Your Guide to Weathering the PFAS Storm

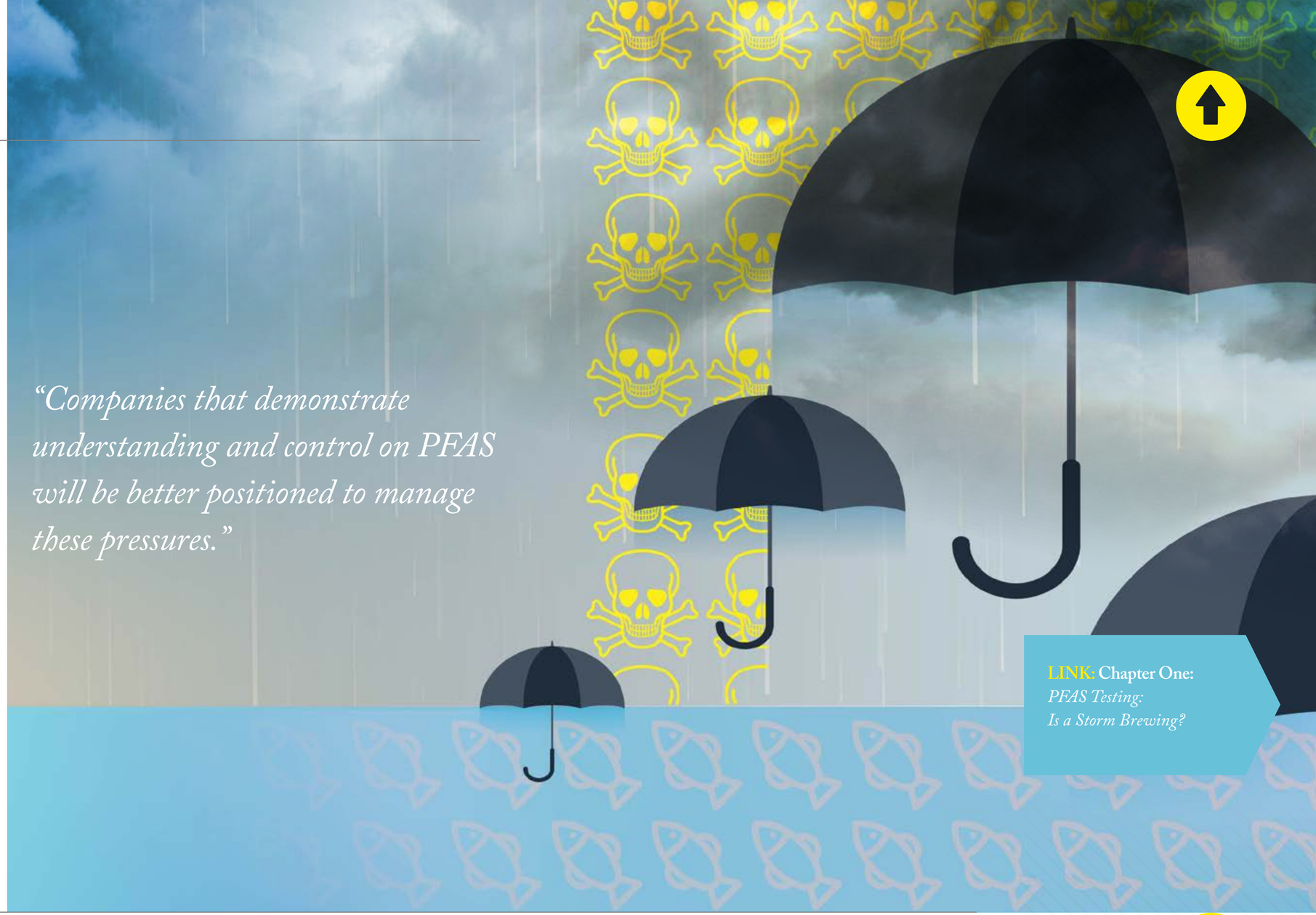
Dark clouds may be on the horizon for the food and beverage industry, but with the right strategies, labs can build reliable, contamination-resistant, and future-proof PFAS testing workflows

the Analytical Scientist x Agilent Technologies

In the first chapter of our PFAS Testing eBook – *"Is a Storm Brewing?"* – we spoke with a range of experts to understand what the evolving PFAS landscape could mean for the food and beverage sector. The consensus was clear: as regulators weigh sweeping PFAS bans and consumer lawsuits multiply, dark clouds are gathering. "The PFAS problem is an incredible societal challenge," said Michele Suman, Food Safety & Authenticity Senior Scientist-Research Manager at Barilla SpA. And as Sue Bullock, head of chemical compliance, stewardship, and sustainability at TSG Consulting, put it. "Companies that demonstrate understanding and control on PFAS will be better positioned to manage these pressures."

In this second chapter, we turn to the next critical question: how can food manufacturers get a handle on the PFAS problem? Here, experts from Agilent explain how to establish and maintain a reliable PFAS testing workflow, examine common challenges, pitfalls, and hidden risks that can distort results or trigger costly missteps, and reveal the mindset needed for effective PFAS testing. We also present a roadmap to reliable results, showing how the complete Agilent workflow can underpin a future-proof PFAS testing strategy.

In short, consider this your guide to weathering the PFAS storm.



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LINK: Chapter One:
PFAS Testing:
Is a Storm Brewing?

So You're Planning to Set Up a PFAS Testing Workflow…

How to overcome the difficulties labs face when establishing and maintaining PFAS testing protocols

By Limian Zhao, Application Scientist, and Emily Parry, LC/MS Applications Scientist, both at Agilent Technologies

PFAS testing in the food industry may still be in its infancy, but as regulations emerge and official methods begin to take shape, more and more labs are embarking on their PFAS testing journey – often encountering the same core challenges.

For example, many labs will be familiar with EPA methods for environmental testing in fish or related matrices. With growing demand from their clients, they want to extend that expertise into food-specific testing. However, the regulatory frameworks are far less mature than in pesticide testing, where regulatory expectations are long established. There are established PFAS testing methods in other environmental matrices – such as EPA 1633 – and some labs have simply extended those to food, but the approach is highly time-consuming and labor-intensive.

Another challenge is instrumentation. PFAS analysis requires careful adjustments to existing systems. Many labs already operate LC-triple quad platforms for food safety, but PFAS testing often means having to dedicate instruments exclusively to PFAS to avoid cross-contamination and background interference. CROs and contract labs must therefore plan strategically, deciding how many instruments they can adapt or assign to food PFAS analysis.

The requirements on those instruments can be high too. For PFAS, particularly as some regulations now target 10 ppt or even sub-LOQ levels, the entire setup – the instrument, the lab environment, the consumables – must all be qualified to reliably achieve that performance.

Cultivate a PFAS testing mindset

Before we discuss some specific suggestions for setting up a PFAS testing workflow, let's discuss what is arguably the most important factor: mindset.

To put things into perspective, consumer perception and its impact on company value is hugely important. To miss something that's later found in surveillance testing could force your product off the market – and the consequences of a recall can be enormous. On the flip side, false positives also hurt. Throwing away manufacturing batches and raw materials has a direct business impact.

When Agilent surveyed individuals in the food industry about PFAS concerns, it found that the most concerning problem was false positives and false negatives, and their impact. Moreover, PFAS are different to other potential contaminants because they can come from anywhere: surfaces, consumables, solvents, tubing, seals, and even the air. This is what makes them so challenging to address.

Contamination control must be treated as non-negotiable. Even though it may feel like overkill, you have to assume the risk is everywhere and de-risk absolutely everything you can. This means approaching lab hygiene with PFAS specifically in mind and thinking carefully about how to modify workflows and instruments to reduce potential sources of contamination.

Contamination control 101

A standard LC system contains tubing and parts made with fluoropolymer materials, such as Teflon, which introduces a natural PFAS background. Your system should be modified to replace these materials with those optimized for PFAS testing. You'll also want to add a delay column before the sampler to hold back contaminants from the LC mobile phase, so that any background PFAS peaks are shifted and separated from the actual analytical

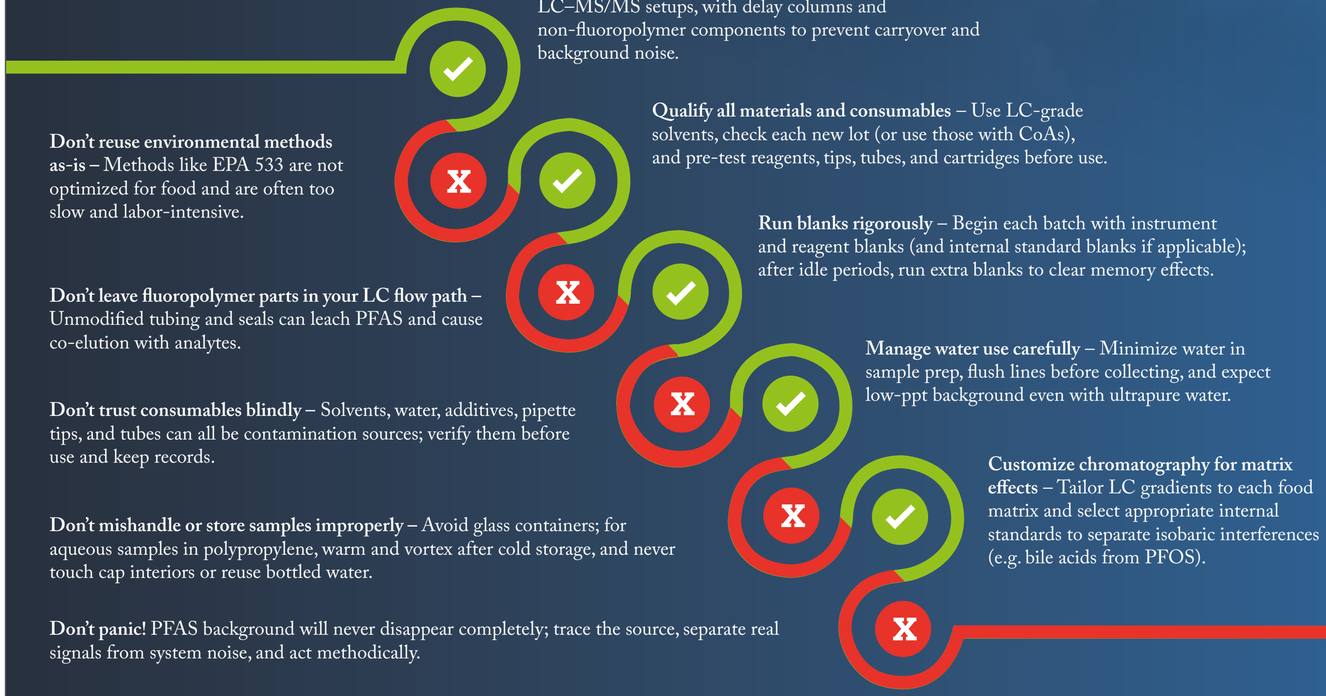
peaks of the sample. Agilent offers a kit, which includes tubing and materials that have been tested for PFAS, a delay column, and Captiva EMR PFAS cartridges – which simplify sample preparation (scroll down to "The Workflow to Weather the PFAS Storm" to find out more about those).

Solvents are another important potential source of contamination. The delay column will help with background from the mobile phase, but if the contamination is introduced as part of the sample, it won't be mitigated. If the sample has been extracted and reconstituted in a contaminated solvent, there's no way to separate it out. This is why rigorous checking of batches of consumables before use is essential. Always check each new lot of consumables before putting them to use, or purchase consumables with a certificate of analysis.

Having said that, we would still recommend purchasing LC/MS-grade solvents as a minimum because these are critical for mass spec performance, which should not be sacrificed to eliminate a potential source of trace PFAS. This is a key reason why we recommend the delay column – to eliminate potential contamination from the solvent.

Labs also face a tradeoff between water quality and potential contamination. High-quality water is essential for mass spec performance, but if you're using water in your process, there will always be some background PFAS. Fortunately, the levels are very low – typically single-digit ppt. Even ultrapure water can sometimes show some PFAS background. You can let the system flush after collecting the water before filling your container, which helps wash away any surface contamination, but overall, we'd recommend minimizing the use of water wherever possible during sample preparation (again, scroll down to find out how the Agilent sample preparation workflow alleviates this problem).

Your PFAS Testing Cheat Sheet



Dedicate and adapt instruments – Use PFAS-only LC–MS/MS setups, with delay columns and non-fluoropolymer components to prevent carryover and background noise.

Qualify all materials and consumables – Use LC-grade solvents, check each new lot (or use those with CoAs), and pre-test reagents, tips, tubes, and cartridges before use.

Run blanks rigorously – Begin each batch with instrument and reagent blanks (and internal standard blanks if applicable); after idle periods, run extra blanks to clear memory effects.

Manage water use carefully – Minimize water in sample prep, flush lines before collecting, and expect low-ppt background even with ultrapure water.

Customize chromatography for matrix effects – Tailor LC gradients to each food matrix and select appropriate internal standards to separate isobaric interferences (e.g. bile acids from PFOS).

Don't reuse environmental methods as-is – Methods like EPA 533 are not optimized for food and are often too slow and labor-intensive.

Don't leave fluoropolymer parts in your LC flow path – Unmodified tubing and seals can leach PFAS and cause co-elution with analytes.

Don't trust consumables blindly – Solvents, water, additives, pipette tips, and tubes can all be contamination sources; verify them before use and keep records.

Don't mishandle or store samples improperly – Avoid glass containers; for aqueous samples in polypropylene, warm and vortex after cold storage, and never touch cap interiors or reuse bottled water.

Don't panic! PFAS background will never disappear completely; trace the source, separate real signals from system noise, and act methodically.

Another important point: we advise avoiding glass vials or tubes for sample storage because compounds can be lost by adsorbing onto the glass surface, especially in the presence of metal ions. This is often worse when there's a higher amount of organic solvent in the sample. Over time, compounds can precipitate or stick to the container, so the measured concentration goes down. This can happen with polypropylene – especially when standards or samples are in aqueous solution and stored at low temperatures. But vigorous vortexing can usually prevent this issue. Regardless of the materials used for sample storage, whenever you take standards or stock solutions out of the refrigerator, you must warm them up thoroughly before use – both for the reasons outlined above and to guarantee accurate measurements.. This applies to both samples and standards.

Additives are another potential source of contamination – acetic acid or ammonium hydroxide used during extraction, for example. Anything that comes into contact with your sample or the detection system – including pipette tips – could be a potential source of contamination. Of course, you can't realistically test every single tip and often the vast majority are clean, but it is worth bearing in mind if you do see a spike and are trying to track down the source.

Blanks are another critical safeguard against false positives and mysterious background peaks. Running them systematically not only reveals contamination but also helps pinpoint its source. At minimum, every batch should begin with an instrument blank (no injection) and a reagent blank. If internal standards are being used, an internal standard blank is also recommended. Each type provides different information, and together they form a safety net to catch problems before they compromise your data.

It's also important to remember that PFAS compounds can exhibit a "memory effect." Even after thorough washing at the end of a sequence, contamination can reappear when the system sits idle overnight. The first blank of the following day often shows background again, which then clears after one or two cycles. For this reason, it's best practice to run a series of blanks – starting with instrument blanks, then reagent blanks, before beginning any new work. This simple routine ensures that your system is fully equilibrated, reducing the risk of background PFAS sneaking into your analyses.

Much of what we've discussed so far applies broadly to PFAS analysis – but food testing introduces unique challenges. No two matrices are the same, and matrix effects make chromatography, internal standard selection, and calibration especially critical.

Fatty acids and bile acids, for example, present different interferences, including suppression, charge competition, and in the case of bile acids, direct overlap with PFOS transitions. Because some bile acids are true isobaric isomers of PFOS, mass spectrometry alone cannot separate them. Careful chromatographic separation – such as optimized LC gradients tailored to the food matrix – ensures reliable quantitation.

Don't panic!

In brief, treat contamination control and lab hygiene as essential risk management. Make sure you're cleaning all labware and surfaces with cleaning agents optimized for PFAS testing, never reuse bottled water, let water run before collecting so that you don't use water that's been sitting in PFAS-containing tubing, run blanks for all solvents, and so on.

But it's also important not to panic! Contamination is manageable, once you know what to look for. Consistent background contamination across all samples usually points to system-related sources such as solvents, water, or the LC system itself. In contrast, sporadic spikes in just a few samples often implicate consumables such as pipette tips, tubes, or even gloves. Practical habits – like never touching the inside of tube caps and keeping them facing upward to prevent contamination from gloves or surfaces – help reduce risk. Over time, each run teaches you more about these patterns, and the lessons build into an experience base that makes troubleshooting faster and more confident.

"PFAS background will never disappear completely, but it is possible to separate system background from true sample signal."

PFAS background will never disappear completely, but it is possible to separate system background from the sample signal. Before disappearing down rabbit holes chasing background noise, pause and ask: is it systematic or random? Decide that first, then act by making use of the wealth of strategies described above that we – as a community – know work. Then, apply those consistently and build on that shared knowledge through your own experience.

The Workflow to Weather the PFAS Storm

Your three-step roadmap to reliable result

By Limian Zhao, Emily Parry, Agilent Technologies

Laying the groundwork with sound principles is essential, but putting them into practice can be challenging. It often requires not just careful planning, but also the right combination of tools to make principles workable day to day.

What follows is one example of how this can be achieved: a three-step workflow designed to simplify sample preparation, minimize LC system background, and support scalable, high-sensitivity MS detection. Together, these steps illustrate how labs can move from broad best practices toward a reliable, adaptable PFAS testing setup.

Step one: simplify and future-proof your sample prep

Traditionally, sample preparation – or more specifically, sample clean-up – involves several steps, each of which can introduce PFAS contamination. Typically, if you're working with a food sample, you begin by homogenizing or milling it in a container, which itself can be a source of contamination or analyte loss. After extraction, you take aliquots, add reference, internal, or recovery standards (all diluted in solvents) – and each of those solvents can contain trace PFAS. While reference standards are generally tested and characterized for PFAS content, everything added afterward carries contamination risk.

The standard approach is often a dispersive Quick, Easy, Cheap, Effective, Rugged, and Safe (QuEChERS) extraction followed by solid phase extraction (SPE) cleanup. This involves placing the sample and solvent in plastic tubes, shaking, then transferring aliquots to be passed through conditioned SPE cartridges. At every stage – solvent bottles, beakers, pipettes, cartridges, autosampler vials – there is the potential for PFAS contamination, especially from plastics or Teflon seals. Conditioning, washing, elution, drying, and reconstitution steps all increase opportunities for contamination and analyte losses.

The approach taken by Agilent, using the Captiva EMR PFAS Food cartridges, eliminates many of those risk points. Instead of SPE after QuEChERS extraction, we pass the extracted sample through a mixed-mode chemical sorbent filter to retain the matrix components, allowing the PFAS pass straight through. This offers two major advantages: (i) reduced contamination risk and complexity – no conditioning or wash steps means fewer manipulations and fewer opportunities for PFAS to leach in; and (ii) greater efficiency and lower cost – fewer steps mean less solvent, less time, and less consumable use overall.

From a performance perspective, we've performed side-by-side comparisons of EMR PFAS cartridge with traditional SPE. In complex matrices, even the most time-consuming SPE workflows often fail to achieve reliable quantification; recoveries may be low, and matrix effects high. For example, fish often contains high levels of fatty acids, which due to their acidity are co-extracted along with PFAS when using WAX SPE, creating strong matrix effects that interfere with quantitation. By contrast, EMR PFAS cartridges are designed specifically for different food matrices. The PFAS Food II cartridges, for example, use a proprietary Agilent solvent for highly selective lipid removal, which is far more effective than standard SPE for fatty or animal-origin samples.

EMR cartridges can be bought separately, or as a complete start-up kit that also includes vials, delay and analytical columns, and tubing. Each component is optimized and verified for PFAS testing to ensure it does not introduce contamination.

Another challenge associated with traditional sample preparation methods, often relying on trapping, adsorbing, and then desorbing PFAS, is that they can become highly complex. Developing a single method that efficiently captures all the diverse range of PFAS compounds – fluorotelomer alcohols, acids, salts, and so on, each with very different chemistries – at once is extremely difficult. Scaling such a method to incorporate new PFAS would often require redeveloping it entirely, whereas the Agilent "pass-through" approach removes the need to elute or recover analytes from the sorbent. It simply removes the interfering material and this approach is inherently more scalable.

It may also be better suited to testing needs as we move beyond traditional target quantitation towards discovery and risk assessment – asking not just "are these known PFAS present?" but "what else might be in this sample?" Here, conventional SPE is inherently selective and can unintentionally filter out certain PFAS or other unknown compounds. In contrast, our pass-through method minimizes that risk because it removes only the bulk matrix, not analytes, allowing a fuller picture of what is present.

It is also worth bearing in mind that even if a class action lawsuit doesn't come today, it could come 10 years from now – and may concern a compound you aren't testing for using a targeted analysis. So if you're

operating in that risk assessment space, it may be important to know what else is in your sample.

As discussed earlier, the delay column also comes into play here to hold-up PFAS and other contaminants coming from the mobile phase before you inject your sample. It's also useful diagnostically: if you extend the run long enough to see what comes off the delay column, you can tell what was present in your mobile phase. And if you've used that same solvent during sample preparation, you can assess whether you may have introduced contamination into the samples.

Step two: high performance LC – without background PFAS

Once you have cleaned up your sample using the "pass through" approach with the EMR PFAS cartridges and captured any PFAS from the mobile phase, it's time to inject your sample into the LC flow. One challenge here is that your sample extract will often be high in acetonitrile, which can't be directly injected into an LC flow due to peak distortion.

Traditionally, people try to avoid that by diluting the extract with water so that its solvent composition matches the starting conditions of the LC gradient. The problem is: adding water at that stage is a major contamination risk. If you introduce it just before injection, and you see PFAS, you won't know whether it came from the sample or from the water – giving you a false positive. Another workaround is to dry the sample down completely and then reconstitute it. But that introduces new risks because many drying/evaporative systems use Teflon seals, which can leach PFAS, and you can also pick up airborne PFAS in the lab environment.

The Hybrid Multisampler lets the user inject that acetonitrile-based extract directly by using a small-volume sandwiching technique, so you avoid having to dilute or dry down the sample – eliminating two major contamination pathways. In addition, because the acetonitrile extract is introduced so gradually, there's never enough present at once to disrupt trapping at the head of the column. This preserves a sharp peak shape, which offers two big advantages: (i) improved sensitivity – because the peak is narrow and tall rather than broad and low; and (ii) better chromatographic resolution – which is critical when you're trying to separate branched isomers and other PFAS-like contaminants that might elute close together.

It is also important to ensure that the LC itself doesn't introduce PFAS contamination. Some LC systems use tubing and seals that can be potential sources of contamination, and standard systems often contain Teflon-based seals, which are another potential PFAS source.

The Agilent PFAS LC conversion kit addresses this by replacing all of these components with alternative materials that don't contribute PFAS. This approach eliminates system-derived contamination and ensures that any PFAS detected is truly from the sample, and not from the instrument itself.

Step three: precise, reproducible, and scalable MS detection

With the sample cleaned up and background contamination minimized, the final piece is ensuring that your detection system can deliver accurate, reproducible results – not just today, but also as testing demands grow in the future.

Labs may soon need to track hundreds of PFAS, including isomers and degradation products, all at ever-lower concentrations. This means increasing the number of triple quad multiple reaction monitoring (MRM) transitions, which shrinks the dwell time for each transition. Fewer counts are collected per data point, which can lead to more noise, reducing precision and sensitivity.

The 6495D LC/MS is designed specifically to maintain precision and sensitivity at low dwell times by maximizing ion transmission for multi-analyte methods. This preserves dwell time, keeps noise low, and maintains point-to-point precision, allowing labs to expand their PFAS panels without losing sensitivity or throughput. And because the 6495D's front end is engineered for mechanical robustness, that performance holds steady over more than 10,000 of injections – critical for high-throughput PFAS testing where reproducibility run after run is essential.

In addition, to support labs as PFAS panels grow, Agilent has built a dynamic MRM database containing around 200 PFAS compounds. "Dynamic" refers to how it's implemented on the instrument: rather than firing every transition on every run, the system triggers transitions only around each compound's expected retention time. This makes it possible to handle large compound panels without overloading the duty cycle – while still collecting enough data points for accurate quantitation.

Crucially, the database includes not just transitions but retention times, collision energies, source parameters, and labeled internal standards. Retention times are essential for distinguishing the many branched PFAS isomers, while the internal standards correct for matrix effects and variability, ensuring consistent quantitation. Labeled standards aren't strictly mandatory for food testing, but they are best practice and add

significant confidence to the data.

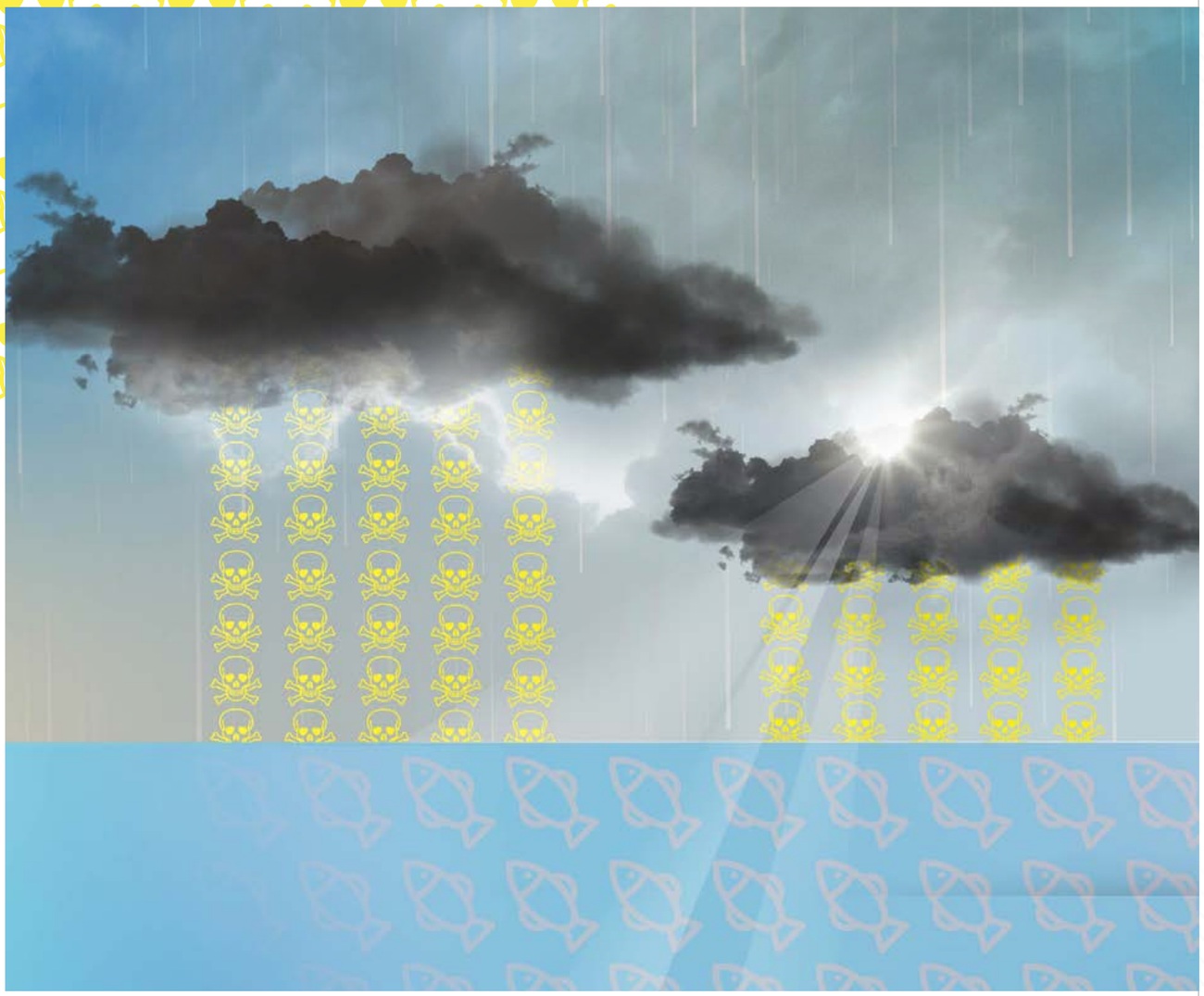
Once the method is loaded, labs can tailor their analytical strategy: they can perform targeted quantitation against a watch list, screen more broadly across all compounds in the database (which can reveal additional PFAS), or even pivot to untargeted analysis using high-resolution accurate-mass platforms such as the new Revident LC/Q-TOF. In untargeted workflows, data from broad screens can be processed with tools such as feature extractors, library matching software, or platforms such as FluoroMatch, which can suggest likely identities even without reference spectra.

Looking ahead: more compounds, lower limits

We don't have a clear global legislative roadmap for PFAS for the next decade – and what emerges will probably be driven by risk discoveries. If someone finds something unexpected, everything will shift.

This is the real challenge for labs. If you're performing contract testing, you know the list you have today – but what will your clients want tested tomorrow? What will they demand in a year's time? And for food manufacturers, a new supplier, a packaging change, or an unexpected PFAS finding can suddenly reshape testing priorities.

Right now, the trends we anticipate are more compounds added to target lists, lower detection limits, and testing extending further up the supply chain. So future-proofing, for us, is about making sure the workflow can adapt to whatever comes next. We can't predict the details, but we can make sure our systems – whether that's the pass-through EMR PFAS sample prep, clean LC setup, or scalable triple quadrupole detection – are robust and flexible enough to evolve.



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