

# Maximizing Production While Minimizing Costs

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## Abstract:

The need to increase productivity and reduce cost is becoming of greater concern to environmental laboratories. EST Analytical has addressed many issues inhibiting production with moisture reduction innovations and proprietary means of decreasing carryover. The Encon Evolution uses a purge side moisture trap to improve chromatography and a programmable sparge tube heater to clean high level samples from the glassware. These advances facilitate sample throughput; however decreasing purge and trap cycle time in order to run more samples in the mandated 12 hour tune window is key to boosting production.

## Discussion:

In studying sample throughput demands, one thing is evident; purge and trap cycle time is the limiting factor in increasing laboratory productivity. However, the EPA is clear that an eleven minute purge time is a mandate of the method. This purge time coupled with auto-sampler process times, dry purge, desorb, and bake times makes decreasing cycle times a challenge. EST Analytical has addressed this challenge so as to maximize your sample throughput and minimize your cost. The use of our Centurion WS auto-sampler and two Encon Evolution concentrators coupled to one GC/MS system can double your sample throughput without doubling your cost.



## Experimental:

The sampling system used for this study was the EST Analytical Centurion WS autosampler and two Encon Evolution concentrators. The experiments were run in water mode with a 10mL purge volume. Coupled to the sampling system were an Agilent 6890A GC and 5973 MS. The GC was configured with a Restek Rtx-624 30m x 0.250mm x 1.4µm column. Experimental parameters for both the purge and trap and GC/MS are listed in Tables 1 and 2 respectively.

Purge and Trap Concentrator	EST Encon Evolution
Trap Type	Vocarb 3000
Valve Oven Temp.	150°C
Transfer Line Temp.	150°C
Trap Temp.	35°C
Moisture Reduction Trap (MoRT) Temp.	39°C
Purge Time	11 min.
Purge Flow	40mL/min
Dry Purge Temp.	ambient
Dry Purge Flow	40mL/min
Dry Purge Time	1.0 min.
Desorb Pressure Control	On
Desorb Pressure	5psi
Desorb Time	1.0 min.
Desorb Temp.	260°C
Moisture Reduction Trap (MoRT) Bake Temp.	39°C
Bake Temp	265°C
Sparge Vessel Bake Temp.	110°C
Bake Time	8
Bake Flow	40mL/min
Purge and Trap Auto-Sampler	EST Centurion WS
Sample Size	10mL
Internal Standard Volume	5µL

**Table 1: Purge and Trap Parameters**

GC/MS	Agilent 6890A/5973
Inlet	Split/Splitless
Inlet Temp.	200°C
Inlet Head Pressure	9.69 psi
Mode	Split
Split Ratio	40:1
Column	RTX-624 30m x 0.25mm I.D. x 1.4µm film thickness
Oven Temp. Program	40°C hold for 1 min., ramp 18°C/min to 220°C, hold for 0.0 min., 11.00 min. runtime
Column Flow Rate	1.2mL/min
Gas	Helium
Total Flow	94.7mL/min
Source Temp.	230°C
Quad Temp.	150°C
MS Transfer Line Temp.	180°C
Scan Range	m/z 35-265
Scans	3.12 scans/sec
Solvent Delay	0.7 min

**Table 2: GC/MS Parameters**

The USEPA Method 8260b standards were purchased from Restek. The compound concentration was 2000µg/ml for all of the analytes with the exception of tert-butyl alcohol which



was at 10,000µg/ml and 1,4 Dioxane and p&m-xylene which were at 4000µg/ml. A calibration curve was prepared and run on each concentrator. A range of 0.5 to 200 pb was used to establish the curves and Agilent Chemstation software was employed to ascertain the linear calibration of the analytes. Both curves achieved the USEPA Method 8260b requirements and the results are listed in Table 3.

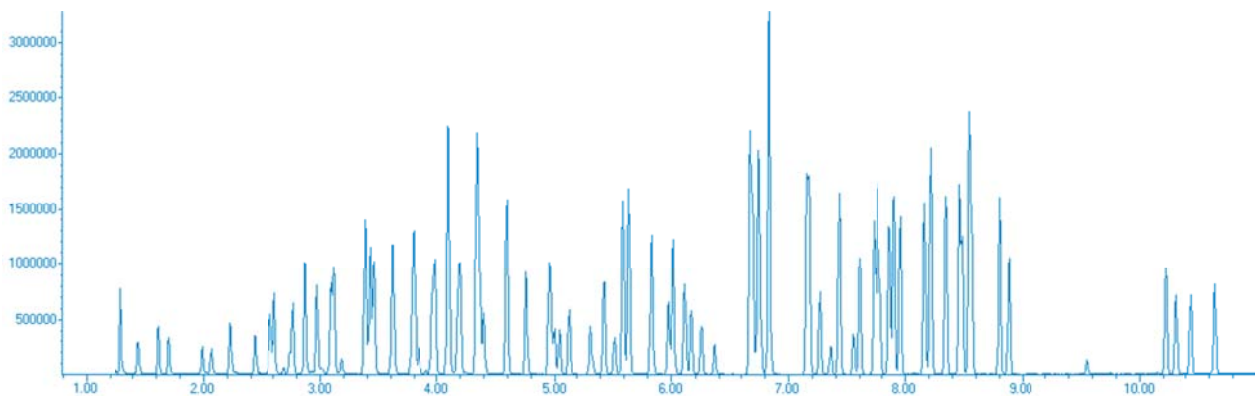
Compound	Concentrator 1		Concentrator 2		Compound	Concentrator 1		Concentrator 2	
	%RSD	RF	%RSD	RF		%RSD	RF	%RSD	RF
Dichlorodifluoromethane	9.16	0.905	9.57	1.127	2-chloroethanol	8.71	0.264	8.81	0.302
<b>Chloromethane</b>	<b>10.55</b>	<b>1.179</b>	<b>8.65</b>	<b>1.622</b>	2-nitropropane	12.15	0.129	10.63	0.150
Vinyl Chloride	7.77	0.898	8.85	1.101	cis-1,3-Dichloropropene	7.59	0.924	6.55	1.072
Bromomethane	12.54	0.463	10.02	0.562	4-methyl-2-pentanone	6.62	0.547	4.48	0.595
Chloroethane	7.38	0.541	4.93	0.676	Toluene-d8 SUR	4.24	2.131	5.74	2.499
Trichlorofluoromethane	8.45	1.095	12.88	1.310	Toluene	12.68	1.566	6.78	1.807
diethyl ether	7.29	0.632	5.81	0.736	ethyl methacrylate	5.83	0.646	6.63	0.730
1,1,2-trichlorofluoroethane	10.05	0.703	12.10	0.834	trans-1,3-Dichloropropene	6.85	0.805	6.09	0.947
1,1-Dichloroethene	7.36	0.707	7.58	0.842	1,1,2-Trichloroethane	5.86	0.443	4.05	0.511
Acetone	10.98	0.201	8.20	0.252	Tetrachloroethene	14.60	0.648	14.89	0.795
Iodomethane	0.998*	0.518	0.997*	0.821	1,3-Dichloropropane	4.86	0.793	4.18	0.908
Carbon Disulfide	10.68	2.371	7.31	2.755	isopropyl acetate	9.21	0.128	6.34	0.145
allyl chloride	7.38	1.900	4.81	2.224	butyl acetate	7.74	0.399	4.64	0.437
Methylene Chloride	5.73	0.865	3.81	1.026	Dibromochloromethane	8.55	0.480	11.15	0.561
acetonitrile	8.68	0.069	11.78	0.086	2-Hexanone	7.94	0.356	6.30	0.408
Tert Butyl Alcohol	12.25	0.037	8.44	0.061	1,2-Dibromoethane	6.02	0.403	4.24	0.463
MTBE	6.58	2.286	6.25	2.623	<b>Chlorobenzene</b>	<b>7.48</b>	<b>1.656</b>	<b>5.83</b>	<b>1.940</b>
cis-1,2-Dichloroethene	6.61	0.842	5.22	0.995	1,1,1,2-Tetrachloroethane	7.54	0.521	7.04	0.620
acrylonitrile	10.88	0.314	3.86	0.350	Ethylbenzene	5.56	2.934	6.34	3.510
Isopropylether	5.31	4.103	4.58	4.736	Xylene (m+p)	6.22	2.281	5.58	2.736
Vinyl acetate	9.90	2.007	6.17	2.200	Styrene	4.51	1.699	4.45	2.068
<b>1,1-Dichloroethane</b>	<b>5.73</b>	<b>1.889</b>	<b>4.58</b>	<b>2.210</b>	Xylene (o)	4.81	2.296	6.08	2.730
Ethyl Tert Butyl Ether (ETBE)	5.72	3.516	6.34	4.017	n-amyl acetate	5.55	1.059	9.41	1.169
trans-1,2-Dichloroethene	5.83	0.917	8.77	1.093	<b>Bromoform</b>	<b>10.62</b>	<b>0.303</b>	<b>13.75</b>	<b>0.344</b>
ethyl acetate	10.36	0.127	11.67	0.141	Isopropylbenzene	4.80	2.650	6.25	3.235
2-Butanone	7.93	1.196	4.00	1.334	cis-1,4-dichloro-2-butene	10.77	0.160	9.37	0.186
2,2-Dichloropropane	11.87	1.184	4.63	1.427	BFB SUR	5.73	1.523	3.73	1.691
Bromochloromethane	7.49	0.487	7.96	0.575	Bromobenzene	5.45	2.014	3.85	2.295
propionitrile	8.80	0.094	9.14	0.116	1,2,3-Trichloropropane	6.45	1.054	7.43	1.120
methacrylonitrile	10.91	0.683	4.50	0.736	<b>1,1,2,2-Tetrachloroethane</b>	<b>6.85</b>	<b>0.908</b>	<b>3.89</b>	<b>0.964</b>
THF	8.87	0.247	8.98	0.296	n-Propylbenzene	6.11	5.869	7.40	6.637
Chloroform	9.21	1.725	11.24	2.070	trans-1,4-dichloro-2-butene	9.51	0.421	7.78	0.448
methyl acrylate	6.49	0.786	5.17	0.858	2-Chlorotoluene	5.89	1.048	4.12	1.178
Dibromofluoromethane SUR	9.79	0.864	7.70	1.006	4-Chlorotoluene	6.47	1.085	4.50	1.230
1,1,1-Trichloroethane	9.18	1.367	9.49	1.622	1,3,5-Trimethylbenzene	5.44	3.885	6.55	4.458
2-Chloroethylvinylether	6.73	0.551	4.42	0.630	tert-Butylbenzene	5.45	3.207	5.78	3.656
Carbon Tetrachloride	12.24	1.014	13.85	1.202	sec-Butylbenzene	5.26	0.998	7.04	1.162
1,1-Dichloropropene	8.55	1.205	7.38	1.433	1,2,4-Trimethylbenzene	6.66	3.858	6.62	4.503
methyl acetate	5.47	2.778	3.69	3.091	nitrobenzene	13.03	0.022	9.39	0.030
isobutyl alcohol	10.49	0.018	9.73	0.026	1,3-Dichlorobenzene	6.83	2.116	4.91	2.497
Tert Amyl Methyl Ether (TAME)	6.05	2.470	5.65	2.824	1,4-Dichlorobenzene	7.69	2.144	5.94	2.546
Benzene	5.42	3.648	5.29	4.274	Isopropyltoluene	6.81	3.900	6.46	4.563
1,2-Dichloroethane	5.32	1.339	4.51	1.554	1,2-Dichlorobenzene	5.85	1.896	6.95	2.293
propyl acetate	6.12	0.846	3.85	0.944	n-Butylbenzene	7.64	3.743	7.77	4.349
Trichloroethene	5.02	0.579	7.29	0.688	1,2-Dibromo-3-chloropropane	12.83	0.139	10.31	0.164
1,4-Dioxane	13.97	0.001	10.97	0.003	1,2,4-Trichlorobenzene	7.35	1.310	5.98	1.625
1,2-Dichloropropane	4.12	0.696	4.59	0.805	Naphthalene	9.22	2.448	6.33	2.876
methyl methacrylate	7.79	0.335	7.49	0.360	Hexachlorobutadiene	9.91	0.609	6.83	0.727
Dibromomethane	4.94	0.326	3.18	0.370	1,2,3-Trichlorobenzene	7.43	1.140	5.56	1.380
Bromodichloromethane	6.25	0.785	7.16	0.935					

\*Compound was linear regressed

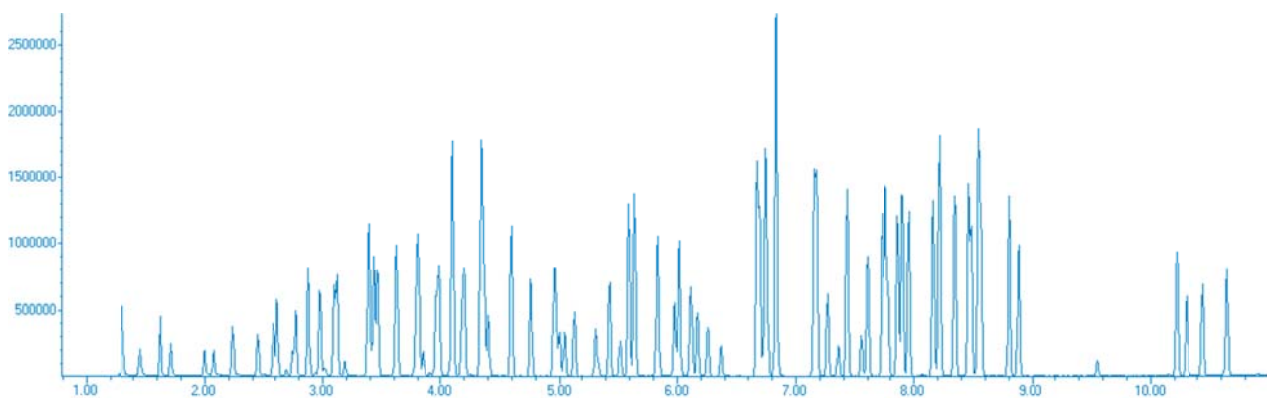
SPCC Compounds are highlighted in Orange

Table 3: Curve Results

After the curves were calibrated successfully, a precision and accuracy study was performed for the dual system over the following three days. The study was done in order to replicate the process as in an environmental laboratory. Thus, a verification of a BFB tune passing tune parameters was performed. Next, two CCVs were run at a 50ppb concentration and the CCC compounds passed within the +/- 20% window. Note: Two CCVs were run in order to determine the reproducibility of the CCV results. Then, a blank was run in order to display the cleanliness of the system. Finally, 10 precision and accuracy samples prepared at a concentration of 20ppb were run on both concentrators. This process was repeated for three days and the results are presented in Figures 1, 2, 3 and 4 and Tables 4, 5 and 6.



**Figure 1: 20ppb Chromatogram on Concentrator 1**



**Figure 2: 20ppb Chromatogram on Concentrator 2**



Compound	Concentrator 1 Day 1		Concentrator 2 Day 1		Concentrator 1 Day 2		Concentrator 2 Day 2		Concentrator 1 Day 3		Concentrator 2 Day 3	
	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y
Dichlorodifluoromethane	2.00	106.35	8.48	103.75	5.25	100.48	4.63	99.00	0.20	101.94	6.31	102.29
Chloromethane	9.57	101.01	4.21	94.53	3.68	96.19	6.16	101.30	8.60	106.98	1.51	110.47
Vinyl Chloride	6.94	104.15	5.47	99.46	3.77	102.94	6.27	103.47	4.40	109.31	3.80	112.47
Bromomethane	7.88	97.29	5.75	90.41	1.97	90.57	5.42	93.13	6.97	95.58	1.87	106.63
Chloroethane	9.29	98.79	3.76	96.97	3.32	101.55	5.42	99.34	5.48	109.95	0.75	110.03
Trichlorofluoromethane	5.09	112.24	5.82	106.06	4.12	112.88	6.04	112.92	1.69	117.42	4.11	122.77
diethyl ether	9.44	94.85	5.53	93.61	4.76	104.33	3.54	102.45	4.80	110.63	0.88	109.89
1,1,2-trichlorofluoroethane	2.27	112.42	6.82	105.93	3.67	113.89	6.70	114.19	1.16	119.12	4.63	121.57
1,1-Dichloroethene	4.02	106.03	4.17	99.83	5.23	108.83	6.36	106.73	2.78	115.02	2.92	117.43
Acetone	13.54	94.30	11.74	95.64	9.14	104.11	1.85	97.71	0.95	100.23	0.84	97.60
Iodomethane	8.35	102.99	1.09	96.91	6.32	102.46	4.09	104.24	9.92	101.62	1.57	106.67
Carbon Disulfide	4.30	103.12	3.93	97.94	4.97	103.73	6.08	101.98	3.43	110.92	2.64	112.96
allyl chloride	3.67	102.85	3.65	99.30	2.75	105.13	5.26	104.24	4.02	112.84	0.95	115.34
Methylene Chloride	4.86	98.31	1.62	96.88	5.09	102.19	4.72	100.36	4.66	110.43	0.23	111.22
acetonitrile	8.40	95.65	4.29	102.94	3.86	106.36	5.08	109.84	2.74	111.93	2.39	108.57
Tert Butyl Alcohol	9.09	90.66	12.24	90.39	9.69	117.05	3.31	111.40	3.03	107.01	0.05	101.21
MTBE	5.74	98.83	2.97	98.56	3.82	106.94	2.49	104.46	3.26	111.31	1.34	111.54
cis-1,2-Dichloroethene	4.79	103.81	1.89	99.09	4.87	105.49	5.83	104.05	4.03	112.93	1.09	115.12
acrylonitrile	7.39	94.09	3.51	93.69	4.58	102.69	0.78	100.44	0.57	105.88	0.24	104.63
Isopropylether	5.02	99.93	1.08	97.35	4.97	102.79	3.82	102.29	3.77	109.05	0.44	111.55
Vinyl acetate	5.93	108.42	2.67	105.63	1.96	111.00	0.29	114.91	2.92	118.83	2.03	119.57
1,1-Dichloroethane	5.25	102.11	1.75	97.97	5.65	104.93	5.68	103.86	4.97	111.63	0.44	114.62
Ethyl Tert Butyl Ether (ETBE)	5.54	100.39	1.99	96.73	4.32	104.21	3.47	104.75	4.36	110.14	1.58	113.37
trans-1,2-Dichloroethene	4.67	98.51	2.07	96.39	4.62	103.05	5.58	100.28	4.92	110.07	0.05	110.75
ethyl acetate	8.23	93.27	6.30	92.93	1.02	99.43	1.11	99.22	1.59	102.57	1.33	102.58
2-Butanone	8.06	95.87	4.55	95.00	3.20	104.11	0.73	104.30	0.19	106.92	0.71	108.05
2,2-Dichloropropane	12.80	105.87	17.90	104.01	7.84	113.69	5.43	121.39	3.31	129.59	2.35	130.55
Bromochloromethane	4.25	96.28	1.59	96.86	3.96	101.99	4.64	99.29	3.87	110.31	1.59	108.47
propionitrile	9.28	96.60	3.46	95.70	5.52	105.40	0.71	105.29	0.84	107.16	0.34	107.43
methacrylonitrile	6.71	95.19	4.51	92.25	3.53	100.29	0.67	102.22	0.04	102.22	0.58	105.79
THF	7.58	88.57	4.92	93.45	4.84	102.90	1.62	96.08	0.27	104.44	1.25	99.52
Chloroform	5.08	95.98	1.72	94.07	5.07	100.67	4.58	97.74	5.43	107.79	0.36	107.57
methyl acrylate	7.30	97.85	3.60	96.43	3.61	105.12	0.04	106.06	0.12	108.05	0.39	109.79
Dibromofluoromethane SUR	4.71	97.20	1.85	92.57	3.80	99.16	5.15	98.93	5.17	106.76	0.12	109.57
1,1,1-Trichloroethane	4.73	107.31	3.40	100.56	4.47	108.35	6.03	109.18	2.55	114.27	1.50	119.86
2-Chloroethylvinylether	5.61	99.09	2.84	99.43	4.77	108.77	1.25	104.77	2.01	111.46	1.61	108.59
Carbon Tetrachloride	3.97	112.23	5.27	105.25	4.50	112.49	6.87	114.04	3.35	117.45	1.75	121.79
1,1-Dichloropropene	4.38	105.41	3.14	100.49	4.95	109.34	7.17	108.02	3.33	114.68	1.21	116.29
methyl acetate	6.03	97.39	3.72	95.43	3.35	103.73	0.68	103.85	2.49	108.48	0.72	109.71
isobutyl alcohol	15.28	99.35	13.04	88.69	6.14	106.50	2.66	114.48	0.07	107.80	4.33	114.88
Tert Amyl Methyl Ether (TAME)	5.38	99.32	2.68	96.68	3.81	105.25	3.27	105.68	4.40	111.42	0.85	112.56
Benzene	5.33	100.80	1.36	96.78	5.08	103.24	5.87	102.56	4.77	110.66	0.91	113.84
1,2-Dichloroethane	5.19	99.25	1.93	97.87	3.87	104.41	3.36	102.96	4.61	110.22	1.28	111.75
propyl acetate	6.02	99.19	4.96	101.33	1.61	108.23	1.76	109.26	0.59	107.84	1.06	107.38
Trichloroethene	4.47	102.63	1.86	99.38	6.60	109.79	4.65	107.94	3.65	108.38	1.39	111.33
1,4-Dioxane	13.01	94.94	2.49	108.28	4.48	122.79	11.59	109.91	11.72	112.66	4.69	92.60
1,2-Dichloropropane	4.36	103.99	1.02	100.43	3.04	105.61	3.79	108.60	4.18	109.46	0.06	112.65
methyl methacrylate	6.05	105.39	3.74	102.71	3.43	111.82	0.05	115.58	1.26	109.93	1.31	114.54
Dibromomethane	4.53	101.81	2.18	99.79	2.18	107.21	2.14	110.04	4.00	108.31	0.75	110.81



Compound	Concentrator 1 Day 1		Concentrator 2 Day 1		Concentrator 1 Day 2		Concentrator 2 Day 2		Concentrator 1 Day 3		Concentrator 2 Day 3	
	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y	50ppb %RSD	50ppb %Rec'y
Bromodichloromethane	4.82	106.66	2.08	105.42	2.78	110.15	3.21	111.04	5.11	113.58	0.61	114.01
2-chloroethanol	6.16	95.36	3.31	95.85	3.37	103.01	0.10	101.30	0.73	101.32	1.61	98.71
2-nitropropane	3.24	100.07	2.55	106.72	5.82	112.23	3.27	110.43	1.96	109.08	0.71	104.90
cis-1,3-Dichloropropene	4.4	105.24	3.08	102.77	0.93	108.99	3.29	113.58	4.54	113.91	0.87	116.82
4-methyl-2-pentanone	9.97	97.69	6.14	97.99	3.66	107.77	1.58	109.98	0.09	105.38	0.22	106.73
Toluene-d8 SUR	7.25	102.95	1.23	100.14	3.31	106.32	4.21	109.36	4.51	109.73	0.32	114.13
<b>Toluene</b>	<b>6.47</b>	<b>98.43</b>	<b>0.59</b>	<b>94.13</b>	<b>3.68</b>	<b>99.07</b>	<b>4.32</b>	<b>103.95</b>	<b>4.23</b>	<b>102.96</b>	<b>0.48</b>	<b>107.86</b>
ethyl methacrylate	8.82	102.44	3.82	104.57	0.46	110.69	0.18	114.35	1.98	113.00	0.66	112.82
trans-1,3-Dichloropropene	5.27	103.19	3.04	104.58	1.22	111.17	2.37	113.61	4.10	115.04	1.00	115.82
1,1,2-Trichloroethane	7.13	100.27	1.93	99.55	3.25	106.72	1.66	107.73	2.39	107.92	0.37	109.43
Tetrachloroethene	10.19	82.39	2.63	80.07	2.33	83.75	9.10	88.10	3.48	83.05	3.13	84.90
1,3-Dichloropropane	7.35	101.03	2.76	100.25	2.64	106.13	0.79	108.34	3.36	107.88	1.33	110.35
isopropyl acetate	9.61	98.68	4.70	101.03	2.09	107.33	0.12	113.04	1.67	109.69	2.53	111.05
butyl acetate	9.78	99.53	4.49	100.10	2.71	105.48	1.16	111.92	0.21	107.99	1.64	111.26
Dibromochloromethane	6.91	107.73	2.68	107.87	1.87	113.23	2.47	117.63	3.15	114.38	1.30	117.26
2-Hexanone	9.17	93.97	5.80	98.05	2.80	108.79	2.16	107.73	2.12	105.76	0.65	105.18
1,2-Dibromoethane	7.21	101.08	3.42	101.31	2.03	108.05	1.02	110.65	2.92	109.97	0.39	112.22
Chlorobenzene	5.18	96.61	1.38	94.56	1.19	97.27	5.17	97.88	4.56	99.18	0.70	102.13
1,1,1,2-Tetrachloroethane	4.15	103.51	3.16	101.55	0.96	104.50	4.92	104.86	4.37	106.16	0.94	108.72
<b>Ethylbenzene</b>	<b>4.69</b>	<b>100.61</b>	<b>1.64</b>	<b>97.91</b>	<b>1.78</b>	<b>101.08</b>	<b>5.45</b>	<b>101.17</b>	<b>3.79</b>	<b>103.13</b>	<b>0.01</b>	<b>105.77</b>
Xylene (m+p)	5.01	102.08	1.74	98.96	1.16	102.69	5.55	102.43	3.89	104.43	0.35	107.42
Styrene	4.68	100.07	1.99	98.38	1.26	101.75	4.76	100.95	4.13	103.43	1.10	104.99
Xylene (o)	4.77	102.12	1.55	97.70	1.33	100.35	5.62	102.76	4.09	102.37	0.55	107.07
n-amyl acetate	7.82	97.71	4.34	97.30	4.26	99.74	0.68	107.49	1.06	102.22	1.63	107.04
Bromoform	4.70	107.18	2.69	104.66	1.21	109.31	2.13	113.50	3.35	108.52	1.98	111.89
Isopropylbenzene	4.56	102.89	1.86	98.71	0.96	102.09	5.98	104.04	3.26	104.16	0.97	108.09
cis-1,4-dichloro-2-butene	2.40	101.69	3.97	103.39	5.18	112.93	1.02	115.40	1.81	114.09	1.70	113.10
BFB SUR	3.53	96.29	0.86	93.09	2.34	94.47	3.24	96.22	4.99	94.98	1.43	98.49
Bromobenzene	3.29	95.13	0.75	94.93	2.35	96.82	1.98	94.72	5.84	98.02	1.35	96.89
1,2,3-Trichloropropane	3.89	97.32	1.37	96.27	1.53	103.19	1.83	104.51	1.97	99.56	1.25	100.48
1,1,2,2-Tetrachloroethane	5.25	94.91	2.27	94.53	2.15	94.57	1.22	97.98	2.09	95.64	1.85	97.14
n-Propylbenzene	3.66	100.59	3.11	95.54	1.62	98.02	4.09	99.72	3.88	98.52	0.42	102.67
trans-1,4-dichloro-2-butene	2.24	95.01	3.24	95.14	5.35	101.51	2.64	103.02	1.57	101.17	0.20	99.28
2-Chlorotoluene	3.66	96.63	1.86	91.99	2.15	94.78	2.63	96.15	5.47	94.93	1.63	98.99
4-Chlorotoluene	3.26	95.77	2.25	92.19	2.13	94.29	2.53	96.36	4.40	94.87	1.98	97.71
1,3,5-Trimethylbenzene	3.21	100.39	2.27	95.16	1.84	97.43	4.01	99.14	4.07	98.18	0.10	102.30
tert-Butylbenzene	2.98	100.91	2.46	94.87	1.77	97.13	3.62	99.90	4.49	97.90	0.15	102.07
sec-Butylbenzene	4.46	101.73	3.81	96.20	0.79	98.54	3.27	100.82	3.63	98.95	0.17	102.92
1,2,4-Trimethylbenzene	3.36	100.82	2.07	95.79	1.60	98.05	3.64	99.21	4.97	99.32	1.16	102.37
nitrobenzene	3.84	99.67	1.92	94.63	8.34	104.22	5.59	99.65	5.13	95.37	0.48	84.91
1,3-Dichlorobenzene	3.53	94.54	0.88	91.69	1.35	93.66	2.36	95.64	4.96	95.16	1.52	97.24
1,4-Dichlorobenzene	4.42	93.47	1.47	91.24	1.37	93.04	2.76	94.22	4.99	94.22	1.35	95.75
Isopropyltoluene	2.97	102.07	3.32	96.85	0.87	99.79	3.62	101.45	3.89	100.99	0.15	104.90
1,2-Dichlorobenzene	3.78	93.70	1.12	93.69	0.99	95.16	1.96	94.41	4.37	95.66	1.64	96.34
n-Butylbenzene	2.96	103.73	3.70	97.53	0.94	100.49	3.72	102.89	4.26	101.88	0.29	106.57
1,2-Dibromo-3-chloropropane	4.29	93.73	3.67	92.06	2.46	103.37	1.28	97.12	2.37	97.47	0.24	94.63
1,2,4-Trichlorobenzene	2.29	96.15	3.14	93.20	1.57	98.37	1.16	98.70	3.99	99.59	1.84	99.49
Naphthalene	4.68	94.53	2.86	95.38	0.18	101.84	1.13	99.75	2.17	98.80	1.46	98.66
Hexachlorobutadiene	2.16	101.25	4.63	97.53	1.29	103.87	5.05	100.89	4.08	106.13	1.26	106.16
1,2,3-Trichlorobenzene	4.13	94.29	0.81	94.07	1.50	98.14	1.96	97.98	4.03	97.82	1.47	99.46

Table 4: CCV Data over Three Days (CCC Compounds Highlighted in Orange)





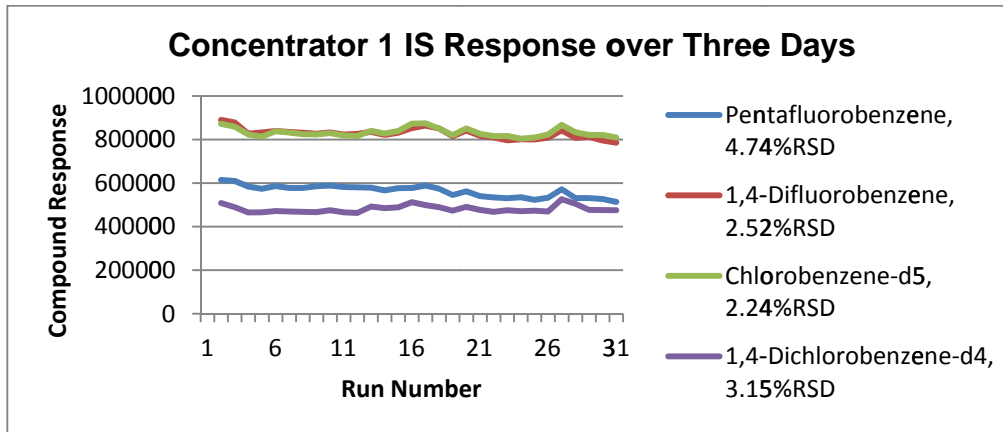
Compound	Concentrator 1 Day 1		Concentrator 2 Day 1		Concentrator 1 Day 2		Concentrator 2 Day 2		Concentrator 1 Day 3		Concentrator 2 Day 3	
	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y
Dichlorodifluoromethane	5.67	89.27	5.59	93.26	6.50	86.49	7.22	86.31	4.51	82.55	0.13	91.7
Chloromethane	5.09	89.76	3.71	93.36	5.36	92.24	5.70	95.48	5.64	91.15	1.09	103.18
Vinyl Chloride	5.35	94.51	4.51	100.20	5.65	98.01	7.05	102.41	4.57	96.76	1.41	111.15
Bromomethane	6.54	91.45	3.35	96.20	4.11	94.72	4.85	99.63	6.92	87.94	1.33	105.78
Chloroethane	4.15	97.68	4.49	98.95	5.24	102.67	5.94	105.30	5.34	100.79	2.31	114.97
Trichlorofluoromethane	5.2	97.92	5.50	102.91	6.32	104.16	7.00	106.27	4.37	103.60	0.46	116.40
diethyl ether	5.54	95.67	4.76	95.72	2.77	107.18	2.15	108.89	7.04	106.46	0.73	110.92
1,1,2-trichlorofluoroethane	5.84	94.47	5.46	98.91	6.10	102.58	6.42	104.21	4.34	102.81	0.36	115.67
1,1-Dichloroethene	5.07	97.76	5.37	102.43	5.74	104.13	6.75	108.47	4.17	103.61	1.06	117.60
Acetone	7.94	107.70	5.83	104.15	4.70	108.31	3.92	106.93	5.71	110.28	3.11	106.25
Iodomethane	5.65	88.96	5.20	96.35	6.79	98.83	6.78	103.17	6.78	101.01	3.27	110.22
Carbon Disulfide	4.66	94.24	4.36	98.17	5.51	99.05	6.04	104.16	5.28	98.65	1.68	114.38
allyl chloride	4.28	96.79	3.37	100.93	4.24	103.65	4.28	108.85	5.24	103.04	1.78	118.57
Methylene Chloride	2.77	97.89	2.46	100.55	3.12	105.08	3.96	108.86	4.96	104.59	2.12	116.12
acetonitrile	5.86	101.95	6.19	102.36	7.76	108.41	6.56	108.81	3.83	111.83	2.30	108.28
Tert Butyl Alcohol	12.50	100.87	7.19	95.97	4.64	115.85	3.28	105.99	6.65	111.94	3.68	99.74
MTBE	3.15	100.00	3.51	100.22	2.40	108.53	1.49	110.36	6.00	107.45	1.51	111.20
cis-1,2-Dichloroethene	4.70	99.24	4.79	102.50	5.23	105.48	5.60	110.82	4.20	106.01	1.40	118.85
acrylonitrile	3.72	96.48	2.69	97.25	3.26	104.67	1.78	105.79	5.86	104.03	3.91	106.32
Isopropylether	2.30	97.12	3.11	100.91	2.80	104.15	2.75	109.52	6.27	103.16	1.02	114.20
Vinyl acetate	11.11	93.43	8.53	96.40	10.43	95.16	9.12	96.75	9.11	112.89	2.55	118.83
1,1-Dichloroethane	3.83	98.42	3.87	102.79	3.76	105.91	4.83	112.15	5.02	104.46	1.63	119.37
Ethyl Tert Butyl Ether (ETBE)	2.36	97.93	3.11	102.03	2.19	106.45	2.22	111.73	6.11	105.79	1.43	114.87
trans-1,2-Dichloroethene	3.56	97.74	3.10	99.49	3.63	105.55	4.62	109.06	5.57	104.55	1.52	114.58
ethyl acetate	5.97	95.91	4.44	96.50	3.92	105.94	3.36	104.94	9.03	105.63	1.13	108.18
2-Butanone	4.33	98.71	3.11	100.23	2.90	109.35	1.59	111.39	6.39	108.28	2.11	110.83
2,2-Dichloropropane	7.41	91.55	4.19	93.27	4.63	106.36	5.01	109.32	6.12	112.85	0.86	125.70
Bromochloromethane	2.58	98.41	2.71	98.98	3.39	106.68	2.30	109.77	6.77	105.65	0.82	113.78
propionitrile	7.61	99.62	3.88	99.28	3.97	109.56	1.84	109.86	11.11	109.38	2.64	110.35
methacrylonitrile	3.78	95.3	2.94	100.26	2.45	104.33	1.61	109.59	7.15	104.16	2.98	110.08
THF	5.81	98.71	3.20	95.81	3.04	107.72	2.47	104.05	6.60	109.35	1.25	103.38
Chloroform	3.14	96.04	3.30	96.72	3.73	103.06	4.02	105.72	5.37	102.56	1.58	112.62
methyl acrylate	3.71	98.5	3.14	100.93	2.54	106.82	1.33	109.92	6.45	107.79	0.83	110.25
Dibromofluoromethane SUR	3.43	93.74	3.00	98.05	2.72	101.32	3.61	106.87	5.87	101.18	0.62	112.75
1,1,1-Trichloroethane	4.75	98.51	4.89	103.65	4.23	105.44	6.52	110.42	5.09	105.01	2.11	120.08
2-Chloroethylvinylether	3.06	100.50	2.60	100.26	2.17	110.76	1.84	111.11	5.92	109.40	2.02	109.07
Carbon Tetrachloride	5.47	98.66	5.08	103.91	5.19	103.96	6.74	109.8	5.27	104.08	1.28	120.38
1,1-Dichloropropene	4.89	98.39	4.90	102.03	5.27	104.96	6.28	109.38	4.61	104.41	2.06	119.67
methyl acetate	3.48	98.49	3.66	100.10	2.04	106.73	1.56	109.68	6.77	106.30	0.61	110.70
isobutyl alcohol	11.75	97.32	5.42	104.35	9.19	108.37	8.93	113.85	6.71	110.94	2.86	116.42
Tert Amyl Methyl Ether (TAME)	3.03	98.31	3.31	100.85	2.43	107.32	1.88	111.45	5.74	106.43	1.25	113.28
Benzene	3.51	97.08	4.02	101.05	4.05	104.43	4.91	110.17	4.94	103.43	1.50	117.83
1,2-Dichloroethane	2.97	97.97	3.17	100.49	2.72	105.75	2.50	109.76	5.95	106.14	0.62	114.65
propyl acetate	4.35	106.57	3.28	103.26	2.53	109.39	1.73	109.90	7.36	108.54	1.35	107.40
Trichloroethene	3.54	104.62	4.78	106.66	4.29	108.19	6.03	112.63	4.33	102.84	1.33	115.80
1,4-Dioxane	18.19	109.77	9.14	116.93	10.29	114.88	13.15	102.00	20.39	117.84	4.86	95.99
1,2-Dichloropropane	2.73	103.94	2.79	106.50	2.76	106.46	3.42	112.25	5.67	104.13	1.05	116.07
methyl methacrylate	4.43	106.00	3.53	108.45	2.21	110.08	1.26	114.62	6.81	110.88	3.22	113.88
Dibromomethane	2.39	103.51	2.98	106.61	1.77	108.15	2.16	110.74	6.17	105.93	1.91	113.12



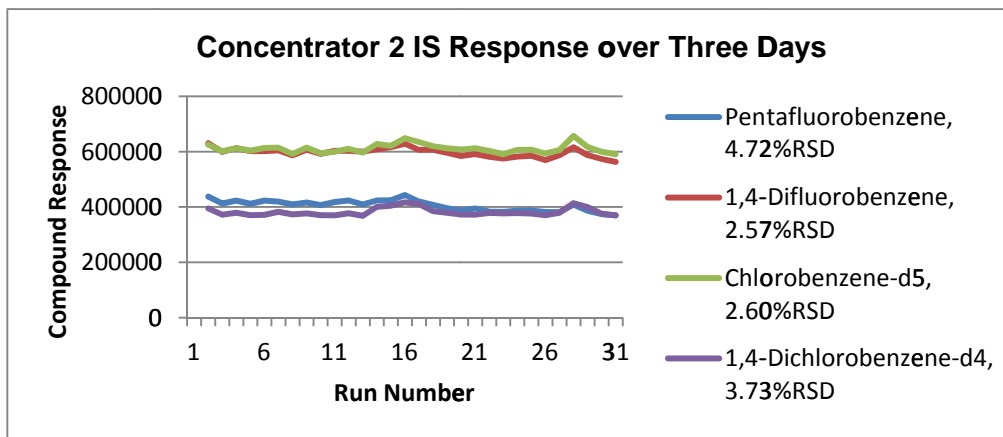
Compound	Concentrator 1 Day 1		Concentrator 2 Day 1		Concentrator 1 Day 2		Concentrator 2 Day 2		Concentrator 1 Day 3		Concentrator 2 Day 3	
	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y	20ppb %RSD	20ppb % Rec'y
Bromodichloromethane	2.60	106.56	2.86	106.96	3.32	108.91	3.09	111.71	5.66	106.81	2.38	114.58
2-chloroethanol	4.18	100.65	3.44	99.72	3.47	104.04	4.38	104.22	5.42	102.93	1.25	101.40
2-nitropropane	3.47	102.09	3.16	95.55	4.30	101.03	3.57	95.54	6.06	100.83	4.31	98.02
cis-1,3-Dichloropropene	2.36	102.82	2.28	105.46	2.68	107.06	2.65	112.99	6.17	106.21	1.07	116.38
4-methyl-2-pentanone	5.35	104.90	3.96	104.40	2.55	108.05	1.66	110.88	6.51	105.21	3.50	109.27
Toluene-d8 SUR	3.57	103.36	3.41	107.04	4.40	105.69	4.77	112.32	4.89	104.00	1.76	118.48
<b>Toluene</b>	<b>3.83</b>	<b>97.84</b>	<b>4.05</b>	<b>102.36</b>	<b>4.15</b>	<b>99.59</b>	<b>4.89</b>	<b>107.10</b>	<b>4.62</b>	<b>97.73</b>	<b>1.77</b>	<b>112.15</b>
ethyl methacrylate	3.58	107.10	3.52	107.61	2.41	112.42	1.95	113.64	6.36	110.26	1.35	112.75
trans-1,3-Dichloropropene	2.40	104.44	1.87	104.31	1.40	110.10	1.75	111.20	6.01	108.95	1.44	113.57
1,1,2-Trichloroethane	3.25	105.28	2.86	106.20	2.25	109.31	2.59	110.87	5.57	106.56	1.41	112.18
Tetrachloroethene	19.64	109.34	15.97	114.68	11.70	126.31	14.18	131.38	8.71	91.23	7.07	94.15
1,3-Dichloropropene	2.83	104.63	2.65	106.63	1.34	107.67	2.64	111.83	6.38	106.16	1.62	112.32
isopropyl acetate	4.73	106.04	3.43	103.32	4.33	111.06	1.96	110.29	6.04	110.38	0.28	109.63
butyl acetate	4.43	105.35	3.71	106.48	2.25	109.50	2.37	112.70	6.43	109.65	1.37	112.48
Dibromochloromethane	3.48	108.67	2.76	109.88	2.37	111.11	2.82	114.43	5.70	109.61	1.89	114.47
2-Hexanone	5.55	104.62	4.15	101.37	2.87	109.20	1.88	108.72	6.98	106.63	2.39	105.32
1,2-Dibromoethane	3.36	106.08	3.19	105.42	2.27	109.69	1.55	112.72	6.08	107.88	2.67	112.22
Chlorobenzene	2.94	95.45	2.97	98.95	2.88	96.31	3.39	101.05	5.98	93.29	1.21	103.78
1,1,1,2-Tetrachloroethane	2.35	100.66	3.04	101.71	3.50	101.57	3.35	103.45	5.19	97.86	1.72	106.13
<b>Ethylbenzene</b>	<b>3.46</b>	<b>97.73</b>	<b>3.95</b>	<b>100.50</b>	<b>4.11</b>	<b>98.42</b>	<b>4.54</b>	<b>102.45</b>	<b>5.16</b>	<b>95.48</b>	<b>1.69</b>	<b>106.02</b>
Xylene (m+p)	3.42	98.44	3.85	101.75	4.02	99.18	4.45	103.48	5.33	95.79	1.43	107.39
Styrene	2.90	99.85	3.10	102.12	2.84	101.34	2.77	104.32	6.08	98.14	0.68	105.60
Xylene (o)	3.48	98.39	3.36	102.75	3.46	99.29	3.60	104.71	5.28	95.83	1.44	108.10
n-amyl acetate	3.88	101.17	3.97	102.63	2.24	103.67	1.40	106.56	6.84	100.83	0.67	104.87
Bromoform	2.72	102.41	3.61	103.91	3.14	102.48	1.45	106.06	6.39	99.41	2.05	102.37
Isopropylbenzene	3.74	98.91	3.96	102.34	3.98	100.22	4.66	104.77	5.11	97.08	1.24	109.05
cis-1,4-dichloro-2-butene	3.54	98.63	3.05	96.46	2.86	104.25	3.27	102.49	7.30	102.56	1.64	101.45
BFB SUR	2.25	93.34	2.59	96.94	2.40	93.39	2.74	99.33	5.68	89.58	1.06	99.98
Bromobenzene	2.49	95.81	2.82	95.78	4.86	96.37	3.65	97.98	5.98	91.90	1.04	96.78
1,2,3-Trichloropropane	2.94	97.26	2.45	96.97	2.57	98.38	2.01	100.27	5.82	95.39	2.27	97.80
1,1,1,2-Tetrachloroethane	3.17	93.82	3.13	95.27	2.95	93.21	2.97	95.94	6.57	93.09	1.61	96.13
n-Propylbenzene	3.66	94.33	3.60	97.87	3.79	94.40	4.60	99.33	4.88	90.98	1.39	102.83
trans-1,4-dichloro-2-butene	3.63	92.58	2.16	89.79	4.02	95.02	3.94	95.58	6.58	93.78	1.17	93.85
2-Chlorotoluene	2.89	93.16	3.36	96.74	3.49	93.78	4.43	99.91	4.76	90.00	1.16	102.25
4-Chlorotoluene	2.73	93.22	3.73	96.71	3.45	93.40	3.58	99.08	5.00	89.26	0.90	99.17
1,3,5-Trimethylbenzene	.07	94.78	3.63	98.22	3.57	94.86	4.39	100.14	4.68	91.69	1.56	103.72
tert-Butylbenzene	4.05	94.50	4.48	98.51	3.98	94.47	4.83	100.10	4.40	91.29	1.20	103.82
sec-Butylbenzene	3.60	96.09	3.80	98.97	3.35	96.85	4.93	101.10	4.59	93.25	0.88	105.25
1,2,4-Trimethylbenzene	3.24	95.56	3.37	98.79	3.22	96.03	3.86	100.61	4.93	92.39	1.34	103.17
nitrobenzene	7.51	92.97	5.00	87.75	7.07	87.55	4.70	84.78	11.02	81.11	1.04	77.37
1,3-Dichlorobenzene	2.67	92.88	2.37	95.06	2.34	93.04	3.24	97.64	5.55	89.10	0.73	99.18
1,4-Dichlorobenzene	2.33	92.04	2.94	94.44	2.61	92.35	3.08	96.08	5.00	88.76	0.69	97.45
Isopropyltoluene	3.61	95.34	3.59	98.14	3.93	96.25	4.93	100.54	4.94	92.70	1.58	104.20
1,2,-Dichlorobenzene	2.58	93.78	2.96	95.19	2.07	94.03	2.82	97.03	5.86	90.39	1.41	97.35
n-Butylbenzene	4.01	93.62	3.92	98.19	4.27	96.00	4.62	100.99	4.92	93.04	1.46	105.03
1,2-Dibromo-3-chloropropane	4.22	94.90	3.84	91.97	5.37	95.96	2.54	93.08	5.62	92.29	2.34	91.03
1,2,4-Trichlorobenzene	2.18	94.30	2.71	97.33	2.08	95.61	2.39	100.10	5.14	91.50	0.68	99.90
Naphthalene	3.74	95.90	2.54	96.92	2.25	97.22	1.24	99.74	6.54	93.14	1.05	96.75
Hexachlorobutadiene	5.07	94.87	5.39	96.09	4.18	98.60	5.57	100.12	5.50	97.00	0.28	104.18
1,2,3-Trichlorobenzene	2.66	93.64	3.19	97.28	2.11	95.04	2.11	100.20	5.64	90.16	1.00	98.70

**Table 5: Precision and Accuracy Data over Three Days (CCC Compounds Highlighted in Orange)**





**Figure 3: Concentrator 1 Internal Standard Study**



**Figure 4: Concentrator 2 Internal Standard Study**

Compound	Concentrator 1 Day 1	Concentrator 2 Day 1	Concentrator 1 Day 2	Concentrator 2 Day 2	Concentrator 1 Day 3	Concentrator 2 Day 3
	%RSD	%RSD	%RSD	%RSD	%RSD	%RSD
pentafluorobenzene	1.61	1.47	3.68	1.99	1.42	2.36
1,4-Difluorobenzene	1.80	1.16	2.71	1.70	1.36	2.25
Chlorobenzene-d5	1.51	1.43	2.55	1.34	0.67	1.44
1,4-Dichlorobenzene-d4	1.54	1.20	2.09	1.03	0.10	1.79

**Table 6: Internal Standard Daily Precision and Accuracy**

## Conclusion:

The data presented displays the capability of the dual sampling system to not only produce a valid EPA Method 8260b curve, but also to maintain the curve and produce viable CCV samples and hold precision and accuracy over an extended period of time. A single system is limited by purge and trap method requirements and thus the sampling time is approximately one sample every 25 to 30 minutes. The dual system on the other hand, is limited only by the GC/MS cycle time and therefore sample production can be increased to one sample every 15 minutes. The dual system requires two purge and trap concentrators and only one Centurion WS autosampler and one GC/MS. This configuration delivers the productivity of two full systems at a cost of little more than one.

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