

Section 1.3 Reference no. 17

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Note: This is a reference cited in AP 42, *Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources*. AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

Reference 11

Natural Gas
Combustion

AP-42 Section 1.4
Reference Number
15

Emissions Assessment of Conventional Stationary Combustion Systems; Volume I. Gas- and Oil-fired Residential Heating Sources

by

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TABLE 19. FIELD DATA: GAS-FIRED RESIDENTIAL COMBUSTION SOURCES

Unit No.	Test No.	Cycle, on/off	Date of test	Rated input (10 ⁶ J/hr)	CO ₂ (%)	O ₂ (%)	CO (ppmv)*	Particulate emissions		NO _x emissions		Bacharach smoke number
								(mg/m ³)	(ng/J)	(ppmv)*	(ng/J)	
1	100	50/10	6/10/77	85	6.4	16.7	ND	0.46	0.55	53	31	-
1	127 [†]	-	3/13/78	85	9.3	9.7	1220	ND	ND	ND	ND	0-1
2	101	50/10	5/24/77	85	1.4	12.9	ND	0.40	0.26	11	6	-
2	128 [†]	-	3/13/78	85	7.9	11.3	0	ND	ND	ND	ND	0-1
3	102	50/10	5/26/77	85	3.0	19.5	ND	0.49	1.7	119	66	-
3	125 [†]	-	3/10/78	85	4.4	14.3	16	ND	ND	ND	ND	-
4	103	50/10	6/08/77	106	1.7	19.1	ND	0.64	1.7	66	33	-
4	126 [†]	-	3/17/78	106	5.7	11.6	0	ND	ND	ND	ND	0-1
5	104	50/10	6/14/77	79	1.1	16.8	ND	0.62	0.76	21	11	-
6	129 [†]	-	3/13/78	85	5.4	10.5	920	ND	ND	ND	ND	1
6	130	50/10	3/14/78	85	4.1	15.8	ND	ND	ND	ND	ND	-
6	131	10/20	3/15/78	85	3.5	14.3	ND	ND	ND	ND	ND	-

* ppmv values at 3 percent O₂.[†] Parameter check at exit from heat exchanger; other tests at stack exit.

ND - Not Determined.

TABLE 22. TOTAL ORGANIC EMISSIONS FROM GAS- AND OIL-FIRED RESIDENTIAL COMBUSTION SOURCES

Volatile Organics Analyzed in Field ($\mu\text{g}/\text{m}^3$)	Gas-fired sources							Oil-fired sources								
	100	101	102	103*	104	130	131	300	301	302	303	304	326-1	326-2	327-1	327-2
C ₁	LD	LD	LD	39,400	LD	LD	LD	9600	9720	2000	1800	2800	LD	LD	LD	LD
C ₂	LD	LD	LD	37,800	LD	LD	LD	1700	1900	400	LD	140	LD	LD	LD	LD
C ₃	LD	LD	LD	5,500	LD	LD	LD	LD	4400	LD	LD	LD	LD	LD	LD	LD
C ₄	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD
C ₅	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD
C ₆	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD
Volatile Organics Analyzed in Laboratory ($\mu\text{g}/\text{m}^3$)																
C ₇ (BP 90-110°C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C ₈ (BP 110-140°C)	< 10	< 10	ND	< 10	< 10	ND	ND	6	1	8	1	5	ND	ND	ND	ND
C ₉ (BP 140-160°C)	< 10	< 10	ND	< 10	< 10	ND	ND	5	3	9	15	7	ND	ND	ND	ND
C ₁₀ (BP 160-180°C)	1490	< 10	ND	770	1960	ND	ND	46	14	26	43	43	ND	ND	ND	ND
C ₁₁ (BP 180-200°C)	560	< 10	ND	600	2680	ND	ND	25	7	44	47	49	ND	ND	ND	ND
C ₁₂ (BP 200-220°C)	60	< 10	ND	< 10	370	ND	ND	1	33	45	65	81	ND	ND	ND	ND
C ₁₃ (BP 220-240°C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C ₁₄ (BP 240-260°C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C ₁₅ (BP 260-280°C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C ₁₆ (BP 280-300°C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C _{7-C₁₆} (BP 90-300°C)	ND	ND	ND	ND	ND	117	140	170	180	560	560	320	260	610	385	235
Nonvolatile Organics Analyzed in Laboratory ($\mu\text{g}/\text{m}^3$)																
> C ₁₆ (BP > 300°C)	400	1240	780	480	920	340	304	650	1800	420	1300	1210	1900	1200	370	620
Total Organics (mg/m ³)	2.5	1.2	0.8	1.9	5.9	0.5	0.4	12.1	11.0	2.8	3.7	9.3	2.2	1.8	0.7	0.9

* C₁-C₆ values not included in total.

+ 10/20 cycle; all other tests 50/10 cycle.

LD - Lower than detection limit; 100 to 1000 $\mu\text{g}/\text{m}^3$ for C₁-C₆; 1 $\mu\text{g}/\text{m}^3$ for C₇-C₁₆.

ND - Not determined.

TABLE 26. MEASURED EMISSION FACTORS FOR PARTICULATE, NO_x,
AND TOTAL ORGANICS

Combustion source type	Site No.	Pollutant (ng/J)		
		Particulate	NO _x	Total organics
Gas-fired sources	100	0.55	28	3.0
	101	0.26	6	1.5
	102	1.7	66	0.9
	103	1.7	53	2.3
	104	0.76	12	7.1
	130	ND	ND	0.5
	Mean $\bar{x}$	0.99	33	2.55
	s($\bar{x}$)	0.30	11.58	0.98
	ts($\bar{x}$)/ $\bar{x}$	0.83	0.97	0.99
Oil-fired sources	300	3.1	ND	16.2
	301	1.7	ND	15.4
	302	8.3	ND	11.7
	303	3.5	ND	5.1
	304	2.8	ND	13.4
	326-1	1.3	ND	1.7
	327-2	1.3	ND	0.7
	Mean $\bar{x}$	3.1	-	9.2
	s($\bar{x}$)	0.92	-	2.47
	ts($\bar{x}$)/ $\bar{x}$	0.72	-	0.66

ND - Not Determined.

Note: $\bar{x}$ - Mean, ng/J

s($\bar{x}$) - Standard error, ng/J

ts($\bar{x}$)/ $\bar{x}$ - Variability, percent/100

TABLE 27. COMPARISON OF CRITERIA POLLUTANT EMISSION FACTORS FOR GAS- AND OIL-FIRED RESIDENTIAL COMBUSTION SOURCES

Combustion source type	Data source*	Pollutant (ng/J)				
		Particulate	NO _x	SO ₂	CO	HC
Gas-fired sources	Test program	1.0	33	ND	ND	2.6
	Existing data	0.4	57	0.21	38	39
	Existing data ²	2.1	36	-	8	2.0
	EPA AP-42 ³	2 - 6	33	0.26	8.4	3.3
Oil-fired sources	Test program	3.1	ND	ND	ND	9.2
	Existing data	8	44	93	47 ⁺	10 ⁺
	EPA AP-42 ³	7.7	55	106	15	3

* The existing data base is discussed in Section 4.1.

⁺ Includes tests with excessively high HC and CO values; if these data are not included, HC and CO values are reduced to 2 and 17, respectively.

ND - Not Determined.

The concentrations of POM's found in the flue gas from oil-fired residential sources were two to three orders of magnitude below published MATE values, as shown in Table 31. Multiple source severity factors, based on maximum measured concentrations, were small (10^{-3} to 10^{-7}). POM emissions are not significant from the gas- and oil-fired residential combustion sources tested in this program.

TABLE 31. POM EMISSIONS AND SEVERITY FACTORS
FOR OIL-FIRED RESIDENTIAL SOURCES

Compound	Maximum measured stack concentration* ($\mu\text{g}/\text{m}^3$)	MATE value ($\mu\text{g}/\text{m}^3$)	Multiple source severity factor
Acenaphthene	9.3		
Acetonaphthone	2.3		
Anthracene	1.5	480	3.0×10^{-4}
Azulene or naphthalene	20	225,000	6.0×10^{-5}
Benzo(c)cinnoline	1.2		
Biphenyl	23	1,000	2×10^{-3}
Butyl phenanthrene	20		
Dimethyl naphthalene	6.0	225,000	1.5×10^{-5}
Dimethyl phenanthrene	0.4		
Ethyl naphthalene	23	225,000	6.5×10^{-5}
Fluorenone	8.9		
Methyl anthracene	2.4	480	4.5×10^{-4}
Methyl dibenzo thiophene	0.1	200,000	4×10^{-8}
Methyl naphthalene	15.4	225,000	4.5×10^{-5}
Methyl phenanthrene	0.2	30,000	7×10^{-7}
Octyl phenanthrene	3.7		
Phenanthrene	5.2	1,600	3.0×10^{-4}
Phenanthrene quinone	5.4		

* See Table 25 to identify sites of maximum emissions.