APPENDIX C

TANKS AND LOADING EMISSIONS CALCULATIONS

BASELINE - Fixed Roof Tank Calculations

These equations and constants are consistent with the 09/97 version of AP-42. revised: 7/27/99			Company: Plains Exploration					Facility No. 43		
	Tank No.		10401	10435	10436	10397	10398	10399	10433	10434
	Product		crude	crude	crude	crude	crude	crude	crude	crude
standing loss										
vapor space volume										
tank roof height (ft)	Hr		2	2	2	2	2	2	2	2
tank shell height (ft)	Hs		16	16	16	16	16	16	16	16
average liquid height (ft)	Hl	(a)	8	8	8	8	8	8	8	8
tank diameter (feet)	D		21.5	29.7	29.7	29.7	29.7	29.7	21.5	21.5
vapor space outage (ft)	***Hvo***		8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Hvo=Hs-Hl+(Hr/3) (E1-4, 6), cone roof										
See AP-42 for dome roof tank calcs.										
vapor space volume (cf)	***Vv***		3,146.4	6,004.2	6,004.2	6,004.2	6,004.2	6,004.2	3,146.4	3,146.4
Vv=(3.14/4)D^2(Hvo) (E1-3)										
vapor density										
average ambient temp, R, adjusted to 623	Tavg	(b)	623	623	623	623	623	623	623	623
shell solar absorbancy	as	(c)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
liquid bulk temp (R)	***Tb***		625.24	625.24	625.24	625.24	625.24	625.24	625.24	625.24
Tb=Tavg+6as-1 (E1-15)										
If the Tbulk is known, adjust Tavg so										
that Tb = Tbulk.	Tbulk		625	625	625	625	625	625	625	625
insolation (BTU/sf-day)	i	(b)	1608	1608	1608	1608	1608	1608	1608	1608
average liquid surface temp (R)	***Tla***		631.11	631.11	631.11	631.11	631.11	631.11	631.11	631.11
Tla=0.44Tavg+0.56Tb+0.0079asi (E1-13)										
If the surface temperature is known for										
insulated tanks, adjust Tavg so Tla = Tsurf.	Tsurf									
Reid vapor pressure (psi), adjusted so Pva=TVP	RVP		0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
adjust RVP so Pva = TVP, if TVP known										
True Vapor Pressure	**TVP**		**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
vapor pressure constant A	***A***		14.72	14.72	14.72	14.72	14.72	14.72	14.72	14.72
A=12.82-0.9672ln(RVP) (F1-16)										
vapor pressure constant B	***B***		9,652	9,652	9,652	9,652	9,652	9,652	9,652	9,652
B=7261-1216ln(RVP) (F1-16)										
vapor pressure at avg liq surface temp	***Pva***		0.565	0.565	0.565	0.565	0.565	0.565	0.565	0.565
Pva=exp(A-(B/Tla)) (E1-12a)										
vapor molecular weight (lb/lb-mole)	**Mv**		**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
vapor density (lb/cf)	***Wv***		0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
Wv=(MvPva)/(10.731Tla) (E1-9)										
vapor space expansion factor										
roof solar absorbancy	ar	(c)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
ambient temp difference (R)	Td	(b)	23	23	23	23	23	23	23	23
vapor temperature range	***Tv***		40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Tv=0.72Td+0.028ari (E1-17)										
max liquid surface temp (R)	***Tlx***		641.3	641.3	641.3	641.3	641.3	641.3	641.3	641.3
Tlx=Tla+0.25Tv (F1-17)										
max liquid vapor pressure	***Pvx***		0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Pvx=exp(A-(B/Tlx)) (E1-12a)										
min liquid surface temp (R)	***Tln***		620.9	620.9	620.9	620.9	620.9	620.9	620.9	620.9
Tln=Tla-0.25Tv (F1-17)										
min liquid vapor pressure	***Pvn***		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Pvn=exp(A-(B/Tln)) (E1-12a)										
vapor pressure range (psi)	***Pv***		0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Pv=Pvx-Pvn (E1-18)										
breather vent pressure range (psi)	Pb	(d)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
vapor space expansion factor	***Ke***		0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Ke=(Tv/Tla)+((Pv-Pb)/(14.7-Pva)) (E1-16)										
vented vapor saturation factor	***Ks***		0.794	0.794	0.794	0.794	0.794	0.794	0.794	0.794
Ks=1/(1+0.053PvaHvo) (E1-22)										
standing storage loss (lb/yr)	***Ls***		306	583	583	583	583	583	306	306
Ls=365VvWvKeKs (E1-2)										

BASELINE - Fixed Roof Tank Calculations

These equations and constants are consistent with the 09/97 version of AP-42. revised: 7/27/99	Company: Plains Exploration						Facility No. 43		
	Tank No.	10401	10435	10436	10397	10398	10399	10433	10434
	Product	crude	crude	crude	crude	crude	crude	crude	crude
working loss									
annual throughput (Mbbl/yr)	Q	**0.0**	**146.0**	**146.0**	**0.0**	**146.0**	**146.0**	**0.0**	**0.0**
annual throughput (gall/yr)		-	6,131,580	6,131,580	-	6,131,580	6,131,580	-	-
daily throughput (bbl/day)		-	400.0	400.0	-	400.0	400.0	-	-
turnovers (per APCD)	N	-	182	182	-	100	100	-	-
turnover factor	***Kn*** (e)	-	0.33	0.33	-	0.47	0.47	-	-
product factor	Kp	-	0.75	0.75	-	0.75	0.75	-	-
working loss (lb/yr)	***Lw***	0.00	1,024.66	1,024.66	0.00	1,442.46	1,442.46	0.00	0.00
lw=MvPvaQKnKp (E1-23), in mbbls throughput									
Total fixed roof losses (pounds/year)									
Lt = Ls + Lw (E1-1), lb/yr	***Lt***	305.7	1,608.1	1,608.1	583.4	2,025.9	2,025.9	305.7	305.7
Control Efficiency, %, use 0 for no control	CE	95	95	95	95	95	95	95	95
emfac = Lt x (100-CE)/annual throughput/100	***emfac***	**-**	0.551	0.551	**-**	0.694	0.69	**-**	**-**
TOC, tons/year			**0.040**	**0.040**	**-**	**0.051**	**0.051**	**-**	**-**
Use a CE of 100 to reduce emfac to zero for unused tanks.			CE = 100 for empty tank with no standing losses calculated.						**TOTAL TOG 0.18 Tons/yr**

Legend
AP-45 values - normal
tank constants - normal Italics
tank variables - bold
equations - bold Italics

(a) AP-42 is not specific so average liq ht is assumed here because outage vapor volume has a significant impact on emissions. 75% of the tank shell height is recommended here, unless specific data is available.
(b) inland county based on 7.1-6, Bakersfield: insolation=1749 BTU/ft2-day, Tmax=77.7F, Tmin=53.3, Tdiff=24.4, Tavg=65.5
coastal county based on 7.1-6, Santa Maria: insolation=1608 BTU/ft2-day, Tmax=68.3F, Tmin=45.3F, Tdiff=23F, Tavg=56.8F
For the calculation, the Tavg. Has been adjusted so that Tb = Tbulk.
(c) Table 7.1-6 solar absorbancy factors vs paint condition.
(d) assume pressure setting of 0.03 psig and vacuum setting of -0.03 psig for range of 0.06 psi unless more specific info available
(e) turnover factor = 1.0 for turnovers of 36 or less; above 36 use (180+n)/6n. See AP-42 notes to E1-23.
(f) RVP has been adjusted so Pva = TVP. The TVP as per December 2007 analysis.

PROJECT - Fixed Roof Tank Calculations

These equations and constants are consistent with the 09/97 version of AP-42. revised: 7/27/99	Company:		Plains Exploration				Facility No. 43			
	Tank No.		10401	10435	10436	10397	10398	10399	10433	10434
	Product		crude	crude	crude	crude	crude	crude	crude	crude
standing loss										
vapor space volume										
tank roof height (ft)	Hr		2	2	2	2	2	2	2	2
tank shell height (ft)	Hs		16	16	16	16	16	16	16	16
average liquid height (ft)	Hl	(a)	8	8	8	8	8	8	8	8
tank diameter (feet)	D		21.5	29.7	29.7	29.7	29.7	29.7	21.5	21.5
vapor space outage (ft)	***Hvo***		8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Hvo=Hs-Hl+(Hr/3) (E1-4, 6), cone roof										
See AP-42 for dome roof tank calcs.										
vapor space volume (cf)	***Vv***		3,146.4	6,004.2	6,004.2	6,004.2	6,004.2	6,004.2	3,146.4	3,146.4
Vv=(3.14/4)D^2(Hvo) (E1-3)										
vapor density										
average ambient temp ® (adjusted to 623 R)	Tavg	(b)	623	623	623	623	623	623	623	623
shell solar absorbancy	as	(c)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
liquid bulk temp (R)	***Tb***		625.24	625.24	625.24	625.24	625.24	625.24	625.24	625.24
Tb=Tavg+6as-1 (E1-15)										
If the Tbulk is known, adjust Tavg so										
that Tb = Tbulk.	Tbulk		625	625	625	625	625	625	625	625
insolation (BTU/sf-day)	i	(b)	1608	1608	1608	1608	1608	1608	1608	1608
average liquid surface temp (R)	***Tla***		631.11	631.11	631.11	631.11	631.11	631.11	631.11	631.11
Tla=0.44Tavg+0.56Tb+0.0079asi (E1-13)										
If the surface temperature is known for insulated										
tanks, adjust Tavg so Tla = Tsurf.	Tsurf									
Reid vapor pressure (psi), adjusted so Pva=TVP	RVP	(f)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
adjust RVP so Pva = TVP, if TVP known										
True Vapor Pressure	TVP		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
vapor pressure constant A	***A***		14.72	14.72	14.72	14.72	14.72	14.72	14.72	14.72
A=12.82-0.9672ln(RVP) (F1-16)										
vapor pressure constant B	***B***		9,651.8	9,651.8	9,651.8	9,651.8	9,651.8	9,651.8	9,651.8	9,651.8
B=7261-1216ln(RVP) (F1-16)										
vapor pressure at avg liq surface temp	***Pva***		0.5646	0.5646	0.5646	0.5646	0.5646	0.5646	0.5646	0.5646
Pva=exp(A-(B/Tla)) (E1-12a)										
vapor molecular weight (lb/lb-mole)	Mv		50	50	50	50	50	50	50	50
vapor density (lb/cf)	***Wv***		0.00417	0.00417	0.00417	0.00417	0.00417	0.00417	0.00417	0.00417
Wv=(MvPva)/(10.731Tla) (E1-9)										
vapor space expansion factor										
roof solar absorbancy	ar	(c)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
ambient temp difference (R)	Td	(b)	23	23	23	23	23	23	23	23
vapor temperature range	***Tv***		40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Tv=0.72Td+0.028ari (E1-17)										
max liquid surface temp (R)	***Tlx***		641.3	641.3	641.3	641.3	641.3	641.3	641.3	641.3
Tlx=Tla+0.25Tv (F1-17)										
max liquid vapor pressure	***Pvx***		0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Pvx=exp(A-(B/Tlx)) (E1-12a)										
min liquid surface temp (R)	***Tln***		620.9	620.9	620.9	620.9	620.9	620.9	620.9	620.9
Tln=Tla-0.25Tv (F1-17)										
min liquid vapor pressure	***Pvn***		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Pvn=exp(A-(B/Tln)) (E1-12a)										
vapor pressure range (psi)	***Pv***		0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Pv=Pvx-Pvn (E1-18)										
breather vent pressure range (psi)	Pb	(d)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
vapor space expansion factor	***Ke***		0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Ke=(Tv/Tla)+((Pv-Pb)/(14.7-Pva)) (E1-16)										
vented vapor saturation factor	***Ks***		0.794	0.794	0.794	0.794	0.794	0.794	0.794	0.794
Ks=1/(1+0.053PvaHvo) (E1-22)										
standing storage loss (lb/yr)	***Ls***		305.7	583.4	583.4	583.4	583.4	583.4	305.7	305.7
Ls=365VvWvKeKs (E1-2)										

PROJECT - Fixed Roof Tank Calculations

These equations and constants are consistent with the 09/97 version of AP-42. revised: 7/27/99										
		Company:	**Plains Exploration**			**Facility No. 43**				
	Tank No.		10401	10435	10436	10397	10398	10399	10433	10434
	Product		crude	crude	crude	crude	crude	crude	crude	crude
working loss										
annual throughput (Mbbl/yr)	Q		**228**	**228**	**228**	**228**	**228**	**228**	**228**	**228**
annual throughput (gall/yr)			9581250	9581250	9581250	9581250	9581250	9581250	9581250	9581250
daily throughput (bbl/day)			625.0	625.0	625.0	625.0	625.0	625.0	625.0	625.0
turnovers	N		114	114	114	114	114	114	114	114
turnover factor	***Kn***	(e)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
product factor	Kp		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
working loss (lb/yr)	***Lw***		2,075.3	2,075.3	2,075.3	2,075.3	2,075.3	2,075.3	2,075.3	2,075.3
lw=MvPvaQKnKp (E1-23), in mbbls throughput										
Total fixed roof losses (pounds/year)										
Lt = Ls + Lw (E1-1), lb/yr	***Lt***		2,381.1	2,658.8	2,658.8	2,658.8	2,658.8	2,658.8	2,381.1	2,381.1
Control Efficiency, %, use 0 for no control	CE		95	95	95	95	95	95	95	95
emfac = Lt x (100-CE)/annual throughput/100	***emfac***		0.522	0.583	0.583	0.583	0.583	0.58	0.52	0.522
TOC, tons/year			**0.060**	**0.066**	**0.066**	**0.066**	**0.066**	**0.066**	**0.060**	**0.060**
										TOTAL
Legend	AP-45 values									**TOG**
	tank constants									**0.51**
	tank variables									**Tons/yr**
	equations									

(a) AP-42 is not specific so average liq ht is assumed here because outage vapor volume has a significant impact on emissions. 75% of the tank shell height is recommended here, unless specific data is available.

(b) inland county based on 7.1-6, Bakersfield: insolation=1749 BTU/ft2-day, Tmax=77.7F, Tmin=53.3, Tdiff=24.4, Tavg=65.5
coastal county based on 7.1-6, Santa Maria: insolation=1608 BTU/ft2-day, Tmax=68.3F, Tmin=45.3F, Tdiff=23F, Tavg=56.8F
For the calculation, the Tavg. Has been adjusted so that Tb = Tbulk.

(c) Table 7.1-6 solar absorbancy factors vs paint condition.

(d) assume pressure setting of 0.03 psig and vacuum setting of -0.03 psig for range of 0.06 psi unless more specific info available

(e) turnover factor = 1.0 for turnovers of 36 or less; above 36 use (180+n)/6n. See AP-42 notes to E1-23.

(f) RVP has been adjusted so Pva = TVP. The TVP as per December 2007 analysis.

Data for Calculation of Emissions from Storage Tanks and Truck Loading

Table A. Gas in Gas Plant

Time	Specific Gravity*
Quarter	**Air = 1**
1 Qtr	1.311
2 Qtr	1.315
3 Qtr	1.346
4 Qtr	1.365
Average	**1.334**

Source: 2006 Emission Inventory, Gas Plant Gas Analysis Lab Report

* Specific Gravity = Density of gas / Density of Air = MW of gas / MW air
Density of Air at standard conditions, kg/m3 = **1.2**
Density of gas at standard conditions, kg/m3 = **1.6**

Table B. HAPs in Emissions from Tanks and Truck Loading

HAP	Mol Wt	Gas Phase*** ppbv	Gas Phase ppmv	Specific Gravity*	Vapor Density kg/m3	Weight**** ratio
Xylene	106	200	0.200	3.66	4.39	5.48E-07
Benzene	78	6500	6.500	2.69	3.23	1.31E-05
Ethylbenzene	106	310	0.310	3.66	4.39	8.49E-07
Toluene	92	1000	1.000	3.17	3.81	2.38E-06
H2S**	34		9210	1.17	1.41	8.09E-03

Source:
* Specific Gravity = Density of gas / Density of Air = MW of gas / MW air
** H2S concentration is from 2000 gas report of tank head space.
*** December 2007 Tank Head Space Analysis (see lab report).
**** Weight ratio = ppmv HAP / 1,000,000 x density of HAP / density of gas =
= ppmv HAP / 1,000,000 x kg/m3 of HAP / kg/m3 of gas =
= kg HAP / kg of Gas

Emissions From Truck Loading (AP-42, Chapter 5)

Emissions from loading petroleum liquid can be estimated
using the following expression:

L_L = 12.46 x S x P x M/T **Total Loading Loss = L_L x Cf**

Total Loading Loss with Vapor Control, lbs/1000 gallons loaded	**0.0249**
L_L = loading loss, pounds per 1000 gallons (lb/10^3 gal) of liquid loaded	**0.498**
S = a saturation factor (see AP-42, Table 5.2-1)	1
P = true vapor pressure of liquid loaded, pounds per sq. inch absolute (psia)	0.5
M = MW of vapors, pounds per pound-mole (lb/lb-mole)	50
T = temperature of bulk liquid loaded, °R (°F + 460)	625
Cf = Vapor Recovery System Control Factor, per SLO APCD	95%