

Fashion's chemical certification complex.

Needlessly complicated,
woefully ineffective.



TRANSFORMERS
FOUNDATION

This report was commissioned by the Transformers Foundation.

OUR GOAL is to help suppliers share their expertise and opinion on industry threats and solutions, brands and retailers transform their jeans from a commodity into unique and valuable fashion, and consumers choose the most environmentally-sound denim products and avoid greenwashing. Our events connect industry professionals who want a deeper understanding of the denim industry, covering topics ranging from energy and water to social responsibility, technology and waste.

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A note on imagery by Heather Knight:

The images in this report are created with *cyanotype*, a photographic printing process developed with exposure to sunlight. As they developed, the cyanotypes slowly revealed images of denim manufacturing process in a blue wash that nods to the indigo dyes of denim, and the murky landscape of chemical certifications.



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Dear sustainability professionals, brands, retailers and concerned citizens

We face a common challenge: the chemical management system governing the fashion industry is not working.

We can hear the groans from the corporate social responsibility teams already: **We've been working on chemical safety for the better part of a decade and have made significant progress. Do we really need to wade into this again?**

Definitions for **underlined words** can be found in the Glossary on page 57

Yes. Effective **chemical** management systems are a critical component of addressing safety, water pollution, air emissions, waste and—of increasing concern—consumer health. The chemical sector in total is also one of the largest industrial consumers of both oil and gas.¹ It relies heavily on fossil fuels to create its products, including for the fashion industry. No decarbonization effort would be complete without a strategy for reducing chemical usage overall, and moving the remaining chemical feedstock to bio-based alternatives.

Effective chemical management systems are also an important part of fiber-to-fiber recycling and circularity goals.² Lax chemical management systems can be a deadly problem for workers in wet processing facilities, and with proposed due diligence legislation in the EU, chemical accidents and exposures at facilities in production countries could become a liability for brands. Chemical pollution is already impacting wildlife in the remotest regions of the world, far from where effluent pours into waterways. Last but certainly not least, a sound system for managing chemical safety is critical to health outcomes for people working on the production floor and consumers alike.

A better system for chemical management is achievable... if we work together.

The Transformers Foundation is a non-profit founded by 12 leaders in the denim supply chain. Our founders represent cotton growers, mills, laundries, chemical companies, and beyond. We're on a mission to make sure their stories, technical knowledge, and lived experiences are represented in conversations about sustainable fashion.

We love this industry and want to see it do better. But if there's anything to be gleaned from the last two years of turmoil—from pandemic-induced order cancellations in the fashion industry to global racial justice movements—it's that those who get to tell the story also get to define the "solution". It's hard for denim suppliers to be candid about what they witness, experience, and struggle with—conversations between brands and suppliers tend to be filled with distrust.

Every year we put out a deep dive report on an issue that matters to our community; it's our way of facilitating a better, more open, more honest conversation between brands and their suppliers.

This paper sets out to do three things:

1

Explain how we got here.

2

Explain why the current chemical management system is inefficient, ineffective, and serves primarily to shift responsibility.

3

Lay out where we should go from here.

The qualitative research for this report was done by Alden Wicker, an industry expert and independent journalist with a forthcoming consumer-facing book on chemical safety in the fashion industry. She brought her own ideas about who should be interviewed for this report, and we also connected her with our colleagues in the world of denim manufacturing. Our review board, composed of prominent professionals and members of Transformers Foundation, offered feedback throughout the process, which Alden was free to incorporate as she saw fit.

Certainly, the denim supply chain is not a monolith and we at the Transformers Foundation cannot claim to represent it in its entirety. The research for this report is centered on individuals and companies that perceive themselves to be progressive, and leverages decades of relationship building that long pre-dates the founding of Transformers Foundation (which was established in 2020).

However, we made a deliberate effort to engage with a broad range of actors working in the denim supply chain from chemical companies selling indigo and other chemical products, to the mills and laundries using those products, to the auditors responsible for inspecting chemical safety, to key industry stakeholders who, like us, spend significant parts of their day talking to the denim supply chain. We also made every effort to engage stakeholders from a variety of geographies.

The following people were interviewed:

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ANDREA VENIER

CEO, Officina+39

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Albeit imperfect, this approach is a starting point, the beginning (not the end) of a conversation. We invite denim suppliers who disagree with the findings of this report, or who feel their perspective is not represented, to reach out to us. We'd love to talk.

So without further ado, this is our humble attempt to put forward the unified voice of the denim industry, its perspectives on the way the fashion industry handles chemical safety, and where we should go from here.

Sincerely,

Transformers Foundation



Dozens of private-sector auditors, consultancies, labs, and certifications provide an expensive and inefficient form of surveillance over the supply chain on behalf of brands.

Many of these organizations offer almost identical services, and yet the supply chain must adopt all of them, and front the cost.

Many brands have even created their own suite of restricted substance lists (RSLs) and testing protocols on top of the third-party auditing they require.³ While the brands use chemical management as a differentiator, a marketing tool, and a way to shirk responsibility, it is the supply chain—from the chemical companies to the denim laundries—that pays for testing, certification, and management of these overlapping safety protocols. That is capital that suppliers often do not have, and this penny-pinching from brands can lead to cut corners.

This system puts consumers and garment workers at risk—consumer advocacy groups continue to test clothes and accessories and find heavy metals, hormone disrupting chemicals, carcinogens, and banned azo dyes.⁴

This breakdown started in the 1990s. After three decades of outsourcing production, very few fashion brands have the in-house expertise to understand what is on their clothing, how it got there, and its health risks. During the same period the global chemical manufacturing industry fragmented into a chaotic landscape, with actors ranging from large chemical companies focused on safety and innovation, down to fly-by-night traders that buy and sell cheap and contaminated chemical products.

A lack of trust has developed between chemical companies, apparel manufacturers and brands. Chemical companies don't trust that their research and trade secrets won't be ripped off by suppliers and brands. Suppliers don't trust chemical companies (outside of a half dozen large legacy companies) to provide them with safe chemical products, and don't trust brands to be a true partner and reward them for safer chemistry. Brands don't trust that suppliers will manufacture products free of hazardous chemicals.

What's more, the science of textile toxicology is woefully under-researched. There is uncertainty about how many types of chemicals are currently used in the fashion industry or global commerce. There is significant debate around which chemicals are hazardous, how much of a hazardous chemical can be present on a fashion product, routes of exposure, the accuracy of testing methods, and more. Legislation on consumer product chemical safety, which could align and enforce standards, has been uneven and in most cases inadequate.

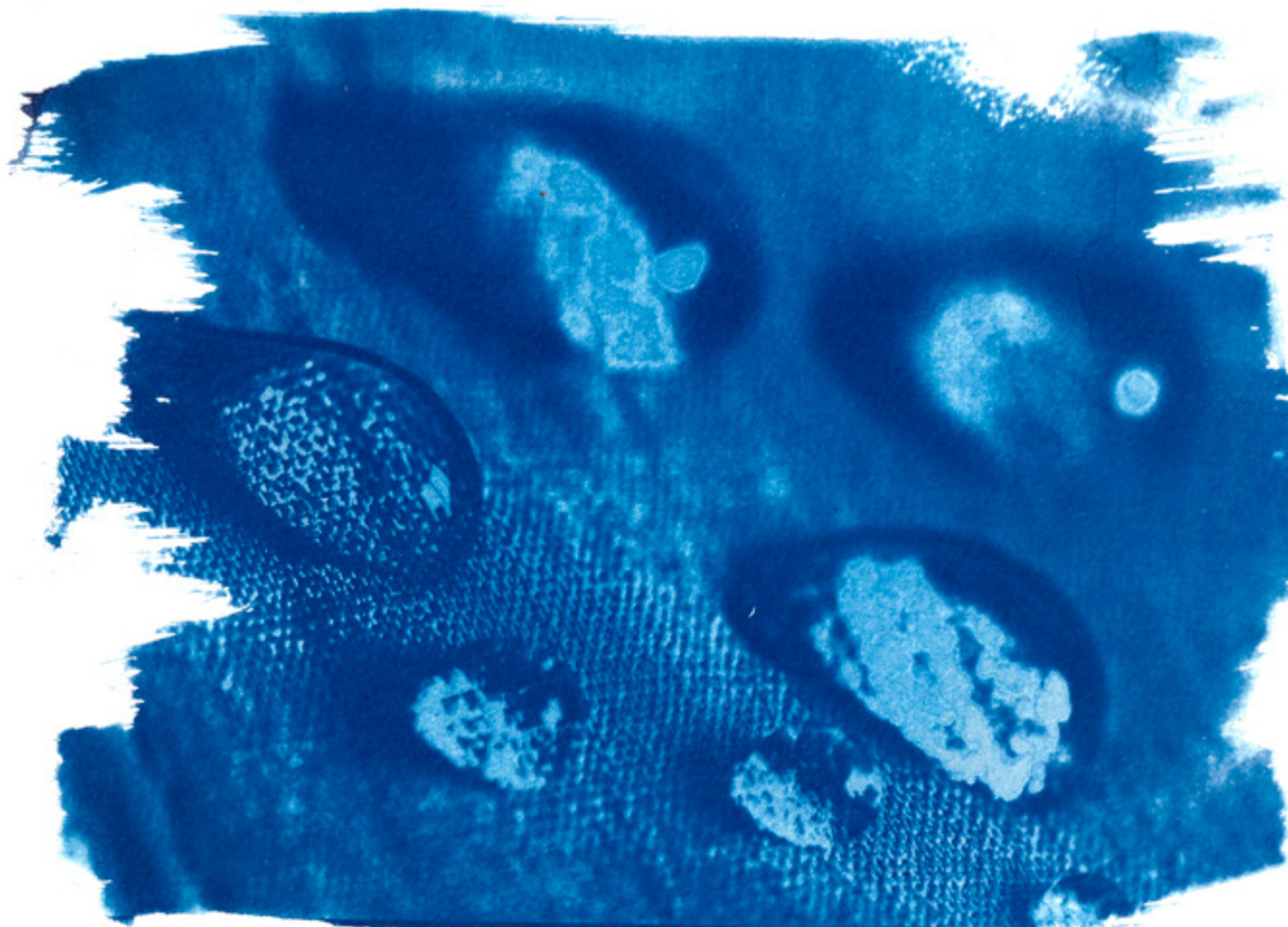
We use the example of aniline, a probable carcinogen that can contaminate products with synthetic indigo dye, to illustrate how this confusion and debate plays out.

Many large brands have joined Zero Discharge Hazardous Chemicals, the industry group dedicated to ensuring factory effluent is free of hazardous chemicals. While this has aligned much of the fashion industry around safer standards, a positive development for sure, there is not enough government regulation and enforcement, and chemical management remains largely voluntary. Far from stamping out the use of contamination and banned chemicals and dyes, certification and auditing schemes are expensive, hard to scale up, and easily circumvented by those who wish to cut corners.

Though private certification and testing schemes may not have delivered the results we hope for, we can build on them to make a more efficient, more innovative, fairer, and more effective global chemical management program. We can make fashion products safe—for everyone. But to do so, we need to collaborate. We have hope that brands, governments, and chemical suppliers can work together to reform chemical safety in the fashion industry.

The alternative is just too expensive, and too risky.

**Find our vision for this new future,
and our calls to action at the end
of this paper.**



competition over collaboration

*“In the late 90s and early 2000s, apparel brands and retailers started to wonder, **Oh my God, what’s being used on our products? We need to be in control, we need to know more.** And that is all incredibly fair and correct. What has happened, though, is that instead of forming overarching bodies that were in charge of understanding and regulating the issue, **there has been a proliferation of individual approaches from brands and retailers.**”*

– ALBERTO DE CONTI, HEAD OF MARKETING AND FASHION DIVISION, RUDOLF GROUP

Step 1: Brands cede expertise and knowledge

In the 1990s, most production, from chemical and dye manufacturing to garment sewing, was outsourced and moved offshore, to locations outside of the U.S. and Europe.

One result: a lack of in-house technical expertise within brands. Brands wound down their chemical and engineering departments, and now no longer have chemists on staff that can talk intelligently or problem-solve with designers and the corporate social responsibility team about this complex topic. “They say that they care, but just a few of them have a real understanding of what you’re talking about,” says Roberto Camera of Nearchimica about brand **CSR** teams.

“A lot of the medium-sized brands that you would think of, they have one person in charge of sustainability, labor issues, community involvement issues, and it’s clearly hard to be at expert on all of those topics,” says Scott Echols, Senior Director at Zero Discharge of Hazardous Chemicals, the global industry group devoted to reducing the use of hazardous chemicals. “Many of the **ZDHC** contributor brands, they have huge teams working on these issues. But the brands that are in the middle, or the brands that are just a brand in name only, and everything is licensed product—they just don’t have the resources internally to focus on it. They want to do something, but it’s almost overwhelming to get started.”

Rehan Ahmed, who manages chemistry for the Pakistan-based denim manufacturer Crescent Bahuman, says that brands' understanding of chemistry varies. American brands have recently taken more of an interest in chemical management, but some of the brands don't do much more than send guidelines, and require product testing. Few have teams on the ground in Pakistan to establish and maintain personal relationships with their suppliers, instead, opting to go through agents and sourcing companies.

"The sustainability team within brands understand this very well, but some buying & design teams who we interact with are sometimes not as updated with the current guidelines," says Ali Abdullah, of Pakistan-based Diamond Denim. "This can at times create confusion and delays in the whole process."

Meanwhile, offshoring and outsourcing of production resulted in incredibly fragmented supply chains, with hundreds of chemical manufacturers, dye makers, formulators, and traders undercutting one another on price and operating in a wide variety of regulatory environments.

*"There are three kinds of chemical companies. You have the **manufacturers**—and those are the ones that actually do the chemical synthesis, they are in control of everything they put in their formulations. And then you have the **formulators**. Those are the ones that buy chemicals from the manufacturers and do mixes and cocktails that are proprietary to them. The level of investment if you are a formulator is much lower than a manufacturer; you only need to have a mixer. And then you have a third level: **traders** that buy and resell products."*

– ALBERTO DE CONTI, HEAD OF MARKETING AND FASHION DIVISION, RUDOLF GROUP

"I would say that's the area where you could have issues. Traders buy cheap, they sell cheap, they don't really care or know what they sell." Out of what he estimates to be more than 20,000 chemical distributors, "quite a few are traders."

"A company like ours, Rudolf Group, which mostly focuses on textile chemistry and has been globally present for 100 years—has less than 3% of the global marketshare," De Conti continues. "And we are fairly large. There is not one single chemical company in the world that is able to make a difference or to be in control of anything."

At the same time, brands switched to what is called the "merchandising model." The buyer asks a garment factory to produce a product for a certain price, without asking or caring how that product is made or with what substances, as long as it meets the buyer's performance requirements. The brand is then only responsible for marketing and selling the final product to the consumer, and so gets the largest profit margin with the lowest risk.

“It’s not the brands that are buying the chemicals, it’s their suppliers. It’s whoever’s making and dyeing and finishing the fabric. Most of the brands don’t have direct engagement with the people that are dyeing and finishing the fabric, they have direct engagement and contracts with their cut and sew facilities. And so they’re trying to control something that’s even a stage beyond where they have contractual agreements.”

– SCOTT ECHOLS, SENIOR DIRECTOR, ROADMAP TO ZERO PROGRAMME,
ZDHC FOUNDATION

Practically, globalized supply chains mean that information about the chemical products used to make a garment is no longer visible to brands. When wet processing facilities and mills buy chemical products, they may get a Safety Data Sheet that commonly describes in general terms what is inside that product, plus handling instructions, often excluding physical and environmental hazards—and even a CAS number. The quality of the information included in an SDS varies greatly from chemical company to chemical company—information can even be contradictory. This scant information is rarely passed through the supply chain.

The information gap is more than just a problem of information not being passed on. “There is a number called CAS [Chemical Abstracts Service], it’s a chemical identity number. And sometimes it’s being asked for by manufacturers because the brands are asking for it,” says Kaan Şen, formerly the business development and circularity manager for the Ereks-Blue Matters denim laundry in Turkey. “For a chemical company, providing this CAS number is like providing your national identity number. Because once you provide it, there is a risk of copying the chemistry, because you transparently give what’s inside.”

“Companies in the West are extremely fearful of having all their intellectual property disappear. Because it’s happened before,” says Franky Vangaeveer, the executive director of Responsible Textile Innovation, and former Levi’s employee. “There’s a real fear that by releasing their information, they’ll just be losing business to companies that aren’t subject to the same requirements that they have in Europe, or even the U.S.”

But Andrea Venier of Officina+39, which markets several new innovative dye technologies, disagrees. “During the last few years when we should have been trying to complete the cycle of transparency, of information sharing, really, I see nothing happening. I believe we still need to work harder to design a better model of transparency.”

But there are legitimate reasons to shy away from more transparency. “I think that also on the brand side, discussing chemistry with consumers is difficult given the negative perception of the general public about chemicals,” Echols says. “The fear is that if they tell consumers chemicals are in the product, even if that chemical is safe, there will be a negative reaction. They don’t want to be the first to do it.”

Brands are also fearful about being lied to. A famous example: American companies DuPont and 3M knew the toxicity of PFOA used in Teflon and Gore-Tex. And yet, they hid that information from regulators (and by extension, fashion brands and consumers) until it came out in a lawsuit and large-scale epidemiological study in the early 2000s of West Virginia residents who had been drinking contaminated water. The CDC estimates most Americans have detectable levels of PFOA and PFAS in their blood.⁵



Step 2: Ignore what is happening in the world of chemicals

Brand decisions to cede technical expertise must be understood within the context of rising consumption⁶ and chemical production more generally.⁷

Estimates for the number of chemical substances currently used in global commerce range from 40,000 to 82,000, though some put the number of total chemicals registered as high as 350,000.⁸

In 2018, Nike estimated that 3,000 chemicals are used in the value chain and manufacture of apparel and footwear.⁹ But past research has shown that in a few years the number of known chemicals on the market can quickly expand. In 2021, Duke researchers identified nearly 5,000 chemicals registered for use that have the chemical structure of azo dye,¹⁰ indicating that there are far more azo dyes in use than labeled as such in PubChem, the freely-accessible, U.S.-government funded platform that is a database of chemicals and their health effects. The same year, the EPA estimated that there are 12,000 types of perfluorinated chemicals¹¹ in existence, double its estimate from just a few years prior.¹² Again, while only a subset of these 12,000 are used to provide stain and water repellency in fashion products, it indicates there might be many more chemicals used in fashion than were included in Nike's original estimate.

It's worth highlighting that these estimates refer to **chemical substances**, which are combined to produce branded **chemical products** sold to fashion manufacturers. There are 55,000 reported chemical products in ZDHC's Gateway platform.¹³ To say it another way, chemical substances are not usually chemical products that anyone can buy. They are the ingredients that chemical formulators use to create chemical products, which manufacturers then buy to use in the production of fashion. (A good analogy is that fructose is a chemical substance in high-fructose corn syrup, a product that food companies buy to put in processed foods, which consumers then buy.)

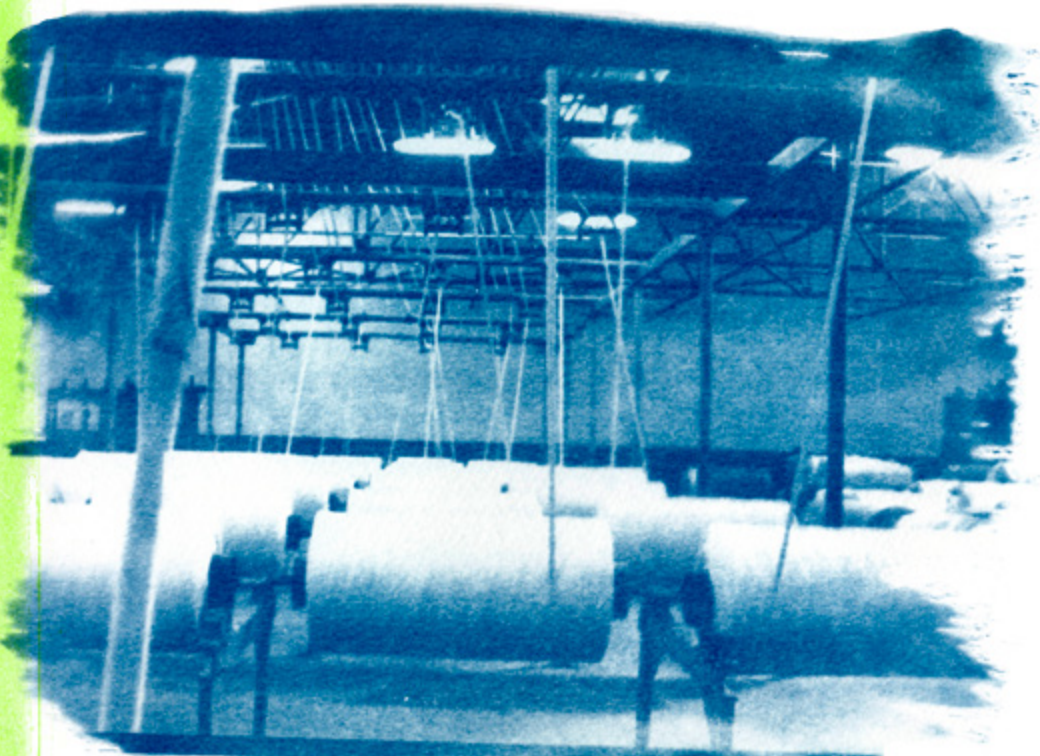
In other words: at a time when the volume of chemical products on the market was rising, brands —because it was better for their shareholders and their books, were ceding some of the very knowledge they would have needed to better manage the situation.

Step 3: Turn a public health issue into a market differentiator

While brands lost expertise, and more chemicals came to market, consumers started demanding more information about the carcinogenic and toxic substances ending up in waterways and, potentially, on finished products. So brands introduced the restricted substance list, or RSL. Instead of understanding everything that is in a product, brands wanted to be assured of what is **not** in it.

An RSL is a list of hazardous substances that could appear in a garment, alongside limits on how much of each substance is allowed to be there. Garment manufacturers are required to have products tested by a third-party lab before the it is shipped to retailers, and send the document to brands certifying that no hazardous substance exceeded the limit specified by the RSL.¹⁴ In other words: third-party auditing and consulting companies have stepped in to fill the gap between consumer expectations and reality.

Hohenstein, a German lab, has for decades provided this testing of textile products and is the most highly respected commercial lab when it comes to textile chemistry. Germany's ban of azo dyes based on carcinogenic **amines** in the 1990s spurred Hohenstein to create **OEKO-TEX**,¹⁵ a non-profit which came up with standardized testing procedures and which provides brands and products with a label, Standard 100 by OEKO-TEX, certifying that they are safe for the consumer.



In 1995, H&M produced its own RSL, the first brand to do so. Bluesign, a Swiss company that provides chemical management training to brands and manufacturers, came next in 2000 with a manufacturer restricted substance list ([MRSL](#)). That same year, Levi's came out with its own RSL.¹⁶ There's also the nonprofit certification Global Organic Textile Standard ([GOTS](#)),¹⁷ and [Cradle to Cradle](#),¹⁸ which certifies that a product is free of chemical substances that would prevent its recycling or biodegradation. It also uses the GOTS RSL.

Then there is [Screened Chemistry](#) from [ToxServices](#) and [Scivera](#), which provides a toxicology report to brands on the chemical products sold by large chemical companies. These reports don't share the exact chemicals in a product, but do purport to give a full (if simplified) picture of potential health risks. Brands can then work with the chemical supplier to reformulate the product.¹⁹

There are many more labels and labs and consultancies, of varying credibility. Whereas OEKO-TEX and bluesign are considered pioneers with strong technical credentials, newcomers to the scene typically are seen as rubber stamps for brands looking for simple ways to assure consumers their products are safe.



“Inditex Group has its own list. Levi’s has its own standards. In Europe, they prefer GOTS, bluesign. They each have made their own RSL, which is becoming a nightmare for us and for everybody in the supply chain,” says Camera of the chemical company Nearchimica.

“Always we think we have already met all the RSLs. But every year some new one comes out, like a surprise,” says Venier of Officina+39.

These RSLs, especially for global brands, are often very similar, but with just enough difference to needlessly complicate the system.

“We have more than 450 different dossier files open for an equal number of brands, retailers, and customers, and it’s becoming really impossible for a company like ours to follow up on every single file. And what’s ironic is that, in most of the cases, it’s basically the same requirements that are asked for but it’s still something different to check on. There might be one or two differences out of hundreds of inquiries.”

– ALBERTO DE CONTI, RUDOLF

This is also a problem for denim manufacturers, who must manage these differing RSLs.

“It’s not difficult to manage per se per customer, but it does create additional work and time which could be avoided if there was one global dossier file for everyone to follow,” says Abdullah of Diamond Denim.

The apparel and footwear trade organization **AFIRM**, which has been around since before even ZDHC, comes the closest to achieving a global RSL, while providing guidance to brands on testing protocols for final products. Only a dozen or so brands are dues-paying members, and unlike ZDHC, it does not have a transparent governing structure. And, because it has no consumer-facing label, it doesn’t give brands a marketing story to sell to consumers.

Certifications and industry groups compete with each other to convince skittish and confused brands that their service is the best, and will safeguard both the workers and consumers from exposure to hazardous chemicals—and safeguard the brand from bad press. The result? Denim mills, laundries, and chemical companies are required to have multiple, overlapping certifications. This is multiplied down the supply chain, as a brand that wants to have a certification on a product must ensure that all the suppliers that touched that product have that same certification. An OEKO-TEX-certified chemical product is not good enough for a GOTS-certified facility, and vice versa. Some brands have their own RSL, but also expect suppliers to work with Scivera, bluesign, or Cradle to Cradle on top of that.

“I tell you, frankly speaking, the product that I sell is the same, but if I don’t have bluesign or ZDHC or GOTS I will lose almost 50 percent of the business. You are the supplier and you do what the customer wants.”

– ROBERTO CAMERA, NEARCHIMICA

“Sometimes the starting point of those certification bodies differs. But the point where they come, where they gather information, is mostly the same,” agrees Şen of Ereks-Blue Matters.

And with all the different regulations in the world, brands will come up with different RSLs for different products and countries they sell into. Testing every product to the most restrictive standards around the world would be needlessly expensive for a US-only brand or its garment factories—it can cost over \$2,000 per garment.

“I don’t see why we shouldn’t have one globally-accepted RSL. Can you think of any reason why Diesel jeans should have different requirements, environmentally speaking, than Levi’s jeans, Pepe jeans or Calvin Klein jeans? There is a bad need for alignment.”

– ALBERTO DE CONTI, RUDOLF



Step 4: Be forced to act by an activist campaign

In 2011, Greenpeace's launched its Detox fashion campaign, which called out large brands for the toxic effluents flowing out of factories they sourced from.

This time, instead of allowing more companies to pitch their solution, six global brands came together to create a new industry group, ZDHC, denim-first brands Levi Strauss and G-Star RAW, plus multi-product brands like C&A, Gap, Primark, and Next, and chemical companies Rudolf, DyStar, and BASF, plus some mills and manufacturers, would join.

ZDHC¹⁹ worked with a wide array of stakeholders to come up with a manufacturer restricted substance list (MRSL). This applies not to the final product, but to the chemicals used in the supply chain.

Although ZDHC has managed to align the largest players around one MRSL, signing up for the industry group is voluntary, and expensive. When asked, Echols said no one has been able to come up with an exact estimate of ZDHC's market coverage. But ZDHC's membership probably covers less than a tenth of the fashion industry when it comes to total production volume.²⁰

“There’s definitely a long tail of places that we don’t yet reach, I can say, even after 11 years, we still have brands within collaborations that say yes, we all need to agree, but then to give up that last little bit of control they have because they’ve got two compounds that are different from everybody else...it’s a long process.”

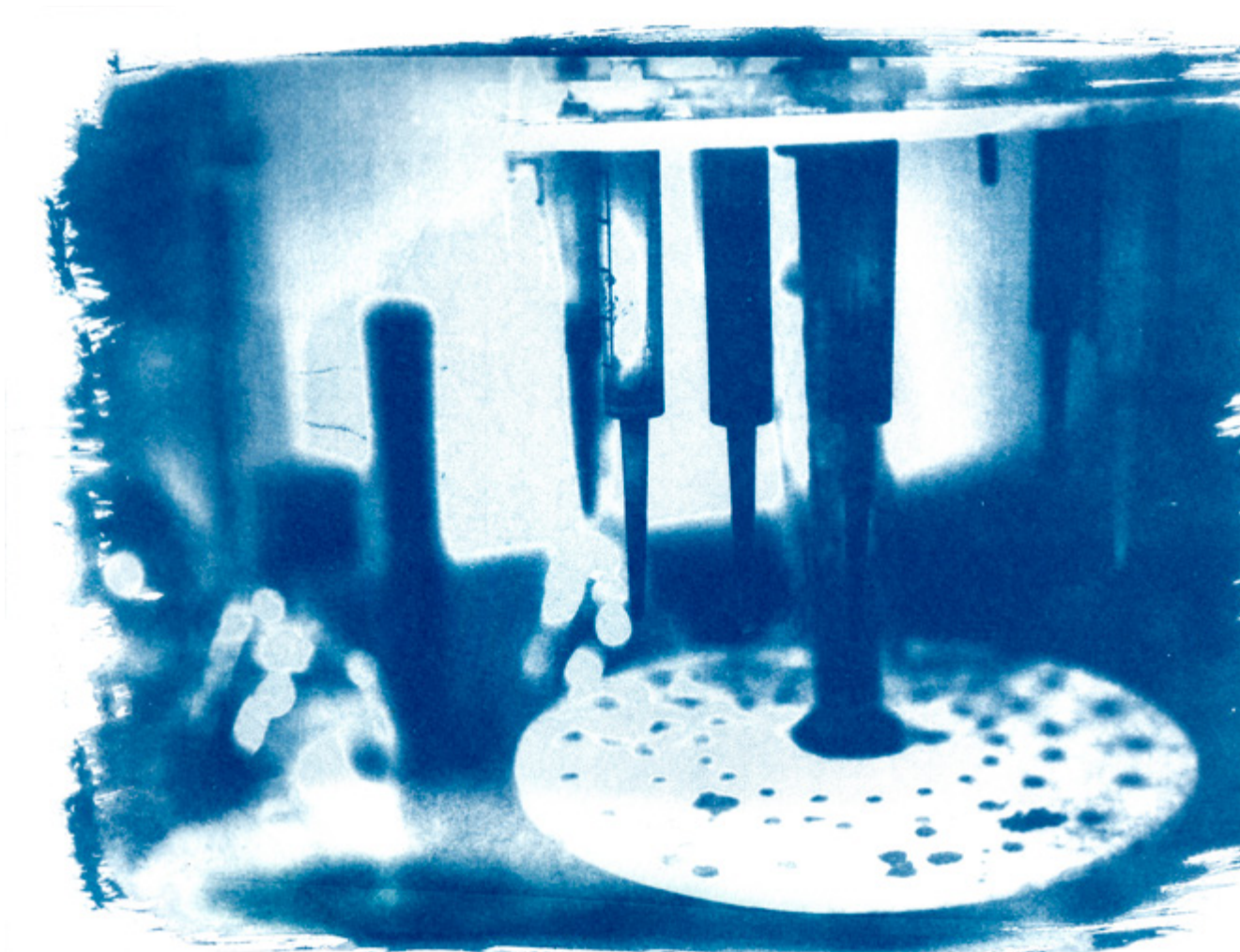
– SCOTT ECHOLS, ZDHC

Still others have large teams working on this subject that would be made redundant and laid off by ascribing to a common industry MRSL or RSL.

As long as there isn't a governing body that can come to a decision and enforce it for the whole industry, there will continue to be brands that refuse to play by the rules. Because until that time, they're not rules—they're just suggestions.

“You have an industry marking their own homework. A conflict of interest issue where you have certification schemes and a revolving door, potentially, between the people writing the rules and people who are making money out of that same business model. If you don't make it mandatory for companies to act in a certain way, what we've seen is that action is not going to happen fast enough just with the kind of goodwill of industry. But all that said, we've specifically highlighted ZDHC in our policy paper—we can build on what's been done and these voluntary initiatives.”

– EMILY MACINTOSH, POLICY OFFICER FOR TEXTILES AT THE EUROPEAN ENVIRONMENTAL BUREAU



Step 5: Slap a certificate on it

Brands have leveraged individual approaches to chemical management as a market differentiator.

But the result isn't just inefficient and redundant, it's also ineffective. Certificates meant to protect against adversity and uncertainty are no substitute for relationships, technical understanding, and alignment on values.

Hazardous chemical contamination can happen by accident anywhere along the supply chain; ferreting out where that might have happened is impossible unless a brand has a strong, long-term, and mutually respectful relationship not just with the laundry and garment finishers, but with **Tier 2** (fabric mills), and **Tier 3** (spinners and chemical suppliers). And yet, factories often have to dump expired chemicals that they bought but were unable to use due to brands canceling orders.

Instead of investing in these relationships, many brands are using audits and certifications to offload responsibility onto their supply chain, all while threatening to move orders elsewhere if suppliers don't drop their price.

If a brand switches from factory to factory based solely on price, or refuses inventory that's already been produced (or for which raw materials have already been purchased), a factory manager's most effective cost-saving strategies involve buying cheap chemicals from a local trader, or getting sundries like pocket fabric, buttons, and tags from dodgy and cheap suppliers.

A merchandiser at one garment factory told us that they regularly doctor RSL product tests to mask failures for things like azo dyes or heavy metals. As long as the consumer won't notice, and the brand is prioritizing low prices above all else, the factory is not incentivized to go through the time-consuming process of fixing a test failure. And the brand uses the certification scheme to check boxes, so later they can say they had no idea and don't condone the behavior. Whereas, the brand's priorities—cheap products no matter what—are abundantly clear to the supplier, to the point of collusion.

Dr. Siva Pariti, a consultant from BluWin described the time his team was trying to find out for a brand why a jeans pocket had failed for azo dye. They followed the supply chain from Berlin to Manchester to Mumbai to Pakistan, discovering that the pocket lining for two pockets in the same jeans had come from two different factories. “They can come from any small factory operating under the radar.” Because brands push all the financial risk onto suppliers, they are incentivized to cut corners to survive.

“I’ve always told people, this is not a technology problem. This is a business and socio-economic problem. Most of the problems result from being pushed on price, and the idea that you can say, sorry, it’s not our problem. We didn’t know that that came from that factory. Yeah, you may not own it, but you set it in motion by what your design and your requirements were.”

– SCOTT ECHOLS, ZDHC

Or, factories find savings on their chemical products. Small chemical companies buy their raw materials as byproducts from the coal, construction, mining, metal processing, or pharmaceutical industry, and sell these contaminated products onto wet processing facilities.

“If, for example, you are a garment manufacturer in Bangladesh, and you are being forced by brands or retailers to meet certain costs, then instead of buying thoroughly developed and multi-certified auxiliaries, you go out, and you buy similar options coming from small, local companies, which are cheaper because they don’t go through the certification process. That’s particularly true for basic chemical products,” says De Conti.

The result? Certifications have gaping loopholes, and fraud is pervasive.

“You have to build trustworthy relationships with the biggest chemical suppliers because we cannot just trust the certification, It’s really easy to fake documentation. Each company today is capable of getting the certification for the products that actually they cannot get a certification for.”

– KAAAN ŞEN, FORMERLY EREKS-BLUE MATTERS



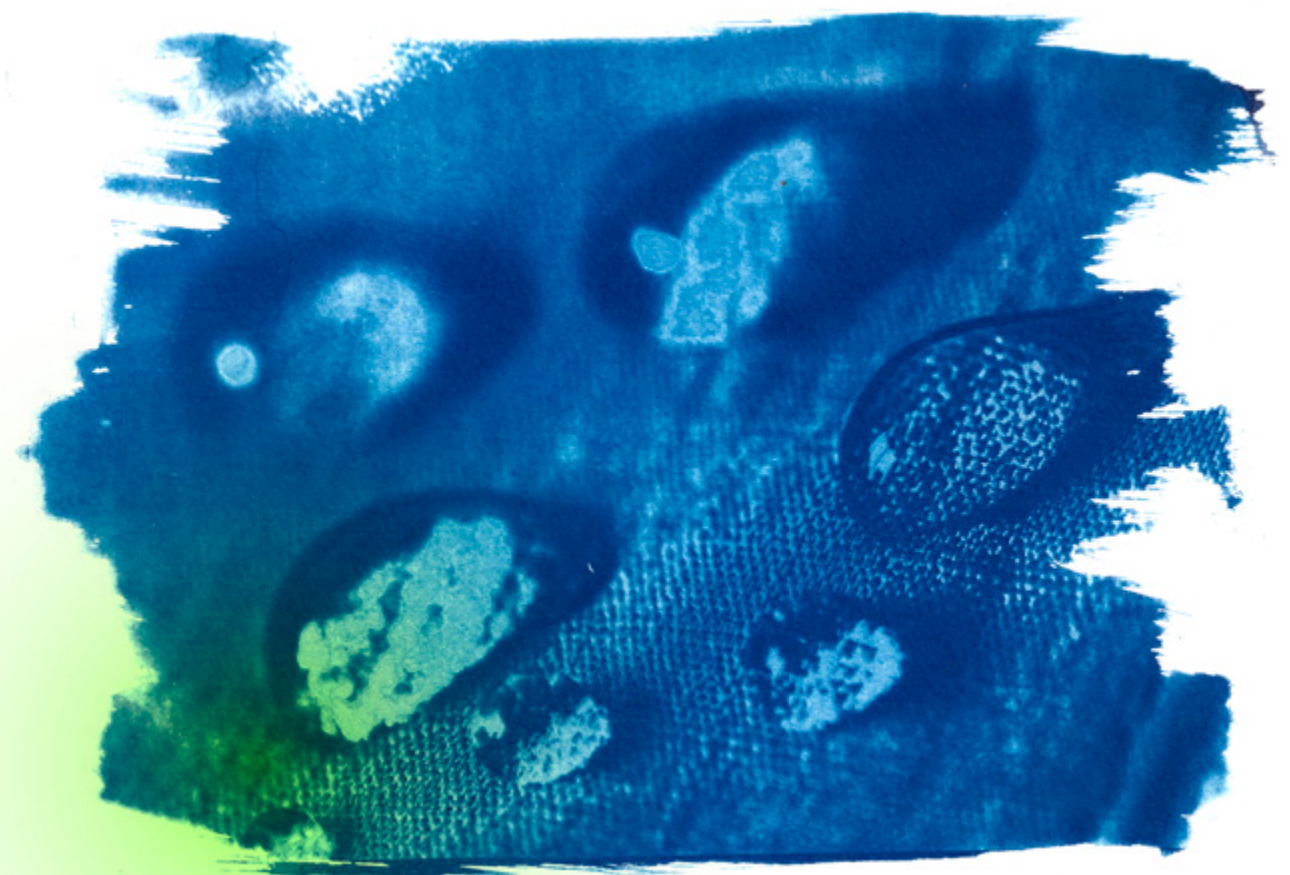
For example, Ereks-Blue Matters has requested a GOTS-certified enzymatic wash from chemical suppliers. The large ones—DyStar, Rudolf, and CHT—said that wasn't possible, because GOTS does not allow genetically modified products (the enzymes) in its supply chain. "But when we asked for the same product from the smaller companies, somehow they were able to certify the enzymes under GOTS. Crazy," Şen deadpans.

He's a chemical engineer, so he can discern when he's being lied to. But that's not true for many working in denim. When he was looking for a hypochlorite alternative that could be used under GOTS certification, a small chemical supplier brought him a "GOTS-certified" calcium hypochlorite in lieu of sodium hypochlorite, which is still not allowed under GOTS certification.

Abdullah of Diamond Denim said that a year ago the company had to incinerate an order of 5,000 jeans because the pockets (from an OEKO-TEX-certified manufacturer) tested too high for azo dyes. In between the yearly product testing requirements by OEKO-TEX, a supplier can easily switch to cheaper chemistry.

"If the creatives allowed a minimum deviation, there are possibilities for much more sustainable replacements. And, if you combine this state-of-the-art chemistry with modern machine technology, there's a lot that could be done with less water and less energy. But all these innovations require more flexibility from designers in terms how a garment looks."

– THOMAS APLAS, CHT



Step 6: Make the supply chain pay for it

Although the certifications are pitching their service to brands, it's the supply chain that ultimately pays.²¹

Manufacturers must buy more expensive certified chemical products from reputable manufacturers, and pay multiple certification labels and bodies to prove they follow and enforce guidelines on safe chemical use by workers and proper treatment of effluent and disposal of waste. Brands pay only for the right to display these labels on their websites for consumers as a marketing message. And if a shipment fails the test, it's the manufacturer that has to eat that cost, not the brand.

“This is slowly killing us. Customers are asking you for registration of course, but they don't want to pay the cost. So, everything must be given free of charge. Just to give you an idea, our company has a turnover of around 15 or 16 million euros. Just REACH's cost,” the European Union's Registration, Evaluation, Authorisation and Restriction of Chemicals, “has been over 1 million euros. Every year we spend for certification—I include also the analysis that we have to do for Inditex because they want the product analyzed two times a year—we spend more or less 150,000 euros for different certifications, including the cost of the people managing this.”

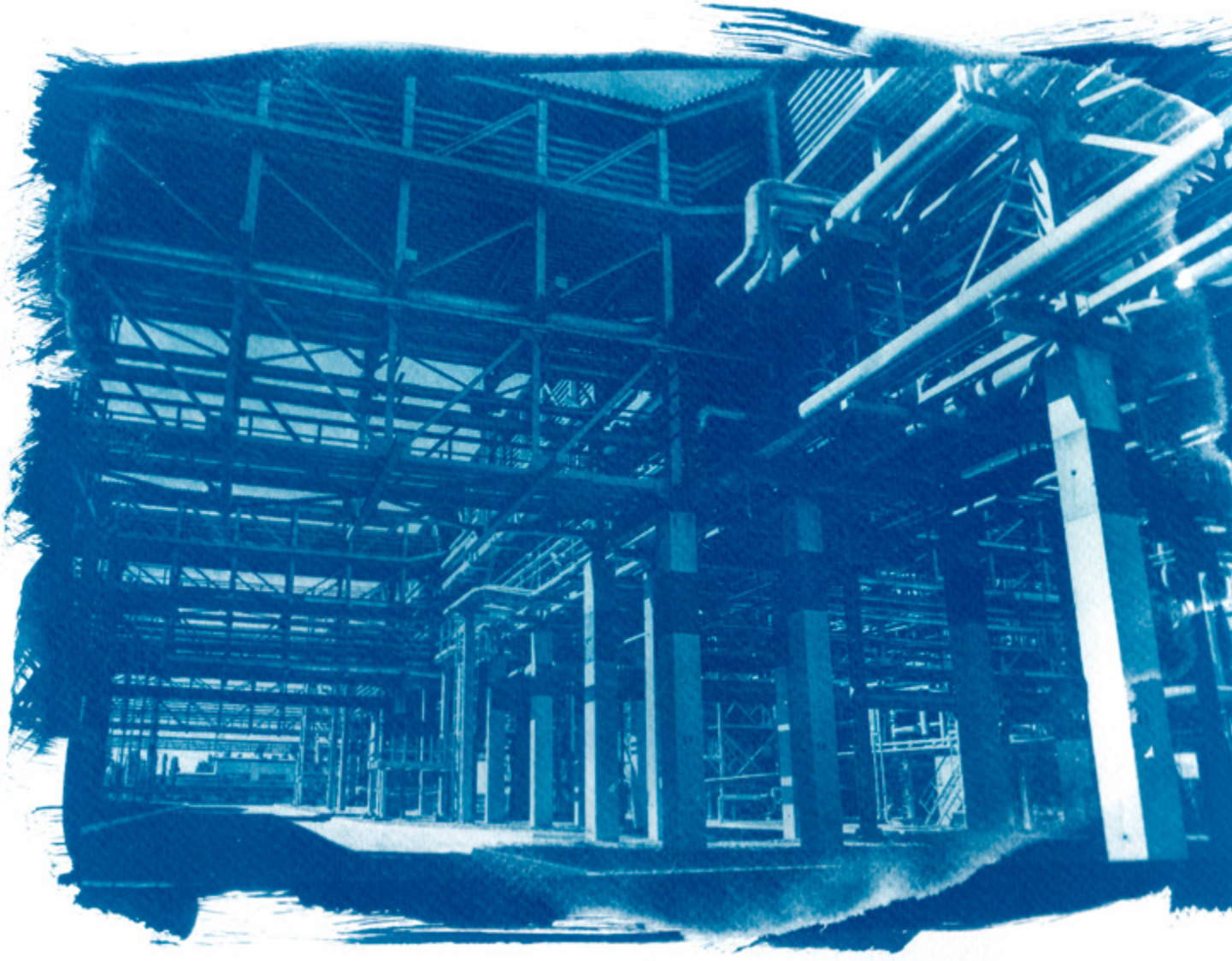
– ROBERTO CAMERA, NEARCHIMICA

“It's not only the cost, it's the fatigue of these audits,” Romain Narcy of Ereks-Blue Matters says. “I have nothing to hide and they are always welcome, but you know, the team has to repeat itself and fill hundreds of pages of forms.”

This is not just a fast fashion problem. “In garments, we work with a premium sector so all the brands are asking for safe garments or safe products,” says Camera. “When they don’t accept that they have to invest some money and they pretend that all the improvement is at zero cost, that is not realistic.”

The vast sums spent toward ensuring safe chemistry is flowing toward labs, certifications, and auditors such as SGS, Intertek, Bureau Veritas, and Control Union. Suppliers told us that that money would be better spent on researching and developing safer chemistry solutions.

“I’m not happy with the R&D and the improvements going on in the chemical industry,” says Şen of Ereks-Blue Matters. “They don’t have a product that can really replace the hypochlorite and give the same effect that we desire. So the R&D work must increase.”



Step 7: Try to define and categorize hazardous chemistry

The numerical limits listed in RSLs make the subject look like settled science, but those can be estimates based off of decades-old, out-of-date studies.

“The RSL concentrations came out of legislation that already existed, like the German legislation for aryl amines when the first RSL’s were developed 20 to 30 years ago.

There needs to be more work done to refine limits to keep pace with evolving information,” Echols of ZDHC says.

Advocacy organizations use terms around chemicals and their properties in manner that differ from regulators and scientists, which further serves to confuse the public and non-chemists: acutely toxic; poisonous; carcinogenic, mutagenic, reproductive toxic (CMR); persistent organic pollutants (POPs); endocrine-disrupting chemicals (EDs or EDCs) or hormone-disrupting chemicals; substances of very high concern (SVHC); persistent, bioaccumulative and toxic (PBT); and more.

Some chemicals can be a combination of two or three of these categories, such as PFAS. **PFOA and PFOS** have been found to have a probable link²² to cancer, are suspected **endocrine disruptors**,²³ and are persistent and bio-accumulative.²⁴ Emerging research on **short-chain PFAS** shows similar persistence in the environment and accumulation.²⁵ (European chemical suppliers have²⁶ offered fluorinated-free durable water treatments since at least 2003, followed by some American²⁷ and then Asian chemical suppliers, but these safer alternatives found little uptake from brands until the past five years of increased activist and consumer pressure.²⁸⁾²⁹

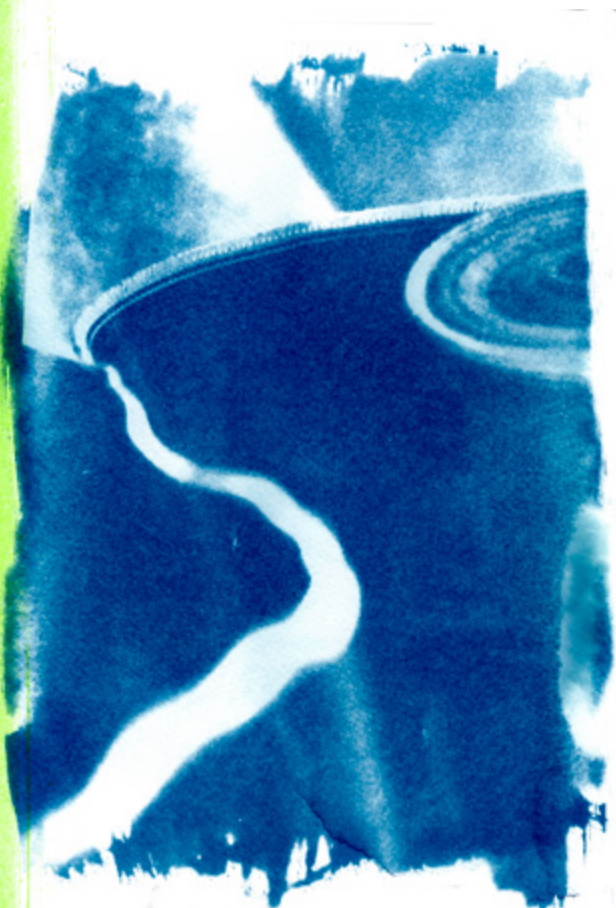
Recently, there has been a significant increase in our understanding of endocrine disruptors—bisphenol-A³⁰ and -S, phthalates,³¹ and, again, PFAS—which interfere in the body’s many hormone-regulated processes, including its reproductive, immunological, neurological, metabolic, and cardiovascular³² systems.³³ Evidence indicates that the health effects of EDs can be passed down through subsequent generations from exposed parents,³⁴ and that the initial exposure may not be dose dependent. At levels as low³⁵ as one part per billion,³⁶ they can cause complex and cascading problems that are as yet poorly understood.³⁷ Such unpredictable effects at low exposure means that efforts to date by some regulators in some countries, a few dozen brands, and responsible chemical companies to mitigate uncontrolled consumer exposure³⁸ won’t be enough. It will take a coordinated effort by all to protect the public’s health.

This is why there is also much debate about the risk versus hazard-based approach to chemical management. A risk-based approach takes into account both the inherent health hazards of a chemical and the estimated amount of exposure.³⁹ In addition to hazard and risk assessment, a government may factor in the economic burden to companies and society of restricting or banning the chemical.⁴⁰ This allows for many chemicals with hazardous substances⁴¹ to be used in consumer products, especially if they stay below a commonly accepted limit. This is the attitude taken in the United States at the federal level. The European Union and California lean toward the hazard-based approach, in which some substances are not allowed to be present in consumer products at all—or if they are, consumers are warned.

As great as the precautionary approach sounds, however, it would be impossible to follow it 100 percent of the time. As has often been pointed out, simply biting into an apple generates minute amounts of formaldehyde.⁴² The acrylamide generated roasting coffee beans is why Starbucks briefly had to label its coffee with California’s Proposition 65 cancer warning before common sense prevailed in the courts.⁴³

But we have huge knowledge gaps when it comes to measuring both hazard and risk of fashion chemicals. Traditionally, toxicology has been an elective course in some chemistry programs. “In general, a weakness of all chemistry programs is they don’t spend enough time teaching people about toxicology and how it intersects with chemistry,” says Echols. “When you’re brought up in a pure chemistry program, there’s not a lot of overlap, and you might take a toxicology class, and you might not.” Proponents of green chemistry have been trying to shift the field of chemistry for the past two decades so chemists and designers consider the full lifecycle impact of a chemical at the outset of its creation, and long before it is introduced to the market.

Even if green chemistry principles became the norm, in the United States, we would still need to contend with the tens of thousands of chemicals already in wide use.⁴⁴



Step 8: Rehash the same little research without contributing anything new

Layered on top of the debate about risk versus hazard, outside of the EU, few synthetic chemicals have been tested for safety.⁴⁵

Thousands of new chemicals are registered every year (though mostly created for applications outside of fashion, many of these chemicals are taken up by the fashion industry eventually). They are produced and released onto the market—and the environment—faster than they can be assessed, or even identified and tracked. For example, 40 percent of the substantial risk notices filed by chemical manufacturers with the U.S. Environmental Protection Agency (EPA) in 1998 kept the very identity of the chemical substance a secret, using a legal loophole that allows companies to keep the chemicals confidential under a justification of trade secrets.⁴⁶ Twenty-three years later, the EPA stopped posting any substantial risk notices online for the public for two years, saying that it was underfunded, had not replaced the employee in charge of the website when they retired, and furthermore, it was not legally obligated to publish notices.⁴⁷ It started reposting these disclosures only in early 2022.⁴⁸

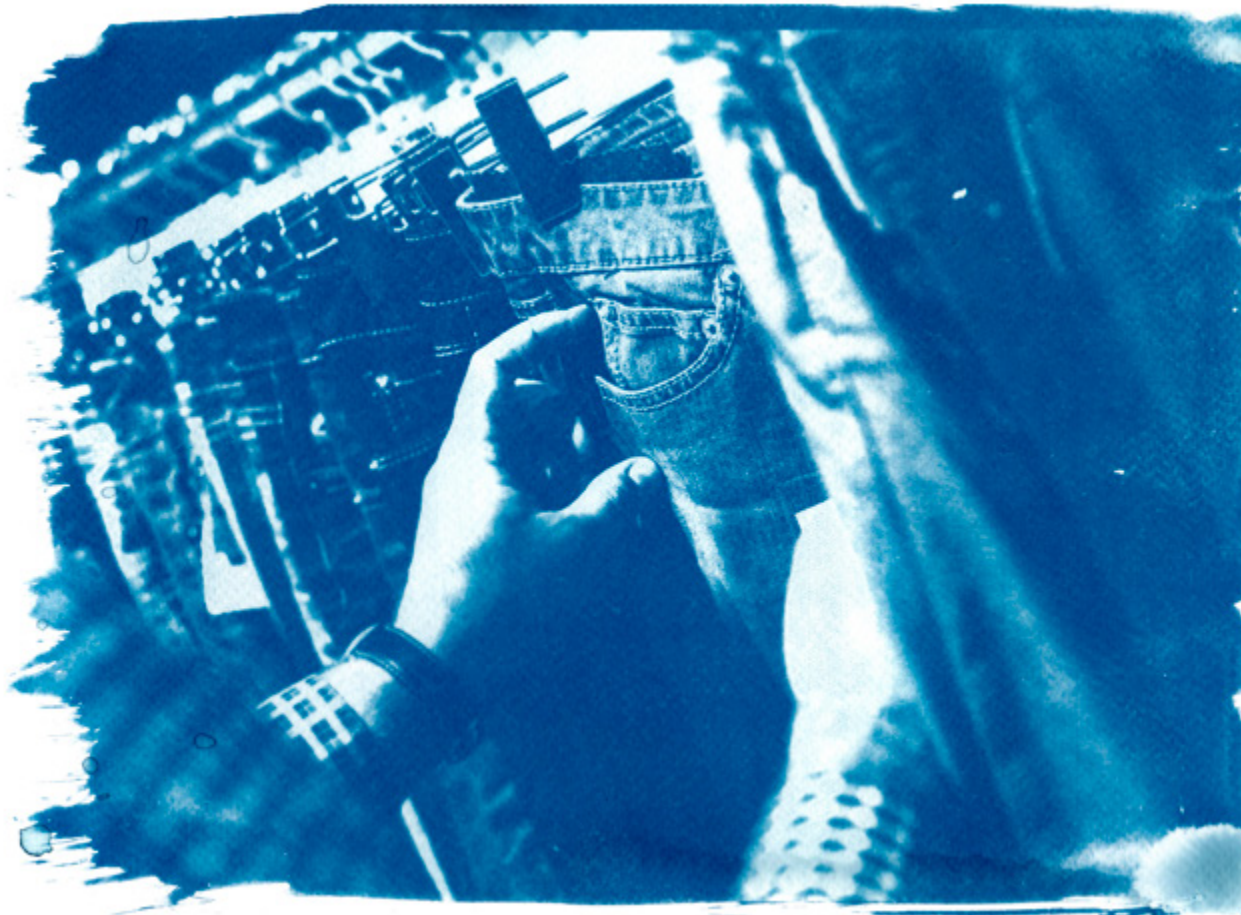
REACH, on the other hand, by requiring the registration of chemicals and the sharing of any and all research on their toxicological effects, has greatly improved the public's understanding of chemicals used in consumer products.

While we have a fairly robust understanding of worker risks when it comes to daily and high exposure to many carcinogenic, mutagenic, and reproductive toxic chemicals,⁴⁹ we have very little understanding of the risk of wearing clothing with textile finishes, dyes, and contaminants, beyond acute sensitization that manifests in rashes or short-term breathing problems.⁵⁰

How much of a particular substance can slough off a textile when you're wearing it and seep into your skin? How much of an off-gassing solvent do you breathe in when you wear a piece indoors? How do these chemicals interact when on a piece of clothing together, or when they end up in the body together? These are questions yet to be answered. Consumers are just exposed to too many chemical substances in too many ways on a daily basis to definitely link chronic health concerns like autoimmune disease, fertility issues, or cancer to one industry, brand, product, or substance.

Notice the frequent use of the words, "linked to," and "suspected." There is not enough funding for the study of chemical health risks, especially when it comes to their use on consumer products.⁵¹⁻⁵² Independent, robust studies conducted by university researchers can take years and often have a very narrow focus. For example, it took over five years for a team at Duke⁵² to produce research characterizing azo disperse dyes in children's clothing, and the researchers were only able to characterize about a dozen azo disperse dyes out of thousands registered and listed for use.⁵³

Studies also tend to look at only clear types of exposure that can be isolated and well-studied, such as occupational exposure of factory workers, mostly in Western countries or China. Some examples of this research include formaldehyde's possible link to leukemia⁵⁴ and "flock worker's lung": interstitial lung disease in factory workers caused by inhaling synthetic microfibers.⁵⁵

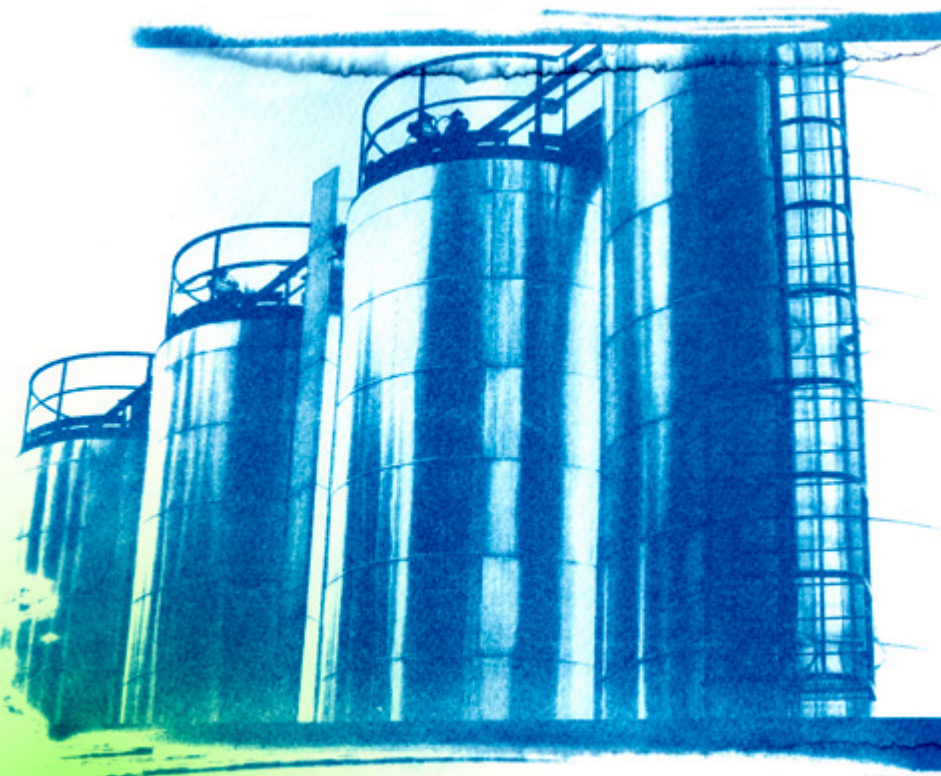


“Especially in the early days, you would talk to [brand executives] about the fact that the consumers had questions about chemicals, they just didn’t see it,” says Echols of ZDHC. “Because they were focused very much on the legal point of view and making sure that they didn’t create a problem in their own factory and that their workers are protected. They weren’t necessarily thinking about when we design stuff, are we really considering [what’s going in the product]? You know, it’s changing, because the younger generation that’s coming in has begun to think like that.”

Further exacerbating the confusion, textile chemists tend to find their only opportunities for employment in the private sector, either working directly for fashion brands, or for companies that have fashion brands as clients.⁵⁶ Their findings are kept largely private and protected under non-disclosure agreements.⁵⁷ “My feeling is that the information is out there, but we just don’t have the structures in place or the obligation for it to be disclosed,” says Emily Macintosh, the policy officer for textiles at the, European Environmental Bureau.

Meanwhile, despite billions being sent to the commercial testing industry, which rehash the same profile work over and over on the same chemicals in different products for different clients, we are not learning new things about the toxicology of chemicals and their effects on the human body because of the lack of in vitro research by independent university research labs.⁵⁸ Research toxicologists largely do not evaluate the chemicals used in fashion—or have their work read by those who work in fashion.

Due to this lack of consistent research or agreement on basic principles, no one can agree on what constitutes “safe” limits to chemicals used in fashion manufacture and on consumer products.



Step 9: Fall behind on the latest research and get called out

In addition to being inefficient, redundant, and ineffective, the industry-led approach to chemical management has fallen behind the latest research and testing methods.

For example, private RSLs contradict the latest health research, allowing things like short-chain PFAS, despite activists and researchers sounding the alarm on the entire class of PFAS chemicals. Some allow endocrine disruptors such as phthalates and BPA up to a certain limit, even though scientists say that there is no safe level of endocrine disruptors.

Another example: researchers are running newer tests—such as mass spectrometry for organic chemicals⁵⁹ or PIGE for fluorinated chemicals—that can give some indication of all the substances that are in something. But commercial labs use a type of test that checks for one specific chemical substance at a time.⁶⁰ Each test is expensive, so they are only run on the riskiest few hundred of chemicals, out of thousands of potential hazards. This leaves room for manufacturers to switch to substances that are in the same toxic family, but aren't on the RSL of brands or certifications.

For example, labs who test to OEKO-TEX standards only look for a few dozen of the most common perfluorinated chemicals, even though there are an estimated 12,000 of them.⁶¹ Researchers, such as those in the Silent Spring Institute study, now test for total fluorine and, if it's over 50 to 100 ppm, do further tests to try and establish what kind of PFAS a textile contains.⁶²

These mismatches between private certifications and public research has led to some egg on the fashion industry's face. In September 2021, the Center for Environmental Health in California publicized that it found the endocrine disruptor BPA in polyester socks bought in the U.S. from 95⁶³ different large brands at levels up to 19 times the California limit. While BPA is firmly in the public's mind as a toxic chemical, it was not previously considered a risk for textiles and so wasn't often seen as worth the extra expense of testing for it.⁶⁴⁻⁶⁵ (OEKO-TEX tightened its standards for BPA in response.)⁶⁶ In early 2022, law firms in California filed dozens of notices under Prop 65 against retailers—Five Below, Target, Ross, Revolve, Nordstrom, Walmart, Burlington, T.J. Maxx, Jo-Ann, Amazon, and Macy's—for selling items containing ortho-phthalates.⁶⁷

There is currently a lawsuit from American customers against the OEKO-TEX-certified, period-proof panty brand Thinx, because a university lab found the presence of high amounts of fluorinated chemicals indicating intentionally-added PFAS, when Thinx had promised its customers it was completely non-toxic. In May 2022, the Silent Spring institute released a report showing that children's products labeled as eco-friendly from retailers including Gap, Lands' End, Old Navy and Columbia contained PFAS.⁶⁸

How is this happening, while the industry, in some cases, spends millions on testing schemes, auditing, and certifications?

Researchers are interested in questions of public health, so they publish their results in journals. Advocates are interested in drumming up public support for better chemical legislation, so they publish their work in media outlets. But because certifications are private and their clients are brands, manufacturers, and chemical companies, they're not incentivized to find every hazardous substance that could be in a product. They're focused on risk management. If a product fails one of the thousands of tests administered every year by commercial labs, that is a private matter between the brand, the supplier, and the lab.

All of these RSLs operate in secret, far from the view of any customer who might have allergies, be recovering from cancer, or just have general concerns about the chemicals in their closets.

“Do all these RSLs help the consumer to buy better clothes? That’s a question. Maybe, but as we said already, it’s not enough, because at the end consumer doesn’t know what they are buying. Yes, today—for the most recognized brands in the world—when a consumer is going to buy a garment, he is buying a better garment than in the past. There is no doubt about that. But really, to be better brothers to the final consumer, we have to simplify more and create clearer rules.”

– ANDREA VENIER, OFFICINA+39

Step 10: Make it optional

Some brands do only the bare minimum, such as ascribing to a common MRSL and having their supplier sign a document attesting they will follow it.

“There is a lot of greenwashing to me. Far too much,” says Vangaever. “And everybody has the impression that a lot is happening. But I don’t see a lot happening, honestly, that has a big impact. I see a lot of brands that are doing something, but it does not impact the total business.”

Some brands do nothing at all. In recent years, lead, ortho-phthalates and PFAS were found in children’s products shipped to Canada from ultrafast fashion brands like Shein and Zaful,⁶⁹ while tests of counterfeit products in the U.S. found arsenic, lead, phthalates and cadmium.⁷⁰ Researchers in Europe found PFAS in medical face masks.⁷¹

Meanwhile, garment factory workers and their communities are needlessly put in dangerous situations. They’re spraying potassium permanganate without protection onto denim, breathing in aniline in indigo dust, and drinking water contaminated by effluent or waste sludge that’s been dumped in unlined pits.⁷²

As an industry, it no longer makes sense to continue down this competitive—and chaotic—path. It’s time to collaborate, to bring all the stakeholders to the table—from industry to academia to government and beyond—to agree on a single, credible, enforceable set of rules that puts relationships first.

A problem or not?

A case study of aniline

As a case study in chemical confusion, we're going to dive into **aniline, an impurity in synthetic indigo**. The industry furor around aniline is an excellent demonstration of what happens when there isn't enough research to inform a decision that is accepted by all.

What we know about aniline: occupational exposure

**Powdered indigo
can contain around**

**12,000
ppm of
aniline**

**(1,000 times higher
than a typical limit
specified by brands
and certifications)**

Aniline, a clear liquid with a fishy smell, is a chemical for which the dose really does make the poison.

It is acutely toxic in higher amounts, whether inhaled, ingested, or absorbed through the skin. It temporarily damages hemoglobin, an important protein in the blood that ferries oxygen around the body.⁷³ At low levels, you'll get a headache and feel dizzy. If the dose is high enough, your lips and extremities turn purple-blue, in what is called cyanosis.⁷⁴ You may start vomiting, convulse, and end up in a coma. Some people have even died.⁷⁵

However, aniline isn't persistent or bioaccumulative.⁷⁶ The body can metabolize it, and one human study found that after workplace exposure, hemoglobin levels were back to normal within about 24 hours their hemoglobin is back to normal and they've made a full recovery.⁷⁷

It's important to clarify that high exposure to pure aniline only occurs in chemical factory settings. There have been no recorded instances of acute toxicity from wearing clothing with trace amounts of aniline.

There is an industry worry that thousands of denim laundry workers, after cutting open bags of powdered indigo while wearing improper or no protective equipment, are inhaling powdered indigo, which can contain +10,000 ppm of aniline, according to Vangaever, a denim technology-chemistry consultant and former chemical Innovation engineer at Levi's.

The U.S. Occupational Health and Safety Administration, or OSHA, limit for how much aniline a worker can be exposed to during an eight-hour day is 5 ppm.⁷⁸ While there have been several human studies of workers in indigo production plants, there have been no studies, to our knowledge, of exposure to aniline in denim mills that use indigo.

Pre-reduced indigo, which is sold in liquid form, is a safer alternative, according to several experts we talked to. Workers can more easily pour it into the equipment without being exposed to any residual aniline inside. This has become the norm in European and American denim mills, but our interviewees estimated, based on anecdotal evidence, that roughly half of indigo used today is still in powder form, mostly in Chinese denim mills because it is cheaper, and in Japan where artisanal denim production methods are often preferred.

What we don't know about aniline: consumer exposure

There are studies showing that repeated aniline exposure could damage the spleen and lead to cancer. However, these studies use rats, not humans,⁷⁹ so there is no reliable information on what a “safe” dose is for humans with repeated exposure might be.

Combine this lack of information with little research on what kind of exposure humans get from denim that has trace amounts of aniline (or really any substance on any type of textile), and even experts cannot agree on what constitutes a “safe” amount of aniline in jeans that consumers wear. For some substances, the fashion industry could decide that no consumer exposure is the safest route. However, there will always be some aniline in synthetic indigo-dyed jeans. It may be so low that it is not detectable, but it is there.

Adding to the confusion is the fact that there is not a widely-accepted test to check specifically for aniline. The ISO 14362-1:2017 method, which is recommended by ZDHC, OEKO-TEX,⁸⁰ and bluesign,⁸¹ only tests for all amines that can cleave off aniline. And when used in different labs on the same sample of dyestuff or indigo-dyed fabric, it often yields different results.⁸² So, an acrimonious debate has ensued on how to set the limit on aniline in clothing for the benefit of consumer health.

There is not a widely-accepted test to check

specifically for aniline



A lack of legislation for aniline

1. It's not a problem

The U.S. Environmental Protection Agency categorizes aniline as a Group B2 human carcinogen, meaning studies only from rats link it to cancer.⁸³ While the CPSC only regulates a few chemicals in consumer products, aniline is not one of them.

In Europe, aniline is classified as carcinogenic category 2 (suspected) and mutagenic category 2 (cause for concern).⁸⁴ REACH requires children's product to have less than 30 ppm.⁸⁵ The EU affirmed in 2018 that currently no action is needed on regulating aniline in adult clothing.⁸⁶

So, the industry is left to take on its own risk/benefit analysis. In conversations with different experts, we got several different opinions:

"Usually, if denim is washed, most of that aniline is going to be removed and just residual amounts will remain. We've been wearing jeans for a long, long time. I would say as a brand, you need to address aniline just in case it gets regulated," says Amanda Cattermole, a textile chemistry consultant and former Levi's employee.

Her concern is more on the pollution side. "When denim is washed, any residual aniline on the surface of the fabric will be removed during garment finishing and will remain in wastewater,⁸⁷ which must then be treated prior to discharge".

During indigo dyeing, a reducing agent (sodium hydrosulfite) is used, which produces lots of salts that cannot be easily recycled or reused. Instead these salts must be responsibly landfilled, or they can negatively impact water and soil ecosystems.

"Sometimes we spend too much time looking at chemicals that either exist in minute amounts or are not necessarily hazardous, when we should be focusing on the bigger polluting issues."

– AMANDA CATTERMOLLE, TEXTILE CHEMISTRY CONSULTANT

2. It can be a problem with cheap denim

“Ultra-cheap denim brands that make \$10 jeans, depending on the finishing-washing, likely use production methods that leave higher amounts of aniline on the denim, relative to more careful dyeing,” says Vangaever.

For a well-dyed pair of jeans, the denim fabric would have only between 4 and 7 ppm of aniline. (Another note: Experts disagree on whether to even talk about non-fixed versus fixed aniline. Non-fixed is aniline that can shed off the denim, especially in a test that mimics sweat exposure, or in a consumer’s washing machine. Fixed aniline is in the garment but would not come off while you wear it. Advocates have made the argument that fixed substances will become unfixed through wear, and so the entire amount of a substance in a textile should be considered, not just the unfixed amount.)

“I’m more concerned about those cheap jeans coming from the fast fashion industry, those are the ones that you really have to go after.”

– FRANKY VANGAEVER, DENIM CHEMISTRY CONSULTANT

3. It’s a problem that deserves oversight

In 2018, Archroma debuted the first “aniline-free” indigo dye, and some denim mills and laundries switched to it out of an abundance of caution. (By “aniline-free,” Archroma means at levels below the limit of detection in tests for amines.) DyStar also assured mills that if they used its indigo, they would pass all restricted substance tests.

In July 2021, the safe chemistry consultancy bluesign specified that only aniline-reduced indigo would meet its standards.⁸⁸ OEKO-TEX, another company that focuses on ensuring a safe end product, specifies that products with its **Standard 100** certification cannot be present at levels higher than 20 ppm in baby products, and 50 ppm in all other products,⁸⁹ while GOTS says 100 ppm.⁹⁰ H&M used to specify 10 ppm,⁹¹ but has since referred to the AFIRM RSL, which does not specify a limit for aniline.⁹²

We looked at a half dozen different brands’ RSLs and found aniline limits of 20 in all of them. That would be an almost impossible standard to achieve unless dyers are using aniline-reduced indigo.

In conclusion... there is no conclusion

The truth might be out there about aniline, but without additional research and/or innovation in testing methods, the industry's smartest will likely continue to go around in circles on the subject of how much aniline on jeans is too much.

If we go by the precautionary principle, then this lack of information should lead us to manage levels of aniline in denim and dye products with care, and continue the search for alternatives that give the same beloved look without the risks.

But as long as there is no organization or entity that can arbitrate and make a final decision that aligns all players behind a single standard, the denim supply chain will struggle to fulfill the disparate and oftentimes expensive requirements imposed by brands and auditing labels.



regulatory gaps

Layered on top of this ineffective chemical management system invented by the private sector, is a patchy and inadequate legislative landscape.

*“The general perception is there are laws against all these things, **the truth is a little murkier.**”*

– SCOTT ECHOLS, PROGRAM DIRECTOR, ZDHC

To illustrate this point, we’re going to give a brief overview of how two of the largest economies in the world attempt to regulate hazardous substances in consumer products:

The United States (GDP :\$25 trillion in 2021) and the European Union (GDP \$17 trillion)

Regulator	What does it require?	Does it apply to chemical substances, chemical products or consumer goods?	Who is considered legally responsible?	How is it enforced?
USA (EPA)	Testing, reporting of, and limits on emissions and effluents.	Substances and chemical products.	Chemical companies, manufacturers, and more.	Legal action, criminal prosecution, and fines against violators.
USA (Consumer Product Safety Commission)	Certification of children’s products as free of phthalates, cadmium, lead.	Children’s consumer goods.	Importers and Manufacturers.	Third party testing and certification. Random spot tests. Failures can be seized, appealed, or destroyed.
California Proposition 65	Labels on products containing exposures to chemicals that cause cancer, birth defects or other reproductive harm.	Adult and children consumer goods.	The brand overseeing the manufacture and selling of the product, if they have employees in California.	Private enforcers that test and find hazardous substances file notice with CA, can choose to sue brands.
European Union REACH	Registration of products with hazardous substances. Limits on substances of very high concern (SVHC) in products (annex 14 & 17).	Chemical substances made or imported into EU. Consumer products with special textile and children’s categories.	Chemical companies, manufacturers, brands.	Inspection/audits by ECHA. Economic penalty or plant shutdown. Tests of shipments, failures can be recalled, rejected at ports, or destroyed.

The United States: where chemical substances are deemed innocent... until it's too late

the EPA has not
attempted to
completely ban the
use of a chemical
since the
1980s

In the United States, the uncertainty around chemicals and health has stalled legislative progress on restricting and banning hazardous chemical substances, especially when it comes to consumer fashion products. The chemical industry's tactic is to demand proof beyond a doubt before the EPA or Consumer Product Safety Bureau can take any action to ban or restrict a chemical's manufacture or use. But with research taking many years and a lack of adequate funding, certainty is almost impossible to come by. Recently, investigations have revealed a culture at the EPA of kowtowing to the chemical manufacturers, and even meddling with scientific health evaluations of new chemicals submitted for approval.⁹³

"Sometimes, maintaining this confusion is a strategy," observes Andrea Venier of Officina+39, an Italian chemical supplier. (To be clear, Venier does not condone it.) Whenever research comes out, say on formaldehyde or PVC, the American chemical lobby funds competing research to muddy the waters and delay action. They call this strategy "sound science" and label potentially damaging research "junk science."⁹⁴

Stonewalled by the chemical lobby, the EPA has not completely banned the use of a chemical since the 1980s. Asbestos, for example, is still technically allowed in consumer products as of mid-2022. But because there is a clear proven link between asbestos and mesothelioma,⁹⁵ manufacturers avoid its use because they can be sued for damages by Americans sick with the disease.⁹⁶ For fashion chemistry, we may never get to the point where an American can link their cancer to the use of PFAS or carcinogenic azo dyes on clothing, and so sue a chemical company or brand.

There has been some extremely limited progress. Starting in 2008, the Consumer Product Safety Commission first restricted the quantity and later banned the use of lead, cadmium and several phthalates in children's products,⁹⁷ and now requires certificates from brands attesting to this. The Custom and Border Protection Bureau randomly tests shipments of children's clothing every few days and can seize or destroy shipments that fail.⁹⁸

Brands and factories rose to this requirement, instituting strict third-party testing requirements for children's clothing. "There's systems set up so that for every kid's garment, people figured out how to generate a certificate that showed that it met the requirements," Echols at ZDHC says. "But they weren't going to do that until there was actually legislation. There were brands that saw it as a need internally, but unless there's something pushing it, it just doesn't happen." This ban and random testing initiative for children's products is effective. According to a May 2022, on-the-ground interview with a garment factory merchandiser in India, garment factories take failures of lead, cadmium, and phthalates in children's clothing bound for the U.S. seriously, because they know a shipment can be tested and destroyed by Customs and Border Patrol. However, this does not apply to adult products, which are not regulated for hazardous chemistry, nor tested at the border.

California has the largest economy in the United States. If it were a country, it would rank fifth in the world, right after Germany,⁹⁹ and how it regulates chemicals affects the entire U.S. market. In 2008, it passed Proposition 65, which requires brands to label both adult and children's products to warn consumers about significant exposures to chemicals that cause cancer, birth defects or other reproductive harm. For example, anything over 0.5 ppm of lead is considered significant.¹⁰⁰

Under Prop 65, advocacy organizations have been buying and testing products from global brands and sending legal notices to those that fail for things like lead, phthalates, cadmium, PFOA, PFOS, chromium VI, and BPA. Two large settlements with global brands have been negotiated on the basis of unlabeled toxins.¹⁰¹

This regulation has gone a long way to getting these particular chemicals out of fashion products across the United States. But there are loopholes. The first is that a company needs to be in California's jurisdiction.¹⁰² If a fashion brand is headquartered in China, ships straight to consumers, and doesn't have any staff in the U.S., it can't be held accountable for toxic chemicals in its products—there would be no person or entity that consumer advocate groups could serve papers to. Some brands refuse to ship certain products to California consumers as a way not to put labels on their products.¹⁰³

The second loophole was only recently closed in June 2022. Amazon was sued in 2019 for knowingly allowing skin-whitening cream containing mercury at levels thousands of times above the U.S. federal limit on its site. Amazon argued that it was immune from California's Prop 65 requirement under the federal Communications Decency Act because the product was listed by a third-party seller. California's Supreme Court ruled against Amazon on appeal, stating Amazon does have a responsibility to warn consumers about third-party products.¹⁰⁴ The ramifications of the decision will play out over the next few years.

The third loophole is warning-label fatigue.

“Even in California, you have a California Prop 65 warning on everything you touch during the day, from going to Starbucks to pumping your gas to walking into a hotel room, the warnings have become kind of meaningless.”

– SCOTT ECHOLS, PROGRAM DIRECTOR, ZDHC

Some brands decide they would rather not have the Prop 65 labels and instead invest in the process of getting restricted substances out of their products. Other brands decide to just put labels on everything, betting on consumers not caring.



Europe: up ahead but still behind

Germany kicked off the age of textile chemistry restrictions in the 1990s by banning certain azo dyes that release carcinogenic arylamines.¹⁰⁵

These azo dyes do pose some danger to the consumer, as they can cleave back into amines during wear.¹⁰⁶ (These azo dyes are not used in real denim.) But the larger danger is during azo dye production. At the time, Germany was the largest market for denim in Europe, so was in a position to make demands.

“For many years, the regulation of different countries tried to stop the application [of certain azo dyes], but at the end, they were not able,” explains Roberto Camera of Nearchimica, a European chemical company. “The Germans solved the problem very simply. They said, ‘We will not buy any more products or garments or textile containing forbidden amines. You have six months to complete the sale of these products. Then, if we catch you with these amines, you pay damages.’”

And voila, azo dyes fell out of favor.

The European Union’s REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) legislation came into force in 2007, requiring chemical manufacturers and importers to gather and register information on the health properties of chemical substances. In 2020, the European Union added to REACH legislation with Annex 17 by restricting the presence of more than 30 hazardous substances of very high concern (SVHC) in consumer textile products. (Most of these substances are not regularly used in real denim, save for formaldehyde.)¹⁰⁷

The European chemical companies agree that REACH has done a lot to standardize and clean up chemical use in the European Union. The rules regarding registering and disclosure are clear and robust when it comes to chemical products. “In general, I can see huge improvements happening during the last 10, 15 years around the safety of chemistry,” says Venier of Officina+39.

But that same positive feeling doesn’t yet apply to consumer products. A quick perusal of the EU’s Safety Gate alerts for dangerous non-food products show recalled and rejected clothing and accessories that have excessive substances such as chromium, phthalates, chlorinated paraffins, and cadmium. But shipments are only rarely tested, so toxic chemicals can still hitch a ride into the EU on clothing and accessories.

In short: Even in two of the world's largest economies, legislators struggle to cope with the global nature of the problem. We currently have a patchwork of regulations from dozens of countries, mostly constituting an inconsistently-enforced bare minimum of chemical safety. The limits that governments such as Germany, California, and Japan have chosen when it comes to how much of a hazardous substance can be in a consumer product are often based on disparate human or animal exposure studies—resulting in divergent policies about safety limits.

“In some cases, people have done studies or have data to predict from maybe occupational exposures, and that’s what was written into the law. It’s difficult because in some cases, there isn’t a lot of data that’s been collected on these things, or only certain members of that compound class.”

– SCOTT ECHOLS, PROGRAM DIRECTOR, ZDHC

Some industry players have made moves to go above and beyond bare minimum legal frameworks to differentiate themselves from the competition. But this is limited to the companies who choose to engage in more rigorous safety practices, and consumers and even professionals are left confused or in the dark about which products can be considered “safe” or “non-toxic.”



calls to action

**Now is the time
for collaboration.**
We would like
to share ways in
which, if we work
together, we can
rebuild chemical
management in
fashion so it is
airtight and equitable.

We also envision collaboration among different consumer product industries. While we focus on denim and fashion, which creates products that consumers touch and wear on a daily basis and are intimately familiar with, these steps would benefit other consumer product categories such as electronics, children's products, and home goods.

As we've said in our past reports, we don't believe the industry and government can pick and choose from the above solutions to this toxic crisis. These recommendations would combine to align standards globally, fund research, increase testing and enforcement, increase transparency and information sharing, reduce the number and amount of hazardous chemicals in circulation, and improve the global health of consumers, communities, and ecological systems.

Brands and retailers

1

Ascribe to the ZDHC MRSL and the AFIRM RSL

We are calling on brands to align themselves with the most respected MRSL and RSL in the industry. This simple step will cut down on confusion and inefficiencies, so that chemical management is standardized and (more importantly) done well no matter the brand or supplier.

In addition, brands and retailers should align on certification equivalence. For example, if a chemical company is certified to OEKO-TEX standards, then GOTS should accept products from that company into a dyehouse certified to its standards.

2

Develop in-house technical expertise

An RSL is no good unless a brand can understand how to achieve it. Every large brand should have at least one in-house chemical engineer and/or toxicologist who can oversee chemical management and interface with suppliers to ensure that their chemical safety standard, MRSL, and RSL are being met.

These experts can also work with the design team to set parameters that ensure suppliers don't feel pressure to use hazardous chemistry to achieve brand requests. For example, a design parameter could be to avoid certain turquoise blues that require azo dyes that cleave into carcinogenic amines, or to avoid requests for the type of distressed look or wash that requires dangerous processing chemicals in denim laundries.

3 Treat your suppliers ethically

Suppliers cannot adhere to an MRSL unless brands create the economic conditions for them to do so. A brand's own KPIs must be aligned with the KPIs set for their manufacturers, with a view towards shared profitability instead of a race to the bottom on prices.

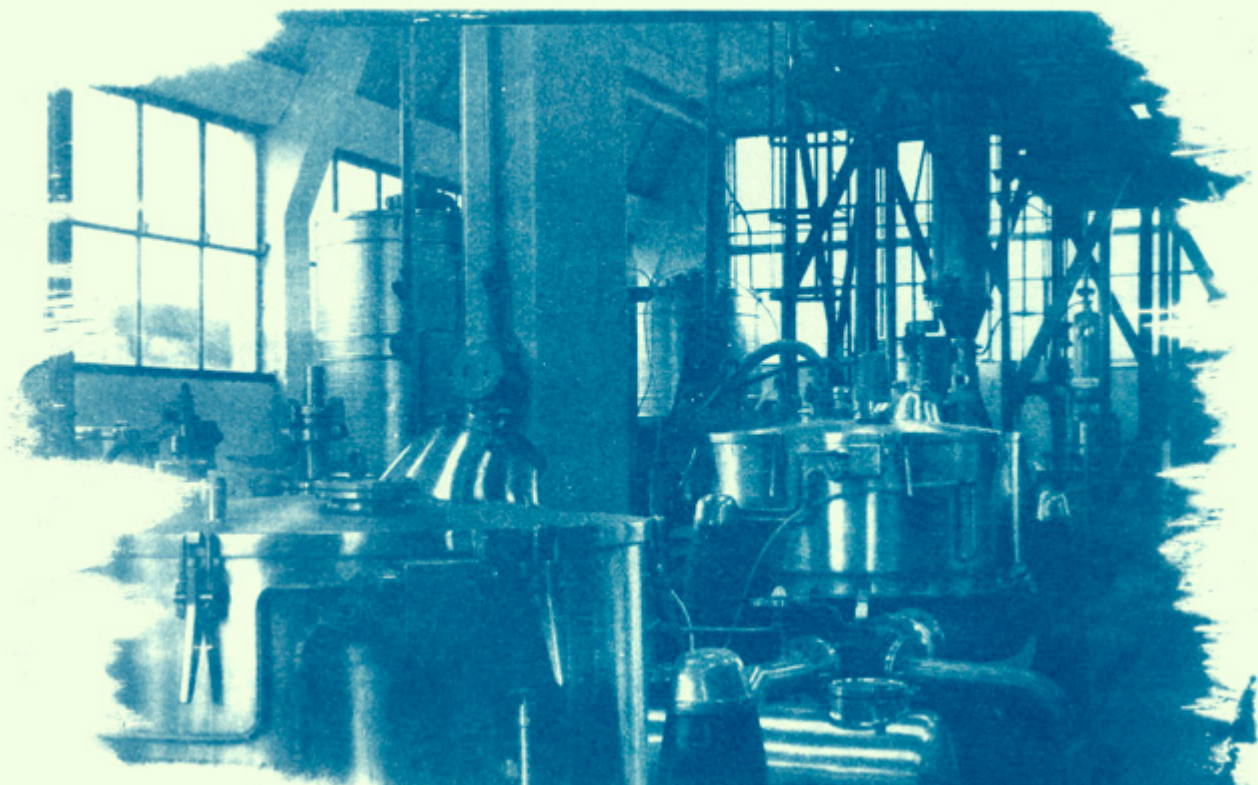
Brands should select suppliers in part on the basis of their chemical management systems, commit to long-term contracts, and share the financial burden of testing products, equipment upgrades, and more expensive safe chemical products. Signal your commitment to ethical purchasing practices by endorsing the [Eight Ethical Principles](#) put forward by Transformers Foundation.

4 Lobby government to incorporate standards into law

Strong chemical management systems should be a ticket to play, not a market differentiator. Brands and retailers should lobby governments in countries where their products are sold to put the ZDHC MRSL and the AFIRM RSL into law as a bare legal minimum standard applicable to all.

Putting these standards into law would also increase testing, which is not happening enough. This applies in the EU, especially in the U.S., and most of all in large markets in India, Brazil, and China. There should be something pulled from fashion shipments for testing at every port—airports and marine—every day, at the very least.

Brands and retailers should advocate for use of the latest testing methods, such as PIGE, which tests for total fluorine,¹⁰⁸ and high-resolution mass spectrometry, which gives a complete picture of the chemical makeup of a material.¹⁰⁹



5 Provide ingredient lists for consumers

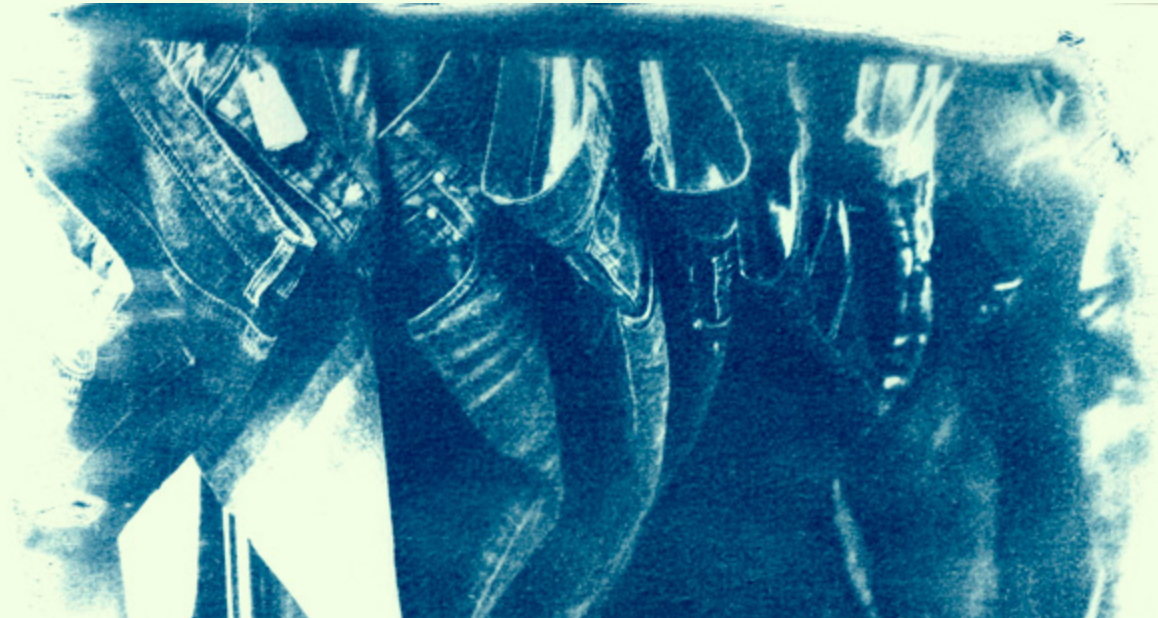
We believe consumers deserve to know what is in their fashion so that they can avoid substances that give them a rash or exacerbate an illness.

Every consumer fashion product should carry a label or QR code that lists all known carcinogenic, mutagenic, reproductive toxic, bio-accumulative, persistent, allergenic, or sensitizing chemicals present. This builds on the success of the EU's and California's legislation, which strikes a balance between a hazard-based and risk-based approach: Though all hazardous substances are labeled, not all are completely banned.

We see the food industry, the cleaning product industry, and the beauty product industry all providing ingredient lists, while staying profitable. In the construction materials business, architects, design professionals, contractors, and consumers can look up the Health Product Declarations (HPDs) at hpd-collaborative.org for over 30,000 building products for around 700 manufacturers. The information is not very consumer-friendly, but it shows that this information can be provided even for performance textile products like synthetic carpeting.

“We are calling on retailers and brand owners to disclose chemical ingredients to consumers, including for articles like textiles. If you’re going to say yes, as a business, we’re going to regulate and restrict harmful chemicals in our supply chain, you can’t really do that if you don’t know what’s in the products that you’re selling.”

– MICHAEL SCHADE, TOXIC-FREE FUTURE

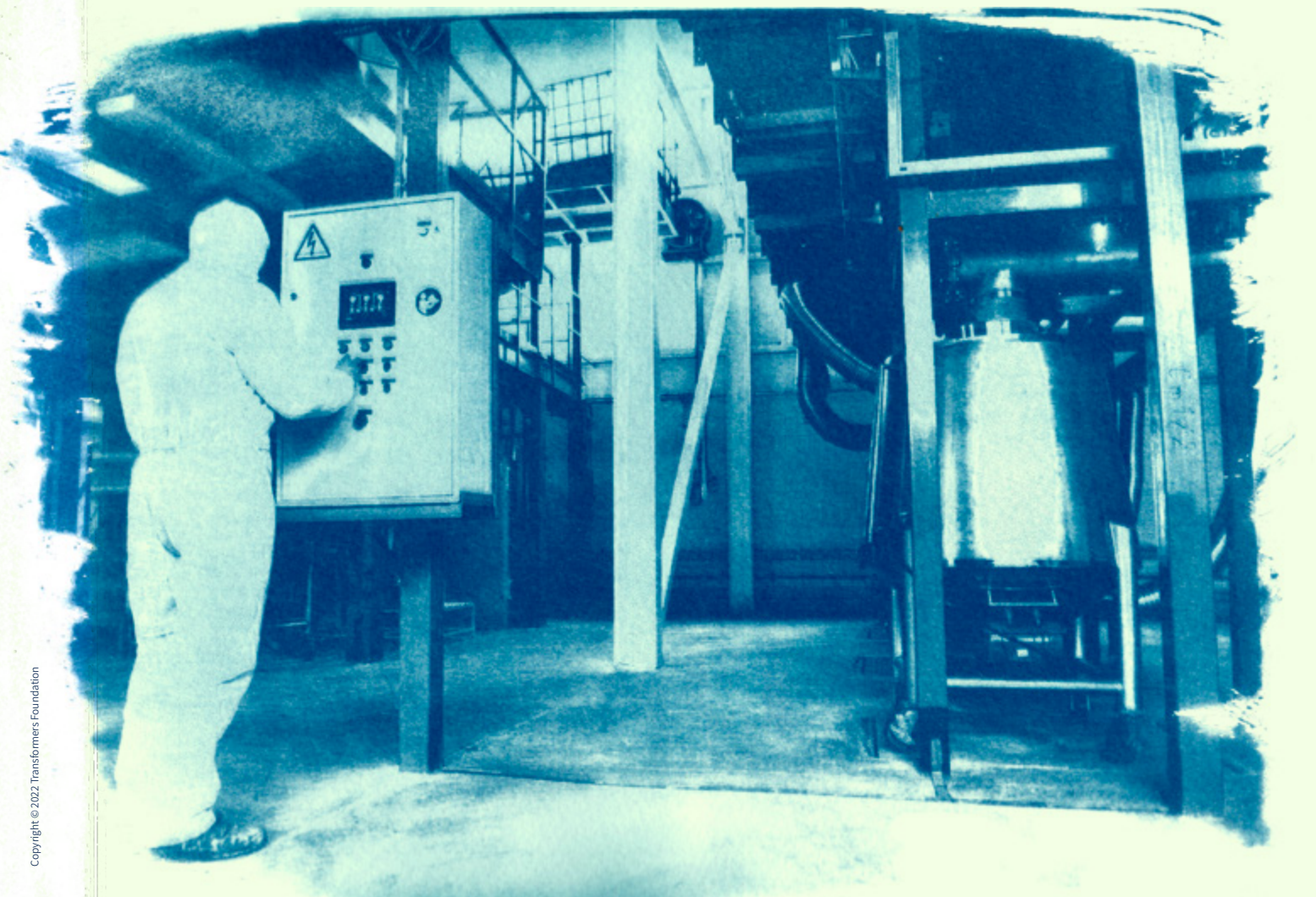


“It’s not just about putting the responsibility on consumers to change. It is about creating the kind of critical mass of pressure on companies that says, we see you, we see what’s happening - and we don’t want to take part in such a system when we buy something for ourselves or a loved one.”

– EMILY MACINTOSH, POLICY OFFICER FOR TEXTILES,
EUROPEAN ENVIRONMENTAL BUREAU

According to everyone we spoke to, it is technically possible based on today’s technology to list ingredients on the final product. But this legislation would also be an incentive for brands to build deeper and longer-lasting relationships with the kind of chemical and dye suppliers that are organized and responsible enough to provide an accurate list of chemical ingredients while protecting that information from being copied.

If chemical companies are worried about intellectual property theft, the information can be passed straight through to a third party that works under a non-disclosure agreement to collate the ingredients on the final product. And it can exclude non-hazardous ingredients and process chemicals so recipes are somewhat protected from being copied.



Legislators

1 Fund and empower governing bodies to focus on consumer product chemical safety

As long as chemical safety is voluntary, many suppliers and brands will choose not to engage with it, or will engage with it at different levels, yielding a chaotic and inefficient environment of hundreds of RSLs and standards.

We need every country to have an agency that can arbitrate and simplify this system so it is focused on public health instead of profits.

In June 2021, a large group of organizations—including the American Apparel & Footwear Association, the American Chemistry Council, Breast Cancer Prevention Partners, Consumer Reports, Earthjustice, and Natural Resources Defense Council—banded together to send a letter asking Congress to give the Consumer Product Safety Commission more money. “The agency is significantly underfunded and therefore short-staffed compared to other federal health and safety regulatory agencies,” the letter said, pointing out that its budget is “by far the smallest among federal health and safety regulatory agencies,” and it struggles to keep up with the work of overseeing “15,000 different types of consumer products.”¹¹⁰ We agree. The CPSC needs to do more testing of products coming into the country. It needs funding to hand out research grants that can help it make better-informed decisions on limits for more substances on more products. And it needs more power to force recalls of products that are toxic and sensitizing for consumers.

We are calling for additional funding for both the Consumer Product Safety Commission and the EPA, to expand their mandate to research, test, approve or disapprove new chemical product use. We would like to see similar increased funding and directives to focus on research and testing in other large markets whose economic clout means ripple effects into unregulated markets, including the European Union, the United Kingdom, India, Canada, Brazil, China, South Korea, and Japan.

One way of funding this would be for governments to tax and tariff the sale and importation of understudied chemicals created from fossil fuel products, and products that have these substances in them. This would have the additional effect of reducing the amount and number of substances used.

2 Align with other countries to unify chemical guidance

Ideally, chemical standards would be harmonized, and there would be no more than a few RSLs that differ only according to product category, material or, in rare cases, religious beliefs. To achieve that, governments need to work together to agree upon higher standards of chemical safety, with aligned regulations both on what can be used in fashion production, and what can be on the final product.

The strictest RSLs by a handful of brands show what is possible—their limits should be the standard to which governments aspire.



3

Pass due diligence laws that hold fashion companies liable for worker exposure

For too long, fashion brands and global suppliers have avoided taking responsibility for worker health by offshoring operations to countries with looser legislation and enforcement.

We have a good understanding of the health risks for workers of exposure to substances like powdered indigo with aniline, potassium permanganate, hypochlorite, and formaldehyde. But many workers in countries like China, Pakistan, Tunisia, and India continue to have unnecessary exposure when they are not provided proper training or protective gear. Again, much of the time this is due to brands demanding orders faster and cheaper. In order to make quota, for example, workers don't wear protective gear, which can slow them down. Or suppliers can't afford to invest in safer new equipment because brands won't pay anymore for material made in a safe environment.

“The only way to solve it is to have a legislation that somehow takes the costs that they're pushing off—like the cost of polluting the waterway around the factory or health impacts on the workers—and include them in the triple-bottom-line costs, not just the cost per garment...If you had a system where they could trust that you weren't going to walk away when they had to raise the price, because there was more requirements, you wouldn't need as much policing of the system to go in and try to do random checks to see if somebody was doing something wrong.”

– SCOTT ECHOLS, ZDHC

We support due diligence legislation, which is currently being considered in several European countries and at the EU level. It would allow workers in production facilities to hold brands liable for injury, sickness, and death due to poor practices in a factory the brand sources from.

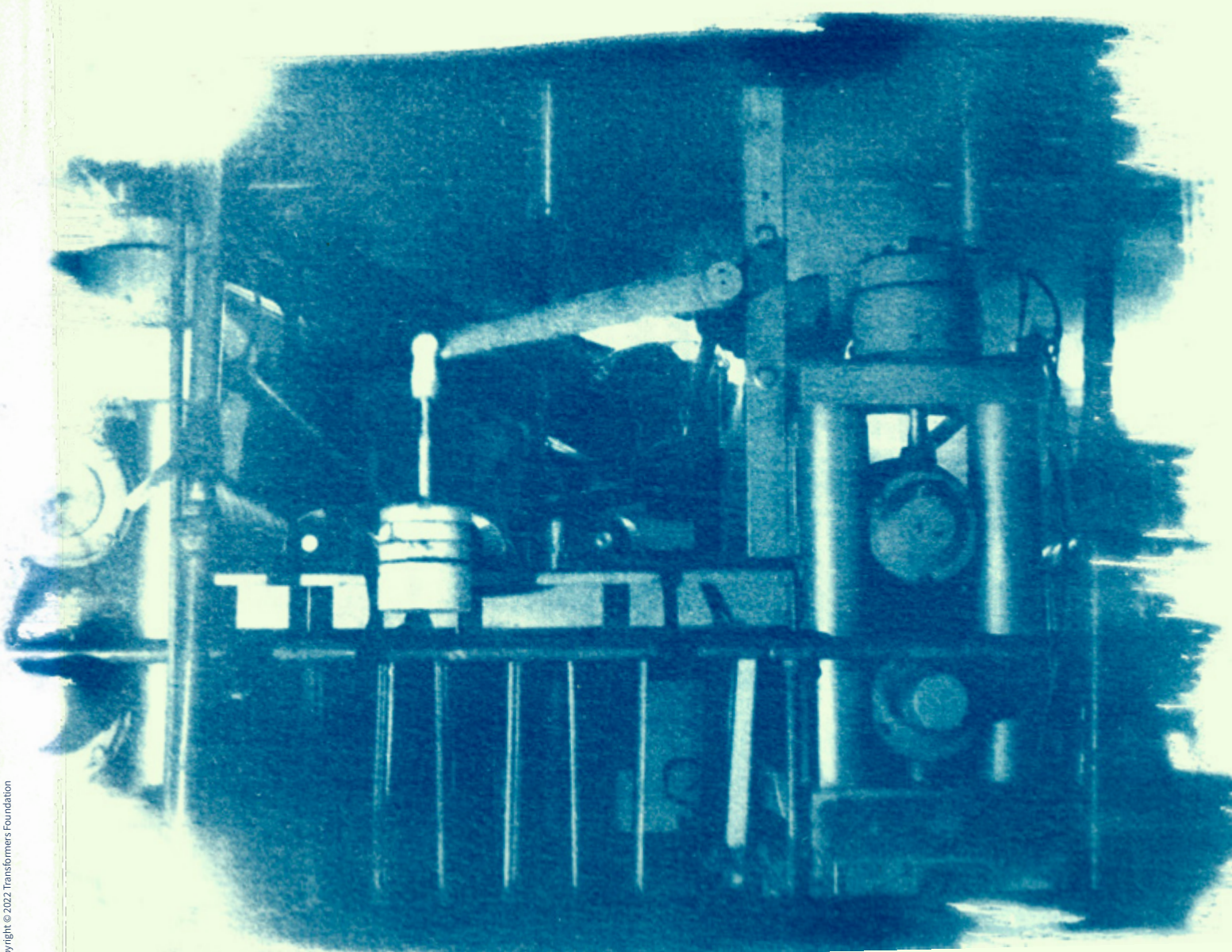
For example, if a dye house worker died because they were told to climb into a dye waste storage tank for cleaning, their family could hold the brands that had active orders with that dye house responsible. This would make brands think twice before walking away from a safe facility based on a slightly higher price ensuring that dye houses in their supply chain have automatic storage tank cleaning equipment that functions properly. Brands might even provide loans or financing to factories that don't.

Chemical companies

1

Collaborate on a collective position on chemical complexity

The ZDHC's success so far is based on the industry's willingness to collaborate in an organization with a clear governing structure. We are calling on chemical manufacturers and formulators to come together and decide which chemical products should be officially retired from the market. This working group could also work on language that is more accessible to non-chemistry-educated advocates, journalists, and legislators.



Glossary

AFIRM	The Apparel and Footwear International RSL Management Group. A membership organization of apparel and footwear companies that collaborate to create a restricted substance list (RSL) and provide guidance on risk management and testing for hazardous chemicals in consumer fashion products. Facilitated by the Phylmar Group, an environmental health and safety and sustainability consulting company based in California.
AMINES	A class of basic organic (containing carbon and covalently single bonded nitrogen) chemical compounds that are an ingredient in chemical substances like synthetic azo dyes. Exposure to certain arylamines, especially among factory workers, has been linked to cancer. ¹¹¹ Tests for aniline residue in synthetic-indigo-dyed denim use the presence of amines to make a determination.
AZO DYES	A large class of synthetic dyes. Twenty-two azo dyes are banned in the European Union because they have been shown to release carcinogenic and mutagenic amines when in contact with our skin bacteria. ¹¹²
BLUESIGN	A Swiss company that provides advisory services to brands and retailers, chemical suppliers, and manufacturers. The bluesign label verifies that a product or facility has been audited and found to be up to bluesign's standards of chemical safety.
BPA	bisphenol A. A chemical used in the production of plastics and potent endocrine disruptor. Some products containing BPA have been banned or voluntarily phased out in the European Union and several other developed countries. In some cases, it has been replaced with other chemicals in the same class, such as BPS and BPF, which research shows have similar health concerns. ¹¹³
CAS REGISTRY NUMBER	Because many chemicals have multiple names, the U.S.-based Chemical Abstracts Service assigns a unique number to every publicly-listed chemical substance, for easy identification. The CAS numbers of chemicals present in chemical products are not normally shared, as they are deemed proprietary information by chemical companies. ¹¹⁴
CHEMICAL	While many lay people use "chemical" denote a synthetic substance that has hazardous properties, a chemical is any substance that has a defined composition, from H ₂ O and CO ₂ to man-made chemicals like 4-phenylenediamine and perfluorooctanoic acid (PFOA).
CHEMICAL CLASSES	Chemicals that have similar structures, indicating they might act similarly when it comes to human toxicity. Examples include bisphenols (BPA, BPS) and PFAS (per- and polyfluoroalkyl substances such as PFOA and PFOS).
CRADLE TO CRADLE	An institute and certification promoting circularity, safety, and sustainability in consumer products.

CSR	Corporate social responsibility. Used to describe the teams in for-profit corporations who are responsible for matters of labor, sustainability, and community relations. In fashion, CSR teams liaison with suppliers and give guidance on expectations for environmental and labor performance.
ENDOCRINE DISRUPTORS	Your endocrine system manages your hormones, which in turn regulate all the important systems in your body: immune, metabolic, neurological, and cardiovascular. Endocrine disruptors, which include PFAS, BPA, and phthalates, interfere in this subtle system of hormone regulation. Some of these as-yet poorly understood, cascading health effects can happen at the level of a few parts per trillion (PPT). ¹¹⁵ They are more serious for children, and can even be passed from mother and father to child. ¹¹⁶
GREEN CHEMISTRY	A practice of designing chemical products so that they have reduced or no hazardous substances from the outset.
GOTS	Global Organic Textile Standard. A certification and label that covers various aspects of textile production, including safe chemistry.
HAZARDOUS	When used to describe chemicals, anything that causes physical, environmental, or health harm.
INDIGO, SYNTHETIC	Chemically identical to plant-based indigo, synthetic indigo achieves identical aesthetic results when applied to denim, but is produced using a mix of fossil-based chemicals, many highly hazardous to store, use, and transport. ¹¹⁷ Concerns have been raised about the presence of the residue of aniline, a potential carcinogen, in synthetic indigo-dyed products.
MRSL	Manufacturing Restricted Substance List. A list created by ZDHC of chemical substances that should not be intentionally used in facilities that produce for fashion brands and retailers.
MASS SPECTROMETRY	A scientific technique used in analytical chemistry to measure the mass-to-charge ratio of charged particles. The latest mass spectrometry technology and techniques can be used to identify all the chemical substances present in a sample and their chemical structure. This is a more holistic approach than traditional testing methods, which test for different chemicals one by one and requires prior knowledge of what chemicals, out of thousands of possibilities, to look for.
OEKO-TEX	A non-profit company with a suite of labels certifying that a material has been tested in an accredited lab and deemed free of hazardous substances.
PFAS	Or per- and polyfluoroalkyl substances. A class of manmade chemicals invented in the mid-twentieth century, some of which are used to provide water and stain repellency to a wide range of consumer products, including textiles. Includes long-chain PFOA and PFOS, along with thousands of other types of short-chain perfluorinated chemicals.

PFOA, PFOS

Perfluorinated chemicals with 8 carbon bonds. Have been definitely linked to cancer, are suspected endocrine disruptors, and are persistent and bio-accumulative. Some products containing these chemicals have been banned in the EU and voluntarily phased out in the United States. A common type of PFAS on the market is PTFE, otherwise known as Teflon.

PHTHALATES

Chemicals known as plasticizers that are used in plastics, including polyester and PVC. They are known endocrine disruptors and some are subject to regulation in the European Union and United States.

PIGE

Particle induced gamma ray emission. A type of nuclear analysis that can be used to identify the presence and amount of inorganic chemicals in consumer products, such as heavy metals, and—as pioneered by physicist Dr. Graham Peaslee at Notre Dame—total fluorine at a level indicating the presence of intentionally-added perfluorinated chemicals (PFAS).

REACH

The European Union's Registration, Evaluation, Authorisation and Restriction of Chemicals. Enacted in 2006, it is meant to help protect the health of Europeans and the environment from the negative impacts of uncontrolled chemical use and release. European companies who import or sell chemical products or products with hazardous chemicals are compelled to identify and manage that risk, plus communicate safety measures to users. If a chemical's risks cannot be managed, it is restricted. The long-term goal is for most hazardous substances to be substituted with safer alternatives.

RSL

Restricted substance list. A list of chemicals that are not allowed in or on a consumer product, or, that are only allowed to be detected by tests up to a certain limit. This limit is usually listed in ppm (parts per million) or ug/g (microgram per gram), which have a one-to-one conversion.

SDS

Safety Data Sheet. Formerly known as Material Safety Data Sheets, chemical manufacturers and sellers provide SDSs to users of their chemical products. They include the chemical product's properties, its physical and health hazards, its environmental hazards, and how to safely handle, store, and transport it. They often do not include what basic chemical components the chemical product contains, or their CAS numbers.

SCIVERA

A company that provides chemistry certifications and toxicology risk screening for consumer products to brands.

**SHORT-CHAIN
PER- AND
POLYFLUOROALKYL
SUBSTANCES**

Possessing less than eight or more carbon atoms. Although at first thought to be less persistent than long-chain PFAS and so safe for use on consumer products, emerging research on short-chain PFAS shows similar health effects to long-chain PFOA and PFOS. Has not yet been fully banned. Has been voluntarily phased out by a handful of fashion brands.

SCREENED CHEMISTRY	A service provided by Scivera and ToxServices. Chemical companies provide the chemical makeup of their products straight to Scivera or ToxServices, and these companies in turn provide a risk assessment report to brands on the potentially hazardous properties of all the chemicals used in the manufacture and finishing of those products. Brands can then request a reformulation or alternatives from chemical companies in order to bring the risk down to a level they are comfortable with.
TIER 1	In the denim supply chain, denim laundries and garment factories that dye, sew, and finish jeans, before shipping them to retailers.
TIER 2	In the denim supply chain, fabric mills that weave denim and manufacturers of sundries (zippers, rivets, pockets), and ship them to Tier 1.
TIER 3	(Spinners and chemical suppliers) - In the denim supply chain, cotton spinners, synthetic fiber spinners, and chemical suppliers, who ship to Tier 2.
TOXSERVICES	A U.S.-based consultancy that provides chemical risk assessments and screening to consumer product companies, NGOs, and the public sector.
ZDHC	An acronym for Zero Discharge of Hazardous Chemicals, ZDHC was founded in 2011 as an industry group of a half-dozen large brands dedicated to cleaning up the effluent of fashion manufacturers by specifying what chemicals are not allowed to be used in the supply chain through its MRSL, and regularly testing effluent. It now includes 49 global brands, suppliers, chemical manufacturers, NGOs, trade associations, auditors, and labs.

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