Faster Semivolatiles Analysis with a Scaled-Down Method and GC Accelerator Kit

Analysis times for semivolatile compounds can limit sample throughput and decrease overall lab productivity. You can significantly speed up methods on your existing GC-MS by using a properly scaled-down column and appropriately adjusted instrument conditions. The challenge with this approach is that the new conditions can result in oven ramp rates that exceed the performance of standard GC ovens, especially 120 V ovens. However, by using a GC Accelerator oven insert kit, Agilent 6890 and 7890 GCs can meet aggressive scaled-down oven programs, producing the same chromatographic separations in much less time.

In this technical article, we will walk through an example of scaling down EPA Method 8270 and using a GC Accelerator kit to reduce cycle time. Significantly faster semivolatiles analysis times were achieved, providing an opportunity for labs to increase sample throughput or process more rush samples.

Scaling Down Your Semivolatiles Column

To achieve the same chromatographic results in less time, the first step is to take the traditional column for semivolatiles analysis, a 30 m long, 0.25 mm ID, 0.25 µm df arylene-type column (e.g., an Rxi-5Sil MS column) and scale it down to a more efficient format that retains the same number of theoretical plates as the original column. A 20 m long, 0.15 mm ID, 0.15 µm df Rxi-5Sil MS column (cat.# 43816) fits these requirements. The proportionally narrower ID and thinner film will improve efficiency (i.e., give narrower peaks) and provide the same selectivity by keeping the phase ratio (β) constant. Higher efficiency results in more theoretical plates per meter of column, so by shortening the column to 20 m, a very similar total number of plates is achieved. As summarized in Table I, these changes result in the same degree of separation that is obtained on the traditional column format.

Table I: Properly scaled-down columns provide the same separation in less time.

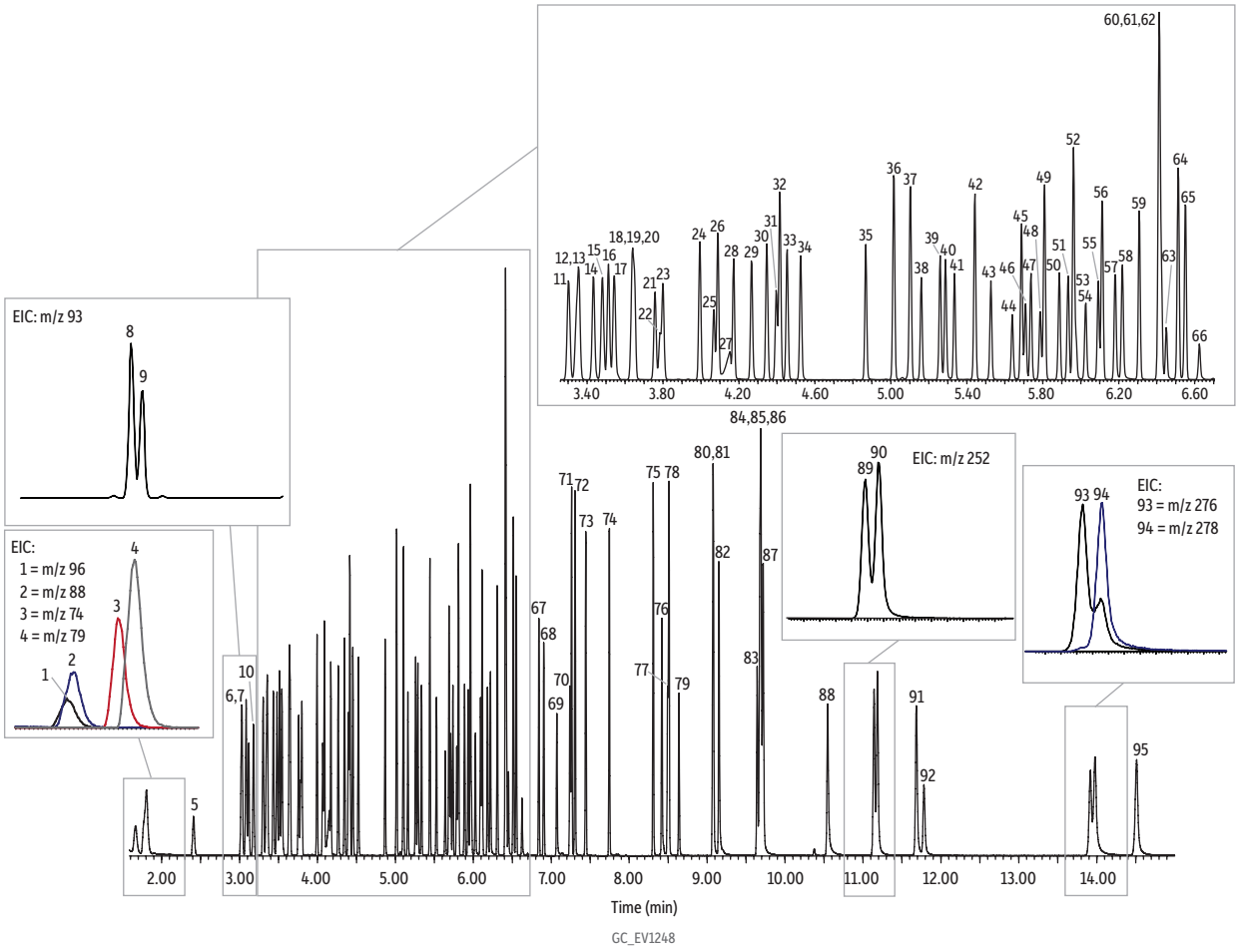
	Column Formats			
	Traditional		**Scaled-down**	**Effect**
Part Number	13623		43816	
ID (mm)	0.25	>	0.15	Narrower ID creates greater efficiency
Film Thickness, df (µm)	0.25	>	0.15	Thinner film creates greater efficiency
Relative efficiency (plates/m) compared to traditional format	100%	<	141%	The scaled-down column is more efficient and will produce narrower peaks
Phase Ratio (β)	250	=	250	Equivalent β will maintain the same selectivity between columns
Length (m)	30	>	20	Shortening the scaled-down column will create a similar *total number of plates*
Relative Total Plates compared to traditional format	**100%**	**≈**	**94%**	**Very similar total number of plates means the same degree of separation in less time**

Scaling Down Method Conditions with the *EZ*GC Method Translator

A scaled-down column requires a scaled-down method to ensure that compound elution temperatures will be the same so that equivalent separations will be achieved in a faster analysis time. Correctly translating the scaled-down column flow rates and oven temperature ramp rates can be a challenge, but this task is made simple by using Restek's *EZ*GC method translator. This free, online tool calculates properly translated method conditions based on your original column and method in seconds. Just input your current column dimensions, flow parameters, and oven program, then define the new column format you'd like to use, and the software will do the rest.

To set up a comparison of traditional vs. scaled-down, faster semivolatiles analysis, Figure 1 shows a chromatogram generated using EPA 8270D method conditions, split injection, and the traditional column format. In this case, the analysis time has already been shortened by a few minutes from the typical splitless injection approach by the successful adoption of a split injection.

Figure 1: Split analysis of semivolatiles on a traditional 30 m, 0.25 mm ID, 0.25 µm df Rxi-5Sil MS column



Column	Rxi-5Sil MS, 30 m, 0.25 mm ID, 0.25 µm (cat.# 13623)
Sample	8270 MegaMix (cat.# 31850) 8270 Benzidines mix (cat.# 31852) Benzoic acid (cat.# 31879) 1,4-Dioxane (cat.# 31853) Revised B/N surrogate mix (cat.# 31888) Acid surrogate mix (4/89 SOW) (cat.# 31063) Revised SV internal standard mix (cat.# 31886)
Diluent:	Methylene chloride
Conc.:	40 µg/mL (IS/SS 20 µg/mL)
Injection	
Inj. Vol.:	1 µL split (split ratio 10:1)
Liner:	Premium 4 mm Precision liner w/wool (cat.# 23305.5)
Inj. Temp.:	270 °C
Split Vent Flow Rate:	12 mL/min
Oven	
Oven Temp.:	70 °C (hold 1 min) to 285 °C at 28 °C/min to 305 °C at 3 °C/min to 320 °C at 30 °C/min (hold 1 min)

Carrier Gas	He, constant flow
Flow Rate:	1.2 mL/min
Detector	MS
Mode:	Scan
Transfer Line Temp.:	280 °C
Analyzer Type:	Quadrupole
Source Temp.:	270 °C
Quad Temp.:	150 °C
Electron Energy:	70 eV
Solvent Delay Time:	1.3 min
Tune Type:	DFTPP
Ionization Mode:	EI
Scan Range:	35-550 amu
Scan Rate:	5.36 scans/sec
Instrument	Agilent 7890A GC & 5975C MSD

Figure 1 (cont.)

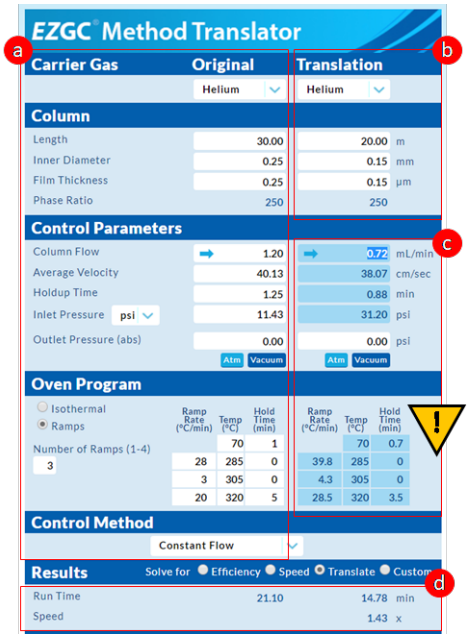
Peaks

1. 1,4-Dioxane-d8 (IS)
2. 1,4-Dioxane
3. N-Nitrosodimethylamine
4. Pyridine
5. 2-Fluorophenol (SS)
6. Phenol-d6 (SS)
7. Phenol
8. Aniline
9. Bis(2-chloroethyl)ether
10. 2-Chlorophenol
11. 1,3-Dichlorobenzene
12. 1,4-Dichlorobenzene-D4 (IS)
13. 1,4-Dichlorobenzene
14. Benzyl alcohol
15. 1,2-Dichlorobenzene
16. 2-Methylphenol
17. Bis(2-chloroisopropyl)ether
18. 4-Methylphenol
19. 3-Methylphenol
20. N-Nitroso-di-*n*-propylamine
21. Hexachloroethane
22. Nitrobenzene-D5 (SS)
23. Nitrobenzene
24. Isophorone
25. 2-Nitrophenol
26. 2,4-Dimethylphenol
27. Benzoic acid
28. Bis(2-chloroethoxy)methane
29. 2,4-Dichlorophenol
30. 1,2,4-Trichlorobenzene
31. Naphthalene-D8 (IS)
32. Naphthalene
33. 4-Chloroaniline
34. Hexachlorobutadiene
35. 4-Chloro-3-methylphenol
36. 2-Methylnaphthalene
37. 1-Methylnaphthalene
38. Hexachlorocyclopentadiene
39. 2,4,6-Trichlorophenol
40. 2,4,5-Trichlorophenol
41. 2-Fluorobiphenyl (SS)
42. 2-Chloronaphthalene
43. 2-Nitroaniline
44. 1,4-Dinitrobenzene
45. Dimethyl phthalate
46. 1,3-Dinitrobenzene
47. 2,6-Dinitrotoluene
48. 1,2-Dinitrobenzene
49. Acenaphthylene
50. 3-Nitroaniline
51. Acenaphthene-d10 (IS)
52. Acenaphthene
53. 2,4-Dinitrophenol
54. 4-Nitrophenol
55. 2,4-Dinitrotoluene
56. Dibenzofuran
57. 2,3,5,6-Tetrachlorophenol
58. 2,3,4,6-Tetrachlorophenol
59. Diethyl phthalate
60. 4-Chlorophenyl phenyl ether
61. Fluorene
62. 4-Nitroaniline
63. 4,6-Dinitro-2-methylphenol
64. N-nitrosodiphenylamine
65. 1,2-Diphenylhydrazine
66. 2,4,6-Tribromophenol (SS)
67. 4-Bromophenyl phenyl ether
68. Hexachlorobenzene
69. Pentachlorophenol
70. Phenanthrene-D10 (IS)
71. Phenanthrene
72. Anthracene
73. Carbazole
74. di-*n*-Butyl phthalate
75. Fluoranthene
76. Benzidine
77. Pyrene-D10 (SS)
78. Pyrene
79. *p*-Terphenyl-d14 (SS)
80. 3,3'-Dimethylbenzidine
81. Butyl benzyl phthalate
82. Bis(2-ethylhexyl)adipate
83. 3,3'-Dichlorobenzidine
84. Benz[a]anthracene
85. Chrysene-D12 (IS)
86. Bis(2-ethylhexyl)phthalate
87. Chrysene
88. Di-*n*-octyl phthalate
89. Benzo[b]fluoranthene
90. Benzo[k]fluoranthene
91. Benzo[a]pyrene
92. Perylene-D12 (IS)
93. Indeno[1,2,3-cd]pyrene
94. Dibenz[a,h]anthracene
95. Benzo[ghi]perylene

Figure 2 shows how the split injection semivolatiles analysis illustrated in Figure 1 can be easily translated to the scaled-down column format using the *EZ*GC method translator. Split injection is particularly important with the scaled-down analysis to avoid overloading the column and to transfer a sample band narrow enough to be compatible with the very narrow peaks that the more efficient, scaled-down column produces. Because the narrower peaks are also taller, there is the additional benefit of enough sensitivity to still meet the low detection limits commonly required for semivolatiles analysis. In the scaled-down example shown later in this article, the split ratio was successfully increased from 10:1 to 20:1.

Note that in the examples presented here, the final oven ramp rates and final hold times may differ from the method translator output in Figure 2. The final oven ramp rate shown in the original method of the *EZ*GC method translator example was lowered to 20 °C/min (compared to 30 °C/min Figure 1) in order to represent a rate that is attainable by analysts using Agilent 6890 and 7890 120 V GC ovens. Because the last compound elutes before the final oven ramp, these differences do not affect the chromatographic comparison. Final hold times also do not affect the chromatographic separations and are generally defined in analytical methods.

Figure 2: Use the *EZ*GC method translator to move from a traditional column format to a scaled-down column for faster semivolatiles analysis: (a) Fields to input original method conditions; (b) field to input new column dimensions; (c) calculated scaled method conditions, with ramp rates that pose a problem for certain GCs but that can be resolved with the GC Accelerator kit; (d) calculated analysis time changes.



With the scaled-down column and translated conditions defined, you are nearly ready to try the new method in the lab, but, first, you need to review the oven ramp rates and ensure your GC oven can meet them. In this example, the scaled-down oven program has aggressive ramp rates that some GC ovens can't consistently achieve. As shown in Table II, 120 V ovens would not be able to meet the new scaled-down oven program reliably, which would result in inconsistent retention times for compounds eluting during that ramp. Also, from the table, it is clear that this problem is easily resolved by the use of the GC Accelerator kit.

The GC Accelerator kit was specifically designed for Agilent 6890 and 7890 GCs equipped with mass selective detectors (MSD). As shown in Figure 3, the inserts install without interfering with a column in the front inlet position or with the connection to the MSD transfer line. Once in place, the oven inserts occupy oven volume, which reduces the volume of air that the oven needs to heat and cool. This, in turn, permits faster oven ramp rates and quicker oven cooldown times.

Figure 4 compares split analyses with the traditional column format (bottom) and the scaled-down column using the translated method conditions and a GC Accelerator kit (top). The chromatograms are mirrored and scaled such that the starting and ending oven temperatures are the same for both chromatograms, which allows for a direct comparison of the separations. The separation profile is practically identical, even with difficult-to-resolve critical pairs like benzo[b]fluoranthene and benzo[k]fluoranthene maintaining acceptable resolution. The last eluting compound elutes over four minutes faster with the scaled-down column and method, and the total analysis time dropped by over six minutes. The speed increase shown in the faster semivolatiles analysis would be greater still when compared to a traditional splitless injection.

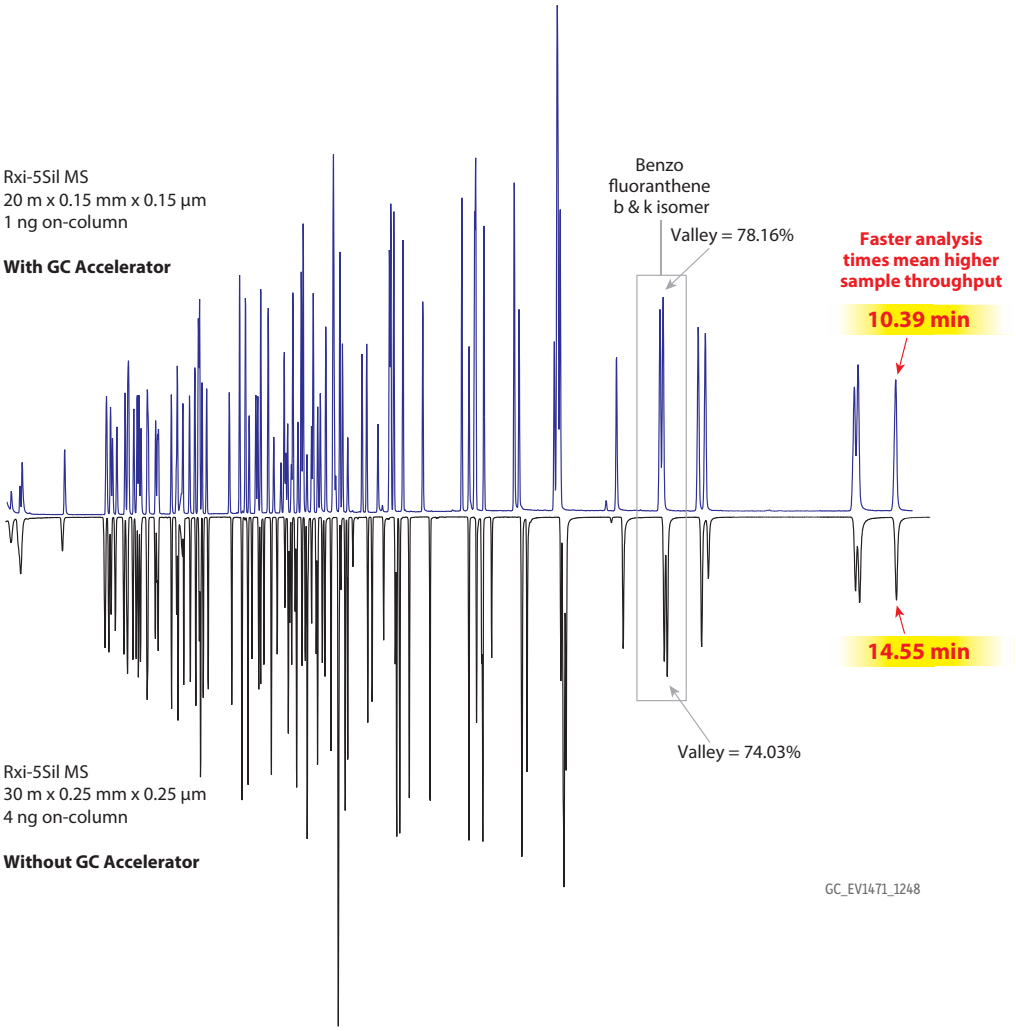
Table II: Maximum oven ramp rates for Agilent 6890 and 7890 GC ovens with and without the GC Accelerator kit.

Temperature Range (°C)	120 V Oven Ramp Rate (°C/min)		>200 V Oven Ramp Rate (°C/min)	
	Without GC Accelerator Kit	With GC Accelerator Kit	Without GC Accelerator Kit	With GC Accelerator Kit
50–70	75	**120**	120	**120**
70–115	45	**95**	95	**120**
115–175	40	**65**	65	**110**
175–300	30	**40**	45	**70**
300–350*	20	**30**	35	**60**

* Agilent ovens are programmable to 450 °C, but this product was only tested to a maximum operating temperature of 350 °C. Prior to analysis, confirm the analytical column can withstand the temperatures and ramp rates you plan to use.

Figure 3: Restek GC Accelerator Oven Insert Kit.

Figure 4: Faster semivolatiles analysis can be obtained using a scaled-down column, properly adjusted conditions, and a GC Accelerator kit. (For reference, the instrument conditions for the top chromatogram are show below this figure, and the conditions for the bottom chromatogram are shown in Figure 1.)



Peaks

1. 1,4-Dioxane-d8 (IS)
2. 1,4-Dioxane
3. N-Nitrosodimethylamine
4. Pyridine
5. 2-Fluorophenol (SS)
6. Phenol-d6 (SS)
7. Phenol
8. Aniline
9. Bis(2-chloroethyl)ether
10. 2-Chlorophenol
11. 1,3-Dichlorobenzene
12. 1,4-Dichlorobenzene-D4 (IS)
13. 1,4-Dichlorobenzene
14. Benzyl alcohol
15. 1,2-Dichlorobenzene
16. 2-Methylphenol
17. Bis(2-chloroisopropyl)ether
18. 4-Methylphenol
19. 3-Methylphenol
20. N-Nitroso-di-*n*-propylamine
21. Hexachloroethane
22. Nitrobenzene-D5 (SS)
23. Nitrobenzene
24. Isophorone
25. 2-Nitrophenol
26. 2,4-Dimethylphenol
27. Benzoic acid
28. Bis(2-chloroethoxy)methane
29. 2,4-Dichlorophenol
30. 1,2,4-Trichlorobenzene
31. Naphthalene-D8 (IS)
32. Naphthalene
33. 4-Chloroaniline
34. Hexachlorobutadiene
35. 4-Chloro-3-methylphenol
36. 2-Methylnaphthalene
37. 1-Methylnaphthalene
38. Hexachlorocyclopentadiene
39. 2,4,6-Trichlorophenol
40. 2,4,5-Trichlorophenol
41. 2-Fluorobiphenyl (SS)
42. 2-Chloronaphthalene
43. 2-Nitroaniline
44. 1,4-Dinitrobenzene
45. Dimethyl phthalate
46. 1,3-Dinitrobenzene
47. 2,6-Dinitrotoluene
48. 1,2-Dinitrobenzene
49. Acenaphthylene
50. 3-Nitroaniline
51. Acenaphthene-d10 (IS)
52. Acenaphthene
53. 2,4-Dinitrophenol
54. 4-Nitrophenol
55. 2,4-Dinitrotoluene
56. Dibenzofuran
57. 2,3,5,6-Tetrachlorophenol
58. 2,3,4,6-Tetrachlorophenol
59. Diethyl phthalate
60. 4-Chlorophenyl phenyl ether
61. Fluorene
62. 4-Nitroaniline
63. 4,6-Dinitro-2-methylphenol
64. N-nitrosodiphenylamine
65. 1,2-Diphenylhydrazine
66. 2,4,6-Tribromophenol (SS)
67. 4-Bromophenyl phenyl ether
68. Hexachlorobenzene
69. Pentachlorophenol
70. Phenanthrene-D10 (IS)
71. Phenanthrene
72. Anthracene
73. Carbazole
74. di-*n*-Butyl phthalate
75. Fluoranthene
76. Benzidine
77. Pyrene-D10 (SS)
78. Pyrene
79. *p*-Terphenyl-d14 (SS)
80. 3,3'-Dimethylbenzidine
81. Butyl benzyl phthalate
82. Bis(2-ethylhexyl)adipate
83. 3,3'-Dichlorobenzidine
84. Benz[a]anthracene
85. Chrysene-D12 (IS)
86. Bis(2-ethylhexyl)phthalate
87. Chrysene
88. Di-*n*-octyl phthalate
89. Benzo[b]fluoranthene
90. Benzo[k]fluoranthene
91. Benzo[a]pyrene
92. Perylene-D12 (IS)
93. Indeno[1,2,3-cd]pyrene
94. Dibenz[a,h]anthracene
95. Benzo[ghi]perylene

Column	Rxi-5Sil MS, 20 m, 0.15 mm ID, 0.15 µm (cat.# 43816)
Sample	8270 MegaMix (cat.# 31850) 8270 Benzidines mix (cat.# 31852) Benzoic acid (cat.# 31879) 1,4-Dioxane (cat.# 31853) Revised B/N surrogate mix (cat.# 31888) Acid surrogate mix (4/89 SOW) (cat.# 31063) Revised SV internal standard mix (cat.# 31886)
Diluent:	Methylene chloride
Conc.:	20 µg/mL (IS/SS 20 µg/mL)
Injection	
Inj. Vol.:	1 µL split (split ratio 20:1)
Liner:	Topaz 4 mm single taper w/wool (cat.# 23303)
Inj. Temp.:	275 °C
Split Vent Flow Rate:	12 mL/min
Oven	
Oven Temp.:	70 °C (hold 0.7 min) to 285 °C at 39.8 °C/min to 305 °C at 4.3 °C/min to 320 °C at 28.5 °C/min (hold 0.7 min)

Carrier Gas	He, constant flow
Flow Rate:	0.72 mL/min
Detector	MS
Mode:	Scan
Transfer Line Temp.:	280 °C
Analyzer Type:	Quadrupole
Source Temp.:	330 °C
Quad Temp.:	180 °C
Electron Energy:	70 eV
Solvent Delay Time:	1.3 min
Tune Type:	DFTPP
Ionization Mode:	EI
Scan Range:	39-550 amu
Scan Rate:	9.8 scans/sec
Instrument	Agilent 7890B GC & 5977A MSD

Scaled-Down Method: Optimization of Fast Semivolatiles Analysis

The directly translated scaled-down method required small adjustments to optimize results, particularly for early eluting compounds. Note that no changes to the oven ramp rates or the flow were necessary; the values calculated by the method translator were valid. As shown in Figure 5, even though the higher split ratio of 20:1 resulted in a very narrow sample band being transferred onto the column, resolution of the early eluting compounds was not ideal. However, by simply decreasing the initial oven temperature from 70 °C to 60 °C, additional column focusing was achieved and results were improved. Figure 5 shows how 1,4-dioxane is better resolved from the solvent peak and the separation of aniline and bis(2-chloroethyl)ether is also improved by dropping the initial oven temperature just 10 °C.

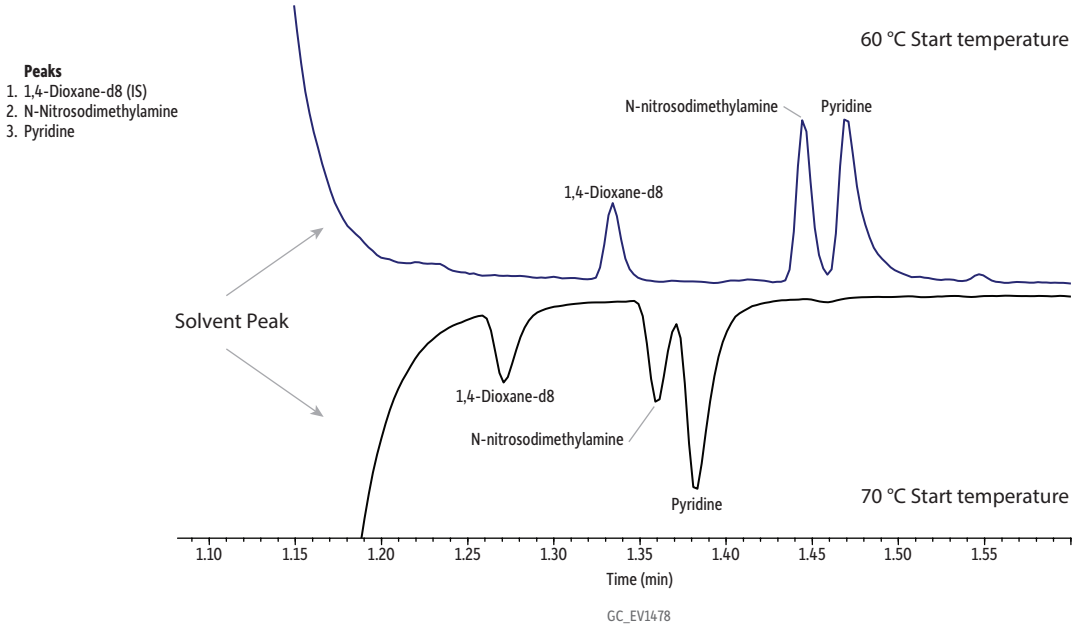
In addition to lowering the initial oven temperature, the final oven temperature was raised from the customary 320 °C to 330 °C to more effectively remove high molecular weight contamination. The time saved in the scaled-down method provided the extra time needed to reach and then cool down from the higher final oven temperature. Table III summarizes the changes made to optimize the directly translated method and Figure 6 shows the final conditions recommended for fast semivolatiles analysis using a scaled-down column, translated method, and the GC Accelerator kit.

Table III: Summary of changes to optimize the scaled-down method.

GC Method Parameters		Traditional Split Method Conditions	Direct Method Translation from *EZ*GC Method Translator	Final Method with Refined Initial and End Temperatures	Differences Between Direct Translation & Final Method
Column Flow (mL/min)		1.2	0.7	0.7	
Oven Program	Initial (hold)	70 °C (hold 1 min)	70 °C (hold 0.7 min)	**60 °C** (hold 0.7 min)	Lowering initial oven temp increased resolution of early-eluting compounds
	Ramp 1	to 285 °C @ 28 °C/min	to 285 °C @ 39.8 °C/min	to 285 °C @ 39.8 °C/min	
	Ramp 2	to 305 °C @ 3 °C/min	to 305 °C @ 4.3 °C/min	to 305 °C @ 4.3 °C/min	
	Ramp 3 (hold)	to 320 °C @ 20 °C/min	to 320 °C @ 28.5 °C/min	to **330 °C** @ 28.5 °C/min	Raising the final oven temperature facilitates more thorough removal of high molecular weight contamination

Figure 5: Lowering the translated initial oven temperature from 70 °C to 60 °C improved resolution of early eluting compounds. (For reference, the instrument conditions for the 60 °C start are shown in Figure 6 and for the 70 °C start, in the top chromatogram in Figure 4.)

Solvent Peak and 1,4-Dioxane



Aniline and Bis(2-Chloroethyl) Ether

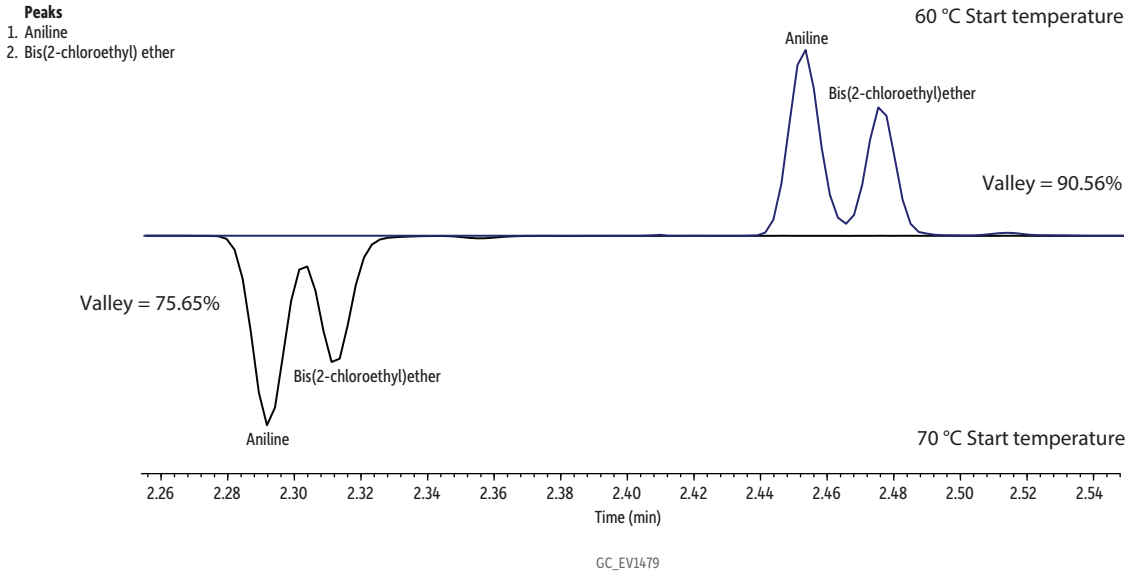
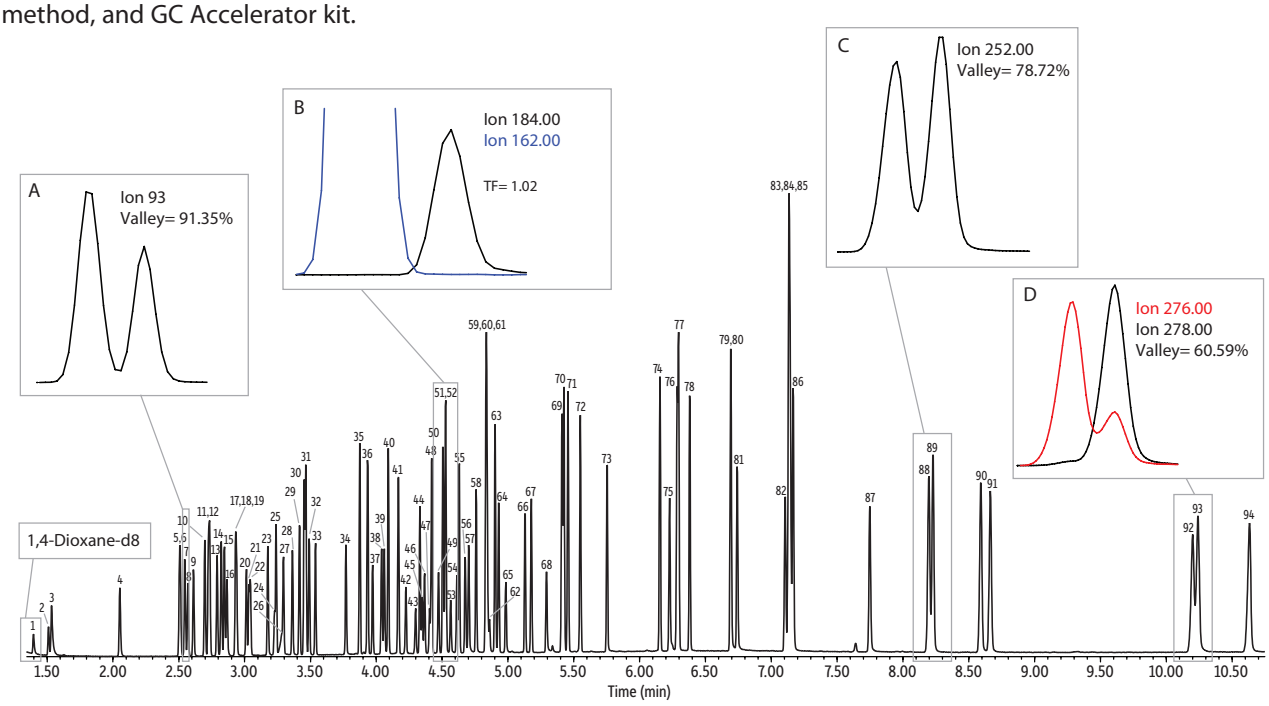


Figure 6: Final optimized method for fast semivolatiles analysis using a scaled-down column format, translated method, and GC Accelerator kit.



GC_EV1476

Peaks	tR (min)	Peaks	tR (min)	Peaks	tR (min)
1. 1,4-Dioxane-d8 (IS)	1.40	33. Hexachlorobutadiene	3.54	65. 2,4,6-Tribromophenol (SS)	4.98
2. N-Nitrosodimethylamine	1.51	34. 4-Chloro-3-methylphenol	3.77	66. 4-Bromophenyl phenyl ether	5.13
3. Pyridine	1.53	35. 2-Methylnaphthalene	3.87	67. Hexachlorobenzene	5.18
4. 2-Fluorophenol (SS)	2.05	36. 1-Methylnaphthalene	3.93	68. Pentachlorophenol	5.29
5. Phenol-d6 (SS)	2.51	37. Hexachlorocyclopentadiene	3.97	69. Phenanthrene-d10 (IS)	5.41
6. Phenol	2.51	38. 2,4,6-Trichlorophenol	4.04	70. Phenanthrene	5.43
7. Aniline	2.55	39. 2,4,5-Trichlorophenol	4.06	71. Anthracene	5.46
8. Bis(2-chloroethyl) ether	2.57	40. 2-Fluorobiphenyl (SS)	4.09	72. Carbazole	5.55
9. 2-Chlorophenol	2.61	41. 2-Chloronaphthalene	4.17	73. di-*n*-Butyl phthalate	5.75
10. 1,3-Dichlorobenzene	2.70	42. 2-Nitroaniline	4.23	74. Fluoranthene	6.15
11. 1,4-Dichlorobenzene-d4 (IS)	2.73	43. 1,4-Dinitrobenzene	4.30	75. Benzidine	6.23
12. 1,4-Dichlorobenzene	2.74	44. Dimethyl phthalate	4.33	76. Pyrene-d10 (SS)	6.28
13. Benzyl alcohol	2.79	45. 1,3-Dinitrobenzene	4.35	77. Pyrene	6.30
14. 1,2-Dichlorobenzene	2.82	46. 2,6-Dinitrotoluene	4.37	78. *p*-Terphenyl-d14 (SS)	6.38
15. 2-Methylphenol	2.85	47. 1,2-Dinitrobenzene	4.41	79. 3,3'-Dimethylbenzidine	6.69
16. Bis(2-chloroisopropyl)ether	2.87	48. Acenaphthylene	4.42	80. Butyl benzyl phthalate	6.69
17. 4-Methylphenol	2.93	49. 3-Nitroaniline	4.47	81. Bis(2-ethylhexyl) adipate	6.74
18. 3-Methylphenol	2.93	50. Acenaphthene-d10 (SS)	4.51	82. 3,3'-Dichlorobenzidine	7.11
19. N-Nitrosodi-N-propylamine	2.94	51. Acenaphthene	4.53	83. Bis(2-ethylhexyl) phthalate	7.13
20. Hexachloroethane	3.01	52. 2,4-Dinitrophenol	4.53	84. Chrysene-d12 (IS)	7.14
21. Nitrobenzene-d5 (SS)	3.03	53. 4-Nitrophenol	4.56	85. Benz[a]anthracene	7.14
22. Nitrobenzene	3.04	54. 2,4-Dinitrotoluene	4.61	86. Chrysene	7.17
23. Isophorone	3.18	55. Dibenzofuran	4.63	87. Di-*n*-octyl phthalate	7.75
24. 2-Nitrophenol	3.23	56. 2,3,5,6-Tetrachlorophenol	4.68	88. Benzo[b]fluoranthene	8.20
25. 2,4-Dimethylphenol	3.24	57. 2,3,4,6-Tetrachlorophenol	4.70	89. Benzo[k]fluoranthene	8.23
26. Benzoic acid	3.28	58. Diethyl phthalate	4.76	90. Benzo[a]pyrene	8.59
27. Bis(2-chloroethoxy)methane	3.30	59. 4-Chlorophenyl phenyl ether	4.83	91. Perylene-d12 (IS)	8.67
28. 2,4-Dichlorophenol	3.36	60. Fluorene	4.84	92. Indeno[1,2,3-cd]pyrene	10.20
29. 1,2,4-Trichlorobenzene	3.42	61. 4-Nitroaniline	4.85	93. Dibenz[a,h]anthracene	10.24
30. Naphthalene-d8 (IS)	3.45	62. 4,6-Dinitro-2-methylphenol	4.86	94. Benzo[ghi]perylene	10.63
31. Naphthalene	3.47	63. N-Nitrosodiphenylamine (as diphenylamine)	4.90		
32. 4-Chloroaniline	3.49	64. Diphenylhydrazine (as azobenzene)	4.93		

Column	Rxi-5Sil MS, 20 m, 0.15 mm ID, 0.15 µm (cat.# 43816)
Sample	8270 MegaMix (cat.# 31850), 8270 Benzidines mix (cat.# 31852) Benzoic acid (cat.# 31879), Revised B/N surrogate mix (cat.# 31888) Acid surrogate mix (4/89 SOW) (cat.# 31063) Revised SV internal standard mix (cat.# 31886)
Diluent:	Methylene chloride
Conc.:	20 µg/mL (IS/SS 20 µg/mL)
Injection	
Inj. Vol.:	1 µL split (split ratio 20:1)
Liner:	Topaz 4 mm single taper w/wool (cat.# 23303)
Inj. Temp.:	275 °C
Oven	
Oven Temp.:	60 °C (hold 0.7 min) to 285 °C at 39.8 °C/min to 305 °C at 4.3 °C/min to 330 °C at 28.5 °C/min (hold 3.5 min)
Carrier Gas	He, constant flow
Flow Rate:	0.72 mL/min

Detector	MS
Mode:	Scan
Transfer Line Temp.:	280 °C
Analyzer Type:	Quadrupole
Source Temp.:	330 °C
Quad Temp.:	180 °C
Electron Energy:	70 eV
Solvent Delay Time:	1.3 min
Tune Type:	DFTPP
Ionization Mode:	EI
Scan Range:	39-550 amu
Scan Rate:	9.8 scans/sec
Instrument	Agilent 7890B GC & 5977A MSD
Notes	Analyzed using a 120 V oven equipped with the GC Accelerator kit (cat.# 23849).

Meeting Method Requirements

All the compounds included in this fast semivolatiles analysis method evaluation met EPA 8270 method requirements of either exhibiting a %RSD of relative response factors (RRFs) of <20% or demonstrating a correlation coefficient of ≥0.99 if an alternative fit method was used. Five of the more active compounds (benzoic acid, 2,4-dinitrophenol, 4,6-dinitro-2-methylphenol, benzidine, and 3,3'-dimethylbenzidine) required the use of an inversely weighted linear curve, although the correlation coefficient in those cases met the method requirements.

In Summary

By applying the principals of column and method scale-down, with the assistance of the GC Accelerator kit to provide the added boost to your oven ramp rates, the analysis of even complex samples can be successfully translated to a much faster method while maintaining the same separation. In the example shown here, scaling down EPA Method 8270 resulted in much faster semivolatiles analysis times that will allow labs to increase sample throughput or process more rush samples.

GC Accelerator Oven Insert Kit
for Agilent 6890 and 7890 instruments

- 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.

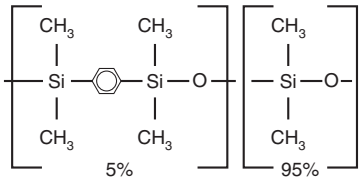
Designed with GC-MS users in mind, the GC Accelerator kit provides a simple way to speed up sample analysis. By reducing oven volume, these inserts allow faster ramp rates to be attained, which reduces oven cycle time and allows for increased sample throughput and more capacity to process rush samples. When faster ramp rates are used, existing methods can be accurately scaled down to smaller, high-efficiency, narrow-bore columns using Restek's *EZ*GC method translator. With a scaled-down column, a properly translated method, and a GC Accelerator kit, you can obtain the same chromatographic separation—often with greater sensitivity—in a fraction of the time without making a capital investment.

Description	qty.	cat.#
GC Accelerator Oven Insert Kit for Agilent 6890 and 7890 instruments	kit	23849

similar **phases**

DB-5ms, DB-5msUI, VF-5ms, ZB-5ms, ZB-SemiVolatiles, Rtx-5Sil MS

Restek's low-bleed MS columns exceed requirements of the most sensitive mass spectrometers.



Rxi-5Sil MS Columns (fused silica)
low-polarity phase; Crossbond 1,4-bis(dimethylsiloxy)phenylene dimethyl polysiloxane

- Engineered to be a low-bleed GC-MS column.
- Excellent inertness for active compounds.
- General-purpose columns—ideal for GC-MS analysis of semivolatiles, polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities, and hydrocarbons.
- Temperature range: -60 °C to 350 °C.

Description	temp. limits	qty.	cat.#
20 m, 0.15 mm ID, 0.15 µm	-60 to 320/350 °C	ea.	43816

Topaz 4.0 mm ID Single Taper Inlet Liner w/ Wool
for Agilent GCs equipped with split/splitless inlets

ID x OD x Length	qty.	cat.#
Single Taper, Premium Deactivation, Borosilicate Glass with Quartz Wool 4.0 mm x 6.5 mm x 78.5 mm	5-pk.	23303

Certified reference materials (CRMs) manufactured and QC-tested in ISO-accredited labs satisfy your ISO requirements.

8270 MegaMix Standard (76 components)

- Fewest mixtures needed for calibration and matrix spikes.
- Mixtures formulated for maximum stability.
- Contains most routinely analyzed compounds.

Acenaphthene (83-32-9)
Acenaphthylene (208-96-8)
Aniline (62-53-3)
Anthracene (120-12-7)
Azobenzene (103-33-3)*
Benz(a)anthracene (56-55-3)
Benzo(a)pyrene (50-32-8)
Benzo(b)fluoranthene (205-99-2)
Benzo(ghi)perylene (191-24-2)
Benzo(k)fluoranthene (207-08-9)
Benzyl alcohol (100-51-6)
Benzyl butyl phthalate (85-68-7)
Bis(2-chloroethoxy)methane (111-91-1)
Bis(2-chloroethyl)ether (111-44-4)
Bis(2-ethylhexyl)adipate (103-23-1)
Bis(2-ethylhexyl)phthalate (117-81-7)
4-Bromophenyl phenyl ether (101-55-3)
Carbazole (86-74-8)
4-Chloroaniline (106-47-8)
4-Chloro-3-methylphenol (59-50-7)
2-Chloronaphthalene (91-58-7)
2-Chlorophenol (95-57-8)
4-Chlorophenyl phenyl ether (7005-72-3)
Chrysene (218-01-9)
Dibenz(a,h)anthracene (53-70-3)
Dibenzofuran (132-64-9)
1,2-Dichlorobenzene (95-50-1)
1,3-Dichlorobenzene (541-73-1)
1,4-Dichlorobenzene (106-46-7)
2,4-Dichlorophenol (120-83-2)
Diethylphthalate (84-66-2)
2,4-Dimethylphenol (105-67-9)
Dimethylphthalate (131-11-3)
Di-*n*-butyl phthalate (84-74-2)
1,2-Dinitrobenzene (528-29-0)
1,3-Dinitrobenzene (99-65-0)
1,4-Dinitrobenzene (100-25-4)
4,6-Dinitro-2-methylphenol (Dinitro-*o*-cresol) (534-52-1)
2,4-Dinitrophenol (51-28-5)
2,4-Dinitrotoluene (121-14-2)
2,6-Dinitrotoluene (606-20-2)
Di-*n*-octyl phthalate (117-84-0)
Diphenylamine (122-39-4)**
Fluoranthene (206-44-0)
Fluorene (86-73-7)
Hexachlorobenzene (118-74-1)
Hexachlorobutadiene (87-68-3)
Hexachlorocyclopentadiene (77-47-4)
Hexachloroethane (67-72-1)
Indeno(1,2,3-cd)pyrene (193-39-5)
Isophorone (78-59-1)
1-Methylnaphthalene (90-12-0)
2-Methylnaphthalene (91-57-6)
2-Methylphenol (*o*-cresol) (95-48-7)
3-Methylphenol (*m*-cresol) (108-39-4)
4-Methylphenol (*p*-cresol) (106-44-5)
Naphthalene (91-20-3)
2-Nitroaniline (88-74-4)
3-Nitroaniline (99-09-2)
4-Nitroaniline (100-01-6)
Nitrobenzene (98-95-3)
2-Nitrophenol (88-75-5)
4-Nitrophenol (100-02-7)
N-Nitrosodimethylamine (62-75-9)
N-Nitroso-di-*n*-propylamine (621-64-7)
2,2'-Oxybis(1-chloropropane) (108-60-1)
Pentachlorophenol (87-86-5)
Phenanthrene (85-01-8)
Phenol (108-95-2)
Pyrene (129-00-0)
Pyridine (110-86-1)
2,3,4,6-Tetrachlorophenol (58-90-2)
2,3,5,6-Tetrachlorophenol (935-95-5)
1,2,4-Trichlorobenzene (120-82-1)
2,4,5-Trichlorophenol (95-95-4)
2,4,6-Trichlorophenol (88-06-2)

1,000 µg/mL each in methylene chloride (3-methylphenol and 4-methylphenol at 500 µg/mL), 1 mL/ampul	cat.# 31850 (ea.)

*1,2-diphenylhydrazine (8270-listed analyte) decomposes to azobenzene (mix component) in the injector.

**N-nitrosodiphenylamine (8270-listed analyte) decomposes to diphenylamine (mix component) in the injector.

8270 Benzidines Mix (3 components)

Benzidine (92-87-5)
3,3'-Dichlorobenzidine (91-94-1)
3,3'-Dimethylbenzidine (*o*-tolidine) (119-93-7)

2,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31688 (ea.)
2,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31852 (ea.)

Benzoic Acid

Benzoic acid (65-85-0)

2,000 µg/mL in methylene chloride, 1 mL/ampul	cat.# 31879 (ea.)
1,000 µg/mL in methanol, 1 mL/ampul	cat.# 31415 (ea.)

Revised B/N Surrogate Mix (4 components)

2-Fluorobiphenyl (321-60-8)
Nitrobenzene-d5 (4165-60-0)
p-Terphenyl-d14 (1718-51-0)
Pyrene-d10 (1718-52-1)

1,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31887 (ea.)
5,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31888 (ea.)
5,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31888.15 (15-pk.)
5,000 µg/mL each in methylene chloride, 5 mL/ampul	cat.# 31889 (ea.)

Acid Surrogate Mix (4/89 SOW) (3 components)

- Highest concentrations commercially available.
- Convenient 1 mL, 5 mL, and 10 mL package sizes.
- Reduces laboratory cost per sample extract.

2-Fluorophenol (367-12-4)
Phenol-d6 (13127-88-3)
2,4,6-Tribromophenol (118-79-6)

2,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31025 (ea.)
2,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31025.15 (15-pk.)
2,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31025.25 (25-pk.)
10,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31063 (ea.)
10,000 µg/mL each in methanol, 1 mL/ampul	cat.# 31063.15 (15-pk.)
10,000 µg/mL each in methanol, 5 mL/ampul	cat.# 31087 (ea.)
10,000 µg/mL each in methanol, 10 mL/ampul	cat.# 33029 (ea.)

Revised SV Internal Standard Mix (7 components)

Acenaphthene-d10 (15067-26-2)
Chrysene-d12 (1719-03-5)
1,4-Dichlorobenzene-d4 (3855-82-1)
1,4-Dioxane-d8 (17647-74-4)
Naphthalene-d8 (1146-65-2)
Perylene-d12 (1520-96-3)
Phenanthrene-d10 (1517-22-2)

2,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31885 (ea.)
4,000 µg/mL each in methylene chloride, 1 mL/ampul	cat.# 31886 (ea.)

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Pure Chromatography

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