

ROC/VOC Emission Factors and Reactivities – Version 1.2, March 12, 2001

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
Oil/Water Separators	use Appendix A, Section III of P&P and the FROG value	use Appendix A, Section III of P&P	MM gallons/day	0.606	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (5)
Sumps, Waste Water Tanks and Well Cellars	use Appendix A, Section II of P&P and the FROG value	use Appendix A, Section II of P&P	ft ²	0.606	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (5)
FHC: Valves and Fittings (non-component count method)	use Tables I.1, I.2 and I.3 of P&P and the FROG value	use Tables I.1, I.2 and I.3 of P&P	lb/day-well	0.391	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 References (2) and (5)
FHC: Pumps (non-component count method)	use Appendix A, Section IV of P&P and the FROG value	use Appendix A, Section IV of P&P	# of wells	0.492	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (5)
FHC: Well Heads (non-component count method)	use Appendix A, Section IV of P&P and the FROG value	use Appendix A, Section IV of P&P	# of wells	0.606	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (5)
FHC: Compressors (non-component count method)	use Appendix A, Section IV of P&P and the FROG value	use Appendix A, Section IV of P&P	# of wells	0.262	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (5)
FHC: Enhanced Oil Recovery Fields (non-component count method)	use Appendix A, Section V of P&P and the FROG value	use Appendix A, Section V of P&P	# of wells	0.912	P&P 6100.060.096 CARB/KVB Method	P&P 6100.060.096 Reference (3)

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
FHC: Offshore Platforms (component count) - Gas/Condensate Service (all types) - Oil Service (all types)	use Table 2 of P&P	use Table 2 and FROG value from the P&P	lb/day-leak path	0.33 (gas) 0.33 (oil)	P&P 6100.061.096 Tecolote Method	Tecolote Report (1986)
FHC: Production Field (component count) - Gas/Condensate Service (all types) - Oil Service (all types)-	use Table 2 of P&P	use Table 2 and FROG value from the P&P	lb/day-leak path	0.31 (gas) 0.56 (oil)	P&P 6100.061.096 API Method	API Report (1980)
FHC: Refinery (component count) - Gas/Condensate Service (all types) - Oil Service (all types)	use Table 2 of P&P	use Table 2 and FROG value from the P&P	lb/day-leak path	0.99 (gas) 0.99 (oil)	P&P 6100.061.096 EPA AP-42	EPA AP-42

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
<p>FHC: Gas Processing Plant (component count)</p> <ul style="list-style-type: none"> - Gas/Condensate: valve - Gas/Condensate: connection - Gas/Condensate: compressor seal - Gas/Condensate: pump seal - Gas/Condensate: pressure relief - Oil Service (all types) 	use Table 2 of P&P	use Table 2 and FROG value from the P&P	lb/day-leak path	<p>0.38 (gas valve)</p> <p>0.43 (gas conn)</p> <p>0.20 (gas comp)</p> <p>0.79 (gas pump)</p> <p>0.07 (gas prd)</p> <p>0.33 (oil all)</p>	<p>P&P 6100.061.096</p> <p>EPA Radian (1982) gas</p> <p>API Report (1980) oil</p>	<p>P&P 6100.061.096</p> <p>EPA Radian (1982) gas</p> <p>API Report (1980) oil</p>

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
FHC: Onshore Oil and Gas Facilities (component count) Tecolote oil factors (used for GTC, Gaviota GP, HS&P only)	0.066	0.0304	lb/day-leak path	0.46	Tecolote Report (1986) Model B	Tecolote Report (1986)
Crude Oil Fixed Roof Storage Tanks: Evaporative Losses	use AP-42 equations	use AP-42 equations and FROG value	lb/yr	0.885	AP-42, Chapter 7, 5th Edition	ARB VOC Profile #297
Crude Oil Fixed Roof Tanks: Flashing Losses	mass balance or API eqn	mass balance or API eqn and FROG value	lb/bbl	0.308	mass balance using site GOR data or API eqn based on upstream pressures	ARB VOC Profile #757
Loading Racks	mass balance using $EF = 12.46 * S * P * M / T$ Use table 5.2-1 for S values; figures 7.1-5, 7.1-5 and table 7.1-2 for P values; use table 7.1-2 for M values.	mass balance using $EF = 12.46 * S * P * M / T$ and FROG value	lb/1000 gal	0.885 (crude oil)	AP-42, Chapter 5, Section 5.2 (Chapter 7 for P and M values). Crude oil default M = 50 lb/lb-mole	ARB VOC Profile #297 for crude oil.

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
Pipeline Pig Launchers/Receivers	mass balance based on volume of gas vented per event. $EF = (P*M)/(R*T)$ $P = 5 \text{ psig}$ $M = 50 \text{ oil, } 23 \text{ gas}$ $R = 10.73$ $T = \text{site conditions or use std condition if not known}$	mass balance based on volume of gas vented and FROG value	lb/acf vented per event	0.308 (gas units) 0.885 (oil units)	APCD Engineering Div. Assumes unit is de-pressurized to VRU or similar, calculate vented volume based on residual pressure of 5 psig and physical volume of unit using ideal gas law.	ARB VOC Profile #757 for gas units ARB VOC Profile #297 for oil units
Piston IC engine: Diesel	0.36	0.30	lb/MMBtu	0.8378	AP-42, Table 3.3-2 (note: use permit specific or BACT EF when available)	ARB VOC Profile #9
Piston IC Engine: Natural Gas (Uncontrolled)	1.354	0.103	lb/MMBtu	0.0763	APCD Hearing Board factor of 300 lb/MMscf (note: use permit specific or BACT EF when available)	ARB VOC Profile #719

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
Piston IC Engine: Natural Gas (Controlled) - Rule 333 Lean Burn 250 ppmv - Rule 333 Rich Burn 750 ppmv	10.92 (rich burn) 32.89 (lean burn)	0.83 (rich burn) 2.50 (lean burn)	lb/MMBtu	0.0763	Rule 333 ROC emission standard (note: use permit specific or BACT EF when available)	ARB VOC Profile #719
Piston IC Engine: Gasoline (Uncontrolled)	3.03	2.92	lb/MMBtu	0.964	AP-42, Table 3.3-2 (note: use permit specific or BACT EF when available)	FROG is a weighted composite of exhaust and evaporative reactivities ARB VOC Profile #502 ARB VOC Profile #710
Piston IC Engine: Gasoline (Controlled with catalyst)	2.08	1.70	lb/MMBtu	0.8186	Rule 333 ROC emission standard based on exhaust only - assumes PCV and evaporative controls are in place (note: use permit specific or BACT EF when available)	ARB VOC Profile #500

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
Turbine: Natural Gas electric generating unit rated over 3 MW	0.024	0.0018	lb/MMBtu	0.0763	AP-42, Table 3.1-2 (note: use permit specific or BACT EF when available)	ARB VOC Profile #719
Turbine: Diesel (all types)	0.017	0.014	lb/MMBtu	0.8378	AP-42, Table 3.1-2 (note: use permit specific or BACT EF when available)	ARB VOC Profile #9
Turbine: Natural Gas electric generating units rated 3 MW and under and all prime mover operations	0.053	0.0040	lb/MMBtu	0.0763	AP-42, Table 3.2-2 (note: use permit specific or BACT EF when available)	ARB VOC Profile #719
Flares, Thermal Oxidizers, Incinerators	0.14	0.086	lb/MMBtu	0.617	AP-42, Table 13.5-1	AP-42, Table 13.5-2 Table 13.5-2 average volume data is converted to a mass basis, then we assume half of ethane/ethylene result is ethane.
External Combustion - Natural Gas: Boilers, Process Heaters, Steam Generators	<u>em fac (MMBtu/hr)</u> 0.0108	<u>em fac (MMBtu/hr)</u> 0.0054	lb/MMBtu	<u>ratio (MMBtu/hr)</u> 0.50	AP-42, Table 1.4-2 (note: use permit specific or BACT EF when available)	AP-42, Table 1.4-2

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
External Combustion - Diesel #2: Boilers, Process Heaters, Steam Generators	<u>em fac (MMBtu/hr)</u> 0.0018 (>=10) 0.0039 (<10)	<u>em fac (MMBtu/hr)</u> 0.0014 (>=10) 0.0024 (<10)	lb/MMBtu	<u>ratio (MMBtu/hr)</u> 0.79 (>=10) 0.61 (<10)	AP-42, Table 1.3-4 (note: use permit specific or BACT EF when available)	AP-42, Table 1.3-4 Amount of ethane assumed minimal based on ARB VOC Profile #504
External Combustion - Propane/Butane: Boilers, Process Heaters, Steam Generators	<u>em fac (MMBtu/hr)</u> 0.0058 (>=10) 0.0088 (<10)	<u>em fac (MMBtu/hr)</u> 0.0028 (>=10) 0.0053 (<10)	lb/MMBtu	<u>ratio (MMBtu/hr)</u> 0.48 (>=10) 0.66 (<10)	AP-42, Table 1.5-2 (emissions assumed to be same as natural gas EFs on a heat input basis) (note: use permit specific or BACT EF when available)	AP-42, Table 1.5-2 (ratios assumed to be same as natural gas)
Crew and Supply Boat Main Engines	varies according to individual engine hp rating (see table)	varies according to individual engine hp rating (see table)	lb/1000 gal	1.0	AP-42, Volume II, Table II-3.3 Only cruise mode EFs are used (note: use permit specific or BACT EF when available)	APCD Assumption
Crew and Supply Boat: Auxiliary Engines	0.36	0.30	lb/MMBtu	0.8378	AP-42, Table 3.3-2 (note: use permit specific or BACT EF when available)	ARB VOC Profile #9

Source Type	TOC Emissions Factor	ROC Emissions Factor	EF Units	ROC/TOC Fraction - mass basis	Emission Factor Reference	ROC/TOC Fraction Reference
Helicopters	platform specific EFs are used	platform specific EFs are used	lb/trip	1.0	Manufacturer data is coupled with platform LTO cycles to generate a platform specific EF	APCD Assumption
Batch Mix Hot Mix Asphalt Plants: Natural Gas Fired Dryer	0.017	0.017	lb/ton	1.0	AP-42, Table 11.1-7 (note: use permit specific or BACT EF when available)	ARB VOC Profile #715
Batch Mix Hot Mix Asphalt Plants: Diesel Fired Dryer	0.046	0.046	lb/ton	1.0	AP-42, Table 11.1-7 (note: use permit specific or BACT EF when available)	ARB VOC Profile #715
Drum Mix Hot Mix Asphalt Plants: Natural Gas Fired Dryer	0.051	0.051	lb/ton	1.0	AP-42, Table 11.1-8 (note: use permit specific or BACT EF when available)	ARB VOC Profile #715
Drum Mix Hot Mix Asphalt Plants: Diesel Fired Dryer	0.069	0.069	lb/ton	1.0	AP-42, Table 11.1-8 (note: use permit specific or BACT EF when available)	ARB VOC Profile #715