

Source ID = 302 Liquid Loadout (Recovered Oil)			
Parameter	Recovered Oil Loading	Units	Source / Basis
Material Loaded	Recovered Oil		
Material Temperature	30	°C	Process data
Material Temperature	545.67	°R	
VOC Vapor Pressure (VP)	0.5	psia	Per LAER review for low VP liquids, no limit/controls for liquids with VP < 0.5 psia required
VOC Vapor MW	130	lb/lb-mole	AP-42, Section 7.1 - Table 7.1-2 value for jet kerosene (surrogate material)
Type of Loadout Operation	TRUCK		
Type of Loading System	SUBMERGED		Design/work practice
Annual Loading Rate	210	10 ³ gal/yr	Loading rate is based on ethylene manufacturing unit material balance data
Hourly Loading Rate	3.96	10 ³ gal/hr	Loading rate is based on the maximum rate for the loading pump
Saturation Factor	0.60		S from AP-42, Table 5.2-1 (Submerged loading: dedicated normal service)
VOC Loading Loss Factor	0.992	lb/10 ³ gal	L _L from AP-42 equation (see below) using VP indicated above
Control Efficiency	0%	wt. %	Recovered Oil is uncontrolled due to its low VP
Annual VOC Emission Rate	0.10	T/yr	= (Ann. Loading Rate) x (VOC LL Factor) x (1 - Control Eff.) / (2000 lb/T)
VOC Vapor Pressure	3.45	kPa	= (6.895 kPa/psi) x (VOC Vapor Pressure (VP) (psia))
Annual HAP Emission Rate	0.0002	T/yr	Sum of HAP emission rates calculated below

Emissions Estimates based on Equation 1 in AP-42, 5.2 - Transportation and Marketing of Petroleum Liquids:

$$L_L = 12.46 \frac{SPM}{T}$$

where:

- L_L = loading loss, pounds per 1000 gallons (lb/10³ gal) of liquid loaded
- S = a saturation factor (see Table 5.2-1)
- P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia)
(see Figure 7.1-5, Figure 7.1-6, and Table 7.1-2)
- M = molecular weight of vapors, pounds per pound-mole (lb/lb-mole) (see Table 7.1-2)
- T = temperature of bulk liquid loaded, °R (°F + 460)

Liquid Composition				
Compound	Liquid Wt %¹	Molecular Wt. (lb/lbmol)	lbmol/lb liquid solution	Liquid Mole %
Benzene	0.010%	78.11	1.28E-06	0.021%
1,3-Butadiene	0.0010%	54.09	1.85E-07	0.0030%
Phenol	0.0010%	94.11	1.06E-07	0.0017%
Toluene	0.010%	92.14	1.09E-06	0.018%
Ethylbenzene	0.0010%	106.17	9.42E-08	0.0015%
Xylenes	0.0010%	106.17	9.42E-08	0.0015%
Styrene	0.010%	104.15	9.60E-07	0.016%
Naphthalene	0.010%	128.17	7.80E-07	0.013%
Acenaphthene	0.0010%	154.21	6.48E-08	0.0011%
Acenaphthylene	0.0010%	152.19	6.57E-08	0.0011%
Fluorene	0.0010%	166.22	6.02E-08	0.0010%
Anthracene	0.0010%	178.23	5.61E-08	0.00091%
Phenanthrene	0.0010%	178.23	5.61E-08	0.00091%
Fluoranthene	0.0010%	202.25	4.94E-08	0.00080%
Pyrene	0.0010%	202.25	4.94E-08	0.00080%
Other VOC ²	99.949%	162	6.17E-03	99.92%
Total	100%	-	0.01	100%

1. The liquid weight fraction indicated for each HAP represents a conservative estimate based on recovered oil composition analysis results.

2. The liquid molecular weight for Other VOC was estimated to equal the liquid molecular weight indicated for jet kerosene in AP-42, Section 7.1 - Table 7.1-2.

Vapor Pressure Equation Constants				
Compound	A	B	C	Notes
Benzene ¹	6.906	1,211	220.79	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
1,3-Butadiene ¹	6.873	941.7	240.4	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Phenol ¹	7.122	1,509.7	174.2	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Toluene ¹	7.017	1,377.6	222.64	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Ethylbenzene ¹	6.95	1,419.3	212.61	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Xylenes ¹ (conservatively used <i>p</i> -Xylene VP as VP for all Xylene isomers)	7.021	1,474.4	217.77	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Styrene ¹	7.095	1,525.1	216.77	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Naphthalene ¹	11.4	3,724.1	273.15	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Acenaphthene ²	4.32236	2,062.099	-73.146	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (bar) and $T = \text{temp. } (K)$
Acenaphthylene ² (assumed VP equals Acenaphthene VP)	4.32236	2,062.099	-73.146	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (bar) and $T = \text{temp. } (K)$
Fluorene ²	5.25103	3,011.076	3.857	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (bar) and $T = \text{temp. } (K)$
Anthracene ²	4.72997	2,759.53	-30.753	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (bar) and $T = \text{temp. } (K)$
Phenanthrene ¹	19.813	10,088.9	400	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Fluoranthene ¹	12.836	5,348.1	273.15	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (mmHg) and $T = \text{temp. } (^{\circ}\text{C})$
Pyrene ²	2.68713	1,086.824	-262.849	$\log_{10}(P) = A - (B / (T + C))$; where, $P = VP$ (bar) and $T = \text{temp. } (K)$

1. The vapor pressure equation constants were obtained from AP-42, Section 7.1 - Table 7.1-3.

2. The vapor pressure equation constants were obtained from <https://webbook.nist.gov>.

Vapor Composition					
Compound	Molecular Wt. (lb/lbmol)	Partial Pressure (psia)	Vapor Mole % ¹	lb/lbmol vapor mixture	Vapor Wt %
Benzene	78.11	4.79E-04	0.10%	7.48E-02	0.058%
1,3-Butadiene	54.09	1.42E-03	0.28%	1.54E-01	0.12%
Phenol	94.11	1.78E-07	0.000036%	3.35E-05	0.000026%
Toluene	92.14	1.25E-04	0.025%	2.30E-02	0.018%
Ethylbenzene	106.17	3.71E-06	0.00074%	7.88E-04	0.00061%
Xylenes	106.17	3.47E-06	0.00069%	7.36E-04	0.00057%
Styrene	104.15	2.47E-05	0.0049%	5.15E-03	0.0040%
Naphthalene	128.17	3.19E-07	0.000064%	8.17E-05	0.000063%
Acenaphthene	154.21	3.46E-09	0.00000069%	1.07E-06	0.00000082%
Acenaphthylene	152.19	3.51E-09	0.00000070%	1.07E-06	0.00000082%
Fluorene	166.22	3.92E-09	0.00000078%	1.30E-06	0.0000010%
Anthracene	178.23	5.24E-10	0.00000010%	1.87E-07	0.00000014%
Phenanthrene	178.23	3.94E-11	0.000000079%	1.40E-08	0.000000011%
Fluoranthene	202.25	2.42E-12	0.0000000048%	9.80E-10	0.0000000076%
Pyrene	202.25	6.09E-29	0.0000000000000000%	2.46E-26	0.0000000000000000%
Other VOC	130	0.498	99.59%	129.46	99.80%
Total	-	0.500	100%	130	100%

1. The vapor mole fraction was calculated using Raoult's law.

HAP Emission Rate Calculation

Pollutant	Short-Term Max. Emission Rate (lb/hr)	Annual Emission Rate (tpy)
Benzene	2.27E-03	6.01E-05
1,3-Butadiene	4.66E-03	1.24E-04
Phenol	1.02E-06	2.69E-08
Toluene	6.96E-04	1.84E-05
Ethylbenzene	2.39E-05	6.33E-07
Xylenes	2.23E-05	5.91E-07
Styrene	1.56E-04	4.13E-06
Naphthalene	2.47E-06	6.56E-08
Acenaphthene	3.24E-08	8.58E-10
Acenaphthylene	3.24E-08	8.58E-10
Fluorene	3.95E-08	1.05E-09
Anthracene	5.66E-09	1.50E-10
Phenanthrene	4.25E-10	1.13E-11
Fluoranthene	2.97E-11	7.86E-13
Pyrene	7.46E-28	1.98E-29