



Sitelab's UVF-Trilogy analyzer uses ultraviolet fluorescence to determine the concentrations of Diesel Range Organics (DRO) from C10 to C28 plus Oil Range Organics (ORO) from C28 to C36 to measure Extended Diesel Range Organics (EDRO) from C10 to C36. This method cannot distinguish these individual carbon ranges and for the purpose of this document evaluation of C10 to C36 is cited as DRO and EDRO, interchangeably. Specifically, this method detects polycyclic aromatic hydrocarbons only, with no or little sensitivity to monoaromatic hydrocarbons, including BTEX (benzene, toluene, ethylbenzene, and xylenes) below the C10 carbon weight. UVF is not sensitive to aliphatic hydrocarbons.

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Sitelab UVF-Trilogy Analyzer
with EDRO UV Module Inserted



EDRO UV Module is Fitted
with 255nm LED and Optical Filters



Sitelab EDRO Calibration Kits:
CAL-042M, CAL042H

TABLE 1

DRO FLUORESCENCE RESPONSE OF AROMATIC HYDROCARBONS

UVF-Trilogy with EDRO Module, Calibrations and Analysis in Methanol Solvent	CAS Number	Molecular Weight (g·mol ⁻¹)	Carbon Number	Factory Calibration, Sitelab EDRO Standard Part No. CAL-042M Fluorescence Response (%)
Polycyclic Aromatic Compounds:				
Naphthalene	91-20-3	128	C10	84
2-Methylnaphthalene	91-57-6	142	C11	160
Phenanthrene	85-01-6	178	C14	900
Anthracene	120-12-7	178	C14	1,280
Benzo[a]Anthracene	56-55-3	228	C18	130
Chrysene	218-01-9	228	C18	740
Benzo[k]Fluoranthene	207-08-9	252	C20	230
Benzo[a]Pyrene	50-32-8	252	C20	122
Dibenz[a,h]Anthracene	53-70-3	278	C22	12
Sitelab EDRO Standard Response for Comparison:				100
Monoaromatic Compounds:				
Benzene	71-43-2	78	C6	0.10
Toluene	108-88-3	92	C7	0.25
Ethylbenzene	100-41-4	106	C8	0.20
m-Xylene	108-38-3	106	C8	0.34
o-Xylene	95-47-6	106	C8	0.50
p-Xylene	106-42-3	106	C8	1.00
1,3,5-Trimethylbenzene	108-67-8	120	C9	1.50

This data is provided for guidance purposes only. Examples shown here compare the fluorescence of PAHs and monoaromatic compounds measured using Sitelab's EDRO standard used to factory calibrate the UVF-Trilogy analyzer. Samples supplied in methanol using Certified Reference Materials (CRMs) made by AccuStandard, Inc.

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. PAH compounds in the exhibit high response. Monoaromatics exhibit very low response and contribute little to DRO detection.

TABLE 2

DRO FLUORESCENCE RESPONSE OF FUELS AND OILS

U VF-Trilogy with EDRO Module, Calibration and Analysis in Methanol Solvent	CAS No.	Source	Fluorescence Response (%)	Factory Calibration, Sitelab EDRO Standard Part No. CAL-042M
Automotive and Heating Fuels with Low to High DRO Content:				
Gasoline, Regular 87 Octane	8006-61-9	Retail	0.7	
50% Weathered Gasoline	8006-61-9	CRM	6.0	
Weathered Gasoline, UST Site	N/A	NAPL	10	
Ultra-Low Sulfur Diesel Fuel	68476-34-6	CRM	7.5	
Highway Diesel, Ultra-Low Sulfur	68476-34-6	Retail	18	
No. 2 Diesel Fuel, High Sulfur	68334-30-5	CRM	62	
No. 2 Fuel Oil	68476-30-2	CRM	68	
Weathered Diesel, UST Site	N/A	NAPL	90	
No. 4 Fuel Oil	68476-31-3	CRM	158	
No. 6 Fuel Oil	68553-00-4	CRM	265	
Other Fuels and Oils with Low to High DRO Content:				
Kerosene	8008-20-6	CRM	1.8	
JET-A Jet Fuel	8008-20-6	CRM	5.0	
Weathered Jet Fuel, UST Site	N/A	NAPL	10	
Transformer Oil	64742-53-6	CRM	10	
Light Crude Oil, NIST 2779	8002-05-9	SRM	75	
Heat Transfer Fluid	101-84-8	Retail	150	
Coal Tar, MGP Site	N/A	NAPL	400	
Creosote, Wood Treatment Site	N/A	NAPL	750	
		Sitelab EDRO Standard Response for Comparison:	100	

This data is provided for guidance purposes only. Response in fuels and oils varies in DRO content, shown here calibrated to Sitelab's EDRO standard. Samples consisted of CRMs, Non-Aqueous Phase Liquids (NAPL) collected from oil recovery wells, light crude oil and other samples collected from retail stores or manufacturers for comparison.

TABLE 3

DIESEL RANGE ORGANICS IN WATER TESTING ERA AND NSI PROFICIENCY SAMPLES

UVF-Trilogy with EDRO Module Comparing 3 Calibrations, Samples Tested in Hexane	Sample 1 µg/L	Sample 2 Duplicate µg/L	Average Result µg/L	Certified Value µg/L	%R
PT Study 1: Environmental Resource Associates					
1. DRO Water Standard, ERA 764, Lot P315-764	1,798	1,714	1,756	1,770	99%
2. No. 2 Diesel Fuel Standard, AccuStandard FU-009-40X	368	350	359	1,770	20%
3. EDRO Calibration Standard, Sitelab CAL-042H	214	204	209	1,770	12%
	ERA Proficiency Study, Lot P315-764 Diesel Range Organics Mean Result:		1,250	1,770	71%
	QC Performance Acceptance Limits:		556 – 2,040		
	PT Performance Acceptance Limits:		219 – 2,350		
PT Study 2: NSI Lab Solutions, LLC					
1. DRO Water Standard, NSI QC-115, Lot U0223	1,900	1,950	1,925	1,880	102%
2. No. 2 Diesel Fuel Standard, AccuStandard FU-009-40X	430	450	440	1,880	23%
3. EDRO Calibration Standard, Sitelab CAL-042H	270	280	275	1,880	15%
	NSI Proficiency Study, Lot U0223 Diesel Range Organics Mean Result:		1,300	1,880	69%
	PT Study Acceptance Limits:		415 – 2,460		

This data is provided for guidance purposes only. UVF performed using three calibrations using different standards available for comparison.

Samples spiked 1:1000 in tap water using DRO standards provided with each vendor's product. Samples extracted using hexane. Samples 1 were extracted 15 minutes after preparation. Samples 2 were extracted 1 hour after preparation.

DRO analysis performed best using ERA's and NSI's DRO standards. Percent recovery (%R) values are within each vendor's Acceptance Limits. Both ERA and NSI use ultra-low sulfur diesel (USLD), CAS #68476-34-6, in their water and soil proficiency testing products. Calibrations using Sitelab EDRO and AccuStandard No.2 Diesel Fuel produced lower recoveries due to their higher aromatic composition.

TABLE 4

DIESEL RANGE ORGANICS IN SOIL TESTING ERA AND NSI PROFICIENCY SAMPLES

UVF-Trilogy with EDRO Module Comparing 3 Calibrations, Samples Tested in Methanol	Sample 1 mg/Kg	Sample 2 Duplicate mg/Kg	Average Result mg/Kg	Certified Value mg/Kg	%R
PT Study 1: Environmental Resource Associates					
1. DRO Water Standard, ERA 764, Lot P315-764	2,010	1,710	1,860	1,850	101%
2. No. 2 Diesel Fuel Standard, AccuStandard FU-009-40X	340	290	315	1,850	17%
3. EDRO Calibration Standard, Sitelab CAL-042M	210	180	195	1,850	11%
	ERA Proficiency Study, Lot D115-765 Diesel Range Organics Mean Result:		1,350	1,850	73%
	QC Performance Acceptance Limits:		829 – 2,150		
	PT Performance Acceptance Limits:		478 – 2,220		
PT Study 2: NSI Lab Solutions, LLC					
1. DRO Water Standard, NSI QC-115, Lot U0223	2,040	2,216	2,128	2,200	97%
2. No. 2 Diesel Fuel Standard, AccuStandard FU-009-40X	484	522	503	2,200	23%
3. EDRO Calibration Standard, Sitelab CAL-042M	300	326	313	2,200	14%
	NSI Proficiency Study, Lot U0223 Diesel Range Organics Mean Result:		2,114	2,200	96%
	PT Study Acceptance Limits:		793 – 3,610		

This data is provided for guidance purposes only. UVF performed using three calibrations using different standards available for comparison.

Soils provided by each vendor were analyzed in duplicate using 10 grams each extracted in 20 mL methanol for 24 hours.

DRO analysis performed best using ERA's and NSI's DRO standards. Percent recovery (%R) values are within each vendor's Acceptance Limits. Both ERA and NSI use ultra-low sulfur diesel (USLD), CAS #68476-34-6, in their water and soil proficiency testing products. Calibrations using Sitelab EDRO and AccuStandard No.2 Diesel Fuel produced lower recoveries due to their higher aromatic composition.

TABLE 5

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

UVF-Trilogy Calibrated to EDRO using CAL-042M, Samples Tested in Methanol	Sample with No Spike mg/Kg	Sample with 100 ppm Spike mg/Kg	LCS Oil Standard 100 ppm Response mg/Kg	%R
Beach Sand	0.5	73	75	97%
Sandy Loam Soil	0.7	70	75	92%
Clay	0.3	65	75	86%
ERA 570 TPH Soil 1	33	99	75	88%
ERA 570 TPH Soil 2	57	116	75	77%

This data is provided for guidance purposes only. EDRO tests performed exhibited percent recoveries (%R) >50% using Standard Reference Material (SRM) 2779 by the National Institute of Standards & Technology (NIST).

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 6

**SPIKE RECOVERY AND AQUEOUS STABILITY USING LABORATORY CONTROL SAMPLE
TESTING EDRO IN WATER SPIKED WITH NIST SRM 2779 GULF OF MEXICO CRUDE OIL**

UVF-Trilogy Calibrated to EDRO using CAL-042H, Samples Tested in Hexane		Sample with No Spike mg/L	Sample with 10 ppm Spike mg/L	LCS Oil Standard 10 ppm Response mg/L	%R
Samples Extracted Same Day and 10 Days After Preparation					
30 Minutes	Fresh Water	0.0	6.8	6.6	103%
	Salt Water	0.0	6.2	6.6	94%
3 Hours	Fresh Water	0.0	6.0	6.6	91%
	Salt Water	0.0	6.7	6.6	102%
10 Days	Fresh Water	0.0	5.7	6.6	86%
	Salt Water	0.0	6.2	6.6	94%

This data is provided for guidance purposes only. EDRO tests performed exhibited percent recoveries (%R) >50% using Standard Reference Material (SRM) 2779 by the National Institute of Standards & Technology (NIST).

TABLE 7

EXTENDED DIESEL RANGE ORGANICS IN SOILS TESTING BLIND U.S. EPA PROFICIENCY EVALUATION SAMPLES SPIKED WITH LOW CONCENTRATIONS OF NO. 2 DIESEL FUEL

Contaminant, Matrix	U.S. EPA Sample ID Number	Certified Value mg/Kg	UVF EDRO Result mg/Kg	Lab 8015M EDRO Result mg/Kg	Acceptance Limits mg/Kg
No. 2 Diesel Fuel, Spiked in 7 Soils used for MDL Study	PE S66	37.3	17.9	12.0	18.1 – 47.4
	PE S67	37.3	18.9	16.5	18.1 – 47.4
	PE S68	37.3	17.5	13.7	18.1 – 47.4
	PE S69	37.3	15.8	16.4	18.1 – 47.4
	PE S70	37.3	18.1	17.4	18.1 – 47.4
	PE S71	37.3	19.0	17.2	18.1 – 47.4
	PE S72	37.3	18.5	14.8	18.1 – 47.4
Method Detection Limit (MDL) Reported:			3.4	6.32	

This data is provided for guidance purposes only. Source: U.S. EPA Publication EPA/600/R-01/080 (Table 7.1).

TABLE 8

EDRO RESULTS COMPARED TO TWO CERTIFIED LABORATORY RESULTS USING EPA METHOD 8015M TESTING SOILS WITH HIGH CONCENTRATIONS OF NIGERIA CRUDE OIL

Split Samples Collected from Pipeline Spill Site	Sample 1 mg/Kg	Sample 2 mg/Kg
UVF EDRO Results: Field Sample, Nigeria	7,160	15,150
EPA Method 8105M Results: Nigeria Certified Laboratory	6,829	14,999
RPD:	5%	1.0%
UVF EDRO Results: Confirmatory Sample, United States	7,800	15,430
EPA Method 8015M Results: United States Certified Laboratory	10,200	24,800
RPD:	27%	47%

This data is provided for guidance purposes only. UVF analysis performed using EDRO optics calibrated to Sitelab CAL-042M testing soils with methanol. Nigeria lab performed EPA Method 8015M by GC/FID, detecting hydrocarbons in the C9 to C40 range. U.S. lab performed EPA Method 8015M by GC/FID, detecting hydrocarbons in the C10 to C36 range. Relative percent difference (RPD) values were <50% comparing EDRO and GC/FID results.

TABLE 9

**EDRO RESULTS COMPARED TO TOTAL EPH RESULTS USING MADEP EXTRACTABLE
PETROLEUM HYDROCARBONS METHOD TESTING SOILS FROM FUEL OIL SITE**

Soils Collected from Mixed Fuel Oil Site	Lab EPH C9-C18 Aliphatics mg/Kg	Lab EPH C19-C36 Aliphatics mg/Kg	Lab EPH C11-C22 Aromatics mg/Kg	Total EPH Result mg/Kg	UVF EDRO Result mg/Kg	RPD
1	67	78	98	243	350	36%
2	270	57	140	487	390	22%
3	1,600	170	700	2,470	1,530	47%
4	1700	150	680	2,530	2,200	14%
5	2,700	220	1,200	4,120	4,400	7%
6	3,600	290	1,800	5,690	6,000	5%
7	8,800	750	2,600	12,150	11,200	8%
8	12,000	1,100	3,600	16,700	14,400	15%

This data is provided for guidance purposes only. UVF analysis performed using EDRO optics calibrated to Sitelab CAL-042M testing soils with methanol. Laboratory performed MADEP EPH Method by GC/FID. Total EPH calculated as the sum of aliphatic and aromatic fractions. Relative percent difference (RPD) values exhibited in example results were <50%.

TABLE 10

**EDRO RESULTS COMPARED TO EPH RESULTS USING CANADA EXTRACTABLE
PETROLEUM HYDROCARBONS METHOD TESTING SOILS WITH HEAVY CRUDE OIL**

Soils from Landfill Site with Crude Oil	Lab EPH C10-C16 F2 Fraction mg/Kg	Lab EPH C16-C34 F3 Fraction mg/Kg	Lab F2 + F3 C10-C34 EPH Fractions mg/Kg	UVF EDRO Result mg/Kg	RPD
1	153	2,280	2,433	2,245	8%
2	216	2,300	2,516	2,392	5%
3	302	2,580	2,882	2,429	17%
4	236	2,640	2,876	2,594	10%
5	303	3,560	3,560	3,374	5%

This data is provided for guidance purposes only. UVF analysis performed using EDRO optics calibrated to Sitelab CAL-042M testing soils with methanol. Laboratory performed Canada EPH Method by GC/FID. The F2 and F3 fractions were added together to report diesel and oil range hydrocarbons, similar to EDRO's carbon range sensitivity. Relative percent difference (RPD) values exhibited in example results were <50%.