PFAS LC Column Anatomy: Which Phase, Dimensions, and Particle Type Are Best?

If you work in one of the many labs routinely testing samples for per- and polyfluoroalkyl substances (PFAS), you know that awareness and interest are growing as we continue to better understand the pervasiveness, persistence, and potential health risks associated with these "forever chemicals." As interest grows, the need for fast, accurate, and precise testing is growing with it. This demand is driving the development of better methods, and LC column selection is the foundation for building an improved approach. Here, we'll examine the properties that are important to consider when choosing an LC column for PFAS analysis.

Column Phase Selection

The first decision to make when determining which PFAS LC column to use is identifying an effective stationary phase. In our scouting of different phase chemistries for the analysis of short-chain PFAS (C4-C6) and above, the C18 phase proved to be the best choice. As the alkyl chain on PFAS molecules gets longer, the interactions between those chains and the C18 ligand increase, providing a great mechanism for retention and resolution. Retention is strong enough that a relatively short and narrow column can be used to quickly and effectively resolve target analytes. The example in Figure 1 shows that a 50 x 2.1 mm Raptor C18 column easily elutes and separates the compounds of interest while meeting all of EPA 537.1 method criteria for drinking water testing in less than 8 minutes (10 minute total analysis time).

When C8 PFAS were banned, other compounds with shorter alkyl chains were commercially adopted, and as the list of PFAS of interest grows, compounds with chains shorter than 4 carbons or ultrashort-chain (C2 and C3) are getting more attention. As the length of the carbon chain decreases, the influence of the polar head increases, ultimately decreasing retention on a C18 column, which has a retention mechanism based primarily on hydrophobic interaction.

For C3 PFAS compounds like perfluoropropanoic acid (PFPrA) and perfluoropropanesulfonic acid (PFPrS), a C18 phase will still work when appropriate column dimensions are selected. In Figure 2, for example, a 100 x 3 mm Raptor C18 shows great performance, easily incorporating ultrashort-chain PFAS compounds into a quick 11-minute analysis.

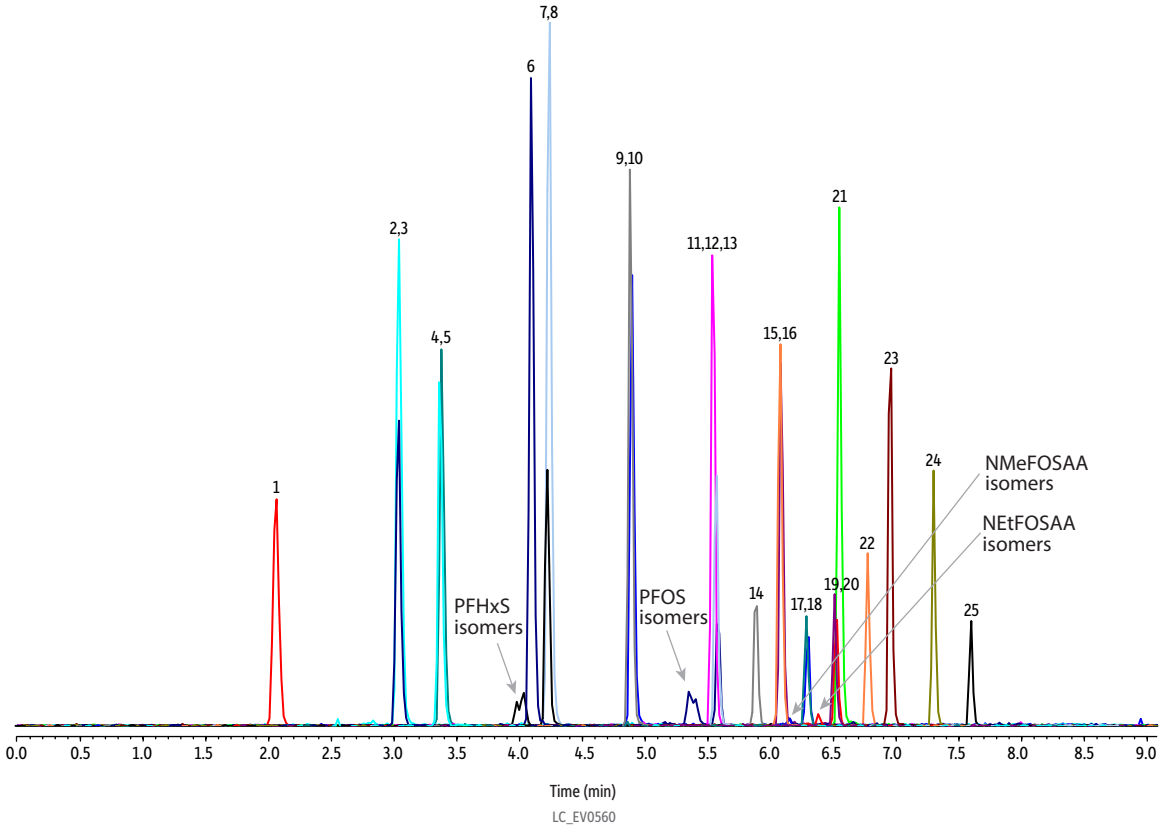
If C2 PFAS (e.g., trifluoroacetic acid) eventually make it on a list of monitored compounds, an alternate phase chemistry that targets the polar moiety of a PFAS molecule will likely be required.

Column Particle Size and Particle Type Selection

In addition to phase chemistry and column dimensions, choices about particle size and type have to be made. Ultimately, a 2.7 µm superficially porous particle (SPP), such as those used in Raptor columns, is the most versatile choice. PFAS LC columns made with these particles produce efficient chromatography that rivals the sub-2 µm fully-porous particles (FPP) without the associated ultra-high pressure, which allows labs using either UHPLC or HPLC instruments to obtain fast, efficient analyses.

However, choice in particle size and type will have a greater or lesser effect depending on your instrument setup. For instance, labs operating traditional HPLC instruments and regularly using 5 µm FPP columns may be surprised at the improvement an SPP column can offer, regardless of the particle size. With SPP columns, you could easily see improvements in chromatographic efficiency and better peak shapes while still operating in the pressure region of most HPLC instruments. Faster runs with the same equipment are a winning combination for many labs interested in increasing sample throughput without the capital expense of a UHPLC instrument.

Figure 1: A 50 x 2.1 mm Raptor C18 column is a great PFAS LC column choice; it meets all EPA 537.1 method criteria in a fast 10-minute total cycle time.



	Peaks	tR (min)	Conc. (ng/mL)	Precursor Ion	Product Ion
1.	Perfluorobutanesulfonic acid (PFBS)	2.06	10	298.8	79.9
2.	Perfluoro-n-[1,2-$^{13}C_2$]hexanoic acid ($^{13}C_2$-PFHxA)	3.03	5	314.9	270.0
3.	Perfluorohexanoic acid (PFHxA)	3.04	5	312.9	268.7
4.	Tetrafluoro-2-heptafluoropropoxy-$^{13}C_3$-propanoic acid ($^{13}C_3$-HFPO-DA)	3.36	5	286.8	168.7
5.	Hexafluoropropylene oxide dimer acid (HFPO-DA)	3.38	5	285.0	168.9
6.	Perfluoroheptanoic acid (PFHpA)	4.09	5	362.8	318.8
7.	Perfluorohexanesulfonic acid (PFHxS)	4.22	10	398.8	79.9
8.	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	4.24	5	376.9	250.7
9.	Perfluoro-[1,2-$^{13}C_2$]octanoic acid ($^{13}C_2$-PFOA)	4.88	5	415.0	370.0
10.	Perfluorooctanoic acid (PFOA)	4.90	5	413.1	368.9
11.	Perfluorononanoic acid (PFNA)	5.54	5	462.9	418.9
12.	Perfluoro-1-[1,2,3,4-$^{13}C_4$]octanesulfonic acid ($^{13}C_4$-PFOS)	5.57	10	503.0	80.0
13.	Perfluorooctanesulfonic acid (PFOS)	5.58	10	498.9	80.0
14.	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	5.88	5	530.8	350.7
15.	Perfluoro-n-[1,2-$^{13}C_2$]decanoic acid ($^{13}C_2$-PFDA)	6.08	5	514.9	469.9
16.	Perfluorodecanoic acid (PFDA)	6.08	5	512.9	469.0
17.	N-deuteriomethylperfluoro-1-octanesulfonamidoacetic acid (d3-NMeFOSAA)	6.28	10	572.9	418.8
18.	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	6.30	10	569.8	418.8
19.	N-deuterioethylperfluoro-1-octanesulfonamidoacetic acid (d5-NEtFOSAA)	6.51	10	588.9	418.8
20.	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	6.52	10	583.8	418.8
21.	Perfluoroundecanoic acid (PFUnA)	6.55	5	562.9	518.8
22.	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	6.77	5	630.7	451.0
23.	Perfluorododecanoic acid (PFDoA)	6.95	5	612.7	568.9
24.	Perfluorotridecanoic acid (PFTrDA)	7.30	5	662.7	618.8
25.	Perfluorotetradecanoic acid (PFTA)	7.60	5	712.7	668.7

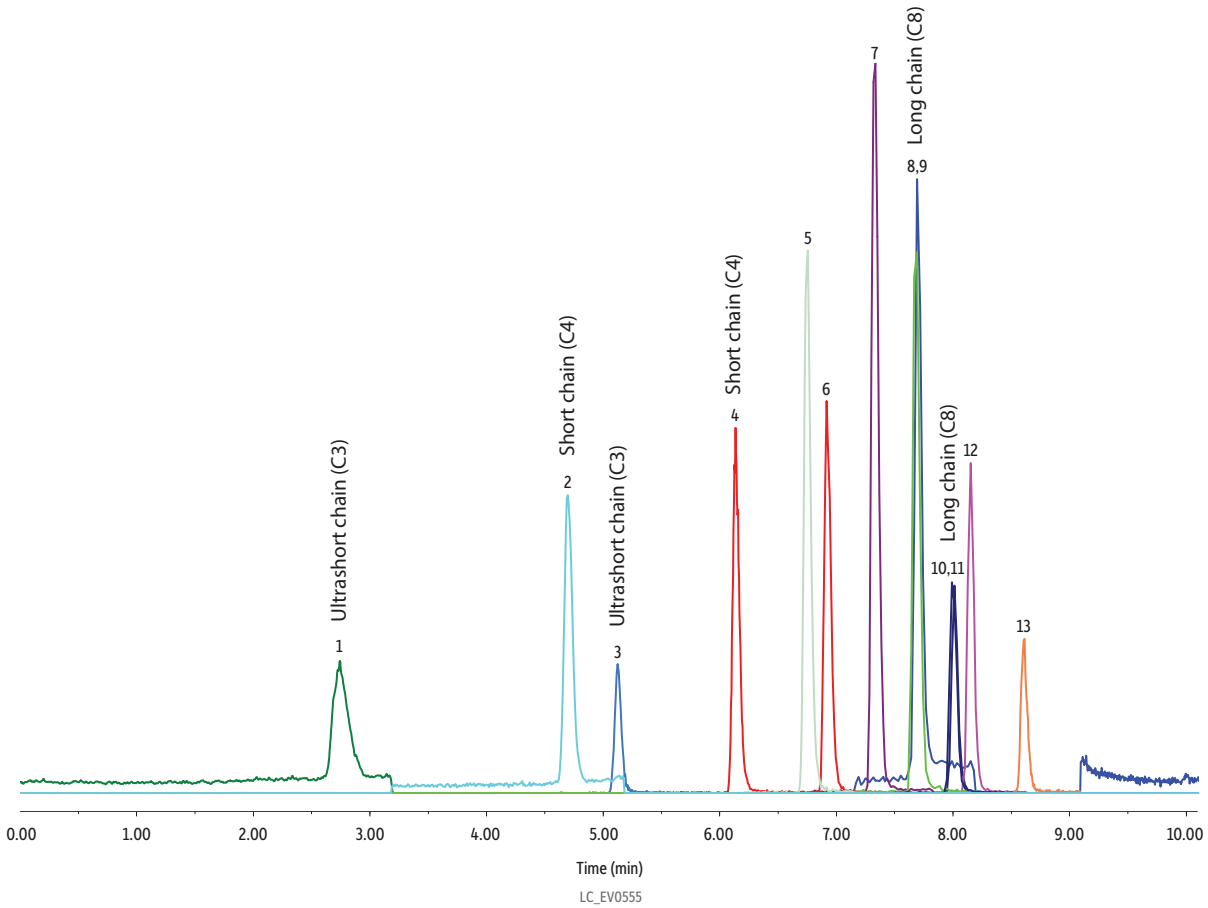
Column	Raptor C18 (cat.# 9304A52)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	2.7 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	96:4 Methanol:water
Conc.:	5-10 ng/mL
Inj. Vol.:	2 µL

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

Figure 2: The Raptor C18 stationary phase will also effectively separate short-chain PFAS, but column dimensions must be increased to ensure adequate retention.



Peaks	t_R (min)	Conc. (ng/L)	Precursor Ion	Product Ion
1. Perfluoropropanoic acid (PFPrA)	2.74	80	162.9	119.0
2. Perfluorobutanoic acid (PFBA)	4.69	80	212.8	169.0
3. Perfluoropropanesulfonic acid (PFPrS)	5.13	80	248.8	79.6
4. Perfluorobutanesulfonic acid (PFBS)	6.14	80	298.8	79.9
5. Perfluoro-*n*-[1,2-$^{13}C_2$]hexanoic acid ($^{13}C_2$-PFHxA)	6.75	50	314.9	270.0
6. Hexafluoropropylene oxide-dimer acid (HFPO-DA)	6.92	80	285.0	168.9
7. Ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA)	7.33	80	376.9	250.7
8. Perfluorooctanoic acid (PFOA)	7.70	80	413.1	368.9
9. Perfluoro-[1,2-$^{13}C_2$]octanoic acid ($^{13}C_2$-PFOA)	7.70	50	415.0	370.0
10. Perfluorooctanesulfonic acid (PFOS)	8.01	80	498.8	80.0
11. Perfluoro-[1,2,3,4-$^{13}C_4$]octanesulfonic acid ($^{13}C_4$-PFOS)	8.01	50	503.0	80.0
12. 9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate (9Cl-PF3ONS)	8.15	80	530.8	350.7
13. 11-Chloroeicosafluoro-3-oxanonane-1-sulfonate (11Cl-PF3OUdS)	8.61	80	630.7	451.0

Column
Dimensions: 100 mm x 3 mm ID
Particle Size: 2.7 µm
Guard Column: 90 Å
Temp.: 40 °C

Sample
Conc.: 80 ppt
Inj. Vol.: 10 µL

Mobile Phase
A: Water, 5 mM ammonium acetate
B: Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.25	80	20
7.00	0.25	5	95
9.00	0.25	5	95
9.01	0.25	80	20
11.0	0.25	80	20

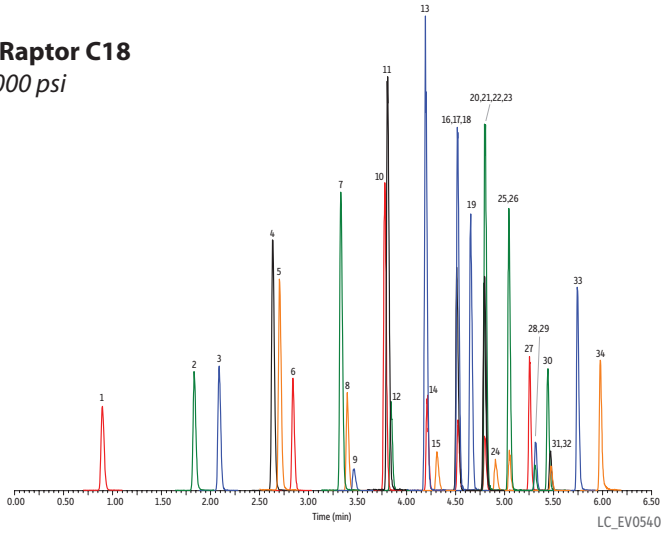
Detector MS/MS
Ion Mode: ESI-
Mode: MRM
Instrument UHPLC
Notes A PFAS delay column (cat.# 27854) was installed between the pump mixer and the injector.

In a polypropylene vial, 250 µL of reagent water (fortified at 80 ppt) was mixed with 250 µL of 40:60 reagent water:methanol and 5 µL of internal standard solution (5 ng/mL of $^{13}C_2$-PFHxA, $^{13}C_2$-PFOA, $^{13}C_4$-PFOS in methanol). The vial was capped with a polyethylene cap prior to analysis.

Figure 3: For SPP columns, similar chromatographic performance can be obtained with different particle sizes, but choosing 2.7 or 5 µm particle columns keeps back pressure within the limits of traditional HPLC systems. (All columns are 50 mm x 2.1 mm.)

1.8 µm Raptor C18

6500–8000 psi



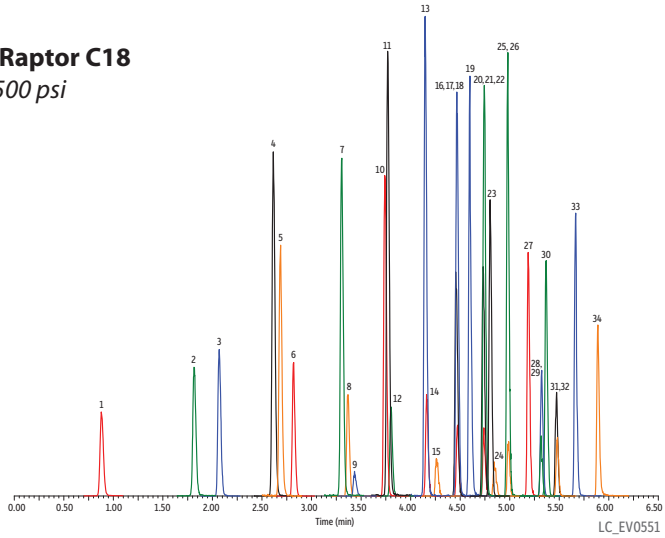
Column	Raptor C18 (cat.# 9304252)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	1.8 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	80:20 Water:methanol
Conc.:	5-250 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	5 mM Ammonium acetate in water
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	80	20
6.00	0.4	5	95
6.50	0.4	5	95
6.51	0.4	80	20
8.00	0.4	80	20

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	UHPL

2.7 µm Raptor C18

4000–5500 psi



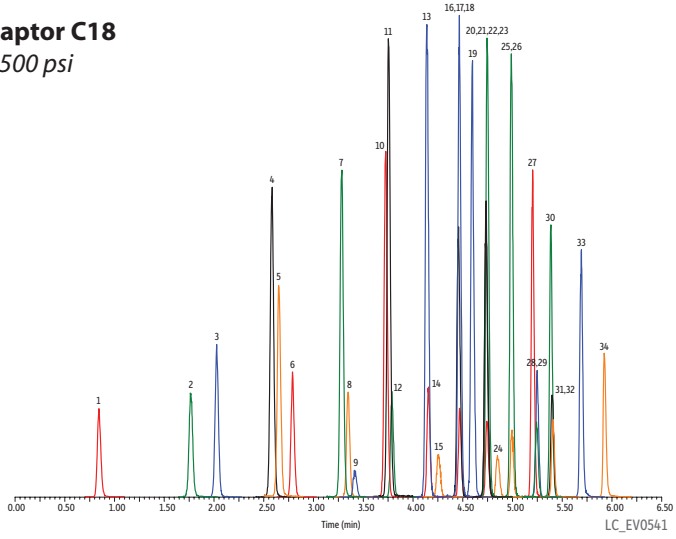
Column	Raptor C18 (cat.# 9304A52)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	2.7 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	80:20 Water:methanol
Conc.:	5-250 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	Water, 5 mM ammonium acetate
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	80	20
6.00	0.4	5	95
6.50	0.4	5	95
6.51	0.4	80	20
8.00	0.4	80	20

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	UHPLC

5 µm Raptor C18

2000–3500 psi



Column	Raptor C18 (cat.# 9304552)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	5 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	80:20 Water:methanol
Conc.:	5-250 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	5 mM Ammonium acetate in water
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	80	20
6.00	0.4	5	95
6.50	0.4	5	95
6.51	0.4	80	20
8.00	0.4	80	20

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	UHPLC

For those labs already using UHPLC instruments, the choice of particle size, especially for SPP-packed columns, makes less of a difference in efficiency and analysis speed. Figure 3 illustrates the effect of particle size using three Raptor SPP columns and a panel of PFAS on a UHPLC system. Even though the peaks are narrowest for the 1.8 µm particle column, as dictated by general chromatographic principles, the difference in observed efficiency of 5 µm and 1.8 µm columns was not significant. However, the difference in the back pressure generated while achieving those very similar results is significant, with pressures being in the range of traditional HPLC instruments for the 5 and 2.7 µm particle columns. Using a PFAS LC column packed with these particles, you can get UHPLC performance without UHPLC pressure.

Figure 3 *(continued)*

LC_EV0540

Peaks	t_R (min)	Conc. (ng/mL)	Precursor Ion	Product Ion
1. Perfluorobutanoic acid (PFBA)	0.90	5	213.07	169.07
2. Perfluoropentanoic acid (PFPeA)	1.83	5	263.10	219.11
3. Perfluorobutane sulfonic acid (PFBS)	2.09	5	299.10	79.99
4. 1H, 1H, 2H, 2H-perfluorohexane sulfonic acid (4:2 FTS)	2.63	5	327.10	307.08
5. Perfluorohexanoic acid (PFHxA)	2.70	5	313.10	269.12
6. Perfluoropentane sulfonic acid (PFPeS)	2.84	5	349.10	79.98
7. Perfluoroheptanoic acid (PFHpA)	3.33	5	363.16	319.09
8. Perfluorohexane sulfonic acid (PFHxS)	3.39	5	399.13	79.98
9. 2-Perfluorohexyl ethanoic acid (FHEA)	3.46	250	377.13	293.07
10. 1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	3.78	5	427.17	407.18
11. Perfluorooctanoic acid (PFOA)	3.81	5	413.16	369.10
12. Perfluoroheptane sulfonic acid (PFHpS)	3.84	5	449.17	79.98
13. Perfluorononanoic acid (PFNA)	4.19	5	463.16	419.19
14. Perfluorooctane sulfonic acid (PFOS)	4.21	5	499.17	79.98
15. 2-Perfluorooctyl ethanoic acid (FOEA)	4.31	250	477.17	393.15
16. 1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	4.51	5	527.17	507.16
17. Perfluorodecanoic acid (PFDA)	4.52	5	513.17	469.16
18. Perfluorononane sulfonic acid (PFNS)	4.53	5	549.17	79.98
19. N-methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	4.66	5	570.20	419.17
20. Perfluorodecane sulfonic acid (PFDS)	4.79	5	599.17	79.98
21. N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	4.79	5	584.20	419.18
22. Perfluorooctane sulfonamide (FOSA)	4.79	5	498.17	77.97
23. Perfluoroundecanoic acid (PFUnA)	4.80	5	563.23	519.24
24. 2-Perfluorodecyl ethanoic acid (FDEA)	4.91	250	577.23	493.18
25. Perfluorododecanoic acid (PFDoA)	5.04	5	613.23	569.19
26. 1H, 1H, 2H, 2H-perfluorododecane sulfonic acid (10:2 FTS)	5.05	5	627.23	607.20
27. Perfluorotridecanoic acid (PFTrDA)	5.25	5	663.23	619.21
28. N-methyl perfluorooctane sulfonamide (N-MeFOSA)	5.31	5	512.17	169.07
29. N-methyl perfluorooctane sulfonamidoethanol (N-MeFOSE)	5.31	50	616.27	59.11
30. Perfluorotetradecanoic acid (PFTeDA)	5.44	5	713.23	669.23
31. N-ethyl perfluorooctane sulfonamide (N-EtFOSA)	5.47	5	526.23	169.06
32. N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	5.47	50	630.33	59.11
33. Perfluorohexadecanoic acid (PFHxDA)	5.74	5	813.30	769.28
34. Perfluorooctadecanoic acid (PFODA)	5.98	5	913.30	869.32

LC_EV0541

Peaks	t_R (min)	Conc. (ng/mL)	Precursor Ion	Product Ion
1. Perfluorobutanoic acid (PFBA)	0.84	5	213.07	169.07
2. Perfluoropentanoic acid (PFPeA)	1.76	5	263.10	219.11
3. Perfluorobutane sulfonic acid (PFBS)	2.03	5	299.10	79.99
4. 1H, 1H, 2H, 2H-perfluorohexane sulfonic acid (4:2 FTS)	2.58	5	327.10	307.08
5. Perfluorohexanoic acid (PFHxA)	2.65	5	313.10	269.12
6. Perfluoropentane sulfonic acid (PFPeS)	2.79	5	349.10	79.98
7. Perfluoroheptanoic acid (PFHpA)	3.29	5	363.16	319.09
8. Perfluorohexane sulfonic acid (PFHxS)	3.35	5	399.13	79.98
9. 2-Perfluorohexyl ethanoic acid (FHEA)	3.41	250	377.13	293.07
10. 1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	3.73	5	427.17	407.18
11. Perfluorooctanoic acid (PFOA)	3.75	5	413.16	369.10
12. Perfluoroheptane sulfonic acid (PFHpS)	3.79	5	449.17	79.98
13. Perfluorononanoic acid (PFNA)	4.14	5	463.16	419.19
14. Perfluorooctane sulfonic acid (PFOS)	4.16	5	499.17	79.98
15. 2-Perfluorooctyl ethanoic acid (FOEA)	4.26	250	477.17	393.15
16. 1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	4.46	5	527.17	507.16
17. Perfluorodecanoic acid (PFDA)	4.47	5	513.17	469.16
18. Perfluorononane sulfonic acid (PFNS)	4.47	5	549.17	79.98
19. N-methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	4.60	5	570.20	419.17
20. Perfluorodecane sulfonic acid (PFDS)	4.74	5	599.17	79.98
21. N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	4.74	5	584.20	419.18
22. Perfluorooctane sulfonamide (FOSA)	4.74	5	498.17	77.97
23. Perfluoroundecanoic acid (PFUnA)	4.74	5	563.23	519.24
24. 2-Perfluorodecyl ethanoic acid (FDEA)	4.85	250	577.23	493.18
25. Perfluorododecanoic acid (PFDoA)	4.99	5	613.23	569.19
26. 1H, 1H, 2H, 2H-perfluorododecane sulfonic acid (10:2 FTS)	5.00	5	627.23	607.20
27. Perfluorotridecanoic acid (PFTrDA)	5.20	5	663.23	619.21
28. N-methyl perfluorooctane sulfonamide (N-MeFOSA)	5.24	5	512.17	169.07
29. N-methyl perfluorooctane sulfonamidoethanol (N-MeFOSE)	5.25	50	616.27	59.11
30. Perfluorotetradecanoic acid (PFTeDA)	5.39	5	713.23	669.23
31. N-ethyl perfluorooctane sulfonamide (N-EtFOSA)	5.41	5	526.23	169.06
32. N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	5.41	50	630.33	59.11
33. Perfluorohexadecanoic acid (PFHxDA)	5.69	5	813.30	769.28
34. Perfluorooctadecanoic acid (PFODA)	5.92	5	913.30	869.32

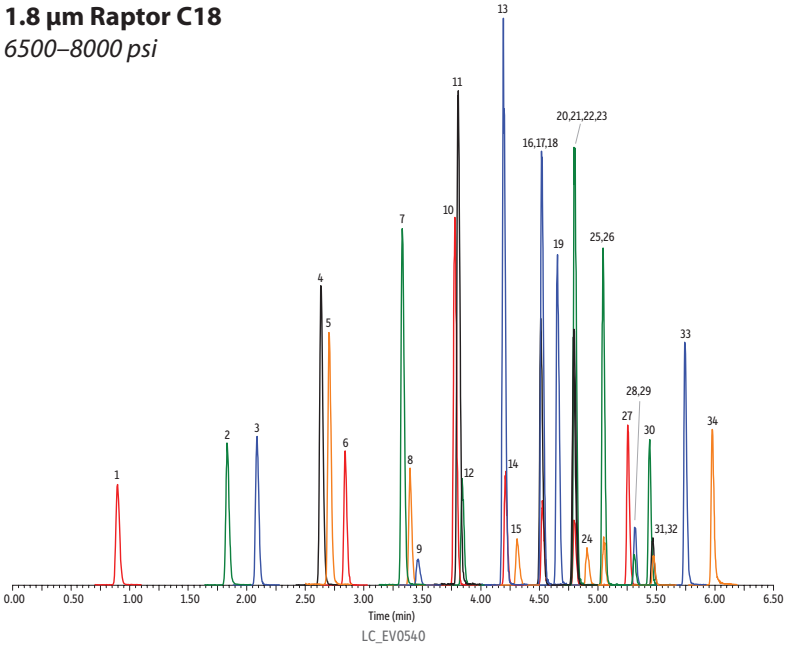
LC_EV0551

Peaks	t_R (min)	Conc. (µg/mL)	Precursor Ion	Product Ion
1. Perfluorobutanoic acid (PFBA)	0.88	5	213.1	169.1
2. Perfluoropentanoic acid (PFPeA)	1.81	5	263.1	219.1
3. Perfluorobutane sulfonic acid (PFBS)	2.07	5	299.1	80.0
4. 1H, 1H, 2H, 2H-Perfluorohexane sulfonic acid (4:2 FTS)	2.61	5	327.1	307.1
5. Perfluorohexanoic acid (PFHxA)	2.69	5	313.1	269.1
6. Perfluoropentane sulfonic acid (PFPeS)	2.82	5	349.1	80.0
7. Perfluoroheptanoic acid (PFHpA)	3.31	5	363.2	319.1
8. Perfluorohexane sulfonic acid (PFHxS)	3.37	5	399.1	80.0
9. 2-Perfluorohexyl ethanoic acid (FHEA)	3.43	250	377.1	293.1
10. 1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid (6:2 FTS)	3.74	5	427.2	407.2
11. Perfluorooctanoic acid (PFOA)	3.77	5	413.2	369.1
12. Perfluoroheptane sulfonic acid (PFHpS)	3.80	5	449.2	80.0
13. Perfluorononanoic acid (PFNA)	4.15	5	463.2	419.2
14. Perfluorooctane sulfonic acid (PFOS)	4.16	5	499.2	80.0
15. 2-Perfluorooctyl ethanoic acid (FOEA)	4.26	250	477.2	393.2
16. 1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid (8:2 FTS)	4.45	5	527.2	507.2
17. Perfluorodecanoic acid (PFDA)	4.47	5	513.2	469.2
18. Perfluorononane sulfonic acid (PFNS)	4.48	5	549.2	80.0
19. N-Methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	4.60	5	570.2	419.2
20. Perfluorodecane sulfonic acid (PFDS)	4.74	5	599.2	80.0
21. N-Ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	4.74	5	584.2	419.2
22. Perfluoroundecanoic acid (PFUnA)	4.74	5	563.2	519.2
23. Perfluorooctane sulfonamide (FOSA)	4.80	5	498.2	78.0
24. 2-Perfluorodecyl ethanoic acid (FDEA)	4.84	250	577.2	493.2
25. Perfluorododecanoic acid (PFDoA)	4.98	5	613.2	569.2
26. 1H, 1H, 2H, 2H-Perfluorododecane sulfonic acid (10:2 FTS)	4.99	5	627.2	607.2
27. Perfluorotridecanoic acid (PFTrDA)	5.19	5	663.2	619.2
28. N-Methyl perfluorooctane sulfonamide (N-MeFOSA)	5.32	5	512.2	169.1
29. N-Methyl perfluorooctane sulfonamidoethanol (N-MeFOSE)	5.32	50	616.3	59.1
30. Perfluorotetradecanoic acid (PFTeDA)	5.37	5	713.2	669.2
31. N-Ethyl perfluorooctane sulfonamide (N-EtFOSA)	5.48	5	526.2	169.1
32. N-Ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	5.48	50	630.3	59.1
33. Perfluorohexadecanoic acid (PFHxDA)	5.67	5	813.3	769.3
34. Perfluorooctadecanoic acid (PFODA)	5.89	5	913.3	869.3

When it comes to generating the most efficiency—which often translates into fast run times—while keeping instrument back pressure as low as possible, a PFAS LC column containing SPP particles is the clear winner. However, many labs that have a long history using FPP columns and may prefer to continue using them. The good news is that an FPP column can be used to successfully analyze PFAS as well. The higher surface area and carbon load in an FPP column, such as a Force C18 column, results in increased chromatographic retention compared to an SPP column (Raptor C18) of similar particle size (Figure 4).

Figure 4: If an FPP column is preferred, Force C18 columns provide effective separations for PFAS analysis. (All columns are 50 mm x 2.1 mm.)

1.8 µm Raptor C18
6500–8000 psi

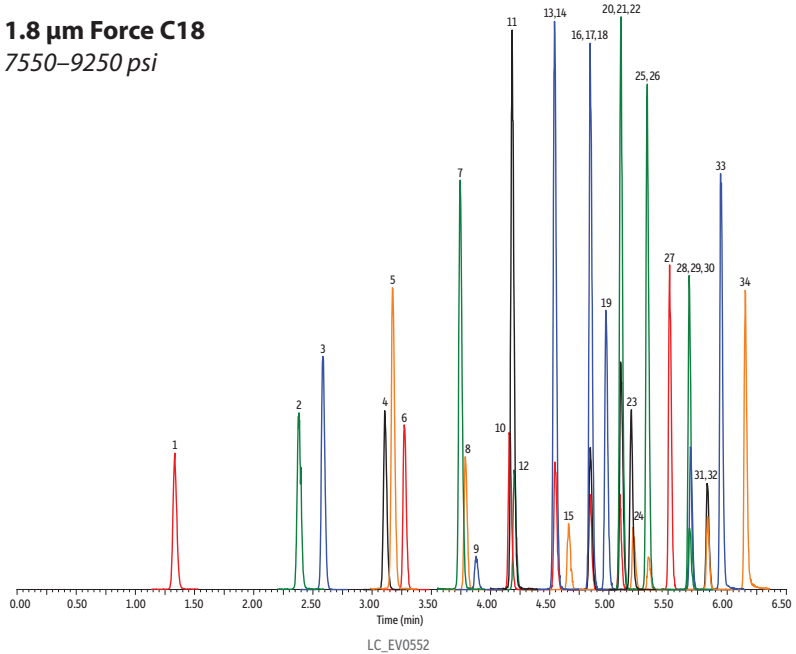


Column	Raptor C18 (cat.# 9304252)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	1.8 µm
Pore Size:	90 Å
Temp.:	40 °C
Sample	
Diluent:	80:20 Water:methanol
Conc.:	5-250 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	5 mM Ammonium acetate in water
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	80	20
6.00	0.4	5	95
6.50	0.4	5	95
6.51	0.4	80	20
8.00	0.4	80	20

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	UHPL

1.8 µm Force C18
7550–9250 psi



Column	Force C18 (cat.# 9634252)
Dimensions:	50 mm x 2.1 mm ID
Particle Size:	1.8 µm
Pore Size:	100 Å
Temp.:	40 °C
Sample	
Diluent:	80:20 Water:methanol
Conc.:	5-250 ng/mL
Inj. Vol.:	5 µL
Mobile Phase	
A:	Water, 5 mM ammonium acetate
B:	Methanol

Time (min)	Flow (mL/min)	%A	%B
0.00	0.4	80	20
6.00	0.4	5	95
6.50	0.4	5	95
6.51	0.4	80	20
8.00	0.4	80	20

Detector	MS/MS
Ion Mode:	ESI-
Mode:	MRM
Instrument	UHPLC

Conclusion

When choosing a PFAS LC column, a 2.7 µm Raptor C18 SPP column is a versatile choice that provides excellent resolution, short run times, and compatibility with both UHPLC and HPLC instruments. And for trace-level analysis, it can be paired with a PFAS delay column to eliminate instrument-related, background PFAS contaminants that can coelute with sample analytes, causing false positives or elevated responses. To find out more about this companion product and how to use it, please read EVAR3001-UNV.

Figure 4: *(continued)*

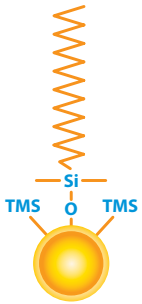
LC_EV0540

	Peaks	t_R (min)	Conc. (ng/mL)	Precursor Ion	Product Ion
1.	Perfluorobutanoic acid (PFBA)	0.90	5	213.07	169.07
2.	Perfluoropentanoic acid (PFPeA)	1.83	5	263.10	219.11
3.	Perfluorobutane sulfonic acid (PFBS)	2.09	5	299.10	79.99
4.	1H, 1H, 2H, 2H-perfluorohexane sulfonic acid (4:2 FTS)	2.63	5	327.10	307.08
5.	Perfluorohexanoic acid (PFHxA)	2.70	5	313.10	269.12
6.	Perfluoropentane sulfonic acid (PFPeS)	2.84	5	349.10	79.98
7.	Perfluoroheptanoic acid (PFHpA)	3.33	5	363.16	319.09
8.	Perfluorohexane sulfonic acid (PFHxS)	3.39	5	399.13	79.98
9.	2-Perfluorohexyl ethanoic acid (FHEA)	3.46	250	377.13	293.07
10.	1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	3.78	5	427.17	407.18
11.	Perfluorooctanoic acid (PFOA)	3.81	5	413.16	369.10
12.	Perfluoroheptane sulfonic acid (PFHpS)	3.84	5	449.17	79.98
13.	Perfluorononanoic acid (PFNA)	4.19	5	463.16	419.19
14.	Perfluorooctane sulfonic acid (PFOS)	4.21	5	499.17	79.98
15.	2-Perfluorooctyl ethanoic acid (FOEA)	4.31	250	477.17	393.15
16.	1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	4.51	5	527.17	507.16
17.	Perfluorodecanoic acid (PFDA)	4.52	5	513.17	469.16
18.	Perfluorononane sulfonic acid (PFNS)	4.53	5	549.17	79.98
19.	N-methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	4.66	5	570.20	419.17
20.	Perfluorodecane sulfonic acid (PFDS)	4.79	5	599.17	79.98
21.	N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	4.79	5	584.20	419.18
22.	Perfluorooctane sulfonamide (FOSA)	4.79	5	498.17	77.97
23.	Perfluoroundecanoic acid (PFUnA)	4.80	5	563.23	519.24
24.	2-Perfluorodecyl ethanoic acid (FDEA)	4.91	250	577.23	493.18
25.	Perfluorododecanoic acid (PFDoA)	5.04	5	613.23	569.19
26.	1H, 1H, 2H, 2H-perfluorododecane sulfonic acid (10:2 FTS)	5.05	5	627.23	607.20
27.	Perfluorotridecanoic acid (PFTrDA)	5.25	5	663.23	619.21
28.	N-methyl perfluorooctane sulfonamide (N-MeFOSA)	5.31	5	512.17	169.07
29.	N-methyl perfluorooctane sulfonamidoethanol (N-MeFOSE)	5.31	50	616.27	59.11
30.	Perfluorotetradecanoic acid (PFTeDA)	5.44	5	713.23	669.23
31.	N-ethyl perfluorooctane sulfonamide (N-EtFOSA)	5.47	5	526.23	169.06
32.	N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	5.47	50	630.33	59.11
33.	Perfluorohexadecanoic acid (PFHxDA)	5.74	5	813.30	769.28
34.	Perfluorooctadecanoic acid (PFODA)	5.98	5	913.30	869.32

LC_EV0552

	Peaks	t_R (min)	Conc. (µg/mL)	Precursor Ion	Product Ion
1.	Perfluorobutanoic acid (PFBA)	1.33	5	213.1	169.1
2.	Perfluoropentanoic acid (PFPeA)	2.38	5	263.1	219.1
3.	Perfluorobutane sulfonic acid (PFBS)	2.58	5	299.1	80.0
4.	1H, 1H, 2H, 2H-Perfluorohexane sulfonic acid (4:2 FTS)	3.11	5	327.1	307.1
5.	Perfluorohexanoic acid (PFHxA)	3.17	5	313.1	269.1
6.	Perfluoropentane sulfonic acid (PFPeS)	3.27	5	349.1	80.0
7.	Perfluoroheptanoic acid (PFHpA)	3.74	5	363.2	319.1
8.	Perfluorohexane sulfonic acid (PFHxS)	3.79	5	399.1	80.0
9.	2-Perfluorohexyl ethanoic acid (FHEA)	3.88	250	377.1	293.1
10.	1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid (6:2 FTS)	4.16	5	427.2	407.2
11.	Perfluorooctanoic acid (PFOA)	4.18	5	413.2	369.1
12.	Perfluoroheptane sulfonic acid (PFHpS)	4.20	5	449.2	80.0
13.	Perfluorononanoic acid (PFNA)	4.54	5	463.2	419.2
14.	Perfluorooctane sulfonic acid (PFOS)	4.54	5	499.2	80.0
15.	2-Perfluorooctyl ethanoic acid (FOEA)	4.66	250	477.2	393.2
16.	1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid (8:2 FTS)	4.84	5	527.2	507.2
17.	Perfluorodecanoic acid (PFDA)	4.84	5	513.2	469.2
18.	Perfluorononane sulfonic acid (PFNS)	4.84	5	549.2	80.0
19.	N-Methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	4.97	5	570.2	419.2
20.	Perfluorodecane sulfonic acid (PFDS)	5.09	5	599.2	80.0
21.	N-Ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	5.10	5	584.2	419.2
22.	Perfluoroundecanoic acid (PFUnA)	5.10	5	563.2	519.2
23.	Perfluorooctane sulfonamide (FOSA)	5.19	5	498.2	78.0
24.	2-Perfluorodecyl ethanoic acid (FDEA)	5.20	250	577.2	493.2
25.	Perfluorododecanoic acid (PFDoA)	5.32	5	613.2	569.2
26.	1H, 1H, 2H, 2H-Perfluorododecane sulfonic acid (10:2 FTS)	5.33	5	627.2	607.2
27.	Perfluorotridecanoic acid (PFTrDA)	5.51	5	663.2	619.2
28.	N-Methyl perfluorooctane sulfonamide (N-MeFOSA)	5.68	5	512.2	169.1
29.	N-Methyl perfluorooctane sulfonamidoethanol (N-MeFOSE)	5.68	50	616.3	59.1
30.	Perfluorotetradecanoic acid (PFTeDA)	5.68	5	713.2	669.2
31.	N-Ethyl perfluorooctane sulfonamide (N-EtFOSA)	5.83	5	526.2	169.1
32.	N-Ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	5.83	50	630.3	59.1
33.	Perfluorohexadecanoic acid (PFHxDA)	5.94	5	813.3	769.3
34.	Perfluorooctadecanoic acid (PFODA)	6.15	5	913.3	869.3

Column Characteristics:



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.

Raptor C18 LC Columns (USP L1)

Chromatographic Properties

When you need a general-purpose LC column, don't just grab any C18. Choose the speed, efficiency, and long-lasting ruggedness of the Raptor C18. This traditional end-capped C18 offers the highest hydrophobic retention of any Raptor phase, and it is compatible with a wide range of mobile phases from moderately acidic to neutral (pH 2–8). Whether for food safety or environmental or bioanalytical analyses, this phase offers consistently excellent data quality in less time across myriad reversed-phase applications, matrices, and compound classes. To lower costs and improve profitability, you need columns to last longer, data to be reproducible, and existing HPLC and UHPLC instrumentation to run faster. Get there with the only general-purpose C18 that gives you *Selectivity Accelerated*.

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

Column Characteristics:

Particle: 5 µm, spherical, fully porous
pH Range: 2.5 to 8
Maximum Temperature: 80 °C
Maximum Pressure: 1,034 bar/15,000 psi

PFAS Delay Column

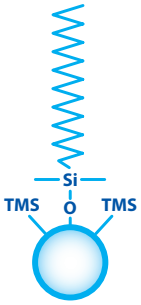
Chromatographic Properties

Per-and polyfluorinated alkyl substances (PFAS) are a group of widely used industrial compounds that resist degradation and have become ubiquitous in the environment and in human samples from around the world. Because of their inertness, PFAS are used in tubing and other liquid-contacting parts of an HPLC system where they can leach into the mobile phase and interfere with sample analysis. This contamination is particularly problematic when analyzing at trace levels, such as at the ppt health advisory levels for drinking water. With many labs analyzing at single-digit ppt levels and striving for sub-ppt level detection, PFAS contamination from HPLC components can prevent accurate identification and quantitation of PFAS in samples. To eliminate this issue, Restek's new PFAS delay column traps and "delays" system-related PFAS, preventing them from interfering with sample analysis. This delay column is a universal solution that can be used with any type of HPLC or UHPLC system up to 15,000 psi (1034 bar) and with any analytical column (fully porous or superficially porous).

Length	2.1 mm ID cat.#
5 µm Columns	
50 mm	27854

Column Characteristics:

Stationary Phase Category: C18, octadecylsilane (L1)
Ligand Type: End-capped C18
Particle: 1.8 µm, 3 µm, or 5 µm fully porous silica
Pore Size: 100 Å
Carbon Load: 20%
End-Cap: yes
Surface Area: 300 m^2/g
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 (3 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.

Force C18 LC Columns (USP L1)

Chromatographic Properties

The general-purpose Restek C18 is a conventional monomeric octadecylsilane column suitable for analyses of a wide range of compounds from acidic through slightly basic.

Length	2.1 mm cat.#	3.0 mm cat.#	4.6 mm cat.#
1.8 µm Columns			
30 mm	9634232		
50 mm	9634252	963425E	
100 mm	9634212	963421E	
3 µm Columns			
30 mm	9634332		
50 mm	9634352	963435E	
100 mm	9634312	963431E	9634315
150 mm	9634362	963436E	9634365
5 µm Columns			
50 mm	9634552	963455E	
100 mm	9634512	963451E	9634515
150 mm	9634562	963456E	9634565
250 mm			9634575

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