SANTA BARBARA COUNTY

AIR POLLUTION CONTROL DISTRICT

POLICIES AND PROCEDURES

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Topic: Determination of Fugitive Hydrocarbon Emissions at Oil and Gas Facilities Through the Use of Facility Component Leak Path Counts - Modified for Revised ROC Definition

Distribution: Engineering Division Staff

This Policy and Procedure provides guidance on the quantification of fugitive Reactive Organic Compound (ROC) emissions from oil and gas related facilities through the use of detailed component leak path counts. For facilities where detailed component counts have not been required, please refer to Policy and Procedure 6100.060.1996 (*Determination of Fugitive Hydrocarbon Emissions at Oil and Gas Facilities through the KVB Method*).

I. Component Counts

1. General Overview. To calculate fugitive emissions from piping components (e.g., valves, flanges, connection, seals), a detailed component leak path count of all components in hydrocarbon service at the facility is necessary. This component count must classify each potential leak path on each component type by:

- Type (valve, connection, pressure relief device, pump or compressor seal)
- Service (gas/condensate or oil)
- Accessibility (accessible/inaccessible, unsafe to monitor, no detectable emissions)

Component counts submitted in compliance with Rule 331 requirements are not adequate for the purposes of performing emissions calculations. A Rule 331 component count groups several leak paths into single component classifications. For example, under Rule 331, a "valve" includes the valve stem, bonnet, and up/downstream connections. To implement the emission calculation methodology described herein requires that each of these potential "leak paths" on the valve be identified and classified consistent with the above bulleted items. Therefore, to avoid confusion with the definition of component in Rule 331, this policy shall use the term *leak path* to describe potential emission points. However, the definitions of accessible, inaccessible, and unsafe to monitor shall be the same as those found in Rule 331.

2. Counting Methodology. Quantification and categorization of each leak path should be consistent with Table 1 (below). For preliminary leak path estimates, the total quantity of each type of leak path described in Table 1 can be estimated for the purposes of Authority to Construct permit processing. However, once construction of the facility is complete, the preliminary estimates should be replaced with a count of the actual as-built leak paths.

Table 1: Leak Path Counting Methodology

Leak Path Type	Number of Associated Leak Paths
Flanges and Connections	Each flange or threaded connection shall be counted as 1 connection. Valve bonnets and flanges shall be counted as connections. Connections and flanges associated with compressors, pumps, relief devices and sight glasses should be counted as connections.
Valves	Each valve stem shall be counted as 1 valve. Low emitting or bellows stem valves should be listed separately.
Pump Seals	Each pumping device shall be counted as a separate pump seal on pumps utilizing a common driver. Pumps equipped with tandem or dual mechanical seals should be listed separately.
Compressor Seals	Each compressor cylinder shall be counted as a separate compressor seal on multiple cylinder compressors. Compressor seals that are vented to vapor recovery should be listed separately.
Open Ended Lines	Rule 331 prohibits open ended lines by requiring that they be sealed with a plug or with two closed valves. However, each leak path associated with sealed open ended lines should be counted consistent with the leak paths "valves" and "connections" above up to and including the second valve stem.
Pressure Relief Device	Each pressure relief device (PRD) not equipped with or vented to an emission control device shall be counted as 1 PRD. PRDs vented to control devices or equipped with rupture disks should be listed separately.

Attachment 1 is an example form which can be used for summarizing the leak path information necessary for calculating fugitive emissions.

3. Exempt Leak Paths. The following services and leak path types are considered to have minimal fugitive emissions liability and thus are not to be included in the leak path counts summarized in Table 1:

1. Process fluids with 10% or less ROC content by weight
2. Glycol service
3. Therminol or equivalent heating medium
4. Lube oils
5. Non-ROC oil treatment chemicals
6. 1/2" and smaller stainless steel leak paths
7. Acid gas in sulfur treating plants
8. Instrument air service

9. Produced water
10. Leak paths operating exclusively under negative pressure
11. Underground leak paths
12. Totally enclosed leak paths

II. Emission Factors and Calculation Method

Emission factors for leak paths at refineries, oil and gas production fields, oil and gas processing plants, and offshore platforms are presented in Table 2. The leak path counts described in Section I above should be multiplied by the appropriate THC and ROC/THC factors in Table 2 to obtain the uncontrolled ROC emissions for the facility. Facilities that have implemented an Inspection and Maintenance (I&M) program should have uncontrolled emissions reduced accordingly (please see section III).

Most oil and gas facilities can be categorized into one of the facility types listed in Table 2. If a facility does not clearly fall under one of these groups, use the factors from the facility type which most closely resembles the facility in question. If necessary, adjustment can be made to the ROC/THC ratio as necessary to account for any differences in process fluid composition between that of the actual facility and average factors presented in Table 2. Appropriate ROC/THC ratios may be determined from representative gas samples, gas quality specifications from the purchaser, or other District approved methods on a case-by-case basis. Adjustment to the ROC/THC ratio on a facility-specific basis is not appropriate for facilities which clearly fall under the defined facility categories, since the factors presented were specifically derived from these facility types, and thus, on the average, are representative of these facilities' emissions.

The API-Rockwell Report was used as a basis for emission factors at production fields and for components in oil service at gas processing plants. This study developed more than 44 leak path-based emission factors for each service type, as opposed to the five categories presented in Table 2. For example, the API-Rockwell Report developed separate factors for each type of valve, (gate, ball, globe, needle, plug, check, butterfly), whereas the more streamlined EPA methodology consists of a single generic valve factor. In order to apply the API-Rockwell factors consistent with the more streamlined methodology developed by the EPA, the various API/Rockwell component styles were consolidated into single factors for each of the standard leak path types. To consolidate the factors, a "weighted average factor" was determined based on District field experience. The results are presented in Attachment 2.

III. Emission Reduction Measures

Facilities that implement an I&M program consistent with the requirements of Rule 331 should, in general, have their emissions liability reduced by 80 percent. In addition, facilities that implement other I&M practices or controls can further reduce emissions as specified in Table 3 and APCD Form 200-20.

IV. Example Fugitive Emission Calculations

An example fugitive emission calculation is provided in Table 4.

Table 2

Fugitive Emission Factors for Oil and Gas Facilities
Using the Component Count Method (P&P 6100.061)

Component Type	FACILITY TYPE							
	Production Field[1]		Gas Processing Plant[2]		Refinery[3]		Offshore Platform[4]	
	THC EF lb/day-leak path	ROC/THC Ratio	THC EF lb/day-leak path	ROC/THC Ratio	THC EF lb/day-leak path	ROC/THC Ratio	THC EF lb/day-leak path	ROC/THC Ratio
Gas/Condensate Service								
Valve	0.295	0.31	1.0580	0.38	1.4200	0.99	0.2230	0.33
Connection	0.070	0.31	0.0580	0.43	0.0134	0.99	0.2230	0.33
Compressor Seal	2.143	0.31	10.7940	0.20	33.6000	0.99	0.2230	0.33
Pump Seal	1.123	0.31	3.3000	0.79	6.0000	0.99	0.2230	0.33
Pressure Relief	6.670	0.31	9.9470	0.07	8.6400	0.99	0.2230	0.33
Oil Service[5]								
Valve	0.0041	0.56	0.4306	0.33	0.0120	0.99	0.0133	0.33
Connection	0.0020	0.56	0.0694	0.33	0.0134	0.99	0.0133	0.33
Pump Seal	0.0039	0.56	1.3080	0.33	1.1040	0.99	0.0133	0.33
Pressure Relief	0.2670	0.56	1.7400	0.33	n/a	0.99	0.0133	0.33

NOTES:

(1) Eaton, W.S. et al., "Fugitive Hydrocarbon Emissions From Petroleum Operations", American Petroleum Institute, Rockwell International, March 1980, See Attachment 1 for the methodology used to consolidate the API emission factors .

(2) Harris, G.E. et al., "Frequency of Leak Occurrence and Emission Factors for Natural Gas Factors for Natural Gas Liquid Plants", EPA DCN 82-222-018-04-48, July 1982. For oil service components, see page 3 of Attachment 1.

(3) EPA, AP-42, Table 5.1-2

(4) Santa Barbara County APCD, "Modeling of Fugitive Hydrocarbon Emissions", Tecolote Research Inc., January 1986. Assumes the facility is primarily a crude oil site with a significant portion of gas components. For ROC/THC ratios for other facility types, please see page 63.

(5) Oil service includes water, oil and gas emulsions.

(6) "lb/day-leak path" = pound of pollutant per day for each component leak path.
"THC" = total hydrocarbons (includes methane and ethane)
"ROC" = reactive organic compounds (non-methane, non-ethane)

Table 3: Emission Reduction Factors

Item	Description[5]	Notes	BACT	Vapor Recovery	Monthly Inspections	LDAR 100 ppmv	LDAR 500 ppmv	Control Efficiency %
1	Valves - Accessible/Inaccessible	1						80%
2	Valves - Unsafe							0%
3	Valves - Bellows		x			x		90%
4	Valves - Bellows / Background ppmv	2	x					100%
5	Valves - Category A	3			x			84%
6	Valves - Category B	3					x	85%
7	Valves - Category C	3				x		87%
8	Valves - Category D	3			x		x	87%
9	Valves - Category E	3			x	x		88%
10	Valves - Category F	4	x			x		90%
11	Valves - Category G	4	x		x	x		92%
12	Flanges/Connections - Accessible/Inaccessible							80%
13	Flanges/Connections - Unsafe							0%
14	Flanges/Connections - Category A	3			x			84%
15	Flanges/Connections - Category B	3					x	85%
16	Flanges/Connections - Category C	3				x		87%
17	Flanges/Connections - Category D	3			x		x	87%
18	Flanges/Connections - Category E	3			x	x		88%
19	Flanges/Connections - Category F	4	x			x		90%
20	Flanges/Connections - Category G	4	x		x	x		92%
21	Compressor Seals - To Atm							80%
22	Compressor Seals - To VRS			x				100%
23	PSV - To Atm/Flare							80%
24	PSV - To VRS			x				100%
25	Pump Seals - Single							80%
26	Pump Seals - Dual/Tandem							100%

Notes:

1. "Standard" valves and connections/flanges subject to Rule 331 (1000 ppmv/quarterly inspection) = 80% control
2. Bellows valves with 100% control have a minor leak threshold of any OVA reading above background.
3. Categories A through E are defined by lower leak threshold limits and/or increased monitoring frequency of standard components.
4. Categories F and G are BACT approved components that have been designed to perform at a lower leak threshold.

Table 4
Example Fugtive Emission Calculations
Natural Gas Processing Plant

Component Type and Service		Number of Comp-lp	Emission Factors: THC EF lb/day-leak path	Emission Factors: ROC/THC Ratio	Emission Factors: ROC EF lb/day-leak path	Control Efficiency	ROC Emissions: lb/day	ROC Emissions: ton/yr
Gas Service								
Valves	Acc/Inacc	950	1.058	0.38	0.4020	80%	76.39	13.94
	Mo. Monitor	240	1.058	0.38	0.4020	84%	15.44	2.82
	Unsafe	10	1.058	0.38	0.4020	0%	4.02	0.73
LE Valves	Acc	300	1.058	0.38	0.4020	90%	12.06	2.20
Flanges	Acc/Inacc	2,775	0.058	0.43	0.0249	80%	13.84	2.53
	Unsafe	90	0.058	0.43	0.0249	0%	2.24	0.41
Relief Valves	To VRS	45	9.947	0.07	0.6963	100%	-	-
	To Atm	5	9.947	0.07	0.6963	80%	0.70	0.13
Comp Seals	To VRS	4	10.794	0.20	2.1588	100%	-	-
Pump Seals	Dual Seal	8	3.300	0.79	2.6070	100%	-	-
Oil Service								
Valves	Acc/Inacc	650	0.4306	0.33	0.1421	80%	18.47	3.37
	Unsafe	24	0.4306	0.33	0.1421	0%	3.41	0.62
Flanges	Acc/Inacc	1,900	0.0694	0.33	0.0229	80%	8.70	1.59
	Unsafe	65	0.0694	0.33	0.0229	0%	1.49	0.27
Relief Valves	To VRS	21	1.3080	0.33	0.4316	80%	1.81	0.33
	To Atm	2	1.7400	0.33	0.5742	100%	-	-
Pump Seals	Single	10	1.7400	0.33	0.5742	80%	1.15	0.21
	Subtotal Gas	4,427					124.69	22.76
	Subtotal Oil	2,672					35.04	6.39
	Grand Total	7,099					159.73	29.15

Legend:

Acc =	accessible
Inacc =	inaccessible
Unsafe =	unsafe to monitor
Mo Monitor =	monthly monitoring
LE =	low emitting
To VRS =	vented to vapor recovery or flare
To Atm =	vented to teh atmopshere
Dual Seal =	dual mechanical or tandem seals
Single =	single seal

Attachment 1
Leak Path Count Summary Table

Leak Path Type	Number of Leak Paths					
	Gas/Condensate Service Unsafe to			Oil Service Unsafe to		
	Acc/ Inacc	Monitor	NDE	Acc/ Inacc	Monitor	NDE
Valves - Standard						
Valves - Low Emission						
Flanges/Connections						
Compressor Seals to Atm				- na -	- na -	- na -
Compressor Seals to VRS				- na -	- na -	- na -
Compressor Seal						
Relief Valves to Atm						
Relief Valves w/Rupture Disk						
Relief Valves to VRS						
Pump /Seals, Single						
Pump Seals, Dual/Tandem						
Subtotal Leak Paths						

Legend:

Atm - Atmosphere
Acc - Accessible
Inacc - Inaccessible
NDE - No Detectable Emissions
VRS - Vapor Recovery System

ATTACHMENT 2
Consolidation of API/Rockwell Factors

Production Fields – Gas/Condensate Service Factors

Reference: American Petroleum Institute, Fugitive Hydrocarbon Emissions From Petroleum Production Operations, Vol 1, March 1980, Table E–1, (Gas).

Note: Please refer to API Report, Appendix D for legend of abbreviations.

API/Rockwell Data			APCD Emission Estimates	
Component	Style	Factor lb/D–comp	Est. % Field Population	Normalized Emissions THC lb/D–comp
Valve				
VL	GATE	4.15E–01	50	2.08E–01
VL	MULT	1.59E–04	0	0.00E+00
VL	BALL	2.79E–02	20	5.58E–03
VL	PLUG	1.22E–01	19	2.32E–02
VL	GLBE	4.71E–01	10	4.71E–02
VL	NDLE	8.32E–02	0	0.00E+00
VL	CHOK	1.12E+00	1	1.12E–02
	API Average:	3.20E–01	APCD Norm Ave:	2.95E–01
Connection				
CN	FLFF	8.22E–03	14	1.15E–03
CN	FLGA	2.67E–01	13	3.47E–02
CN	FLBO	1.52E–02	13	1.98E–03
CN	THRD	3.32E–02	40	1.33E–02
CN	UNIN	7.23E–02	10	7.23E–03
CN	ORIN	1.42E–01	5	7.10E–03
CN	GASK	9.63E–02	5	4.82E–03
	API Average:	9.06E–02	APCD Norm Ave:	7.03E–02
Pump Seals				
SP	RERO	2.63E+00	20	5.26E–01
SP	ROSH	7.75E–01	75	5.81E–01
SP	MESL	3.08E–01	5	1.54E–02
	API Average:	1.24E+00	APCD Norm Ave:	1.12E+00
Comp Seals				
SP	RERO	2.63E+00	75	1.97E+00
SP	ROSH	7.75E–01	20	1.55E–01
SP	MESL	3.08E–01	5	1.54E–02
	API Average:	1.24E+00	APCD Norm Ave:	2.14E+00
Relief Valves				
SM	RELF	6.67E+00	100	6.67E+00
	API Average:	6.67E+00	APCD Norm Ave:	6.67E+00

Production Fields – Oil Service Factors

Reference: American Petroleum Institute, Fugitive Hydrocarbon Emissions From Petroleum Production Operations, Vol 1, March 1980, Table E-1, (Other).

Note: Please refer to API Report, Appendix D for legend of abbreviations.

API/Rockwell Data			APCD Emission Estimates	
Component	Style	Factor lb/D-comp	Est. % Field Population	Normalized Factor THC lb/D-comp
Valve				
VL	GATE	5.93E-03	50	2.97E-03
VL	MULT	2.46E-06	0	0.00E+00
VL	BALL	3.36E-04	20	6.72E-05
VL	PLUG	1.52E-03	19	2.89E-04
VL	GLBE	6.24E-03	10	6.24E-04
VL	NDLE	9.33E-04	0	0.00E+00
VL	CHOK	1.55E-02	1	1.55E-04
	API Average:	4.35E-03	APCD Norm Ave:	4.10E-03
Connection				
CN	FLFF	1.93E-04	14	2.70E-05
CN	FLGA	6.96E-03	13	9.05E-04
CN	FLBO	1.58E-03	13	2.05E-04
CN	THRD	8.09E-04	40	3.24E-04
CN	UNIN	1.77E-03	10	1.77E-04
CN	ORIN	4.15E-03	5	2.08E-04
CN	GASK	2.36E-03	5	1.18E-04
	API Average:	2.55E-03	APCD Norm Ave:	1.96E-03
Pump Seals				
SP	RERO	3.42E-03	35	0.0029
SP	ROSH	1.34E-03	50	0.0007
SP	MESL	3.71E-04	5	0.0000
SP	WLHD	2.93E-03	10	0.0003
	API Average:	3.27E-03	APCD Norm Ave:	3.93E-03
Relief Valves				
SM	RELF	2.67E-01	100	2.67E-01
	API Average:	2.67E-01	APCD Norm Ave:	2.67E-01

Gas Processing Plants – Oil Service Factors

Reference: American Petroleum Institute, Fugitive Hydrocarbon Emissions From Petroleum Produ Operations, Vol 1, March 1980, Table E–3, Group3, (heavy crude).

Note. Please refer to API Report, Appendix D for legend of abbreviations.

API/Rockwell Data			APCD Emission Estimates		
Component	Style	Factor lb/D–comp	Est. % Field Population	Normalized Emissions THC lb/D–comp	
Valve					
VL	GATE	4.92E–01	25	1.23E–01	
VL	MULT	4.64E–01	0	0.00E+00	
VL	BALL	1.58E–02	30	4.74E–03	
VL	PLUG	4.81E–01	25	1.20E–01	
VL	GLBE	9.13E–01	20	1.83E–01	
VL	NDLE	2.48E–02	0	0.00E+00	
	API Average:	3.98E–01	APCD Norm Ave:	4.31E–01	.331
Connection					
CN	FLFF	2.27E–02	35	7.95E–03	
CN	THRD	1.82E–02	35	6.37E–03	
CN	UNIN	1.22E–01	10	1.22E–02	
CN	ORIN	4.27E–01	10	4.27E–02	
CN	GASK	1.46E–03	10	1.46E–04	
	API Average:	1.18E–01	APCD Norm Ave:	6.94E–02	.063
Pump Seals					
SP	RERO	1.11E+00	20	2.22E–01	
SP	ROSH	1.41E+00	75	1.06E+00	
SP	MESL	5.69E–01	5	2.85E–02	
	API Average:	1.03E+00	APCD Norm Ave:	1.31E+00	1.01
Relief Valves					
SM	RELF	1.74E+00	100	1.74E+00	
	API Average:	1.74E+00	APCD Norm Ave:	1.74E+00	1.74