Revision Coversheet
for

CARB/KVB FHC EMISSION CALC

REV.	DESCRIPTION/REASON for REVISION	DATE
0	Initial Release	Jan. 29, 1990
1		
2	Revise for change in ROC definition	Jul. 18, 1996
3	Revise pump EF to 0.0039 due to error reading ARB VOC profile #530 and updated Table I.3 Model #2 Mixture EF to 302.83 and Model #3 Condensate EF to 0.099 to correct ARB transposition error.	Mar. 31, 1997

FUGITIVE HYDROCARBON CALCULATIONS - CARB/KVB METHOD

Fugitive Hydrocarbon (FHC) Emission Calculation Worksheets

I. Valves and Fittings
II. Sumps and Well Cellars
III. Oil/Water Separators
IV. Pumps, Compressors, and Well Heads
V. Enhanced Oil Recovery Fields
VI. FHC Emission Summary Sheet

PTO Number: _____ Attachment Item: _____

Facility Name: _____

Calculations By: _____

Date: _____

Comments: _____

I. Valves and Fittings

1. Number of active (not abandoned) wells at facility.	1._____	(wells)
2. Facility gas production.	2._____	(SCF/day)
3. Facility dry oil production.	3._____	(bbls/day)
4. Calculate the facility gas to oil ratio.		
Line 2 / Line 3 =	4._____	(SCF/bbl)
5. Refer to TABLE I.1 and choose the corresponding facility model number based on lines 1 and 4 above.	5._____	[Model #]

6. Valve Emission Factors: Refer to TABLE I.2 and write down below the emission factors corresponding to the facility model number (line 5).

$\underline{\text{(lb ROC/day-well)(10)}^{-4}}$

6.1 Gas _____

6.2 Liquid _____

6.3 Mixture _____

6.4 Condensate_____

7. Sum lines 6.1 through 6.4 to obtain composite valve emission factor (lb ROC/day-well)$(10)^{-4}$.

Lines 6.1 + 6.2 + 6.3 + 6.4 = 7._____

8. Fitting Emission Factors:
Refer to TABLE I.3 and write down below the emission factors corresponding to the facility model number (line 5).

(lb ROC/day-well)$(10)^{-4}$

8.1 Gas _____

8.2 Liquid _____

8.3 Mixture _____

8.4 Condensate _____

9. Sum lines 8.1 through 8.4 to obtain composite fitting emission factor (lb ROC/day-well)$(10)^{-4}$.

Lines 8.1 + 8.2 + 8.3 + 8.4 = 9._____

10. Sum lines 7 and 9 above to obtain the facility composite valve and fitting FHC emission factor (lb ROC/day-well)$(10)^{-4}$.

Line 7 + Line 9 = 10._____

11. Calculate the total daily facility valve and fitting FHC emissions.

Line 10 * Line 1 / 10,000 = 11._____ ROC (lb/day)

12. Calculate hourly valve and

fitting FHC emissions.

Line 11 / 24 hours per day = 12._____ ROC (lb/hr)

13. Calculate yearly valve and fitting FHC emissions.

Line 11 * (365 days/year) /

(2000 lbs/ton) = 13._____ ROC (tons/yr)

TABLE I.1

FACILITY MODEL NUMBERS

Model #1: Number of wells on the lease is less than 10 and the GOR is less than 500.

Model #2: Number of wells on the lease is between 10 and 50 and the GOR is less than 500.

Model #3: Number of wells on the lease is greater than 50 and the GOR is less than 500.

Model #4: Number of wells on the lease is less than 10 and the GOR is greater than or equal to 500.

Model #5: Number of wells on the lease is between 10 and 50 and the GOR is greater than or equal to 500.

Model #6: Number of wells on the lease is greater than 50 and the GOR is greater than or equal to 500.

TABLE I.2

VALVE EMISSION FACTORS

Lease Model	Service	ROC Emission Factor (lb/day-well)*10^{-4}
Model #1	Gas	14171.700
	Liquid	0.982
	Mixture	748.355
	Condensate	0.000
Model #2	Gas	6807.460
	Liquid	0.971
	Mixture	190.993
	Condensate	0.000
Model #3	Gas	62.177
	Liquid	0.260
	Mixture	154.327
	Condensate	0.000
Model #4	Gas	44784.900
	Liquid	1.215
	Mixture	303.513
	Condensate	0.000
Model #5	Gas	8293.500
	Liquid	0.509
	Mixture	344.359
	Condensate	0.000
Model #6	Gas	16839.200
	Liquid	0.084
	Mixture	239.978
	Condensate	0.000

TABLE I.3

FITTING EMISSION FACTORS

Lease Model	Service	ROC Emission Factor (lb/day-well)*10^{-4}
Model #1	Gas	8483.620
	Liquid	323.495
	Mixture	1139.750
	Condensate	0.000
Model #2	Gas	5788.960
	Liquid	0.000
	Mixture	302.830
	Condensate	0.000
Model #3	Gas	166.743
	Liquid	9.719
	Mixture	496.834
	Condensate	0.099
Model #4	Gas	20399.100
	Liquid	0.001
	Mixture	920.142
	Condensate	0.000
Model #5	Gas	17547.300
	Liquid	29.052
	Mixture	1847.850
	Condensate	0.000
Model #6	Gas	24890.200
	Liquid	0.000
	Mixture	115.139
	Condensate	0.243

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APPLICATION PROCESSING AND CALCULATIONS

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II. Sumps, Waste Water Tanks, and Well Cellars

Section 1.0 Facility Equipment Description and List

1.1 Sumps, Uncovered Waste Water Tanks and Well Cellars in Light Crude Service

	Sump/Well Cellar Surface Area Versus Type (ft^2)			
Description/Name	Primary	Secondary	Tertiary	Well Cellars
Total Facility Sump/Well Cellar Surface Areas (Sum all column lines) (ft^2)	A.	B.	C.	D.

1.2 Sumps, Uncovered Waste Water Tanks and Well Cellars in Heavy Crude Service

	Sump/Well Cellar Surface Area Versus Type (ft^2)			
Description/Name	Primary	Secondary	Tertiary	Well Cellars

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Total Facility Sump/Well Cellar Surface Areas (Sum all column lines) (ft^2)	E._____	F._____	G._____	H_____

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1.3 Covered Waste Water Tanks in Light Crude Service

	Waste Water Tank Surface Area Versus Type (ft^2)		
Description/Name	Primary	Secondary	Tertiary
Total Covered Waste Water Tank Surface Areas (Sum all column lines) (ft^2)	I.	J.	K.

1.4 Covered Waste Water Tanks in Heavy Crude Service

	Waste Water Tank Surface Area Versus Type (ft^2)		
Description/Name	Primary	Secondary	Tertiary
Total Covered Waste Water Tank Surface Areas (Sum			

all column lines) (ft^2)

L._____ M._____ N._____

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1.5 Waste Water Tanks Equipped with Vapor Recovery (VR) in Light Crude Service

	Waste Water Tank Surface Area Versus Type (ft^2)		
Description/Name	Primary	Secondary	Tertiary
Total VR Equipped Waste Water Tank Surface Areas (Sum all column lines) (ft^2)	O.	P.	Q.

1.6 Waste Water Tanks Equipped with Vapor Recovery (VR) in Heavy Crude Service

	Waste Water Tank Surface Area Versus Type (ft^2)		
Description/Name	Primary	Secondary	Tertiary
Total VR Equipped Waste Water Tank Surface Areas			

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(Sum all column lines)
(ft^2) R._____ S._____ T._____

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Section 2.0 Calculations

2.1 Sumps, Uncovered Waste Water Tanks, and Well Cellars in Light Crude Service

1. Primary Sump Emissions

Line A * 0.138 (lb ROC/ft2-day) = 1._____ ROC (lb/day)

2. Secondary Sump Emissions

Line B * 0.018 (lb ROC/ft2-day) = 2._____ ROC (lb/day)

3. Tertiary Sump Emissions

Line C * 0.0087 (lb ROC/ft2-day) = 3._____ ROC (lb/day)

4. Well Cellar Emissions

Line D * 0.138 (lb ROC/ft2-day) = 4._____ ROC (lb/day)

2.2 Sumps and Well Cellars in Heavy Crude Service

5. Primary Sump Emissions

Line E * 0.094 (lb ROC/ft2-day) = 5._____ ROC (lb/day)

6. Secondary Sump Emissions

Line F * 0.0126 (lb ROC/ft2-day) = 6._____ ROC (lb/day)

7. Tertiary Sump Emissions

Line G * 0.0058 (lb ROC/ft2-day) = 7._____ ROC (lb/day)

8. Well Cellar Emissions

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Line H * 0.094 (lb ROC/ft2-day) = 8._____ ROC (lb/day)

2.3 Covered Waste Water Tanks in Light Crude Service

9. Primary Type Emissions

Line I * 0.138 (lb ROC/ft2-day) = 9._____ ROC (lb/day)

10. Secondary Type Emissions

Line J * 0.018 (lb ROC/ft2-day) = 10._____ ROC (lb/day)

11. Tertiary Type Emissions

Line K * 0.0087 (lb ROC/ft2-day) = 11._____ ROC (lb/day)

12. Total covered waste water tank emissions in light crude service.

Line(9 + 10 + 11) * (1-0.85) = 12._____ ROC (lb/day)

2.4 Covered Waste Water Tanks in Heavy Crude Service

13. Primary Type Emissions

Line L * 0.094(lb ROC/ft2-day) = 13._____ ROC (lb/day)

14. Secondary Type Emissions

Line M * 0.0126 (lb ROC/ft2-day) = 14._____ ROC (lb/day)

15. Tertiary Type Emissions

Line N * 0.0058 (lb ROC/ft2-day) = 15._____ ROC (lb/day)

16. Total covered waste water tank

emissions in heavy crude service.

Lines(13 + 14 + 15) * (1-0.85) = 16._____ ROC (lb/day)

2.5 Waste Water Tanks Equipped with Vapor Recovery in Light Crude Service

17. Primary Type Emissions

Line O * 0.138 (lb ROC/ft2-day) = 17._____ ROC (lb/day)

18. Secondary Type Emissions

Line P * 0.018 (lb ROC/ft2-day) = 18._____ ROC (lb/day)

19. Tertiary Type Emissions

Line Q * 0.0087 (lb ROC/ft2-day) = 19._____ ROC (lb/day)

20. Total VR equipped waste water tank emissions in light crude service.

Line(17 + 18 + 19) * (1-0.95) = 20._____ ROC (lb/day)

2.6 Waste Water Tanks Equipped with Vapor Recovery in Heavy Crude Service

21. Primary Type Emissions

Line R * 0.094 (lb ROC/ft2-day) = 21._____ ROC (lb/day)

22. Secondary Type Emissions

Line S * 0.0126 (lb ROC/ft2-day) = 22._____ ROC (lb/day)

23. Tertiary Type Emissions

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Line T * 0.0058 (lb ROC/ft2-day) = 23._____ ROC (lb/day)

24. Total covered waste water tank emissions in heavy crude service.

Lines(21 + 22 + 23) * (1-0.95) = 24._____ ROC (lb/day)

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2.7 Sump, Waste Water Tank and Well Cellar FHC Emissions Summary

25. Total daily sump, waste water tank, and well cellar FHC emissions.

(Sum Lines 1 to 8 above + Lines 12 + 16 + 20 + 24) = 25._____ ROC (lb/day)

26. Total hourly sump, waste water tank, and well cellar FHC emissions.

Line 25 / 24 (hr/day) = 26._____ ROC (lb/hr)

27. Total yearly sump, waste water tank, and well cellar FHC emissions.

Line 25 * 365 (days/yr)

/ 2000 (lb/ton) = 27._____ ROC (tons/yr)

III. Oil/Water Separators

Section 1.0 Equipment Listing

	Oil/Water Separator Type Versus Wastewater Throughput (MM gals/day)		
Description/Name	Equipped with Cover	Equipped with Vapor Recovery	Open Top
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
Total throughput for each type of oil/water separator (MM Gals/day)	A._____	B._____	C._____

Section 2.0 Calculations

1. Covered oil/water separator FHC emissions.

   Line A * 560 (lb ROC/MM gal) * (0.15) = 1._____ ROC (lb/day)

2. Oil/water separators equipped with vapor recovery.

   Line B * 560 (lb ROC/MM gal) * (0.05) = 2._____ ROC (lb/day)

3. Open top oil/water separators.

   Line C * 560 (lb ROC/MM gal) = 3._____ ROC

(lb/day)

4. Total oil/water separator FHC emissions.

   Lines 1 + 2 + 3 = 4._____ ROC (lb/day)

5. Hourly oil/water separator FHC emissions.

   Line 4 / 24 (hrs/day) = 5._____ ROC (lb/hr)

6. Yearly oil/water separator FHC emissions.

   Line 4 * 365 (days/yr) / 2000 (lb/ton) = 6._____ ROC (tons/yr)

Section 1.0 Calculations

1.	Number of active (not abandoned) wells at facility.	1._____	(wells)
2.	Calculate well head emissions.		
	Line 1 * 0.0097 (lb ROC/day-well) =	2._____	ROC (lb/day)
3.	Calculate pump FHC emissions if facility is equipped with motor driven pumps.		
	Line 1 * 0.0039 (lb ROC/day-well) =	3._____	ROC (lb/day)
4.	Calculate compressor FHC emissions if facility is equipped with motor driven compressors.		
	Line 1 * 0.068 (lb ROC/day-well) =	4._____	ROC (lb/day)
5.	Total daily facility well head, pump and compressor FHC emissions.		
	Lines 2 + 3 + 4 =	5._____	ROC (lb/day)
6.	Hourly facility well head, pump and compressor FHC emissions.		
	Line 5 / 24 (hrs/day) =	6._____	ROC (lb/hr)
7.	Annual facility well head, pump and compressor FHC emissions.		
	Line 5 * 365 (days/yr) / 2000 (lb/ton) =	7._____	ROC (tons/yr)

V. Enhanced Oil Recovery Fields

Section 1.0 Quantities of Enhanced Oil Wells

			Units
1.	Total number of Steam Drive wells with **controlled** well vents.	1._____	(wells)
2.	Total number of Steam Drive wells with **uncontrolled** well vents.	2._____	(wells)
3.	Total number of Cyclic Steam well with **controlled** well vents.	3._____	(wells)
4.	Total number of Cyclic Steam wells with **uncontrolled** well vents.	4._____	(wells)

Section 2.0 Calculations

5.	Total FHC emissions from controlled Steam Drive wells.		
	Line 1 * 9.890 (lb ROC/well-day) =	5._____	ROC (lb/day)
6.	Total FHC emissions from uncontrolled Steam Drive wells.		
	Line 2 * 201 (lb ROC/well-day) =	6._____	ROC (lb/day)
7.	Total FHC emissions from controlled Cyclic Steam wells.		
	Line 3 * 3.315 (lb ROC/well-day) =	7._____	ROC (lb/day)
8.	Total FHC emissions from uncontrolled Cyclic Steam wells.		
	Line 4 * 3.6 (lb ROC/well-day) =	8._____	ROC (lb/day)

9. Total daily enhanced oil recovery FHC emissions.

   Lines 5 + 6 + 7 + 8 = 9._____ ROC (lb/day)

10. Total hourly enhanced oil recovery FHC emissions.

    Line 9 / 24 (hr/day) = 10._____ ROC (lb/hr)

11. Totaly yearly enhanced oil recovery FHC emissions.

    Line 9 * 365 (day/yr) / 2000 (lb/ton) = 11._____ ROC (tons/yr)

VI. FHC Emission Calculation Summary Sheet

PTO Number:_____ Facility Name:_____ Comments:_____

Worksheet Data Location	ROC Emissions (lb/hour)	ROC Emissions (tons/year)
A. Section I: Total FHC Emissions from Valves and Fittings		
1. Values from Section I Worksheets:	Line 12:_____	Line 13:_____
B. Section II: Total FHC Emissions from Sumps and Well Cellars		
2. Values from Section II Worksheets:	Line 26:_____	Line 27:_____
C. Section III: Total FHC Emissions from Oil/Water Separators		
3. Values from Section III Worksheets:	Line 5:_____	Line 6:_____
D. Section IV: Total FHC Emissions from Pumps, Compressors, and Well Heads		
4. Values from Section IV Worksheets:	Line 6:_____	Line 7:_____
E. Section V: Total FHC Emissions from Enhanced Oil Recovery Fields		
5. Values from Section V Worksheets:	Line 10:_____	Line 11:_____

Total Facility FHC Emissions:

Lines 1 + 2 + 3 + 4 + 5 (each column) = _____ _____