ARCADIS

Potential to Emit Calculations - CAVSARP Air Permit #1530 Renewal Application, November 2012

Emissions based on all engines operating up to 8,760 hours per year AT MAXIMUM RATED HORSEPOWER.

All engines equipped with air-fuel ratio controllers to reduce NOx emissions and catalytic oxidation units to reduce CO and formaldehyde emissions.

Site Location Number		Max HP	Operating HP	Uncontrolled Emissions, ton/yr (@ MAX HP)							Controlled Emissions, ton/yr (@ MAX HP)						
				VOC	PM10	SO_2	HAPs[1]	Formal-dehyde	NOx	CO	VOC	PM10	SO_2	HAPs[2]	Formal-dehyde	NOx	CO
Driving Well Pump Engines (Waukesha)	AF-31B	296	275	1.12	7.30E-04	5.57E-03	0.68	0.50	3.00	4.86	1.12	7.30E-04	5.57E-03	0.33	0.15	2.86	0.49
	AF-32B	298	275	1.12	7.35E-04	5.60E-03	0.69	0.50	3.02	4.89	1.12	7.35E-04	5.60E-03	0.34	0.15	2.88	0.49
	AF-34B	296	275	1.12	7.30E-04	5.57E-03	0.68	0.50	3.00	4.86	1.12	7.30E-04	5.57E-03	0.33	0.15	2.86	0.49
	AF-37B	298	275	1.12	7.35E-04	5.60E-03	0.69	0.50	3.02	4.89	1.12	7.35E-04	5.60E-03	0.34	0.15	2.88	0.49
	AF-38B	298	275	1.12	7.35E-04	5.60E-03	0.69	0.50	3.02	4.89	1.12	7.35E-04	5.60E-03	0.34	0.15	2.88	0.49
	AF-39B	296	275	1.12	7.30E-04	5.57E-03	0.68	0.50	3.00	4.86	1.12	7.30E-04	5.57E-03	0.33	0.15	2.86	0.49
	AF-40B	298	225	1.12	7.35E-04	5.60E-03	0.69	0.50	3.02	4.89	1.12	7.35E-04	5.60E-03	0.34	0.15	2.88	0.49
	CA-009A	384	305	1.45	9.47E-04	7.22E-03	0.89	0.65	3.89	6.30	1.45	9.47E-04	7.22E-03	0.43	0.19	3.71	0.63
	CA-012A	384	305	1.45	9.47E-04	7.22E-03	0.89	0.65	3.89	6.30	1.45	9.47E-04	7.22E-03	0.43	0.19	3.71	0.63
	CA-014A	384	330	1.45	9.47E-04	7.22E-03	0.89	0.65	3.89	6.30	1.45	9.47E-04	7.22E-03	0.43	0.19	3.71	0.63
	CA-015A	384	305	1.45	9.47E-04	7.22E-03	0.89	0.65	3.89	6.30	1.45	9.47E-04	7.22E-03	0.43	0.19	3.71	0.63
	CA-016A	296	275	1.12	7.30E-04	5.57E-03	0.68	0.50	3.00	4.86	1.12	7.30E-04	5.57E-03	0.33	0.15	2.86	0.49
	CA-017A	296	275	1.12	7.30E-04	5.57E-03	0.68	0.50	3.00	4.86	1.12	7.30E-04	5.57E-03	0.33	0.15	2.86	0.49
Booster Pump Engines (Caterpillar)	B-8	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-9	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-10	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-11	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-12	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-13	460	385	1.74	1.14E-03	8.66E-03	1.06	0.78	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	B-14	460	385	1.74	1.14E-03	8.66E-03	1.06	0.65	23.99	8.88	1.74	1.13E-03	8.65E-03	0.52	0.23	4.44	0.76
	Total	7428	6365	28.0	1.83E-02	1.40E-01	17.2	12.4	210.6	131.3	28.0	1.83E-02	1.40E-01	8.37	3.76	71.7	12.2

Caterpillar Emission Factors - converted from lb/MMBtu to lb/hp-hr per Brake-Specific Fuel Consumption (BSFC) of 7313 Btu/hp-hr per Caterpillar engine spec sheet attached.

Emission Factors		lb/hp-hr	Source
VOC (lb/MMBtu)	0.118	8.63E-04	AP-42 Table 3.2-2 (July 2000)
PM_{10} (lb/MMBtu)	7.71E-05	5.64E-07	AP-42 Table 3.2-2 (July 2000)
SO_2 (lb/MMBtu)	5.88E-04	4.30E-06	AP-42 Table 3.2-2 (July 2000)
HAPs (lb/MMBtu)	7.22E-02	5.28E-04	AP-42 Table 3.2-2 (July 2000)
Formaldehyde (lb/MMBtu)	5.28E-02	3.86E-04	AP-42 Table 3.2-2 (July 2000)

Example conversion: 0.118 lb/MMBtu x 1 MMBtu/10^6 Btu x 7313 Btu/hp-hr = 8.63E-04 lb/hp-hr

Waukesha Emission Factors - converted from lb/MMBtu to lb/hp-hr per Brake-Specific Fuel Consumption (BSFC) of 7300 Btu/hp-hr per Waukesha engine spec sheet attached.

Emission Factors		lb/hp-hr	Source
VOC (lb/MMBtu)	0.118	8.61E-04	AP-42 Table 3.2-2 (July 2000)
PM_{10} (lb/MMBtu)	7.71E-05	5.63E-07	AP-42 Table 3.2-2 (July 2000)
SO_2 (lb/MMBtu)	5.88E-04	4.29E-06	AP-42 Table 3.2-2 (July 2000)
HAPs (lb/MMBtu)	7.22E-02	5.27E-04	AP-42 Table 3.2-2 (July 2000)
Formaldehyde (lb/MMBtu)	5.28E-02	3.85E-04	AP-42 Table 3.2-2 (July 2000)

Example conversion: 0.118 lb/MMBtu x 1 MMBtu/10^6 Btu x 7300 Btu/hp-hr = 8.61E-04 lb/hp-hr

NOx and CO Emission Factors

Emission Factors	Caterpillar[3] (g/bhp-hr)		Waukesha[4] (g/bhp-hr)		Caterpillar (tons/bhp-yr)		Waukesha (tons/bhp-yr)		Source
	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	
NOx	5.4	1.0	1.05	1.0	5.21E-02	9.66E-03	1.01E-02	9.66E-03	Manufacturer Certification. See Attached Forms
CO	2.0	0.2	1.7	0.2	1.93E-02	1.93E-03	1.64E-02	1.64E-03	Manufacturer Certification. See Attached Forms

Conversion Factor		
lb/MMBtu to lb/hp-hr (Caterpillar)	0.007313	Conversion Factor based on BSFC of 7313 Btu/hp-hr: 1 lb/MMBtu x 1 MMBtu/10^6 Btu x 7313 Btu/hp-hr = 0.007313 lb/hp-hr
lb/MMBtu to lb/hp-hr (Waukesha)	0.007300	Conversion Factor based on BSFC of 7300 Btu/hp-hr: 1 lb/MMBtu x 1 MMBtu/10^6 Btu x 7300 Btu/hp-hr = 0.007300 lb/hp-hr
g/bhp to tons/hp-yr	0.009656	Conversion: 1 gram/bhp-hr x 1 lb/453.6 g x 1 ton/2000 lb x 8760 hr/yr = 0.009656 tons/bhp-yr
grams (g) to lb	0.00220	Conversion: 1 gram x 1 lb/453.6 grams = 0.00220 lb

Catalytic Oxidizer Efficiency		
Formaldehyde	70%	Formaldehyde control efficiency of catalytic oxidizer based on R.F. Partridge document for Waukesha engine attached.

1 Uncontrolled HAPs emissions include uncontrolled formaldehyde emissions.

2 Controlled HAPs emissions are the total of controlled formaldehyde emissions + uncontrolled remaining HAPs listed in AP-42 Table 3.2-2.

3 Uncontrolled Caterpillar NOx and CO emission factors based on worst-case scenario of 50% load per Caterpillar spec sheet. Controlled Caterpillar NOx and CO emission factors based on use of air-fuel ratio controllers and catalytic oxidizers, and past performance testing of the engines that demonstrated compliance with the current permit limits of 1.0 g/bhp-hr and 0.2 g/bhp-hr, respectively.

4 Uncontrolled Waukesha NOx and CO emission factors based on Waukesha spec sheets. Controlled Waukesha NOx and CO emission factors based on manufacturer certification for use of air-fuel ratio controller and catalytic oxidizer. Also per current permit limits.

	VOC	PM10	SO_2
Controlled Emissions, ton/yr (@ **MAX** HP)	28.0	0.0183	0.14
Controlled Emissions, ton/yr (@ **Operating** HP)	24.0	0.0157	0.12
Increase in Controlled Emissions between Max and Operating HP (tpy)	**4.0**	**0.0026**	**0.02**

HAPs	Formal-dehyde	NOx	CO
8.4	3.77	71.8	12.2
7.2	3.23	61.5	11.2
1.2	**0.54**	**10.3**	**1.0**

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