or other sustainably sourced materials by 2030. Their study examined the chemical content of post-consumer cotton, wool, and polyester waste sourced from different regions of the world, and contributors included adidas, Bestseller, Kingfisher, Gap Inc,. and PVH Corp. They found that polyester samples had the widest range of substances detected, while wool samples almost all contained at least one substance that failed safe limits.

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23 Australian Government (2019) National PFAS Position Statement: Appendix D to the Intergovernmental Agreement on a National Framework for Responding to PFAS Contamination, Last updated: Monday, 21 October 2019, https://federation.gov.au/sites/default/files/about/agreements/appd-national-pfas-position-statement.pdf

24 https://pfascentral.org/pfas-free-products/

25 https://www.sixclasses.org/use-it

26 https://marketplace.chemsec.org/

## Green chemistry and safer alternatives

Adherence to the principles of green chemistry will be a particularly important strategy for the avoidance of regrettable substitution and cocktail effects in future innovation for the first and subsequent lives of products and materials.

The following description of the 12 Principles of Green Chemistry in Table 1 is provided by the United States Environment Protection Agency.[27]

| PRINCIPLE | DESCRIPTION |
|---|---|
| 1. Prevent waste | Design chemical syntheses to prevent waste. Leave no waste to treat or clean up. |
| 2. Maximize atom economy | Design syntheses so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms. |
| 3. Design less hazardous chemical syntheses | Design syntheses to use and generate substances with little or no toxicity to either humans or the environment. |
| 4. Design safer chemicals and products | Design chemical products that are fully effective yet have little or no toxicity. |
| 5. Use safer solvents and reaction conditions | Avoid using solvents, separation agents, or other auxiliary chemicals. If you must use these chemicals, use safer ones. |
| 6. Increase energy efficiency | Run chemical reactions at room temperature and pressure whenever possible. |
| 7. Use renewable feedstocks | Use starting materials (also known as feedstocks) that are renewable rather than depletable. The source of renewable feedstocks is often agricultural products or the wastes of other processes; the source of depletable feedstocks is often fossil fuels (petroleum, natural gas, or coal) or mining operations. |
| 8. Avoid chemical derivatives | Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste. |
| 9. Use catalysts, not stoichiometric reagents | Minimize waste by using catalytic reactions. Catalysts are effective in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and carry out a reaction only once. |
| 10. Design chemicals and products to degrade after use | Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment. |
| 11. Analyse in real time to prevent pollution | Include in-process, real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts. |
| 12. Minimize the potential for accidents | Design chemicals and their physical forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment. |

[27] USEPA. 2021. Basics of Green Chemistry. https://www.epa.gov/greenchemistry/basics-green-chemistry

There are a number of examples emerging of safer options entering the market that adhere to the principles of green chemistry. For example, in the mattress treatment market, an area that traditionally uses a number of chemicals of concern, new treatments are emerging that are not only safer but employ an entirely different approach to achieving the desired outcomes. For example, Purotex® contain microcapsules that are filled with natural probiotics rather than achieving antibacterial properties through antimicrobial compounds, many of which are hazardous and can contribute to anti-microbial resistance. Purotex® actively inhibits the growth of pathogenic bacteria rather than attempting to kill it once established. After 24 hours the probiotics begin to multiply until after two weeks the mattress is completely and permanently protected. Similarly, CompriSheild® is a product based on coconut oil that is infused into mattress foam during manufacturing to prevent bacterial growth and mould, thus preventing the use of harmful biocides.

## A WAY FORWARD FOR PRODUCT STEWARDSHIP

Product stewardship approaches can drive and support industry and government action to address chemicals of concern in supply chains. There is a specific opportunity for existing and emerging product stewardship initiatives to promote safe and sustainable design, improve information, and coordinate industry-wide approaches to manage chemicals of concern. This will not only help protect human and environmental health, but create a more profitable, trusted and safe circular economy in Australia.

While many companies and organisations in Australia are participating in voluntary initiatives, standards and certifications committed to eliminating chemicals of concern in their supply chains, further action is required to harmonise definitions and approaches to address chemicals of concern across supply chains to make it easy and effective for industry to implement best practice. For this to happen, improved data, traceability and transparency, consistent definitions, certification and labelling are required, in addition to the implementation and standardisation of concepts such as essential use and class-based restrictions.

There are a range of voluntary standards, certification and industry-led initiatives that have emerged to create more effective product stewardship in Australia (e.g. see Box 3). With the support of regulators, and improved education and resources around the centrality of hazardous chemicals management in the circular economy, these existing tools and initiatives can be updated to include design for safe chemicals management as central to their product stewardship approach.

Product Stewardship Centre of Excellence | c/- Institute for Sustainable Futures | University of Technology
PO Box 123 | Broadway NSW 2007

www.stewardshipexcellence.com.au