SECTION 7.14

STRUCTURE AND AUTOMOBILE FIRES

(Updated March 1999)

EMISSION INVENTORY SOURCE CATEGORY
Miscellaneous Processes/Fires

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION
660-656-0200-0000 (47324) Structure Fires

660-658-0200-0000 (57307) Automobile Fires

METHODS AND SOURCES

These categories are used to inventory the combustion emissions from structure, mobile home, and automobile fires. The ***Structure fires*** category includes residential and commercial structures as well as mobile home fires. The criteria pollutant emissions for 1996 are presented in Table II (***Structure Fires***) and Table III (***Automobile Fires***). Estimates of building, mobile home, and automobile fires in 1996 were based on data from an annual report generated by the California Fire Incident Reporting System (CFIRS). [1]

STRUCTURE FIRES

For structure fires, the average amount of structure and content material burned are first estimated. An average percent structural loss per fire was calculated by dividing the total monetary damage due to fires by the product of the average value of a residence in California and the number of structure fires.[2] The average loss per fire is estimated to be 7.3 percent. This estimate can be applied to structure loss and content loss.

Based on census data, the average size of existing homes in California is estimated to be 1,649 square feet. [3] The average residence has approximately 11,000 board feet of lumber in the structure, according to information provided by the National Association of Home Builders. [4]

ARB staff assumed an average of one ton of material per 1,000 board feet. Therefore, an average residence has approximately 11 tons of combustible material. Assuming a rate loss of 7.3 percent, the structure loss is estimated to be 0.80 tons per fire.

Next, the amount of content material burned is estimated. The National Bureau of Standards lists the combustible contents per square foot of the functional areas of the average home. [5] These figures are then multiplied by the percent of fires estimated to originate within each of these functional areas, [1] and the products are then added to obtain the weighted average of 7.91 pounds per square foot.

Functional Area	Origin of fires(%)	Combustibles (lbs/sq. ft.)	Weighted Average (lbs/sq. ft.)
Bedroom	28.96	10.4	3.012
Sleeping Area	0.20	10.4	0.021
Dining Area	2.20	7.2	0.159
Kitchen	53.92	6.8	3.667
Bathroom	6.32	7.0	0.443
Laundry	8.08	7.2	0.582
Office	0.17	7.9	0.013
Other	0.13	9.6	0.012
			7.909

With a 7.3 percent loss rate, an average of 7.91 pounds of combustible contents per square foot, and assuming an average floor space of 1649 square feet, the content loss for the average residential fire would be:

$$[(1649) \times (0.073) \times (7.91)] / 2000 = 0.48 \text{ tons/fire}$$

Total amount burned per residential fire (fuel loading) = structure loss + content loss
= 0.80 + 0.48
= 1.28 tons/fire

Structure fire emission factors in pounds per ton of material burned for TOG, CO and PM have been obtained from tests on the burning of model wood buildings. [6] The emission factor for NOx is assumed to be similar to that listed in AP-42 for municipal refuse. [7] These emission factors have been converted to units of pounds per fire using the factor of 1.28 tons/fire.

Emission Factors for Structural Fires

	TOG	CO	NOx	SOx	PM
Pounds/Ton	13.9	168.0	4.0	0	10.8
Pounds/Fire	17.8	215.0	5.1	0	13.8

CFIRS structure fires data is available on the county level. For those instances where an air basin splits a county, emissions estimates are apportioned based on total housing

units as estimated by the California Department of Finance (DOF).

AUTOMOBILE FIRES

The emission factors for automobile fires are taken from AP-42, Sections 2.2.2 and 2.4.2. Table 2.2-1 of AP-42 lists the emission factors for uncontrolled auto body incineration. These are based on automobiles that have been partially stripped (tires, seats, etc. removed). Table 2.4-1 of AP-42 lists the emission factors for open burning of automobile components. These emission factors are for upholstery, belts, hoses, and tires burned in common.

It has been assumed that tires are burned in 60 percent of the automobile fires. Composite emission factors have been calculated as a weighted average of the emission factors listed in Table 2.2-1 and 2.4-1 of AP-42. It has been assumed that the average car body weighs 3,700 pounds and the components weigh 500 pounds. The composite emission factors are listed below. Their derivation is presented in Table I.

Emission Factors for Automobile Fires (lbs/fire)

TOG	CO	NOx	SOx	PM
7.21	21.25	0.7	0	17

For automobile fires, sub-county splits between air basins are based on population estimates from DOF.

ASSUMPTIONS

1. The emission factors that have been derived for structure fires are also valid for mobile home fires.

2. An average residence is constructed with approximately 11 tons of combustible material.

3. An average residence covers an area of 1,649 square fee.

4. The tires are burned in 60 percent of the automobile fires.

5. The average car body weighs 3,700 pounds.

6. The components on an average car weigh 500 pounds.

7. The estimates of structural loss rate (7.3%) and content loss rate (7.91 lb/sq. ft.) continue to be applicable.

COMMENTS AND RECOMMENDATIONS

Emission factors for mobile home and commercial structure fires may be significantly different from those for residential fires. Little data are available; therefore, the emission factors for mobile home fires and commercial structure fires are assumed to be the same as for residential structure fires. The emission factors for oxides of nitrogen, which are actually for open burning of municipal refuse, may not be the best estimate for structure fires.

A more accurate estimate of the percentage of cars that burn completely (tires included) needs to be determined, since most emissions are associated with automobile component and tire combustion.

CHANGES IN METHODOLOGY

The estimate of the average size of a residence in California has been increased based on census data. This increase resulted in a larger estimate of the amount of material burned per fire (fuel loading). As a result, emission factors in pounds of pollutant per fire have also been increased.

Emission estimates have been adjusted to account for the newly formed Salton Sea Air Basin.

DIFFERENCES BETWEEN 1995 AND 1996 EMISSION ESTIMATES

The differences between the 1995 and 1996 emission estimates for structure fires and automobile fires are primarily due to the difference in the numbers of fire incidents. Increases in emission factors have also affected emission estimates.

TEMPORAL ACTIVITY

For both categories, the annual activity and the weekly activity are uniform. The daily activity occurs primarily during daylight hours.

SAMPLE CALCULATIONS

To calculate the emissions from ***Structural Fires*** (CES 47324), and ***Automobile Fires*** (CES 57307) for Sacramento County in the Sacramento Valley air basin:

Number of ***Structural Fires*** = 1,546
Number of ***Automobile Fires*** = 1,877

Emissions = [Process Rate (# of Fires)] x (Emission Factor) / 2000 lbs/ton

The process rate and emissions for Sacramento County are summarized below:

Type of Fires	Process Rate (# of Fires)	Emissions (tons/yr) TOG	CO	NOx	SOx	PM
Structural Fires	1,546	13.7	166.2	3.94	0	10.7
Automobile Fires	1,877	6.8	19.9	0.66	0	16.0

REFERENCES

1. California State Fire Marshall, California Fire Incident Reporting System, 1996.

2. California State Fire Marshall, California Fire Incident Reporting System, 1991.

3. Sue Lord, American Housing Survey Branch, Census Bureau, 1999.

4. National Association of House Builders, http://www.nahb.com/mub.html.

5. National Bureau of Standards, Combustible Contents in Buildings.

6. Butler, C.P. and Darley, E.E. "Fires Dynamics of Model Wood Buildings," Fire and Flammability, Vol. 3, p. 336 (October 1972).

7. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, AP-42, Section 2.2 and 2.4. (April 1973).

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Table I

Derivation of Emission Factors for Automobile Fires

The emission factors for uncontrolled auto body incineration (Table 2.6-1 of AP-42, 1/95) are:

Emission Factors for Auto Body (lbs/car)

TOG	CO	NOx	SOx	PM
0.91	2.5	0.1	0	2.0

The emission factors for automobile components (Table 2.5-1 of AP-42), including upholstery, belts, hoses and tires, are listed in terms of lbs/ton of components burned and must be multiplied by the weight of components per car. If the components per car are assumed to be 500 lbs, the emission factors for components in terms of lbs/car can be converted as show below.

Weight of components = 500 lbs/car
= 0.25 tons/car

PM emission factor = (100 lbs/ton components) x (0.25 tons components/car)
= 25 lbs/car

Emission Factors for Components (lbs/car)

TOG	CO	NOx	SOx	PM
10.5	31.25	1.0	0	25

Composite emission factors, assuming that tires are burned in 60% of automobile fires, were calculated as follows:

Composite EF = [EF (body) + EF (components)] x 0.6 + [EF (body)] x 0.4

The weighted composite emission factors are listed below:

Composite Emission Factors (lbs/fire)

TOG	CO	NOx	SOx	PM
7.21	21.25	0.7	0	17.0

Table II
1996 Area Source Emissions
Activity: Unspecified Activities
Process: Structure Fires
Entrainment: Solid Material Combustion
Dimn:
CES: 47324
Process Rate Unit: Fires

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	1	0.01	0.16	0.00	0.00	0.01
	INYO	2	0.03	0.33	0.01	0.00	0.02
	MONO	0	0.00	0.00	0.00	0.00	0.00
LC	LAKE	44	0.60	7.21	0.17	0.00	0.46
LT	EL DORADO	17	0.23	2.78	0.07	0.00	0.18
	PLACER	2	0.03	0.33	0.01	0.00	0.02
MC	AMADOR	9	0.12	1.47	0.04	0.00	0.09
	CALAVERAS	30	0.41	4.91	0.12	0.00	0.32
	EL DORADO	62	0.84	10.16	0.24	0.00	0.65
	MARIPOSA	52	0.70	8.52	0.20	0.00	0.55
	NEVADA	50	0.68	8.19	0.20	0.00	0.53
	PLACER	8	0.11	1.31	0.03	0.00	0.08
	PLUMAS	3	0.04	0.49	0.01	0.00	0.03
	SIERRA	0	0.00	0.00	0.00	0.00	0.00
	TUOLUMNE	90	1.22	14.74	0.35	0.00	0.95
MOJ	KERN	92	1.25	15.07	0.36	0.00	0.97
	LOS ANGELES	169	2.29	27.68	0.66	0.00	1.78
	RIVERSIDE	17	0.23	2.78	0.07	0.00	0.18
	SAN BERNARDINO	355	4.81	58.15	1.38	0.00	3.75
NC	DEL NORTE	29	0.39	4.75	0.11	0.00	0.31
	HUMBOLDT	58	0.79	9.50	0.23	0.00	0.61
	MENDOCINO	74	1.00	12.12	0.29	0.00	0.78
	SONOMA	173	2.34	28.34	0.67	0.00	1.83
	TRINITY	1	0.01	0.16	0.00	0.00	0.01
NCC	MONTEREY	197	2.67	32.27	0.77	0.00	2.08
	SAN BENITO	25	0.34	4.10	0.10	0.00	0.26
	SANTA CRUZ	162	2.20	26.54	0.63	0.00	1.71
NEP	LASSEN	13	0.18	2.13	0.05	0.00	0.14
	MODOC	2	0.03	0.33	0.01	0.00	0.02
	SISKIYOU	8	0.11	1.31	0.03	0.00	0.08
SC	LOS ANGELES	5119	69.36	838.49	19.96	0.00	54.01
	ORANGE	1470	19.92	240.79	5.73	0.00	15.51
	RIVERSIDE	755	10.23	123.67	2.94	0.00	7.97
	SAN BERNARDINO	1169	15.84	191.48	4.56	0.00	12.33
SCC	SAN LUIS OBISPO	143	1.94	23.42	0.56	0.00	1.51
	SANTA BARBARA	152	2.06	24.90	0.59	0.00	1.60
	VENTURA	7	0.09	1.15	0.03	0.00	0.07
SD	SAN DIEGO	1813	24.57	296.97	7.07	0.00	19.13
SF	ALAMEDA	236	3.20	38.66	0.92	0.00	2.49
	CONTRA COSTA	961	13.02	157.41	3.75	0.00	10.14
	MARIN	201	2.72	32.92	0.78	0.00	2.12
	NAPA	205	2.78	33.58	0.80	0.00	2.16
	SAN FRANCISCO	408	5.53	66.83	1.59	0.00	4.30
	SAN MATEO	346	4.69	56.67	1.35	0.00	3.65
	SANTA CLARA	661	8.96	108.27	2.58	0.00	6.97
	SOLANO	3	0.04	0.49	0.01	0.00	0.03
	SONOMA	152	2.06	24.90	0.59	0.00	1.60
SJV	FRESNO	1310	17.75	214.58	5.11	0.00	13.82
	KERN	400	5.42	65.52	1.56	0.00	4.22
	KINGS	146	1.98	23.91	0.57	0.00	1.54
	MADERA	143	1.94	23.42	0.56	0.00	1.51
	MERCED	209	2.83	34.23	0.82	0.00	2.20
	SAN JOAQUIN	192	2.60	31.45	0.75	0.00	2.03
	STANISLAUS	482	6.53	78.95	1.88	0.00	5.09
	TULARE	592	8.02	96.97	2.31	0.00	6.25
SS	IMPERAIL	82	1.11	13.43	0.32	0.00	0.87
	RIVERSIDE	187	2.53	30.63	0.73	0.00	1.97
SV	BUTTE	356	4.82	58.31	1.39	0.00	3.76
	COLUSA	1	0.01	0.16	0.00	0.00	0.01
	GLENN	4	0.05	0.66	0.02	0.00	0.04
	PLACER	39	0.53	6.39	0.15	0.00	0.41
	SACRAMENTO	1184	16.04	193.94	4.62	0.00	12.49
	SHASTA	293	3.97	47.99	1.14	0.00	3.09
	SOLANO	2	0.03	0.33	0.01	0.00	0.02
	SUTTER	43	0.58	7.04	0.17	0.00	0.45
	TEHAMA	102	1.38	16.71	0.40	0.00	1.08
	YOLO	124	1.68	20.31	0.48	0.00	1.31
	YUBA	29	0.39	4.75	0.11	0.00	0.31
TOTAL		21466	290.86	3516.11	83.72	0.00	226.46

Fraction of Reactive Organic Gases (FROG): .7500 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
Fraction of PM10 (FRPM10): .9800 (PM10 Emissions = PM X FRPM10)

Table III
1996 Area Source Emissions
Activity: Unspecified Activities
Process: Unplanned Fires
Entrainment: Solid Material Combustion
Dimn: Auto Body
CES: 57307
Process Rate Unit: Autos Burned

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	0	0.00	0.00	0.00	0.00	0.00
	INYO	7	0.03	0.07	0.00	0.00	0.06
	MONO	1	0.00	0.01	0.00	0.00	0.01
LC	LAKE	38	0.14	0.40	0.01	0.00	0.32
LT	EL DORADO	8	0.03	0.09	0.00	0.00	0.07
	PLACER	3	0.01	0.03	0.00	0.00	0.03
MC	AMADOR	20	0.07	0.21	0.01	0.00	0.17
	CALAVERAS	37	0.13	0.39	0.01	0.00	0.31
	EL DORADO	30	0.11	0.32	0.01	0.00	0.26
	MARIPOSA	24	0.09	0.26	0.01	0.00	0.20
	NEVADA	36	0.13	0.38	0.01	0.00	0.31
	PLACER	13	0.05	0.14	0.00	0.00	0.11
	PLUMAS	1	0.00	0.01	0.00	0.00	0.01
	SIERRA	0	0.00	0.00	0.00	0.00	0.00
	TUOLUMNE	87	0.31	0.92	0.03	0.00	0.74
MOJ	KERN	83	0.30	0.88	0.03	0.00	0.71
	LOS ANGELES	259	0.93	2.75	0.09	0.00	2.20
	RIVERSIDE	22	0.08	0.23	0.01	0.00	0.19
	SAN BERNARDINO	405	1.46	4.30	0.14	0.00	3.44
NC	DEL NORTE	8	0.03	0.09	0.00	0.00	0.07
	HUMBOLDT	38	0.14	0.40	0.01	0.00	0.32
	MENDOCINO	44	0.16	0.47	0.02	0.00	0.37
	SONOMA	13	0.05	0.14	0.00	0.00	0.11
	TRINITY	3	0.01	0.03	0.00	0.00	0.03
NCC	MONTEREY	181	0.65	1.92	0.06	0.00	1.54
	SAN BENITO	28	0.10	0.30	0.01	0.00	0.24
	SANTA CRUZ	132	0.48	1.40	0.05	0.00	1.12
NEP	LASSEN	6	0.02	0.06	0.00	0.00	0.05
	MODOC	1	0.00	0.01	0.00	0.00	0.01
	SISKIYOU	17	0.06	0.18	0.01	0.00	0.14
SC	LOS ANGELES	7826	28.21	83.15	2.74	0.00	66.52
	ORANGE	1645	5.93	17.48	0.58	0.00	13.98
	RIVERSIDE	963	3.47	10.23	0.34	0.00	8.19
	SAN BERNARDINO	1335	4.81	14.18	0.47	0.00	11.35
SCC	SAN LUIS OBISPO	142	0.51	1.51	0.05	0.00	1.21
	SANTA BARBARA	104	0.37	1.11	0.04	0.00	0.88
	VENTURA	5	0.02	0.05	0.00	0.00	0.04
SD	SAN DIEGO	2189	7.89	23.26	0.77	0.00	18.61
SF	ALAMEDA	292	1.05	3.10	0.10	0.00	2.48
	CONTRA COSTA	872	3.14	9.27	0.31	0.00	7.41
	MARIN	112	0.40	1.19	0.04	0.00	0.95
	NAPA	153	0.55	1.63	0.05	0.00	1.30
	SAN FRANCISCO	196	0.71	2.08	0.07	0.00	1.67
	SAN MATEO	245	0.88	2.60	0.09	0.00	2.08
	SANTA CLARA	837	3.02	8.89	0.29	0.00	7.11
	SOLANO	6	0.02	0.06	0.00	0.00	0.05
	SONOMA	93	0.34	0.99	0.03	0.00	0.79
SJV	FRESNO	1485	5.35	15.78	0.52	0.00	12.62
	KERN	359	1.29	3.81	0.13	0.00	3.05
	KINGS	157	0.57	1.67	0.05	0.00	1.33
	MADERA	210	0.76	2.23	0.07	0.00	1.79
	MERCED	281	1.01	2.99	0.10	0.00	2.39
	SAN JOAQUIN	117	0.42	1.24	0.04	0.00	0.99
	STANISLAUS	388	1.40	4.12	0.14	0.00	3.30
	TULARE	690	2.49	7.33	0.24	0.00	5.87
SS	IMPERIAL	63	0.23	0.67	0.02	0.00	0.54
	RIVERSIDE	238	0.86	2.53	0.08	0.00	2.02
SV	BUTTE	256	0.92	2.72	0.09	0.00	2.18
	COLUSA	1	0.00	0.01	0.00	0.00	0.01
	GLENN	7	0.03	0.07	0.00	0.00	0.06
	PLACER	66	0.24	0.70	0.02	0.00	0.56
	SACRAMENTO	1148	4.14	12.20	0.40	0.00	9.76
	SHASTA	226	0.81	2.40	0.08	0.00	1.92
	SOLANO	3	0.01	0.03	0.00	0.00	0.03
	SUTTER	32	0.12	0.34	0.01	0.00	0.27
	TEHAMA	106	0.38	1.13	0.04	0.00	0.90
	YOLO	129	0.47	1.37	0.05	0.00	1.10
	YUBA	24	0.09	0.26	0.01	0.00	0.20
TOTAL		24546	88.48	260.77	8.58	0.00	208.65

Fraction of Reactive Organic Gases (FROG): 0.7500 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
Fraction of PM10 (FRPM10): 0.9970 (PM10 Emissions = PM X FRPM10)