



Sitelab's UVF-Trilogy analyzer uses ultraviolet fluorescence to determine the concentrations of polycyclic aromatic hydrocarbons (PAHs) in the C10 to C22 carbon range, specifically as the sum of the 16 PAH compounds on U.S. EPA's priority pollutant compound list plus 2-Methylnaphthalene, for a total of 17 compounds which all have specific toxicity limits. This analysis is called PAHs or Target PAHs in this method. The analyzer can also be used to quantitate PAH fractions or carbon ranges typically performed using Extractable Petroleum Hydrocarbon methods using GC instrumentation. This analysis is called EPH Aromatics in this method. UVF cannot quantitate individual PAH compounds.

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Sitelab UVF-Trilogy Analyzer with PAHS Module Inserted



PAHS Module for Target PAHs, EDRO Module for EPH Aromatics



Sitelab PAH Calibration Kits: CAL-060M, CAL-060H

TABLE 1

COMPOSITION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)
IN CERTIFIED REFERENCE MATERIALS USED FOR UVF ANALYSIS

Compounds Listed in C10 – C22 Range	AccuStandard DRH-006S 17 Compounds	AccuStandard ASM-098-5X 16 Compounds	ERA 715 PAHs in Water Lot P318-715	ERA 715 PAHs in Water Lot P321-715	ERA 722 PAHs in Soil Lot D115-722
	PAH Content %	PAH Content %	PAH Content %	PAH Content %	PAH Content %
Naphthalene	5.9	6.3	10.1	11.0	2.7
2-Methylnaphthalene	5.9	0	0	0	0
Acenaphthylene	5.9	6.3	20.7	25.1	10.0
Acenaphthene	5.9	6.2	10.1	14.7	14.8
Fluorene	5.9	6.2	11.8	3.3	6.8
Phenanthrene	5.9	6.2	5.9	5.5	12.7
Anthracene	5.9	6.3	2.0	4.4	7.8
Fluoranthene	5.8	6.2	6.5	2.3	5.0
Pyrene	5.9	6.3	7.2	3.1	6.5
Benzo[a]Anthracene	5.9	6.2	1.8	4.3	7.3
Chrysene	5.9	6.2	6.2	5.2	6.3
Benzo[b]Fluoranthene	5.9	6.3	1.2	3.0	2.1
Benzo[k]Fluoranthene	5.9	6.2	1.7	5.2	2.1
Benzo[a]Pyrene	5.9	6.2	6.0	1.3	3.3
Indeno[1,2,3-cd]Pyrene	5.9	6.3	2.1	3.0	2.5
Dibenz[a,h]Anthracene	5.9	6.3	5.4	2.8	3.5
Benzo[g,h,i]Perylene	5.9	6.2	1.2	5.6	6.6
Total PAH Content %	100	100	100	100	100

This data is provided for guidance purposes only. Certified Reference Materials (CRMs) supplied by AccuStandard contain PAH mixtures with 17 or 16 compounds at equal concentrations. Composition of PAHs in CRMs supplied by Environmental Resource Associates (ERA) vary from lot to lot or by part number. ERA's CRMs are developed to validate Method 8310 and are suitable to validate this method.

TABLE 2

FLUORESCENCE RESPONSE OF POLYCYCLIC AROMATIC COMPOUNDS IN METHANOL
COMPARING TWO REFERENCE STANDARDS USED FOR CALIBRATION AND ANALYSIS

UVF Analyzer with PAH Optics, Calibrations and Analysis in Methanol Solvent			Calibration 1: 17 PAHs, AccuStandard DRH-006S	Calibration 2: 16 PAHs, AccuStandard ASM-098-5X	
Example Compounds in C10 – C22 Range	Molecular Weight (g·mol ⁻¹)	Aromatic Rings per Compound	Fluorescence Response (%)	Fluorescence Response (%)	RPD
Naphthalene, C10	128	2 Rings	0.07	0.06	15.4
2-Methylnaphthalene, C11	142	2 Rings	0.20	0.18	10.5
Phenanthrene, C14	178	3 Rings	11.7	10.8	8.0
Anthracene, C14	178	3 Rings	475	440	7.6
Fluoranthene, C16	202	4 Rings	12.5	11.7	6.6
Pyrene, C16	202	4 Rings	13.8	12.8	7.5
Benzo[a]Anthracene, C18	228	4 Rings	94	87	7.7
Chrysene, C18	228	4 Rings	38	35	8.2
Benzo[k]Fluoranthene, C20	252	5 Rings	645	600	7.2
Benzo[a]Pyrene, C20	252	5 Rings	330	308	6.9
Dibenz[a,h]Anthracene, C22	278	5 Rings	11.0	10.3	6.6
17 Compound PAH Mixture Standard Response:			100	93	7.3
16 Compound PAH Mixture Standard Response:			108	100	7.7

This data is provided for guidance purposes only. Fluorescence response was calculated by dividing sample readings by the concentration of the standard used and shown as a percentage. Response varies depending on the size and shape of each molecule.

The 16 compound mixture fluoresces 1.08 times stronger compared to the 17 compound mixture due to the absence of 2-Methylnaphthalene. Relative percent difference (RPD) values show subtle variances analyzing 11 PAH compounds and the two calibration standards. RPDs exhibited in most of the samples ranged from 6% to 8%.

TABLE 3

SPIKE RECOVERY ANALYSIS TESTING PAHS IN WATER COMPARING TWO REFERENCE STANDARDS PREPARED IN HEXANE USED FOR UVF CALIBRATION AND ANALYSIS

UVF-Trilogy with PAHS Module, Calibrations and Analysis in Hexane Solvent	Spike Conc. µg/L	Calibration 1: 17 PAH Compounds, AccuStandard DRH-006S (Sitelab CAL-060H)		Calibration 2: 16 PAH Compounds, AccuStandard ASM-098-5X	
		Result µg/L	%Recovery	Result µg/L	%Recovery
5 Drinking Water Samples					
Unspiked Sample	0	0.0		0.0	
Spike 1, 17 PAHs	50	51	102%	48	96%
Spike 2, 16 PAHs	50	59	118%	56	112%
Spike 3, 17 PAHs	100	107	107%	101	101%
Spike 4, 16 PAHs	100	110	110%	105	105%
5 Pond Water Samples					
Unspiked Sample	0	0.2		0.2	
Spike 1, 17 PAHs	50	54	108%	51	102%
Spike 2, 16 PAHs	50	51	102%	52	104%
Spike 3, 17 PAHs	100	101	101%	95	95%
Spike 4, 16 PAHs	100	101	101%	95	95%
5 River Water Samples					
Unspiked Sample	0	0.5		0.5	
Spike 1, 17 PAHs	50	46	91%	44	87%
Spike 2, 16 PAHs	50	48	95%	46	91%
Spike 3, 17 PAHs	100	101	101%	96	96%
Spike 4, 16 PAHs	100	105	105%	99	99%

This data is provided for guidance purposes only. Spike recovery values testing three types of water ranged from 88% to 118%. Spikes 1 and 3 contain a 17 PAH compound mixture in methanol using the same Certified Reference Material (CRM) in Calibration 1. Spikes 2 and 4 contain a 16 PAH compound mixture in methanol using the CRM in Calibration 2. Results exhibited show little difference using the two PAH mixtures; both are suitable for analysis.

TABLE 4

POLYCYCLIC AROMATIC HYDROCARBONS IN WATER TESTING TWO LOTS OF ERA CRM 715 PROFICIENCY SAMPLES CONTAINING LOW CONCENTRATIONS OF PAHS

UVF-Trilogy with PAHS Module, Calibrations and Analysis in Hexane Solvent	Sample 1 µg/L	Sample 2 Duplicate µg/L	Average Result µg/L	Total 16 PAHs Certified Value µg/L	%R
Lot 1 Water Study:					
1. PAH Water Standard, ERA 715, Lot P318-715	56.0	62.0	59.0	60.9	97%
2. Target PAHs Standard, Sitelab CAL-060H	30.0	32.0	31.0	60.9	51%
	ERA Proficiency Study, Lot P318-715 Total 16 PAH Compounds Mean Result: (Based on 46 lab tests)		45.2	60.9	74%
Lot 2 Water Study:					
1. PAH Water Standard, ERA 715, Lot P321-715	69.0	73.0	71.0	70.5	101%
2. Target PAHs Standard, Sitelab CAL-060H	50.0	52.0	51.0	70.5	72%
	ERA Proficiency Study, Lot P321-715 Total 16 PAH Compounds Mean Result: (Based on 37 lab tests)		57.4	70.5	81%

This data is provided for guidance purposes only. UVF calibrations performed using two CRMs supplied in methanol by Environmental Resource Associates (ERA), containing 16 PAH compounds at varying concentrations, with calibration standards prepared in hexane. Additional calibrations performed using Sitelab CAL-060H for comparison.

Samples spiked 1:1000 in tap water using ERA's 715 standards and extracted in hexane for analysis. Sample 1 was extracted 15 minutes after preparation. Sample 2 was extracted 1 hour after preparation.

PAH tests performed produced accurate recoveries >50%. Calibrations using Sitelab's Target PAH standard exhibited lower recoveries due to its different composition of PAHs. No QC or PT Performance Acceptance Limits are provided by ERA 715 for Total PAH concentrations; only individual compound limits are provided.

TABLE 5

ACCURCY AND PRECISION USING TWO UVF ANALYZERS TESTING TARGET PAHS IN
SOIL USING ERA CRM 722 PROFICIENCY SAMPLE

UVF-Trilogy with PAHS Module, Calibrations and Analysis in Methanol Solvent	Sample 1 ug/Kg	Sample 2 Duplicate ug/Kg	Average Result ug/Kg	Total 16 PAHs Certified Value ug/Kg	%R
Analyzer 1:					
PAH Factory Calibration, Sitelab CAL-060M, Lot 1	4,400	5,000	4,700	5,838	81%
Analyzer 2:					
PAH Factory Calibration, Sitelab CAL-060M, Lot 2	4,360	4,800	4,580	5,838	78%
	ERA Proficiency Study, Lot D115-722 Total 16 PAH Compounds Mean Result: (Based on 39 lab tests)		4,029	5,838	69%

This data is provided for guidance purposes only. Two soil samples containing 10-g each were extracted in 20 mL methanol solvent for 24 hours. PAH tests performed produced accurate recoveries >50%. No QC or PT Performance Acceptance Limits are provided by ERA 722 for Total PAH concentrations; only individual compound limits are provided.

TABLE 6

SPIKE RECOVERY ANALYSIS TESTING SOILS AND OTHER SOLID MATRICES IN
METHANOL SPIKED WITH 17 COMPOUND PAH MIXTURE AT THREE CONCENTRATIONS

UVF with PAHS Module, Target PAHs using Sitelab CAL-060M	Sample with No Spike mg/Kg	Spike 1 5 ppm		Spike 2 10 ppm		Spike 3 200 ppm	
		mg/Kg	%R	mg/Kg	%R	mg/Kg	%R
Play Sand	0.02	5.2	104%	10.4	104%	202	101%
Sandy Loam Soil	0.06	4.8	95%	9.6	95%	184	92%
Clay	0.04	4.6	91%	9.8	98%	180	90%
ERA 570 TPH Soil	1.6	6.2	92%	11	94%	182	90%
Charcoal Grill Briquets	11	13	40%	14	30%	82	36%
Charcoal Grill Ash	0.08	0.12	0.8%	0.12	0.4%	3.8	1.9%

This data is provided for guidance purposes only. Samples contained 5-g each extracted in 20 mL methanol solvent for 24 hours. Percent recovery (%R) values account for sample concentrations without spike added. Most recoveries (%R) exhibited were >50%. Poor recoveries observed in the charcoal and ash samples due to matrix effects or interferences.

Environmental Resource Associates (ERA) CRM 570 Total Petroleum Hydrocarbons (TPH) in Soil, Lot D118-632, contains 579 mg/Kg TPH by Gravimetric and 712 mg/Kg TPH by Infrared. This product contains vacuum pump oil.

TABLE 7

**SPIKE RECOVERY ANALYSIS USING LABORATORY CONTROL SAMPLE TESTING
TARGET PAHS IN SOILS SPIKED WITH NIST SRM 2779 GULF OF MEXICO CRUDE OIL**

Low Oil Spiked Samples:	Sample with No Spike mg/Kg	Spike 1 100 ppm mg/Kg	100 ppm LCS Oil Standard Response	
			mg/Kg	%Recovery
Beach Sand	0.04	2.8	3.0	92%
Sandy Loam Soil	0.06	2.6	3.0	85%
Clay	0.04	2.2	3.0	72%
ERA 570 TPH Soil 1	1.6	4.4	3.0	93%
ERA 570 TPH Soil 2	1.8	4.6	3.0	93%
	Target PAHs LCS Acceptance Criteria: (single laboratory in-house QC study)		2.7 – 3.3	
High Oil Spiked Samples:	Sample with No Spike mg/Kg	Spike 2 5,000 ppm mg/Kg	5,000 ppm LCS Oil Standard Response	
			mg/Kg	%Recovery
Beach Sand	0.04	140	150	93%
Sandy Loam Soil	0.06	130	150	87%
Clay	0.04	130	150	87%
ERA 570 TPH Soil 1	1.6	130	150	86%
ERA 570 TPH Soil 2	1.8	100	150	65%
	Target PAHs LCS Acceptance Criteria: (single laboratory in-house QC study)		135 – 165	

This data is provided for guidance purposes only. Study performed using UVF-Trilogy analyzer with PAHS Module calibrated to Sitalab CAL-060M in methanol. The LCS standard fluoresces 33 times lower due to the different composition of PAH compounds in the oil. PAH tests performed produced accurate recoveries >50%.

Environmental Resource Associates (ERA) 570 TPH Soil CRMs contain vacuum pump oil with different composition. TPH in Soil 1, Lot D118-632, contains 579 mg/Kg TPH by Gravimetric and 712 mg/Kg TPH by Infrared. TPH in Soil 2, Lot D116-632, contains 1,770 mg/Kg TPH by Gravimetric and 2,180 mg/Kg by Infrared.

TABLE 8

EXAMPLE PAH RESULTS IN SOILS, SEDIMENTS AND OTHER SOLIDS FROM DIFFERENT
CONTAMINATED SITES COMPARED TO LABORATORY GC RESULTS

Site Description, Matrix Contaminant	Sample Number	UVF Target PAHs mg/Kg	Lab GC/MS Total PAHs mg/Kg	RPD
Petroleum Tank Farm Soils, Mixed Fuel Oil Site	1	3	ND <1	---
	2	75	80	7%
	3	97	82	17%
	4	180	130	32%
	5	370	350	6%
	6	455	682	40%
Underground Storage Tank Soils, Diesel Fuel Site	7	8	6.8	16%
	8	17	15	13%
	9	60	57	5%
Underground Storage Tank Soils, Gasoline Site	10	4.4	3.0	38%
	11	7.7	6.0	25%
	12	30	21	35%
U.S. AFB Power Plant Soils, Coal Ash Site	13	9	10	11%
	14	16	13	21%
	15	30	21	35%
MGP Coal Tar Site River Sediments, Colorado	16	110	113	3%
	17	600	666	10%
	18	1,500	1,200	22%
MGP Coal Tar Site, River Sediments, North Carolina	19	44	46	4%
	20	184	174	6%
Urban Fill, Soil with Asphalt and Coal Ash	21	61	69	12%
Dry Pavement Sealer, Ethylene Cracked Residue	22	26,000	25,585	2%
Dry Pavement Sealer, Refined Coal Tar	23	70,000	77,779	11%

This data is provided for guidance purposes only. UVF performed using PAH optics calibrated to Sitelab CAL-060M in methanol. Confirmatory results performed by certified laboratories using U.S. EPA Method 8270 or MADEP EPH Method testing split samples. Concentrations of the 17 compounds were added together to report Total PAHs.

TABLE 9

**FLUORESCENCE RESPONSE OF PAH COMPOUNDS AND FUEL OILS COMPARING
EPH AROMATICS AND TARGET PAHS CALIBRATED TO 17 COMPOUND STANDARD**

Analyzers Calibrated to Sitalab CAL-060M	UVF-Trilogy with EDRO Optics	UVF-Trilogy with PAH Optics	
Example PAHs with Carbon Size and Fuel Oils Tested for Comparison	EPH Aromatics, Fluorescence Response (%)	Target PAHs, Fluorescence Response (%)	Response Factor Exhibited (RF)
Naphthalene, C10	30	0.07	434
2-Methylnaphthalene, C11	55	0.20	275
Phenanthrene, C14	320	11.7	27
Anthracene, C14	370	475	0.78
Benzo[k]Fluoranthene, C20	80	645	0.12
Benzo[a]Pyrene, C20	33	330	0.10
No. 2 Fuel Oil	25	0.70	36
No. 4 Fuel Oil	50	5.0	10
No. 6 Fuel Oil	80	10.0	8.0
Light Crude Oil, NIST SRM 2779	28	3.0	9.3

This data is provided for guidance purposes only. Samples analyzed using configurations in Sec. 6.2.1 and 6.2.2.

TABLE 10

**EPH AROMATICS IN SOILS FROM FUEL OIL SITES COMPARED TO MADEP EPH C11-C22
AROMATIC HYDROCARBONS PERFORMED BY CERTIFIED LABORATORIES**

Example Soils from NAPL Plume Investigations with Low to High Concentrations	Sample Number	UVF EPH Aromatics mg/Kg	Lab GC/FID EPH Aromatics mg/Kg	RPD
Tank Farm, Massachusetts Mixed Fuel Oil Site	1	1,100	1,130	3%
	2	3,585	4,600	25%
	3	7,200	6,820	5%
Wire Factory, Connecticut No. 6 Fuel Oil Site	4	5,250	4,800	9%
	5	9,100	11,000	19%
	6	23,600	21,000	12%

This data provided is for guidance purposes only. UVF calibrated to Sitalab CAL-060M using EDRO Optics.