

SECTION 4.1

OIL & GAS PRODUCTION SUMPS AND PITS

(Updated - December 1993)

EMISSION INVENTORY SOURCE CATEGORY

Petroleum Production and Marketing/Oil and Gas Production

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTIONS

310-300-1600-0000 (81950) Oil Production Fugitive Losses - Sumps & Pits

METHODS AND SOURCES

This methodology is used to estimate the fugitive emissions of total organic gases (TOG) and photochemically reactive organic gases (ROG) from the **sumps and pits** used in oil production processes.

A **sump** is defined as an excavated lined or unlined pit in the ground that is used to separate oil, water, and sand for oil and gas production operations.¹ There are three types of sumps for which emissions are estimated. A primary production sump is a sump that receives a stream of oil and water directly from oil production wells and/or field gathering systems. There are no primary sumps operating in California. The primary sumps were converted to storage tanks or some other type of storage devices. Secondary production sumps receive waste water streams from one or more first stage separators (including 1st stage sumps and/or tanks), and the tertiary production sumps receive waste water streams from secondary separation processes (sumps or tanks) upstream of the sump. In most cases, there are only small amounts of oil present in the waste streams. In this methodology, sumps are classified as serving light oil or heavy oil. Light oil service sumps are those which contain crude oil having an API gravity of 30 or greater. Heavy oil service sumps are those which contain crude oil having API gravity less than 30.

The TOG emission factor for light crude sumps are based on test data collected by Rockwell in a report prepared for the American Petroleum Institute (API) entitled "Fugitive Hydrocarbon Emissions from Petroleum Production Operations".² Rockwell scientists performed field emissions tests on a number of oil field processes and components including sumps situated at

various locations across the state. From the results of these tests, Rockwell was able to calculate twenty-six TOG emission factors for various classifications of sumps.

The ROG emission factors for heavy crude were obtained from ARB tests conducted between 1983 and 1986.

From the Rockwell TOG emission factors, the ARB staff derived corresponding emission factors for ROG by using speciation profiles provided by Rockwell. For the 1991 inventory, the ARB staff used the ARB and Rockwell emission factors as follows:

Table I

SUMP TYPE	EMISSION FACTORS (lbs/sq ft-day) ROG
Heavy Crude ^a	
Primary	0.097
Secondary	0.013
Tertiary	0.006
Light Crude ^b	
Primary	0.142
Secondary	0.019
Tertiary	0.009

a results obtained from ARB testing between 1983-1986.

b Extrapolated from API/Rockwell and ARB test results.

Sump emissions can be calculated using the following equation:

$$\text{Emissions} = (\text{Sump Surface Area}) \times (\text{Emission Factor})$$

To obtain sump data for the 1991 inventory, the ARB staff contacted the districts known to have sumps within their jurisdiction.³ The data gathered were: sump area (sq ft), type of sump (Primary, Secondary, Tertiary) and the API gravity of the sump liquid. The Air Pollution Control Districts to respond were San Joaquin Valley Unified APCD, Santa Barbara County APCD and Ventura County APCD. From this data, and the emission factors listed above, the ROG emissions were estimated. To convert the ROG emission estimates to TOG emissions, the Fraction of Reactive Organic Gases (FROG) was used to back calculate the TOG emissions.

The emission estimates from other districts with sumps and pits were carried over from the previous year inventory.

Table II shows the total 1991 sump emissions broken down by county.

ASSUMPTIONS

1. The sump surface area is the entire liquid surface, not just that portion of the surface area in which a layer of oil is visible.
2. The emission data collected by Rockwell and ARB, and used for the development of the emission factors, are representative of California sump emissions.
3. If no values for API gravity were provided then it is assumed to be heavy oil.
4. If no values for surface area were provided then the device is assumed not to be a sump.
5. In the calculation of the emission factors for sumps, it is assumed that the emission factor is independent of temperature.
6. Emergency sumps were assumed to have zero emissions.

COMMENTS AND RECOMMENDATIONS

The emission factors for sumps were based upon field tests performed by Rockwell and the ARB. The tests were performed on sumps that contained heavy crudes, mixtures of heavy crudes and water, mixtures of light crudes and water, and wastewater only. Due to the confidentiality of the data, the locations of the test sites were not disclosed by Rockwell or API to the ARB. It is assumed by the ARB staff that the overall results from the emission tests performed by Rockwell and the ARB were representative of California sump emissions as a whole.

There has also been a discussion on the application of the emission factors themselves. When estimating the 1991 sump emissions, the ARB staff multiplied an emission factor by the entire surface area of each sump. Representatives of the Western States Petroleum Association (WSPA) have contended that an emission factor should only be applied to that area of a sump on which a layer of oil is visible. The ARB staff supports the methodology used for the 1991 inventory, "based on the reasoning that oil is present in the liquid mixture as it enters the sump and there is a gradual migration of oil to the sump surface so that a progressively larger percentage of the surface consists of oil molecules as one proceeds from the inlet of the sump to the point in the sump where all the surface molecules are oil molecules."⁴

CHANGES IN METHODOLOGY

No change in methodology.

DIFFERENCES BETWEEN 1987 AND 1991 EMISSION ESTIMATES

The 1991 emission inventory contains accurate sump data for the districts that reported sump information. The primary sumps were converted to storage tanks or some other storage device. Secondary and tertiary sumps are the only sumps reported in the 1991 inventory. Since statewide sump data are not complete, the trends in increasing, or decreasing, activity are unknown.

TEMPORAL ACTIVITY

The emissions from *sumps and pits* are the result of evaporation to the atmosphere. This annual activity occurs uniformly throughout the year. The emissions are independent of both daily and weekly activity. The source tests for sumps were conducted throughout the year and emission factors were developed. Therefore, even if the ambient temperature fluctuated significantly the emission factors still reflect the correct emissions.

SAMPLE CALCULATIONS

The following is a sample calculation for reactive organic gas (ROG) sump emissions for a hypothetical facility located in Kern County. The company reports the following sumps in use:

	<u>SUMP TYPE</u>	<u>SURFACE AREA (sq ft)</u>
1.	One Secondary Sump that contains Heavy Crude	500
2.	One Tertiary Sump that contains Light Crude	1,000

To calculate total facility sump ROG emissions, each sump's surface area is multiplied by the appropriate emission factor and the resulting numbers are total added together.

$$\begin{aligned} \text{Total Sump ROG Emissions} &= (1,000 \text{ sq ft}) \times (0.009 \text{ lbs/sq ft-day}) \\ &\quad + \\ &\quad (500 \text{ sq ft}) \times (0.013 \text{ lbs/sq ft-day}) \\ &= 15.5 \text{ lbs/day} \\ &= 0.00775 \text{ tons/day} \end{aligned}$$

Total county sump emissions are found simply by adding together the total facility sump emissions for each active source in the county.

ADDITIONAL CODES

SOURCE CATEGORY GROWTH AND CONTROL CODES

81950 Growth= 148, Control Code= 534

SOURCE CATEGORY POLLUTANT SPECIATION PROFILE CODES

81950 VOC= 537, PM= 331

SOURCE CATEGORY CODE REACTIVITY FACTORS

Not Available

REFERENCES

1. Mr. Alan Goodley, Air Resources Board, Sacramento, CA, attachments to the letter addressed to the Emission Inventory Technical Advisory Committee (April 30, 1982).
2. Eaton, W.S. et al., "Fugitive Hydrocarbon Emissions from Petroleum Production Operations," American Petroleum Institute, Rockwell International, March 1980.
3. APCD staff reports on sumps and pits (1993).
4. Mr. Alan Goodley, Air Resources Board, Sacramento, CA, letter addressed to the Emission Inventory Technical Advisory Committee (April 30, 1982)

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Table II
 1991 Area Source Emissions
 Activity: Oil & Gas Extraction
 Process: Petroleum & Related
 Entrainment: Process Loss
 Dimn: Primary/Secondary Operation Fugitive
 CES: 81950
 Process Rate Unit: Sq Ft Sump Area

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
NCC	MONTEREY	0	0.00	0.00	0.00	0.00	0.00
SC	LOS ANGELES	85315	26.30	0.00	0.00	0.00	0.00
	ORANGE	0	0.00	0.00	0.00	0.00	0.00
SCC	SAN LUIS OBISPO	12000	36.90	0.00	0.00	0.00	0.00
	SANTA BARBARA	81253	206.90	0.00	0.00	0.00	0.00
	VENTURA	69315	418.10	0.00	0.00	0.00	0.00
SJV	FRESNO	1131500	1799.40	0.00	0.00	0.00	0.00
	KERN	7878998	18195.80	0.00	0.00	0.00	0.00
	KINGS	9151	18.60	0.00	0.00	0.00	0.00
TOTAL		9267532	20702.00	0.00	0.00	0.00	0.00

Fraction of Reactive Organic Gases (FROG): .9120
 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
 Fraction of PM10 (FRPM10): .6100
 (PM10 Emissions = PM X FRPM10)