PARTNERS IN
PFAS
ANALYSIS

Fox
Scientific, Inc.

Advanced Analytical Solutions for PFAS Analysis

- Certified Reference Materials (CRMs)
- LC & GC Columns
- Sample Preparation
- Air & Gas Sampling
- Expert Technical Support

**Featuring:
PFAS 3 and
PFAS 4
Mixes**

RESTEK

Pure Chromatography

www.restek.com

Your Partner in PFAS Analysis

The landscape of PFAS testing regulations and methods continues to evolve around the world, yet the needs of analytical labs stay the same no matter where you are. You need fast, accurate, and dependable products supported by personalized advice and expert technical service from people who understand the challenges of your market. We're here to help.

Explore our full selection of products and technical resources, and contact our PFAS team today at **www.restek.com/PFAS**

Fox Scientific, Inc.
8221 East FM 917 • Alvarado, TX 76009 • Phone:(800)369-5524 • Fax:(817)783-3571
www.foxscientific.com • sales@foxscientific.com

Meet Our New Standards

Restek's two new multicomponent PFAS certified reference materials (CRMs) are ideal for labs analyzing water, food, and other matrices. By combining these frequently analyzed PFAS compounds into two ampuls, calibration complexity is reduced, enabling labs to minimize errors, save time, and decrease costs compared to sourcing raw materials or costly singles.

- Two mixes for PFAS labs analyzing water, food, and other matrices.
- Expanded data packs report trace impurities, ensuring no off-target analytes affect other PFAS compounds in your analysis.
- In stock and ready for immediate shipment, helping you meet quality requirements.
- Second independent lot availability helps you meet your requirements without needing to source another supplier.
- Single components are tested through NMR, verifying purity and isomeric composition.

PFAS 3 (PFOS/PFOA/PFHxS) Standard

Potassium Perfluorooctanesulfonate (PFOSK) (2795-39-3)
Perfluorooctanoic acid (PFOA) (335-67-1)
Sodium Perfluorohexanesulfonate (PFHxSNa) (82382-12-5)

Product	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
PFAS 3	10 µg/mL, Methanol (1mM NaOH)/ 2-Propanol (98:2), 1mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30804 NEW!

PFAS 4 (PFOS/PFOA/PFHxS/PFNA) Standard

Potassium Perfluorooctanesulfonate (PFOSK) (2795-39-3)
Perfluorooctanoic acid (PFOA) (335-67-1)
Sodium Perfluorohexanesulfonate (PFHxSNa) (82382-12-5)
Perfluorononanoic acid (PFNA) (375-95-1)

Product	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
PFAS 4	10 µg/mL, Methanol (1mM NaOH)/ 2-Propanol (98:2), 1mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30805 NEW!

Also Available As Singles

- 100 µg/mL concentrations provide additional flexibility when creating working standards.
- Expanded data packs report trace impurities to ensure no off-target analytes affect other PFAS compounds in your analysis.
- Second independent lot availability helps you meet your requirements without needing to source another supplier.
- Single components are tested through NMR to verify purity and isomeric composition.

Native Perfluoroalkylcarboxylic acids (PFCA)

Product	CAS	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
Perfluorooctanoic acid (PFOA) Standard	335-67-1	100 µg/mL, Methanol (1mM NaOH)/ 2-propanol (98:2), 1 mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30800 NEW!
Perfluorononanoic acid (PFNA) Standard	375-95-1	100 µg/mL, Methanol (1mM NaOH)/ 2-propanol (98:2), 1 mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30801 NEW!

Native Perfluoroalkanesulfonates (PFSA)

Product	CAS	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
Perfluorooctanesulfonic acid (PFOS) Standard	2795-39-3	100 µg/mL, Methanol (1mM NaOH)/ 2-propanol (98:2), 1 mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30802 NEW!
Perfluorohexanesulfonic acid (br-PFHxS) Standard	3871-99-6	100 µg/mL, Methanol (1mM NaOH)/ 2-propanol (98:2), 1 mL/ampul	Yes	6 months	36 months	Ambient	10 °C or colder	ea.	30803 NEW!

Concentration reported as the acid.

Additional PFAS Reference Standards

PFAS 24 Calibration Standard

(24 components)

1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2 FTS) (39108-34-4)
1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2 FTS) (757124-72-4)
1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2 FTS) (27619-97-2)
N-ethylperfluoro-1-octanesulfonamidoacetic acid (NEtFOSAA) (2991-50-6)
N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA) (2355-31-9)
Perfluoro-1-decanesulfonic acid (PFDS) (335-77-3)
Perfluoro-1-nonanesulfonic acid (PFNS) (68259-12-1)
Perfluoro-1-octanesulfonamide (FOSA) (754-91-6)
Perfluoro-1-pentanesulfonic acid (PFPeS) (2706-91-4)
Perfluorobutanesulfonic acid (PFBS) (375-73-5)
Perfluorobutanoic acid (PFBA) (375-22-4)
Perfluorodecanoic acid (PFDA) (335-76-2)
Perfluorododecanoic acid (PFDOA) (307-55-1)
Perfluoroheptanesulfonic acid (PFHpS) (375-92-8)
Perfluoroheptanoic acid (PFHpA) (375-85-9)
Perfluorohexanesulfonic acid (PFHxS)* (355-46-4)
Perfluorohexanoic acid (PFHxA) (307-24-4)
Perfluorononanoic acid (PFNA) (375-95-1)
Heptadecafluorooctanesulfonic acid (PFOS)* (1763-23-1)
Perfluorooctanoic acid (PFOA)* (335-67-1)
Perfluoropentanoic acid (PFPeA) (2706-90-3)
Perfluorotetradecanoic acid (PFTeDA) (376-06-7)
Perfluorotridecanoic acid (PFTrDA) (72629-94-8)
Perfluoroundecanoic acid (PFUnA) (2058-94-8)

*Technical grade compound containing both branched and linear isomers; see certificate for details.

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
1 µg/mL, Methanol (1 mM KOH), 1 mL/ampul	Yes	6 months	60 months	Ambient	0 °C or colder	ea.	30733

PFAS 28 Calibration Standard

(28 components)

11-chloroeicosafluoro-3-oxaundecane-1sulfonic acid (11Cl-PF3OUdS) (763051-92-9)
1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2 FTS) (39108-34-4)
1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2 FTS) (757124-72-4)
1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2 FTS) (27619-97-2)
4,8-dioxa-3H-perfluorononanoic acid (ADONA) (919005-14-4)
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS) (756426-58-1)
2-(Heptafluoropropoxy)2,3,3,3tetrafluoropropionic acid (HFPO-DA) (13252-13-6)
N-ethylperfluoro-1-octanesulfonamidoacetic acid (NEtFOSAA)* (2991-50-6)
N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)* (2355-31-9)
Perfluoro-1-decanesulfonic acid (PFDS) (335-77-3)
Perfluoro-1-nonanesulfonic acid (PFNS) (68259-12-1)
Perfluoro-1-octanesulfonamide (FOSA) (754-91-6)
Perfluoro-1-pentanesulfonic acid (PFPeS) (2706-91-4)
Perfluorobutanesulfonic acid (PFBS) (375-73-5)
Perfluorobutanoic acid (PFBA) (375-22-4)
Perfluorodecanoic acid (PFDA) (335-76-2)
Perfluorododecanoic acid (PFDOA) (307-55-1)
Perfluoroheptanesulfonic acid (PFHpS) (375-92-8)
Perfluoroheptanoic acid (PFHpA) (375-85-9)
Perfluorohexanesulfonic acid (PFHxS)* (355-46-4)
Perfluorohexanoic acid (PFHxA) (307-24-4)
Perfluorononanoic acid (PFNA) (375-95-1)
Heptadecafluorooctanesulfonic acid (PFOS)* (1763-23-1)
Perfluorooctanoic acid (PFOA)* (335-67-1)
Perfluoropentanoic acid (PFPeA) (2706-90-3)
Perfluorotetradecanoic acid (PFTeDA) (376-06-7)
Perfluorotridecanoic acid (PFTrDA) (72629-94-8)
Perfluoroundecanoic acid (PFUnA) (2058-94-8)

*Technical grade compound containing both branched and linear isomers; see certificate for details.

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
1 µg/mL, Methanol (1 mM KOH), 1 mL/ampul	Yes	6 months	60 months	Ambient	0 °C or colder	ea.	30734

EPA 537.1 PFAS Calibration Standard

(18 components)

11-chloroeicosafluoro-3-oxaundecane-1sulfonic acid (11Cl-PF3OUdS) (763051-92-9)
4,8-dioxa-3H-perfluorononanoic acid (ADONA) (919005-14-4)
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS) (756426-58-1)
2-(Heptafluoropropoxy)2,3,3,3tetrafluoropropionic acid (HFPO-DA) (13252-13-6)
N-ethylperfluoro-1-octanesulfonamidoacetic acid (NEtFOSAA)* (2991-50-6)
N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)* (2355-31-9)
Perfluorobutanesulfonic acid (PFBS) (375-73-5)
Perfluorodecanoic acid (PFDA) (335-76-2)
Perfluorododecanoic acid (PFDOA) (307-55-1)
Perfluoroheptanoic acid (PFHpA) (375-85-9)
Perfluorohexanesulfonic acid (PFHxS)* (355-46-4)
Perfluorohexanoic acid (PFHxA) (307-24-4)
Perfluorononanoic acid (PFNA) (375-95-1)
Heptadecafluorooctanesulfonic acid (PFOS)* (1763-23-1)
Perfluorooctanoic acid (PFOA)* (335-67-1)
Perfluorotetradecanoic acid (PFTeDA) (376-06-7)
Perfluorotridecanoic acid (PFTrDA) (72629-94-8)
Perfluoroundecanoic acid (PFUnA) (2058-94-8)

*Technical grade compound containing both branched and linear isomers; see certificate for details.

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
2 µg/mL, Methanol (1 mM KOH), 1 mL/ampul	Yes	6 months	60 months	Ambient	0 °C or colder	ea.	30735

EPA 533 PFAS Calibration Standard

(25 components)

11-chloroeicosafluoro-3-oxaundecane-1sulfonic acid (11Cl-PF3OUdS) (763051-92-9)
1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2 FTS) (39108-34-4)
1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2 FTS) (757124-72-4)
1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2 FTS) (27619-97-2)
4,8-dioxa-3H-perfluorononanoic acid (ADONA) (919005-14-4)
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS) (756426-58-1)
2-(Heptafluoropropoxy)2,3,3,3tetrafluoropropionic acid (HFPO-DA) (13252-13-6)
Perfluoro-3,6-dioxaheptanoic acid (NFDHA) (151772-58-6)
Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA) (113507-82-7)
Perfluoro-5-oxahexanoic acid (PFMPA) (377-73-1)
Perfluoro-4-methoxybutanoic acid (PFMBA) (863090-89-5)
Perfluorobutanesulfonic acid (PFBS) (375-73-5)
Perfluorobutanoic acid (PFBA) (375-22-4)
Perfluorodecanoic acid (PFDA) (335-76-2)
Perfluorododecanoic acid (PFDOA) (307-55-1)
Perfluoroheptanesulfonic acid (PFHpS) (375-92-8)
Perfluoroheptanoic acid (PFHpA) (375-85-9)
Perfluorohexanesulfonic acid (PFHxS)* (355-46-4)
Perfluorohexanoic acid (PFHxA) (307-24-4)
Perfluorononanoic acid (PFNA) (375-95-1)
Heptadecafluorooctanesulfonic acid (PFOS)* (1763-23-1)
Perfluorooctanoic acid (PFOA)* (335-67-1)
Perfluoropentanesulfonic acid (2706-91-4)
Perfluoropentanoic acid (PFPeA) (2706-90-3)
Perfluoroundecanoic acid (PFUnA) (2058-94-8)

*Technical grade compound containing both branched and linear isomers; see certificate for details.

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
2 µg/mL, Methanol (1 mM KOH), 1 mL/ampul	Yes	6 months	60 months	Ambient	0 °C or colder	ea.	30736

Our Definitive Guide to PFAS Methods

Designed for labs starting PFAS analysis or adding new compounds or matrices to their testing program, our definitive method and guideline summaries help you compare methods, select appropriate workflows, and find the right supplies quickly and easily.

Access your free guide today at **www.restek.com/pfas-methods**

LC Columns and Accessories

Whether you're analyzing short-chain or ultrashort-chain PFAS, our Raptor and Force C18 LC columns quickly and easily achieve effective separation of these compounds. Performing trace analyses? Combine them with our PFAS delay columns to eliminate instrument-related background PFAS.

Need help choosing the right product?

Access our free methods-based product guides at **www.restek.com/pfas-products**

Raptor C18 HPLC Columns

- A traditional end-capped C18 ideal for general-purpose use in reversed-phase chromatography.
- Wide pH range (2–8) provides excellent data quality for many applications, matrices, and compounds.
- Offers the highest hydrophobic retention of any Raptor phase.
- Part of Restek's Raptor LC column line featuring 1.8, 2.7, and 5 µm SPP core-shell silica.

ID	Length	Particle Size	Units	Cat.#
2.1 mm	50 mm	1.8 µm	ea.	9304252
2.1 mm	50 mm	2.7 µm	ea.	9304A52
2.1 mm	50 mm	5 µm	ea.	9304552
2.1 mm	100 mm	5 µm	ea.	9304512

Raptor Polar X LC Columns

- Reliably analyze a wide variety of polar analytes (acidic, basic, and neutral) without time-consuming derivatization or complex ion pairing.
- Switch between HILIC and ion-exchange retention modes with simple mobile phase changes and short equilibration times.
- Raptor 2.7 µm core-shell particles provide UHPLC-like speed and efficiency on all makes and models of LC systems.
- Ideal for increasing sensitivity and selectivity in LC-MS analyses.
- Included in the Quick Polar Pesticides (QuPPe) method published by the European Union Research Laboratory for Single Residue Methods.

ID	Length	Particle Size	Units	Cat.#
2.1 mm	50 mm	2.7 µm	ea.	9311A52

Force C18 Columns

- A traditional end-capped C18 ideal for general-purpose use in reversed-phase chromatography.
- Wide pH range (2–8) provides excellent data quality for many applications, matrices, and compounds.
- High carbon load (20%) offers high hydrophobic retention.

ID	Length	Particle Size	Units	Cat.#
2.1 mm	50 mm	1.8 µm	ea.	9634252
2.1 mm	50mm	3 µm	ea.	9634352

PFAS Delay Column

- Traps system-related PFAS, preventing interference and ensuring accurate trace-level analysis of PFAS in samples.
- Universal compatibility: works with
  - any HPLC or UHPLC up to 15,000 psi (1034 bar);
  - both FPP and SPP analytical columns; and
  - all stationary phases.
- Highly retentive of system-related PFAS; no breakthrough even with extended equilibration times.
- Easy installation with standard fittings.

ID	Length	Particle Size	Units	Cat.#
2.1 mm	50 mm	5 µm	ea.	27854

Raptor C18 EXP Guard Column Cartridge

- Free-Turn architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- Guard column cartridges require EXP direct connect holder (cat.# 25808).
- Pair with EXP hand-tight fitting (cat.# 25937–25938) for tool-free installation.

ID	Length	Particle Size	Units	Cat.#
2.1 mm	5 mm	2.7 µm	3-pk.	9304A0252
2.1 mm	5 mm	5 µm	3-pk.	930450252
2.1 mm	5 mm	UHPLC	3-pk.	9304U0252

Force C18 Guard Column Cartridge

- Free-Turn architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- Guard column cartridges require EXP direct connect holder (cat.# 25808).
- Pair with EXP hand-tight fitting (cat.# 25937–25938) for tool-free installation.

ID	Length	Units	Cat.#
2.1 mm	5 mm	3-pk.	963450252

EXP Direct Connect Holder for EXP Guard Cartridges

(Includes Fitting & Ferrules)

- Free-Turn architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- EXP direct connect holder requires separate guard column cartridges; available from Restek in 2.1, 3.0, and 4.6 mm.
- Pair with EXP hand-tight fitting (cat.# 25937–25938) for tool-free installation.

Product Name	Units	Cat.#
EXP Direct Connect Holder for EXP Guard Cartridges, Includes Fitting & Ferrules	ea.	25808

Explore our full range of LC columns at **www.restek.com/LC**

GC Columns and Accessories

Need help choosing the right product?

Access our free methods-based product guides at **www.restek.com/pfas-products**

LPGC Rtx-200 Column Kit

- 1.9x faster fluorotelomer alcohols (FTOH) analysis with 60% less helium consumption.
- Factory-coupled, leak-free kit makes setup as simple as a column change.
- Ideal for speeding up GC-MS and GC-MS/MS methods.

Product Name	Includes	Temp Limits	Units	Cat.#
2.1 mm	10 m x 0.32 mm ID x 1.00 µm Rtx-200 analytical column and 5 m x 0.15 mm ID Rxi restrictor factory connected via SilTite connector	-20 to 290/310 °C	ea.	11807

Topaz Precision Inlet Liner

for Agilent GCs

Inner Diameter (ID)	Length	Outer Diameter (OD)	Geometry	Packing	Units	Cat.#
4.0 mm	78.5 mm	6.3 mm	Precision	Quartz Wool	ea.	23305

GC Accelerator Oven Insert Kit

for Agilent 5890, 6890, 7890, and 8890 GCs

- Get the same GC separation in less time—use a GC Accelerator kit and the *EZ*GC method translator to accurately convert methods to a scaled-down column format.
- Scaled-down methods let you speed up analysis time and increase sample throughput without capital investment.
- GC Accelerator kit installs easily without damaging the GC column or interfering with the MS interface.

Product Name	Instrument Model	Units	Cat.#
GC Accelerator Oven Insert Kit	Agilent 5890|6890|7890|8890	kit	23849

Explore our full range of GC columns at **www.restek.com/GC**

Sample Preparation

Need help choosing the right product?

Access our free methods-based product guides at **www.restek.com/pfas-products**

Resprep Polymeric SPE Cartridges

- Silica-free, bonded polymeric material—no unwanted secondary silica interactions, even with basic compounds.
- High surface area—higher loading capacity compared to silica-based sorbents.
- Stable over a wide pH range (0–14)—won't hydrolyze under extreme conditions.
- Water-wettable—streamlined conditioning and equilibration steps drastically reduce solvent usage and sample prep time.
- No flow-rate dependence—maintains retention and capacity after conditioning, even if dried out from vacuum or positive pressure flows.
- Choose cartridges for high loading capacity; 96-well plates for high throughput and automation.

Volume	Particle Size	Sorbent Phase	Units	Cat.#
3 mL, 60 mg	60 µm	Polymeric WAX	50-pk.	28468
6 mL, 150 mg	60 µm	Polymeric WAX	30-pk.	28469
6 mL, 500 mg	60 µm	Polymeric WAX	30-pk.	28470
6 mL, 500 mg	30 µm	Polymeric WAX	30-pk.	28291
6 mL, 200 mg	30 µm	Polymeric WAX	30-pk.	28292

Resprep S-DVB SPE Cartridge

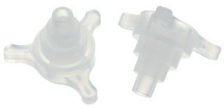
- High-purity material with highest reproducibility and lowest blank values due to an optimized manufacturing process.
- Excellent recovery rates, especially for the enrichment of pharmaceuticals and active ingredients, due to the spherical particle shape, homogeneous surface, and optimized pore structure.
- Hydrophobic styrene-divinylbenzene (SDVB) copolymer, pH stability 1–14.
- Unique polypropylene locking ring helps prevent frit movement common to S-DVB sorbent.
- Recommended analytes: PFAS in drinking water; pharmaceuticals/active ingredients from tablets, creams, and water/wastewater; drugs from blood, plasma, serum, and urine; trace analysis of herbicides, pesticides, PAHs, PCBs; and phenols from water.
- Ideal for EPA Method 537.1 PFAS in drinking water; meets method performance requirements.

Volume	Sorbent Phase	Units	Cat.#
6 mL, 500 mg	S-DVB	30-pk.	28937

SPE Empty Tubes

Material	Volume	Units	Cat.#
Polypropylene	Sample reservoir, 75 mL	12-pk.	26015

SPE Connector, 1, 3, 6, 10, or 15 mL, Polypropylene



Material	Volume	Units	Cat.#
Polypropylene	1, 3, 6, 10, or 15 mL	15-pk.	26007

Limited-Volume Screw-Thread Polypropylene Vials

- Limited-volume design fits all 2.0 mL, 12 x 32 mm, vial-based autosamplers.
- Compatible with all 9 mm screw-thread caps.
- PTFE-free—ideal for PFAS analysis (e.g., EPA 537) and other PFAS-sensitive methods.

Size	Type	Volume	Units	Cat.#
12 x 32 mm	9 mm Screw-Thread	700 µL	100-pk.	23243
12 x 32 mm	9 mm Screw-Thread	700 µL	1000-pk.	23246
12 x 32 mm	9 mm Screw-Thread	1.5 mL	100-pk.	23242
12 x 32 mm	9 mm Screw-Thread	1.5 mL	1000-pk.	23245

2 mL Solid-Top Polyethylene Caps

- Limited-volume design fits all 2.0 mL, 12 x 32 mm, vial-based autosamplers.
- Compatible with all 9 mm screw-thread caps.
- PTFE-free—ideal for PFAS analysis (e.g., EPA 537) and other PFAS-sensitive methods.

Cap Size	Type	Units	Cat.#
9 mm	Screw-Thread	100-pk.	23244
9 mm	Screw-Thread	1000-pk.	23247

Resprep Vacuum Manifolds

- Disposable, quick-replace valve liners ensure a clean flow path and eliminate cross-contamination of samples extracted on the same port.
- Individual screw-type valves in each SPE port provide precise flow control.
- Easily modified sample collection rack supports a wide variety of collection vessels.
- Solvent-resistant vacuum gauge and bleed valve offer better sealing and vacuum control.
- Valves are compatible with any standard male luer end SPE cartridge.

Product Name	Size	Units	Cat.#
QR-12	12-Port	kit	28298-VM
QR-24	24-Port	kit	28299-VM

Explore our full range of sample preparation products at **www.restek.com**

Air & Gas Sampling

SilcoCan Air Sampling Canister

- Siltek-treated canister with optional Siltek-treated valve offers unsurpassed inertness, even for sulfur-containing or brominated compounds.
- High-quality, metal-to-metal seal, 2/3-turn valve with stainless-steel diaphragms prevents sample adsorption for more accurate results.
- Canisters and valves made of 304 and 316 stainless steel to withstand the rigors of field work.
- Both 2-port and 3-port valves are available; 3-port valve includes -30" Hg/60 psi vacuum/pressure gauge (other gauges available).
- Featuring the proven long life, leak-free performance, and effortless operation of RAVE+ valves.

Product Name	Modification	Volume	Units	Cat.#
SilcoCan Air Sampling Canister	2-Port RAVE+ Valve	6 L	ea.	27306
SilcoCan Air Sampling Canister	3-Port Siltek-Treated RAVE+ Valve with Gauge	6 L	ea.	27309

Explore our full range of air & gas sampling products at **www.restek.com**

Everything You Need for PFAS Analysis

Explore our vast library of PFAS resources, including chromatograms, webinars, application notes, tips & tricks, and more! Learn about the products we've designed specifically for PFAS analysis and get quick access to our global team of PFAS experts who are ready to help you with your analysis.

Visit our PFAS portal today at **www.restek.com/pfas**

Fox Scientific, Inc.

8221 East FM 917 • Alvarado, TX 76009 • Phone:(800)369-5524 • Fax:(817)783-3571
www.foxscientific.com • sales@foxscientific.com

C1-C10 PFAS Analysis in Human Plasma and Serum

Integrating Ultrashort-Chain Compounds into PFAS Biomonitoring

By Shun-Hsin Liang and Justin Steimling

Abstract

Human exposure to ultrashort-chain (C1 to C3) PFAS and their potential adverse health effects are poorly understood, partly due to a lack of analytical methods to properly monitor their occurrence. This study introduces an innovative methodology for the simultaneous analysis of C1 to C10 carboxylic and sulfonic acid PFAS, along with four alternative compounds, in human plasma and serum samples. The chromatographic analysis was conducted using a polar-embedded, reversed-phase LC column for accurate and robust quantification.

Introduction

While concerns about the adverse effects of long-chain per- and polyfluoroalkyl substances (PFAS) on human health have led to increased biomonitoring, less is known about the potential toxicity of ultrashort-chain PFAS. Ultrashort-chain PFAS are ubiquitous in environmental aquatic systems and can occur at very high concentrations, so determining exposure levels is important, particularly for vulnerable populations. Since both human plasma and serum are widely used for biomonitoring longer-chain PFAS, developing methods that include shorter chain PFAS is critical to gaining a more comprehensive understanding of the relationship between PFAS exposure and adverse health outcomes.

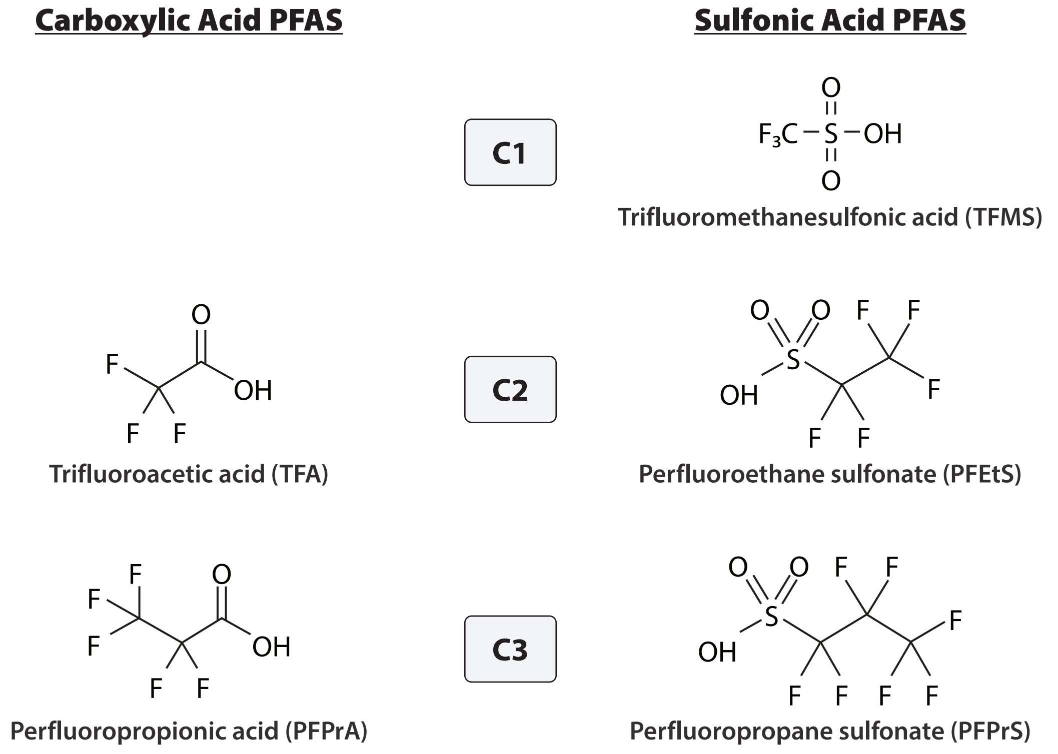
Related Products

- *PFAS delay column (cat. # 27854)*
- *Ultra IBD 3 µm, 100 mm x 2.1 mm (cat.# 9175312)*
- *Ultra Inert IBD 3 µm, 100 mm x 2.1 mm (cat.# 9175312-T)*
- *PFAS 28 calibration standard (cat.# 30734)*
- *Big Mouth Step screw-thread vials (cat.# 24626)*
- *Polypropylene vial inserts (cat.# 24518)*
- *Survival kit for HPLC, stainless steel (cat.# 25097)*

Ultrashort-chain PFAS are small, highly polar compounds with carbon chain lengths shorter than C4 (Figure 1). Their high polarity creates a challenge for analytical practices that are based on reversed-phase liquid chromatography, primarily due to insufficient chromatographic retention. To improve analytical performance, the following method was developed on an Ultra IBD column because its polar-embedded stationary phase provides stronger retention of polar compounds, even in the presence of the various salts, electrolytes, and buffers that are inherently found in human plasma and serum.

In this study, a simple and reliable workflow was developed for the simultaneous analysis of C1 to C10 perfluoroalkyl carboxylic and sulfonic acids, along with four alternative PFAS, in human plasma and serum. The samples underwent a simple, single-step protein precipitation procedure and were analyzed with a user-friendly LC-MS/MS method. Method accuracy and precision were evaluated with fortified fetal bovine serum. In addition, the method's suitability for real-world samples was confirmed by accurately measuring targeted PFAS with known concentrations in NIST standard reference human plasma (NIST SRM 1950) and serum (NIST SRM 1957).

Figure 1: Structures of C1 to C3 PFAS



Experimental

Plasma and Serum Samples

Since PFAS-free human plasma and serum were not found during the screening of commercially obtained samples, charcoal-stripped fetal bovine serum (FBS) obtained from MilliporeSigma (Burlington, MA) was used as the blank matrix for method verification because it did not contain any of the analytes of interest except for TFA. To compensate for this, a TFA isotope, ^{13}C-TFA, was employed as a surrogate to assess method accuracy for TFA in FBS. NIST SRM 1950 (metabolites in human plasma) and NIST SRM 1957 (organic contaminants in non-fortified human serum) were purchased from NIST Store (Gaithersburg, MD). These SRMs are characterized by known concentrations of six or seven short-chain and long-chain PFAS.

Standard and Sample Preparation

TFA is commonly present in laboratory materials, such as pipette tips, glass and polypropylene HPLC vials, and polypropylene tubes. Following a comprehensive examination, the materials with the lowest TFA contamination levels were chosen for standard and sample preparation. Additionally, deionized water and reverse osmosis (RO) water generated at Restek were assessed to determine if they contained PFAS. The results revealed that RO water was free of PFAS contamination, with the exception of TFA, which was found to be present at very low levels. Consequently, RO water was used for the preparation of mobile phase and calibration standards.

The calibration standard solutions (100 µL) were prepared in RO water, supplemented with 1x phosphate-buffered saline (PBS), across a range of 0.05 to 40 ng/mL (ppb) in polypropylene HPLC vials. Initial testing revealed that early eluting compounds displayed slightly broader peak shapes in the human plasma and serum samples compared to the neat standard solutions prepared in 100% water. Therefore, PBS was incorporated into the standard solutions to mitigate this variability and ensure uniform chromatographic performance between standard and sample solutions.

Five isotopically labeled PFAS were used as quantitative internal standards (QIS) (Table I). A 5 µL aliquot of QIS working solution (40 ng/mL of $^{13}C_3$-PFBA; 20 ng/mL of $^{13}C_2$-PFHxA and $^{13}C_4$-PFOA; and 10 ng/mL of $^{13}C_5$-PFNA and $^{13}C_2$-PFDA) was added to the standard solutions, which were then mixed with 200 µL of methanol containing 1.5% formic acid.

For the assessment of method accuracy and precision, 100 µL aliquots of FBS were fortified at 0.4, 2, 10, and 30 ppb with non-labeled PFAS and isotopically labeled ^{13}C-TFA, which served as a surrogate for the determination of TFA recovery. The fortified FBS samples were mixed with 5 µL of QIS working solution and 2 µL of extracted internal standard (EIS) working solution (50 ng/mL of $^{13}C_3$-PFPrA, $^{13}C_4$-PFBA, $^{13}C_5$-PFPeA, $^{13}C_5$-PFHxA, $^{13}C_4$-PFHpA, $^{13}C_8$-PFOA, $^{13}C_9$-PFNA, $^{13}C_6$-PFDA, $^{13}C_3$-PFHxS, and $^{13}C_8$-PFOS). A 200 µL aliquot of methanol containing 1.5% formic acid was then added to the fortified FBS samples followed by vortexing for 30 seconds at 3000 rpm. After centrifugation at 4200 rpm for 10 minutes, approximately 150 µL of supernatant was transferred to a polypropylene vial insert (cat.# 24518), placed in a glass HPLC vial (cat.# 24626), and subsequently injected for LC-MS/MS analysis. This single-step protein precipitation in clean polypropylene HPLC vials was used to minimize background PFAS contamination and to ensure accurate measurement of target analytes. Non-fortified human plasma and serum samples were also prepared using the same procedure that was used for the fortified FBS samples.

Analytical System

PFAS analysis was performed by LC-MS/MS under the conditions shown below. A PFAS delay column was installed between the mixer and injector to prevent any potential PFAS contamination upstream of the injector from coeluting with PFAS in the samples.

System: Waters ACQUITY UPLC I-Class and Xevo TQ-S triple quadrupole mass spectrometer

Columns:

- Analytical column: Ultra IBD, 100 mm x 2.1 mm, 3 µm (cat.# 9175312)
- PFAS delay column (cat.# 27854)

Injection volume: 5 µL

Mobile phase A: 5 mM ammonium formate, 0.1% formic acid in water

Mobile phase B: Acetonitrile

Flow rate: 0.3 mL/min

Temperature: 40 °C

Gradient:

Time (min)	%B
0.00	20
7.00	95
9.00	95
9.01	20
11.00	20

Ion mode: Negative ESI

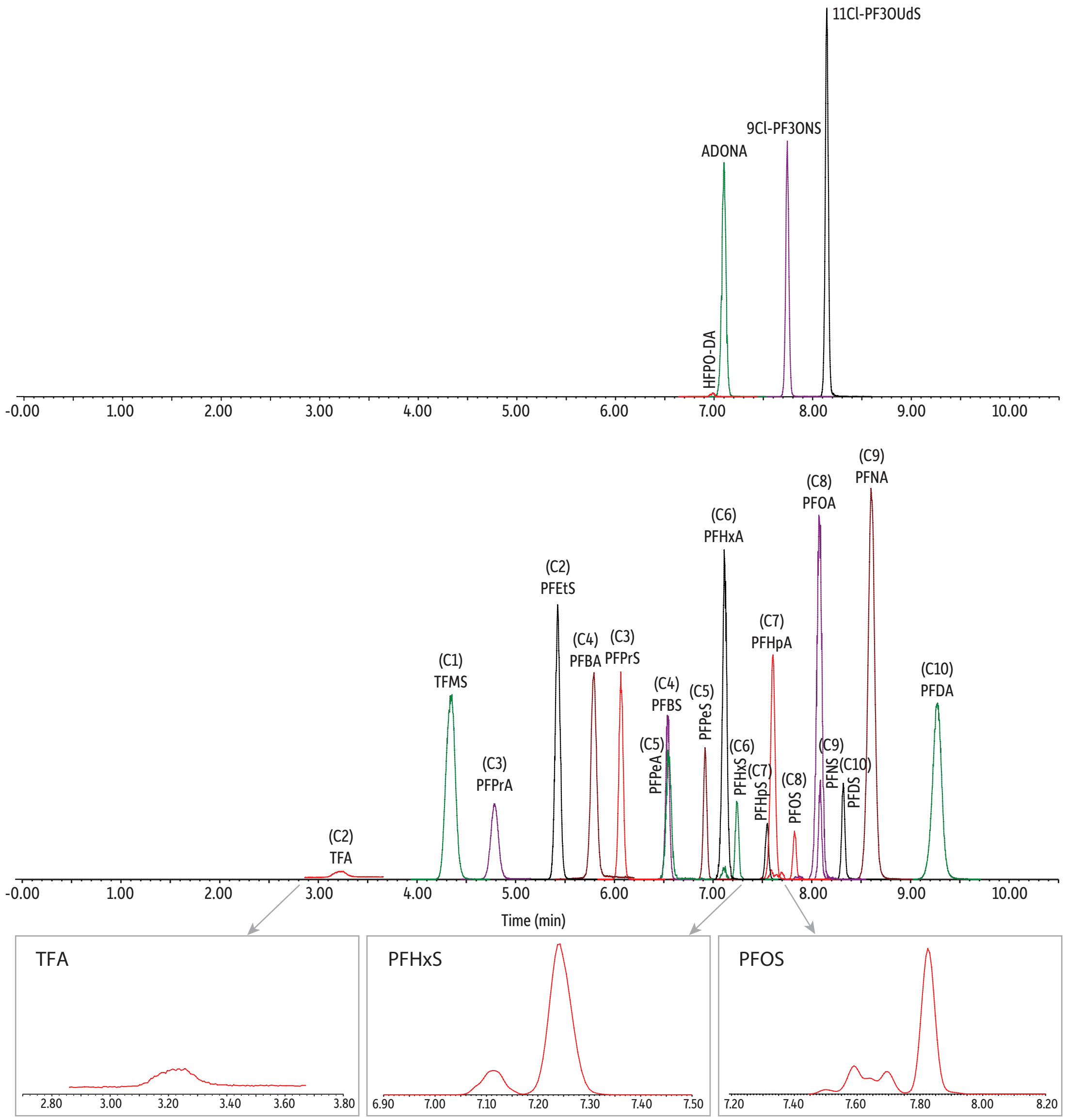
Mode: Scheduled MRM

Results and Discussion

LC-MS/MS Method Development

After exploring various mobile phases and chromatographic conditions, a final method (Figure 2) was established for the analysis of C1 to C10 PFAS in human plasma and serum. The polar embedded Ultra IBD column provided strong retention and good separation of early eluting, ultrashort-chain PFAS analyzed under reversed-phase conditions. More important, the extensive retention of ultrashort-chain PFAS, especially for the first-eluted analyte (TFA), led to reduced matrix interferences. Matrix impact was further minimized by using stable isotopes as internal standards to correct for any matrix interference during quantification. The MS/MS transition parameters and internal standards used for each analyte are provided in Table I.

Figure 2: Analysis of a 10 ppb PFAS Standard



LC_CF0812

Column	Ultra IBD (cat.# 9175312)
Dimensions:	100 mm x 2.1 mm ID
Particle Size:	3 µm
Pore Size:	100 Å
Temp.:	40 °C
Standard/Sample	PFAS 28 calibration standard (cat.# 30734)
Diluent:	1:2 water:methanol
Conc.:	10 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	Water, 5 mM ammonium formate, 0.1% formic acid
B:	Acetonitrile

Time (min)	Flow (mL/min)	%A	%B
0.00	0.3	80	20
7.00	0.3	5	95
9.00	0.3	5	95
9.01	0.3	80	20
11.00	0.3	80	20

Max Pressure:	275 bar

Detector	Waters Xevo TQ-S
Ion Mode:	ESI-
Mode:	MRM
Instrument	Waters ACQUITY UPLC I-Class
Sample Preparation	The standard solution (100 µL) was prepared in reverse osmosis water supplemented with 1x phosphate-buffered saline at 10 ng/mL (ppb) in a polypropylene HPLC vial followed by mixing with 200 µL of methanol containing 1.5% formic acid.
Notes	A PFAS delay column (cat.# 27854) was installed before the injector. The peaks of confirmation ions are not displayed in this chromatogram.

Table I: MS Transitions and Analytes Retention Times

Compounds	Retention Time (min)	Precursor Ion	Product Ions*	Cone (V)	Collision (V)	Quantification Internal Standard
Target Analytes						
TFA	3.25	113.03 [M-H]-	69.01	10	10	$^{13}C_3$-PFBA
PFPrA	4.81	162.97 [M-H]-	119.02	10	8	$^{13}C_3$-PFBA
PFBA	5.80	213.03 [M-H]-	168.98	14	8	$^{13}C_3$-PFBA
PFPeA	6.56	262.97 [M-H]-	218.97	2	6	$^{13}C_2$-PFHxA
PFHxA	7.13	313.10 [M-H]-	268.97/118.99	2	8/20	$^{13}C_2$-PFHxA
PFHpA	7.62	363.16 [M-H]-	319.09/169.06	8	10/18	$^{13}C_4$-PFOA
PFOA	8.10	413.10 [M-H]-	368.96/168.90	2	10/16	$^{13}C_4$-PFOA
PFNA	8.62	463.10 [M-H]-	419.01/219.02	4	10/16	$^{13}C_5$-PFNA
PFDA	9.29	513.17 [M-H]-	469.16/219.06	4	12/16	$^{13}C_2$-PFDA
TFMS	4.37	148.97 [M-H]-	79.93/98.92	62	18/18	$^{13}C_3$-PFBA
PFEtS	5.44	198.90 [M-H]-	79.92/98.91	38	22/22	$^{13}C_3$-PFBA
PFPrS	6.08	248.97 [M-H]-	79.92/98.91	2	24/24	$^{13}C_3$-PFBA
PFBS	6.55	298.97 [M-H]-	79.97/98.89	2	26/26	$^{13}C_2$-PFHxA
PFPeS	6.93	349.10 [M-H]-	79.98/98.98	6	32/30	$^{13}C_2$-PFHxA
PFHxS	7.24	398.90 [M-H]-	79.97/98.89	56	32/34	$^{13}C_2$-PFHxA
PFHpS	7.56	449.17 [M-H]-	79.98/98.97	4	42/38	$^{13}C_2$-PFHxA
PFOS	7.82	499.03 [M-H]-	79.92/98.90	8	40/40	$^{13}C_4$-PFOA
PFNS	8.09	549.10 [M-H]-	79.92/98.83	12	42/40	$^{13}C_4$-PFOA
PFDS	8.32	599.17 [M-H]-	79.98/98.83	8	44/46	$^{13}C_5$-PFNA
HFPO-DA	7.01	285.03 [M-COOH]-	169.02/185.02	2	6/16	$^{13}C_2$-PFHxA
ADONA	7.11	376.90 [M-H]-	250.93/84.97	22	12/26	$^{13}C_2$-PFHxA
9Cl-PF3ONS	7.75	530.78 [M-H]-	350.85/82.96	12	26/24	$^{13}C_2$-PFHxA
11Cl-PF3OUdS	8.15	630.78 [M-H]-	450.80/82.95	8	26/32	$^{13}C_5$-PFNA
Extracted Internal Standards						
$^{13}C_3$-PFPrA	4.81	165.97 [M-H]-	120.96	10	11	$^{13}C_3$-PFBA
$^{13}C_4$-PFBA	5.80	217.03 [M-H]-	171.98	2	8	$^{13}C_3$-PFBA
$^{13}C_5$-PFPeA	6.56	267.97 [M-H]-	222.99	2	6	$^{13}C_2$-PFHxA
$^{13}C_5$-PFHxA	7.13	318.03 [M-H]-	272.93	2	7	$^{13}C_2$-PFHxA
$^{13}C_4$-PFHpA	7.62	366.90 [M-H]-	321.93	2	10	$^{13}C_4$-PFOA
$^{13}C_8$-PFOA	8.10	420.97 [M-H]-	375.94	2	10	$^{13}C_4$-PFOA
$^{13}C_9$-PFNA	8.62	471.97 [M-H]-	426.87	4	8	$^{13}C_5$-PFNA
$^{13}C_6$-PFDA	9.29	518.90 [M-H]-	473.87	4	13	$^{13}C_2$-PFDA
$^{13}C_3$-PFHxS	7.24	401.90 [M-H]-	79.97	2	32	$^{13}C_2$-PFHxA
$^{13}C_8$-PFOS	7.82	506.84 [M-H]-	79.97	4	48	$^{13}C_4$-PFOA
Quantitative Internal Standards						
$^{13}C_3$-PFBA	5.80	215.97 [M-H]-	171.97	10	8	
$^{13}C_2$-PFHxA	7.13	314.97 [M-H]-	269.93	8	8	
$^{13}C_4$-PFOA	8.10	416.87 [M-H]-	371.88	2	8	
$^{13}C_5$-PFNA	8.62	467.87 [M-H]-	422.89	16	10	
$^{13}C_2$-PFDA	9.29	514.87 [M-H]-	469.84	8	10	

*Quantifier ion/qualifier ion. No qualifier ion was used for TFA, PFPrA, PFBA, and PFPeA because only one product ion could be identified for each.

Linearity

With quadratic regression (1/x weighted), all analytes showed acceptable linearities with r2 >0.995 and deviations <20%. Table II shows the specific linear range for each analyte, ranging from 0.05 ppb to 40 ppb, with variation occurring at the lowest calibration concentration.

Accuracy and Precision

Accuracy and precision for most analytes were assessed at 0.4, 2, and 10 ppb. However, for HFPO-DA and TFA, the evaluation was conducted at 2, 10, and 30 ppb because 0.4 ppb was below the linear range of these compounds. Three batches of samples were prepared and analyzed on different days, totaling nine replicates at each fortification level. The average recoveries and relative standard deviations (%RSD) are presented in Table II. All analytes exhibited recovery values within the range of 82.3–115% across the three fortification levels. Satisfactory method precision was demonstrated with %RSD values ranging from 0.965 to 11.3%. Additionally, the results indicated that all EIS had recovery values within 20% of the nominal concentration. The use of EIS as an additional quality control measure enhanced the reliability and robustness of the method.

Based on the results of the accuracy and precision experiments, the method LOQ was set as the lowest concentration of the standard calibration curve for each analyte. The method LOD was estimated from the analysis of fortified FBS and was defined by a peak signal-to-noise ratio of 3:1.

Measurement of C1–C10 and Alternative PFAS in NIST 1950 and 1957 SRMs

Six preparations of each SRM were analyzed with the developed LC-MS/MS method. The results indicated that all measured EIS concentrations fell within 20% of the nominal concentration. Moreover, Table III illustrates that the average experimental concentrations of most PFAS closely matched the reference concentrations, with deviations within 20%. Although the measured PFDA concentration in NIST SRM 1957 exhibited a slightly higher deviation of 26%, it remained within the deviation range of the reference concentration. These results demonstrated that the established method was suitable for accurate measurement of PFAS—including ultrashort-chain PFAS—in both human plasma and serum samples. In addition to the reference PFAS, other measurable PFAS were also reported in Table III.

Table II: Linearity, LOD, Accuracy, and Precision Results for Fortified Fetal Bovine Serum Samples

			Average Recovery (%RSD)			
			Fortified Concentration (ng/mL)			
Analytes	**Linearity Range (ng/mL)**	**LOD (ng/mL)**	**0.4**	**2**	**10**	**30**
^{13}C-TFA	0.50 - 40	0.1250*	—	90.6 (9.28)	98.0 (2.99)	100 (10.7)
PFPrA	0.25 - 40	0.0102	108 (2.53)	115 (0.965)	105 (6.99)	—
PFBA	0.10 - 40	0.0222	104 (5.57)	109 (1.75)	104 (1.51)	—
PFPeA	0.10 - 40	0.0125	97.4 (3.25)	93.3 (4.19)	89.1 (5.57)	—
PFHxA	0.10 - 40	0.0098	99.2 (2.46)	109 (4.65)	102 (6.31)	—
PFHpA	0.10 - 40	0.0050	86.7 (5.37)	99.2 (2.04)	89.2 (1.80)	—
PFOA	0.10 - 40	0.0051	94.8 (8.24)	107 (5.30)	95.6 (3.35)	—
PFNA	0.10 - 40	0.0012	96.2 (1.44)	111 (1.87)	99.1 (2.62)	—
PFDA	0.10 - 40	0.0083	93.6 (1.93)	102 (2.03)	95.5 (3.64)	—
TFMS	0.05 - 40	0.0070	89.4 (7.33)	88.8 (3.80)	91.9 (3.19)	—
PFEtS	0.05 - 40	0.0020	98.0 (2.62)	103 (1.47)	99.3 (2.26)	—
PFPrS	0.05 - 40	0.0030	98.1 (8.18)	108 (4.23)	98.9 (4.15)	—
PFBS	0.05 - 40	0.0124	88.0 (8.84)	94.1 (4.95)	86.5 (6.17)	—
PFPeS	0.10 - 40	0.0031	94.8 (4.57)	100 (8.05)	94.3 (5.43)	—
PFHxS	0.10 - 40	0.0115	85.8 (7.88)	96.0 (10.0)	92.2 (8.98)	—
PFHpS	0.10 - 40	0.0088	92.5 (6.75)	99.8 (6.45)	93.4 (5.74)	—
PFOS	0.10 - 40	0.0200	97.8 (8.66)	97.9 (7.01)	95.9 (3.37)	—
PFNS	0.10 - 40	0.0129	92.1 (7.98)	94.2 (4.43)	91.9 (2.78)	—
PFDS	0.10 - 40	0.0111	92.6 (8.20)	82.3 (3.48)	87.6 (3.55)	—
HFPO-DA	0.50 - 40	0.1875	—	99.9 (11.3)	91.1 (8.95)	90.4 (6.13)
ADONA	0.10 - 40	0.0035	90.4 (7.14)	106 (4.67)	95.7 (4.25)	—
9Cl-PF3ONS	0.10 - 40	0.0031	95.8 (4.20)	93.7 (5.12)	93.8 (6.71)	—
11Cl-PF3OUdS	0.10 - 40	0.0023	106 (5.10)	84.5 (4.20)	97.2 (4.86)	—

*For non-labeled TFA

Table III: Quantification of PFAS in NIST 1950 and 1957 SRMs

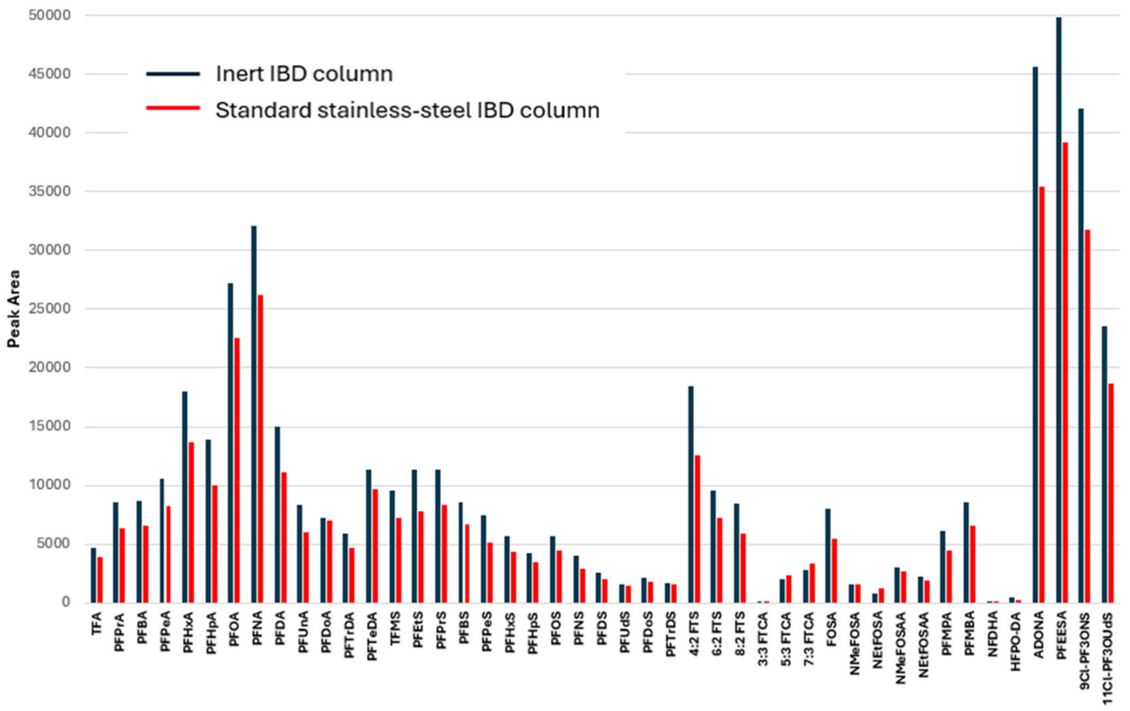
Analytes	Reference Conc. (ng/mL)	Experimental Avg. Conc. (ng/mL)	Experimental Precision (%RSD)	Relative Concentration (%)**
NIST SRM 1950				
PFOA	3.27 ± 0.06	3.12	3.70	95.4
PFNA	0.720 ± 0.028	0.85	0.74	117
PFDA	0.322 ± 0.007	0.30	3.47	91.6
PFHxS	3.25 ± 0.08	2.91	6.26	89.5
PFOS	10.64 ± 0.13	12.57	2.92	118
TFA	—	5.74	4.45	—
PFPrA	—	0.26	6.90	—
PFHpA	—	0.23	3.04	—
TFMS	—	0.08	3.95	—
PFPeS	—	0.15	4.31	—
PFHpS	—	0.36	4.90	—
PFDS	—	0.10	4.64	—
NIST SRM 1957*				
PFHpA	0.305 ± 0.051	0.28	2.16	92.1
PFOA	5.00 ± 0.44	4.21	1.91	84.2
PFNA	0.878 ± 0.077	0.77	1.38	87.9
PFDA	0.39 ± 0.12	0.29	2.69	74.4
PFHxS	4.00 ± 0.83	3.35	9.88	83.8
PFOS	21.1 ± 1.3	20.46	3.81	97.0
TFA	—	3.22	3.79	—
TFMS	—	0.07	0.10	—
PFPeS	—	0.10	7.97	—
PFHpS	—	0.48	6.20	—
PFDS	—	0.10	4.23	—

*The reference concentration for NIST SRM 1957 is presented as mass fraction (µg/kg).
**Relative concentration = (experimental concentration/reference concentration) x 100

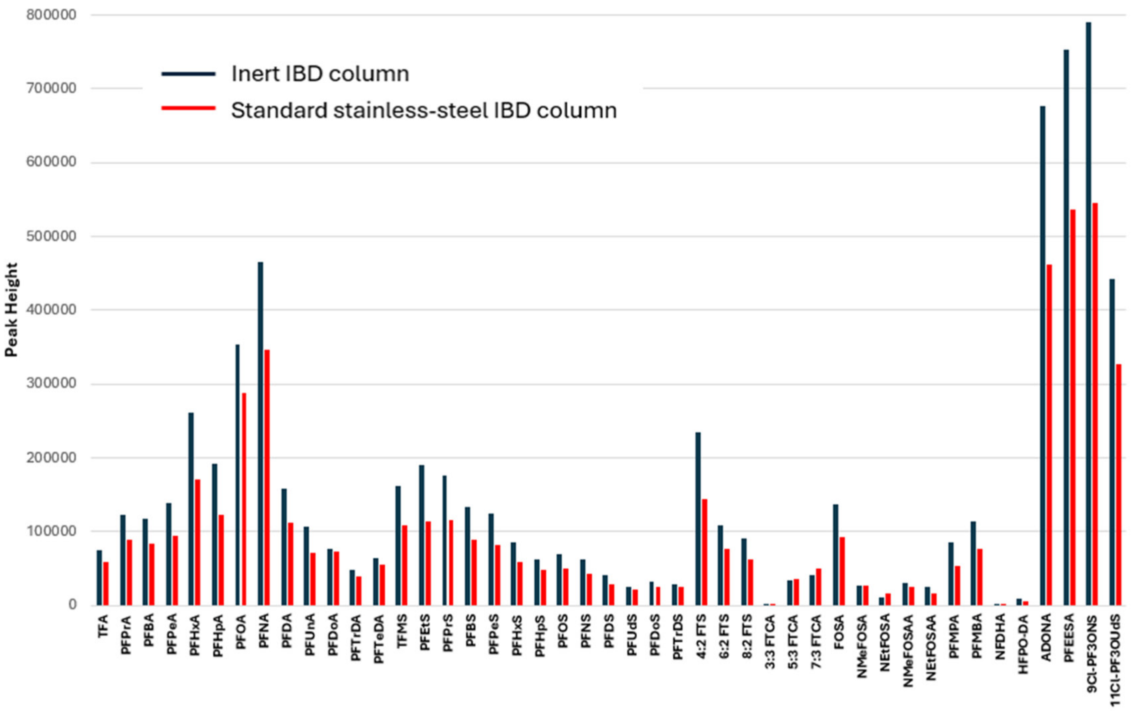
Future Directions

While the data reported here were generated using a standard, stainless-steel Ultra IBD column (cat.# 9175312), the same column (stationary phase and dimensions) is now available in an inert hardware format (Ultra Inert IBD, cat.# 9175312-T). The hardware used to make the Ultra Inert IBD column is treated with an inert coating, which improves sensitivity by preventing unwanted analyte interactions with the stainless-steel surface. As shown in Figure 3, the inert hardware results in a notable enhancement in detection sensitivity for most of the PFAS tested (3-70% increase in peak area and 5-75% increase in peak height) compared to columns made with uncoated hardware. Future applications of the method developed here may benefit from using an Ultra Inert IBD column, particularly for samples containing PFAS at trace levels.

Figure 3: Inert LC column hardware increased peak area and height for most PFAS compared to columns made with traditional stainless-steel hardware.



Peak Area



Peak Height

Conclusions

A simple, reliable workflow was established in this study to incorporate ultrashort-chain PFAS analysis into a method that also included longer-chain PFAS that are commonly monitored in human plasma and serum. The method utilized a polar-embedded Ultra IBD column to increase chromatographic retention of these small polar analytes, and the results demonstrated that the method was rugged, accurate, and precise. Most important, this method can offer a valuable tool for gaining insights into human exposure to these emergent ultrashort-chain PFAS. Visit www.restek.com/PFAS for additional products, methods, and technical resources.

PFAS Delay Column

- Traps system-related PFAS, preventing interference and ensuring accurate trace-level analysis of PFAS in samples.
- Universal compatibility: works with
    - any HPLC or UHPLC up to 15,000 psi (1034 bar);
    - both FPP and SPP analytical columns; and
    - all stationary phases.
- Highly retentive of system-related PFAS; no breakthrough even with extended equilibration times.
- Easy installation with standard fittings.

Catalog No.	Product Name	Units
27854	PFAS Delay Column, 5 µm, 50 x 2.1 mm HPLC Column	ea.

Ultra IBD HPLC Column

The Restek IBD is a polar-embedded column that acts as a strong hydrogen bonder and may be the most versatile column available today. With a unique polar group, this column is very retentive and selective for acids. It also provides symmetrical peak shape for strong bases. Restek's IBD is compatible with 100% aqueous mobile phases and can be used under reversed-phase or HILIC conditions to retain very polar, ionic compounds in highly organic mobile phases.

Catalog No.	Product Name	Units
9175312	Ultra IBD HPLC Column, 3 µm, 100 mm x 2.1 mm	ea.

Ultra Inert IBD HPLC Column

- Inert LC column technology reduces nonspecific binding of chelating analytes, enabling sensitive analysis and smooth integration of peaks.
- Ideal for the analysis of metal-sensitive compounds.
- Increased response and analyte recovery, allowing lower detection limits.
- Improved peak shape without passivation or mobile phase additives.
- Specialized columns for mixed polar and nonpolar compounds.

Catalog No.	Product Name	Units
9175312-T	Ultra Inert IBD HPLC Column, 3 µm, 100 mm x 2.1 mm	ea.

PFAS 28 Calibration Standard

Contains:
11-chloroeicosafluoro-3-oxaundecane-1sulfonic acid (11Cl-PF3OUdS) (763051-92-9)
1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2 FTS) (39108-34-4)
1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2 FTS) (757124-72-4)
1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2 FTS) (27619-97-2)
4,8-dioxa-3H-perfluorononanoic acid (ADONA) (919005-14-4)
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS) (756426-58-1)
2-(Heptafluoropropoxy)2,3,3,3tetrafluoropropionic acid (HFPO-DA) (13252-13-6)
N-ethylperfluoro-1-octanesulfonamidoacetic acid (NEtFOSAA)* (2991-50-6)
N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)* (2355-31-9)
Perfluoro-1-decanesulfonic acid (PFDS) (335-77-3)
Perfluoro-1-nonanesulfonic acid (PFNS) (68259-12-1)
Perfluoro-1-octanesulfonamide (FOSA) (754-91-6)
Perfluoro-1-pentanesulfonic acid (PFPeS) (2706-91-4)
Perfluorobutanesulfonic acid (PFBS) (375-73-5)
Perfluorobutanoic acid (PFBA) (375-22-4)
Perfluorodecanoic acid (PFDA) (335-76-2)
Perfluorododecanoic acid (PFDOA) (307-55-1)
Perfluoroheptanesulfonic acid (PFHpS) (375-92-8)
Perfluoroheptanoic acid ((PFHpA) (375-85-9)
Perfluorohexanesulfonic acid (PFHxS)* (355-46-4)
Perfluorohexanoic acid ((PFHxA) (307-24-4)
Perfluorononanoic acid (PFNA) (375-95-1)
Heptadecafluorooctanesulfonic acid (PFOS)* (1763-23-1)
Perfluorooctanoic acid (PFOA)* (335-67-1)
Perfluoropentanoic acid (PFPeA) (2706-90-3)
Perfluorotetradecanoic acid (PFTeDA) (376-06-7)
Perfluorotridecanoic acid (PFTrDA) (72629-94-8)
Perfluoroundecanoic acid (PFUnA) (2058-94-8)

*Technical grade compound containing both branched and linear isomers; see certificate for details.

Catalog No.	Concentration	Solvent	Volume	Units
30734	1 µg/mL	Methanol (1 mM KOH)	1 mL/ampul	ea.

Big Mouth Step Screw-Thread Vials

Catalog No.	Product Name	Units
24626	Big Mouth Step Screw-Thread Vials with Grad Marking Spot, 2.0 mL, 12 x 32 mm, 10 mm/425 Thread (Vial Only), Clear	100-pk.

Vial Inserts, Polypropylene

Catalog No.	Product Name	Units
24518	Vial Inserts, Polypropylene, Big Mouth w/Bottom Spring, 250 µL	100-pk.

Survival Kit for HPLC, Stainless Steel

For start-up and maintenance in all HPLC systems.

The stainless-steel survival kit contains a wide range of tubing, fittings, and tools necessary to set up and maintain your HPLC system: a selection of lengths and IDs of 1/16-inch tubing, nuts, ferrules, a ValvTool wrench, and a zero-dead-volume union.

Catalog No.	Product Name	Units
25097	Survival Kit for HPLC	kit

Fox Scientific, Inc.

Fox Scientific, Inc.
8221 East FM 917 • Alvarado, TX 76009 • Phone:(800)369-5524 • Fax:(817)783-3571
www.foxscientific.com • sales@foxscientific.com

RESTEK

www.restek.com

QUALITY ISO 9001 • 17025 • 17034

Lit. Cat.# CFAN4273A-UNV

Meet Requirements of EPA Method 537.1 PFAS Analysis with Contaminant-Free Workflow

By Landon Wiest

Abstract

The ubiquitous nature of PFAS in the environment makes ensuring a contaminant-free workflow essential. In this application note, we demonstrate that Resprep S-DVB SPE cartridges and related sample preparation products are consistently free of background interferences. In addition, a PFAS delay column effectively removes any contamination that may be present in the instrument. Using the materials and procedure presented here, EPA Method 537.1 requirements for cleanliness, accuracy, and precision were reliably met.

Introduction

Per- and polyfluoroalkyl substances (PFAS) are being analyzed more now than ever before due to growing concern about human exposure and potential adverse health effects. Their persistent nature and widespread use across many industries and in diverse products, ranging from non-stick kitchenware, weatherproof clothes, and aqueous film-forming foam (AFFF) to food packaging coatings, has made them essentially ubiquitous contaminants worldwide. Accordingly, testing of soils, wastewater, drinking water, and other environmental matrices, along with PFAS testing in foods, continues to increase.

In 2020, the U.S. EPA released Method 537.1 revision 2 [1] for PFAS analysis in drinking water. The method specifies that sample preparation must be performed using styrene-divinylbenzene (S-DVB) SPE cartridges and that deviation in the extraction procedure is not allowed. Because background PFAS contaminants can leach out of materials anywhere in the sample pathway and interfere with target compound analysis, labs must demonstrate acceptable background, accuracy, and precision results each time a new lot of supplies is used. In addition to this initial qualification, routine blank and QC sample analysis is required to ensure continued performance.

In a typical workflow, the sample comes in contact with multiple surfaces and substances, each of which can be possible sources of PFAS contamination or retention. These include collection vessels, chemicals (Trizma base, solvents, mobile phases, etc.), pipettes, SPE products, manifolds or automated systems, tubing, filters, vials, vial caps, and components within the LC. Even when care is taken to avoid materials known to leach PFAS, such as PTFE, or to which target analytes may adhere, such as glass, the use of clean, high-quality consumables will help prevent downtime due to system suitability failures.

Here, we followed U.S. EPA Method 537.1 and demonstrated a contaminant-free workflow that meets the stringent method requirements. While this data set is based on Method 537.1, similar testing to determine if background PFAS are present is strongly recommended for other PFAS methods [2] due to the pervasiveness of PFAS contamination.

Experimental

Calibration Standards and Quality Control Samples

PFAS analytical, internal, and surrogate standards were used to create calibration standards and laboratory fortified blanks as directed by EPA 537.1. Eight calibration standards were created from 0.2–50 ppb corresponding to 0.8–200 ppt in drinking water prior to 250-fold concentration, which occurs during sample preparation. Laboratory reagent blanks (LRB) and laboratory fortified blanks (LFB) were used as per EPA 537.1, sections 9.2.2–9.2.4. LFBs spiked at 40 ppt were used to determine the accuracy and precision of the method.

Sample Preparation

Analytical and surrogate standards were added to 250 mL 18.3 MΩ•cm (megohm) ultrapure reagent water for the LFB samples. The LFB samples were kept in polypropylene containers prior to extraction. The materials used for this workflow are detailed in Table I.

PFAS were extracted by using Resprep S-DVB SPE cartridges (6 mL, 500 mg) attached to a Resprep vacuum manifold. Cartridges were first conditioned using 15 mL methanol followed by 18 mL reagent water, never allowing the bed to dry. Reservoirs were affixed to the SPE cartridges with adaptors to avoid the use of PTFE transfer lines. Use of reservoirs, as set up in Figure 1, made the addition of the samples more convenient. The full sample preparation procedure is described below and in Figure 2.

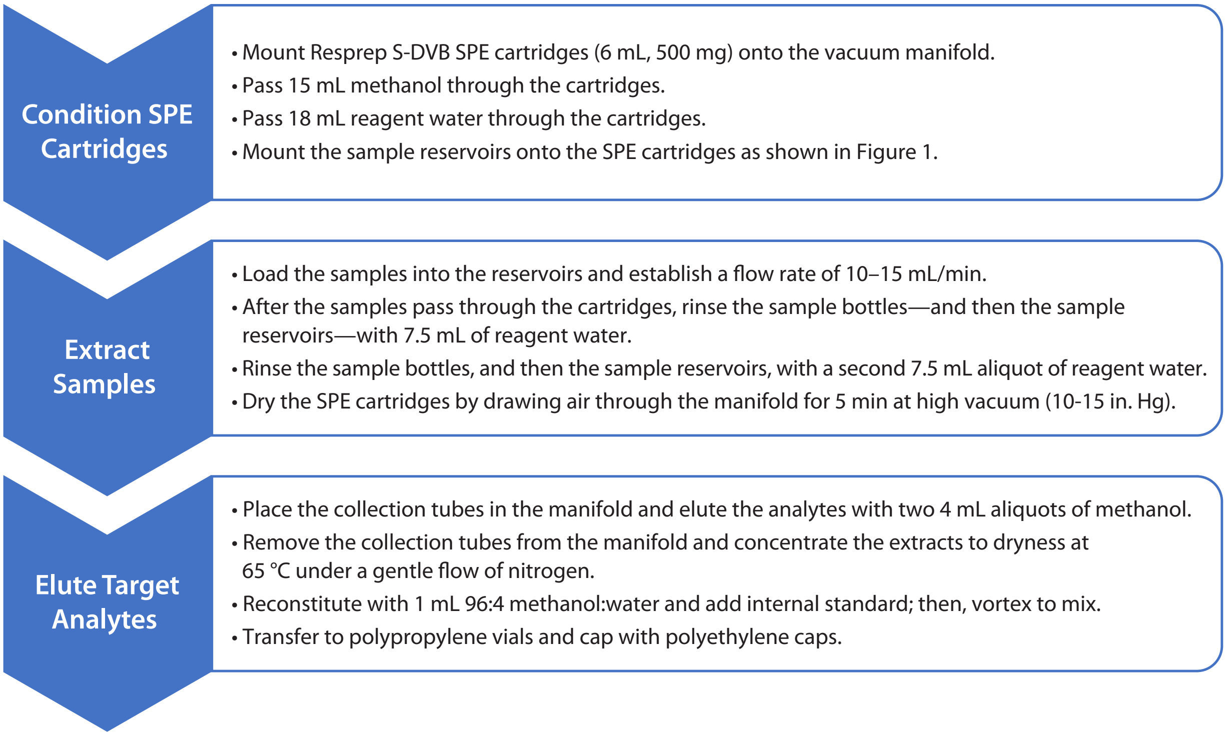
For extraction, a flow rate of approximately 10–15 mL/min was established, and care was taken to never allow the particle bed to dry throughout the extraction process. After the samples had passed through the cartridges, we rinsed each sample bottle with two 7.5 mL aliquots of reagent water. After rinsing the sample bottles, the aliquot was used to rinse each sample reservoir as well to ensure that no PFAS of interest in the sample were left behind.

Following extraction, we dried the SPE cartridges by drawing air through them while they were still attached to the vacuum manifold. After drying, collection tubes were placed in the manifold and two 4 mL aliquots of methanol were passed through each SPE cartridge and collected. The collection tubes were removed from the manifold, and the extract was concentrated to dryness under nitrogen flow while heating the samples at 65 °C.

Once the samples were dry, we added 1 mL 96:4 methanol:water solution and internal standard and then vortexed to ensure proper mixing. After vortexing, aliquots of the concentrated solution were transferred to polypropylene sample vials and capped with polyethylene caps. Samples were then analyzed via an LC-MS/MS equipped with a PFAS delay column (cat.# 27854) and a Raptor C18 LC column (50 mm x 2.1 mm, 2.7 µm; cat.# 9304A52). Method conditions can be found in Figures 3 and 4.

Figure 1: Sample preparation setup using sample reservoirs attached to Resprep S-DVB SPE cartridges mounted on a vacuum manifold.

Figure 2: Sample preparation following Method 537.1. Caution: do not allow cartridge bed to dry during any step.



Condition SPE Cartridges

- Mount Resprep S-DVB SPE cartridges (6 mL, 500 mg) onto the vacuum manifold.
- Pass 15 mL methanol through the cartridges.
- Pass 18 mL reagent water through the cartridges.
- Mount the sample reservoirs onto the SPE cartridges as shown in Figure 1.

Extract Samples

- Load the samples into the reservoirs and establish a flow rate of 10–15 mL/min.
- After the samples pass through the cartridges, rinse the sample bottles—and then the sample reservoirs—with 7.5 mL of reagent water.
- Rinse the sample bottles, and then the sample reservoirs, with a second 7.5 mL aliquot of reagent water.
- Dry the SPE cartridges by drawing air through the manifold for 5 min at high vacuum (10-15 in. Hg).

Elute Target Analytes

- Place the collection tubes in the manifold and elute the analytes with two 4 mL aliquots of methanol.
- Remove the collection tubes from the manifold and concentrate the extracts to dryness at 65 °C under a gentle flow of nitrogen.
- Reconstitute with 1 mL 96:4 methanol:water and add internal standard; then, vortex to mix.
- Transfer to polypropylene vials and cap with polyethylene caps.

Table I: Sample preparation materials used for Method 537.1 PFAS analysis.

Description	Restek Cat.#
Resprep S-DVB SPE cartridges (6 mL, 500 mg)	28937
Resprep vacuum manifold (12 or 24 port)	28298-VM, 28299-VM*
Reservoirs (polypropylene)	26015
Connectors (polypropylene)	26007
Vials (polypropylene)	23245
Vial caps (polyethylene)	23247

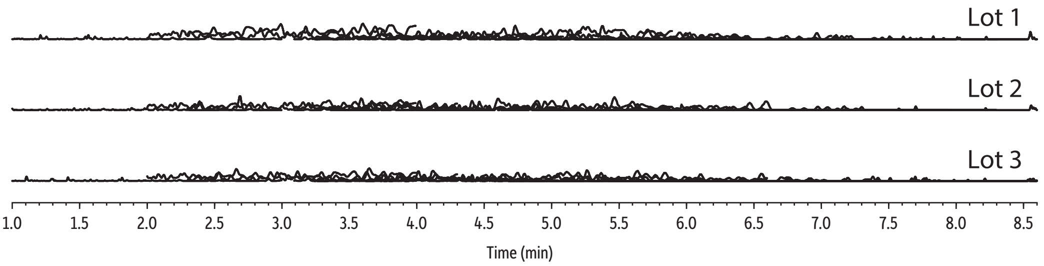
*A 12-port manifold was used in this study, but either manifold can be employed because the SPE cartridges do not contact the manifold directly; they only contact the quick-replace disposable liners that are used for both manifold styles.

Results and Discussion

Method 537.1 PFAS analysis in drinking water requirements include initial and ongoing demonstration of low system background and suitable accuracy and precision to ensure that the workflow, from sample collection through analysis, is free of contamination and qualified for use. To verify cleanliness, laboratory reagent blanks were prepared for three different lots of Resprep S-DVB SPE cartridges according to the method. As shown in Figure 3, all lots were free of contamination and no target analytes were detected, satisfying the low system background requirement of section 9.2.2. LOD values were 0.2–5 ppt, defined as a signal-to-noise ratio >3 for each compound. LOQ values were established as signal-to-noise ratios >10 and were found to be 0.5–10 ppt across the range of target analytes.

In addition to demonstrating the consistent cleanliness of Resprep S-DVB cartridges across multiple lots, this experiment proved that no interfering contaminants leached from any other component in the entire sample prep workflow listed in Table I (vacuum manifold system, vials, and caps, etc.). LC instruments can also contribute background contamination, but none was present in these analyses because the LC was plumbed with PEEK or stainless-steel tubing, and a PFAS delay column was installed. A PFAS delay column prevents interference from any PFAS leaching out of components in the LC system by trapping them and delaying their elution until after the sample analytes have eluted. Retention on a PFAS delay column is strong enough to prevent breakthrough even with extended equilibration times. [3,4]

Figure 3: Multi-Lot Laboratory Reagent Blanks (LRB)



LC_EV0574

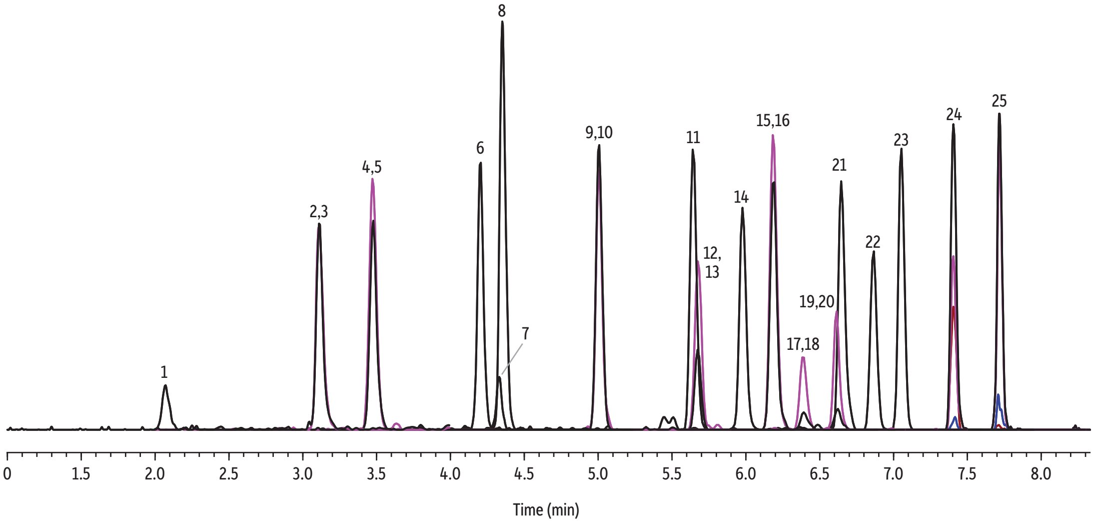
Column	Raptor C18 (cat.# 9304A52)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	2.7 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	96:4 Methanol:water
Conc.:	0 ng/mL laboratory reagent blank
Inj. Vol.:	2 µL
Mobile Phase	
A:	Water, 5 mM ammonium acetate
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	70	30
8.00	0.4	10	90
8.01	0.4	70	30
10.0	0.4	70	30

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	HPLC
Notes	A PFAS delay column (cat.# 27854) was installed before the injector. The sample was prepared using Resprep S-DVB SPE cartridges (cat.# 28937) mounted on a Resprep vacuum manifold (cat.# 29298-VM) following the procedure in U.S. EPA Method 537.1.

Recovery performance for Method 537.1 PFAS analysis was assessed using four laboratory fortified blanks prepared at 40 ppt. A representative LFB chromatogram is presented in Figure 4, which shows that good peak efficiency, selectivity, and asymmetry were obtained. To meet the method requirements for recovery, precision values across the LFB replicates must have %RSD <20%, and accuracy results for the same LFB samples must be within ±30% of the true value. The data presented in Table II demonstrate that method precision and accuracy (Section 9.2.3. and Section 9.2.4. of Method 537.1, respectively) requirements were easily met. Good recoveries indicate that the target analytes were not lost due to adhesion to surfaces encountered in the sample pathway.

Figure 4: Laboratory Fortified Blank (LFB) at Midrange (40 ppt)



LC_EV0573

	Peaks	t_R (min)	Conc. (ng/L)	Precursor Ion	Product Ion
1.	Perfluorobutanesulfonic acid (PFBS)	2.08	40	299.0	80.0
2.	Perfluoro-*n*-[1,2-$^{13}C_2$]hexanoic acid ($^{13}C_2$-PFHxA)	3.11	20	315.1	270.1
3.	Perfluorohexanoic acid (PFHxA)	3.11	40	313.2	269.0
4.	Tetrafluoro-2-heptafluoropropoxy-$^{13}C_3$-propanoic acid ($^{13}C_3$-HFPO-DA)	3.47	20	332.1	287.3
5.	Hexafluoropropylene oxide dimer acid (HFPO-DA)	3.47	40	328.9	284.9
6.	Perfluoroheptanoic acid (PFHpA)	4.19	40	363.2	319.2
7.	Perfluorohexanesulfonic acid (PFHxS)	4.33	40	399.2	79.9
8.	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	4.34	40	376.9	251.0
9.	Perfluoro-[1,2-$^{13}C_2$]octanoic acid ($^{13}C_2$-PFOA)	5.00	20	414.9	370.0
10.	Perfluorooctanoic acid (PFOA)	5.00	40	413.1	369.1
11.	Perfluorononanoic acid (PFNA)	5.64	40	463.1	419.0
12.	Perfluorooctanesulfonic acid (PFOS)	5.66	40	499.2	80.1
13.	Perfluoro-1-[1,2,3,4-$^{13}C_4$]octanesulfonic acid ($^{13}C_4$-PFOS)	5.67	60	503.1	80.2
14.	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	5.97	40	531.0	350.9
15.	Perfluoro-*n*-[1,2-$^{13}C_2$]decanoic acid ($^{13}C_2$-PFDA)	6.18	20	515.2	470.1
16.	Perfluorodecanoic acid (PFDA)	6.18	40	512.9	468.9
17.	N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	6.38	40	570.2	419.0
18.	N-deuteriomethylperfluoro-1-octanesulfonamidoacetic acid (d3-N-MeFOSAA)	6.38	80	573.1	419.1
19.	N-deuterioethylperfluoro-1-octanesulfonamidoacetic acid (d5-N-EtFOSAA)	6.61	80	589.2	419.1
20.	N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	6.62	40	583.8	418.9
21.	Perfluoroundecanoic acid (PFUnA)	6.64	40	563.2	519.1
22.	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	6.86	40	630.8	451.1
23.	Perfluorododecanoic acid (PFDoA)	7.05	40	613.1	569.1
24.	Perfluorotridecanoic acid (PFTrDA)	7.40	40	663.0	619.2
25.	Perfluorotetradecanoic acid (PFTA)	7.71	40	713.1	669.0

Column	Raptor C18 (cat.# 9304A52)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	2.7 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	96:4 Methanol:water
Conc.:	5-20 ng/mL in the final solution after sample preparation (equivalent to 20-80 ppt in laboratory reagent water sample prior to extraction)
Inj. Vol.:	2 µL
Mobile Phase	
A:	Water, 5 mM ammonium acetate
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	70	30
8.00	0.4	10	90
8.01	0.4	70	30
10.0	0.4	70	30

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	HPLC
Notes	A PFAS delay column (cat.# 27854) was installed before the injector. The sample was prepared using Resprep S-DVB SPE cartridges (cat.# 28937) mounted on a Resprep vacuum manifold (cat.# 29298-VM) following the procedure in U.S. EPA Method 537.1. While internal standard concentrations varied, all target analytes were fortified at 40 ppt.

Table II: Precision and Accuracy Results for Method 537.1 PFAS Analysis (n = 4)

Analyte	%RSD*	Mean Recovery**
Perfluorobutanesulfonic acid (PFBS)	11.9%	91.1%
Perfluorohexanoic acid (PFHxA)	7.96%	99.4%
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6.34%	94.4%
Perfluoroheptanoic acid (PFHpA)	4.19%	92.7%
Perfluorohexanesulfonic acid (PFHxS)	11.9%	89.4%
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	5.18%	96.6%
Perfluorooctanoic acid (PFOA)	5.21%	91.6%
Perfluorononanoic acid (PFNA)	6.79%	97.2%
Perfluorooctanesulfonic acid (PFOS)	6.78%	87.8%
9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	8.59%	85.1%
Perfluorodecanoic acid (PFDA)	6.96%	93.6%
N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	10.1%	82.8%
N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	16.5%	106%
Perfluoroundecanoic acid (PFUnA)	2.30%	97.5%
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	5.47%	87.6%
Perfluorododecanoic acid (PFDoA)	5.73%	99.0%
Perfluorotridecanoic acid (PFTrDA)	12.7%	89.1%
Perfluorotetradecanoic acid (PFTA)	8.90%	89.7%

*%RSD must be <20%.
**Recovery must within ±30% of the true value.

Conclusion

The data presented here clearly demonstrate that Resprep S-DVB SPE cartridges and the other sample preparation products used in this workflow for EPA Method 537.1 PFAS analysis were consistently free of background contaminants. In addition, use of a PFAS delay column effectively removed any PFAS background contamination that was potentially present in the LC instrument. Based on the results shown here, use of these workflow consumables will reduce interfering background contamination, leading to reliable system qualification and more accurate analysis and reporting.

References

[1] J. Shoemaker and D. Tettenhorst, U.S. EPA Method 537.1 Rev 2., Method 537.1 Determination of selected per- and polyflourinated alkyl substances in drinking water by solid phase extraction and liquid chromatography/tandem mass spectrometry (LC/MS/MS), 2020. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=539984&Lab=CESER
[2] Restek Corporation, Product guide for PFAS analysis: a methods-based reference to lab supplies for PFAS testing (EVAR3498-UNV), (2021). https://www.restek.com/globalassets/pdfs/literature/evar3498-unv.pdf
[3] Restek Corporation, Eliminate the impact of instrument-related PFAS interferences by using a delay column, (2019). https://www.restek.com/Technical-Resources/Technical-Library/Environmental/enviro_EVAR3001-UNV.
[4] Restek, PFAS Analysis – Why a Delay Column is Important, Video. https://www.restek.com/Technical-Resources/Technical-Library/Video-Library/PFAS-Analysis-Why-a-Delay-Column-is-Important

Raptor C18 LC Columns (USP L1)

- A traditional end-capped C18 ideal for general-purpose use in reversed-phase chromatography.
- Wide pH range (2–8) provides excellent data quality for many applications, matrices, and compounds.
- Offers the highest hydrophobic retention of any Raptor phase.
- Part of Restek's Raptor LC column line featuring 1.8, 2.7, and 5 µm SPP core-shell silica.

ID	Length	qty.	cat.#
1.8 µm Particles			
2.1 mm	30 mm	ea.	9304232
	50 mm	ea.	9304252
	100 mm	ea.	9304212
	150 mm	ea.	9304262
3.0 mm	50 mm	ea.	930425E
	100 mm	ea.	930421E
2.7 µm Particles			
2.1 mm	30 mm	ea.	9304A32
	50 mm	ea.	9304A52
	100 mm	ea.	9304A12
	150 mm	ea.	9304A62
3.0 mm	30 mm	ea.	9304A3E
	50 mm	ea.	9304A5E
	100 mm	ea.	9304A1E
	150 mm	ea.	9304A6E
4.6 mm	30 mm	ea.	9304A35
	50 mm	ea.	9304A55
	100 mm	ea.	9304A15
	150 mm	ea.	9304A65
5 µm Particles			
2.1 mm	50 mm	ea.	9304552
	100 mm	ea.	9304512
	150 mm	ea.	9304562
3.0 mm	30 mm	ea.	930453E
	50 mm	ea.	930455E
	100 mm	ea.	930451E
	150 mm	ea.	930456E
4.6 mm	50 mm	ea.	9304555
	100 mm	ea.	9304515
	150 mm	ea.	9304565
	250 mm	ea.	9304575

Stationary Phase Category: C18, octadecylsilane (L1)
Ligand Type: End-capped C18
Particle: 1.8 µm, 2.7 µm, or 5 µm superficially porous silica (SPP or "core-shell")
Pore Size: 90 Å
Carbon Load: 9% (1.8 µm), 7% (2.7 µm), 5% (5 µm)
End-Cap: yes
Surface Area: 125 m^2/g (1.8 µm), 130 m^2/g (2.7 µm), or 100 m^2/g (5 µm)
Recommended Usage: pH Range: 2.0–8.0
Maximum Temperature: 80 °C
Maximum Pressure: 1,034 bar/15,000 psi* (1.8 µm), 600 bar/8,700 psi (2.7 µm); 400 bar/5,800 psi (5 µm)
* For maximum lifetime, recommended maximum pressure for 1.8 µm particles is 830 bar/12,000 psi.

Properties:

- Compatible with moderately acidic to neutral mobile phases (pH 2–8).
- Excellent data quality in food, environmental, bioanalytical, and other applications.

Switch to a C18 when:

- You need a general-purpose column for reversed-phase chromatography.
- You need to increase retention of hydrophobic compounds.

PFAS Delay Column

- Traps system-related PFAS, preventing interference and ensuring accurate trace-level analysis of PFAS in samples.
- Universal compatibility; works with
  - Any HPLC or UHPLC up to 15,000 psi (1034 bar),
  - Both FPP and SPP analytical columns,
  - All stationary phases.
- Highly retentive of system-related PFAS; no breakthrough even with extended equilibration times.
- Easy installation with standard fittings.

ID	Length	qty.	cat.#
5 µm Particles			
2.1 mm	50 mm	ea.	27854

27854

Particle: 5 µm, spherical, fully porous
pH Range: 2.5 to 8
Maximum Temperature: 80 °C
Maximum Pressure: 1034 bar/15,000 psi

Resprep SPE Tube Parts & Accessories

Resprep tubes, frits, caps, and connectors for your method development needs.

Description	Material	Porosity	Volume	qty.	cat.#
Empty Tubes	polypropylene		1 mL	50-pk.	26010
	polypropylene		3 mL	50-pk.	26011
	polypropylene		6 mL	50-pk.	26012
	polypropylene		15 mL	50-pk.	26013
	polypropylene		sample reservoir, 25 mL	12-pk.	26014
	polypropylene		sample reservoir, 75 mL	12-pk.	26015
Frits	polyethylene	20 µm	1 mL, 6 mm	100-pk.	26016
	polyethylene	20 µm	3 mL, 9 mm	100-pk.	26017
	polyethylene	20 µm	6 mL, 1.2 cm	100-pk.	26018
	polyethylene	20 µm	15 mL, 1.6 cm	100-pk.	26019
	polyethylene	20 µm	25 mL, 2.0 cm (For 20 mL packed tubes.)	100-pk.	26020
Tube Caps	polyethylene		1 mL	12-pk.	26001
	polyethylene		3 mL	12-pk.	26002
	polyethylene		6 mL	12-pk.	26003
	polyethylene		15 mL	12-pk.	26004
	polyethylene		25 mL (For 20 mL packed tubes.)	12-pk.	26005
Female Luer End Caps	polypropylene		universal	12-pk.	26000
Connectors	polypropylene		1, 3, 6, 10, or 15 mL	15-pk.	26007
	polypropylene		12, 25 mL	12-pk.	26008
	polypropylene		60 mL	12-pk.	26009

28298-VM

Resprep Quick-Replace SPE Vacuum Manifolds (12- or 24-Port)

- Disposable, quick-replace valve liners ensure a clean flow path and eliminate cross-contamination of samples extracted on the same port.
- Individual screw-type valves in each SPE port provide precise flow control.
- Easily modified sample collection rack supports a wide variety of collection vessels.
- Screw-type, solvent-resistant vacuum gauge and bleed valve offer better sealing and vacuum control.
- Compatible with any standard male luer end SPE cartridge.

Description	qty.	cat.#
Resprep QR-12 Quick-Replace vacuum manifold Includes: cover with 12 flow control valves & gasket; glass basin with vacuum gauge & valve assembly; collection rack (base, 3 support rods, center plate, 10 mm test tube plate, 12 clips); plate for 16 mm test tubes; 12 test tubes (10 x 75 mm); 12 liner guides (stainless steel); 100 quick-replace disposable liners (PTFE)	kit	28298-VM
Resprep QR-24 Quick-Replace vacuum manifold Includes: cover with 24 flow control valves & gasket; glass basin with vacuum gauge & valve assembly; collection rack (base, 2 support rods, center plate, 10 mm test tube plate, 8 clips); plate for 16 mm test tubes; 24 test tubes (10 x 75 mm); 24 liner guides (stainless steel); 100 quick-replace disposable liners (PTFE)	kit	28299-VM

Resprep S-DVB SPE Cartridge (Reversed Phase)

- High-purity material with highest reproducibility and lowest blank values due to an optimized manufacturing process.
- Excellent recovery rates, especially for the enrichment of pharmaceuticals and active ingredients, due to the spherical particle shape, homogeneous surface, and optimized pore structure.
- Hydrophobic styrene-divinylbenzene (SDVB) copolymer, pH stability 1–14.
- Recommended analytes: PFAS in drinking water; pharmaceuticals/active ingredients from tablets, creams, and water/wastewater; drugs from blood, plasma, serum, and urine; trace analysis of herbicides, pesticides, PAHs, PCBs, and phenols from water.
- Ideal for EPA Method 537.1 PFAS in drinking water; meets method performance requirements.

28937

Description	Packing	Volume	qty.	cat.#
Resprep S-DVB	500 mg spherical styrene-divinylbenzene (SDVB) copolymer	6 mL	30-pk.	28937

Limited-Volume 2.0 mL, 9 mm Screw-Thread Polypropylene Vials

- Available in 1.5 mL or 700 µL volumes.
- Limited-volume design fits all 2.0 mL, 12 x 32 mm, vial-based autosamplers.
- Compatible with all 9 mm screw-thread caps.
- PTFE-free—ideal for PFAS analysis (e.g., EPA 537) and other PFAS-sensitive methods.

23242

Description	Type	Volume	Color	Size	qty.	cat.#
Limited-Volume 2.0 mL, 9 mm Screw-Thread Polypropylene Vials	9 mm Screw-Thread	1.5 mL	Clear	12 x 32 mm	100-pk.	23242
	9 mm Screw-Thread	1.5 mL	Clear	12 x 32 mm	1000-pk.	23245
	9 mm Screw-Thread	700 µL	Clear	12 x 32 mm	100-pk.	23243
	9 mm Screw-Thread	700 µL	Clear	12 x 32 mm	1000-pk.	23246

Note: Polypropylene vials and caps prevent sample contamination from PTFE-coated septa. However, since polypropylene caps do not reseal, evaporation occurs after injection. Multiple injections from the same vial are therefore not possible.

2.0 mL, 9 mm Solid-Top Polyethylene Caps

- Compatible with all 9 mm screw-thread vials.
- Molded, 10 mil, solid, pierceable cap.
- PTFE-free—ideal for PFAS analysis (e.g., EPA 537) and other PFAS-sensitive methods.

23244

Description	Type	Cap Size	Color	qty.	cat.#
2.0 mL, 9 mm Solid-Top Polyethylene Caps	Screw-Thread	9 mm	Clear	100-pk.	23244
	Screw-Thread	9 mm	Clear	1000-pk.	23247

25008

Low-Pressure Slip-On Inlet Filter for Mobile Phase Reservoir

A 316 stainless-steel tip with a Tefzel collar seals to a corrosion-resistant 316 stainless-steel filter element. The slip-on filter easily attaches to the pump inlet line, without the use of wrenches. The universal 1/8" OD tip accommodates standard PTFE tubing inner diameters. The cylindrical filter is standard 10 µm porosity. Fits Altex, ISCO, LDC, Varian, Waters, PerkinElmer, and other pumps.

Description	qty.	cat.#
Slip-On Inlet Filter	ea.	25008

25097

Survival Kit for HPLC, Stainless Steel

For start-up and maintenance in all HPLC systems.

The stainless-steel survival kit contains a wide range of tubing, fittings, and tools necessary to set up and maintain your HPLC system: a selection of lengths and IDs of 1/16" tubing, nuts, ferrules, a ValvTool wrench, and a zero-dead-volume union.

Kit includes:

- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.005" x 5 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.005" x 10 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.005" x 20 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.005" x 30 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.007" x 5 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.007" x 10 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.007" x 20 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.007" x 30 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.010" x 5 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.010" x 10 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.010" x 20 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.010" x 30 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.020" x 5 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.020" x 10 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.020" x 20 cm, 3-pk.
- HPLC Capillary Tubing, SS, $^{1}/_{16}$" x 0.020" x 30 cm, 3-pk.
- $^{1}/_{16}$" Rheodyne Style Nut, 10-pk.
- $^{1}/_{16}$" Rheodyne Style Ferrule, 10-pk.
- ValvTool Wrench, ea.
- Ferrules, $^{1}/_{16}$" Stainless Steel, 10-pk.
- Nuts, $^{1}/_{16}$" Stainless Steel, 10-pk.
- Zero-Dead-Volume Internal Union, ea.

Description	qty.	cat.#
Survival Kit for HPLC	kit	25097

Questions? Contact us or your local Restek representative (www.restek.com/contact-us).

www.restek.com

Lit. Cat.# EVAN3497-UNV